DOE/EIS - 0286F

Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement Richland, Washington

Volume II
Appendixes A through O

U.S. Department of Energy
Richland Operations Office
Richland, Washington

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Cover Photographs:

1. Hanford workers preparing to retrieve and repackage TRU waste drums
2. Drums of transuranic waste in a retrievable storage trench
3. A partial aerial view of Hanford's Low Level Burial Grounds
4. Waste Receiving and Processing Facility inspection and repackaging glove boxes
5. Hanford's Mixed Low-Level Waste disposal facility
6. Placing TRU waste into a TRUPACT shipping container for shipment to the Waste Isolation Pilot Plant

RESPONSIBLE AGENCY: **COVER SHEET**

U.S. Department of Energy, Richland Operations Office

TITLE:

Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Benton County, Washington (DOE/EIS-0286F)

CONTACT:

For further information on this document, write or call:

Mr. Michael S. Collins
HSW EIS Document Manager
Richland Operations Office
U.S. Department of Energy, A6-38
P.O. Box 550
Richland, Washington 99352-0550
Telephone: (509) 376-6536
Fax: (509) 372-1926
Email: hsweis@rl.gov

For further information on the Department's National Environmental Policy Act (NEPA) process, contact:

Ms. Carol M. Borgstrom, Director
Office of NEPA Policy and Compliance, EH-42
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington, D.C. 20585
Telephone: (202) 586-4600
Voice Mail: (800) 472-2756

ABSTRACT:

The Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement (HSW EIS) provides environmental and technical information concerning U.S. Department of Energy (DOE) proposed waste management practices at the Hanford Site. The HSW EIS updates analyses of environmental consequences from previous documents and provides evaluations for activities that may be implemented consistent with the Waste Management Programmatic Environmental Impact Statement (WM PEIS) Records of Decision (RODs). Waste types considered in the HSW EIS include operational low-level radioactive waste (LLW), mixed low-level waste (MLLW), immobilized low-activity waste (ILAW), and transuranic (TRU) waste (including TRU mixed waste). MLLW contains chemically hazardous components in addition to radionuclides. Alternatives for management of these wastes at the Hanford Site, including the alternative of No Action, are analyzed in detail. The LLW, MLLW, and TRU waste alternatives are evaluated for a range of waste volumes, representing quantities of waste that could be managed at the Hanford Site. A single maximum forecast volume is evaluated for ILAW. The No Action Alternative considers continuation of ongoing waste management practices at the Hanford Site and ceasing some operations when the limits of existing capabilities are reached. The No Action Alternative provides for continued storage of some waste types. The other alternatives evaluate expanded waste management practices including treatment and disposal of most wastes. The potential environmental consequences of the alternatives are generally similar. The major differences occur with respect to the consequences of disposal versus continued storage and with respect to the range of waste volumes managed under the alternatives. DOE's preferred alternative is to dispose of LLW, MLLW, and ILAW in a single, modular, lined facility near PUREX on Hanford's Central Plateau; to treat MLLW using a combination of onsite and offsite facilities; and to certify TRU waste onsite using a combination of existing, upgraded, and mobile facilities. DOE issued the Notice of Intent to prepare the HSW EIS on October 27, 1997, and held public meetings during the scoping period that extended through January 30, 1998. In April 2002, DOE issued the initial draft of the EIS. During the public comment period that extended from May through August 2002, DOE received numerous comments from regulators, tribal nations, and other stakeholders. In March 2003, DOE issued a revised draft of the HSW EIS to address those comments, and to incorporate disposal of ILAW and other alternatives that had been under consideration since the first draft was published. Comments on the revised draft were received from April 11 through June 11, 2003. This final EIS responds to comments on the revised draft and includes updated analyses to incorporate information developed since the revised draft was published. DOE will publish the ROD(s) in the *Federal Register* no sooner than 30 days after publication of the Environmental Protection Agency's Notice of Availability of the final HSW EIS.

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Public Scoping and Review Comments and DOE Responses

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Public Scoping and Review Comments and DOE Responses

The Council on Environmental Quality (CEQ) regulations for implementing the National Environmental Policy Act (NEPA) (42 USC 4321) state “there shall be an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action. This process shall be termed scoping” (40 CFR 1501.7). The principal purpose of scoping is to determine the “range of actions, alternatives, and impacts to be considered in an Environmental Impact Statement (EIS)” (40 CFR 1508.25).

This appendix presents a summary of the scoping comments and responses for 1) the *Immobilized Low-Activity Waste Disposal Supplemental Environmental Impact Statement* (ILAW SEIS) in Part 1, and 2) the *Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement* (HSW EIS) in Part 2, because the proposed ILAW SEIS was subsequently merged with the HSW EIS.

Part 1—Public Scoping Comments and Responses for the ILAW SEIS

Following the Notice of Intent (67 FR 45104) to prepare the ILAW SEIS, the U.S. Department of Energy (DOE) held a scoping meeting in Richland, Washington, on August 20, 2002. During scoping, meetings were held with tribal nations, organizations, and agencies; written comments were received from nine of those entities.

The scoping comments and questions centered on several major themes:

- requests for technical information and clarification
- ILAW disposal alternatives
- long-term performance, mitigation, and stewardship
- ILAW waste form and treatment alternatives
- cumulative impacts
- regulatory and NEPA issues
- waste classification, definition of ILAW and high-level waste (HLW)
- other impacts and analyses
- relationship to this HSW EIS and other NEPA documents
- public involvement process

- relationship to current DOE cleanup plans
- opposition to disposal or storage of ILAW at Hanford.

After the end of scoping for the ILAW disposal SEIS, DOE decided to combine that proposed SEIS with the HSW EIS, which was subsequently issued as a revised draft to provide an opportunity for public comment. This HSW EIS provides a NEPA review for ILAW disposal in addition to Hanford Solid Waste (HSW) Program operations evaluated in the first and revised drafts of the HSW EIS. Individuals, organizations, and agencies commenting on the scoping phase of the ILAW SEIS are listed in Table A.1. The scoping comments and questions regarding the ILAW disposal SEIS and DOE responses to those comments are summarized in Table A.2.

Table A.1. Individuals, Organizations, and Agencies that Commented on the Scoping Phase of the ILAW SEIS

Name	Organization
Public Scoping Meeting, Richland – August 20, 2002	
Allyn Boldt	Private citizen
Don Clark	Private citizen
Gordon Rogers	Private citizen
Dick Schmidt	Private citizen
Seattle Briefing – August 22, 2002	
Tom Carpenter	Government Accountability Project, West Coast Office
Ashley Evans	Government Accountability Project, West Coast Office
Clare Gilbert	Government Accountability Project, West Coast Office
Dave Johnson	Private citizen
Hyun Lee	Heart of America Northwest
Ruth Yarrow	Private citizen
Portland Briefing – September 3, 2002	
Doug Huston	Oregon Office of Energy
Doug Riggs	Private citizen
Written Comments	
Tom Carpenter, Ashley Evans, Clare Gilbert	Government Accountability Project, West Coast Office –August 26, 2002
Suzanne Dahl and Michael Wilson	Washington State Department of Ecology – August 23, 2002
Glenn Eades	The Mountaineers, president – August 12, 2002
Paige Knight	Hanford Watch – August 15, 2002
Doug Huston and Ken Niles	Oregon Office of Energy – August 30, 2002
Hyun S. Lee	Heart of America – August 26, 2002
Richard Tripp	Private citizen
Harry Smiskin	Confederated Tribes and Bands of the Yakama Nation, administrator – September 26, 2002
Gordon Smith	Private citizen – August 11, 2002

Table A.2. ILAW Disposal SEIS – Public Scoping Comments and Responses

Name or Organization	Comment/Statement/Question/Concern	Response
1. Technical/General		
Richard K. Tripp, 8806 W. Grande Ronde Ave., Kennewick, WA 99336-1091, letter	ILAW trenches should be fenced in with permanent signs attached to them identifying the trenches. Should be maintained and replaced when needed over a very long time.	A number of technical comments across a range of topics were received during the scoping meetings, including institutional controls (fences and signs), waste inventories, waste disposal approaches, etc. The U.S. Department of Energy (DOE) has considered these comments and the HSW EIS addresses these issues, as appropriate. The evaluation of immobilized low-activity waste (ILAW) disposal incorporates the latest available and referenceable data (e.g., best basis inventory, current waste loading plans, ILAW Performance Assessment, etc.). It includes the disposal of all ILAW from tank waste treatment. DOE recently announced its intent to prepare a follow-on EIS (Environmental Impact Statement for Retrieval, Treatment, and Disposal of Tank Waste and Closure of Single-Shell Tanks at the Hanford Site, Richland, Washington [DOE/EIS-0356]) to the Tank Waste Remediation System (TWRS) EIS for retrieval, treatment, and disposal of Hanford tank waste, and for closure of 149 single-shell tanks (68 FR 1052). That EIS would evaluate alternative treatment processes for some tank waste and disposal of low-activity waste forms other than the vitrified ILAW considered in this HSW EIS.
Richard K. Tripp, 8806 W. Grande Ronde Ave., Kennewick, WA 99336-1091, letter	Will leachate be contained in such a way to prevent it from percolating up to the surface? Is the only thing between the leachate and the air the earth closure cap?	
Public scoping meeting in Richland, August 20, 2002, Questions and concerns	The volume of the ILAW	
Public scoping meeting in Richland, August 20, 2002, Public comments	Dick Schmidt, Office of Sustainable Development for the City of Portland, Oregon - Proposes using cathode ray tubes from computer monitors and televisions as frit for making the glass rather than mining natural resources and therefore reducing the unavoidable adverse impacts and potential irreversible and irretrievable commitment of resources.	
Public scoping meeting in Richland, August 20, 2002, Public comments	Allyn Boldt, retired Hanford worker and Kennewick resident – Address all of the waste and not just Phase I.	
Public scoping meeting in Richland, August 20, 2002, Public comments	Allyn Boldt, retired Hanford worker and Kennewick resident – Use the 2002 Best Bases Inventory.	
Public scoping meeting in Richland, August 20, 2002, Public comments	Allyn Boldt, retired Hanford worker and Kennewick resident – Don't base analysis in the SEIS on the SA3 because the SA3 data is out of date.	
Seattle briefing, August 22, 2002	Clare Gilbert asked for clarification between storage and disposal.	

Table A.2. (contd)

Name or Organization	Comment/Statement/Question/Concern	Response
Seattle briefing, August 22, 2002	Tom Carpenter wanted to know what fraction of the waste was ILAW.	
Seattle briefing, August 22, 2002	Hyun Lee commented on the carbon tetra chloride and solid wastes that are already in the ground in the 200 West Area and is concerned about placing additional ILAW in the ground.	
Seattle briefing, August 22, 2002	Tom Carpenter wanted to know what the curie difference in the LAW would be when it is vitrified compared to 500 years from now.	
Seattle briefing, August 22, 2002	Tom Carpenter wanted to know who has jurisdiction over the MUSTs.	
Seattle briefing, August 22, 2002	Hyun Lee requested a chart or matrix be made that shows where ILAW fits in the tank farm and WTP operations, including a time line.	
Seattle briefing, August 22, 2002	Dave Johnson asked about chemical constituents in the waste.	
Seattle briefing, August 22, 2002	Ruth Yarrow requested that curies be shown as well as volume when discussing tank waste.	
Portland briefing, September 3, 2002	Doug Riggs asked what is the half-life of LAW?	
Portland briefing, September 3, 2002	Doug Huston asked what the radiation per canister would be.	
Paige Knight, Hanford Watch, letter, August 15, 2002	Please include the kinds and longevity of radionuclides and chemicals.	
Tom Carpenter, Ashley Evans, and Clare Gilbert, Government Accountability Project, West Coast Office, letter, August 26, 2002	There have been major new discoveries at the Hanford Site since 1997 (when the TWRS EIS was issued) which affect greatly the plan to dispose of vitrified tank waste in the 200 Area burial grounds. These include the discovery of technetium-99 seeping into the groundwater from tank leaks.	
Tom Carpenter, Ashley Evans, and Clare Gilbert, Government Accountability Project, West Coast Office, letter, August 26, 2002	DOE must analyze the possibility that in order to vitrify the tank waste, the waste loading would have to be reduced to extremely low levels. This could increase greatly the volume of vitrified waste disposed of at Hanford.	

Table A.2. (contd)

Name or Organization	Comment/Statement/Question/Concern	Response
Tom Carpenter, Ashley Evans, and Clare Gilbert, Government Accountability Project, West Coast Office, letter, August 26, 2002	The possibility of terrorist attacks on the trenches housing the low-activity waste must be considered in the SEIS.	
Oregon Office of Energy, Formal comments, August 30, 2002	This SEIS should present the long-range plan showing key actions and annual progress anticipated for this project along with the funding requirements for this project for the duration of the tank waste treatment schedule. The budgeting information should include monitoring costs and be presented in FY 2003 dollars, as escalated dollars, and as net present value dollars to provide a clear analysis of future costs.	
The Mountaineers, Glenn Eades, President, letter, August 12, 2002	Issues and Concerns: Illegal practices by increasing contractor “self assessment” and reducing federal oversight for safety and health.	
2. Opposed to Onsite Storage or Disposal of Solid Waste at Hanford		
Gordon Smith 8029 Meridian N. Seattle, WA 98103, letter, August 11, 2002	No more storage of any sort on this site on the edge of the Columbia River ecosystem.	DOE acknowledges that there is some opposition to onsite storage/ disposal of ILAW but is proceeding based on decisions derived from environmental impact analysis conducted under the Final TWRS EIS (DOE and Ecology 1996). After consultation with the U.S. Nuclear Regulatory Commission (NRC), DOE determined that LAW is appropriate for disposal at Hanford (see HSW EIS, Volume I, Section 1). The HSW EIS evaluates waste management options for the disposal of ILAW at Hanford. The HSW EIS considers a No Action Alternative that evaluates retrievable disposal of ILAW in vaults. The EIS also considers other alternatives for disposal of ILAW (see HSW EIS, Volume I, Section 3).
Seattle briefing, August 22, 2002	Tom Carpenter was concerned that LAW was still HLW and as long as DOE did not dispose of it on site it would be ok.	
Seattle briefing, August 22, 2002	Tom Carpenter said he had no problem with long-term storage of the ILAW but was not in agreement with disposal of ILAW on the Hanford Site. ORP should keep their options open for ILAW storage versus disposal.	

Table A.2. (contd)

Name or Organization	Comment/Statement/Question/Concern	Response
3. Immobilized Low-Activity Waste Form and Treatment Alternatives		
Gordon Smith 8029 Meridian N. Seattle, WA 98103 letter, August 11, 2002	Strongly favors cullet size vitrification because it is easier and safer to process.	The TWRS EIS evaluated waste treatment options and decided it was feasible to vitrify tank waste. DOE has published a Notice of Intent (68 FR 1052) regarding the Tank Waste Retrieval and Closure EIS to evaluate alternative waste forms and supplemental treatment technologies. This HSW EIS focuses on the disposal of vitrified ILAW (cullet and monolithic forms). For the purposes of analysis in this EIS the treated waste form is assumed to be glass, or another waste form having equivalent long-term performance. The HSW EIS provides explanation of the technical, environmental, and financial criteria, uncertainties, and cumulative impacts for the alternatives associated with the proposed action and related alternatives for disposal of ILAW and melters evaluated in the EIS.
Public scoping meeting in Richland, August 20, 2002, Questions and concerns	Will there be a statement in the SEIS about a future alternative waste treatment?	
Public scoping meeting in Richland, August 20, 2002, Questions and concerns	We should only address glass in the SEIS and not make any statement about the future.	
Public scoping meeting in Richland, August 20, 2002, Public comments	Allyn Boldt, retired Hanford worker and Kennewick resident – Keep the option for cullet or monolith in the SEIS in case the monolith form becomes a handling problem during production.	
Seattle briefing, August 22, 2002	Ashley Evans inquired about the practicality of vitrifying tank waste and whether it was technically achievable.	
Seattle briefing, August 22, 2002	Ruth Yarrow was concerned about Jessie Roberson's statement about vitrifying 10% of the waste and using other technologies to stabilize the remaining 90%.	
Portland briefing, September 3, 2002	Doug Riggs stated he was glad that the SEIS continues with the intent to treat the low-activity waste by turning it into glass. He believes it is beneficial that DOE remains open to considering other options to supplemental vitrification if it meets the current standards for treatment and disposal. The presentation explained why the monolith form is proposed and this makes sense. Doug Riggs requested that the draft SEIS include clear explanations on the technical, environmental, and financial criteria for the alternatives.	

Table A.2. (contd)

Name or Organization	Comment/Statement/Question/Concern	Response
Portland briefing, September 3, 2002	Doug Riggs asked if the SEIS covered waste forms other than glass ILAW, and believes this should be clarified in the executive summary.	
Washington State Department of Ecology, Formal Comments, August 3, 2002	The analysis of the waste to be disposed of must include the disposal of both the vitrified waste and the melters in which the vitrified waste was processed. The analysis cannot consider other waste forms now under consideration within the DOE because Ecology has not agreed that they are appropriate for land disposal of the wastes.	
Tom Carpenter, Ashley Evans, and Clare Gilbert, Government Accountability Project, West Coast Office, letter, August 26, 2002	The tank waste should be discussed in terms of its radiological properties and components, rather than in vague production terms such as 'high-level and "low-activity" waste. If the DOE is now defining "high-level" waste as cesium-137, strontium-90, plutonium, and other transuranics, it should discuss the waste in these specific terms. DOE should rely on scientifically accurate and comprehensive inventories of the contents of the tanks and discuss the waste in these terms. If DOE continues to use the irrelevant production terms, it should explain why it is doing so.	
Tom Carpenter, Ashley Evans, and Clare Gilbert, Government Accountability Project, West Coast Office, letter, August 26, 2002	In the past year the Bush administration and DOE's Jessie Roberson have publicly stated that they plan to vitrify only 10% of the waste currently stored in Hanford's HLW tanks. Yet DOE-Richland asserts that it will vitrify 100% of the tank waste. This discrepancy within DOE's policies must be addressed in a new EIS that considers the TWRS EIS (and SEIS) in light of the Bush administration's vision of 'accelerated cleanup.'	
The Mountaineers, Glenn Eades, President, letter, August 12, 2002	Issues and Concerns: Grouting the tank waste prior to appropriate NEPA documentation.	
Public scoping meeting in Richland, August 20, 2002, Public comments	Allyn Boldt, retired Hanford worker and Kennewick resident – We've given up privatization (Phase I demonstration, Phase II production) so the SEIS should reflect what we are doing now.	

Table A.2. (contd)

Name or Organization	Comment/Statement/Question/Concern	Response
Tom Carpenter, Ashley Evans, and Clare Gilbert, Government Accountability Project, West Coast Office, letter, August 26, 2002	In the cumulative impacts analysis, DOE must consider each of the following: The accelerated cleanup plan: Cumulative impact analysis must also consider how DOE's accelerated cleanup plan to vitrify only 10% of the tank waste is being factored into the proposed action. If it is not being factored in, then DOE must explain why not and whether they will reissue a new EIS if the plan comes to fruition.	
The Mountaineers, Glenn Eades, President, letter, August 12, 2002	Issues and Concerns: The Bush administration's goal to eliminate vitrification of 75% of the tank waste.	
Heart of America Northwest, formal comments, submitted by Hyun S. Lee, August 26, 2002	There have been drastic new changes in factual circumstances that require DOE to consider conducting a new environmental impacts statement. There have been changes in the factual circumstances since the 1996 TWRS EIS ROD which selected the Phased Implementation alternative and decided to privatize the project. Since the issuance of the ROD, DOE has terminated contracts with Lockheed Martin Advanced Environmental Systems and British Nuclear Fuel, Inc. and has awarded the contract to a new contractor altogether. Furthermore, DOE is considering departing from the Tri-Party Agreement milestone requirements and leaving 75% of Hanford's liquid high-level wastes in the tanks forever.	
Confederated Tribes and Bands of the Yakama Nation, Harry Smiskin, administrator, letter, September 26, 2002	DOE has stated that it does not yet have complete characterization data for the contents of the Hanford single-and double-shell tanks. What statistical methods has DOE utilized to determine the uncertainty of the inventory in each tank being considered in the SEIS? Does DOE's inventory analysis rely primarily on recent sampling data or on historical production data? Is the level of uncertainty in the inventory for the tanks similar, or does the uncertainty vary widely between tanks? The SEIS must include a detailed description of the record developed to date on tank content inventory, and its sufficiency. Is further characterization planned? This information should be provided in detail in the SEIS.	

Table A.2. (contd)

Name or Organization	Comment/Statement/Question/Concern	Response
4. Hanford Solid Waste Disposal Alternatives		
Public scoping meeting in Richland, August 20, 2002, Questions and concerns	Should the SEIS address alternative kinds of trenches, such as ERDF, for example?	This HSW EIS evaluates a reasonable range of ILAW disposal facility alternatives for accomplishing the proposed action, including disposal in dedicated facilities or with other waste types (see HSW EIS, Volume I, Sections 2 and 3). It addresses various locations (including a new disposal facility in 200 East Area, 200 West Area, the Environmental Restoration Disposal Facility, or existing Low Level Burial Grounds). It discusses various options for liners and disposal facility covers (see HSW EIS, Volume I, Section 2 and Volume II, Appendix D). The alternatives and disposal facilities described were developed to comply with applicable regulatory requirements as described in the HSW EIS. The EIS describes the related analysis of long-term performance (including environmental impacts) and estimates impacts over those time periods (see HSW EIS, Volume I, Sections 5.3 and 5.11). The EIS also describes administrative controls and procedures including waste inspection and verification in accordance with established waste acceptance criteria. DOE also plans to evaluate a reasonable range of alternatives for accomplishing the proposed actions for tank closure and tank waste treatment under the Tank Waste Retrieval and Closure EIS.
Public scoping meeting in Richland, August 20, 2002, Public comments	Gordon Rogers, Pasco resident – Recommends using trenches to dispose of LAW other than the LAW from the vit plant.	
Seattle briefing, August 22, 2002	Hyun Lee asked how ILAW would be stored with the solid waste.	
Seattle briefing, August 22, 2002	Ruth Yarrow asked why we were evaluating ILAW trenches located in the 200 West Area with a modified RCRA barrier.	
Portland briefing, September 3, 2002	Doug Riggs said the draft should be upfront where the SEIS meets initial protections and clear if it does not. A clear and effective executive summary is critical. The differences and benefits that the various barriers provide should be explained.	
Portland briefing, September 3, 2002	Doug Huston stated the collection system is not a long-term protection system and asked if the original TWRS EIS looked at a trench option.	
Heart of America Northwest, formal comments, submitted by Hyun S. Lee, August 26, 2002	DOE has suggested that the ILAW wastes in question in this SEIS may be disposed of in the same facilities as LLW considered in the HSWEIS. DOE must consider the long history of waste mismanagement at Hanford's LLBG where offsite generators have mislabeled, mischaracterized, and mispackaged shipments of radioactive waste sent to Hanford for disposal. Heart of America Northwest has documented that offsite generators have disposed of mixed waste in the LLW-only burial grounds. Disposal of highly radioactive waste in a facility where there has been a long history of waste mismanagement would have potentially catastrophic consequences. These factors must be considered before moving forward with the disposal of ILAW in the same facilities as LLW.	

Table A.2. (contd)

Name or Organization	Comment/Statement/Question/Concern	Response
Heart of America Northwest, formal comments, submitted by Hyun S. Lee, August 26, 2002	DOE must consider the full range of reasonable alternatives, including meeting Tri Party Agreement milestone requirements to empty tanks and complete vitrification of tank wastes by 2028.	
Oregon Office of Energy, Formal comments, August 30, 2002	A clear explanation of the reason for changing the proposed ILAW disposal method from the belowground vaults to trenches needs to be presented in this EIS. Additionally, although we recognize this is a supplemental EIS, we recommend that DOE consider and analyze and include in this SEIS all other reasonable ILAW disposal options.	
Washington State Department of Ecology, Formal Comments, August 23, 2002	This SEIS should address all the land-based disposal facilities required for disposing of all ILAW generated by the Hanford Waste Treatment Plant. It should identify the total number of trenches required, their proposed locations, and the impacts of such uses of the land.	
Washington State Department of Ecology, Formal Comments, August 23, 2002	All disposal facilities must be assumed to meet the requirements of the Washington Dangerous Waste Regulations (WAC Chapter 173, Part 303) for land-based disposal facilities. Ecology is not entertaining petitions to delist the dangerous waste constituents, or listed wastes in the LAW, or considering any delisting before the waste form is generated.	
Confederated Tribes and Bands of the Yakama Nation, Harry Smiskin, administrator, letter, September 26, 2002	Is the primary authority for tank waste disposal the Washington Dangerous Waste Regulations (WAC Chapter 173 Part 303)?	
Paige Knight, Hanford Watch, letter, August 15, 2002	Please offer real alternatives that truly permanently protect the environment since the assumption has changed from storage to permanent disposal.	
Paige Knight, Hanford Watch, letter, August 15, 2002	Offer more long-term protection of waste trenches than an impermanent, short-lived plastic caps.	
Paige Knight, Hanford Watch, letter, August 15, 2002	We need a full range of alternatives with all impacts addressed to the environment.	

Table A.2. (contd)

Name or Organization	Comment/Statement/Question/Concern	Response
Tom Carpenter, Ashley Evans, and Clare Gilbert, Government Accountability Project, West Coast Office, letter, August 26, 2002	The reason for DOE's proposed changes to the TWRS EIS (from retrievable storage in concrete vaults to disposal in trenches) should be explained in the SEIS.	
Tom Carpenter, Ashley Evans, and Clare Gilbert, Government Accountability Project, West Coast Office, letter, August 26, 2002	A new EIS and/or the Supplemental EIS must include as alternatives: 1) storage of waste, 2) disposal of waste, and 3) the Tri-Party Agreement milestone of emptying tanks and completing vitrification by 2028.	
5. Relationship to HSW EIS and Other NEPA Documents		
Public scoping meeting in Richland, August 20, 2002, Public comments	Gordon Rogers, Pasco resident – Integrate this SEIS with the Solid Waste EIS and make sure all the waste forms are covered.	DOE has incorporated the ILAW SEIS into this HSW EIS, which adopts the Industrial-Exclusive designations relative to land-use decisions set forth under the Hanford Comprehensive Land-Use Plan EIS Record of Decision (ROD) (64 FR 61615).
Portland briefing, September 3, 2002	Doug Huston advised that the tank SEIS be communicated clearly so it does not become confused with the Hanford solid waste EIS.	
Heart of America Northwest, formal comments, submitted by Hyun S. Lee, August 26, 2002	DOE must consider public comments submitted during the Hanford site solid waste environmental impact statement. These comments reflect the concerns of the Citizens of the Pacific Northwest about future land disposal of radioactive waste at the Hanford Nuclear Reservation. Disposal of the ILAW in question in trenches with a volume of 200,000 m^3 each (potentially containing 81,000 waste monoliths) will impact alternatives considered in the HSWEIS.	
Oregon Office of Energy, Formal comments, August 30, 2002	An analysis of the compatibility of this SEIS's various options with the Hanford Comprehensive Land Use Plan should be included.	
6. Classification and Definition of ILAW and High-Level Waste		
Public scoping meeting in Richland, August 20, 2002, Questions and concerns	Definition of low-activity waste	This HSW EIS only addresses disposal of the ILAW component of the tank waste. For the purposes of the HSW EIS, DOE assumes that previous designations of LAW remain valid. The wastes described and defined in the HSW EIS are also classified consistent with the TWRS EIS.
Seattle briefing, August 22, 2002	Tom Carpenter asked if DOE should still go ahead with ILAW disposal with the court challenge pending on tank waste classification.	

Table A.2. (contd)

Name or Organization	Comment/Statement/Question/Concern	Response
Tom Carpenter, Ashley Evans, and Clare Gilbert, Government Accountability Project, West Coast Office, letter, August 26, 2002	DOE must consider the possibility that the federal courts may rule that "low-activity waste" is still "high-level waste" under the *Nuclear Waste Policy Act*. DOE has attempted to bypass laws applicable to high-level waste, such as the Nuclear Waste Policy Act, by reclassifying high-level waste as low-activity waste. DOE defines low-activity waste as "The waste that remains after separating from HLW as much of the radioactivity as is practicable that when solidified may be disposed of as low-level waste in a near surface facility" (TWRS EIS, GL-13, Volume One). However, HLW is defined by the Nuclear Regulatory Commission and the Nuclear Waste Policy Act by its source as "material resulting from reprocessing." DOE ignores this when defining "low activity waste." Similarly, in DOE Order 435.1, DOE grants itself permission to reclassify HLW as "incidental waste." DOE's attempts to reclassify high-level waste as something other than high-level waste are being challenged in U.S. District Court by public interest organizations, indigenous tribes, and the states of Washington and Idaho. The lawsuit recently survived DOE's Motion for Summary Decision, and presumably will be ruled upon in the near future. The TWRS Supplemental EIS must consider that the court may rule in favor of the plaintiffs and find that "low-activity waste" is still "high-level waste," subject to the Nuclear Waste Policy Act.	Waste retrieval, separations, treatment, storage, and disposal of high-level waste, as well as closure of the tank farms and WTP will be addressed in the Tank Waste Retrieval and Closure EIS that is currently being prepared by the Office of River Protection (ORP). Classification of some tank waste as TRU waste is not being considered as part of this HSW EIS.
The Mountaineers, Glenn Eades, President, letter, August 12, 2002	Issues and Concerns: Illegitimate reclassification of wastes at Hanford to mixed low-level or TRU.	
Confederated Tribes and Bands of the Yakama Nation, Harry Smiskin, administrator, letter, September 26, 2002	Are the contents of the Hanford single-shell tanks classified as high-level waste? Are the contents of any single-shell tanks, in whole or in part, classified as waste other than high-level waste? If so, the procedure for classification of the wastes in each of the 149 single-shell tanks must be explicitly described in the SEIS, along with the statutes that govern the disposal of such waste.	

Table A.2. (contd)

Name or Organization	Comment/Statement/Question/Concern	Response
Confederated Tribes and Bands of the Yakama Nation, Harry Smiskin, administrator, letter, September 26, 2002	Are the contents of the Hanford double-shell tanks classified as high-level waste? Are the contents of any double-shell tanks, in whole or in part, classified as waste other than high-level waste? If so, the procedure for classification of the wastes in each of the 28 double-shell tanks must be explicitly described in the SEIS, along with the statutes that govern the disposal of such waste.	
Confederated Tribes and Bands of the Yakama Nation, Harry Smiskin, administrator, letter, September 26, 2002	Does the *Nuclear Waste Policy Act* govern disposal of the entire contents of all Hanford singe-shell tanks? Does the *Nuclear Waste Policy Act* govern disposal of the entire contents of all Hanford double-shell tanks? The SEIS must clearly describe the authority (or authorities) upon which DOE relies in making decisions for 1) removal of waste from tanks, 2) pretreatment of waste, and 3) final disposal of tank waste.	
Confederated Tribes and Bands of the Yakama Nation, Harry Smiskin, administrator, letter, September 26, 2002	Under what authority may DOE dispose of any Hanford single- or double-shell tank waste in near-surface trenches? What is the legal and technical process by which DOE determines such disposal to be legally compliant, including the process for classifying the tank waste and analyzing the waste to ensure that it meets the classification criteria? A logic diagram in the SEIS for waste classification would allow for a clear analysis of this important issue.	
7. Cumulative Impacts		
Seattle briefing, August 22, 2002	Tom Carpenter would like the SEIS to include cumulative impacts and update them since the TWRS EIS, which was released in 1996. New knowledge needs to be factored into the SEIS.	This HSW EIS has absorbed the scope of the former ILAW SEIS. The HSW EIS addresses the cumulative environmental impacts from ILAW and other Hanford solid wastes handled during past, present, and reasonably foreseeable future solid waste management activities at Hanford (see HSW EIS, Volume I, Section 5.14 and Volume II, Appendix L). Alternatives considered in this EIS would not preclude retrieval of ILAW, although some alternatives for combined disposal could make
Heart of America Northwest, formal comments, submitted by Hyun S. Lee, August 26, 2002	DOE must consider the cumulative environmental impacts disposal of the ILAW in trenches in the 200 Area will have. 40 CFR 1508.25 is not adequate to merely consider the impacts of this proposed action to the environment as though it were taking place in a vacuum or sterile environment. This proposed action will result in the disposal of 1,840,000 Ci of radiation being disposed of in the 200 Area. The NEPA regulations require the agency to consider the impact on the environment which results from the incremental impact of the action when added	

Table A.2. (contd)

Name or Organization	Comment/Statement/Question/Concern	Response
	to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions (40 CFR 1508.7). DOE must consider what the addition of 1,840,000 Ci of radiation will be to the already existing contamination at Hanford.	retrieval more difficult. However, the impacts of retrieval are not specifically evaluated. If DOE were to decide to retrieve ILAW at some later date, additional environmental review may be required.
Heart of America Northwest, formal comments, submitted by Hyun S. Lee, August 26, 2002	DOE must consider the cumulative, significant impact the proposed disposal of ILAW in the 200 Area will have to the environment (adding 1,840,000 Ci of radiation) in conjunction with the addition of 70,000 truckloads of LLW and mixed waste considered in the Hanford Site solid waste EIS. These cumulative impacts must be analyzed before any decision can be made.	
Oregon Office of Energy, Formal comments, August 30, 2002	The SEIS represents a connected action with respect to the SWEIS, and therefore needs to look at the cumulative impact of adding this waste to those wastes analyzed in the SWEIS, as well as all other current and planned disposal activities.	
Washington State Department of Ecology, Formal Comments, August 23, 2002	The ILAW SEIS must be coordinated with the Hanford solid waste EIS, which addresses other land-based disposal facilities on Hanford's Central Plateau. Included in the coordinated effort must be an analysis that addresses the cumulative effects of all of the land-based dangerous waste disposal facilities on the plateau. That cumulative effect must include the overall impact of land use for those facilities.	
Tom Carpenter, Ashley Evans, and Clare Gilbert, Government Accountability Project, West Coast Office, letter, August 26, 2002	In the cumulative impacts analysis, DOE must consider each of the following: Interplay of HSW EIS and tank waste SEIS: The cumulative impact analysis must analyze the impact of adding almost 2,000,000 Ci of highly radioactive waste to a site slated to house an additional 70,000 truckloads of waste, as proposed recently in the Hanford solid waste EIS. The cumulative effects on both the HSW EIS and the tank waste SEIS must be analyzed.	

Table A.2. (contd)

Name or Organization	Comment/Statement/Question/Concern	Response
Tom Carpenter, Ashley Evans, and Clare Gilbert, Government Accountability Project, West Coast Office, letter, August 26, 2002	In the cumulative impacts analysis, DOE must consider each of the following: The tank waste cumulative impacts analysis must be tailored to both the 200 West and East Areas: The disposal of 2,000,000 Ci will affect the 200 West and 200 East Areas differently, given their differing current conditions. Also, because the *National Environmental Policy Act* requires consideration of both the current condition and foreseeable future actions at site of proposed action, the cumulative analysis should include the effects of the HSW EIS on both sites (40 CFR 1508.25 and 1508.7).	
Tom Carpenter, Ashley Evans, and Clare Gilbert, Government Accountability Project, West Coast Office, August 26, 2002	In the cumulative impacts analysis, DOE must consider each of the following: Effect of retrieval on low-activity waste in shared trench: DOE has indicated that the tank waste could be buried in the trenches that contain (or would under the HSW EIS) low-level waste. DOE also has indicated that the disposal of tank waste might not be permanent and that the waste might be retrieved someday. The new EIS/SEIS must consider how such retrieval would affect the LLW in the shared trench. DOE must also consider the possibility that some mixed low-level waste was inadvertently disposed of in the low-level waste trenches, and the associated risks of putting high-level waste or low-activity waste near mixed low-level waste.	
Confederated Tribes and Bands of the Yakama Nation, Harry Smiskin, administrator, letter, September 26, 2002	DOE must consider the cumulative impacts of its tank waste treatment and disposal program along with the impacts of all other waste and land use planning for Hanford.	
8. Regulatory and Legal NEPA Issues		
Seattle briefing, August 22, 2002	Tom Carpenter said that rather than preparing an SEIS, ORP should prepare a new EIS to evaluate the environmental impacts of disposing of the ILAW in trenches.	DOE considered the need for a new EIS but determined that inclusion of a NEPA analysis for the ILAW disposal in this HSW EIS (merging scopes) would be sufficient to respond to comments. Because of the added scope, the HSW EIS was expanded to
Portland briefing, September 3, 2002	Doug Huston asked about delegation of authority for the tank farm Supplemental EIS. He felt this was a good idea for streamlining the decision-making process.	

Table A.2. (contd)

Name or Organization	Comment/Statement/Question/Concern	Response
Heart of America Northwest, formal comments, submitted by Hyun S. Lee, August 26, 2002	DOE must consider conducting a completely new environmental impact statement, not merely a supplement to the 1996 environmental impact statement. Since the ROD was issued on the 1996 TWRS EIS there has been significant new information that would have substantively impacted decision-makers' decisions such as the discovery that the Hanford tanks were leaking into the groundwater. This SEIS is examining a substantive change in policy from temporary retrievable storage of ILAW (1,840,000 Ci of radiation) to actual permanent disposal at Hanford. This is a major change that requires in-depth examination.	include new information and alternatives for disposal of ILAW at Hanford. DOE issued a revised draft of the HSW EIS to provide an opportunity for public comment on the ILAW disposal alternatives. DOE has consulted with the various tribes and stakeholders during the preparation of the HSW EIS. DOE recently announced its intent to prepare a follow-on EIS (Environmental Impact Statement for Retrieval, Treatment, and Disposal of Tank Waste and Closure of Single-Shell Tanks at the Hanford Site, Richland, Washington [DOE/EIS-0356]) to the TWRS EIS for retrieval, treatment, and disposal of Hanford tank waste, and for closure of 149 single-shell tanks (68 FR 1052). That EIS would evaluate alternative treatment processes for some tank waste and disposal of low-activity waste forms other than the vitrified ILAW considered in this HSW EIS.
Tom Carpenter, Ashley Evans, and Clare Gilbert, Government Accountability Project, West Coast Office, letter, August 26, 2002	The magnitude of the proposed changes since the 1997 TWRS EIS warrants an entirely new EIS rather than a supplement to the earlier EIS.	
9. Native American Treaty Rights/Tribal Concerns		
Confederated Tribes and Bands of the Yakama Nation, Harry Smiskin, administrator, letter, September 26, 2002	DOE's planning must include specific measures it will take to fulfill its enforceable trust obligations to the Yakama Nation. Such measures should be described in the SEIS.	This HSW EIS addresses impacts on Treaty rights and discusses DOE's relationship with Native Americans (see Volume I, Section 6). DOE interacts and consults regularly and directly with the Native American tribes in the vicinity of Hanford Site. DOE will continue to do so
Confederated Tribes and Bands of the Yakama Nation, Harry Smiskin, administrator, letter, September 26, 2002	DOE's planning must include specific measures it will take to ensure compliance with the Treaty of 1855 between the United States and the Yakama Nation. Such measures should be described in the SEIS.	

Table A.2. (contd)

Name or Organization	Comment/Statement/Question/Concern	Response
Portland briefing, September 3, 2002	Doug Riggs asked what are the tribal issues or comments thus far.	during the NEPA process for this EIS and for the Tank Waste Retrieval and Closure EIS. DOE agreed to a Yakama Nation request to participate in the preparation of the HSW EIS; however, the Yakama Nation subsequently withdrew.
Confederated Tribes and Bands of the Yakama Nation, Harry Smiskin, administrator, letter, September 26, 2002	Specifically, by what means and at what decision points will DOE consult with the Yakama Nation on the matters addressed in the SEIS? The planning for tank waste retrieval, treatment, and disposal all affect the near-term and long-term health and safety of Yakama Nation tribal members. In addition, the SEIS considers actions which may have extremely long-term impacts on Treaty rights as well as trust resources, and which are of great concern to the Yakama Nation. The scope of the SEIS should address in detail how DOE will integrate its planning efforts with its consultation obligations to the Yakama Nation to address these matters.	
10. Long-Term Performance, Mitigation Measures, and Stewardship		
Seattle briefing, August 22, 2002	Tom Carpenter inquired how long the monolith would perform.	This HSW EIS evaluates the environmental impacts of various disposal facilities and considers various mitigation measures. Long-term performance is evaluated over 10,000 years for trenches and vaults (as in the TWRS EIS preferred alternative). Assumptions used in modeling are discussed in Volume I, Section 5.3 and Volume II, Appendix G. Mitigation measures and stewardship are addressed in Volume I, Section 5.18. Performance Assessments (PAs) for disposal will be prepared for proposed new and expanded disposal facilities as part of the DOE approval process under DOE Order 435.1 (DOE 2001b). PAs evaluate long-term impacts of disposal of specific wastes in proposed disposal facilities. PAs are re-evaluated regularly to assure that facilities continue to meet the long-term limits.
Seattle briefing, August 22, 2002	Ruth Yarrow asked if vaults were safer than trenches.	
Seattle briefing, August 22, 2002	Dave Johnson suggested that we evaluate the impacts of a potential ice age that could occur in 60,000 years.	
Portland briefing, September 3, 2002	Doug Riggs asked why the concrete vaults are not as beneficial as trenches and if the trenches have a better flow or drainage system.	
Portland briefing, September 3, 2002	Doug Huston stated that it appears you have less barriers without a vault compared to a trench and the reasons need to be explained in the draft. Doug Huston stated that “not taking credit” for barriers confuses the public and the draft should explain and document why the trenches are seen as better than vaults.	
Oregon Office of Energy, Formal comments, August 30, 2002	A performance assessment for each alternative should be included in the EIS along with a description of the maintenance and monitoring programs required for each alternative. This discussion should include a detailed description of how these alternatives will be monitored for leakage. We are particularly concerned that this monitoring plan be able to detect leakage as early as possible.	

Table A.2. (contd)

Name or Organization	Comment/Statement/Question/Concern	Response
Oregon Office of Energy, Formal comments, August 30, 2002	This SEIS must discuss in detail mitigation plans and schedules for each alternative.	
Washington State Department of Ecology, Formal Comments, August 23, 2002	The ILAW SEIS must evaluate the requirements, probable success or failure, and potential costs of long-term stewardship activities associated with each of the alternatives.	
Tom Carpenter, Ashley Evans, and Clare Gilbert, Government Accountability Project, West Coast Office, letter, August 26, 2002	The TWRS EIS called for retrievable storage, as opposed to disposal. The new proposal for changing from storage to disposal has vast repercussions, none of which were contemplated in the original EIS and all of which warrant extensive review and consideration.	
Tom Carpenter, Ashley Evans, and Clare Gilbert, Government Accountability Project, West Coast Office, letter, August 26, 2002	The TWRS SEIS must consider future scenarios. For example, many scientists believe that the vitrified glass will last only 500 years before breaking down and releasing its radioactive contents into the environment. The SEIS must examine what will occur if this prediction is realized.	
Tom Carpenter, Ashley Evans, and Clare Gilbert, Government Accountability Project, West Coast Office, letter, August 26, 2002	Additionally, the SEIS should consider the effects of global warming, climate change, and the possibility of ice age in the next several hundred to one thousand years. These global changes pose the risk of altered burial ground composition and temperature changes leading to the release of radioactive materials.	
11. Public Involvement		
Seattle briefing, August 22, 2002	Clare Gilbert wanted to know if DOE was going to respond to comments.	This HSW EIS considers all comments received on the ILAW SEIS scoping, and on the first and revised drafts of the HSW EIS. Summary level responses to scoping comments are provided in this appendix and responses to public comments received on the revised draft HSW EIS appear in Volume III of this final HSW EIS. DOE recognizes the need for a clear summary and has revised it accordingly.
Portland briefing, September 3, 2002	Both Doug Huston and Doug Riggs were emphatic that the executive summary be reader friendly, clear, and well supported with appropriate data on key questions that the public will have. They recommended that they or someone from their organization have a chance to review the executive summary to ensure the right issues are addressed up front and the information is written in a public friendly style.	

Table A.2. (contd)

Name or Organization	Comment/Statement/Question/Concern	Response
12. Other Impacts and Analyses		
Public scoping meeting in Richland, August 20, 2002, Public comments	Don Clark, retired Hanford worker, Richland resident– Include relative risk and cost in the SEIS.	This HSW EIS evaluates the environmental impacts (e.g., risk, land use, irreversible and irretrievable commitment of resources, cost, transportation, ecology, etc.) for the various ILAW disposal alternatives.
Portland briefing, September 3, 2002	Doug Huston handed out copies of the Oregon of Office of Energy's comments on the SEIS. Doug Huston explained that the size and number of caps and the material required to make them could have an impact on the environment, and asked if there will be enough material onsite to generate the barriers.	
Oregon Office of Energy, Formal comments, August 30, 2002	The SEIS will need to specify potential sources of borrow material for the daily cover and capping material in order to accurately assess costs and mitigation requirements. Other ongoing activities and the HSW EIS depend on onsite borrow areas that may not contain adequate reserves. If adequate volumes cannot be identified, then the development of new borrow sources would have to be evaluated for impacts.	
Washington State Department of Ecology, Formal Comments, August 23, 2002	The SEIS should address risks and transport mechanisms associated with each of the disposal sites described.	
Paige Knight, Hanford Watch, letter, August 15, 2002	One of the values of the Hanford Advisory Board is to do no more harm to the land.	
13. Out of Scope		
Confederated Tribes and Bands of the Yakama Nation, Harry Smiskin, administrator, letter, September 26, 2002	The President and Congress have selected Yucca Mountain in Nevada as the site of the first national high-level waste repository. How does DOE integrate its defense high-level waste disposal plans for Hanford with those of the Yucca Mountain Project? How did DOE arrive at the 10% figure for allocation of repository space for combined defense high-level waste and DOE spent nuclear fuel, while the allocation reserved for commercial spent fuel is 90%? Can the total contents of Hanford's tanks be disposed of in the Yucca Mountain repository? The SEIS scope must include a description of how the DOE repository waste allocation decisions (i.e., space for commercial spent fuel vs. DOE defense high-level waste and DOE spent fuel) affect Hanford tank retrieval, treatment, and disposal planning.	Integration of HLW disposal plans across DOE sites was addressed in the Yucca Mountain EIS. The analysis in this HSW EIS focuses only on disposal of the ILAW component of the waste retrieved from the tanks at Hanford.

Table A.2. (contd)

Name or Organization	Comment/Statement/Question/Concern	Response
Confederated Tribes and Bands of the Yakama Nation, Harry Smiskin, administrator, letter, September 26, 2002	DOE has stated that it intends to maximize the "loading" of the high-level waste canisters designed for disposal in a geologic repository. The SEIS must describe in detail the factors which permit and hinder "loading" of the canisters. The criteria for loading should be described in detail in the SEIS, and the technical basis for such loading.	
Confederated Tribes and Bands of the Yakama Nation, Harry Smiskin, administrator, letter, September 26, 2002	The Hanford Tank Waste Remediation System EIS Record of Decision states that an Environmental Impact Statement will be developed prior to the disposal of any Hanford tank waste. Does this statement apply to planned closure actions for tank C-106 and other tanks being planned for closure in the near future?	

Part 2—Public Scoping Comments and Responses for the HSW EIS

The Notice of Intent (NOI) to prepare the HSW EIS was published in the *Federal Register* (FR) on October 27, 1997, (62 FR 55615) in accordance with 40 CFR 1501.7, 40 CFR 1508.22, and 10 CFR 1021.311. The NOI announced the schedule for the public scoping process and summarized the alternatives and environmental consequences to be considered in the EIS. Two scoping meetings were held in Richland, Washington, on November 12, 1997, followed by a meeting in Pendleton, Oregon, on November 13, 1997. Originally scheduled from October 27, 1997, to December 11, 1997, the comment period was extended by DOE through January 30, 1998 in response to a request from the State of Oregon. The notice of extension appeared in the December 11, 1997, *Federal Register* (62 FR 65254).

In Part 2 of this appendix, comments received by DOE during the scoping period are summarized and grouped into categories corresponding with the topics that were considered in preparing the HSW EIS. The comments are shown in italic typeface, and have been reproduced as accurately as possible with only minor grammatical corrections incorporated. Responses from DOE and the manner in which the comments were addressed in preparing this EIS follow each category. Persons and agency representatives who provided comments are listed in Table A.3.

Table A.3. Individuals, Organizations, and Agencies Commenting on the Scoping Phase of the HSW EIS

Name	Organization
Written Comments	
Barry C. Bede(a)	US Ecology, Inc.
Mary Lou Blazek & Dirk Dunning(a)	Oregon Department of Energy
Dirk Dunning	Oregon Department of Energy
Tim Heffernan	Gaian Technologies
Jay McConnaughey	State of Washington, Department of Fish and Wildlife
Vince Panesko(a)	Pacific Rim Enterprise Center
Sam Volpentest	Tri-City Industrial Development Council (TRIDEC)
Mike Wilson	Washington State Department of Ecology
Public Scoping Meeting Comments	
Barry C. Bede(a)	US Ecology, Inc.
Dirk Dunning(a)	Oregon Department of Energy
Dirk Dunning(a)	Private Citizen
Vince Panesko(a)	Pacific Rim Enterprise Center
(a) These individuals submitted written as well as oral comments.	

A.1 DOE Programmatic/Nationwide Analysis

This category contains comments related to coordination of the HSW EIS with other DOE nationwide initiatives, programs, and NEPA documents.

A.1.1 Coordination with Other Federal Reports, Environmental Impact, and DOE Policy Statements

- *The Notice of Intent (NOI) states that the Solid Waste Programmatic EIS (SW PEIS) will be coordinated with Records of Decisions (ROD) for the Waste Management Programmatic EIS (WM PEIS) and other DOE EIS that affect waste management at the Hanford Site. The NOI also states that the analysis in the SW PEIS of transuranic waste (TRU) waste management will be consistent with the forthcoming ROD for the Waste Isolation Pilot Plant (WIPP) Disposal Phase Final Supplemental EIS. The NOI also states that the goals of the 2006 Plan will be incorporated into the action alternatives evaluated for the SW PEIS. Given these three statements in the NOI, the scope of the SWP EIS must specifically include these three topics. These topics must be clearly addressed so that readers will have no difficulty verifying that the NOI statements have been fulfilled.*

- *In the NOI, there are some statements that the EIS will be coordinated with various RODs and other HSW EIS that affect waste management at the Hanford Site. The NOI also says it will be consistent with the forthcoming ROD on WIPP. It also says the goals of the 2006 Plan will be incorporated into the action alternatives. What my comment is… that these other documents, the RODs for the Waste Management EIS (WM EIS) will be clearly identified and their impact on this HSW EIS will be clearly recognized and stated.*

- *The recent site contractors conceptual study of waste shipment, processing, and packaging for disposal alternatives should be carefully evaluated and utilized when appropriate to achieve the most economical strategy for the ultimate disposal of these wastes.*

- (Note: This comment also addresses issues discussed under Section A.2, Alternatives and Activities Analyzed in the HSW EIS.)

- *Ten years ago, or a little over that, DOE entered into a consent order agreement in regard to a lawsuit in Washington, D.C., about doing a PEIS on all DOE operations. Resulting out of that, DOE splintered that requirement into a bunch of fractions. One of those was a Waste Management EIS (WM EIS) and Environmental Restoration EIS (ER EIS). The WM PEIS is only the waste management portion. The environmental restoration (ER) portion was excluded from analysis. And one of the things that I heard in the question and answer session was that this HSW EIS would also look at ER waste. And I would like to suggest to you that absent the analysis of the ER portion of the PEIS, this HSW EIS has no basis to do so. In addition, the Contractors Report, which came out in association with the focus on 2006 Plan was a report, which was not prepared in compliance with the National Environmental Policy Act (NEPA). It was not done under a Federal Advisory Committee Act process. And as such I believe it has no legal basis to be used in any decision making by DOE.*

- (Note: This comment also addresses issues discussed under Section A.3, Waste Types and Volumes.)

- *The Contractors Report is clearly referenced and portions of it are included as recommendations within the national 2006 Plan. I believe as a consequence of that the 2006 Plan also fails to meet the requirements under the NEPA and under the Federal Advisory Committee Act to be able to be used for decision making. And as a consequence, this SW EIS should consider neither of those in any way as the HSW EIS is performed.*

Response to Comments on Programmatic Coordination Issues

DOE recognizes the numerous relationships that exist between the HSW EIS and other ongoing and historic DOE activities. This HSW EIS takes into account existing decisions and, at the same time, provides DOE and other stakeholders with an updated analysis of HSW Program operations and alternatives for implementing future activities. Effort has been made to coordinate with, and tier from, DOE programmatic NEPA documents and decisions, such as the Waste Management Programmatic Environmental Impact Statement (WM PEIS, DOE 1997b; 63 FR 3629, 63 FR 41810, 64 FR 46661, 65 FR 10061) and the Waste Isolation Pilot Plant Supplemental Environmental Impact Statement II (WIPP SEIS II, DOE 1997c; 63 FR 3623).

A nationwide integration team authored the Site Contractors Study (DOE 1997a). The goal of that study was to identify opportunities for increasing the efficiency of DOE waste management operations by coordinating and maximizing the use of existing facilities across the DOE complex. Options considered in other DOE nationwide and Hanford Site initiatives are included in this HSW EIS to the extent that they are consistent with previous NEPA decisions. Some of those initiatives include the Hanford Federal Facility Agreement and Consent Order (Ecology et al. 1989), also known as the Tri-Party Agreement (TPA); remediation activities conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC 9601); the Hanford Groundwater Protection Program (DOE-RL 1999a, b; DOE-RL 2000), and the DOE complex 2006 Plan. In general, those initiatives deal with methods and schedules for implementing decisions that result from programmatic NEPA documents. Specific studies of various ways to meet DOE waste management objectives are not decision documents, and need not be subject to NEPA review at the conceptual stage. Any activities proposed in those conceptual and planning documents that are incorporated into the HSW EIS alternatives will undergo the appropriate NEPA process and public review as part of preparing this document and a subsequent ROD. Relationships between NEPA documents and other studies are addressed in this HSW EIS.

Environmental restoration waste generated at Hanford is included in the analysis of the HSW EIS cumulative impacts.

A.1.2 Nationwide Impact Comparisons and Equity Issues

- *The SW EIS must be part of a systematic, complex-wide examination of trade-offs between candidate sites for receipt of additional solid waste…In comments on the PEIS and in other forums, Ecology has noted a critical missing element in DOE's decision-making process for selecting sites for waste treatment, storage, or disposal within the DOE complex. The PEIS is sufficient for making conceptual decisions on whether various waste streams should be centrally, regionally, or decentrally managed and disposed of. Site-specific analyses are appropriate for understanding the impacts of those decisions on a given site. Missing is a meaningful comparison of environmental impacts between the candidate sites… To satisfy this need, the SW EIS must be one of several site-specific EIS each addressing a candidate site.*

- *Of special note, both the SW EIS and DOE's broader programmatic decision-making process should consider equity among the sites in both alternative development and impact analysis.*

- (Note: This comment also addresses issues discussed under Section A.2, Alternatives and Activities Analyzed in the HSW EIS.)

- *The transfer of wastes between sites where significant economies of processing and disposal costs and the avoidance of the duplication of needed facilities and programs should be fully considered. In inter-site transfers of wastes between sites, i.e., DOE Richland Operations Office (DOE-RL) and Idaho National Engineering and Environmental Laboratory (INEEL), a reasonable equity balance between the sites should be maintained.*

- (Note: This comment also addresses issues discussed under Section A.2, Alternatives and Activities Analyzed in the HSW EIS.)

- *The mixed waste issue must be addressed on a nation-wide basis, including the shipment of wastes between sites to achieve the most economical waste processing and disposal.*

- (Note: This comment also addresses issues discussed under Section A.2, Alternatives and Activities Analyzed in the HSW EIS.)

- *Managing wastes using primarily cost considerations has been largely responsible for the magnitude of DOE's existing complex-wide cleanup problem. It is time to begin selecting the best disposal sites based on technical and social considerations rather than on economic or other secondary factors.*

- (Note: This comment also addresses issues discussed under the Section A.2, Alternatives and Activities Analyzed in the HSW EIS.)

Response to Comments on Nationwide Analysis

In 1989, DOE established the U.S. Department of Energy, Office of Environmental Management (EM), in an effort to coordinate cleanup and waste management activities at DOE facilities. Before this, DOE had focused on managing its waste through individual site-specific programs. As more sites have come into compliance with regulations and urgent needs have been addressed, DOE has been able to focus on a more unified nationwide vision. This vision is reflected in the Final WM PEIS, which presents a nationwide strategy to treat, store, and dispose of radioactive and hazardous waste in a safe, responsible, and efficient manner.

To increase efficiency across the complex, DOE established an Environmental Management Integration initiative. The underlying strategy of the initiative is to increase the efficiency in DOE waste management operations by eliminating the need for redundant facilities, applying site lessons learned across the nation and using available waste management capabilities across program boundaries. These efforts illustrate a DOE movement towards examining and implementing cleanup and remediation actions from a nationwide perspective.

DOE nationwide waste management impacts have been evaluated in the WM PEIS and in various site-specific NEPA documents. The DOE considered a range of factors, including scientific, technical, economic, and equity issues in making decisions in the WM PEIS RODs (63 FR 3629, 63 FR 41810, 64 FR 46661, 65 FR 10061). The HSW EIS updates analyses of environmental consequences from previous documents and provides evaluations for activities that may be implemented consistent with the Waste Management Programmatic Environmental Impact Statement (WM PEIS) Records of Decision (RODs).

A.2 Alternatives and Activities Analyzed in the HSW EIS

This category contains comments related to the proposed alternatives and waste management activities analyzed in the revised HSW EIS.

A.2.1 Alternative Options

A.2.1.1 Shipment of Offsite Waste to Hanford

- *Any costs related to the processing and disposal of wastes from other sites, which are shipped to Hanford, must be funded by HQ or the originating site as an addition to the Hanford cleanup budget. This supplemental funding must be on a full-cost recovery basis including appropriate site overhead and infrastructure costs.*

- *Normally any wastes shipped to Hanford from other sites for processing should be returned to the originating site or to the end disposal location for final disposal. In some cases, it may be appropriate to dispose of the processed wastes at Hanford if suitable facilities are not available elsewhere within the DOE complex. The shipment of additional offsite waste (over and above that which is already in the Hanford baseline) to Hanford for direct disposal may be done only under the following conditions:*

  - It does not increase the amount of land required to be set aside for Hanford's own waste.

  - The waste meets the acceptance and disposal criteria as currently specified which assures environmental and public safety.

  - It reduces the cost or accelerates the disposal, of Hanford's own waste.

  - Accompanying incremental funding is provided for treatment, storage, and/or disposal of the waste.

- *Any waste shipments to Hanford for processing, interim storage, or disposal must not interfere with or delay any Hanford Site cleanup activities.*

- *As DOE is well aware, there is a significant risk that DOE's proposed actions for handling the immense amounts of other wastes on the Hanford Site are not assured…. Under these circumstances, it is inappropriate for DOE to consider the importation of any waste to Hanford until the cleanup of Hanford wastes is both assured and complete.*

- *The current plans within things such as the 2006 Plan and other documents discuss perhaps leaving a large majority of the tank waste at Hanford buried in-place, rather than retrieving it. If these decisions are made, as the Contractors Report points out, they are recommending increasing the legal exposure limits in order to allow that to occur…As a consequence, bringing any additional waste to Hanford would cause it also to be a part of that exceedence of the legal limit, and as a consequence, it would be unacceptable under the law to do so.*

- (Note: This comment also addresses issues discussed under Section A.1, Programmatic/Complex-Wide Analysis.)

Response to Comments on Shipment of Offsite Waste to Hanford

DOE nationwide waste management impacts have been evaluated in the WM PEIS and in various site-specific NEPA documents. The DOE considered a range of factors, including scientific, technical, economic, and equity issues in making decisions in the WM PEIS RODs (63 FR 3629, 63 FR 41810, 64 FR 46661, 65 FR 10061). The HSW EIS updates analyses of environmental consequences from previous documents and provides evaluations for activities that may be implemented consistent with the Waste Management Programmatic Environmental Impact Statement (WM PEIS) Records of Decision (RODs).

Hanford waste management services currently used by offsite DOE waste generators are supported in part by fees charged to those generators. The U.S. Department of Energy, Richland Operations Office, will request funding adequate to meet cleanup goals, including TPA milestones. However, funding for Hanford Site cleanup and other DOE activities is ultimately determined by Congress.

Any waste received for processing or disposal at Hanford would meet the site waste acceptance criteria (FH 2003). Most offsite waste is expected to be in ready-to-dispose form. Disposal and treatment of offsite waste at Hanford could facilitate the cleanup and closure of other DOE facilities in the short term, which would reduce or eliminate the costs associated with operating those facilities. Reducing the long-term costs of operating those facilities may ultimately make additional funding available to Hanford and other major DOE sites for management of more complex waste streams.

Land-use impacts at Hanford are evaluated in the HSW EIS.

The consequences of alternatives considered in the HSW EIS are evaluated with respect to their cumulative impacts with other past, present, and reasonably foreseeable activities at the Hanford Site.

A.2.1.2 Use of Commercial or Offsite Disposal Facilities

- *US Ecology, Inc. encourages the DOE-RL to include, in the Hanford Site SW EIS scope and alternatives, the potential use of the commercial low-level radioactive waste (LLW) site located between 200 East and 200 West on the Hanford Reservation to dispose of DOE LLW…US Ecology, Inc. offers the use of its site as a viable alternative to expansion or reconfiguration of the existing Hanford LLW burial site. All LLW identified in the recent NOI (with the exception of Greater Than Class C Waste) has previously been and in the future can be disposed of at the US Ecology, Inc. site.*

- *Evaluation of the use of the commercial site in the HSW EIS would clearly demonstrate Hanford Operation's commitment to be fiscally responsible, economically conscience, administratively efficient and environmentally protective in considering LLW disposal options.*

- *Immediate closure of the Hanford LLW burial grounds also should be evaluated. Waste currently at the burial grounds was disposed of using operating procedures significantly different from those at the US Ecology, Inc. site. Possible relocation of this waste to the commercial site should be assessed* *for its potential environmental impact in the HSW EIS scope. Similar attention should be given to the environmental impact of direct receipt of offsite DOE laboratory LLW at the US Ecology, Inc. site.*

- *We (US Ecology, Inc.) believe that the alternatives you have selected are basically very, very broad alternatives, and that under the possible alternative of minimizing waste, that the consideration of using commercial facilities (in particular US Ecology, Inc.) for the disposal of LLW should be considered.*

- *The proposed HSW EIS should evaluate not only the impacts of ongoing and past activities at Hanford but should also seriously consider the relative impacts of utilizing existing offsite disposal alternatives… Any consideration of further onsite waste disposal should be secondary to a consideration of offsite alternatives. Unless onsite disposal can be clearly demonstrated to be preferable on environmental, social and economic grounds, offsite disposal should be prioritized.*

Response to Comments on the Use of Commercial or Offsite Disposal Facilities

This HSW EIS considers the option of sending some LLW to a commercial disposal site, such as the US Ecology, Inc. site at Hanford. However, because waste sent to US Ecology, Inc. would be disposed of in proximity to the DOE Low Level Burial Grounds (LLBGs), the impacts of this option would be similar to other onsite disposal alternatives and are not evaluated in detail (see Section 3.2.3.3).

Some waste that may be generated at Hanford and at other DOE facilities would not be suitable for disposal at commercial facilities under existing permits and regulations. Nor would it be cost-effective or environmentally beneficial to relocate LLW that was disposed of in the LLBGs after 1970, because regulations governing disposal of DOE waste have historically been similar to those for commercial facilities. (Waste that was disposed of at the Hanford Site prior to 1970 will be evaluated under the CERCLA process and remediated as necessary.) Therefore, the Hanford Site would need to maintain its waste management operations and infrastructure to provide for disposition of wastes that are not suitable for commercial disposal, as well as to prepare the existing disposal facilities for final closure.

The WM PEIS ROD for LLW and MLLW identified the Hanford Site as a regional site for disposal of LLW, and for treatment and disposal of MLLW, from onsite and offsite DOE generators (65 FR 10061). The WM PEIS ROD for TRU waste specified that DOE sites, with few exceptions, would be responsible for preparing and certifying TRU waste at the site where it was generated for eventual disposal at the WIPP (63 FR 3629). These decisions also specified the Hanford Site would manage LLW, MLLW, and TRU waste generated at Hanford. Use of commercial facilities for treatment or disposal of some Hanford waste would be consistent with the WM PEIS decisions, to the extent that such use is more cost-effective than developing similar capabilities at Hanford. However, use of other DOE sites for disposal of Hanford LLW or MLLW would generally be inconsistent with the WM PEIS decisions, which considered the environmental consequences associated with management of radioactive and hazardous waste across the DOE complex.

A.2.1.3 Alternative Actions and Emerging Technologies

- *At one time solid waste containing plutonium at Hanford was incinerated to recover the plutonium from the ash. Incineration routinely achieved greater than 95% volume reduction of the waste form. Such a volume reduction would significantly reduce the life cycle costs of subsequent storage and permanent disposal. The cost saved in permanent disposal space is a savings, which will accrue for decades or longer. An ash product may be more amenable to treatments that meet land ban requirements. Therefore, I recommend that incineration be considered as an alternative for all waste types.*

- *One option being considered by another DOE program at Hanford is to fill unused canyon facilities with solid nuclear waste prior to entombment. This alternative should be considered for at least the GTC3 waste. The alternative of putting new solid waste into the canyons should be considered as opposed to contaminating new soil.*

- *The caissons contain remote-handled waste. The radiation levels are so high that recovery actions may put workers at an unacceptable risk. Consider an alternative for adding a fixant to the caissons (perhaps filling the caisson with a liquid that sets up into a solid).*

Response to Comments on Alternative Actions and Emerging Technologies

Thermal treatment of some MLLW streams is being considered in the HSW EIS action alternatives. Both MLLW and TRU waste would be treated as required by regulation, or to meet disposal facility acceptance criteria. However, the environmental consequences of constructing and operating new treatment facilities, the cost of treatment, and the relative advantages of reducing waste volume may not be justified for other types of waste. Consistent with the WM PEIS ROD for LLW, waste will be treated as required to prepare it for transportation and disposal (65 FR 10061). Minimal treatment involves stabilization and packaging of LLW, including solidification of liquid and particulate waste. Additional volume reduction measures, such as compaction, thermal treatments, or size reduction, could be employed at the discretion of individual waste generators. However, DOE decided not to pursue LLW volume reduction as a nationwide policy because the projected benefits would not be justified by the cost, environmental impacts, and potential health risk to workers from constructing and operating facilities to provide those capabilities (65 FR 10061).

An ongoing CERCLA study is considering the use of the major canyon facilities for disposal of some waste types that are included in the HSW EIS. As currently envisioned, higher hazard waste such as Category 3 LLW would be placed inside the canyons and other wastes (Category 1 LLW, for example) would be placed above and outside the canyon. The entire facility would then be covered with a layer of soil and capped. The HSW EIS evaluation of LLW disposal in the LLBGs would bound the impacts of disposal in the canyon facilities.

DOE previously decided to retrieve TRU waste stored in the 200 Area LLBGs, including waste in the caissons, as a result of analyses in the Hanford Defense Waste EIS (HDW EIS) (DOE 1987;

53 FR 12449). The HSW EIS evaluates processing and certification of TRU waste, but additional analysis of retrieval activities has been deferred. LLW within caissons, including remote-handled (RH) LLW, would not be retrieved.

A.2.2 Recommended Alternative Analyses

- *As scoping for this HSW EIS is occurring in advance of decisions on the PEIS, in accordance with NEPA this HSW EIS must also examine and consider all reasonable alternatives to the proposed TSD at Hanford. These alternatives should include analysis of similar options at sites from which waste is proposed to be shipped, as well as separate treatment, storage and disposal at sites with no transport of waste.*

- (Note: This comment also addresses issues discussed under Section A.1, Programmatic/Complex-Wide Analysis.)

- *The SW EIS must examine the full range of alternative management and disposal options. In developing and examining options, the HSW EIS should emphasize the following: waste minimization, treatment, avoidance of impacts, and support of cleanup activities. As the alternatives are analyzed, the HSW EIS should be particularly sensitive to impacts on: land use, cleanup schedules, transportation, habitat and compliance with cleanup laws.*

- (Note: This comment also addresses issues discussed under Section A.4, Environmental Consequences and Analysis Methods.)

- *Closure of these waste streams (Low Level Burial Grounds [LLBGs] and Mixed Low-Level Radioactive Waste [MLLW] trenches) will involve some type of barrier requiring geological resources. The geological resources needed may include: soil, sand, gravel and basalt…Washington Department of Fish and Wildlife (WDFW) requests that a NEPA analysis (EIS) occur to evaluate the environmental impacts related to closure activities for waste streams of the Solid Waste program, the Tank Waste Remediation System (TWRS) program, and the ER program requiring geological resources.*

Response to Comments on Alternative Analyses

Consequences of managing radioactive, hazardous, and mixed waste were evaluated in the WM PEIS, the WIPP SEIS II, and a number of site-specific NEPA documents. The WM PEIS decisions, issued since the HSW EIS scoping period ended, specified that the Hanford Site would be available to treat MLLW and dispose of LLW and MLLW from both offsite and onsite generators. Hanford would also process TRU waste for disposal at WIPP as a result of those decisions. The HSW EIS analyzes the impacts at Hanford from implementing actions consistent with those programmatic decisions. Impacts at other potential waste generator and management sites have been evaluated in the programmatic documents, as well as in other site-specific NEPA analyses, and are not duplicated in this HSW EIS.

Consequences of solid waste program activities at Hanford are evaluated for all applicable resources as required under NEPA, including land use, geological resources, ecological resources, and traffic and transportation. Waste minimization and pollution prevention are also discussed.

The cumulative impacts of waste management activities that are the subject of the HSW EIS are considered in addition to those from other past, present, and reasonably foreseeable activities at Hanford. Hanford Site needs for geologic resources have been addressed in other NEPA documents (DOE 1999, 2001a). As part of commitments made in the *Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (DOE 1999) the Hanford Site is developing a plan for managing geologic resources that may be required for sitewide programs and activities.

A.3 Waste Types and Volumes

This category contains comments related to the types of waste and the waste volumes from Hanford and other DOE generators evaluated in the HSW EIS.

- *The WM PEIS needs to make it clear that pre-1970 waste containing plutonium and buried in cardboard boxes does not fall within the scope of this WM PEIS. The WM PEIS needs to provide a simple and crystal clear explanation as to why the pre-1970 waste is not within its scope. The explanation needs to provide a simple overview of the NEPA process, which is applicable to the pre-1970 burial grounds. Since the pre-1970 burial grounds are within close proximity to post-1970 TRU burial grounds, the WM PEIS needs to address consistencies and inconsistencies which may exist between the results of the NEPA process for the two different types of burial grounds.*

- *I would recommend that the scope of this HSW EIS address the pre-1970 TRU and clearly explain why it's not within the jurisdiction of this HSW EIS...*

- *It is essential that decisions regarding both onsite and offsite waste management and disposal be made with a full understanding of what is currently on site. The SW EIS must establish a detailed (baseline) solid waste inventory. That will require a rigorous assessment of the types and volumes of solid waste that has been previously at Hanford and what is currently waiting disposal. Added to that must be the anticipated onsite solid waste stream including pre-1990 wastes. Offsite wastes currently being received for disposal should not be included in a Hanford baseline. DOE should not assume these current relationships would automatically continue.*

  The solid waste baseline must then be combined with a sitewide waste inventory to create a Hanford Site baseline. This sitewide estimate must include other present and future Hanford Site waste streams such as remedial wastes and low and high activity tank wastes. It also must include residual contamination following planned cleanup activities.

- (Note: This comment also addresses issues discussed under Section A.2, Alternatives and Activities Analyzed in the HSW EIS.)

- *The amount of waste and its content (at Hanford) is very poorly and inadequately understood. At Hanford there is according to papers released by the Secretary of Energy, Hazel O'Leary, last year, 1.522 metric tons of plutonium unaccounted for. DOE is not convinced all of that ever actually existed. They are confidant that at least 400 kilograms really does exist and that they don't know where it is but are fairly certain it didn't leave Hanford. As a consequence, that material is likely in the facilities at Hanford or in disposal somewhere on the Hanford Site in unknown conditions. Those materials pose a sizable risk, which must be accounted for in the analysis under the SW EIS.*

- *Liquid wastes from other sites can only be shipped to Hanford for treatment (and disposal of the residual solid waste) if it can be safely shipped, handled, and treated. No liquids shall be directly disposed of.*

- *We believe that DOE should break this HSW EIS into two separate pieces. One HSW EIS should deal with the onsite waste. The other HSW EIS should deal with offsite wastes. The lack of specific information on the quantity or character of offsite wastes necessitates this.*

- *To aid in the comparison between candidate sites and in the analysis of impacts at Hanford, the SW EIS must examine the incremental impacts of any offsite wastes that may be sent to Hanford for treatment or disposal. Hanford's solid waste baselines are essential to this examination so decision makers, state, local, and tribal officials and the public know what is already present at Hanford.*

Response to Comments on Waste Types and Volumes

The HSW EIS describes the existing and anticipated waste types and volumes included within its scope, as well as an explanation of waste types specifically excluded from analysis. Several waste types, including high-level radioactive waste, immobilized low-activity tank waste, spent nuclear fuel, hazardous waste, and waste from environmental remediation activities (including pre-1970 buried waste), have been evaluated in other NEPA documents, or are being addressed under the CERCLA process. These wastes are also addressed as part of the HSW EIS cumulative impact analysis.

DOE recognizes the importance of examining the combined impacts from all waste storage, treatment, and disposal activities on the Hanford Site. The Groundwater Protection Program (DOE-RL 1999a, b; DOE-RL 2000) has undertaken an extensive task to quantify the radioactive and hazardous materials that may remain at the Hanford Site. Impacts from the management of these waste types are also included in the analyses of cumulative impacts in the HSW EIS to the extent that information is available.

DOE controls the accounting of nuclear material because of safeguards and security. When the material is technically or economically unrecoverable and intentionally sent to waste, it is referred to as "normal operating losses." The 1,522 kg (3355 lb) of plutonium in waste at Hanford is accounted for as follows:

- waste in the tank farms – 455 kg (1003 lb)
- solid waste in the burial grounds – 875 kg (1929 lb)

- waste in cribs, trenches, and ponds – 192 kg (423 lb)
- total – 1,522 kg (3355 lb).

The amount of plutonium in normal operating losses is consistent with the amounts reported in waste. For example, the normal operating loss of 192 kg (423 lb) in cribs, trenches, and ponds is consistent with the inventory of 190 kg (420 lb) (rounded) of plutonium that has been reported for TRU contaminated soil under the Hanford Environmental Restoration Program.

The HSW Program primarily manages solid operational radioactive and hazardous waste, and generally does not receive liquid waste. Liquids are treated and converted to a solid waste form before receipt by the Solid Waste Program for disposal. The Hanford Site *Solid Waste Acceptance Criteria* (HSSWAC) document requires stabilization or use of sorbents with waste containing free liquids in the LLBGs (FH 2003).

The HSW EIS considers the consequences of managing solid radioactive and mixed operational waste at Hanford as described in Section 3.3. This assessment uses the best available information on previously disposed of waste and forecast receipts. For the purposes of analysis in this EIS, a range of forecast LLW and MLLW volumes was evaluated to encompass the uncertainties in quantities of waste that might ultimately be received at Hanford under the WM PEIS RODs. The Lower Bound waste volume considered in this EIS was obtained from the Hanford Solid Waste Integrated Forecast Technical (SWIFT) report (Barcot 1999), which includes forecast waste receipts from onsite programs where applicable, as well as small quantities of waste that Hanford is obligated to receive under existing agreements with offsite generators. Additional offsite waste that could come to Hanford under the WM PEIS RODs is included in an Upper Bound waste volume, so the incremental impacts of that waste can be clearly evaluated. The volume of TRU waste is based on a recently updated forecast (Barcot 2002) to incorporate a single maximum volume only, because the Hanford Site is not expected to receive substantial quantities of TRU waste from offsite DOE generators. A Hanford Only waste volume was also evaluated for all alternatives so the impacts of receiving various quantities of offsite waste can be determined. The basis for quantities of each waste type evaluated is discussed in the HSW EIS.

A.4 Environmental Consequences and Analysis Methods

This category contains comments related to the types of environmental consequences evaluated in the HSW EIS and the methods used to analyze environmental impacts.

- *We are concerned about the risk assessment proposed by DOE. As the SX tank farm expert panel pointed out in their final report - none of the existing site or national vadose zone and groundwater models adequately predict the fate and transport of radioactive and hazardous waste through the soils at Hanford… Any model used must include a good assessment of the uncertainty of the calculations. It also must include a numerical estimate of the uncertainty of the model itself due to invalid assumptions, and model errors. This can only be achieved by validating the models against real world data. This validation must not use data that was used in the creation of the models.*

- *I think it is absolutely vital that all of the cumulative impacts from the site need to be addressed to great degree, and that needs to be with not just the best data available, but accurate data about the transport of radioactive and hazardous materials under the Hanford Site. To date that data does not exist. The most recent data released as part of the SX tank farm expert panel report indicates that previous data was wholly inadequate and inaccurate…*

- *The SW EIS proposed to do a comprehensive assessment of the cumulative risk…. We support a comprehensive assessment, but question whether adequate tools or data exist to perform such an assessment.*

- *To properly analyze the impacts, this HSW EIS should analyze impacts to every community effected by transport from every site waste is shipped. It should analyze the risks from disposal of these wastes in combination with all of the other risks already at Hanford… The scoping of this HSW EIS should be extended to allow affected communities along potential transport routes to have input into the framing of the HSW EIS.*

- (Note: This comment also addresses issues discussed under Section A.2, Alternatives and Activities Analyzed in the HSW EIS.)

- *Any interstate transportation of wastes is an issue, which must be carefully evaluated to ensure an adequate degree of public and environmental safety is maintained.*

- *An extensive stand of a big sagebrush/spiny hopsage plant community can be found there (central Plateau, of the Hanford Site). This plant community has been identified by WDFW as Priority Shrub Steppe Habitat…The expansion of the LLBG and MLLW trenches and any other new facilities related to this action could impact Priority Shrub Steppe Habitat of the Central Plateau if not wisely sited. We are requesting the following site selection processes occur for new facilities, expansions of reconfigurations…1) Avoid shrub steppe habitat by utilizing existing disturbed areas…2) Focus within the 200 East and 200 West fence line, excluding the 200 West expansion area…. etc.*

- (Note: This comment also addresses issues discussed under Section A.2, Alternatives and Activities Analyzed in the HSW EIS.)

- *The burial grounds are located in the vicinity of several facilities including T cribs, Z cribs, T-Tank Farms, 242-T Evaporator, 231-Z, 234-5, covered T-ditches, covered ditches from Z plant to U pond, covered U pond, covered ditches to S ponds and covered S ponds. The cleanup criteria, which may be addressed in the SW PEIS, should be consistent with the criteria used for the cleanup of the surrounding facilities. DOE needs to avoid spending millions of dollars to cleanup a burial ground when a nearby site may be left in place with a larger radionuclide inventory than the burial ground.*

- (Note: This comment also addresses issues discussed under Section A.2, Alternatives and Activities Analyzed in the HSW EIS.)

Response to Comments on Environmental Consequences and Analysis Methods

Hanford Site groundwater and vadose zone models have been incorporated into a sitewide model as part of the Groundwater Protection Program (DOE-RL 1999a, b; DOE-RL 2000). This sitewide simulation capability, known as the System Assessment Capability (SAC), has been designed as a stochastic capability with an option to perform deterministic simulations. It uses the groundwater model of the Hanford Site produced and supported by the Groundwater Monitoring Program. Currently, the groundwater portion of this model implements a fully three-dimensional conceptual model of the unconfined aquifer. This model has been inverse calibrated to Hanford Site water table measurements from 1944 to the present, and uses knowledge of geohydrologic units and field measurements of hydraulic conductivity to condition the model calibration. Future revisions of the SAC will incorporate inverse calibrated alternate conceptual models of the aquifer. However, at present, uncertainty in groundwater contaminant migration and fate is represented by the uncertainty in contaminant mobility as reflected in uncertainties in linear sorption isotherm model parameters (for example, distribution coefficients for various contaminants). At the time of preparation, the HSW EIS cumulative impacts evaluation used the best information available from the Groundwater Protection Program (DOE-RL 1999a, b; DOE-RL 2000) and from the Hanford Site Composite Analysis (Kincaid et al. 1998). The HSW EIS provides a conservative analysis commensurate with the purpose of the document, which is to bound and compare the consequences of the alternatives.

The consequences of transporting waste between DOE sites were evaluated in the WM PEIS (DOE 1997b) and the WIPP SEIS II (DOE 1997c). Analysis of onsite transportation is included in the HSW EIS, as needed, to address alternatives involving onsite and inter-site transportation of waste. The state-specific impacts of transportation through Washington and Oregon were presented in the revised draft HSW EIS. In response to comments, the impacts of shipments of LLW, MLLW, and TRU waste to Hanford and shipments of TRU waste from Hanford to WIPP for the entire route across the United States, using updated census data, are presented in the final HSW EIS.

The consequences of constructing new facilities that may be needed to implement various alternatives are evaluated in the HSW EIS, including ecological impacts on sensitive plant and animal communities.

Cleanup criteria for various facilities surrounding the active LLBGs are outside the scope of the HSW EIS. Cleanup criteria for environmental restoration facilities would be defined and evaluated during remedial actions conducted under the CERCLA process. Soil contamination in the 200 Areas has been evaluated in a number of recent studies (Simpson et al. 2001; Cooney 2002). However, environmental remediation activities are regulated separately from the routine waste disposal operations considered in the HSW EIS. Criteria for disposal of LLW and MLLW in the LLBGs (FH 2003) were established to comply with existing regulations, which generally result in risks similar to those used as criteria for remediation activities.

A.5 Public Involvement and Government Agency Consultations

This category contains comments related to public involvement and coordination of the HSW EIS decisions with other government agencies and stakeholders.

- *Information about this HSW EIS was inadequate for the public to understand the potential scope and ramifications. We formally request DOE extend the public comment period on this HSW EIS until January 30, 1998.*

- *In addition, the HSW EIS should seek input from the Yakama, Umatilla, and other affected Native American communities. Their aboriginal lands have been impacted and they have the greatest personal stake in the outcomes selected for Hanford.*

- *Full public disclosure of hearings must be held on any proposed inter-site transfer of waste for processing, interim storage or disposal.*

- (Note: This comment also addresses issues discussed under Section A.4, Environmental Consequences and Analysis Methods.)

Response to Comments on Public Involvement and Government Agency Consultation

The scoping comment period was extended beyond the required 30 days as requested. In addition to the HSW EIS public meetings, numerous briefings were provided to tribal organizations, state agencies, the Hanford Advisory Board, and other organizations upon request. Information regarding the final HSW EIS was also available at the National Dialog Meetings held in conjunction with publication of the final WM PEIS.

Scoping comments were requested from Tribal Nations, but none offered comments on the scope of the final HSW EIS. At their request, the Yakama Nation was invited to participate in preparation of the HSW EIS. Tribal Nations were given an opportunity to review the initial and revised drafts of the HSW EIS and provide input during the comment periods. Their comments have been considered in preparing the final HSW EIS.

Inter-site transport of waste between DOE sites was evaluated in the WM PEIS and WIPP SEIS II (discussed under responses in Section A.4). During preparation of those documents, extensive public input was obtained from communities potentially affected by transportation activities. Additional consultation with emergency planning organizations in potentially affected communities would take place as actual waste shipments are planned.

A.6 References

10 CFR 1021. "National Environmental Policy Act Implementing Procedures." Code of Federal Regulations. Online at: http://www.access.gpo.gov/nara/cfr/waisidx_02/10cfr1021_02.html

40 CFR 1500-1508. "Council on Environmental Quality Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act." Code of Federal Regulations. Online at: http://www.access.gpo.gov/nara/cfr/waisidx_01/40cfrv28_01.html

53 FR 12449. "Disposal of Hanford Defense High-Level, Transuranic and Tank Wastes, Hanford Site, Richland, Washington; Record of Decision (ROD)." *Federal Register* (April 14, 1988).

62 FR 55615. "Notice of Intent to Prepare a Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Washington." *Federal Register* (October 27, 1997). Online at: http://www.gpoaccess.gov/fr/index.html

62 FR 65254. "Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement Richland, Washington; Public Scoping Period Extension." *Federal Register* (December 11, 1997). Online at: http://www.gpoaccess.gov/fr/index.html

63 FR 3623. "Record of Decision for the Department of Energy's Waste Isolation Pilot Plant Disposal Phase." *Federal Register* (January 23, 1998). Online at: http://www.gpoaccess.gov/fr/index.html

63 FR 3629. "Record of Decision for the Department of Energy's Waste Management Program: Treatment and Storage of Transuranic Waste." *Federal Register* (January 23, 1998). Online at: http://www.gpoaccess.gov/fr/index.html

63 FR 41810. "Record of Decision for the Department of Energy's Waste Management Program: Treatment of Non-wastewater Hazardous Waste." *Federal Register* (August 5, 1998). Online at: http://www.gpoaccess.gov/fr/index.html

64 FR 46661. "Record of Decision for the Department of Energy's Waste Management Program: Storage of High-Level Radioactive Waste." *Federal Register* (August 26, 1999). Online at: http://www.gpoaccess.gov/fr/index.html

64 FR 61615. "Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)." *Federal Register* (November 12, 1999). Online at: http://www.gpoaccess.gov/fr/index.html

65 FR 10061. "Record of Decision for the Department of Energy's Waste Management Program: Treatment and Disposal of Low-Level Waste and Mixed Low-Level Waste; Amendment of the Record of Decision for the Nevada Test Site." *Federal Register* (February 25, 2000). Online at: http://www.gpoaccess.gov/fr/index.html

67 FR 45104. "Supplemental Environmental Impact Statement for Disposal of Immobilized Low-Activity Wastes from Hanford Tank Waste Processing." *Federal Register* (July 8, 2002). Online at: http://www.gpoaccess.gov/fr/index.html

68 FR 1052. "Notice of Intent To Prepare an Environmental Impact Statement for Retrieval, Treatment, and Disposal of Tank Waste and Closure of Single-Shell Tanks at the Hanford Site, Richland, WA." *Federal Register* (January 8, 2003). Online at: http://www.gpoaccess.gov/fr/index.html

42 USC 4321 et seq. National Environmental Policy Act (NEPA) of 1969, as amended. Online at: http://www4.law.cornell.edu

42 USC 9601 et seq. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. Online at: http://www4.law.cornell.edu

Barcot, R. A. 1999. *Solid Waste Integrated Forecast Technical (SWIFT) Report*. HNF-EP-0918, Rev. 5, Fluor Hanford, Inc., Richland, Washington.

Barcot, R. A. 2002. *Solid Waste Integrated Forecast Technical (SWIFT) Report.* HNF-EP-0918, Rev. 9, Fluor Hanford, Inc., Richland, Washington.

Cooney, F. M. 2002. *Groundwater/Vadose Zone Integration Project Methods Used to Assemble Site-Specific Waste Site Inventories for the Initial Assessment*. BHI-01570, Rev 0, Bechtel Hanford, Inc., Richland, Washington.

DOE. 1987. *Final Environmental Impact Statement for Disposal of Hanford Defense High-Level, Transuranic, and Tank Wastes*. DOE/EIS-0113, U.S. Department of Energy, Washington D.C.

DOE. 1997a. *A Contractor Report to the Department of Energy on Environmental Management Baseline Programs and Integration Opportunities (Discussion Draft).* INEL/EXT-97-00493. Complex-Wide EM Integration Team, U.S. DOE Office of Environmental Management, Germantown, Maryland.

DOE. 1997b. *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste.* DOE/EIS-0200-F, Vol. 1-5, U.S. Department of Energy, Washington, D.C.

DOE. 1997c. *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement*. DOE/EIS-0026-S-2, U.S. Department of Energy, Carlsbad Area Office, Carlsbad, New Mexico.

DOE. 1999. *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*. DOE/EIS-0222-F, U.S. Department of Energy, Washington D.C. Online at: http://www.hanford.gov/eis/hraeis/maintoc.htm

DOE. 2001a. *Environmental Assessment – Use of Existing Borrow Areas, Hanford Site, Richland, Washington*. DOE/EA-1403, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Online at: http://www.hanford.gov/netlib/ea.asp

DOE. 2001b. *Radioactive Waste Management*. DOE Order 435.1 Change 1, U.S. Department of Energy, Washington, D.C. Online at: http://www.directives.doe.gov

DOE-RL. 1999a. *Groundwater/Vadose Zone Integration Project Background Information and State of Knowledge*. DOE/RL-98-48, Vol. II, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL. 1999b. *Groundwater/Vadose Zone Integration Project Summary Description*. DOE/RL-98-48, Vol. I, Rev. 0., U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL. 2000. *Volume III: Groundwater/Vadose Zone Integration Project Science and Technology Summary Description*. DOE/RL-98-48, Volume III, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE and Ecology. 1996. *Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement*. DOE/EIS-0189, U.S. Department of Energy Richland Operations Office, Richland, Washington and Washington State Department of Ecology, Olympia, Washington.

Ecology, EPA, and DOE. 1989. *Hanford Federal Facility Agreement and Consent Order*. 89-10 (As Amended). Washington State Department of Ecology, U.S. Environmental Protection Agency, U.S. Department of Energy, Richland, Washington. Online at: http://www.hanford.gov/tpa/tpahome.htm

FH. 2003. *Hanford Site Solid Waste Acceptance Criteria*. HNF-EP-0063, Rev. 9, Fluor Hanford, Inc., Richland Washington. Online at: http://www.hanford.gov/wastemgt/wac/acceptcriteria.cfm

Kincaid, C. T., M. P. Bergeron, C. R. Cole, M. D. Freshley, N. L. Hassig, V. G. Johnson, D. I. Kaplan, R. J. Serne, G. P. Streile, D. L. Strenge, P. D. Thorne, L. W. Vail, G. A. Whyatt, and S. K. Wurstner. 1998. *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site.* PNNL-11800, Pacific Northwest National Laboratory, Richland, Washington.

Simpson, B. C., R. A. Corbin, and S. F. Agnew. 2001. *Groundwater/Vadose Zone Integration Project: Hanford Soil Inventory Model*. BHI-01496, Rev 0, Bechtel Hanford Inc., Richland, Washington.

WAC 173-303. “Dangerous Waste Regulations.” Washington Administrative Code, Olympia, Washington. Online at: http://www.leg.wa.gov/wac/index.cfm?fuseaction=chapterdigest&chapter=173-303

Appendix B

Detailed Alternative Descriptions, Assumptions, Waste Volumes, and Waste Stream Flowsheets

Appendix B

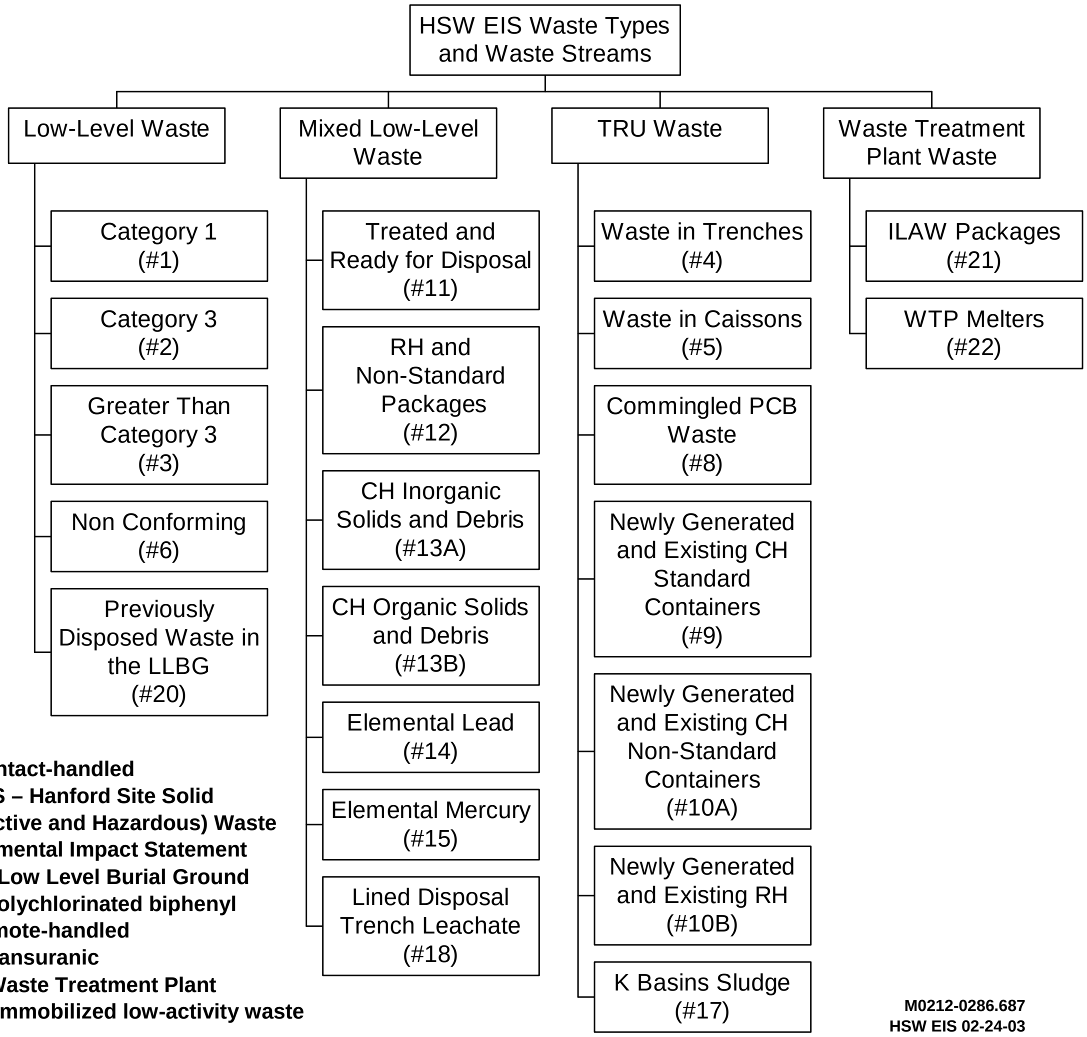
Detailed Alternative Descriptions, Assumptions, Waste Volumes, and Waste Stream Flowsheets

B.1 Introduction

This appendix contains five sets of information. The first set identifies waste streams by waste stream number. Basic information on the waste streams and facilities is contained in Section 2 of this environmental impact statement (EIS). The second set of information is a list by waste type of processing assumptions for each waste stream. The third set of information is the volume of each waste stream expected to be received annually for each waste type. The fourth set of information is the waste stream inventories. The fifth set of information is detailed flowsheets showing the disposition pathway for each waste stream for each alternative. For the presentation of waste volume numbers, the volumes have been rounded to the nearest whole cubic meter. It should be recognized that for some numbers, the number of significant figures exceeds the accuracy of the information. Occasional differences may be noted in the unit digit due to rounding.

B.2 Waste Stream Numbers

Figure B.1 is the same as Figure 2.1 (see Section 2 of Volume I) but includes the waste stream numbers that were used during the development of the *Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement* (HSW EIS) to track individual waste streams. For each waste stream, a number is shown in the figure, such as (#2), and was the identification number assigned to that stream. This is the alphanumeric designation by which each waste stream was initially identified in the development of this EIS. Streams #7, #16, and #19 were dropped from consideration as separate waste streams in the EIS during its development. Stream #7, composed of greater than Class C Wastes (an NRC category no longer applicable to Hanford waste), was combined with Stream #3. Stream 16, composed of contaminated equipment and materials for decontamination, was eliminated from the scope of the EIS, and Stream #19, greater than Category 3 (GTC3) and transuranic (TRU) waste in the Low Level Burial Grounds (LLBGs), was combined with stream #20 when subsequent analyses determined these wastes to be low-level waste (LLW). It can also be noted that two waste streams were subdivided to allow more detailed analysis (#10 and #13).



CH – contact-handled
HSW EIS – Hanford Site Solid (Radioactive and Hazardous) Waste Environmental Impact Statement
LLBG – Low Level Burial Ground
PCB – polychlorinated biphenyl
RH – remote-handled
TRU – transuranic
WTP – Waste Treatment Plant
ILAW – immobilized low-activity waste

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HSW EIS 02-24-03

Figure B.1. Waste Types and Waste Streams Considered in the HSW EIS

(See text for discussion of waste streams #7, #16, and #19 that are not included in this diagram.)

B.3 HSW EIS Waste Processing Assumptions

Planning for the management of LLW, MLLW, TRU waste, and WTP waste at the Hanford Site has been ongoing for several years and has been documented in Anderson and Konynenbelt (1995), Sederburg (1997), and the Hanford Waste Management Strategic Plan (DOE-RL 2001). These documents formed the bases for the waste processing assumptions used to develop annual and life-cycle waste flows through facilities for each alternative. These assumptions specify the processing requirements for a particular waste stream, how much waste is sent, when the waste is sent, and what happens to the waste as it is processed. It should be noted that these assumptions cover the time period 2002 through 2046. Although the first year covered by these assumptions has passed, the environmental impacts would not change significantly by removing the information associated with 2002.

The assumptions for management of LLW, MLLW, TRU waste, and WTP wastes are contained in Tables B.1 through B.4. These assumptions describe how the waste is processed but do not necessarily specify the facilities at which the waste is managed. The facilities may change depending on the alternative. Information about facilities used in each alternative is contained in Section 3.3 of this EIS (Section 3, Volume I).

Table B.1. Assumptions for Management of Low-Level Waste

Stream Number	Description	Assumptions
NA	General Comments	All waste received after 2032 is assumed to be verified and packaged for disposal. Disposal activities such as Repackage into HICs and In-Trench Grouting will continue through 2046.
1	Category 1 LLW	The majority of Cat 1 LLW will be sent directly to disposal. Disposal of RH Cat 1 LLW results in a 3 to 1 volume increase due to handling criteria. A 5% fraction of the CH Cat 1 LLW in drums and boxes will be selected for verification at WRAP. Large boxes are assumed to be verified at the generating facility. Of the waste selected for verification, 10% is assumed to require glovebox processing. Drums will be processed in WRAP; boxes in the T Plant Complex. Drum processing results in a 60% volume decrease due mainly to compaction. Boxes would not be compacted and therefore processing results in a 50% volume increase. 175 m^3 of CH MLLW is assumed to be reclassified as CH Cat 1 LLW and disposed of in FY 2002 (80 m^3) and FY 2003 (95 m^3). These volumes have been included in the disposal estimates.
2	Category 3 LLW	Cat 3 LLW requires either Repackaging in HICs or In-Trench Grouting to provide additional stabilization prior to disposal. These options are considered equally viable for CH waste and rather than limit the amount of waste that can be sent to either option, the impacts will be analyzed assuming 100% of the CH Cat 3 LLW will undergo each operation. It is assumed that In-Trench Grouting would not be appropriate for RH Cat 3 LLW. Repackaging in HICs and Trench Grouting are assumed to result in a 3 to 1 increase for CH waste and a 5 to 1 increase for RH waste. A 5% fraction of the CH Cat 3 LLW in drums and boxes will be selected for verification at WRAP. Large boxes are assumed to be verified at the generating facility. Of the waste selected for verification, 10% is assumed to require glovebox processing. Drums will be processed in WRAP; boxes in the T-Plant Complex. Drum processing results in a 60% volume decrease due mainly to compaction. Boxes would not be compacted and therefore processing results in a 50% volume increase.
3	GTC3	This waste stream would be managed in a manner similar to the Cat 3 LLW.
6	Non-Conforming LLW	Non-Conforming LLW currently stored in CWC will be treated in 2008, which is assumed to double the waste volume. The treated waste will be sent directly to disposal.
20	Previously Disposed of Waste in the LLBGs	The current inventory of waste disposed of in the LLBGs is assumed to remain in the LLBGs.

Table B.2. Assumptions for Management of Mixed Low-Level Waste

Stream Number	Description	Assumptions
NA	General Comments	All waste received after 2032 is assumed to be treated, verified, and packaged for disposal.
11	Treated and Ready for Disposal	A 10% fraction of the CH MLLW currently stored or received in a form suitable for disposal will be sent to WRAP for verification. Of the current inventory selected for verification, 20% is assumed to be verified each year from FY 2002 to FY 2006. Newly generated waste will be verified in the year it is received. 20% of the current inventory will be disposed of each year from FY 2002 to FY 2006. Newly generated waste will be disposed of in the year it is received. 175 m^3 of currently stored MLLW is expected to be reclassified as LLW and disposed of in the LLBGs in FY 2002 (80 m^3) and FY 2003 (95 m^3). Existing MLLW Trench capacity is assumed to be 22,900 m^3 of CH waste per trench. One cubic meter of RH waste is assumed to displace 5.725 m^3 of CH waste.
12	RH & Non-Standard Packages	RH & Non-Standard Packages will be treated beginning in 2016. The processing rate will be a constant quantity (171 m^3/yr) sufficient to process all waste by 2032.
13A	CH Inorganic Solids and Debris	10% of the waste will be verified at WRAP. Inventory waste will be verified over a 5-year period at a constant rate starting in 2002; newly generated waste and waste returning from Commercial Treatment Facilities will be verified in the year received or treated. CH Inorganic Solids and Debris will undergo non-thermal treatment beginning in 2003. The treatment rates will be a constant quantity (813 m^3/yr) sufficient to reduce the storage inventory to zero by 2012. (Note: At the time these assumptions were developed, the target was to reduce the CH MLLW inventory to zero by 2014; however, a constant treatment rate through 2014 results in a negative inventory for this waste stream. Therefore, the rate has been set to reduce the inventory to zero in 2012.) After 2012, wastes will be treated as generated. Treatment is assumed to double the waste volume for disposal. For Alternative Group B, this waste stream will be treated in a new waste processing facility. This facility is assumed to begin operating in 2008 and will process waste at a constant rate (1,479 m^3/yr) sufficient to reduce the storage inventory to zero by 2014. After 2014, wastes will be treated as generated. Treatment is assumed to double the waste volume for disposal.

Table B.2. (contd)

Stream Number	Description	Assumptions
13B	CH Organic Solids and Debris	10% of the waste will be verified at WRAP. Inventory waste will be verified over a 5-year period at a constant rate starting in 2002; newly generated waste and waste returning from Commercial Treatment Facilities will be verified in the year received or treated. CH Organic Solids and Debris will undergo thermal treatment beginning in 2003. The treatment rates will be a constant quantity (417 m^3/yr) sufficient to reduce the storage inventory to zero by 2014. After 2014, wastes will be treated as generated. Treatment is not expected to change the waste volume for disposal. For Alternative Group B, this waste stream will be treated in a new waste processing facility. This facility is assumed to begin operating in 2008 and will process waste at a constant rate (660 m^3/yr) sufficient to reduce the storage inventory to zero by 2014. After 2014, wastes will be treated as generated. Treatment is not expected to change the waste volume for disposal. (Note: The Hanford Site has an existing contract for thermal treatment requiring 120 m^3 of waste to be treated each year from 2003 to 2005. In all alternatives, this contract is assumed to be fulfilled.)
14	Elemental Lead	Elemental Lead will undergo non-thermal treatment beginning in 2003. The treatment rates will be a constant quantity (46 m^3/yr) sufficient to reduce the storage inventory to zero by 2014. After 2014, wastes will be treated as generated. Treatment is assumed to double the waste volume for disposal. For Alternative Group B, this waste stream will be treated in a new waste processing facility. This facility is assumed to begin operating in 2008 and will process waste at a constant rate (78 m^3/yr) sufficient to reduce the storage inventory to zero by 2014. After 2014, wastes will be treated as generated. Treatment is assumed to double the waste volume for disposal.
15	Elemental Mercury	Elemental Mercury will undergo non-thermal treatment beginning in 2003. The treatment rates will be a constant quantity (2 m^3/yr) sufficient to reduce the storage inventory to zero by 2014. After 2014, wastes will be treated as generated. Treatment is assumed to result in a 15 to 1 increase in the waste volume for disposal. For Alternative Group B, this waste stream will be treated in a new waste processing facility. This facility is assumed to begin operating in 2008 and will process waste at a constant rate (3 m^3/yr) sufficient to reduce the storage inventory to zero by 2014. After 2014, wastes will be treated as generated. Treatment is assumed to result in a 15 to 1 increase in the waste volume for disposal.
18	MLLW Trench Leachate	Leachate from the MLLW trenches will be collected and sent to the Effluent Treatment Facility for treatment and disposal through 2025. After 2025, pulse driers will be used to treat the leachate.

Table B.3. Assumptions for Management of Transuranic Waste

Stream Number	Description	Assumptions
NA	General Comments	All waste received after 2032 is assumed to be verified, certified, and packaged for shipment.
4	Waste in Trenches	TRU waste retrievably stored in the LLBG trenches is assumed to be retrieved from the LLBGs. Waste in drums will be moved to CWC for storage while waste in boxes and RH waste will be sent directly to the treatment facility as capacity becomes available. All waste will be shipped to WIPP for disposal. **Retrieval** The following assumptions were made regarding retrieval to estimate subsequent storage, processing, and disposition impacts. From 2002 to 2006, the retrieval rate is assumed to be 732 m^3 per year. From 2007 to 2014, the rate will increase to 1,361 m^3 per year. Although some boxes and RH waste are likely to be encountered throughout the retrieval efforts, to simplify the analysis it has been assumed that all CH drums are retrieved followed by all CH boxes and finally RH waste. CH drums will be moved to CWC for storage prior to processing. CH boxes and RH waste is assumed to be overpacked and stored in the retrieval trench until processing capacity is available. During retrieval the contents of the CH drums will be determined to be either LLW or TRU waste. 50% of this waste is expected to be reclassified as LLW and remain in the trench as disposed of waste. **Processing** Retrievably stored CH drums will be processed at a rate (338 m^3/yr) sufficient to work off the inventory by the startup of processing of non-standard TRU wastes in 2013. Drum processing will result in a LLW Cat 1 volume equal to 10% of the TRU volume. RH and non-standard TRU waste processing is expected to reduce the volume of TRU by approximately 10% and generate volumes of LLW and MLLW roughly 30% and 2% of the original volume respectively. A portion (approximately 30%) of the LLW generated during RH waste processing is assumed to be LLW Cat 3. RH and non-standard TRU waste will be processed starting in 2015 and waste in 2013 respectively. The processing rate will be a constant quantity (366 m^3/yr CH and 10 m^3/yr RH) sufficient to process all waste by 2032. A ramp up in capacity of one-third the first year and two-thirds the second was assumed for CH processing. No ramp up is assumed for RH as the facility will have experience with RH waste from processing the K Basins Sludge. **Shipment to WIPP** Waste is assumed to be shipped to WIPP in the year it is processed.

Table B.3. (contd)

Stream Number	Description	Assumptions
5	Waste in Caissons	TRU waste retrievably stored in Caissons is assumed to be retrieved and shipped directly to the processing facility. **Retrieval** The following assumptions were made regarding retrieval to estimate subsequent storage, processing, and disposition impacts. Caisson retrieval is assumed to occur from 2015 to 2018 at a rate of 6 m^3 per year. **Processing** Caisson wastes will be processed immediately after retrieval at a constant rate from 2015 to 2018. Processing will result in a 2 to 1 volume increase. **Shipment to WIPP** Waste is assumed to be shipped to WIPP in the year it is processed.
8	Commingled PCB Waste	Commingled PCB waste will be processed beginning in 2013. The processing rate will be a constant quantity (5 m^3/yr) sufficient to process all waste by 2032 with a ramp up in capacity of 1/3 the first year and 2/3 the second. Waste is assumed to be shipped to WIPP in the year it is processed.
9	Newly Generated and Existing CH Standard Containers	CH TRU waste in drums and SWBs will be stored in CWC awaiting certification and shipment to WIPP. Newly generated and existing drums in above ground storage will be processed at a constant rate through 2032 (197 m^3 NDE/NDA and 25 m^3 glovebox). SWBs will be processed as generated through 2007 (average 250 m^3/yr). After 2007, the rate will be constant at 801 m^3/yr. This rate will result in all TRU waste in SWBs being shipped to WIPP by 2032. 5% of drums assayed are assumed to be reclassified as LLW. 10% of newly generated drums and 35% of existing drums will require glovebox processing. Glovebox processing will result in a 10% volume increase. Waste is assumed to be shipped to WIPP in the year it is processed.
10A	Newly Generated and Existing CH Non-Standard Containers	CH waste in non-standard containers will be processed beginning in 2013. The processing rate will be a constant quantity (57 m^3/yr) sufficient to process all waste by 2032 with a ramp up in capacity of one-third the first year and two-thirds the second. Processing will result in a 5% increase in the volume of TRU and generate a volume of LLW equal to 20% of the original waste volume. Waste is assumed to be shipped to WIPP in the year it is processed.
10B	Newly Generated and Existing RH Waste	RH waste will be processed beginning in 2015. The processing rate will be a constant quantity (121 m^3/yr) sufficient to process all waste by 2032. No ramp up is assumed as the facility will have experience with RH waste from processing the K Basins Sludge. Processing will result in a 5% increase in the volume of TRU and generate a volume of LLW equal to 20% of the original waste volume. Waste is assumed to be shipped to WIPP in the year it is processed.
17	K Basins Sludge	K Basins Sludge wastes will be treated in 2013 and 2014. One-third of the waste will be treated in 2013 and two-thirds in 2014. Processing by macroencapsulation will result in a 3 to 1 volume increase. Waste is assumed to be shipped to WIPP in the year it is processed.

Table B.4. Assumptions for Management of Waste Treatment Plant Wastes

Stream Number	Description	Assumptions
21	Immobilized Low-Activity Waste	ILAW will be disposed of in the year it is received.
22	WTP Melters	WTP Melters will be disposed of in the year they are received.

B.4 Waste Volumes

Tables B.5 through B.14 summarize the waste volumes to be managed by waste stream under each of the alternatives for LLW, MLLW, TRU waste, and WTP wastes, respectively. Section 2.1 in the body of the EIS can be consulted for text descriptions of each waste stream, and Appendix C contains additional information regarding the development of the waste volumes.

Table B.5. Low-Level Waste Hanford Only Volumes (m^3)[a, b]

Stream Number	Stream Name	Inventory/ Disposed	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012-2046	Total
1	LLW Cat 1	18,944	2,410	2,486	3,241	3,107	3,120	3,117	3,872	4,611	3,827	3,902	36,156	88,792
2	LLW Cat 3	2,773	546	547	573	561	551	534	534	349	345	1,513	30,782	39,607
3	GTC3	<1												<1
6	Non-Conforming	299	0	0	0	0	0	0	0	0	0	0	0	299
20	Previously Disposed	283,067	Not Applicable											283,067

(a) To obtain cubic yards, multiply by 1.31.
(b) Rounded to the nearest cubic meter in this table for calculational convenience; significant figures are not meant to indicate the accuracy of the numbers.

Table B.6. Low-Level Waste Lower Bound Volumes (m^3)[a, b]

Stream Number	Stream Name	Inventory/ Disposed	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012-2046	Total
1	LLW Cat 1	18,944	3,429	4,290	4,181	3,770	4,241	3,493	4,241	4,998	4,196	4,275	47,825	107,883
2	LLW Cat 3	2,773	1,048	769	727	676	568	559	552	366	362	1,530	31,403	41,334
3	GTC3	<1												<1
6	Non-Conforming	299	0	0	0	0	0	0	0	0	0	0	0	299
20	Previously Disposed	283,067	Not Applicable											283,067

(a) To obtain cubic yards, multiply by 1.31.
(b) Rounded to the nearest cubic meter in this table for calculational convenience; significant figures are not meant to indicate the accuracy of the numbers.

Table B.7. Low-Level Waste Upper Bound Volumes (m^3)[a, b]

Stream Number	Stream Name	Inventory/ Disposed	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012-2046	Total
1	LLW Cat 1	18,944	3,429	4,290	24,103	23,692	24,163	23,415	24,163	7,409	6,591	7,882	119,048	287,130
2	LLW Cat 3	2,773	1,048	769	2,905	2,854	2,747	2,737	2,730	630	624	1,925	39,190	60,933
3	GTC3	<1												<1
6	Non-Conforming	299	0	0	0	0	0	0	0	0	0	0	0	299
20	Previously Disposed	283,067	Not Applicable											283,067

(a) To obtain cubic yards, multiply by 1.31.
(b) Rounded to the nearest cubic meter in this table for calculational convenience; significant figures are not meant to indicate the accuracy of the numbers.

Table B.8. Mixed Low-Level Waste Hanford Only Volumes (m^3)$^{(a, b)}$

Stream Number	Stream Name	Inventory/ Disposed	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012-2046	Total
11	Treated & Ready for Disposal	2,112	704	142	691	1,183	863	1,111	1,612	2,164	2,136	2,613	12,726	28,054
12	RH & Non-Standard	65	175	136	127	111	97	43	56	112	118	123	1,743	2,904
13A	CH Inorganic Solids & Debris	3,172	402	416	440	426	377	329	368	385	381	688	12,724	20,108
13B	CH Organic Solids & Debris	2,553	235	196	249	190	187	160	171	201	190	153	2,241	6,727
14	Elemental Lead	445	9	9	10	10	11	8	9	10	9	6	65	600
15	Elemental Mercury	13	0	0	0	0	1	1	1	1	1	1	1	21
18	MLLW Leachate	Dependent on alternative chosen												

(a) To obtain cubic yards, multiply by 1.31.

(b) Rounded to the nearest cubic meter in this table for calculational convenience; significant figures are not meant to indicate the accuracy of the numbers.

Table B.9. Mixed Low-Level Waste Lower Bound Volumes (m^3)$^{(a, b)}$

Stream Number	Stream Name	Inventory/ Disposed	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012-2046	Total
11	Treated & Ready for Disposal	2,112	704	142	691	1,183	863	1,111	1,612	2,164	2,136	2,613	12,754	28,082
12	RH & Non-Standard	65	175	136	127	111	97	43	56	112	118	123	1,743	2,904
13A	CH Inorganic Solids & Debris	3,172	403	417	441	426	377	329	368	385	381	688	12,724	20,111
13B	CH Organic Solids & Debris	2,553	237	198	251	192	189	162	173	203	192	155	2,284	6,790
14	Elemental Lead	445	14	10	11	10	11	8	9	10	9	6	65	608
15	Elemental Mercury	13	0	0	0	0	1	1	1	1	1	1	1	21
18	MLLW Leachate	Dependent on alternative chosen												

(a) To obtain cubic yards, multiply by 1.31.

(b) Rounded to the nearest cubic meter in this table for calculational convenience; significant figures are not meant to indicate the accuracy of the numbers.

Table B.10. Mixed Low-Level Waste Upper Bound Volumes (m^3)[a, b]

Stream Number	Stream Name	Inventory/ Disposed	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012-2046	Total
11	Treated & Ready for Disposal	2,112	704	142	20,190	20,683	20,363	20,610	21,112	3,685	3,441	3,920	51,457	168,419
12	RH & Non-Standard	65	175	136	127	111	97	43	56	112	118	123	1,743	2,904
13A	CH Inorganic Solids & Debris	3,172	403	417	441	426	377	329	368	385	381	688	12,724	20,111
13B	CH Organic Solids & Debris	2,553	237	198	251	192	189	162	173	203	192	155	2,284	6,790
14	Elemental Lead	445	14	10	11	10	11	8	9	10	9	6	65	608
15	Elemental Mercury	13	0	0	0	0	1	1	1	1	1	1	1	21
18	MLLW Leachate	Dependent on alternative chosen												

(a) To obtain cubic yards, multiply by 1.31.

(b) Rounded to the nearest cubic meter in this table for calculational convenience; significant figures are not meant to indicate the accuracy of the numbers.

Table B.11. Transuranic Waste Hanford Only Volumes (m^3)[a, b]

Stream Number	Stream Name	Inventory/ Disposed	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012-2046	Total
4	Waste from Trenches	14,552	0	0	0	0	0	0	0	0	0	0	0	14,552
5	Waste from Caissons	23	0	0	0	0	0	0	0	0	0	0	0	23
8	Commingled PCB Waste	80	15	0	0	0	0	0	0	0	0	0	0	95
9	CH Standard Containers	849	414	424	587	486	752	896	1,519	1,518	1,503	1,438	17,334	27,719
10A	CH Non-Standard Containers	585	0	0	0	0	0	0	0	0	0	0	492	1,077
10B	RH Waste	46	250	130	130	131	130	64	72	72	180	158	794	2,157
17	K Basins Sludge	0	0	64	70	6	0	0	0	0	0	0	0	139

(a) To obtain cubic yards, multiply by 1.31.

(b) Rounded to nearest cubic meter in this table for calculational convenience; significant figures are not meant to indicate the accuracy of the numbers.

Table B.12. Transuranic Waste Lower Bound Volumes (m^3)$^{(a, b)}$

Stream Number	Stream Name	Inventory/ Disposed	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012-2046	Total
4	Waste from Trenches	14,552	0	0	0	0	0	0	0	0	0	0	0	14,552
5	Waste from Caissons	23	0	0	0	0	0	0	0	0	0	0	0	23
8	Commingled PCB Waste	80	15	0	0	0	0	0	0	0	0	0	0	95
9	CH Standard Containers	849	418	428	587	486	752	896	1,519	1,518	1,503	1,438	17,334	27,727
10A	CH Non-Standard Containers	585	0	0	0	0	0	0	0	0	0	0	492	1,077
10B	RH Waste	46	270	144	130	131	130	64	72	72	180	158	794	2,191
17	K Basins Sludge	0	0	64	70	6	0	0	0	0	0	0	0	139

(a) To obtain cubic yards, multiply by 1.31.

(b) Rounded to nearest cubic meter in this table for calculational convenience; significant figures are not meant to indicate the accuracy of the numbers.

Table B.13. Transuranic Waste Upper Bound Volumes (m^3)$^{(a, b)}$

Stream Number	Stream Name	Inventory/ Disposed	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012-2046	Total
4	Waste from Trenches	14,552	0	0	0	0	0	0	0	0	0	0	0	14,552
5	Waste from Caissons	23	0	0	0	0	0	0	0	0	0	0	0	23
8	Commingled PCB Waste	80	15	0	0	0	0	0	0	0	0	0	0	95
9	CH Standard Containers	849	418	428	821	720	986	1,130	1,753	1,518	1,503	1,438	17,334	28,897
10A	CH Non-Standard Containers	585	0	0	56	56	56	56	56	0	0	0	492	1,357
10B	RH Waste	46	270	144	140	141	140	74	82	72	180	158	794	2,241
17	K Basins Sludge	0	0	64	70	6	0	0	0	0	0	0	0	139

(a) To obtain cubic yards, multiply by 1.31.

(b) Rounded to nearest cubic meter in this table for calculational convenience; significant figures are not meant to indicate the accuracy of the numbers.

Table B.14. Waste Treatment Plant Waste Volumes $(m^3)^{(a, b)}$

Stream Number	Stream Name	Inventory/ Disposed	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012-2046	Total
21	ILAW Packages	0	0	0	0	0	0	0	1,673	3,345	3,345	3,345	199,292	211,000
22	WTP Melters	0	0	0	0	0	0	0	0	175	350	350	5,950	6,825

(a) To obtain cubic yards, multiply by 1.31.

(b) Rounded to nearest cubic meter in this table for calculational convenience; significant figures are not meant to indicate the accuracy of the numbers.

B.5 Radionuclide Inventories

Tables B.15 through B.24 contain the inventory of long-lived mobile radionuclides in each of the major waste types or waste streams by the expected final disposal location for the various alternative groups. These radionuclides are of major interest for migration calculations.

In the cases of technetium and iodine, separate values are presented for wastes that will be placed directly in the soil and for wastes that are expected to be disposed of in a grout matrix. The grout matrix substantially reduces the mobility of these radionuclides.

Since 1996, Hanford disposal criteria has required Category 3 LLW to be disposed of either in an HIC or using in-trench grouting. Therefore, all technetium and iodine disposed of after 1996 Category 3 LLW have been assumed to be in a grout matrix.

MLLW is composed of a variety of waste streams. Some of the MLLW is expected to be encased in grout during treatment to meet land disposal restrictions and some will be disposed of in HICs or grouted in the trench to meet Hanford disposal criteria. The simplifying assumption was made that each MLLW waste stream is either entirely ungrouted, entirely grouted, or half of the volume is assumed to be grouted. The grouted and ungrouted volumes of each waste stream were associated with their annual disposal rates and their respective radionuclide concentrations to determine the grouted and ungrouted activities in the forecast MLLW. Then the grouted and ungrouted activities of all waste streams disposed of in a location were tallied for each nuclide. The grouted fractions assumed for each MLLW stream are as follows:

Stream 11 – Treated and Ready for Disposal: RH portion and all offsite waste grouted
Stream 12 – RH and Non-Standard Packages: 100% grouted
Stream 13A&B – CH Inorganic and Organic Solids and Debris: 50% grouted
Stream 14 – Elemental Lead: 100% Ungrouted
Stream 15 – Elemental Mercury: 100% Ungrouted

Table B.15. Inventory of Long-Lived Mobile Radionuclides in HSW for the Various Alternative Groups, Ci

LLW Previously Buried in LLBGs - Included in All Alternative Groups												
Radionuclide	**Pre-1970 LLW**		**Total**	**1970-1988 LLW**		**Total**	**1989-1995 LLW**		**Total**	**Area Totals**		**Total**
	200 E	**200 W**		**200 E**	**200 W**		**200 E**	**200 W**		**200 E**	**200 W**	
C-14	0	0	0	2.2E+2	3.9E+2	6.1E+2	5.1E+0	9.3E+0	1.4E+1	2.2E+2	4.0E+2	6.2E+2
Tc-99	5.2E-1	1.3E-1	6.5E-1	0	0	0	1.4E-1	4.7E-1	6.1E-1	6.6E-1	6.0E-1	1.3E+0
Grouted Tc-99	0	0	0	0	0	0	0	0	0	0	0	0
I-129	1.2E-3	1.7E-4	1.4E-3	1.9E-2	1.8E-3	2.0E-2	9.5E-5	3.1E-2	3.1E-2	2.0E-2	3.3E-2	5.3E-2
Grouted I-129	0	0	0	0	0	0	0	0	0	0	0	0
U-233	1.0E+1	0	1.0E+1	0	0	0	2.1E-5	6.5E-2	6.5E-2	1.0E+1	6.5E-2	1.0E+1
U-234	3.7E-1	1.4E+0	1.8E+0	3.1E-2	3.9E+1	3.9E+1	1.9E-3	5.8E+0	5.8E+0	4.0E-1	4.7E+1	4.7E+1
U-235	1.1E-2	4.4E-2	5.5E-2	2.6E-3	3.3E+0	3.3E+0	4.3E-4	1.3E+0	1.3E+0	1.4E-2	4.7E+0	4.7E+0
U-236	7.5E-3	3.0E-2	3.7E-2	0	0	0	1.9E-6	5.8E-3	5.8E-3	7.5E-3	3.5E-2	4.3E-2
U-238	2.7E-1	1.1E+0	1.3E+0	6.3E-2	2.8E+1	2.8E+1	1.9E-2	6.0E+1	6.0E+1	3.5E-1	9.0E+1	9.0E+1
Sum U-23x[(a)]	1.1E+1	2.6E+0	1.4E+1	9.6E-2	7.1E+1	7.1E+1	2.2E-2	6.7E+1	6.8E+1	1.1E+1	1.4E+2	1.5E+2

(a) Doses per unit activity for the listed uranium isotopes are sufficiently similar that it is often convenient to employ only the total uranium in some calculations. For that reason, the sum of the activity of individual uranium isotopes is also given in this and following inventory tabulations.

Table B.16. Inventory of Long-Lived Mobile Radionuclides in HSW for Alternative Group A, Ci (Sheet 1 of 4)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046 Alternative Group A - LLW and MLLW in Deeper/Wider Trenches in 200E and 200W; Melters and ILAW near PUREX												
Radionuclide	**Category 1 LLW**						**Category 3 LLW**					
	1996 to 2007			**2008 to 2046**			**1996 to 2007**			**2008 to 2046**		
	200 E	**200 W**	**Total**	**200 E**	**200 W**	**Total**	**200 E**	**200 W**	**Total**	**200 E**	**200 W**	**Total**
Hanford Only Waste Volume[(a)]												
C-14	0	3.3E+0	3.3E+0	0	1.3E+1	1.3E+1	0	1.5E-1	1.5E-1	0	4.4E-1	4.4E-1
Tc-99	0	3.0E-1	3.0E-1	0	1.1E+0	1.1E+0	0	0	0	0	0	0
Grouted Tc-99	0	0	0	0	0	0	0	7.2E+1	7.2E+1	0	3.2E+3	3.2E+3
I-129	0	2.6E-3	2.6E-3	0	3.0E-3	3.0E-3	0	0	0	0	0	0
Grouted I-129	0	0	0	0	0	0	0	3.4E-7	3.4E-7	0	5.0E+0	5.0E+0
U-233	0	1.0E-1	1.0E-1	0	3.7E-1	3.7E-1	0	9.8E-2	9.8E-2	0	3.0E-1	3.0E-1
U-234	0	1.7E-1	1.7E-1	0	6.1E-1	6.1E-1	0	1.2E+2	1.2E+2	0	3.7E+2	3.7E+2
U-235	0	3.6E-2	3.6E-2	0	1.3E-1	1.3E-1	0	3.5E+0	3.5E+0	0	1.1E+1	1.1E+1
U-236	0	4.0E-3	4.0E-3	0	1.5E-2	1.5E-2	0	1.6E+1	1.6E+1	0	4.8E+1	4.8E+1
U-238	0	4.1E-1	4.1E-1	0	1.5E+0	1.5E+0	0	2.0E+2	2.0E+2	0	6.0E+2	6.0E+2
Sum of U-23x	0	7.2E-1	7.2E-1	0	2.6E+0	2.6E+0	0	3.4E+2	3.4E+2	0	1.0E+3	1.0E+3
Lower Bound Waste Volume												
C-14	0	4.1E+0	4.1E+0	0	1.6E+1	1.6E+1	0	1.5E-1	1.5E-1	0	4.6E-1	4.6E-1
Tc-99	0	3.7E-1	3.7E-1	0	1.3E+0	1.3E+0	0	0	0	0	0	0
Grouted Tc-99	0	0	0	0	0	0	0	7.2E+1	7.2E+1	0	3.2E+3	3.2E+3
I-129	0	3.2E-3	3.2E-3	0	3.7E-3	3.7E-3	0	0	0	0	0	0
Grouted I-129	0	0	0	0	0	0	0	3.5E-7	3.5E-7	0	5.0E+0	5.0E+0
U-233	0	1.3E-1	1.3E-1	0	4.5E-1	4.5E-1	0	1.0E-1	1.0E-1	0	3.1E-1	3.1E-1
U-234	0	2.1E-1	2.1E-1	0	7.5E-1	7.5E-1	0	1.3E+2	1.3E+2	0	3.9E+2	3.9E+2
U-235	0	4.3E-2	4.3E-2	0	1.6E-1	1.6E-1	0	3.7E+0	3.7E+0	0	1.1E+1	1.1E+1
U-236	0	4.9E-3	4.9E-3	0	1.8E-2	1.8E-2	0	1.7E+1	1.7E+1	0	5.0E+1	5.0E+1
U-238	0	5.0E-1	5.0E-1	0	1.8E+0	1.8E+0	0	2.1E+2	2.1E+2	0	6.2E+2	6.2E+2
Sum of U-23x	0	8.8E-1	8.8E-1	0	3.2E+0	3.2E+0	0	3.6E+2	3.6E+2	0	1.1E+3	1.1E+3

Table B.16. (contd)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046
Alternative Group A - LLW and MLLW in Deeper/Wider Trenches in 200E and 200W; Melters and ILAW near PUREX

	Category 1 LLW						**Category 3 LLW**					
	1996 to 2007			**2008 to 2046**			**1996 to 2007**			**2008 to 2046**		
Radionuclide	**200 E**	**200 W**	**Total**	**200 E**	**200 W**	**Total**	**200 E**	**200 W**	**Total**	**200 E**	**200 W**	**Total**
Upper Bound Waste Volume												
C-14	0	5.2E+0	5.2E+0	0	1.6E+1	1.6E+1	0	3.5E-1	3.5E-1	0	1.5E+2	1.5E+2
Tc-99	0	4.0E-1	4.0E-1	0	1.3E+0	1.3E+0	0	0	0	0	0	0
Grouted Tc-99	0	0	0	0	0	0	0	7.2E+1	7.2E+1	0	3.2E+3	3.2E+3
I-129	0	3.2E-3	3.2E-3	0	3.7E-3	3.7E-3	0	0	0	0	0	0
Grouted I-129	0	0	0	0	0	0	0	3.5E-7	3.5E-7	0	5.0E+0	5.0E+0
U-233	0	1.3E-1	1.3E-1	0	4.5E-1	4.5E-1	0	2.3E-1	2.3E-1	0	1.8E-1	1.8E-1
U-234	0	9.0E-1	9.0E-1	0	9.2E-1	9.2E-1	0	2.9E+2	2.9E+2	0	3.1E+2	3.1E+2
U-235	0	8.9E-2	8.9E-2	0	1.7E-1	1.7E-1	0	8.4E+0	8.4E+0	0	1.2E+1	1.2E+1
U-236	0	4.9E-3	4.9E-3	0	1.8E-2	1.8E-2	0	3.8E+1	3.8E+1	0	2.9E+1	2.9E+1
U-238	0	1.7E+0	1.7E+0	0	2.1E+0	2.1E+0	0	4.7E+2	4.7E+2	0	5.0E+2	5.0E+2
Sum of U-23x	0	2.8E+0	2.8E+0	0	3.6E+0	3.6E+0	0	8.1E+2	8.1E+2	0	8.6E+2	8.6E+2

(a) For same locations: 0.82% of Lower Bound volume [LBV] Cat 1 LLW; 0.96% of LBV Cat 3 LLW [except Tc-99 & I-129 same as LBV]; 0.996% of MLLW LBV.

Table B.16. (contd)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046
Alternative Group A - LLW and MLLW in Deeper/Wider Trenches in 200E and 200W; Melters and ILAW near PUREX

	MLLW						Melter MLLW	ILAW (vitrified)	Area Totals Segregated			
	1996 to 2007			2008 to 2046								
Radionuclide	**200 E**	**200 W**	**Total**	**200 E**	**200 W**	**Total**	**Near PUREX**	**Near PUREX**	**200 E**	**200 W**	**Total Segregated**	**Total HSW**
Hanford Only Waste Volume[(a)]												
C-14	0	1.5E+0	1.5E+0	4.3E+0	0	4.3E+0	0	0	4.3E+0	1.8E+1	2.2E+1	6.4E+2
Tc-99	0	3.4E+0	3.4E+0	8.3E+0	0	8.3E+0	0	2.6E+4	2.6E+4	4.8E+0	2.6E+4	2.6E+4
Grouted Tc-99	0	4.9E+0	4.9E+0	1.6E+2	0	1.6E+2	3.9E+1	0	2.0E+2	3.3E+3	3.5E+3	3.5E+3
I-129	0	3.5E-2	3.5E-2	1.0E-1	0	1.0E-1	0	2.2E+1	2.2E+1	4.1E-2	2.2E+1	2.2E+1
Grouted I-129	0	0	0	0	0	0	0	0	0	5.0E+0	5.0E+0	5.0E+0
U-233	0	4.6E-3	4.6E-3	1.4E-2	0	1.4E-2	8.5E-1	1.3E+2	1.3E+2	8.7E-1	1.3E+2	1.4E+2
U-234	0	5.4E+0	5.4E+0	1.6E+1	0	1.6E+1	4.6E-1	4.4E+1	6.1E+1	5.0E+2	5.6E+2	6.1E+2
U-235	0	8.7E-2	8.7E-2	2.6E-1	0	2.6E-1	1.9E-2	1.8E+0	2.1E+0	1.4E+1	1.7E+1	2.1E+1
U-236	0	1.0E-1	1.0E-1	3.0E-1	0	3.0E-1	1.7E-2	1.4E+0	1.7E+0	6.4E+1	6.6E+1	6.6E+1
U-238	0	1.4E+0	1.4E+0	4.0E+0	0	4.0E+0	4.1E-1	4.8E+1	5.3E+1	8.0E+2	8.5E+2	9.4E+2
Sum of U-23x	0	7.0E+0	7.0E+0	2.1E+1	0	2.1E+1	1.8E+0	2.3E+2	2.5E+2	1.4E+3	1.6E+3	1.8E+3
Lower Bound Waste Volume												
C-14	0	1.5E+0	1.5E+0	4.3E+0	0	4.3E+0	0	0	4.3E+0	2.2E+1	2.6E+1	6.5E+2
Tc-99	0	3.4E+0	3.4E+0	8.4E+0	0	8.4E+0	0	2.6E+4	2.6E+4	5.1E+0	2.6E+4	2.6E+4
Grouted Tc-99	0	4.9E+0	4.9E+0	1.6E+2	0	1.6E+2	3.9E+1	0	2.0E+2	3.3E+3	3.5E+3	3.5E+3
I-129	0	3.5E-2	3.5E-2	1.0E-1	0	1.0E-1	0	2.2E+1	2.2E+1	4.2E-2	2.2E+1	2.2E+1
Grouted I-129	0	0	0	0	0	0	0	0	0	5.0E+0	5.0E+0	5.0E+0
U-233	0	4.6E-3	4.6E-3	1.4E-2	0	1.4E-2	8.5E-1	1.3E+2	1.3E+2	9.9E-1	1.3E+2	1.4E+2
U-234	0	5.5E+0	5.5E+0	1.6E+1	0	1.6E+1	4.6E-1	4.4E+1	6.1E+1	5.2E+2	5.9E+2	6.3E+2
U-235	0	8.7E-2	8.7E-2	2.6E-1	0	2.6E-1	1.9E-2	1.8E+0	2.1E+0	1.5E+1	1.7E+1	2.2E+1
U-236	0	1.0E-1	1.0E-1	3.0E-1	0	3.0E-1	1.7E-2	1.4E+0	1.7E+0	6.7E+1	6.9E+1	6.9E+1
U-238	0	1.4E+0	1.4E+0	4.0E+0	0	4.0E+0	4.1E-1	4.8E+1	5.3E+1	8.3E+2	8.9E+2	9.8E+2
Sum of U-23x	0	7.0E+0	7.0E+0	2.1E+1	0	2.1E+1	1.8E+0	2.3E+2	2.5E+2	1.4E+3	1.7E+3	1.8E+3

Table B.16. (contd)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046
Alternative Group A - LLW and MLLW in Deeper/Wider Trenches in 200E and 200W; Melters and ILAW near PUREX

	MLLW						Melter MLLW	ILAW (vitrified)	Area Totals Segregated			
	1996 to 2007			2008 to 2046								
Radionuclide	**200 E**	**200 W**	**Total**	**200 E**	**200 W**	**Total**	**Near PUREX**	**Near PUREX**	**200 E**	**200 W**	**Total Segregated**	**Total HSW**
Upper Bound Waste Volume												
C-14	1.6E+0	1.1E+0	2.7E+0	5.7E+0	0	5.7E+0	0	0	7.3E+0	1.7E+2	1.7E+2	8.0E+2
Tc-99	1.4E+0	2.1E+0	3.5E+0	8.3E+0	0	8.3E+0	0	2.6E+4	2.6E+4	3.8E+0	2.6E+4	2.6E+4
Grouted Tc-99	1.2E+2	6.0E+1	1.8E+2	3.3E+2	0	3.3E+2	3.9E+1	0	5.0E+2	3.4E+3	3.9E+3	3.9E+3
I-129	1.7E-2	1.7E-2	3.4E-2	1.1E-1	0	1.1E-1	0	2.2E+1	2.2E+1	2.4E-2	2.2E+1	2.2E+1
Grouted I-129	0	0	0	0	0	0	0	0	0	5.0E+0	5.0E+0	5.0E+0
U-233	2.2E-3	2.2E-3	4.4E-3	1.4E-2	0	1.4E-2	8.5E-1	1.3E+2	1.3E+2	9.9E-1	1.3E+2	1.4E+2
U-234	2.3E+2	1.1E+2	3.3E+2	3.4E+2	0	3.4E+2	4.6E-1	4.4E+1	6.1E+2	7.2E+2	1.3E+3	1.4E+3
U-235	1.0E+1	4.8E+0	1.5E+1	1.5E+1	0	1.5E+1	1.9E-2	1.8E+0	2.6E+1	2.5E+1	5.2E+1	5.7E+1
U-236	4.9E-2	4.9E-2	9.7E-2	3.1E-1	0	3.1E-1	1.7E-2	1.4E+0	1.8E+0	6.7E+1	6.9E+1	6.9E+1
U-238	2.3E+2	1.1E+2	3.5E+2	3.4E+2	0	3.4E+2	4.1E-1	4.8E+1	6.3E+2	1.1E+3	1.7E+3	1.8E+3
Sum of U-23x	4.7E+2	2.3E+2	6.9E+2	7.0E+2	0	7.0E+2	1.8E+0	2.3E+2	1.4E+3	1.9E+3	3.3E+3	3.4E+3

(a) For same locations: 0.82% of Lower Bound volume [LBV] Cat 1 LLW; 0.96% of LBV Cat 3 LLW [except Tc-99 & I-129 same as LBV]; 0.996% of MLLW LBV.

Table B.17. Inventory of Long-Lived Mobile Radionuclides in HSW for Alternative Group B, Ci (Sheet 1 of 4)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046 Alternative Group B - LLW and MLLW in Conventional Trenches in 200E and 200W; Melters in 200E; and ILAW in 200W												
Radionuclide	**Category 1 LLW**						**Category 3 LLW**					
	1996 to 2007			**2008 to 2046**			**1996 to 2007**			**2008 to 2046**		
	200 E	**200 W**	**Total**	**200 E**	**200 W**	**Total**	**200 E**	**200 W**	**Total**	**200 E**	**200 W**	**Total**
Hanford Only Waste Volume(a)												
C-14	1.2E-1	3.2E+0	3.3E+0	4.8E-1	1.2E+1	1.3E+1	5.6E-3	1.4E-1	1.5E-1	1.7E-2	4.3E-1	4.4E-1
Tc-99	1.1E-2	2.9E-1	3.0E-1	4.1E-2	1.0E+0	1.1E+0	0	0	0	0	0	0
Grouted Tc-99	0	0	0	0	0	0	2.7E+0	6.9E+1	7.2E+1	1.2E+2	3.1E+3	3.2E+3
I-129	9.8E-5	2.5E-3	2.6E-3	1.1E-4	2.9E-3	3.0E-3	0	0	0	0	0	0
Grouted I-129	0	0	0	0	0	0	1.3E-8	3.3E-7	3.3E-7	7.4E-8	5.0E+0	5.0E+0
U-233	3.9E-3	9.8E-2	1.0E-1	1.4E-2	3.6E-1	3.7E-1	3.7E-3	9.4E-2	9.8E-2	1.1E-2	2.9E-1	3.0E-1
U-234	6.4E-3	1.6E-1	1.7E-1	2.3E-2	5.9E-1	6.1E-1	4.7E+0	1.2E+2	1.2E+2	1.4E+1	3.6E+2	3.7E+2
U-235	1.3E-3	3.4E-2	3.6E-2	4.8E-3	1.2E-1	1.3E-1	1.3E-1	3.4E+0	3.5E+0	4.0E-1	1.0E+1	1.1E+1
U-236	1.5E-4	3.9E-3	4.0E-3	5.5E-4	1.4E-2	1.5E-2	6.0E-1	1.5E+1	1.6E+1	1.8E+0	4.6E+1	4.8E+1
U-238	1.5E-2	3.9E-1	4.1E-1	5.5E-2	1.4E+0	1.5E+0	7.5E+0	1.9E+2	2.0E+2	2.2E+1	5.8E+2	6.0E+2
Sum of U-23x	2.7E-2	6.9E-1	7.2E-1	9.7E-2	2.5E+0	2.6E+0	1.3E+1	3.3E+2	3.4E+2	3.9E+1	9.9E+2	1.0E+3
Lower Bound Waste Volume												
C-14	1.5E-1	3.9E+0	4.1E+0	5.9E-1	1.5E+1	1.6E+1	5.8E-3	1.5E-1	1.5E-1	1.7E-2	4.5E-1	4.6E-1
Tc-99	1.4E-2	3.5E-1	3.7E-1	5.0E-2	1.3E+0	1.3E+0	0	0	0	0	0	0
Grouted Tc-99	0	0	0	0	0	0	2.7E+0	6.9E+1	7.2E+1	1.2E+2	3.1E+3	3.2E+3
I-129	1.2E-4	3.1E-3	3.2E-3	1.4E-4	3.5E-3	3.7E-3	0	0	0	0	0	0
Grouted I-129	0	0	0	0	0	0	1.3E-8	3.4E-7	3.5E-7	7.7E-8	5.0E+0	5.0E+0
U-233	4.7E-3	1.2E-1	1.2E-1	1.7E-2	4.4E-1	4.5E-1	3.8E-3	9.8E-2	1.0E-1	1.2E-2	3.0E-1	3.1E-1
U-234	7.8E-3	2.0E-1	2.1E-1	2.8E-2	7.2E-1	7.5E-1	4.9E+0	1.2E+2	1.3E+2	1.5E+1	3.7E+2	3.9E+2
U-235	1.6E-3	4.2E-2	4.3E-2	5.9E-3	1.5E-1	1.6E-1	1.4E-1	3.6E+0	3.7E+0	4.2E-1	1.1E+1	1.1E+1
U-236	1.9E-4	4.7E-3	4.9E-3	6.7E-4	1.7E-2	1.8E-2	6.3E-1	1.6E+1	1.7E+1	1.9E+0	4.8E+1	5.0E+1
U-238	1.9E-2	4.8E-1	4.9E-1	6.7E-2	1.7E+0	1.8E+0	7.8E+0	2.0E+2	2.1E+2	2.3E+1	6.0E+2	6.2E+2
Sum of U-23x	3.3E-2	8.4E-1	8.7E-1	1.2E-1	3.0E+0	3.2E+0	1.3E+1	3.4E+2	3.6E+2	4.0E+1	1.0E+3	1.1E+3

Table B.17. (contd)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046 Alternative Group B - LLW and MLLW in Conventional Trenches in 200E and 200W; Melters in 200E; and ILAW in 200W												
	Category 1 LLW						Category 3 LLW					
	1996 to 2007			2008 to 2046			1996 to 2007			2008 to 2046		
Radionuclide	**200 E**	**200 W**	**Total**	**200 E**	**200 W**	**Total**	**200 E**	**200 W**	**Total**	**200 E**	**200 W**	**Total**
Upper Bound Waste Volume												
C-14	7.2E-1	4.5E+0	5.2E+0	2.2E+0	1.4E+1	1.6E+1	1.3E-2	3.4E-1	3.5E-1	5.5E+0	1.4E+2	1.4E+2
Tc-99	5.5E-2	3.4E-1	4.0E-1	1.8E-1	1.2E+0	1.3E+0	0	0	0	0	0	0
Grouted Tc-99	0	0	0	0	0	0	2.7E+0	6.9E+1	7.2E+1	1.2E+2	3.1E+3	3.2E+3
I-129	4.4E-4	2.8E-3	3.2E-3	5.1E-4	3.2E-3	3.7E-3	0	0	0	0	0	0
Grouted I-129	0	0	0	0	0	0	1.3E-8	3.4E-7	3.5E-7	7.7E-8	5.0E+0	5.0E+0
U-233	1.7E-2	1.1E-1	1.3E-1	6.2E-2	3.9E-1	4.5E-1	8.7E-3	2.2E-1	2.3E-1	6.8E-3	1.7E-1	1.8E-1
U-234	1.3E-1	7.8E-1	9.0E-1	1.3E-1	7.9E-1	9.2E-1	1.1E+1	2.8E+2	2.9E+2	1.2E+1	3.0E+2	3.1E+2
U-235	1.2E-2	7.6E-2	8.9E-2	2.3E-2	1.5E-1	1.7E-1	3.2E-1	8.1E+0	8.4E+0	4.5E-1	1.2E+1	1.2E+1
U-236	6.8E-4	4.2E-3	4.9E-3	2.5E-3	1.5E-2	1.8E-2	1.4E+0	3.7E+1	3.8E+1	1.1E+0	2.8E+1	2.9E+1
U-238	2.3E-1	1.4E+0	1.7E+0	2.9E-1	1.8E+0	2.1E+0	1.8E+1	4.5E+2	4.7E+2	1.9E+1	4.9E+2	5.0E+2
Sum of U-23x	3.8E-1	2.4E+0	2.8E+0	5.0E-1	3.1E+0	3.6E+0	3.1E+1	7.8E+2	8.1E+2	3.2E+1	8.2E+2	8.6E+2
(a) For same locations: 0.82% of Lower Bound volume [LBV] Cat 1 LLW; 0.96% of LBV Cat 3 LLW [except Tc-99 & I-129 same as LBV]; 0.996% of MLLW LBV.												

Table B.17. (contd)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046
Alternative Group B - LLW and MLLW in Conventional Trenches in 200E and 200W; Melters in 200E; and ILAW in 200W

Radionuclide	MLLW						Melter MLLW	ILAW (vitrified)	Area Totals		Total Segregated	Total HSW
	1996 to 2007			2008 to 2046					Segregated			
	200 E	200 W	Total	200 E	200 W	Total	200 E	200W	200 E	200 W		
Hanford Only Waste Volume[(a)]												
C-14	0	1.1E+0	1.1E+0	4.7E+0	0	4.7E+0	0	0	4.9E+0	1.8E+1	2.2E+1	6.4E+2
Tc-99	0	2.0E+0	2.0E+0	9.8E+0	0	9.8E+0	0	2.6E+4	8.4E+0	2.6E+4	2.6E+4	2.6E+4
Grouted Tc-99	0	4.0E+0	4.0E+0	1.6E+2	0	1.6E+2	3.9E+1	0	3.2E+2	3.2E+3	3.5E+3	3.5E+3
I-129	0	2.5E-2	2.5E-2	1.1E-1	0	1.1E-1	0	2.2E+1	1.0E-1	2.2E+1	2.2E+1	2.2E+1
Grouted I-129	0	0	0	0	0	0	0	0	0	5.0E+0	5.0E+0	5.0E+0
U-233	0	3.3E-3	3.3E-3	1.5E-2	0	1.5E-2	8.5E-1	1.3E+2	9.0E-1	1.3E+2	1.3E+2	1.4E+2
U-234	0	3.9E+0	3.9E+0	1.8E+1	0	1.8E+1	4.6E-1	4.4E+1	3.5E+1	5.3E+2	5.6E+2	6.1E+2
U-235	0	6.3E-2	6.3E-2	2.8E-1	0	2.8E-1	1.9E-2	1.8E+0	8.2E-1	1.6E+1	1.7E+1	2.1E+1
U-236	0	7.3E-2	7.3E-2	3.3E-1	0	3.3E-1	1.7E-2	1.4E+0	2.7E+0	6.3E+1	6.6E+1	6.6E+1
U-238	0	9.8E-1	9.8E-1	4.4E+0	0	4.4E+0	4.1E-1	4.8E+1	3.4E+1	8.2E+2	8.5E+2	9.4E+2
Sum of U-23x	0	5.0E+0	5.0E+0	2.3E+1	0	2.3E+1	1.8E+0	2.3E+2	7.4E+1	1.6E+3	1.6E+3	1.8E+3
Lower Bound Waste Volume												
C-14	0	1.1E+0	1.1E+0	4.7E+0	0	4.7E+0	0	0	5.1E+0	2.1E+1	2.6E+1	6.5E+2
Tc-99	0	2.0E+0	2.0E+0	9.8E+0	0	9.8E+0	0	2.6E+4	8.4E+0	2.6E+4	2.6E+4	2.6E+4
Grouted Tc-99	0	4.0E+0	4.0E+0	1.6E+2	0	1.6E+2	3.9E+1	0	3.2E+2	3.2E+3	3.5E+3	3.5E+3
I-129	0	2.5E-2	2.5E-2	1.1E-1	0	1.1E-1	0	2.2E+1	1.0E-1	2.2E+1	2.2E+1	2.2E+1
Grouted I-129	0	0	0	0	0	0	0	0	0	5.0E+0	5.0E+0	5.0E+0
U-233	0	3.3E-3	3.3E-3	1.5E-2	0	1.5E-2	8.5E-1	1.3E+2	9.0E-1	1.3E+2	1.3E+2	1.4E+2
U-234	0	3.9E+0	3.9E+0	1.8E+1	0	1.8E+1	4.6E-1	4.4E+1	3.6E+1	5.5E+2	5.8E+2	6.3E+2
U-235	0	6.3E-2	6.3E-2	2.8E-1	0	2.8E-1	1.9E-2	1.8E+0	8.4E-1	1.6E+1	1.7E+1	2.2E+1
U-236	0	7.4E-2	7.4E-2	3.3E-1	0	3.3E-1	1.7E-2	1.4E+0	2.8E+0	6.6E+1	6.9E+1	6.9E+1
U-238	0	9.8E-1	9.8E-1	4.4E+0	0	4.4E+0	4.1E-1	4.8E+1	3.6E+1	8.5E+2	8.9E+2	9.8E+2
Sum of U-23x	0	5.1E+0	5.1E+0	2.3E+1	0	2.3E+1	1.8E+0	2.3E+2	7.6E+1	1.6E+3	1.7E+3	1.8E+3

Table B.17. (contd)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046 Alternative Group B - LLW and MLLW in Conventional Trenches in 200E and 200W; Melters in 200E; and ILAW in 200W												
	MLLW						Melter MLLW	ILAW (vitrified)	Area Totals			
	1996 to 2007			2008 to 2046					Segregated			
Radionuclide	200 E	200 W	Total	200 E	200 W	Total	200 E	200W	200 E	200 W	Total Segregated	Total HSW
Upper Bound Waste Volume												
C-14	1.1E+0	8.8E-1	2.0E+0	6.4E+0	0	6.4E+0	0	0	1.6E+1	1.6E+2	1.7E+2	8.0E+2
Tc-99	1.2E-1	8.7E-1	9.9E-1	1.1E+1	0	1.1E+1	0	2.6E+4	9.9E+0	2.6E+4	2.6E+4	2.6E+4
Grouted Tc-99	1.3E+2	7.4E+1	2.0E+2	3.2E+2	0	3.2E+2	3.9E+1	0	6.2E+2	3.2E+3	3.9E+3	3.9E+3
I-129	4.7E-3	8.1E-3	1.3E-2	1.3E-1	0	1.3E-1	0	2.2E+1	1.2E-1	2.2E+1	2.2E+1	2.2E+1
Grouted I-129	0	0	0	0	0	0	0	0	0	5.0E+0	5.0E+0	5.0E+0
U-233	6.1E-4	1.1E-3	1.7E-3	1.7E-2	0	1.7E-2	8.5E-1	1.3E+2	9.6E-1	1.3E+2	1.3E+2	1.4E+2
U-234	2.4E+2	1.4E+2	3.7E+2	3.1E+2	0	3.1E+2	4.6E-1	4.4E+1	5.9E+2	7.4E+2	1.3E+3	1.4E+3
U-235	1.1E+1	6.0E+0	1.7E+1	1.3E+1	0	1.3E+1	1.9E-2	1.8E+0	2.5E+1	2.6E+1	5.2E+1	5.7E+1
U-236	1.4E-2	2.4E-2	3.7E-2	3.7E-1	0	3.7E-1	1.7E-2	1.4E+0	2.9E+0	6.6E+1	6.9E+1	6.9E+1
U-238	2.5E+2	1.4E+2	3.9E+2	3.1E+2	0	3.1E+2	4.1E-1	4.8E+1	6.1E+2	1.1E+3	1.7E+3	1.8E+3
Sum of U-23x	4.9E+2	2.8E+2	7.7E+2	6.4E+2	0	6.4E+2	1.8E+0	2.3E+2	1.2E+3	2.1E+3	3.3E+3	3.4E+3
(a) For same locations: 0.82% of Lower Bound volume [LBV] Cat 1 LLW; 0.96% of LBV Cat 3 LLW [except Tc-99 & I-129 same as LBV]; 0.996% of MLLW LBV.												

Table B.18. Inventory of Long-Lived Mobile Radionuclides in HSW for Alternative Group C, Ci (Sheet 1 of 4)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046 Alternative Group C - Single Expandable Trenches: LLW in 200W, MLLW in 200E, and ILAW near PUREX; Melters also near PUREX												
Radionuclide	**Category 1 LLW**						**Category 3 LLW**					
	1996 to 2007			**2008 to 2046**			**1996 to 2007**			**2008 to 2046**		
	200 E	**200 W**	**Total**	**200 E**	**200 W**	**Total**	**200 E**	**200 W**	**Total**	**200 E**	**200 W**	**Total**
Hanford Only Waste Volume$^{(a)}$												
C-14	0	3.3E+0	3.3E+0	0	1.3E+1	1.3E+1	0	1.5E-1	1.5E-1	0	4.4E-1	4.4E-1
Tc-99	0	3.0E-1	3.0E-1	0	1.1E+0	1.1E+0	0	0	0	0	0	0
Grouted Tc-99	0	0	0	0	0	0	0	7.2E+1	7.2E+1	0	3.2E+3	3.2E+3
I-129	0	2.6E-3	2.6E-3	0	3.0E-3	3.0E-3	0	0	0	0	0	0
Grouted I-129	0	0	0	0	0	0	0	3.4E-7	3.4E-7	0	5.0E+0	5.0E+0
U-233	0	1.0E-1	1.0E-1	0	3.7E-1	3.7E-1	0	9.8E-2	9.8E-2	0	3.0E-1	3.0E-1
U-234	0	1.7E-1	1.7E-1	0	6.1E-1	6.1E-1	0	1.2E+2	1.2E+2	0	3.7E+2	3.7E+2
U-235	0	3.6E-2	3.6E-2	0	1.3E-1	1.3E-1	0	3.5E+0	3.5E+0	0	1.1E+1	1.1E+1
U-236	0	4.0E-3	4.0E-3	0	1.5E-2	1.5E-2	0	1.6E+1	1.6E+1	0	4.8E+1	4.8E+1
U-238	0	4.1E-1	4.1E-1	0	1.5E+0	1.5E+0	0	2.0E+2	2.0E+2	0	6.0E+2	6.0E+2
Sum of U-23x	0	7.2E-1	7.2E-1	0	2.6E+0	2.6E+0	0	3.4E+2	3.4E+2	0	1.0E+3	1.0E+3
Lower Bound Waste Volume												
C-14	0	4.1E+0	4.1E+0	0	1.6E+1	1.6E+1	0	1.5E-1	1.5E-1	0	4.6E-1	4.6E-1
Tc-99	0	3.7E-1	3.7E-1	0	1.3E+0	1.3E+0	0	0	0	0	0	0
Grouted Tc-99	0	0	0	0	0	0	0	7.2E+1	7.2E+1	0	3.2E+3	3.2E+3
I-129	0	3.2E-3	3.2E-3	0	3.7E-3	3.7E-3	0	0	0	0	0	0
Grouted I-129	0	0	0	0	0	0	0	3.5E-7	3.5E-7	0	5.0E+0	5.0E+0
U-233	0	1.3E-1	1.3E-1	0	4.5E-1	4.5E-1	0	1.0E-1	1.0E-1	0	3.1E-1	3.1E-1
U-234	0	2.1E-1	2.1E-1	0	7.5E-1	7.5E-1	0	1.3E+2	1.3E+2	0	3.9E+2	3.9E+2
U-235	0	4.3E-2	4.3E-2	0	1.6E-1	1.6E-1	0	3.7E+0	3.7E+0	0	1.1E+1	1.1E+1
U-236	0	4.9E-3	4.9E-3	0	1.8E-2	1.8E-2	0	1.7E+1	1.7E+1	0	5.0E+1	5.0E+1
U-238	0	5.0E-1	5.0E-1	0	1.8E+0	1.8E+0	0	2.1E+2	2.1E+2	0	6.2E+2	6.2E+2
Sum of U-23x	0	8.8E-1	8.8E-1	0	3.2E+0	3.2E+0	0	3.6E+2	3.6E+2	0	1.1E+3	1.1E+3

Table B.18. (contd)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046
Alternative Group C - Single Expandable Trenches: LLW in 200W, MLLW in 200E, and ILAW near PUREX; Melters also near PUREX

	Category 1 LLW						**Category 3 LLW**					
	1996 to 2007			**2008 to 2046**			**1996 to 2007**			**2008 to 2046**		
Radionuclide	**200 E**	**200 W**	**Total**	**200 E**	**200 W**	**Total**	**200 E**	**200 W**	**Total**	**200 E**	**200 W**	**Total**
Upper Bound Waste Volume												
C-14	0	5.2E+0	5.2E+0	0	1.6E+1	1.6E+1	0	3.5E-1	3.5E-1	0	1.5E+2	1.5E+2
Tc-99	0	4.0E-1	4.0E-1	0	1.3E+0	1.3E+0	0	0	0	0	0	0
Grouted Tc-99	0	0	0	0	0	0	0	7.2E+1	7.2E+1	0	3.2E+3	3.2E+3
I-129	0	3.2E-3	3.2E-3	0	3.7E-3	3.7E-3	0	0	0	0	0	0
Grouted I-129	0	0	0	0	0	0	0	3.5E-7	3.5E-7	0	5.0E+0	5.0E+0
U-233	0	1.3E-1	1.3E-1	0	4.5E-1	4.5E-1	0	2.3E-1	2.3E-1	0	1.8E-1	1.8E-1
U-234	0	9.0E-1	9.0E-1	0	9.2E-1	9.2E-1	0	2.9E+2	2.9E+2	0	3.1E+2	3.1E+2
U-235	0	8.9E-2	8.9E-2	0	1.7E-1	1.7E-1	0	8.4E+0	8.4E+0	0	1.2E+1	1.2E+1
U-236	0	4.9E-3	4.9E-3	0	1.8E-2	1.8E-2	0	3.8E+1	3.8E+1	0	2.9E+1	2.9E+1
U-238	0	1.7E+0	1.7E+0	0	2.1E+0	2.1E+0	0	4.7E+2	4.7E+2	0	5.0E+2	5.0E+2
Sum of U-23x	0	2.8E+0	2.8E+0	0	3.6E+0	3.6E+0	0	8.1E+2	8.1E+2	0	8.6E+2	8.6E+2

(a) For same locations: 0.82% of Lower Bound volume [LBV] Cat 1 LLW; 0.96% of LBV Cat 3 LLW [except Tc-99 & I-129 same as LBV]; 0.996% of MLLW LBV.

Table B.18. (contd)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046 Alternative Group C - Single Expandable Trenches: LLW in 200W, MLLW in 200E, and ILAW near PUREX; Melters also near PUREX												
	MLLW						Melter MLLW	ILAW (vitrified)	Area Totals			
	1996 to 2007			2008 to 2046					Segregated			
Radionuclide	200 E	200 W	Total	200 E	200 W	Total	Near PUREX	Near PUREX	200 E	200 W	Total Segregated	Total HSW
Hanford Only Waste Volume[(a)]												
C-14	0	1.5E+0	1.5E+0	4.3E+0	0	4.3E+0	0	0	4.3E+0	1.8E+1	2.2E+1	6.4E+2
Tc-99	0	3.4E+0	3.4E+0	8.3E+0	0	8.3E+0	0	2.6E+4	2.6E+4	4.8E+0	2.6E+4	2.6E+4
Grouted Tc-99	0	4.9E+0	4.9E+0	1.6E+2	0	1.6E+2	3.9E+1	0	2.0E+2	3.3E+3	3.5E+3	3.5E+3
I-129	0	3.5E-2	3.5E-2	1.0E-1	0	1.0E-1	0	2.2E+1	2.2E+1	4.1E-2	2.2E+1	2.2E+1
Grouted I-129	0	0	0	0	0	0	0	0	0	5.0E+0	5.0E+0	5.0E+0
U-233	0	4.6E-3	4.6E-3	1.4E-2	0	1.4E-2	8.5E-1	1.3E+2	1.3E+2	8.7E-1	1.3E+2	1.4E+2
U-234	0	5.4E+0	5.4E+0	1.6E+1	0	1.6E+1	4.6E-1	4.4E+1	6.1E+1	5.0E+2	5.6E+2	6.1E+2
U-235	0	8.7E-2	8.7E-2	2.6E-1	0	2.6E-1	1.9E-2	1.8E+0	2.1E+0	1.4E+1	1.7E+1	2.1E+1
U-236	0	1.0E-1	1.0E-1	3.0E-1	0	3.0E-1	1.7E-2	1.4E+0	1.7E+0	6.4E+1	6.6E+1	6.6E+1
U-238	0	1.4E+0	1.4E+0	4.0E+0	0	4.0E+0	4.1E-1	4.8E+1	5.3E+1	8.0E+2	8.5E+2	9.4E+2
Sum of U-23x	0	7.0E+0	7.0E+0	2.1E+1	0	2.1E+1	1.8E+0	2.3E+2	2.5E+2	1.4E+3	1.6E+3	1.8E+3
Lower Bound Waste Volume												
C-14	0	1.5E+0	1.5E+0	4.3E+0	0	4.3E+0	0	0	4.3E+0	2.2E+1	2.6E+1	6.5E+2
Tc-99	0	3.4E+0	3.4E+0	8.4E+0	0	8.4E+0	0	2.6E+4	2.6E+4	5.1E+0	2.6E+4	2.6E+4
Grouted Tc-99	0	4.9E+0	4.9E+0	1.6E+2	0	1.6E+2	3.9E+1	0	2.0E+2	3.3E+3	3.5E+3	3.5E+3
I-129	0	3.5E-2	3.5E-2	1.0E-1	0	1.0E-1	0	2.2E+1	2.2E+1	4.2E-2	2.2E+1	2.2E+1
Grouted I-129	0	0	0	0	0	0	0	0	0	5.0E+0	5.0E+0	5.0E+0
U-233	0	4.6E-3	4.6E-3	1.4E-2	0	1.4E-2	8.5E-1	1.3E+2	1.3E+2	9.9E-1	1.3E+2	1.4E+2
U-234	0	5.5E+0	5.5E+0	1.6E+1	0	1.6E+1	4.6E-1	4.4E+1	6.1E+1	5.2E+2	5.9E+2	6.3E+2
U-235	0	8.7E-2	8.7E-2	2.6E-1	0	2.6E-1	1.9E-2	1.8E+0	2.1E+0	1.5E+1	1.7E+1	2.2E+1
U-236	0	1.0E-1	1.0E-1	3.0E-1	0	3.0E-1	1.7E-2	1.4E+0	1.7E+0	6.7E+1	6.9E+1	6.9E+1
U-238	0	1.4E+0	1.4E+0	4.0E+0	0	4.0E+0	4.1E-1	4.8E+1	5.3E+1	8.3E+2	8.9E+2	9.8E+2
Sum of U-23x	0	7.0E+0	7.0E+0	2.1E+1	0	2.1E+1	1.8E+0	2.3E+2	2.5E+2	1.4E+3	1.7E+3	1.8E+3

Table B.18. (contd)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046
Alternative Group C - Single Expandable Trenches: LLW in 200W, MLLW in 200E, and ILAW near PUREX; Melters also near PUREX

Radionuclide	MLLW						Melter MLLW	ILAW (vitrified)	Area Totals		Total Segregated	Total HSW
	1996 to 2007			2008 to 2046					Segregated			
	200 E	200 W	Total	200 E	200 W	Total	Near PUREX	Near PUREX	200 E	200 W		
Upper Bound Waste Volume												
C-14	1.6E+0	1.1E+0	2.7E+0	5.7E+0	0	5.7E+0	0	0	7.3E+0	1.7E+2	1.7E+2	8.0E+2
Tc-99	1.4E+0	2.1E+0	3.5E+0	8.3E+0	0	8.3E+0	0	2.6E+4	2.6E+4	3.8E+0	2.6E+4	2.6E+4
Grouted Tc-99	1.2E+2	6.0E+1	1.8E+2	3.3E+2	0	3.3E+2	3.9E+1	0	5.0E+2	3.4E+3	3.9E+3	3.9E+3
I-129	1.7E-2	1.7E-2	3.4E-2	1.1E-1	0	1.1E-1	0	2.2E+1	2.2E+1	2.4E-2	2.2E+1	2.2E+1
Grouted I-129	0	0	0	0	0	0	0	0	0	5.0E+0	5.0E+0	5.0E+0
U-233	2.2E-3	2.2E-3	4.4E-3	1.4E-2	0	1.4E-2	8.5E-1	1.3E+2	1.3E+2	9.9E-1	1.3E+2	1.4E+2
U-234	2.3E+2	1.1E+2	3.3E+2	3.4E+2	0	3.4E+2	4.6E-1	4.4E+1	6.1E+2	7.2E+2	1.3E+3	1.4E+3
U-235	1.0E+1	4.8E+0	1.5E+1	1.5E+1	0	1.5E+1	1.9E-2	1.8E+0	2.6E+1	2.5E+1	5.2E+1	5.7E+1
U-236	4.9E-2	4.9E-2	9.7E-2	3.1E-1	0	3.1E-1	1.7E-2	1.4E+0	1.8E+0	6.7E+1	6.9E+1	6.9E+1
U-238	2.3E+2	1.1E+2	3.5E+2	3.4E+2	0	3.4E+2	4.1E-1	4.8E+1	6.3E+2	1.1E+3	1.7E+3	1.8E+3
Sum of U-23x	4.7E+2	2.3E+2	6.9E+2	7.0E+2	0	7.0E+2	1.8E+0	2.3E+2	1.4E+3	1.9E+3	3.3E+3	3.4E+3

(a) For same locations: 0.82% of Lower Bound volume [LBV] Cat 1 LLW; 0.96% of LBV Cat 3 LLW [except Tc-99 & I-129 same as LBV]; 0.996% of MLLW LBV.

Table B.19. Inventory of Long-Lived Mobile Radionuclides in HSW for Alternative Groups D_1 and D_2, Ci (Sheet 1 of 4)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046
Alternative Group D_1. LLW, MLLW, ILAW, and Melters in a Lined Modular Facility near PUREX
Alternative Group D_2. LLW, MLLW, ILAW, and Melters in a Lined Modular Facility in 200E LLBGs

Radionuclide	Category 1 LLW						Category 3 LLW					
	1996 to 2007			2008 to 2046			1996 to 2007			2008 to 2046		
	200 E	200 W	Total	Near PUREX	200 W	Total	200 E	200 W	Total	Near PUREX	200 W	Total
Hanford Only Waste Volume[(a)]												
C-14	0	3.3E+0	3.3E+0	1.3E+1	0	1.3E+1	0	1.5E-1	1.5E-1	4.4E-1	0	4.4E-1
Tc-99	0	3.0E-1	3.0E-1	1.1E+0	0	1.1E+0	0	0	0	0	0	0
Grouted Tc-99	0	0	0	0	0	0	0	7.2E+1	7.2E+1	3.2E+3	0	3.2E+3
I-129	0	2.6E-3	2.6E-3	3.0E-3	0	3.0E-3	0	0	0	0	0	0
Grouted I-129	0	0	0	0	0	0	0	3.4E-7	3.4E-7	5.0E+0	0	5.0E+0
U-233	0	1.0E-1	1.0E-1	3.7E-1	0	3.7E-1	0	9.8E-2	9.8E-2	3.0E-1	0	3.0E-1
U-234	0	1.7E-1	1.7E-1	6.1E-1	0	6.1E-1	0	1.2E+2	1.2E+2	3.7E+2	0	3.7E+2
U-235	0	3.6E-2	3.6E-2	1.3E-1	0	1.3E-1	0	3.5E+0	3.5E+0	1.1E+1	0	1.1E+1
U-236	0	4.0E-3	4.0E-3	1.5E-2	0	1.5E-2	0	1.6E+1	1.6E+1	4.8E+1	0	4.8E+1
U-238	0	4.1E-1	4.1E-1	1.5E+0	0	1.5E+0	0	2.0E+2	2.0E+2	6.0E+2	0	6.0E+2
Sum of U-23x	0	7.2E-1	7.2E-1	2.6E+0	0	2.6E+0	0	3.4E+2	3.4E+2	1.0E+3	0	1.0E+3
Lower Bound Waste Volume												
C-14	0	4.1E+0	4.1E+0	1.6E+1	0	1.6E+1	0	1.5E-1	1.5E-1	4.6E-1	0	4.6E-1
Tc-99	0	3.7E-1	3.7E-1	1.3E+0	0	1.3E+0	0	0	0	0	0	0
Grouted Tc-99	0	0	0	0	0	0	0	7.2E+1	7.2E+1	3.2E+3	0	3.2E+3
I-129	0	3.2E-3	3.2E-3	3.7E-3	0	3.7E-3	0	0	0	0	0	0
Grouted I-129	0	0	0	0	0	0	0	3.5E-7	3.5E-7	5.0E+0	0	5.0E+0
U-233	0	1.3E-1	1.3E-1	4.5E-1	0	4.5E-1	0	1.0E-1	1.0E-1	3.1E-1	0	3.1E-1
U-234	0	2.1E-1	2.1E-1	7.5E-1	0	7.5E-1	0	1.3E+2	1.3E+2	3.9E+2	0	3.9E+2
U-235	0	4.3E-2	4.3E-2	1.6E-1	0	1.6E-1	0	3.7E+0	3.7E+0	1.1E+1	0	1.1E+1
U-236	0	4.9E-3	4.9E-3	1.8E-2	0	1.8E-2	0	1.7E+1	1.7E+1	5.0E+1	0	5.0E+1
U-238	0	5.0E-1	5.0E-1	1.8E+0	0	1.8E+0	0	2.1E+2	2.1E+2	6.2E+2	0	6.2E+2
Sum of U-23x	0	8.8E-1	8.8E-1	3.2E+0	0	3.2E+0	0	3.6E+2	3.6E+2	1.1E+3	0	1.1E+3

Table B.19. (contd)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046
Alternative Group D_1. LLW, MLLW, ILAW, and Melters in a Lined Modular Facility near PUREX
Alternative Group D_2. LLW, MLLW, ILAW, and Melters in a Lined Modular Facility in 200E LLBGs

	Category 1 LLW						Category 3 LLW					
	1996 to 2007			2008 to 2046			1996 to 2007			2008 to 2046		
Radionuclide	**200 E**	**200 W**	**Total**	**Near PUREX**	**200 W**	**Total**	**200 E**	**200 W**	**Total**	**Near PUREX**	**200 W**	**Total**
Upper Bound Waste Volume												
C-14	0	5.2E+0	5.2E+0	1.6E+1	0	1.6E+1	0	3.5E-1	3.5E-1	1.5E+2	0	1.5E+2
Tc-99	0	4.0E-1	4.0E-1	1.3E+0	0	1.3E+0	0	0	0	0	0	0
Grouted Tc-99	0	0	0	0	0	0	0	7.2E+1	7.2E+1	3.2E+3	0	3.2E+3
I-129	0	3.2E-3	3.2E-3	3.7E-3	0	3.7E-3	0	0	0	0	0	0
Grouted I-129	0	0	0	0	0	0	0	3.5E-7	3.5E-7	5.0E+0	0	5.0E+0
U-233	0	1.3E-1	1.3E-1	4.5E-1	0	4.5E-1	0	2.3E-1	2.3E-1	1.8E-1	0	1.8E-1
U-234	0	9.0E-1	9.0E-1	9.2E-1	0	9.2E-1	0	2.9E+2	2.9E+2	3.1E+2	0	3.1E+2
U-235	0	8.9E-2	8.9E-2	1.7E-1	0	1.7E-1	0	8.4E+0	8.4E+0	1.2E+1	0	1.2E+1
U-236	0	4.9E-3	4.9E-3	1.8E-2	0	1.8E-2	0	3.8E+1	3.8E+1	2.9E+1	0	2.9E+1
U-238	0	1.7E+0	1.7E+0	2.1E+0	0	2.1E+0	0	4.7E+2	4.7E+2	5.0E+2	0	5.0E+2
Sum of U-23x	0	2.8E+0	2.8E+0	3.6E+0	0	3.6E+0	0	8.1E+2	8.1E+2	8.6E+2	0	8.6E+2

(a) For same locations: 0.82% of Lower Bound volume [LBV] Cat 1 LLW; 0.96% of LBV Cat 3 LLW [except Tc-99 & I-129 same as LBV]; 0.996% of MLLW LBV.

Table B.19. (contd)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046
Alternative Group D_1 - LLW, MLLW, ILAW, and Melters in a Lined Modular Facility near PUREX
Alternative Group D_2 - LLW, MLLW, ILAW, and Melters in a Lined Modular Facility in 200E LLBGs

	MLLW						Melter MLLW	ILAW (vitrified)	Area Totals			
	1996 to 2007			2008 to 2046					Segregated			
Radionuclide	200 E	200 W	Total	200 E	200 W	Total	200 E	200 E	200 E	200 W	Total Segregated	Total HSW
Hanford Only Waste Volume$^{(a)}$												
C-14	0	1.5E+0	1.5E+0	4.3E+0	0	4.3E+0	0	0	1.8E+1	4.9E+0	2.2E+1	6.4E+2
Tc-99	0	3.4E+0	3.4E+0	8.3E+0	0	8.3E+0	0	2.6E+4	2.6E+4	3.7E+0	2.6E+4	2.6E+4
Grouted Tc-99	0	4.9E+0	4.9E+0	1.6E+2	0	1.6E+2	3.9E+1	0	3.4E+3	7.7E+1	3.5E+3	3.5E+3
I-129	0	3.5E-2	3.5E-2	1.0E-1	0	1.0E-1	0	2.2E+1	2.2E+1	3.8E-2	2.2E+1	2.2E+1
Grouted I-129	0	0	0	0	0	0	0	0	5.0E+0	0	5.0E+0	5.0E+0
U-233	0	4.6E-3	4.6E-3	1.4E-2	0	1.4E-2	8.5E-1	1.3E+2	1.3E+2	2.1E-1	1.3E+2	1.4E+2
U-234	0	5.4E+0	5.4E+0	1.6E+1	0	1.6E+1	4.6E-1	4.4E+1	4.3E+2	1.3E+2	5.6E+2	6.1E+2
U-235	0	8.7E-2	8.7E-2	2.6E-1	0	2.6E-1	1.9E-2	1.8E+0	1.3E+1	3.7E+0	1.7E+1	2.1E+1
U-236	0	1.0E-1	1.0E-1	3.0E-1	0	3.0E-1	1.7E-2	1.4E+0	5.0E+1	1.6E+1	6.6E+1	6.6E+1
U-238	0	1.4E+0	1.4E+0	4.0E+0	0	4.0E+0	4.1E-1	4.8E+1	6.5E+2	2.0E+2	8.5E+2	9.4E+2
Sum of U-23x	0	7.0E+0	7.0E+0	2.1E+1	0	2.1E+1	1.8E+0	2.3E+2	1.3E+3	3.5E+2	1.6E+3	1.8E+3
Lower Bound Waste Volume												
C-14	0	1.5E+0	1.5E+0	4.3E+0	0	4.3E+0	0	0	2.0E+1	5.7E+0	2.6E+1	6.5E+2
Tc-99	0	3.4E+0	3.4E+0	8.4E+0	0	8.4E+0	0	2.6E+4	2.6E+4	3.8E+0	2.6E+4	2.6E+4
Grouted Tc-99	0	4.9E+0	4.9E+0	1.6E+2	0	1.6E+2	3.9E+1	0	3.4E+3	7.7E+1	3.5E+3	3.5E+3
I-129	0	3.5E-2	3.5E-2	1.0E-1	0	1.0E-1	0	2.2E+1	2.2E+1	3.8E-2	2.2E+1	2.2E+1
Grouted I-129	0	0	0	0	0	0	0	0	5.0E+0	0	5.0E+0	5.0E+0
U-233	0	4.6E-3	4.6E-3	1.4E-2	0	1.4E-2	8.5E-1	1.3E+2	1.3E+2	2.3E-1	1.3E+2	1.4E+2
U-234	0	5.5E+0	5.5E+0	1.6E+1	0	1.6E+1	4.6E-1	4.4E+1	4.5E+2	1.3E+2	5.9E+2	6.3E+2
U-235	0	8.7E-2	8.7E-2	2.6E-1	0	2.6E-1	1.9E-2	1.8E+0	1.3E+1	3.8E+0	1.7E+1	2.2E+1
U-236	0	1.0E-1	1.0E-1	3.0E-1	0	3.0E-1	1.7E-2	1.4E+0	5.2E+1	1.7E+1	6.9E+1	6.9E+1
U-238	0	1.4E+0	1.4E+0	4.0E+0	0	4.0E+0	4.1E-1	4.8E+1	6.8E+2	2.1E+2	8.9E+2	9.8E+2
Sum of U-23x	0	7.0E+0	7.0E+0	2.1E+1	0	2.1E+1	1.8E+0	2.3E+2	1.3E+3	3.6E+2	1.7E+3	1.8E+3

Table B.19. (contd)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046
Alternative Group D_1 - LLW, MLLW, ILAW, and Melters in a Lined Modular Facility near PUREX
Alternative Group D_2 - LLW, MLLW, ILAW, and Melters in a Lined Modular Facility in 200E LLBGs

	MLLW						Melter MLLW	ILAW (vitrified)	Area Totals			
	1996 to 2007			2008 to 2046					Segregated			
Radionuclide	**200 E**	**200 W**	**Total**	**200 E**	**200 W**	**Total**	**200 E**	**200 E**	**200 E**	**200 W**	**Total Segregated**	**Total HSW**
						Upper Bound Waste Volume						
C-14	1.6E+0	1.1E+0	2.7E+0	5.7E+0	0	5.7E+0	0	0	1.7E+2	6.7E+0	1.7E+2	8.0E+2
Tc-99	1.4E+0	2.1E+0	3.5E+0	8.3E+0	0	8.3E+0	0	2.6E+4	2.6E+4	2.5E+0	2.6E+4	2.6E+4
Grouted Tc-99	1.2E+2	6.0E+1	1.8E+2	3.3E+2	0	3.3E+2	3.9E+1	0	3.7E+3	1.3E+2	3.9E+3	3.9E+3
I-129	1.7E-2	1.7E-2	3.4E-2	1.1E-1	0	1.1E-1	0	2.2E+1	2.2E+1	2.0E-2	2.2E+1	2.2E+1
Grouted I-129	0	0	0	0	0	0	0	0	5.0E+0	0	5.0E+0	5.0E+0
U-233	2.2E-3	2.2E-3	4.4E-3	1.4E-2	0	1.4E-2	8.5E-1	1.3E+2	1.3E+2	3.6E-1	1.3E+2	1.4E+2
U-234	2.3E+2	1.1E+2	3.3E+2	3.4E+2	0	3.4E+2	4.6E-1	4.4E+1	9.2E+2	4.0E+2	1.3E+3	1.4E+3
U-235	1.0E+1	4.8E+0	1.5E+1	1.5E+1	0	1.5E+1	1.9E-2	1.8E+0	3.9E+1	1.3E+1	5.2E+1	5.7E+1
U-236	4.9E-2	4.9E-2	9.7E-2	3.1E-1	0	3.1E-1	1.7E-2	1.4E+0	3.1E+1	3.8E+1	6.9E+1	6.9E+1
U-238	2.3E+2	1.1E+2	3.5E+2	3.4E+2	0	3.4E+2	4.1E-1	4.8E+1	1.1E+3	5.9E+2	1.7E+3	1.8E+3
Sum of U-23x	4.7E+2	2.3E+2	6.9E+2	7.0E+2	0	7.0E+2	1.8E+0	2.3E+2	2.3E+3	1.0E+3	3.3E+3	3.4E+3

(a) For same locations: 0.82% of Lower Bound volume [LBV] Cat 1 LLW; 0.96% of LBV Cat 3 LLW [except Tc-99 & I-129 same as LBV]; 0.996% of MLLW LBV.

Table B.20. Inventory of Long-Lived Mobile Radionuclides in HSW for Alternative Group D_3, Ci (Sheet 1 of 4)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046 Alternative Group D_3 - A Lined Modular Facility for LLW, MLLW, ILAW, and Melters at ERDF												
	Category 1 LLW						**Category 3 LLW**					
	1996 to 2007			**2008 to 2046**			**1996 to 2007**			**2008 to 2046**		
Radionuclide	**200 E**	**200 W**	**Total**	**200 E**	**ERDF**	**Total**	**200 E**	**200 W**	**Total**	**200 E**	**ERDF**	**Total**
Hanford Only Waste Volume[(a)]												
C-14	0	3.3E+0	3.3E+0	0	1.3E+1	1.3E+1	0	1.5E-1	1.5E-1	0	4.4E-1	4.4E-1
Tc-99	0	3.0E-1	3.0E-1	0	1.1E+0	1.1E+0	0	0	0	0	0	0
Grouted Tc-99	0	0	0	0	0	0	0	7.2E+1	7.2E+1	0	3.2E+3	3.2E+3
I-129	0	2.6E-3	2.6E-3	0	3.0E-3	3.0E-3	0	0	0	0	0	0
Grouted I-129	0	0	0	0	0	0	0	3.4E-7	3.4E-7	0	5.0E+0	5.0E+0
U-233	0	1.0E-1	1.0E-1	0	3.7E-1	3.7E-1	0	9.8E-2	9.8E-2	0	3.0E-1	3.0E-1
U-234	0	1.7E-1	1.7E-1	0	6.1E-1	6.1E-1	0	1.2E+2	1.2E+2	0	3.7E+2	3.7E+2
U-235	0	3.6E-2	3.6E-2	0	1.3E-1	1.3E-1	0	3.5E+0	3.5E+0	0	1.1E+1	1.1E+1
U-236	0	4.0E-3	4.0E-3	0	1.5E-2	1.5E-2	0	1.6E+1	1.6E+1	0	4.8E+1	4.8E+1
U-238	0	4.1E-1	4.1E-1	0	1.5E+0	1.5E+0	0	2.0E+2	2.0E+2	0	6.0E+2	6.0E+2
Sum of U-23x	0	7.2E-1	7.2E-1	0	2.6E+0	2.6E+0	0	3.4E+2	3.4E+2	0	1.0E+3	1.0E+3
Lower Bound Waste Volume												
C-14	0	4.1E+0	4.1E+0	0	1.6E+1	1.6E+1	0	1.5E-1	1.5E-1	0	4.6E-1	4.6E-1
Tc-99	0	3.7E-1	3.7E-1	0	1.3E+0	1.3E+0	0	0	0	0	0	0
Grouted Tc-99	0	0	0	0	0	0	0	7.2E+1	7.2E+1	0	3.2E+3	3.2E+3
I-129	0	3.2E-3	3.2E-3	0	3.7E-3	3.7E-3	0	0	0	0	0	0
Grouted I-129	0	0	0	0	0	0	0	3.5E-7	3.5E-7	0	5.0E+0	5.0E+0
U-233	0	1.3E-1	1.3E-1	0	4.5E-1	4.5E-1	0	1.0E-1	1.0E-1	0	3.1E-1	3.1E-1
U-234	0	2.1E-1	2.1E-1	0	7.5E-1	7.5E-1	0	1.3E+2	1.3E+2	0	3.9E+2	3.9E+2
U-235	0	4.3E-2	4.3E-2	0	1.6E-1	1.6E-1	0	3.7E+0	3.7E+0	0	1.1E+1	1.1E+1
U-236	0	4.9E-3	4.9E-3	0	1.8E-2	1.8E-2	0	1.7E+1	1.7E+1	0	5.0E+1	5.0E+1
U-238	0	5.0E-1	5.0E-1	0	1.8E+0	1.8E+0	0	2.1E+2	2.1E+2	0	6.2E+2	6.2E+2
Sum of U-23x	0	8.8E-1	8.8E-1	0	3.2E+0	3.2E+0	0	3.6E+2	3.6E+2	0	1.1E+3	1.1E+3

Table B.20. (contd)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046
Alternative Group D_3 - A Lined Modular Facility for LLW, MLLW, ILAW, and Melters at ERDF

Radionuclide	Category 1 LLW						Category 3 LLW					
	1996 to 2007			2008 to 2046			1996 to 2007			2008 to 2046		
	200 E	200 W	Total	200 E	ERDF	Total	200 E	200 W	Total	200 E	ERDF	Total
Upper Bound Waste Volume												
C-14	0	5.2E+0	5.2E+0	0	1.6E+1	1.6E+1	0	3.5E-1	3.5E-1	0	1.5E+2	1.5E+2
Tc-99	0	4.0E-1	4.0E-1	0	1.3E+0	1.3E+0	0	0	0	0	0	0
Grouted Tc-99	0	0	0	0	0	0	0	7.2E+1	7.2E+1	0	3.2E+3	3.2E+3
I-129	0	3.2E-3	3.2E-3	0	3.7E-3	3.7E-3	0	0	0	0	0	0
Grouted I-129	0	0	0	0	0	0	0	3.5E-7	3.5E-7	0	5.0E+0	5.0E+0
U-233	0	1.3E-1	1.3E-1	0	4.5E-1	4.5E-1	0	2.3E-1	2.3E-1	0	1.8E-1	1.8E-1
U-234	0	9.0E-1	9.0E-1	0	9.2E-1	9.2E-1	0	2.9E+2	2.9E+2	0	3.1E+2	3.1E+2
U-235	0	8.9E-2	8.9E-2	0	1.7E-1	1.7E-1	0	8.4E+0	8.4E+0	0	1.2E+1	1.2E+1
U-236	0	4.9E-3	4.9E-3	0	1.8E-2	1.8E-2	0	3.8E+1	3.8E+1	0	2.9E+1	2.9E+1
U-238	0	1.7E+0	1.7E+0	0	2.1E+0	2.1E+0	0	4.7E+2	4.7E+2	0	5.0E+2	5.0E+2
Sum of U-23x	0	2.8E+0	2.8E+0	0	3.6E+0	3.6E+0	0	8.1E+2	8.1E+2	0	8.6E+2	8.6E+2

(a) For same locations: 0.82% of Lower Bound volume [LBV] Cat 1 LLW; 0.96% of LBV Cat 3 LLW [except Tc-99 & I-129 same as LBV]; 0.996% of MLLW LBV.

Table B.20. (contd)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046
Alternative Group D_3 - A Lined Modular Facility for LLW, MLLW, ILAW, and Melters at ERDF

Radionuclide	MLLW						Melter MLLW	ILAW (vitrified)	Area Totals		Total Segregated	Total HSW
	1996 to 2007			2008 to 2046					Segregated			
	200 E	200 W	Total	200 E	ERDF	Total	ERDF	ERDF	200 E	200 W		
Hanford Only Waste Volume[(a)]												
C-14	0	1.5E+0	1.5E+0	0	4.3E+0	4.3E+0	0	0	0	2.2E+1	2.2E+1	6.4E+2
Tc-99	0	3.4E+0	3.4E+0	0	8.3E+0	8.3E+0	0	2.6E+4	0	2.6E+4	2.6E+4	2.6E+4
Grouted Tc-99	0	4.9E+0	4.9E+0	0	1.6E+2	1.6E+2	3.9E+1	0	0	3.5E+3	3.5E+3	3.5E+3
I-129	0	3.5E-2	3.5E-2	0	1.0E-1	1.0E-1	0	2.2E+1	0	2.2E+1	2.2E+1	2.2E+1
Grouted I-129	0	0	0	0	0	0	0	0	0	5.0E+0	5.0E+0	5.0E+0
U-233	0	4.6E-3	4.6E-3	0	1.4E-2	1.4E-2	8.5E-1	1.3E+2	0	1.3E+2	1.3E+2	1.4E+2
U-234	0	5.4E+0	5.4E+0	0	1.6E+1	1.6E+1	4.6E-1	4.4E+1	0	5.6E+2	5.6E+2	6.1E+2
U-235	0	8.7E-2	8.7E-2	0	2.6E-1	2.6E-1	1.9E-2	1.8E+0	0	1.7E+1	1.7E+1	2.1E+1
U-236	0	1.0E-1	1.0E-1	0	3.0E-1	3.0E-1	1.7E-2	1.4E+0	0	6.6E+1	6.6E+1	6.6E+1
U-238	0	1.4E+0	1.4E+0	0	4.0E+0	4.0E+0	4.1E-1	4.8E+1	0	8.5E+2	8.5E+2	9.4E+2
Sum of U-23x	0	7.0E+0	7.0E+0	0	2.1E+1	2.1E+1	1.8E+0	2.3E+2	0	1.6E+3	1.6E+3	1.8E+3
Lower Bound Waste Volume												
C-14	0	1.5E+0	1.5E+0	0	4.3E+0	4.3E+0	0	0	0	2.6E+1	2.6E+1	6.5E+2
Tc-99	0	3.4E+0	3.4E+0	0	8.4E+0	8.4E+0	0	2.6E+4	0	2.6E+4	2.6E+4	2.6E+4
Grouted Tc-99	0	4.9E+0	4.9E+0	0	1.6E+2	1.6E+2	3.9E+1	0	0	3.5E+3	3.5E+3	3.5E+3
I-129	0	3.5E-2	3.5E-2	0	1.0E-1	1.0E-1	0	2.2E+1	0	2.2E+1	2.2E+1	2.2E+1
Grouted I-129	0	0	0	0	0	0	0	0	0	5.0E+0	5.0E+0	5.0E+0
U-233	0	4.6E-3	4.6E-3	0	1.4E-2	1.4E-2	8.5E-1	1.3E+2	0	1.3E+2	1.3E+2	1.4E+2
U-234	0	5.5E+0	5.5E+0	0	1.6E+1	1.6E+1	4.6E-1	4.4E+1	0	5.9E+2	5.9E+2	6.3E+2
U-235	0	8.7E-2	8.7E-2	0	2.6E-1	2.6E-1	1.9E-2	1.8E+0	0	1.7E+1	1.7E+1	2.2E+1
U-236	0	1.0E-1	1.0E-1	0	3.0E-1	3.0E-1	1.7E-2	1.4E+0	0	6.9E+1	6.9E+1	6.9E+1
U-238	0	1.4E+0	1.4E+0	0	4.0E+0	4.0E+0	4.1E-1	4.8E+1	0	8.9E+2	8.9E+2	9.8E+2
Sum of U-23x	0	7.0E+0	7.0E+0	0	2.1E+1	2.1E+1	1.8E+0	2.3E+2	0	1.7E+3	1.7E+3	1.8E+3

Table B.20. (contd)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046
Alternative Group D_3 - A Lined Modular Facility for LLW, MLLW, ILAW, and Melters at ERDF

Radionuclide	MLLW						Melter MLLW	ILAW (vitrified)	Area Totals		Total Segregated	Total HSW
	1996 to 2007			2008 to 2046					Segregated			
	200 E	200 W	Total	200 E	ERDF	Total	ERDF	ERDF	200 E	200 W		
Upper Bound Waste Volume												
C-14	1.6E+0	1.1E+0	2.7E+0	0	5.7E+0	5.7E+0	0	0	1.6E+0	1.7E+2	1.7E+2	8.0E+2
Tc-99	1.4E+0	2.1E+0	3.5E+0	0	8.3E+0	8.3E+0	0	2.6E+4	1.4E+0	2.6E+4	2.6E+4	2.6E+4
Grouted Tc-99	1.2E+2	6.0E+1	1.8E+2	0	3.3E+2	3.3E+2	3.9E+1	0	1.2E+2	3.7E+3	3.9E+3	3.9E+3
I-129	1.7E-2	1.7E-2	3.4E-2	0	1.1E-1	1.1E-1	0	2.2E+1	1.7E-2	2.2E+1	2.2E+1	2.2E+1
Grouted I-129	0	0	0	0	0	0	0	0	0	5.0E+0	5.0E+0	5.0E+0
U-233	2.2E-3	2.2E-3	4.4E-3	0	1.4E-2	1.4E-2	8.5E-1	1.3E+2	2.2E-3	1.3E+2	1.3E+2	1.4E+2
U-234	2.3E+2	1.1E+2	3.3E+2	0	3.4E+2	3.4E+2	4.6E-1	4.4E+1	2.3E+2	1.1E+3	1.3E+3	1.4E+3
U-235	1.0E+1	4.8E+0	1.5E+1	0	1.5E+1	1.5E+1	1.9E-2	1.8E+0	1.0E+1	4.2E+1	5.2E+1	5.7E+1
U-236	4.9E-2	4.9E-2	9.7E-2	0	3.1E-1	3.1E-1	1.7E-2	1.4E+0	4.9E-2	6.9E+1	6.9E+1	6.9E+1
U-238	2.3E+2	1.1E+2	3.5E+2	0	3.4E+2	3.4E+2	4.1E-1	4.8E+1	2.3E+2	1.5E+3	1.7E+3	1.8E+3
Sum of U-23x	4.7E+2	2.3E+2	6.9E+2	0	7.0E+2	7.0E+2	1.8E+0	2.3E+2	4.7E+2	2.8E+3	3.3E+3	3.4E+3

(a) For same locations: 0.82% of Lower Bound volume [LBV] Cat 1 LLW; 0.96% of LBV Cat 3 LLW [except Tc-99 & I-129 same as LBV]; 0.996% of MLLW LBV.

Table B.21. Inventory of Long-Lived Mobile Radionuclides in HSW for Alternative Groups E_1 and E_2, Ci (Sheet 1 of 4)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046
Alternative Group E_1 - Lined Modular Facilities for LLW and MLLW in 200E LLBGs, and for Melters and ILAW at ERDF
Alternative Group E_2 - Lined Modular Facilities for LLW and MLLW near PUREX, and for Melters and ILAW at ERDF

Radionuclide	Category 1 LLW						Category 3 LLW					
	1996 to 2007			2008 to 2046			1996 to 2007			2008 to 2046		
	200 E	200 W	Total	Near PUREX	200 W	Total	200 E	200 W	Total	Near PUREX	200 W	Total
Hanford Only Waste Volume[(a)]												
C-14	0	3.3E+0	3.3E+0	1.3E+1	0	1.3E+1	0	1.5E-1	1.5E-1	4.4E-1	0	4.4E-1
Tc-99	0	3.0E-1	3.0E-1	1.1E+0	0	1.1E+0	0	0	0	0	0	0
Grouted Tc-99	0	0	0	0	0	0	0	7.2E+1	7.2E+1	3.2E+3	0	3.2E+3
I-129	0	2.6E-3	2.6E-3	3.0E-3	0	3.0E-3	0	0	0	0	0	0
Grouted I-129	0	0	0	0	0	0	0	3.4E-7	3.4E-7	5.0E+0	0	5.0E+0
U-233	0	1.0E-1	1.0E-1	3.7E-1	0	3.7E-1	0	9.8E-2	9.8E-2	3.0E-1	0	3.0E-1
U-234	0	1.7E-1	1.7E-1	6.1E-1	0	6.1E-1	0	1.2E+2	1.2E+2	3.7E+2	0	3.7E+2
U-235	0	3.6E-2	3.6E-2	1.3E-1	0	1.3E-1	0	3.5E+0	3.5E+0	1.1E+1	0	1.1E+1
U-236	0	4.0E-3	4.0E-3	1.5E-2	0	1.5E-2	0	1.6E+1	1.6E+1	4.8E+1	0	4.8E+1
U-238	0	4.1E-1	4.1E-1	1.5E+0	0	1.5E+0	0	2.0E+2	2.0E+2	6.0E+2	0	6.0E+2
Sum of U-23x	0	7.2E-1	7.2E-1	2.6E+0	0	2.6E+0	0	3.4E+2	3.4E+2	1.0E+3	0	1.0E+3
Lower Bound Waste Volume												
C-14	0	4.1E+0	4.1E+0	1.6E+1	0	1.6E+1	0	1.5E-1	1.5E-1	4.6E-1	0	4.6E-1
Tc-99	0	3.7E-1	3.7E-1	1.3E+0	0	1.3E+0	0	0	0	0	0	0
Grouted Tc-99	0	0	0	0	0	0	0	7.2E+1	7.2E+1	3.2E+3	0	3.2E+3
I-129	0	3.2E-3	3.2E-3	3.7E-3	0	3.7E-3	0	0	0	0	0	0
Grouted I-129	0	0	0	0	0	0	0	3.5E-7	3.5E-7	5.0E+0	0	5.0E+0
U-233	0	1.3E-1	1.3E-1	4.5E-1	0	4.5E-1	0	1.0E-1	1.0E-1	3.1E-1	0	3.1E-1
U-234	0	2.1E-1	2.1E-1	7.5E-1	0	7.5E-1	0	1.3E+2	1.3E+2	3.9E+2	0	3.9E+2
U-235	0	4.3E-2	4.3E-2	1.6E-1	0	1.6E-1	0	3.7E+0	3.7E+0	1.1E+1	0	1.1E+1
U-236	0	4.9E-3	4.9E-3	1.8E-2	0	1.8E-2	0	1.7E+1	1.7E+1	5.0E+1	0	5.0E+1
U-238	0	5.0E-1	5.0E-1	1.8E+0	0	1.8E+0	0	2.1E+2	2.1E+2	6.2E+2	0	6.2E+2
Sum of U-23x	0	8.8E-1	8.8E-1	3.2E+0	0	3.2E+0	0	3.6E+2	3.6E+2	1.1E+3	0	1.1E+3

Table B.21. (contd)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046
Alternative Group E_1 - Lined Modular Facilities for LLW and MLLW in 200E LLBGs, and for Melters and ILAW at ERDF
Alternative Group E_2 - Lined Modular Facilities for LLW and MLLW near PUREX, and for Melters and ILAW at ERDF

	Category 1 LLW						**Category 3 LLW**					
	1996 to 2007			**2008 to 2046**			**1996 to 2007**			**2008 to 2046**		
Radionuclide	**200 E**	**200 W**	**Total**	**Near PUREX**	**200 W**	**Total**	**200 E**	**200 W**	**Total**	**Near PUREX**	**200 W**	**Total**
Upper Bound Waste Volume												
C-14	0	5.2E+0	5.2E+0	1.6E+1	0	1.6E+1	0	3.5E-1	3.5E-1	1.5E+2	0	1.5E+2
Tc-99	0	4.0E-1	4.0E-1	1.3E+0	0	1.3E+0	0	0	0	0	0	0
Grouted Tc-99	0	0	0	0	0	0	0	7.2E+1	7.2E+1	3.2E+3	0	3.2E+3
I-129	0	3.2E-3	3.2E-3	3.7E-3	0	3.7E-3	0	0	0	0	0	0
Grouted I-129	0	0	0	0	0	0	0	3.5E-7	3.5E-7	5.0E+0	0	5.0E+0
U-233	0	1.3E-1	1.3E-1	4.5E-1	0	4.5E-1	0	2.3E-1	2.3E-1	1.8E-1	0	1.8E-1
U-234	0	9.0E-1	9.0E-1	9.2E-1	0	9.2E-1	0	2.9E+2	2.9E+2	3.1E+2	0	3.1E+2
U-235	0	8.9E-2	8.9E-2	1.7E-1	0	1.7E-1	0	8.4E+0	8.4E+0	1.2E+1	0	1.2E+1
U-236	0	4.9E-3	4.9E-3	1.8E-2	0	1.8E-2	0	3.8E+1	3.8E+1	2.9E+1	0	2.9E+1
U-238	0	1.7E+0	1.7E+0	2.1E+0	0	2.1E+0	0	4.7E+2	4.7E+2	5.0E+2	0	5.0E+2
Sum of U-23x	0	2.8E+0	2.8E+0	3.6E+0	0	3.6E+0	0	8.1E+2	8.1E+2	8.6E+2	0	8.6E+2

(a) For same locations: 0.82% of Lower Bound volume [LBV] Cat 1 LLW; 0.96% of LBV Cat 3 LLW [except Tc-99 & I-129 same as LBV]; 0.996% of MLLW LBV.

Table B.21. (contd)

Radionuclide	MLLW						Melter MLLW	ILAW (vitrified)	Area Totals		Total Segregated	Total HSW
	1996 to 2007			2008 to 2046					Segregated			
	200 E	200 W	Total	Near PUREX	200 W	Total	ERDF	ERDF	200 E	200 W		
Disposition of Segregated Wastes in Various Forms and Locations as of 2046 **Alternative Group E_1 - Lined Modular Facilities for LLW and MLLW in 200E LLBGs, and for Melters and ILAW at ERDF** **Alternative Group E_2 - Lined Modular Facilities for LLW and MLLW near PUREX, and for Melters and ILAW at ERDF**												
Hanford Only Waste Volume[(a)]												
C-14	0	1.5E+0	1.5E+0	4.3E+0	0	4.3E+0	0	0	1.8E+1	4.9E+0	2.2E+1	6.4E+2
Tc-99	0	3.4E+0	3.4E+0	8.3E+0	0	8.3E+0	0	2.6E+4	9.4E+0	2.6E+4	2.6E+4	2.6E+4
Grouted Tc-99	0	4.9E+0	4.9E+0	1.6E+2	0	1.6E+2	3.9E+1	0	3.4E+3	1.2E+2	3.5E+3	3.5E+3
I-129	0	3.5E-2	3.5E-2	1.0E-1	0	1.0E-1	0	2.2E+1	1.1E-1	2.2E+1	2.2E+1	2.2E+1
Grouted I-129	0	0	0	0	0	0	0	0	5.0E+0	0	5.0E+0	5.0E+0
U-233	0	4.6E-3	4.6E-3	1.4E-2	0	1.4E-2	8.5E-1	1.3E+2	6.8E-1	1.3E+2	1.3E+2	1.4E+2
U-234	0	5.4E+0	5.4E+0	1.6E+1	0	1.6E+1	4.6E-1	4.4E+1	3.9E+2	1.7E+2	5.6E+2	6.1E+2
U-235	0	8.7E-2	8.7E-2	2.6E-1	0	2.6E-1	1.9E-2	1.8E+0	1.1E+1	5.5E+0	1.7E+1	2.1E+1
U-236	0	1.0E-1	1.0E-1	3.0E-1	0	3.0E-1	1.7E-2	1.4E+0	4.9E+1	1.8E+1	6.6E+1	6.6E+1
U-238	0	1.4E+0	1.4E+0	4.0E+0	0	4.0E+0	4.1E-1	4.8E+1	6.0E+2	2.5E+2	8.5E+2	9.4E+2
Sum of U-23x	0	7.0E+0	7.0E+0	2.1E+1	0	2.1E+1	1.8E+0	2.3E+2	1.1E+3	5.8E+2	1.6E+3	1.8E+3
Lower Bound Waste Volume												
C-14	0	1.5E+0	1.5E+0	4.3E+0	0	4.3E+0	0	0	2.0E+1	5.7E+0	2.6E+1	6.5E+2
Tc-99	0	3.4E+0	3.4E+0	8.4E+0	0	8.4E+0	0	2.6E+4	9.7E+0	2.6E+4	2.6E+4	2.6E+4
Grouted Tc-99	0	4.9E+0	4.9E+0	1.6E+2	0	1.6E+2	3.9E+1	0	3.4E+3	1.2E+2	3.5E+3	3.5E+3
I-129	0	3.5E-2	3.5E-2	1.0E-1	0	1.0E-1	0	2.2E+1	1.1E-1	2.2E+1	2.2E+1	2.2E+1
Grouted I-129	0	0	0	0	0	0	0	0	5.0E+0	0	5.0E+0	5.0E+0
U-233	0	4.6E-3	4.6E-3	1.4E-2	0	1.4E-2	8.5E-1	1.3E+2	7.8E-1	1.3E+2	1.3E+2	1.4E+2
U-234	0	5.5E+0	5.5E+0	1.6E+1	0	1.6E+1	4.6E-1	4.4E+1	4.1E+2	1.8E+2	5.9E+2	6.3E+2
U-235	0	8.7E-2	8.7E-2	2.6E-1	0	2.6E-1	1.9E-2	1.8E+0	1.2E+1	5.6E+0	1.7E+1	2.2E+1
U-236	0	1.0E-1	1.0E-1	3.0E-1	0	3.0E-1	1.7E-2	1.4E+0	5.1E+1	1.8E+1	6.9E+1	6.9E+1
U-238	0	1.4E+0	1.4E+0	4.0E+0	0	4.0E+0	4.1E-1	4.8E+1	6.3E+2	2.6E+2	8.9E+2	9.8E+2
Sum of U-23x	0	7.0E+0	7.0E+0	2.1E+1	0	2.1E+1	1.8E+0	2.3E+2	1.1E+3	5.9E+2	1.7E+3	1.8E+3

Table B.21. (contd)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046
Alternative Group E_1 - Lined Modular Facilities for LLW and MLLW in 200E LLBGs, and for Melters and ILAW at ERDF
Alternative Group E_2 - Lined Modular Facilities for LLW and MLLW near PUREX, and for Melters and ILAW at ERDF

	MLLW						Melter MLLW	ILAW (vitrified)	Area Totals			
	1996 to 2007			2008 to 2046					Segregated			
Radionuclide	**200 E**	**200 W**	**Total**	**Near PUREX**	**200 W**	**Total**	**ERDF**	**ERDF**	**200 E**	**200 W**	**Total Segregated**	**Total HSW**
Upper Bound Waste Volume												
C-14	1.6E+0	1.1E+0	2.7E+0	5.7E+0	0	5.7E+0	0	0	1.7E+2	6.7E+0	1.7E+2	8.0E+2
Tc-99	1.4E+0	2.1E+0	3.5E+0	8.3E+0	0	8.3E+0	0	2.6E+4	1.1E+1	2.6E+4	2.6E+4	2.6E+4
Grouted Tc-99	1.2E+2	6.0E+1	1.8E+2	3.3E+2	0	3.3E+2	3.9E+1	0	3.7E+3	1.7E+2	3.9E+3	3.9E+3
I-129	1.7E-2	1.7E-2	3.4E-2	1.1E-1	0	1.1E-1	0	2.2E+1	1.3E-1	2.2E+1	2.2E+1	2.2E+1
Grouted I-129	0	0	0	0	0	0	0	0	5.0E+0	0	5.0E+0	5.0E+0
U-233	2.2E-3	2.2E-3	4.4E-3	1.4E-2	0	1.4E-2	8.5E-1	1.3E+2	6.5E-1	1.3E+2	1.3E+2	1.4E+2
U-234	2.3E+2	1.1E+2	3.3E+2	3.4E+2	0	3.4E+2	4.6E-1	4.4E+1	8.8E+2	4.5E+2	1.3E+3	1.4E+3
U-235	1.0E+1	4.8E+0	1.5E+1	1.5E+1	0	1.5E+1	1.9E-2	1.8E+0	3.7E+1	1.5E+1	5.2E+1	5.7E+1
U-236	4.9E-2	4.9E-2	9.7E-2	3.1E-1	0	3.1E-1	1.7E-2	1.4E+0	2.9E+1	4.0E+1	6.9E+1	6.9E+1
U-238	2.3E+2	1.1E+2	3.5E+2	3.4E+2	0	3.4E+2	4.1E-1	4.8E+1	1.1E+3	6.3E+2	1.7E+3	1.8E+3
Sum of U-23x	4.7E+2	2.3E+2	6.9E+2	7.0E+2	0	7.0E+2	1.8E+0	2.3E+2	2.0E+3	1.3E+3	3.3E+3	3.4E+3

(a) For same locations: 0.82% of Lower Bound volume [LBV] Cat 1 LLW; 0.96% of LBV Cat 3 LLW [except Tc-99 & I-129 same as LBV]; 0.996% of MLLW LBV.

Table B.22. Inventory of Long-Lived Mobile Radionuclides in HSW for Alternative Group E_3, Ci (Sheet 1 of 4)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046 Alternative Group E_3 - Lined Modular Facilities for LLW and MLLW at ERDF, and for Melters and ILAW near PUREX												
Radionuclide	**Category 1 LLW**						**Category 3 LLW**					
	1996 to 2007			**2008 to 2046**			**1996 to 2007**			**2008 to 2046**		
	200 E	**200 W**	**Total**	**200 E**	**ERDF**	**Total**	**200 E**	**200 W**	**Total**	**200 E**	**ERDF**	**Total**
Hanford Only Waste Volume[(a)]												
C-14	0	3.3E+0	3.3E+0	0	1.3E+1	1.3E+1	0	1.5E-1	1.5E-1	0	4.4E-1	4.4E-1
Tc-99	0	3.0E-1	3.0E-1	0	1.1E+0	1.1E+0	0	0	0	0	0	0
Grouted Tc-99	0	0	0	0	0	0	0	7.2E+1	7.2E+1	0	3.2E+3	3.2E+3
I-129	0	2.6E-3	2.6E-3	0	3.0E-3	3.0E-3	0	0	0	0	0	0
Grouted I-129	0	0	0	0	0	0	0	3.4E-7	3.4E-7	0	5.0E+0	5.0E+0
U-233	0	1.0E-1	1.0E-1	0	3.7E-1	3.7E-1	0	9.8E-2	9.8E-2	0	3.0E-1	3.0E-1
U-234	0	1.7E-1	1.7E-1	0	6.1E-1	6.1E-1	0	1.2E+2	1.2E+2	0	3.7E+2	3.7E+2
U-235	0	3.6E-2	3.6E-2	0	1.3E-1	1.3E-1	0	3.5E+0	3.5E+0	0	1.1E+1	1.1E+1
U-236	0	4.0E-3	4.0E-3	0	1.5E-2	1.5E-2	0	1.6E+1	1.6E+1	0	4.8E+1	4.8E+1
U-238	0	4.1E-1	4.1E-1	0	1.5E+0	1.5E+0	0	2.0E+2	2.0E+2	0	6.0E+2	6.0E+2
Sum of U-23x	0	7.2E-1	7.2E-1	0	2.6E+0	2.6E+0	0	3.4E+2	3.4E+2	0	1.0E+3	1.0E+3
Lower Bound Waste Volume												
C-14	0	4.1E+0	4.1E+0	0	1.6E+1	1.6E+1	0	1.5E-1	1.5E-1	0	4.6E-1	4.6E-1
Tc-99	0	3.7E-1	3.7E-1	0	1.3E+0	1.3E+0	0	0	0	0	0	0
Grouted Tc-99	0	0	0	0	0	0	0	7.2E+1	7.2E+1	0	3.2E+3	3.2E+3
I-129	0	3.2E-3	3.2E-3	0	3.7E-3	3.7E-3	0	0	0	0	0	0
Grouted I-129	0	0	0	0	0	0	0	3.5E-7	3.5E-7	0	5.0E+0	5.0E+0
U-233	0	1.3E-1	1.3E-1	0	4.5E-1	4.5E-1	0	1.0E-1	1.0E-1	0	3.1E-1	3.1E-1
U-234	0	2.1E-1	2.1E-1	0	7.5E-1	7.5E-1	0	1.3E+2	1.3E+2	0	3.9E+2	3.9E+2
U-235	0	4.3E-2	4.3E-2	0	1.6E-1	1.6E-1	0	3.7E+0	3.7E+0	0	1.1E+1	1.1E+1
U-236	0	4.9E-3	4.9E-3	0	1.8E-2	1.8E-2	0	1.7E+1	1.7E+1	0	5.0E+1	5.0E+1
U-238	0	5.0E-1	5.0E-1	0	1.8E+0	1.8E+0	0	2.1E+2	2.1E+2	0	6.2E+2	6.2E+2
Sum of U-23x	0	8.8E-1	8.8E-1	0	3.2E+0	3.2E+0	0	3.6E+2	3.6E+2	0	1.1E+3	1.1E+3

Table B.22. (contd)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046 Alternative Group E_3 - Lined Modular Facilities for LLW and MLLW at ERDF, and for Melters and ILAW near PUREX												
Radionuclide	**Category 1 LLW**						**Category 3 LLW**					
	1996 to 2007			**2008 to 2046**			**1996 to 2007**			**2008 to 2046**		
	200 E	**200 W**	**Total**	**200 E**	**ERDF**	**Total**	**200 E**	**200 W**	**Total**	**200 E**	**ERDF**	**Total**
Upper Bound Waste Volume												
C-14	0	5.2E+0	5.2E+0	0	1.6E+1	1.6E+1	0	3.5E-1	3.5E-1	0	1.5E+2	1.5E+2
Tc-99	0	4.0E-1	4.0E-1	0	1.3E+0	1.3E+0	0	0	0	0	0	0
Grouted Tc-99	0	0	0	0	0	0	0	7.2E+1	7.2E+1	0	3.2E+3	3.2E+3
I-129	0	3.2E-3	3.2E-3	0	3.7E-3	3.7E-3	0	0	0	0	0	0
Grouted I-129	0	0	0	0	0	0	0	3.5E-7	3.5E-7	0	5.0E+0	5.0E+0
U-233	0	1.3E-1	1.3E-1	0	4.5E-1	4.5E-1	0	2.3E-1	2.3E-1	0	1.8E-1	1.8E-1
U-234	0	9.0E-1	9.0E-1	0	9.2E-1	9.2E-1	0	2.9E+2	2.9E+2	0	3.1E+2	3.1E+2
U-235	0	8.9E-2	8.9E-2	0	1.7E-1	1.7E-1	0	8.4E+0	8.4E+0	0	1.2E+1	1.2E+1
U-236	0	4.9E-3	4.9E-3	0	1.8E-2	1.8E-2	0	3.8E+1	3.8E+1	0	2.9E+1	2.9E+1
U-238	0	1.7E+0	1.7E+0	0	2.1E+0	2.1E+0	0	4.7E+2	4.7E+2	0	5.0E+2	5.0E+2
Sum of U-23x	0	2.8E+0	2.8E+0	0	3.6E+0	3.6E+0	0	8.1E+2	8.1E+2	0	8.6E+2	8.6E+2

(a) For same locations: 0.82% of Lower Bound volume [LBV] Cat 1 LLW; 0.96% of LBV Cat 3 LLW [except Tc-99 & I-129 same as LBV]; 0.996% of MLLW LBV.

Table B.22. (contd)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046
Alternative Group E_3 - Lined Modular Facilities for LLW and MLLW at ERDF, and for Melters and ILAW near PUREX

Radionuclide	MLLW						Melter	ILAW (vitrified)	Area Totals		Total Segregated	Total HSW
	1996 to 2007			2008 to 2046					Segregated			
	200 E	200 W	Total	200 E	ERDF	Total	Near PUREX	Near PUREX	200 E	200 W		
Hanford Only Waste Volume[a]												
C-14	0	1.5E+0	1.5E+0	0	4.3E+0	4.3E+0	0	0	0	2.2E+1	2.2E+1	6.4E+2
Tc-99	0	3.4E+0	3.4E+0	0	8.3E+0	8.3E+0	0	2.6E+4	2.6E+4	1.3E+1	2.6E+4	2.6E+4
Grouted Tc-99	0	4.9E+0	4.9E+0	0	1.6E+2	1.6E+2	3.9E+1	0	3.9E+1	3.5E+3	3.5E+3	3.5E+3
I-129	0	3.5E-2	3.5E-2	0	1.0E-1	1.0E-1	0	2.2E+1	2.2E+1	1.4E-1	2.2E+1	2.2E+1
Grouted I-129	0	0	0	0	0	0	0	0	0	5.0E+0	5.0E+0	5.0E+0
U-233	0	4.6E-3	4.6E-3	0	1.4E-2	1.4E-2	8.5E-1	1.3E+2	1.3E+2	8.9E-1	1.3E+2	1.4E+2
U-234	0	5.4E+0	5.4E+0	0	1.6E+1	1.6E+1	4.6E-1	4.4E+1	4.5E+1	5.2E+2	5.6E+2	6.1E+2
U-235	0	8.7E-2	8.7E-2	0	2.6E-1	2.6E-1	1.9E-2	1.8E+0	1.8E+0	1.5E+1	1.7E+1	2.1E+1
U-236	0	1.0E-1	1.0E-1	0	3.0E-1	3.0E-1	1.7E-2	1.4E+0	1.4E+0	6.5E+1	6.6E+1	6.6E+1
U-238	0	1.4E+0	1.4E+0	0	4.0E+0	4.0E+0	4.1E-1	4.8E+1	4.9E+1	8.0E+2	8.5E+2	9.4E+2
Sum of U-23x	0	7.0E+0	7.0E+0	0	2.1E+1	2.1E+1	1.8E+0	2.3E+2	2.3E+2	1.4E+3	1.6E+3	1.8E+3
Lower Bound Waste Volume												
C-14	0	1.5E+0	1.5E+0	0	4.3E+0	4.3E+0	0	0	0	2.6E+1	2.6E+1	6.5E+2
Tc-99	0	3.4E+0	3.4E+0	0	8.4E+0	8.4E+0	0	2.6E+4	2.6E+4	1.3E+1	2.6E+4	2.6E+4
Grouted Tc-99	0	4.9E+0	4.9E+0	0	1.6E+2	1.6E+2	3.9E+1	0	3.9E+1	3.5E+3	3.5E+3	3.5E+3
I-129	0	3.5E-2	3.5E-2	0	1.0E-1	1.0E-1	0	2.2E+1	2.2E+1	1.5E-1	2.2E+1	2.2E+1
Grouted I-129	0	0	0	0	0	0	0	0	0	5.0E+0	5.0E+0	5.0E+0
U-233	0	4.6E-3	4.6E-3	0	1.4E-2	1.4E-2	8.5E-1	1.3E+2	1.3E+2	1.0E+0	1.3E+2	1.4E+2
U-234	0	5.5E+0	5.5E+0	0	1.6E+1	1.6E+1	4.6E-1	4.4E+1	4.5E+1	5.4E+2	5.9E+2	6.3E+2
U-235	0	8.7E-2	8.7E-2	0	2.6E-1	2.6E-1	1.9E-2	1.8E+0	1.8E+0	1.5E+1	1.7E+1	2.2E+1
U-236	0	1.0E-1	1.0E-1	0	3.0E-1	3.0E-1	1.7E-2	1.4E+0	1.4E+0	6.7E+1	6.9E+1	6.9E+1
U-238	0	1.4E+0	1.4E+0	0	4.0E+0	4.0E+0	4.1E-1	4.8E+1	4.9E+1	8.4E+2	8.9E+2	9.8E+2
Sum of U-23x	0	7.0E+0	7.0E+0	0	2.1E+1	2.1E+1	1.8E+0	2.3E+2	2.3E+2	1.5E+3	1.7E+3	1.8E+3

Table B.22. (contd)

Disposition of Segregated Wastes in Various Forms and Locations as of 2046
Alternative Group E_3 - Lined Modular Facilities for LLW and MLLW at ERDF, and for Melters and ILAW near PUREX

	MLLW						Melter	ILAW (vitrified)	Area Totals			
	1996 to 2007			2008 to 2046					Segregated			
Radionuclide	200 E	200 W	Total	200 E	ERDF	Total	Near PUREX	Near PUREX	200 E	200 W	Total Segregated	Total HSW
Upper Bound Waste Volume												
C-14	1.6E+0	1.1E+0	2.7E+0	0	5.7E+0	5.7E+0	0	0	1.6E+0	1.7E+2	1.7E+2	8.0E+2
Tc-99	1.4E+0	2.1E+0	3.5E+0	0	8.3E+0	8.3E+0	0	2.6E+4	2.6E+4	1.2E+1	2.6E+4	2.6E+4
Grouted Tc-99	1.2E+2	6.0E+1	1.8E+2	0	3.3E+2	3.3E+2	3.9E+1	0	1.6E+2	3.7E+3	3.9E+3	3.9E+3
I-129	1.7E-2	1.7E-2	3.4E-2	0	1.1E-1	1.1E-1	0	2.2E+1	2.2E+1	1.3E-1	2.2E+1	2.2E+1
Grouted I-129	0	0	0	0	0	0	0	0	0	5.0E+0	5.0E+0	5.0E+0
U-233	2.2E-3	2.2E-3	4.4E-3	0	1.4E-2	1.4E-2	8.5E-1	1.3E+2	1.3E+2	1.0E+0	1.3E+2	1.4E+2
U-234	2.3E+2	1.1E+2	3.3E+2	0	3.4E+2	3.4E+2	4.6E-1	4.4E+1	2.7E+2	1.1E+3	1.3E+3	1.4E+3
U-235	1.0E+1	4.8E+0	1.5E+1	0	1.5E+1	1.5E+1	1.9E-2	1.8E+0	1.2E+1	4.0E+1	5.2E+1	5.7E+1
U-236	4.9E-2	4.9E-2	9.7E-2	0	3.1E-1	3.1E-1	1.7E-2	1.4E+0	1.5E+0	6.7E+1	6.9E+1	6.9E+1
U-238	2.3E+2	1.1E+2	3.5E+2	0	3.4E+2	3.4E+2	4.1E-1	4.8E+1	2.8E+2	1.4E+3	1.7E+3	1.8E+3
Sum of U-23x	4.7E+2	2.3E+2	6.9E+2	0	7.0E+2	7.0E+2	1.8E+0	2.3E+2	7.0E+2	2.6E+3	3.3E+3	3.4E+3

(a) For same locations: 0.82% of Lower Bound volume [LBV] Cat 1 LLW; 0.96% of LBV Cat 3 LLW [except Tc-99 & I-129 same as LBV]; 0.996% of MLLW LBV.

Table B.23. Inventory of Long-Lived Mobile Radionuclides in HSW for the No Action Alternative, Ci

Disposition of Segregated Wastes in Various Forms and Locations as of 2046
No Action Alternative - LLW in conventional design trenches (conforming LLW only) and MLLW in existing trenches only; remainder of LLW and MLLW stored at CWC; melters stored on concrete pads at CWC; ILAW disposed of in concrete vaults near PUREX

Radionuclide	Category 1 LLW			Category 3 LLW			MLLW	ILAW (vitrified)	Area Totals		Total Segregated	In Storage	Total HSW
	1996 to 2046			1996 to 2046			1996-2046		Segregated				
	200 E	200 W	Total	200 E	200 W	Total	200 W	Near PUREX	200 E	200 W			
Hanford Only Volume(a)													
C-14	5.9E-1	1.5E+1	1.6E+1	2.2E-2	5.7E-1	5.9E-1	7.5E-1	0	6.1E-1	1.7E+1	1.7E+1	5.3E+0	6.4E+2
Tc-99	5.0E-2	1.3E+0	1.3E+0	0	0	0	9.6E-1	2.6E+4	2.6E+4	2.3E+0	2.6E+4	1.1E+1	2.6E+4
Grouted Tc-99	0	0	0	1.3E+2	3.2E+3	3.3E+3	3.3E+0	0	1.3E+2	3.2E+3	3.3E+3	2.0E+2	3.5E+3
I-129	2.0E-4	5.2E-3	5.4E-3	8.6E-8	2.2E-6	2.3E-6	1.8E-2	2.2E+1	2.2E+1	2.3E-2	2.2E+1	1.2E-1	2.2E+1
Grouted I-129	0	0	0	0	5.0E+0	5.0E+0	0	0	0	5.0E+0	5.0E+0	0	5.0E+0
U-233	1.8E-2	4.6E-1	4.7E-1	1.5E-2	3.8E-1	3.9E-1	2.5E-3	1.3E+2	1.3E+2	8.4E-1	1.3E+2	8.7E-1	1.4E+2
U-234	2.9E-2	7.5E-1	7.8E-1	1.9E+1	4.8E+2	5.0E+2	2.8E+0	4.4E+1	6.3E+1	4.8E+2	5.4E+2	2.0E+1	6.1E+2
U-235	6.2E-3	1.6E-1	1.6E-1	5.3E-1	1.4E+1	1.4E+1	4.5E-2	1.8E+0	2.3E+0	1.4E+1	1.6E+1	3.5E-1	2.1E+1
U-236	7.0E-4	1.8E-2	1.9E-2	2.4E+0	6.2E+1	6.4E+1	5.2E-2	1.4E+0	3.8E+0	6.2E+1	6.6E+1	4.5E-1	6.6E+1
U-238	7.0E-2	1.8E+0	1.9E+0	3.0E+1	7.7E+2	8.0E+2	7.0E-1	4.8E+1	7.8E+1	7.7E+2	8.5E+2	5.8E+0	9.4E+2
Sum of U-23x	1.2E-1	3.2E+0	3.3E+0	5.2E+1	1.3E+3	1.4E+3	3.6E+0	2.3E+2	2.8E+2	1.3E+3	1.6E+3	2.7E+1	1.8E+3
Lower Bound Waste Volume													
C-14	7.2E-1	1.9E+1	1.9E+1	2.3E-2	5.9E-1	6.1E-1	7.5E-1	0	7.4E-1	2.0E+1	2.1E+1	5.4E+0	6.5E+2
Tc-99	6.1E-2	1.6E+0	1.6E+0	0	0	0	9.7E-1	2.6E+4	2.6E+4	2.5E+0	2.6E+4	1.1E+1	2.6E+4
Grouted Tc-99	0	0	0	1.3E+2	3.2E+3	3.3E+3	3.4E+0	0	1.3E+2	3.2E+3	3.3E+3	2.0E+2	3.5E+3
I-129	2.5E-4	6.4E-3	6.6E-3	9.0E-8	2.3E-6	2.4E-6	1.8E-2	2.2E+1	2.2E+1	2.4E-2	2.2E+1	1.2E-1	2.2E+1
Grouted I-129	0	0	0	0	5.0E+0	5.0E+0	0	0	0	5.0E+0	5.0E+0	0	5.0E+0
U-233	2.2E-2	5.6E-1	5.8E-1	1.5E-2	4.0E-1	4.1E-1	2.5E-3	1.3E+2	1.3E+2	9.5E-1	1.3E+2	8.7E-1	1.4E+2
U-234	3.6E-2	9.2E-1	9.5E-1	1.9E+1	5.0E+2	5.2E+2	2.8E+0	4.4E+1	6.4E+1	5.0E+2	5.7E+2	2.0E+1	6.3E+2
U-235	7.5E-3	1.9E-1	2.0E-1	5.6E-1	1.4E+1	1.5E+1	4.5E-2	1.8E+0	2.4E+0	1.4E+1	1.7E+1	3.5E-1	2.2E+1
U-236	8.5E-4	2.2E-2	2.3E-2	2.5E+0	6.4E+1	6.7E+1	5.2E-2	1.4E+0	3.9E+0	6.4E+1	6.8E+1	4.6E-1	6.9E+1
U-238	8.6E-2	2.2E+0	2.3E+0	3.1E+1	8.0E+2	8.3E+2	7.0E-1	4.8E+1	8.0E+1	8.0E+2	8.8E+2	5.9E+0	9.8E+2
Sum of U-23x	1.5E-1	3.9E+0	4.0E+0	5.4E+1	1.4E+3	1.4E+3	3.6E+0	2.3E+2	2.8E+2	1.4E+3	1.7E+3	2.7E+1	1.8E+3

(a) For same locations: 0.82% of Lower Bound volume [LBV] Cat 1 LLW; 0.96% of LBV Cat 3 LLW [except Tc-99 & I-129 same as LBV]; 0.996% of MLLW LBV.

Table B.24a. Inventory of MLLW as Soil and Grouted-Equivalent Fractions for Alternative Groups A, C, D, and E, Ci

Disposition of Segregated Wastes in Various Forms and Locations as of 2046 - Details for MLLW										
	MLLW in SOIL					**MLLW GROUTED – EQUIVALENT**				
	1996 to 2007			**2008 to 2046**	**TOTAL**	**1996 to 2007**			**2008 to 2046**	**TOTAL**
Radionuclide	**200 E**	**200 W**	**Sub-Total**	**Location$^{(a)}$**		**200 E**	**200 W**	**Sub-Total**	**Location$^{(a)}$**	
Hanford Only Volume										
C-14	0	6.0E-1	6.0E-1	1.5E+0	2.1E+0	0	8.6E-1	8.6E-1	2.9E+0	3.7E+0
Tc-99	0	3.4E+0	3.4E+0	8.3E+0	1.2E+1	0	4.9E+0	4.9E+0	1.6E+2	1.6E+2
I-129	0	1.4E-2	1.4E-2	3.5E-2	5.0E-2	0	2.1E-2	2.1E-2	6.9E-2	8.9E-2
U-233	0	2.0E-3	2.0E-3	4.7E-3	6.6E-3	0	2.7E-3	2.7E-3	8.9E-3	1.2E-2
U-234	0	2.2E+0	2.2E+0	5.4E+0	7.7E+0	0	3.2E+0	3.2E+0	1.1E+1	1.4E+1
U-235	0	3.6E-2	3.6E-2	8.7E-2	1.2E-1	0	5.1E-2	5.1E-2	1.7E-1	2.2E-1
U-236	0	4.2E-2	4.2E-2	1.0E-1	1.4E-1	0	6.0E-2	6.0E-2	2.0E-1	2.6E-1
U-238	0	5.6E-1	5.6E-1	1.4E+0	1.9E+0	0	7.9E-1	7.9E-1	2.6E+0	3.4E+0
Sum U-23x	0	2.9E+0	2.9E+0	7.0E+0	9.9E+0	0	4.1E+0	4.1E+0	1.4E+1	1.8E+1
Lower Bound Waste Volume										
C-14	0	6.0E-1	6.0E-1	1.5E+0	2.1E+0	0	8.6E-1	8.6E-1	2.9E+0	3.7E+0
Tc-99	0	3.4E+0	3.4E+0	8.4E+0	1.2E+1	0	4.9E+0	4.9E+0	1.6E+2	1.6E+2
I-129	0	1.5E-2	1.5E-2	3.5E-2	5.0E-2	0	2.1E-2	2.1E-2	6.9E-2	8.9E-2
U-233	0	2.0E-3	2.0E-3	4.7E-3	6.6E-3	0	2.7E-3	2.7E-3	8.9E-3	1.2E-2
U-234	0	2.2E+0	2.2E+0	5.5E+0	7.7E+0	0	3.2E+0	3.2E+0	1.1E+1	1.4E+1
U-235	0	3.6E-2	3.6E-2	8.7E-2	1.2E-1	0	5.1E-2	5.1E-2	1.7E-1	2.2E-1
U-236	0	4.2E-2	4.2E-2	1.0E-1	1.4E-1	0	6.0E-2	6.0E-2	2.0E-1	2.6E-1
U-238	0	5.6E-1	5.6E-1	1.4E+0	1.9E+0	0	8.0E-1	8.0E-1	2.7E+0	3.4E+0
Sum U-23x	0	2.9E+0	2.9E+0	7.0E+0	9.9E+0	0	4.1E+0	4.1E+0	1.4E+1	1.8E+1
Upper Bound Waste Volume										
C-14	2.5E-1	3.7E-1	6.2E-1	1.5E+0	2.1E+0	1.4E+0	7.6E-1	2.1E+0	4.3E+0	6.4E+0
Tc-99	1.4E+0	2.1E+0	3.5E+0	8.3E+0	1.2E+1	1.2E+2	6.0E+1	1.8E+2	3.3E+2	5.2E+2
I-129	6.0E-3	8.8E-3	1.5E-2	3.5E-2	5.0E-2	1.1E-2	8.0E-3	1.9E-2	7.1E-2	8.9E-2
U-233	8.2E-4	1.2E-3	2.0E-3	4.6E-3	6.6E-3	1.4E-3	1.0E-3	2.4E-3	9.2E-3	1.2E-2
U-234	9.3E-1	1.4E+0	2.3E+0	5.4E+0	7.7E+0	2.2E+2	1.1E+2	3.3E+2	3.4E+2	6.7E+2
U-235	1.5E-2	2.2E-2	3.7E-2	8.6E-2	1.2E-1	1.0E+1	4.8E+0	1.5E+1	1.5E+1	2.9E+1
U-236	1.7E-2	2.6E-2	4.3E-2	1.0E-1	1.4E-1	3.1E-2	2.3E-2	5.5E-2	2.1E-1	2.6E-1
U-238	2.3E-1	3.4E-1	5.7E-1	1.4E+0	1.9E+0	2.3E+2	1.1E+2	3.4E+2	3.4E+2	6.9E+2
Sum U-23x	1.2E+0	1.8E+0	3.0E+0	6.9E+0	9.9E+0	4.7E+2	2.2E+2	6.9E+2	6.9E+2	1.4E+3

(a) Location for Alternative Groups A, C, D2, and E1 - 200E burial grounds; for Alternative Groups D1 and E2 - near PUREX; and for Alternative Groups D3 and E3 - at ERDF.

Table B.24b. Inventory of MLLW as Soil and Grouted-Equivalent Fractions for Alternative Group B, Ci

Disposition of Segregated Wastes in Various Forms and Locations as of 2046 - Details for MLLW										
	MLLW in SOIL					MLLW GROUTED – EQUIVALENT				
	1996 to 2007			2008 to 2046	TOTAL	1996 to 2007			2008 to 2046	TOTAL
Radionuclide	200 E	200 W	Sub-Total	200E		200 E	200 W	Sub-Total	200E	
Hanford Only Volume										
C-14	0	3.5E-1	3.5E-1	1.7E+0	2.1E+0	0	7.0E-1	7.0E-1	3.0E+0	3.7E+0
Tc-99	0	2.0E+0	2.0E+0	9.8E+0	1.2E+1	0	4.0E+0	4.0E+0	1.6E+2	1.6E+2
I-129	0	8.4E-3	8.4E-3	4.1E-2	4.9E-2	0	1.7E-2	1.7E-2	7.2E-2	8.9E-2
U-233	0	1.1E-3	1.1E-3	5.5E-3	6.6E-3	0	2.2E-3	2.2E-3	9.4E-3	1.2E-2
U-234	0	1.3E+0	1.3E+0	6.4E+0	7.7E+0	0	2.6E+0	2.6E+0	1.1E+1	1.4E+1
U-235	0	2.1E-2	2.1E-2	1.0E-1	1.2E-1	0	4.2E-2	4.2E-2	1.8E-1	2.2E-1
U-236	0	2.4E-2	2.4E-2	1.2E-1	1.4E-1	0	4.9E-2	4.9E-2	2.1E-1	2.6E-1
U-238	0	3.3E-1	3.3E-1	1.6E+0	1.9E+0	0	6.5E-1	6.5E-1	2.8E+0	3.4E+0
Sum U-23x	0	1.7E+0	1.7E+0	8.2E+0	9.8E+0	0	3.4E+0	3.4E+0	1.4E+1	1.8E+1
Lower Bound Waste Volume										
C-14	0	3.5E-1	3.5E-1	1.7E+0	2.1E+0	0	7.1E-1	7.1E-1	3.0E+0	3.7E+0
Tc-99	0	2.0E+0	2.0E+0	9.8E+0	1.2E+1	0	4.0E+0	4.0E+0	1.6E+2	1.6E+2
I-129	0	8.5E-3	8.5E-3	4.1E-2	5.0E-2	0	1.7E-2	1.7E-2	7.3E-2	8.9E-2
U-233	0	1.1E-3	1.1E-3	5.5E-3	6.6E-3	0	2.2E-3	2.2E-3	9.4E-3	1.2E-2
U-234	0	1.3E+0	1.3E+0	6.4E+0	7.7E+0	0	2.6E+0	2.6E+0	1.1E+1	1.4E+1
U-235	0	2.1E-2	2.1E-2	1.0E-1	1.2E-1	0	4.2E-2	4.2E-2	1.8E-1	2.2E-1
U-236	0	2.5E-2	2.5E-2	1.2E-1	1.4E-1	0	4.9E-2	4.9E-2	2.1E-1	2.6E-1
U-238	0	3.3E-1	3.3E-1	1.6E+0	1.9E+0	0	6.5E-1	6.5E-1	2.8E+0	3.5E+0
Sum U-23x	0	1.7E+0	1.7E+0	8.2E+0	9.9E+0	0	3.4E+0	3.4E+0	1.4E+1	1.8E+1
Upper Bound Waste Volume										
C-14	2.2E-2	1.5E-1	1.7E-1	1.9E+0	2.1E+0	1.1E+0	7.3E-1	1.8E+0	4.6E+0	6.4E+0
Tc-99	1.2E-1	8.7E-1	9.9E-1	1.1E+1	1.2E+1	1.3E+2	7.4E+1	2.0E+2	3.2E+2	5.2E+2
I-129	5.2E-4	3.7E-3	4.2E-3	4.6E-2	5.0E-2	4.2E-3	4.5E-3	8.6E-3	8.1E-2	8.9E-2
U-233	6.7E-5	4.7E-4	5.4E-4	6.1E-3	6.6E-3	5.4E-4	5.8E-4	1.1E-3	1.1E-2	1.2E-2
U-234	8.0E-2	5.7E-1	6.5E-1	7.1E+0	7.7E+0	2.4E+2	1.4E+2	3.7E+2	3.1E+2	6.8E+2
U-235	1.3E-3	9.0E-3	1.0E-2	1.1E-1	1.2E-1	1.1E+1	6.0E+0	1.7E+1	1.3E+1	3.0E+1
U-236	1.5E-3	1.1E-2	1.2E-2	1.3E-1	1.4E-1	1.2E-2	1.3E-2	2.5E-2	2.3E-1	2.6E-1
U-238	2.0E-2	1.4E-1	1.6E-1	1.8E+0	1.9E+0	2.5E+2	1.4E+2	3.9E+2	3.1E+2	7.0E+2
Sum U-23x	1.0E-1	7.3E-1	8.3E-1	9.1E+0	9.9E+0	4.9E+2	2.8E+2	7.7E+2	6.3E+2	1.4E+3

Table B.24c. Inventory of MLLW as Soil and Grouted-Equivalent Fractions for the No Action Alternative, Ci

Disposition of Segregated Wastes in Various Forms and Locations as of 2046 - Details for MLLW						
	MLLW in SOIL			MLLW GROUTED – EQUIVALENT		
	1996 to 2046			1996 to 2046		
Radionuclide	200 E	200 W	Sub-Total	200 E	200 W	Sub-Total
Hanford Only Volume						
C-14	0	1.7E-1	1.7E-1	0	5.8E-1	5.8E-1
Tc-99	0	9.6E-1	9.6E-1	0	3.3E+0	3.3E+0
I-129	0	4.0E-3	4.0E-3	0	1.4E-2	1.4E-2
U-233	0	5.2E-4	5.2E-4	0	1.8E-3	1.8E-3
U-234	0	6.3E-1	6.3E-1	0	2.2E+0	2.2E+0
U-235	0	1.0E-2	1.0E-2	0	3.5E-2	3.5E-2
U-236	0	1.2E-2	1.2E-2	0	4.1E-2	4.1E-2
U-238	0	1.6E-1	1.6E-1	0	5.4E-1	5.4E-1
Sum U-23x	0	8.1E-1	8.1E-1	0	2.8E+0	2.8E+0
Lower Bound Waste Volume						
C-14	0	1.7E-1	1.7E-1	0	5.9E-1	5.9E-1
Tc-99	0	9.7E-1	9.7E-1	0	3.4E+0	3.4E+0
I-129	0	4.0E-3	4.0E-3	0	1.4E-2	1.4E-2
U-233	0	5.3E-4	5.3E-4	0	1.8E-3	1.8E-3
U-234	0	6.3E-1	6.3E-1	0	2.2E+0	2.2E+0
U-235	0	1.0E-2	1.0E-2	0	3.5E-2	3.5E-2
U-236	0	1.2E-2	1.2E-2	0	4.1E-2	4.1E-2
U-238	0	1.6E-1	1.6E-1	0	5.4E-1	5.4E-1
Sum U-23x	0	8.1E-1	8.1E-1	0	2.8E+0	2.8E+0

B.6 Waste Stream Flowsheets

Detailed information about how each waste steam will be managed is provided in the balance of this appendix, in flowsheets that identify the facilities to be used and the volumes of waste that would pass through that facility over the period of analysis (through 2046). The flowsheets are organized first by alternative group, then by waste type, and finally by waste stream. Each flowsheet lists the three sets of waste volumes analyzed: Hanford Only, Lower Bound, and Upper Bound. The Hanford Only waste volumes are presented in bold type, the Lower Bound waste volumes in normal font, and the Upper Bound waste volumes in italics. An index to the flowsheets is shown in Table B.25. This table provides the page numbers for the flowsheet diagrams by alternative group and waste type.

Table B.25. Identification of Flowsheets

Alternative Group	Waste Type	Page Numbers
Group A	LLW	B.52 to B.54
	MLLW	B.54 to B.57
	TRU Waste	B.57 to B.60
	WTP Waste	B.61
Group B	LLW	B.62 to B.64
	MLLW	B.64 to B.67
	TRU Waste	B.67 to B.70
	WTP Waste	B.71
Group C	LLW	B.72 to B.74
	MLLW	B.74 to B.77
	TRU Waste	B.77 to B.80
	WTP Waste	B.81
Groups D & E	LLW	B.83 to B.85
	MLLW	B.85 to B.88
	TRU Waste	B.88 to B.91
	WTP Waste	B.92
No Action Group	LLW	B.93 to B.95
	MLLW	B.95 to B.98
	TRU Waste	B.98 to B.101
	WTP Waste	B.102

*Acronyms, Abbreviations, and Terms for the Waste Flow Diagrams

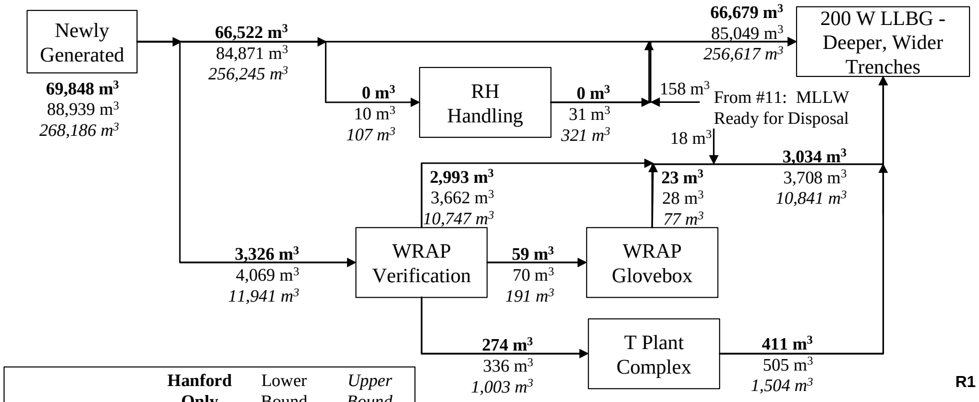
-----	Dashed lines represent waste managed as MLLW or TRU waste expected to be determined to be LLW

CH	contact-handled
CWC	Central Waste Complex
ERDF	Environmental Restoration Disposal Facility
FY	fiscal year
HIC	high-integrity container
ILAW	Immobilized Low-Activity Waste
LLBG	Low Level Burial Grounds
LLW	low-level waste
MLLW	mixed low-level waste
MW	mixed waste
PCB	polychlorinated biphenyl
PUREX	Plutonium Uranium Extraction Plant
RH	remote-handled
TRU	transuranic
WIPP	Waste Isolation Pilot Plant
WRAP	Waste Receiving and Processing Facility
WTP	Waste Treatment Plant

Disposed of FY99-01	Volume of waste disposed of from FY 1999 to FY 2001
Initial Inventory	Volume of waste managed by the Waste Management Program as of 9/30/2001
Receipts	Volume of waste expected to be received from FY 2002 to FY 2046
Waste Stream Total	Total volume of a waste stream to be managed, i.e., the sum of Disposed of FY99-01, Initial Inventory, and Receipts
Total Verification	Life-cycle volume of waste that will undergo verification in a Waste Management facility
Total Stabilized	Life-cycle volume of waste stabilized via in-trench grouting or placement in HICs
Total Treatment	Life-cycle volume of waste treated to meet disposal requirements
Total Processed	Life-cycle volume of waste processed to meet shipment and/or disposal requirements
Total Disposal	Life-cycle volume of waste disposed of at the Hanford Site or shipped offsite for final disposition
Ending Inventory	Total volume of waste remaining in storage at the Hanford Site at the end of FY 2046

Alternative Group A

Stream 1
LLW Category 1



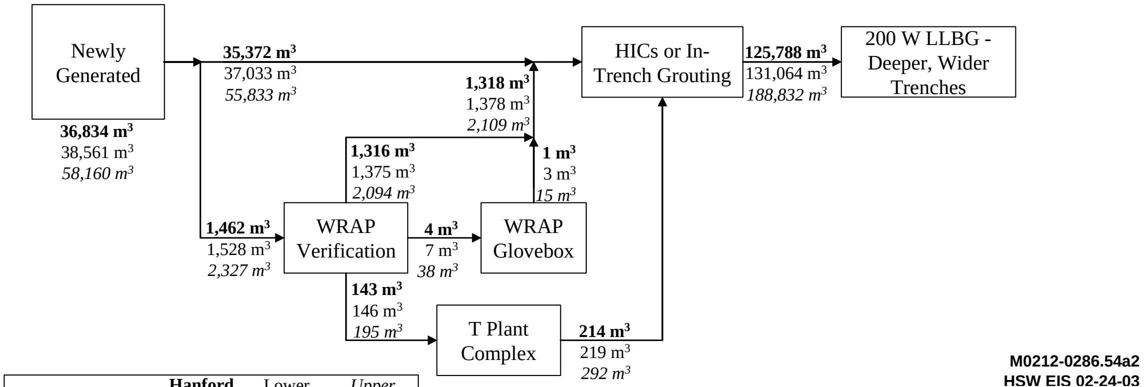
	Hanford Only	Lower Bound	*Upper Bound*
Disposed FY99-01:	**18,944 m^3**	18,944 m^3	*18,944 m^3*
Initial Inventory:	**0 m^3**	0 m^3	*0 m^3*
Receipts:	**69,848 m^3**	88,939 m^3	*268,186 m^3*
Waste Stream Total:	**88,792 m^3**	107,883 m^3	*287,130 m^3*
Total Verification:	**3,326 m^3**	4,069 m^3	*11,941 m^3*
Total Disposal:	**89,069 m^3**	108,205 m^3	*287,906 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

Notes: Both lined and unlined trenches have been analyzed as part of this alternative.

Waste disposed from FY99 to FY01 is not shown in the diagram but is included in the summary of Total Disposal.

Alternative Group A

Stream 2
LLW Category 3



	Hanford Only	Lower Bound	*Upper Bound*
Disposed FY99-01:	**2,773 m^3**	2,773 m^3	*2,773 m^3*
Initial Inventory:	**0 m^3**	0 m^3	*0 m^3*
Receipts:	**36,834 m^3**	38,561 m^3	*58,160 m^3*
Waste Stream Total:	**39,607 m^3**	41,334 m^3	*60,933 m^3*
Total Verification:	**1,462 m^3**	1,528 m^3	*2,327 m^3*
Total Stabilized:	**36,903 m^3**	38,630 m^3	*58,234 m^3*
Total Disposal:	**128,561 m^3**	133,837 m^3	*191,605 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

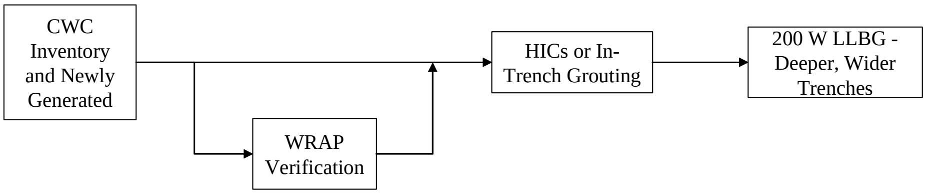
Notes: Both lined and unlined trenches have been analyzed as part of this alternative.

Waste disposed from FY99 to FY01 is not shown in the diagram but is included in the summary of Total Disposal.

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group A

Stream 3
Greater Than Category 3 Waste



M0212-0286.54a3
HSW EIS 02-24-03

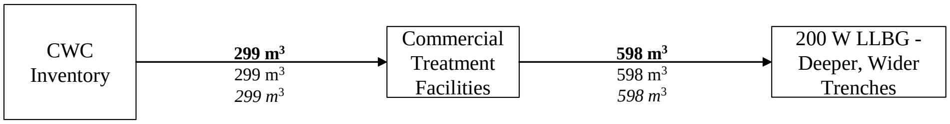
	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**<1 m^3**	<1 m^3	*<1 m^3*
Receipts:	**0 m^3**	0 m^3	*0 m^3*
Waste Stream Total:	**<1 m^3**	<1 m^3	*<1 m^3*
Total Stabilized:	**<1 m^3**	<1 m^3	*<1 m^3*
Total Disposal:	**<1 m^3**	<1 m^3	*<1 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

Notes: Both lined and unlined trenches have been analyzed as part of this alternative.

Waste disposed from FY99 to FY01 is not shown in the diagram but is included in the summary of Total Disposal.

Alternative Group A

Stream 6
LLW – Non-Conforming



M0212-0286.54a4
HSW EIS 02-24-03

	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**299 m^3**	299 m^3	*299 m^3*
Receipts:	**0 m^3**	0 m^3	*0 m^3*
Waste Stream Total:	**299 m^3**	299 m^3	*299 m^3*
Total Treatment:	**299 m^3**	299 m^3	*299 m^3*
Total Disposal:	**598 m^3**	598 m^3	*598 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

Notes: Both lined and unlined trenches have been analyzed as part of this alternative.

Waste disposed from FY99 to FY01 is not shown in the diagram but is included in the summary of Total Disposal.

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group A

Stream 20

LLW – Previously Disposed of

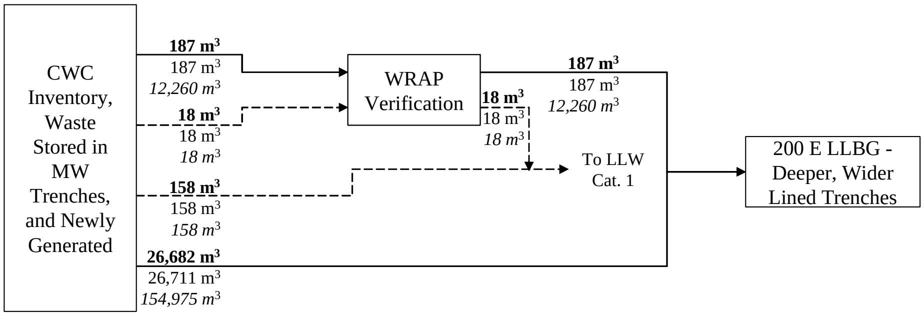
	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**283,067 m^3**	283,067 m^3	*283,067 m^3*
Receipts:	**0 m^3**	0 m^3	*0 m^3*
Waste Stream Total:	**283,067 m^3**	283,067 m^3	*283,067 m^3*
Total Treatment:	**0 m^3**	0 m^3	*0 m^3*
Total Disposal:	**283,067 m^3**	283,067 m^3	*283,067 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a5
HSW EIS 02-24-03

Alternative Group A

Stream 11

MLLW Treated and Ready for Disposal



M0212-0286.54a6
HSW EIS 02-24-03

	Hanford Only	Lower Bound	*Upper Bound*
Disposed FY99-01:	**1,010 m^3**	1,010 m^3	*1,010 m^3*
Initial Inventory:	**1,102 m^3**	1,102 m^3	*1,102 m^3*
Receipts:	**25,942 m^3**	25,970 m^3	*166,307m^3*
Waste Stream Total:	**28,054 m^3**	28,082 m^3	*168,419m^3*
Total Treatment:	**0 m^3**	0 m^3	*0 m^3*
Total Disposal:	**27,879 m^3**	27,907 m^3	*168,244 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

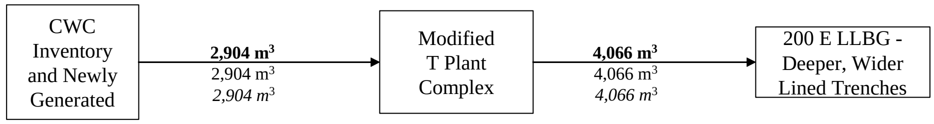
Notes: Dashed lines represent waste managed as MLLW expected to be reclassified as LLW.

Waste disposed from FY99 to FY01 is not shown in the diagram but is included in the summary of Total Disposal.

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group A

Stream 12
RH and Non-Standard Packages



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**65 m^3**	65 m^3	*65 m^3*
Receipts:	**2,839 m^3**	2,839 m^3	*2,839 m^3*
Waste Stream Total:	**2,904 m^3**	2,904 m^3	*2,904 m^3*
Total Treatment:	**2,904 m^3**	2,904 m^3	*2,904 m^3*
Total Disposal:	**4,066 m^3**	4,066 m^3	*4,066 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

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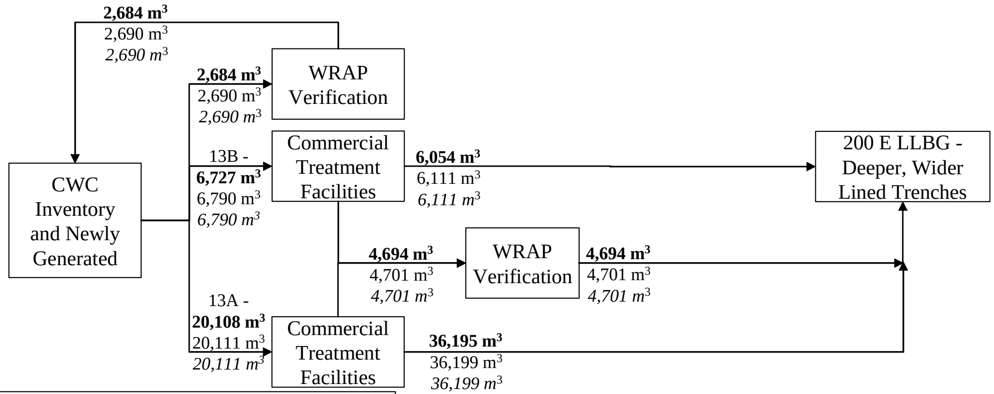
HSW EIS 02-24-03

Alternative Group A

Stream 13A – CH Inorganic Solids and Debris
Stream 13B – CH Organic Solids and Debris



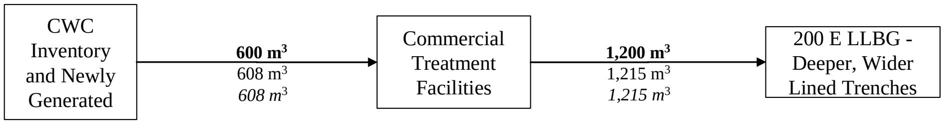
	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**5,725 m^3**	5,725 m^3	*5,725 m^3*
Receipts:	**21,110 m^3**	21,175 m^3	*21,175 m^3*
Waste Stream Total:	**26,835 m^3**	26,901 m^3	*26,901 m^3*
Total Treatment:	**26,835 m^3**	26,901 m^3	*26,901 m^3*
Total Disposal:	**46,944 m^3**	47,011 m^3	*47,011 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a8
HSW EIS 02-24-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group A

Stream 14
Elemental Lead



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**445 m^3**	445 m^3	*445 m^3*
Receipts:	**155 m^3**	163 m^3	*163 m^3*
Waste Stream Total:	**600 m^3**	608 m^3	*608 m^3*
Total Treatment:	**600 m^3**	608 m^3	*608 m^3*
Total Disposal:	**1,200 m^3**	1,215 m^3	*1,215 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a9
HSW EIS 02-24-03

Alternative Group A

Stream 15
Elemental Mercury

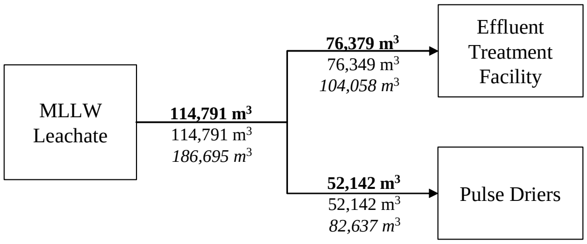
	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**13 m^3**	13 m^3	*13 m^3*
Receipts:	**8 m^3**	8 m^3	*8 m^3*
Waste Stream Total:	**21 m^3**	21 m^3	*21 m^3*
Total Treatment:	**21 m^3**	21 m^3	*21 m^3*
Total Disposal:	**312 m^3**	312 m^3	*312 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a10
HSW EIS 02-24-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group A

Stream 18
MLLW Trench Leachate

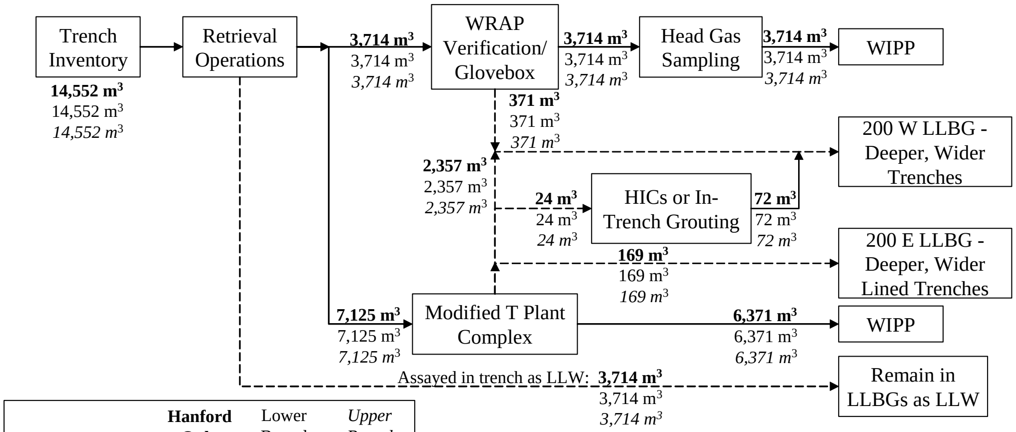


	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**0 m^3**	0 m^3	*0 m^3*
Total Generation:	**114,791 m^3**	114,791 m^3	*186,695 m^3*
Waste Stream Total:	**114,791 m^3**	114,791 m^3	*186,695 m^3*
Total Treatment/ Disposal:	**114,791 m^3**	114,791 m^3	*186,695 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a11
HSW EIS 02-24-03

Alternative Group A

Stream 4
TRU - Waste from Trenches



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**14,552 m^3**	14,552 m^3	*14,552 m^3*
Receipts:	**0 m^3**	0 m^3	*0 m^3*
Waste Stream Total:	**14,552 m^3**	14,552 m^3	*14,552 m^3*
Total Processed:	**10,938 m^3**	10,938 m^3	*10,938 m^3*
Total Disposal:	**10,185 m^3**	10,185 m^3	*10,185 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

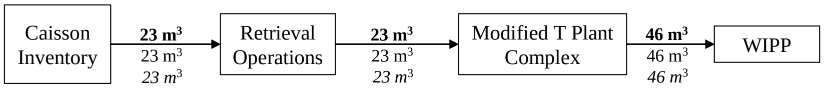
Note: Both lined and unlined trenches have been analyzed for LLW disposal as part of this alternative.

M0212-0286.54a12
R1 HSW EIS 05-23-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group A

Stream 5
TRU - Waste from Caissons

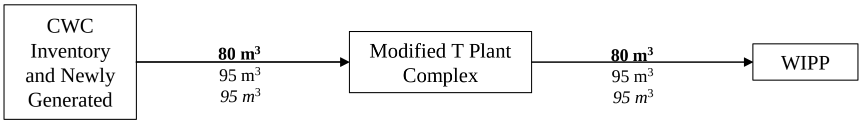


	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**23 m^3**	23 m^3	*23 m^3*
Receipts:	**0 m^3**	0 m^3	*0 m^3*
Waste Stream Total:	**23 m^3**	23 m^3	*23 m^3*
Total Processed:	**23 m^3**	23 m^3	*23 m^3*
Total Disposal:	**46 m^3**	46 m^3	*46 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a13
HSW EIS 02-24-03

Alternative Group A

Stream 8
TRU - Commingled PCB Waste



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**80 m^3**	80 m^3	*80 m^3*
Receipts:	**0 m^3**	15 m^3	*15 m^3*
Waste Stream Total:	**80 m^3**	95 m^3	*95 m^3*
Total Processed:	**80 m^3**	95 m^3	*95 m^3*
Total Disposal:	**80 m^3**	95 m^3	*95 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

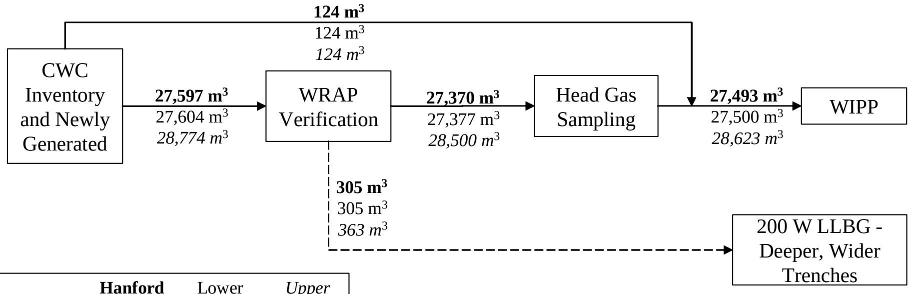
M0212-0286.54a14
HSW EIS 02-24-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group A

Stream 9

TRU – Newly Generated and Existing CH Standard Containers



M0212-0286.54a15
HSW EIS 02-24-03

	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**849 m^3**	849 m^3	*849 m^3*
Receipts:	**26,870 m^3**	26,878 m^3	*28,048 m^3*
Waste Stream Total:	**27,719 m^3**	27,727 m^3	*28,897 m^3*
Total Processed:	**27,597 m^3**	27,604 m^3	*28,774 m^3*
Total Disposal:	**27,493 m^3**	27,500 m^3	*28,623 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

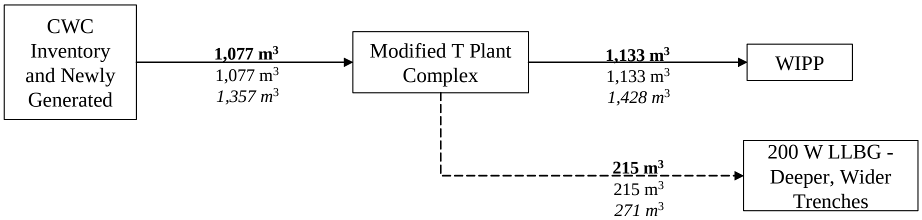
Notes: Both lined and unlined trenches have been analyzed for LLW disposal as part of this alternative.

It is assumed that WIPP or another offsite disposal facility will be available after 2032.

Alternative Group A

Stream 10A

TRU – Newly Generated and Existing CH Non-Standard Containers



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**585 m^3**	585 m^3	*585 m^3*
Receipts:	**492 m^3**	492 m^3	*772 m^3*
Waste Stream Total:	**1,077 m^3**	1,077 m^3	*1,357 m^3*
Total Processed:	**1,077 m^3**	1,077 m^3	*1,357 m^3*
Total Disposal:	**1,133 m^3**	1,133 m^3	*1,428 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

Note: Both lined and unlined trenches have been analyzed for LLW disposal as part of this alternative.

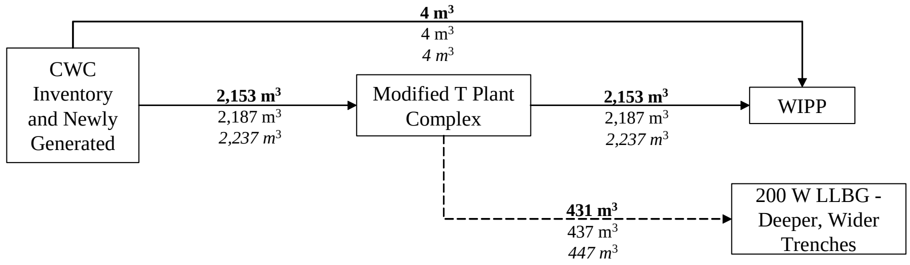
M0212-0286.54a16
HSW EIS 02-24-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group A

Stream 10B

TRU – Newly Generated and Existing RH Waste



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**46 m^3**	46 m^3	*46 m^3*
Receipts:	**2,112 m^3**	2,145 m^3	*2,196 m^3*
Waste Stream Total:	**2,157 m^3**	2,191 m^3	*2,241 m^3*
Total Processed:	**2,153 m^3**	2,187 m^3	*2,237 m^3*
Total Disposal:	**2,157 m^3**	2,191 m^3	*2,241 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a17
HSW EIS 02-24-03

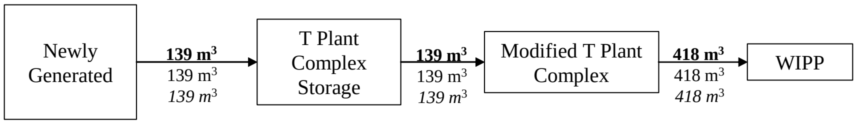
Notes: Both lined and unlined trenches have been analyzed for LLW disposal as part of this alternative.

It is assumed that WIPP or another offsite disposal facility will be available after 2032.

Alternative Group A

Stream 17

TRU – K Basins Sludge



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**0 m^3**	0 m^3	*0 m^3*
Receipts:	**139 m^3**	139 m^3	*139 m^3*
Waste Stream Total:	**139 m^3**	139 m^3	*139 m^3*
Total Processed:	**139 m^3**	139 m^3	*139 m^3*
Total Disposal:	**418 m^3**	418 m^3	*418 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

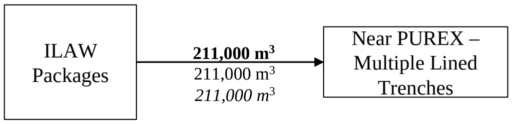
M0212-0286.54a18
HSW EIS 02-24-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group A

Stream 21

WTP Wastes – ILAW Packages



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**0 m^3**	0 m^3	*0 m^3*
Receipts:	**211,000 m^3**	211,000 m^3	*211,000 m^3*
Waste Stream Total:	**211,000 m^3**	211,000 m^3	*211,000 m^3*
Total Processed:	**0 m^3**	0 m^3	*0 m^3*
Total Disposal:	**211,000 m^3**	211,000 m^3	*211,000 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

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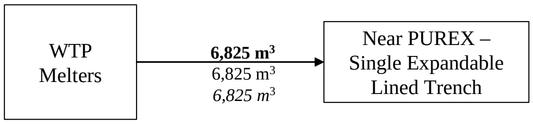
R1 HSW EIS 02-24-03

Alternative Group A

Stream 22

WTP Wastes –WTP Melters



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**0 m^3**	0 m^3	*0 m^3*
Receipts:	**6,825 m^3**	6,825 m^3	*6,825 m^3*
Waste Stream Total:	**6,825 m^3**	6,825 m^3	*6,825 m^3*
Total Processed:	**0 m^3**	0 m^3	*0 m^3*
Total Disposal:	**6,825 m^3**	6,825 m^3	*6,825 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

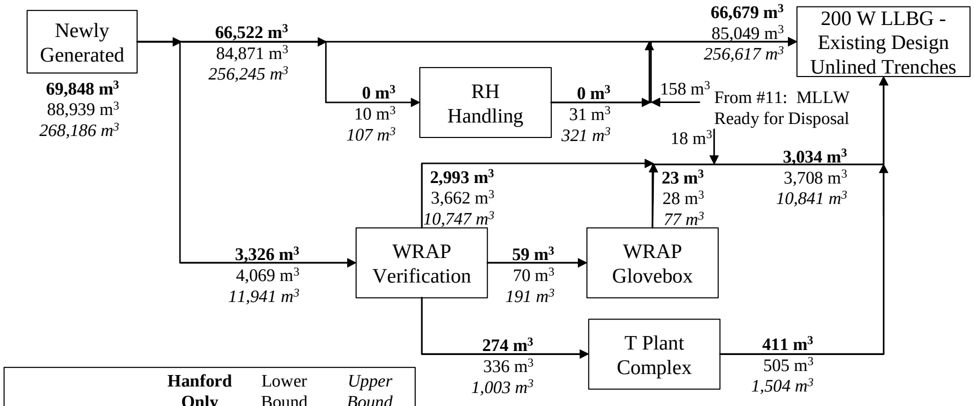
M0212-0286.54a20
R1 HSW EIS 02-24-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group B

Stream 1

LLW Category 1



	Hanford Only	Lower Bound	*Upper Bound*
Disposed FY99-01:	**18,944 m^3**	18,944 m^3	*18,944 m^3*
Initial Inventory:	**0 m^3**	0 m^3	*0 m^3*
Receipts:	**69,848 m^3**	88,939 m^3	*268,186 m^3*
Waste Stream Total:	**88,792 m^3**	107,883 m^3	*287,130 m^3*
Total Verification:	**3,326 m^3**	4,069 m^3	*11,941 m^3*
Total Disposal:	**89,069 m^3**	108,205 m^3	*287,906 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

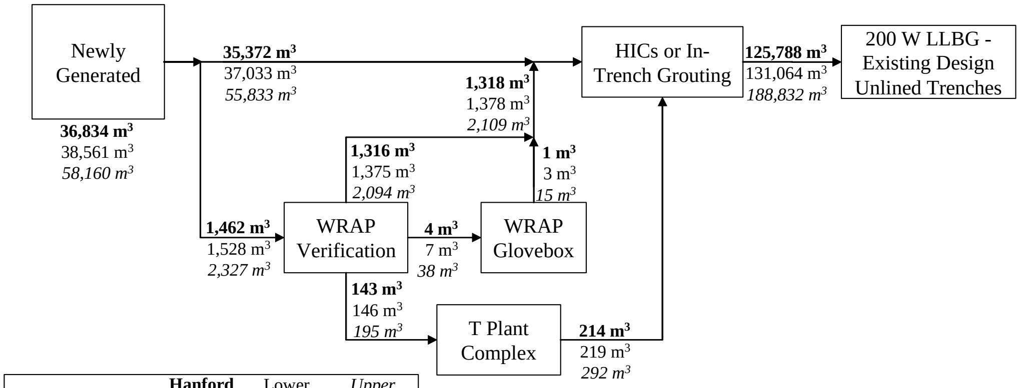
Note: Waste disposed from FY99 to FY01 is not shown in the diagram but is included in the summary of Total Disposal.

M0212-0286.54a21
R1 HSW EIS 05-23-03

Alternative Group B

Stream 2

LLW Category 3



	Hanford Only	Lower Bound	*Upper Bound*
Disposed FY99-01:	**2,773 m^3**	2,773 m^3	*2,773 m^3*
Initial Inventory:	**0 m^3**	0 m^3	*0 m^3*
Receipts:	**36,834 m^3**	38,561 m^3	*58,160 m^3*
Waste Stream Total:	**39,607 m^3**	41,334 m^3	*60,933 m^3*
Total Verification:	**1,462 m^3**	1,528 m^3	*2,327 m^3*
Total Stabilized:	**36,903 m^3**	38,630 m^3	*58,234 m^3*
Total Disposal:	**128,561 m^3**	133,837 m^3	*191,605 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

Note: Waste disposed from FY99 to FY01 is not shown in the diagram but is included in the summary of Total Disposal.

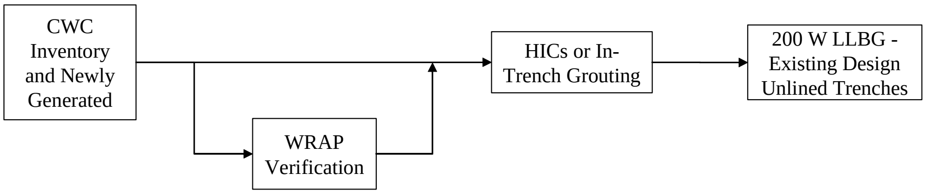
M0212-0286.54a22
HSW EIS 02-24-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group B

Stream 3

Greater Than Category 3 Waste



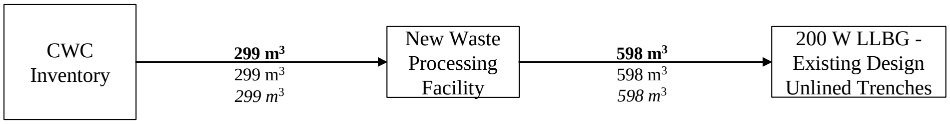
	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**<1 m^3**	<1 m^3	*<1 m^3*
Receipts:	**0 m^3**	0 m^3	*0 m^3*
Waste Stream Total:	**<1 m^3**	<1 m^3	*<1 m^3*
Total Stabilized:	**<1 m^3**	<1 m^3	*<1 m^3*
Total Disposal:	**<1 m^3**	<1 m^3	*<1 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a23
HSW EIS 02-24-03

Alternative Group B

Stream 6

LLW – Non-Conforming



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**299 m^3**	299 m^3	*299 m^3*
Receipts:	**0 m^3**	0 m^3	*0 m^3*
Waste Stream Total:	**299 m^3**	299 m^3	*299 m^3*
Total Treatment:	**299 m^3**	299 m^3	*299 m^3*
Total Disposal:	**598 m^3**	598 m^3	*598 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a24
R1 HSW EIS 02-24-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group B

Stream 20

LLW – Previously Disposed of

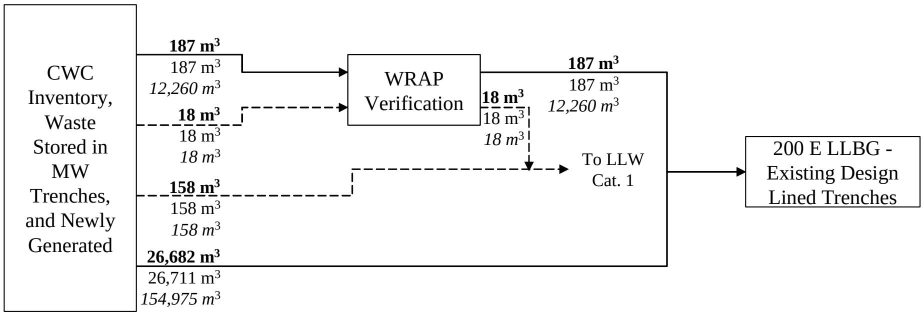
	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**283,067 m^3**	283,067 m^3	*283,067 m^3*
Receipts:	**0 m^3**	0 m^3	*0 m^3*
Waste Stream Total:	**283,067 m^3**	283,067 m^3	*283,067 m^3*
Total Treatment:	**0 m^3**	0 m^3	*0 m^3*
Total Disposal:	**283,067 m^3**	283,067 m^3	*283,067 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a25
HSW EIS 02-24-03

Alternative Group B

Stream 11

MLLW Treated and Ready for Disposal



M0212-0286.54a26
HSW EIS 02-24-03

	Hanford Only	Lower Bound	*Upper Bound*
Disposed FY99-01:	**1,010 m^3**	1,010 m^3	*1,010 m^3*
Initial Inventory:	**1,102 m^3**	1,102 m^3	*1,102 m^3*
Receipts:	**25,942 m^3**	25,970 m^3	*166,307m^3*
Waste Stream Total:	**28,054 m^3**	28,082 m^3	*168,419m^3*
Total Treatment:	**0 m^3**	0 m^3	*0 m^3*
Total Disposal:	**27,879 m^3**	27,907 m^3	*168,244 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

Notes: Dashed lines represent waste managed as MLLW expected to be reclassified as LLW.

Waste disposed from FY99 to FY01 is not shown in the diagram but is included in the summary of Total Disposal.

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group B

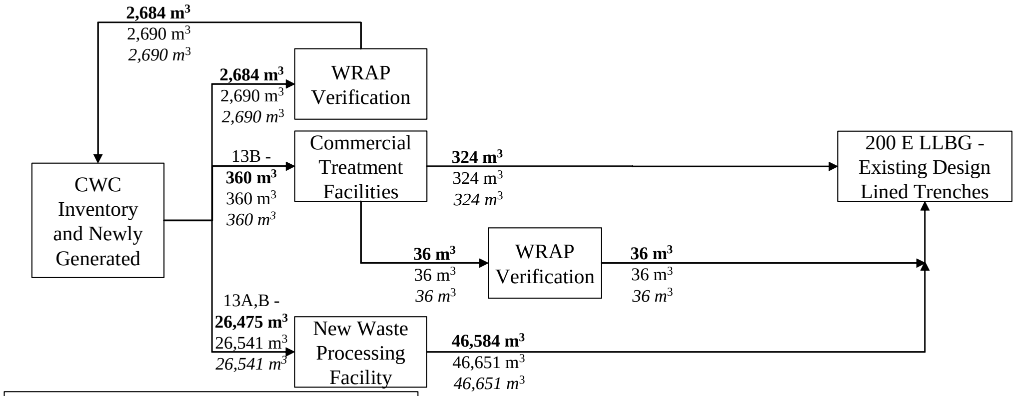
Stream 12
RH and Non-Standard Packages

	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**65 m^3**	65 m^3	*65 m^3*
Receipts:	**2,839 m^3**	2,839 m^3	*2,839 m^3*
Waste Stream Total:	**2,904 m^3**	2,904 m^3	*2,904 m^3*
Total Treatment:	**2,904 m^3**	2,904 m^3	*2,904 m^3*
Total Disposal:	**4,066 m^3**	4,066 m^3	*4,066 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a27
R1 HSW EIS 02-24-03

Alternative Group B

Stream 13A – CH Inorganic Solids and Debris
Stream 13B – CH Organic Solids and Debris



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**5,725 m^3**	5,725 m^3	*5,725 m^3*
Receipts:	**21,110 m^3**	21,175 m^3	*21,175 m^3*
Waste Stream Total:	**26,835 m^3**	26,901 m^3	*26,901 m^3*
Total Treatment:	**26,835 m^3**	26,901 m^3	*26,901 m^3*
Total Disposal:	**46,944 m^3**	47,011 m^3	*47,011 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

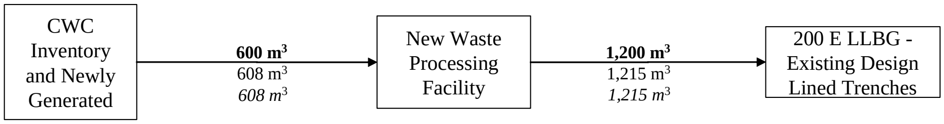
M0212-0286.54a28
R1 HSW EIS 02-24-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group B

Stream 14

Elemental Lead



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**445 m^3**	445 m^3	*445 m^3*
Receipts:	**155 m^3**	163 m^3	*163 m^3*
Waste Stream Total:	**600 m^3**	608 m^3	*608 m^3*
Total Treatment:	**600 m^3**	608 m^3	*608 m^3*
Total Disposal:	**1,200 m^3**	1,215 m^3	*1,215 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a29
R1 HSW EIS 02-24-03

Alternative Group B

Stream 15

Elemental Mercury

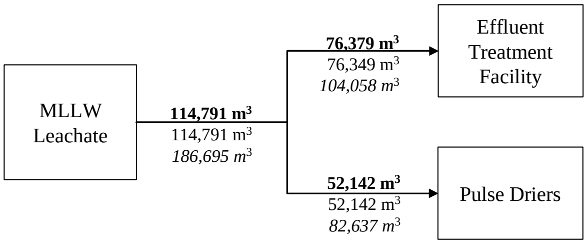
	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**13 m^3**	13 m^3	*13 m^3*
Receipts:	**8 m^3**	8 m^3	*8 m^3*
Waste Stream Total:	**21 m^3**	21 m^3	*21 m^3*
Total Treatment:	**21 m^3**	21 m^3	*21 m^3*
Total Disposal:	**312 m^3**	312 m^3	*312 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a30
R1 HSW EIS 02-24-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group B

Stream 18
MLLW Trench Leachate

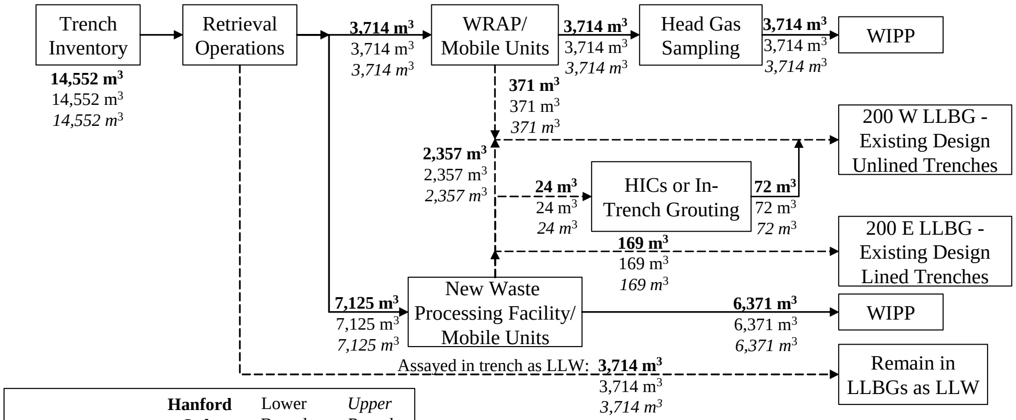


	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**0 m^3**	0 m^3	*0 m^3*
Total Generation:	**114,791 m^3**	114,791 m^3	*186,695 m^3*
Waste Stream Total:	**114,791 m^3**	114,791 m^3	*186,695 m^3*
Total Treatment/ Disposal:	**114,791 m^3**	114,791 m^3	*186,695 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a65
HSW EIS 02-24-03

Alternative Group B

Stream 4
TRU - Waste from Trenches



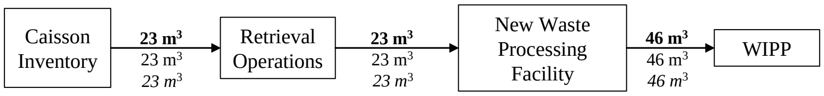
	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**14,552 m^3**	14,552 m^3	*14,552 m^3*
Receipts:	**0 m^3**	0 m^3	*0 m^3*
Waste Stream Total:	**14,552 m^3**	14,552 m^3	*14,552 m^3*
Total Processed:	**10,938 m^3**	10,938 m^3	*10,938 m^3*
Total Disposal:	**10,185 m^3**	10,185 m^3	*10,185 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a31
R3 HSW EIS 05-23-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group B

Stream 5
TRU - Waste from Caissons



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**23 m^3**	23 m^3	*23 m^3*
Receipts:	**0 m^3**	0 m^3	*0 m^3*
Waste Stream Total:	**23 m^3**	23 m^3	*23 m^3*
Total Processed:	**23 m^3**	23 m^3	*23 m^3*
Total Disposal:	**46 m^3**	46 m^3	*46 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a32
R1 HSW EIS 02-24-03

Alternative Group B

Stream 8
TRU - Commingled PCB Waste

	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**80 m^3**	80 m^3	*80 m^3*
Receipts:	**0 m^3**	15 m^3	*15 m^3*
Waste Stream Total:	**80 m^3**	95 m^3	*95 m^3*
Total Processed:	**80 m^3**	95 m^3	*95 m^3*
Total Disposal:	**80 m^3**	95 m^3	*95 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

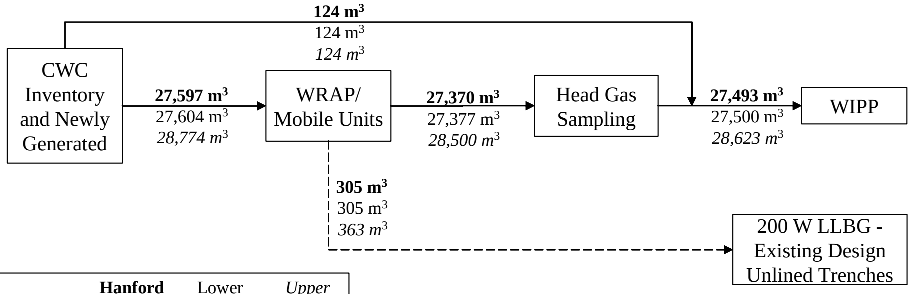
M0212-0286.54a66
R1 HSW EIS 02-24-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group B

Stream 9

TRU – Newly Generated and Existing CH Standard Containers



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**849 m^3**	849 m^3	*849 m^3*
Receipts:	**26,870 m^3**	26,878 m^3	*28,048 m^3*
Waste Stream Total:	**27,719 m^3**	27,727 m^3	*28,897 m^3*
Total Processed:	**27,597 m^3**	27,604 m^3	*28,774 m^3*
Total Disposal:	**27,493 m^3**	27,500 m^3	*28,623 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

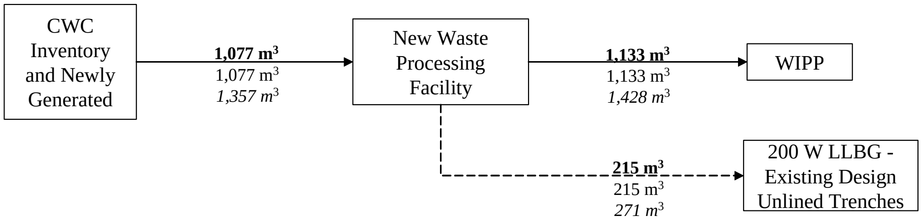
Note: It is assumed that WIPP or another offsite disposal facility will be available after 2032.

M0212-0286.54a33
HSW EIS 02-24-03

Alternative Group B

Stream 10A

TRU – Newly Generated and Existing CH Non-Standard Containers



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**585 m^3**	585 m^3	*585 m^3*
Receipts:	**492 m^3**	492 m^3	*772 m^3*
Waste Stream Total:	**1,077 m^3**	1,077 m^3	*1,357 m^3*
Total Processed:	**1,077 m^3**	1,077 m^3	*1,357 m^3*
Total Disposal:	**1,133 m^3**	1,133 m^3	*1,428 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

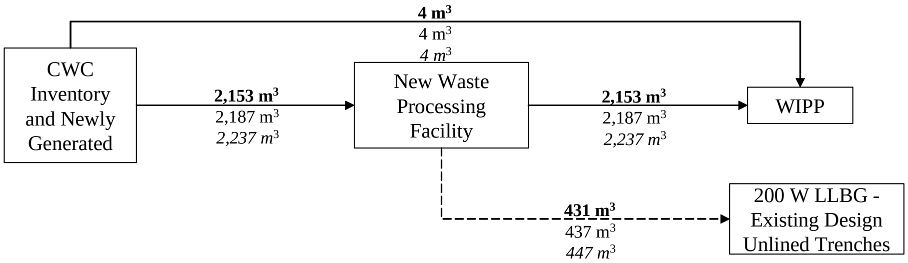
M0212-0286.54a34
R1 HSW EIS 02-24-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group B

Stream 10B

TRU – Newly Generated and Existing RH Waste



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**46 m^3**	46 m^3	*46 m^3*
Receipts:	**2,112 m^3**	2,145 m^3	*2,196 m^3*
Waste Stream Total:	**2,157 m^3**	2,191 m^3	*2,241 m^3*
Total Processed:	**2,153 m^3**	2,187 m^3	*2,237 m^3*
Total Disposal:	**2,157 m^3**	2,191 m^3	*2,241 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

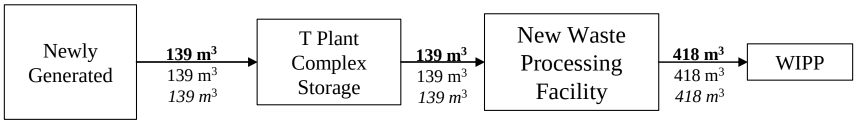
Note: It is assumed that WIPP or another offsite disposal facility will be available after 2032.

M0212-0286.54a35
R1 HSW EIS 02-24-03

Alternative Group B

Stream 17

TRU – K Basins Sludge



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**0 m^3**	0 m^3	*0 m^3*
Receipts:	**139 m^3**	139 m^3	*139 m^3*
Waste Stream Total:	**139 m^3**	139 m^3	*139 m^3*
Total Processed:	**139 m^3**	139 m^3	*139 m^3*
Total Disposal:	**418 m^3**	418 m^3	*418 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

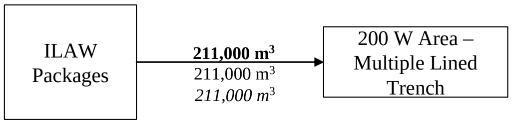
M0212-0286.54a36
R1 HSW EI S 02-24-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group B

Stream 21

WTP Wastes – ILAW Packages



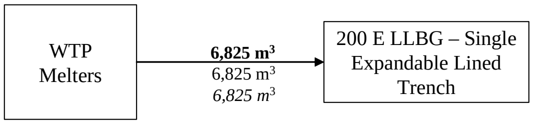
	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**0 m^3**	0 m^3	*0 m^3*
Receipts:	**211,000 m^3**	211,000 m^3	*211,000 m^3*
Waste Stream Total:	**211,000 m^3**	211,000 m^3	*211,000 m^3*
Total Processed:	**0 m^3**	0 m^3	*0 m^3*
Total Disposal:	**211,000 m^3**	211,000 m^3	*211,000 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a37
R1 HSW EIS 02-24-03

Alternative Group B

Stream 22

WTP Wastes –WTP Melters



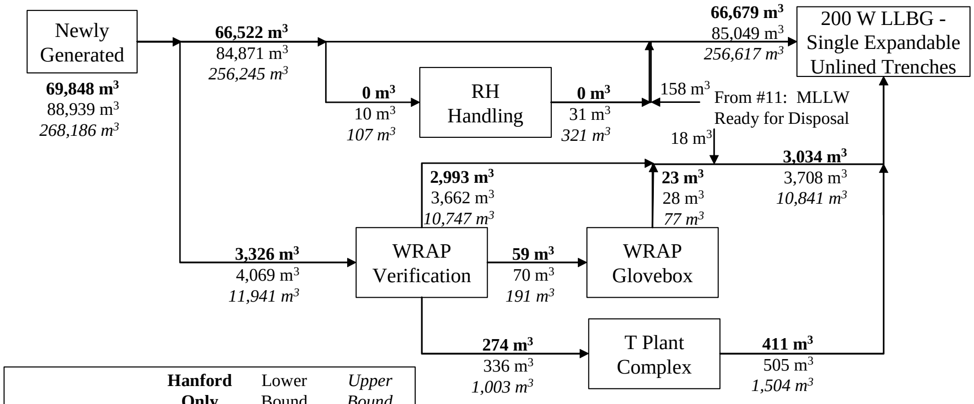
	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**0 m^3**	0 m^3	*0 m^3*
Receipts:	**6,825 m^3**	6,825 m^3	*6,825 m^3*
Waste Stream Total:	**6,825 m^3**	6,825 m^3	*6,825 m^3*
Total Processed:	**0 m^3**	0 m^3	*0 m^3*
Total Disposal:	**6,825 m^3**	6,825 m^3	*6,825 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a38
R1 HSW EIS 02-24-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group C

Stream 1
LLW Category 1



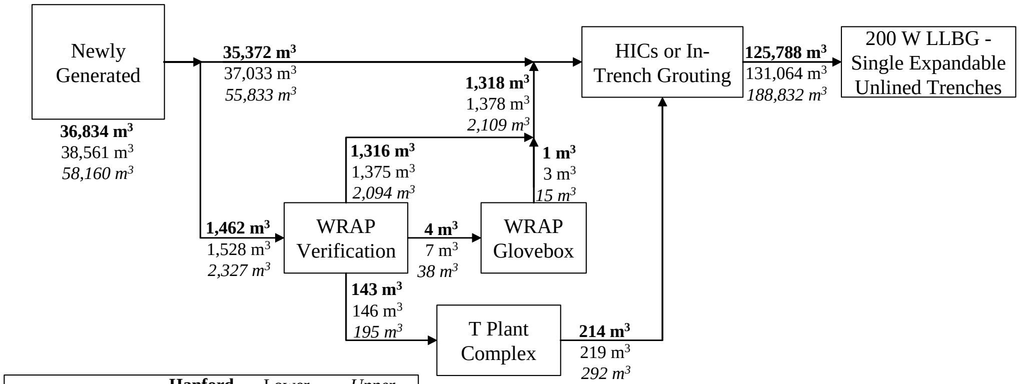
	Hanford Only	Lower Bound	*Upper Bound*
Disposed FY99-01:	**18,944 m^3**	18,944 m^3	*18,944 m^3*
Initial Inventory:	**0 m^3**	0 m^3	*0 m^3*
Receipts:	**69,848 m^3**	88,939 m^3	*268,186 m^3*
Waste Stream Total:	**88,792 m^3**	107,883 m^3	*287,130 m^3*
Total Verification:	**3,326 m^3**	4,069 m^3	*11,941 m^3*
Total Disposal:	**89,069 m^3**	108,205 m^3	*287,906 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

Note: Waste disposed from FY99 to FY01 is not shown in the diagram but is included in the summary of Total Disposal.

M0212-0286.54a39
R1 HSW EIS 05-23-03

Alternative Group C

Stream 2
LLW Category 3



	Hanford Only	Lower Bound	*Upper Bound*
Disposed FY99-01:	**2,773 m^3**	2,773 m^3	*2,773 m^3*
Initial Inventory:	**0 m^3**	0 m^3	*0 m^3*
Receipts:	**36,834 m^3**	38,561 m^3	*58,160 m^3*
Waste Stream Total:	**39,607 m^3**	41,334 m^3	*60,933 m^3*
Total Verification:	**1,462 m^3**	1,528 m^3	*2,327 m^3*
Total Stabilized:	**36,903 m^3**	38,630 m^3	*58,234 m^3*
Total Disposal:	**128,561 m^3**	133,837 m^3	*191,605 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

Note: Waste disposed from FY99 to FY01 is not shown in the diagram but is included in the summary of Total Disposal.

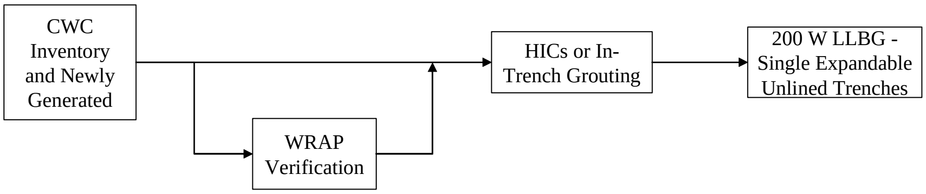
M0212-0286.54a40
HSW EIS 02-24-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group C

Stream 3

Greater Than Category 3 Waste



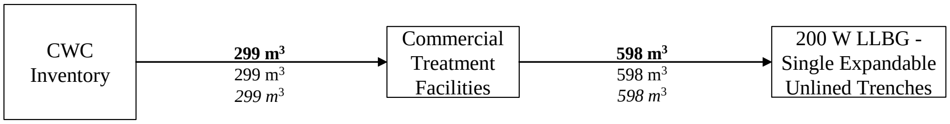
	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**<1 m^3**	<1 m^3	*<1 m^3*
Receipts:	**0 m^3**	0 m^3	*0 m^3*
Waste Stream Total:	**<1 m^3**	<1 m^3	*<1 m^3*
Total Stabilized:	**<1 m^3**	<1 m^3	*<1 m^3*
Total Disposal:	**<1 m^3**	<1 m^3	*<1 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a41
HSW EIS 02-24-03

Alternative Group C

Stream 6

LLW – Non-Conforming



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**299 m^3**	299 m^3	*299 m^3*
Receipts:	**0 m^3**	0 m^3	*0 m^3*
Waste Stream Total:	**299 m^3**	299 m^3	*299 m^3*
Total Treatment:	**299 m^3**	299 m^3	*299 m^3*
Total Disposal:	**598 m^3**	598 m^3	*598 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a42
HSW EIS 02-24-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group C

Stream 20

LLW – Previously Disposed of

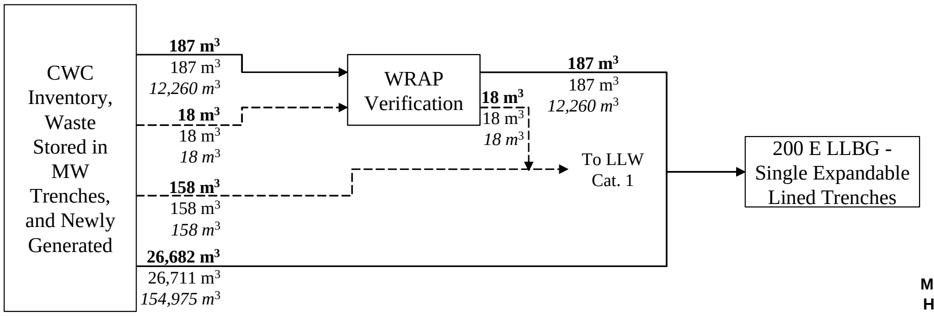
	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**283,067 m^3**	283,067 m^3	*283,067 m^3*
Receipts:	**0 m^3**	0 m^3	*0 m^3*
Waste Stream Total:	**283,067 m^3**	283,067 m^3	*283,067 m^3*
Total Treatment:	**0 m^3**	0 m^3	*0 m^3*
Total Disposal:	**283,067 m^3**	283,067 m^3	*283,067 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a43
HSW EIS 02-24-03

Alternative Group C

Stream 11

MLLW Treated and Ready for Disposal



M0212-0286.54a44
HSW EIS 02-24-03

	Hanford Only	Lower Bound	*Upper Bound*
Disposed FY99-01:	**1,010 m^3**	1,010 m^3	*1,010 m^3*
Initial Inventory:	**1,102 m^3**	1,102 m^3	*1,102 m^3*
Receipts:	**25,942 m^3**	25,970 m^3	*166,307m^3*
Waste Stream Total:	**28,054 m^3**	28,082 m^3	*168,419m^3*
Total Treatment:	**0 m^3**	0 m^3	*0 m^3*
Total Disposal:	**27,879 m^3**	27,907 m^3	*168,244 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

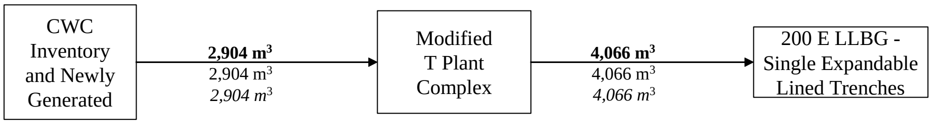
Notes: Dashed lines represent waste managed as MLLW expected to be reclassified as LLW.

Waste disposed from FY99 to FY01 is not shown in the diagram but is included in the summary of Total Disposal.

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group C

Stream 12
RH and Non-Standard Packages

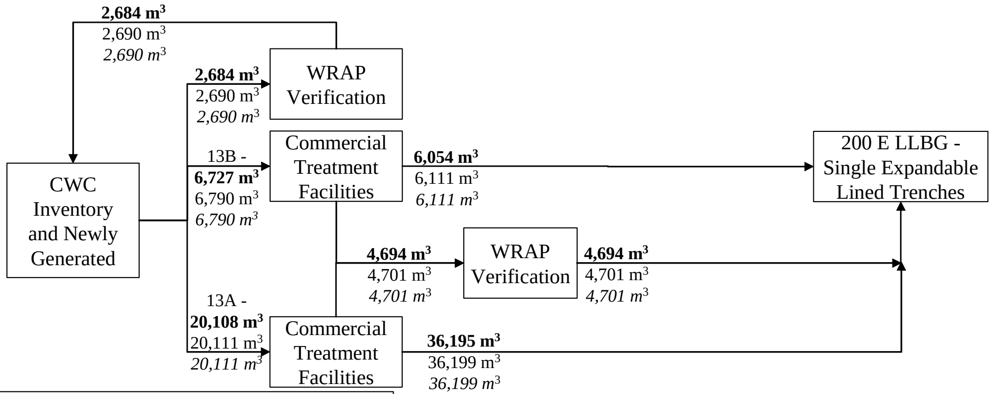


	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**65 m³**	65 m³	*65 m³*
Receipts:	**2,839 m³**	2,839 m³	*2,839 m³*
Waste Stream Total:	**2,904 m³**	2,904 m³	*2,904 m³*
Total Treatment:	**2,904 m³**	2,904 m³	*2,904 m³*
Total Disposal:	**4,066 m³**	4,066 m³	*4,066 m³*
Ending Inventory:	**0 m³**	0 m³	*0 m³*

M0212-0286.54a45
HSW EIS 02-24-03

Alternative Group C

Stream 13A – CH Inorganic Solids and Debris
Stream 13B – CH Organic Solids and Debris



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**5,725 m³**	5,725 m³	*5,725 m³*
Receipts:	**21,110 m³**	21,175 m³	*21,175 m³*
Waste Stream Total:	**26,835 m³**	26,901 m³	*26,901 m³*
Total Treatment:	**26,835 m³**	26,901 m³	*26,901 m³*
Total Disposal:	**46,944 m³**	47,011 m³	*47,011 m³*
Ending Inventory:	**0 m³**	0 m³	*0 m³*

M0212-0286.54a46
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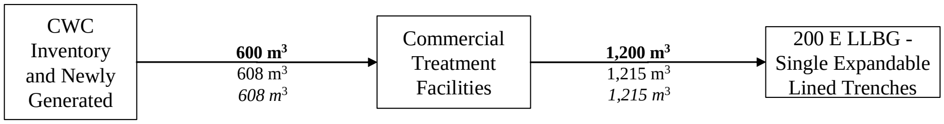
*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group C

Stream 14
Elemental Lead



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**445 m^3**	445 m^3	*445 m^3*
Receipts:	**155 m^3**	163 m^3	*163 m^3*
Waste Stream Total:	**600 m^3**	608 m^3	*608 m^3*
Total Treatment:	**600 m^3**	608 m^3	*608 m^3*
Total Disposal:	**1,200 m^3**	1,215 m^3	*1,215 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

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Alternative Group C

Stream 15
Elemental Mercury

	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**13 m^3**	13 m^3	*13 m^3*
Receipts:	**8 m^3**	8 m^3	*8 m^3*
Waste Stream Total:	**21 m^3**	21 m^3	*21 m^3*
Total Treatment:	**21 m^3**	21 m^3	*21 m^3*
Total Disposal:	**312 m^3**	312 m^3	*312 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a48
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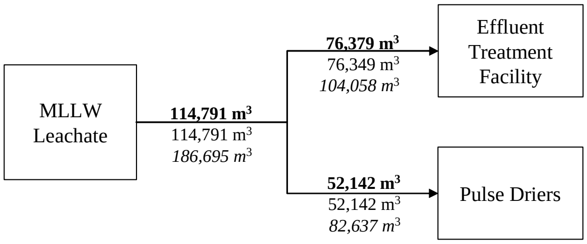
*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group C

Stream 18

MLLW Trench Leachate



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**0 m^3**	0 m^3	*0 m^3*
Total Generation:	**114,791 m^3**	114,791 m^3	*186,695 m^3*
Waste Stream Total:	**114,791 m^3**	114,791 m^3	*186,695 m^3*
Total Treatment/ Disposal:	**114,791 m^3**	114,791 m^3	*186,695 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

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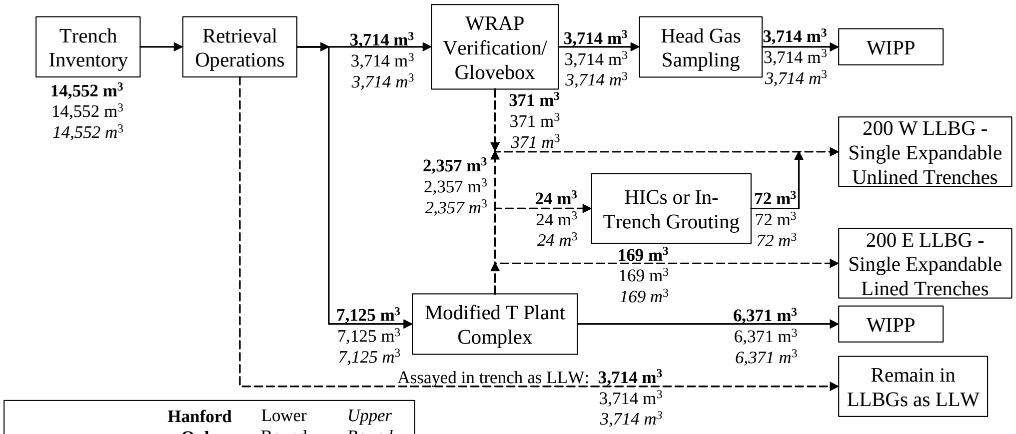
Alternative Group C

Stream 4

TRU - Waste from Trenches



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**14,552 m^3**	14,552 m^3	*14,552 m^3*
Receipts:	**0 m^3**	0 m^3	*0 m^3*
Waste Stream Total:	**14,552 m^3**	14,552 m^3	*14,552 m^3*
Total Processed:	**10,938 m^3**	10,938 m^3	*10,938 m^3*
Total Disposal:	**10,185 m^3**	10,185 m^3	*10,185 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a50
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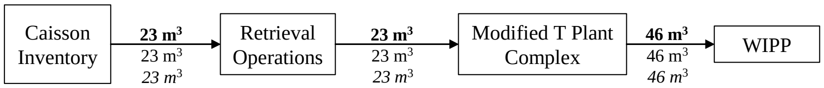
*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group C

Stream 5
TRU - Waste from Caissons



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**23 m^3**	23 m^3	*23 m^3*
Receipts:	**0 m^3**	0 m^3	*0 m^3*
Waste Stream Total:	**23 m^3**	23 m^3	*23 m^3*
Total Processed:	**23 m^3**	23 m^3	*23 m^3*
Total Disposal:	**46 m^3**	46 m^3	*46 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a51
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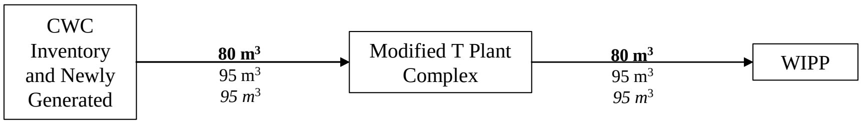
Alternative Group C

Stream 8
TRU - Commingled PCB Waste



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**80 m^3**	80 m^3	*80 m^3*
Receipts:	**0 m^3**	15 m^3	*15 m^3*
Waste Stream Total:	**80 m^3**	95 m^3	*95 m^3*
Total Processed:	**80 m^3**	95 m^3	*95 m^3*
Total Disposal:	**80 m^3**	95 m^3	*95 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a52
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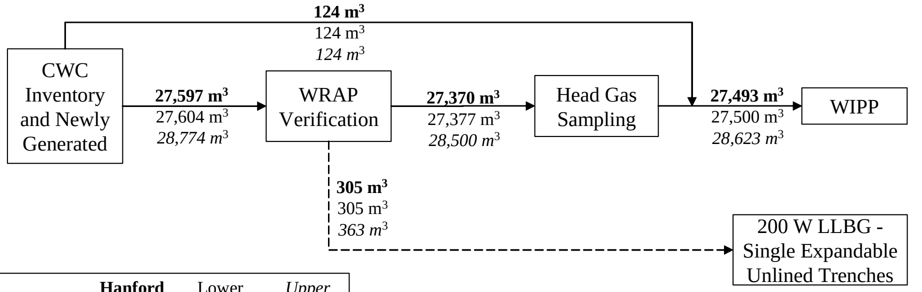
*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group C

Stream 9

TRU – Newly Generated and Existing CH Standard Containers



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**849 m^3**	849 m^3	*849 m^3*
Receipts:	**26,870 m^3**	26,878 m^3	*28,048 m^3*
Waste Stream Total:	**27,719 m^3**	27,727 m^3	*28,897 m^3*
Total Processed:	**27,597 m^3**	27,604 m^3	*28,774 m^3*
Total Disposal:	**27,493 m^3**	27,500 m^3	*28,623 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

Note: It is assumed that WIPP or another offsite disposal facility will be available after 2032.

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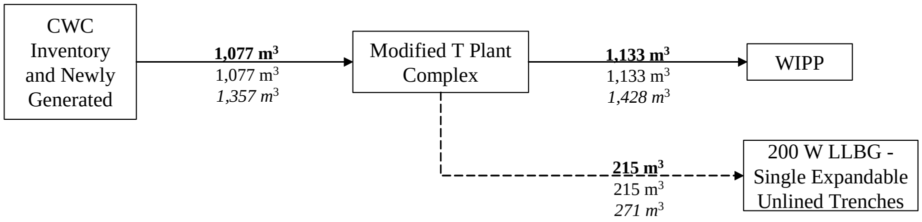
Alternative Group C

Stream 10A

TRU – Newly Generated and Existing CH Non-Standard Containers



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**585 m^3**	585 m^3	*585 m^3*
Receipts:	**492 m^3**	492 m^3	*772 m^3*
Waste Stream Total:	**1,077 m^3**	1,077 m^3	*1,357 m^3*
Total Processed:	**1,077 m^3**	1,077 m^3	*1,357 m^3*
Total Disposal:	**1,133 m^3**	1,133 m^3	*1,428 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

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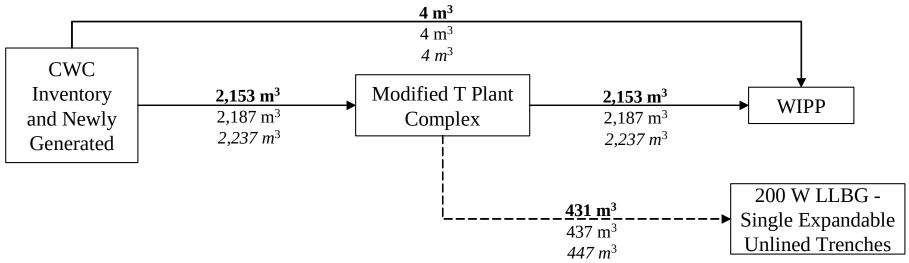
*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group C

Stream 10B

TRU – Newly Generated and Existing RH Waste



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**46 m^3**	46 m^3	*46 m^3*
Receipts:	**2,112 m^3**	2,145 m^3	*2,196 m^3*
Waste Stream Total:	**2,157 m^3**	2,191 m^3	*2,241 m^3*
Total Processed:	**2,153 m^3**	2,187 m^3	*2,237 m^3*
Total Disposal:	**2,157 m^3**	2,191 m^3	*2,241 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

Note: It is assumed that WIPP or another offsite disposal facility will be available after 2032.

M0212-0286.54a55
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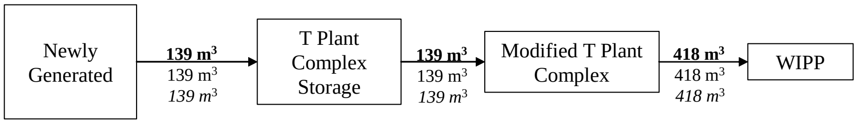
Alternative Group C

Stream 17

TRU – K Basins Sludge



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**0 m^3**	0 m^3	*0 m^3*
Receipts:	**139 m^3**	139 m^3	*139 m^3*
Waste Stream Total:	**139 m^3**	139 m^3	*139 m^3*
Total Processed:	**139 m^3**	139 m^3	*139 m^3*
Total Disposal:	**418 m^3**	418 m^3	*418 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.54a56
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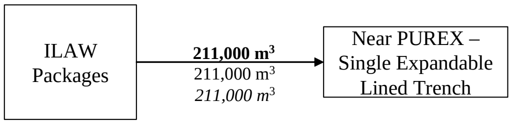
*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Group C

Stream 21

WTP Wastes – ILAW Packages



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**0 m³**	0 m³	*0 m³*
Receipts:	**211,000 m³**	211,000 m³	*211,000 m³*
Waste Stream Total:	**211,000 m³**	211,000 m³	*211,000 m³*
Total Processed:	**0 m³**	0 m³	*0 m³*
Total Disposal:	**211,000 m³**	211,000 m³	*211,000 m³*
Ending Inventory:	**0 m³**	0 m³	*0 m³*

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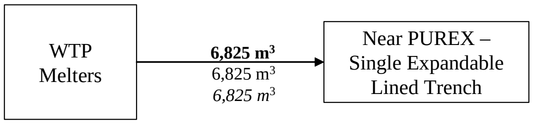
Alternative Group C

Stream 22

WTP Wastes –WTP Melters



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**0 m³**	0 m³	*0 m³*
Receipts:	**6,825 m³**	6,825 m³	*6,825 m³*
Waste Stream Total:	**6,825 m³**	6,825 m³	*6,825 m³*
Total Processed:	**0 m³**	0 m³	*0 m³*
Total Disposal:	**6,825 m³**	6,825 m³	*6,825 m³*
Ending Inventory:	**0 m³**	0 m³	*0 m³*

M0212-0286.54a58
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*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

The waste flow diagrams for Alternative Groups D and E have been combined for simplification. The primary difference between these alternative groups is that Group D assumes a single modular combined-use facility for LLW, MLLW, and WTP wastes disposal whereas Group E assumes two modular combined-use facilities, one for LLW and MLLW disposal and one for disposal of WTP wastes. The subalternatives within each group are also represented by these diagrams. The primary differences among the subalternatives are the locations for the disposal facilities. Table B.26 has been provided as an aid for reviewing these flow diagrams. This table provides a matrix of the disposal options by waste type for each subalternative in Groups D and E.

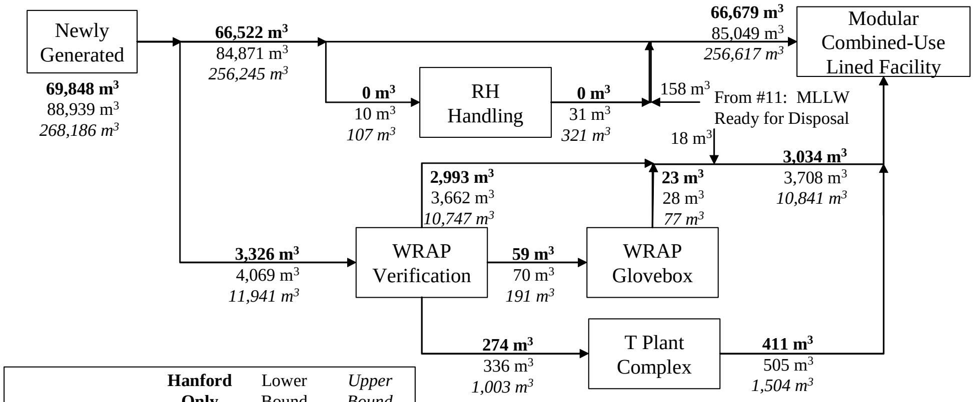
Table B.26. Matrix of Disposal Options for Alternative Groups D and E

	Alternative Group D			**Alternative Group E**		
	1	**2**	**3**	**1**	**2**	**3**
LLW	Near PUREX	200 E LLBG	ERDF	200 E LLBG	Near PUREX	ERDF
MLLW	Near PUREX	200 E LLBG	ERDF	200 E LLBG	Near PUREX	ERDF
ILAW Packages	Near PUREX	200 E LLBG	ERDF	ERDF	ERDF	Near PUREX
WTP Melters	Near PUREX	200 E LLBG	ERDF	ERDF	ERDF	Near PUREX

Alternative Groups D & E

Stream 1

LLW Category 1



	Hanford Only	Lower Bound	*Upper Bound*
Disposed FY99-01:	**18,944 m^3**	18,944 m^3	*18,944 m^3*
Initial Inventory:	**0 m^3**	0 m^3	*0 m^3*
Receipts:	**69,848 m^3**	88,939 m^3	*268,186 m^3*
Waste Stream Total:	**88,792 m^3**	107,883 m^3	*287,130 m^3*
Total Verification:	**3,326 m^3**	4,069 m^3	*11,941 m^3*
Total Disposal:	**89,069 m^3**	108,205 m^3	*287,906 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

Note: Waste disposed from FY99 to FY01 is not shown in the diagram but is included in the summary of Total Disposal.

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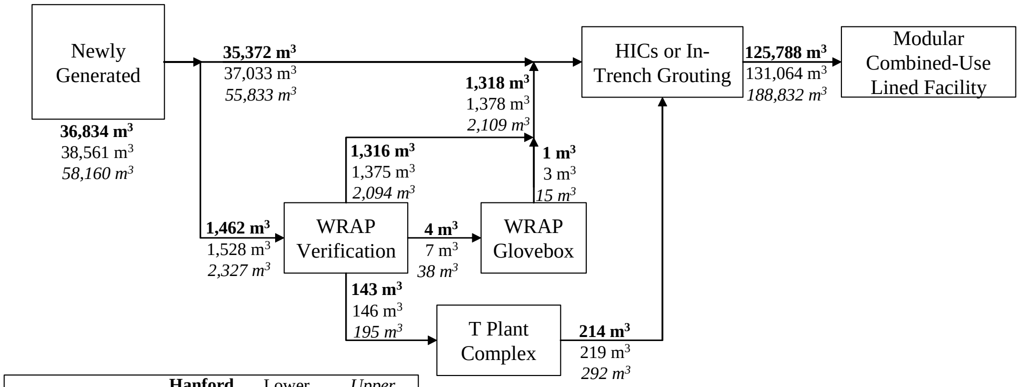
Alternative Groups D & E

Stream 2

LLW Category 3



	Hanford Only	Lower Bound	*Upper Bound*
Disposed FY99-01:	**2,773 m^3**	2,773 m^3	*2,773 m^3*
Initial Inventory:	**0 m^3**	0 m^3	*0 m^3*
Receipts:	**36,834 m^3**	38,561 m^3	*58,160 m^3*
Waste Stream Total:	**39,607 m^3**	41,334 m^3	*60,933 m^3*
Total Verification:	**1,462 m^3**	1,528 m^3	*2,327 m^3*
Total Stabilized:	**36,903 m^3**	38,630 m^3	*58,234 m^3*
Total Disposal:	**128,561 m^3**	133,837 m^3	*191,605 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

Note: Waste disposed from FY99 to FY01 is not shown in the diagram but is included in the summary of Total Disposal.

M0212-0286.55a2
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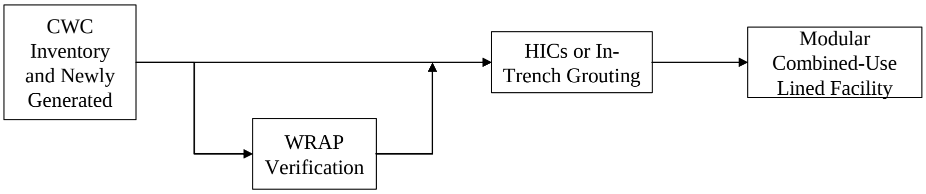
*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Groups D & E

Stream 3

Greater Than Category 3 Waste



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**<1 m^3**	<1 m^3	*<1 m^3*
Receipts:	**0 m^3**	0 m^3	*0 m^3*
Waste Stream Total:	**<1 m^3**	<1 m^3	*<1 m^3*
Total Stabilized:	**<1 m^3**	<1 m^3	*<1 m^3*
Total Disposal:	**<1 m^3**	<1 m^3	*<1 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

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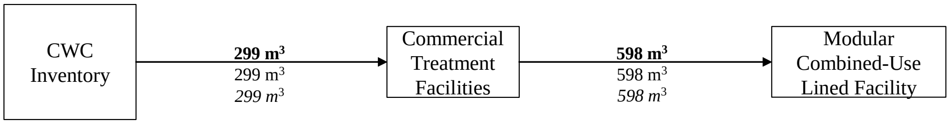
Alternative Groups D & E

Stream 6

LLW – Non-Conforming



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**299 m^3**	299 m^3	*299 m^3*
Receipts:	**0 m^3**	0 m^3	*0 m^3*
Waste Stream Total:	**299 m^3**	299 m^3	*299 m^3*
Total Treatment:	**299 m^3**	299 m^3	*299 m^3*
Total Disposal:	**598 m^3**	598 m^3	*598 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.55a4
R1 HSW EIS 02-24-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Groups D & E

Stream 20

LLW – Previously Disposed of

	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**283,067 m^3**	283,067 m^3	*283,067 m^3*
Receipts:	**0 m^3**	0 m^3	*0 m^3*
Waste Stream Total:	**283,067 m^3**	283,067 m^3	*283,067 m^3*
Total Treatment:	**0 m^3**	0 m^3	*0 m^3*
Total Disposal:	**283,067 m^3**	283,067 m^3	*283,067 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

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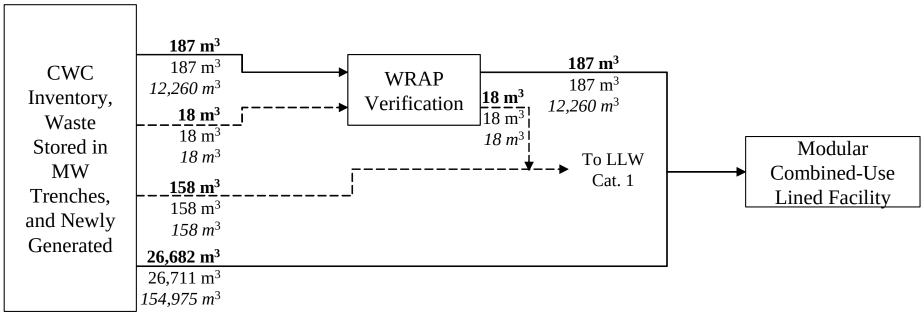
Alternative Groups D & E

Stream 11

MLLW Treated and Ready for Disposal



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R1 HSW EIS 02-24-03

	Hanford Only	Lower Bound	*Upper Bound*
Disposed FY99-01:	**1,010 m^3**	1,010 m^3	*1,010 m^3*
Initial Inventory:	**1,102 m^3**	1,102 m^3	*1,102 m^3*
Receipts:	**25,942 m^3**	25,970 m^3	*166,307m^3*
Waste Stream Total:	**28,054 m^3**	28,082 m^3	*168,419m^3*
Total Treatment:	**0 m^3**	0 m^3	*0 m^3*
Total Disposal:	**27,879 m^3**	27,907 m^3	*168,244 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

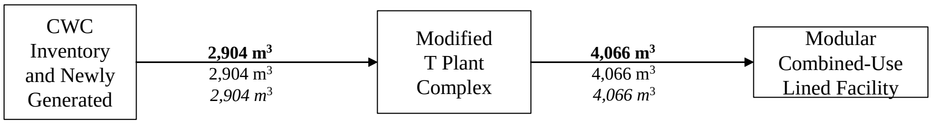
Notes: Dashed lines represent waste managed as MLLW expected to be reclassified as LLW.

Waste disposed from FY99 to FY01 is not shown in the diagram but is included in the summary of Total Disposal.

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Groups D & E

Stream 12
RH and Non-Standard Packages



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**65 m^3**	65 m^3	*65 m^3*
Receipts:	**2,839 m^3**	2,839 m^3	*2,839 m^3*
Waste Stream Total:	**2,904 m^3**	2,904 m^3	*2,904 m^3*
Total Treatment:	**2,904 m^3**	2,904 m^3	*2,904 m^3*
Total Disposal:	**4,066 m^3**	4,066 m^3	*4,066 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

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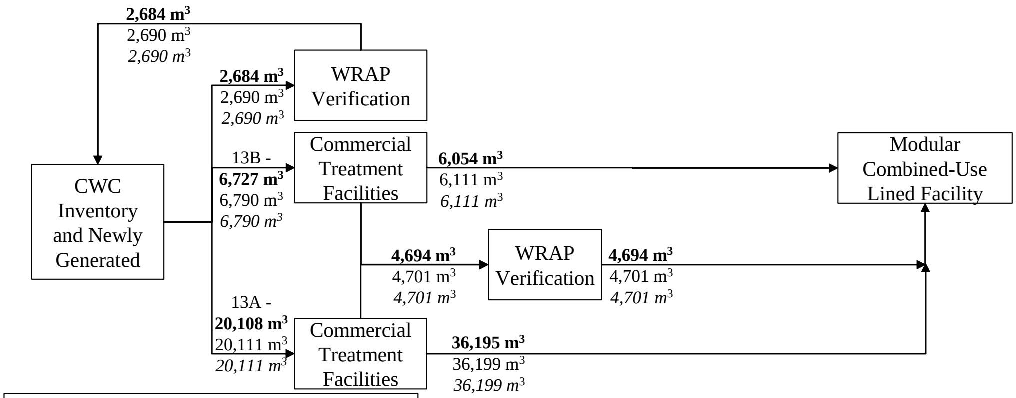
Alternative Groups D & E

Stream 13A – CH Inorganic Solids and Debris
Stream 13B – CH Organic Solids and Debris



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**5,725 m^3**	5,725 m^3	*5,725 m^3*
Receipts:	**21,110 m^3**	21,175 m^3	*21,175 m^3*
Waste Stream Total:	**26,835 m^3**	26,901 m^3	*26,901 m^3*
Total Treatment:	**26,835 m^3**	26,901 m^3	*26,901 m^3*
Total Disposal:	**46,944 m^3**	47,011 m^3	*47,011 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

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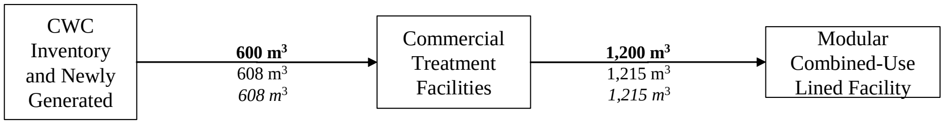
R1 HSW EIS 02-24-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Groups D & E

Stream 14
Elemental Lead



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**445 m^3**	445 m^3	*445 m^3*
Receipts:	**155 m^3**	163 m^3	*163 m^3*
Waste Stream Total:	**600 m^3**	608 m^3	*608 m^3*
Total Treatment:	**600 m^3**	608 m^3	*608 m^3*
Total Disposal:	**1,200 m^3**	1,215 m^3	*1,215 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

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Alternative Groups D & E

Stream 15
Elemental Mercury

	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**13 m^3**	13 m^3	*13 m^3*
Receipts:	**8 m^3**	8 m^3	*8 m^3*
Waste Stream Total:	**21 m^3**	21 m^3	*21 m^3*
Total Treatment:	**21 m^3**	21 m^3	*21 m^3*
Total Disposal:	**312 m^3**	312 m^3	*312 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

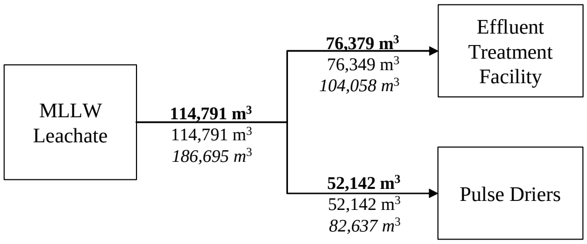
M0212-0286.55a10
R1 HSW EIS 02-24-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Groups D & E

Stream 18

MLLW Trench Leachate



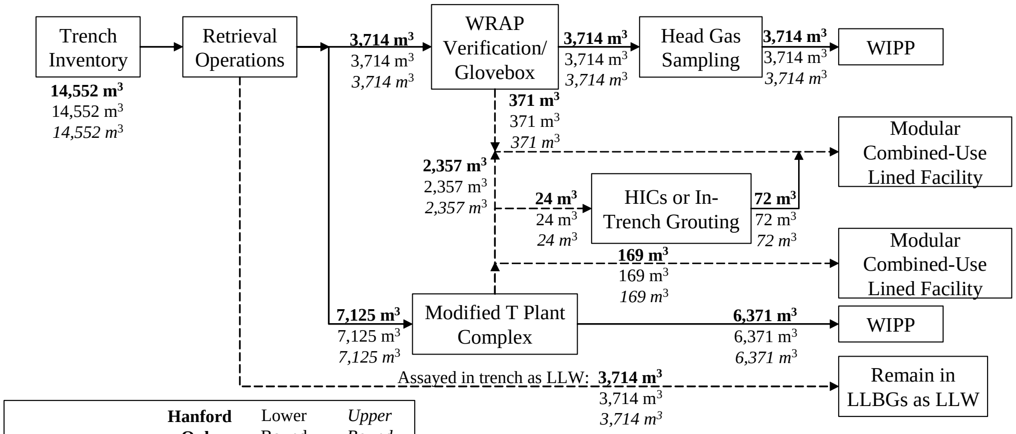
	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**0 m³**	0 m³	*0 m³*
Total Generation:	**114,791 m³**	114,791 m³	*186,695 m³*
Waste Stream Total:	**114,791 m³**	114,791 m³	*186,695 m³*
Total Treatment/ Disposal:	**114,791 m³**	114,791 m³	*186,695 m³*
Ending Inventory:	**0 m³**	0 m³	*0 m³*

M0212-0286.55a11
HSW EIS 02-24-03

Alternative Groups D & E

Stream 4

TRU - Waste from Trenches



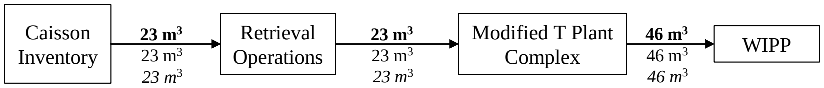
	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**14,552 m³**	14,552 m³	*14,552 m³*
Receipts:	**0 m³**	0 m³	*0 m³*
Waste Stream Total:	**14,552 m³**	14,552 m³	*14,552 m³*
Total Processed:	**10,938 m³**	10,938 m³	*10,938 m³*
Total Disposal:	**10,185 m³**	10,185 m³	*10,185 m³*
Ending Inventory:	**0 m³**	0 m³	*0 m³*

M0212-0286.55a12
R2 HSW EIS 05-23-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Groups D & E

Stream 5
TRU - Waste from Caissons

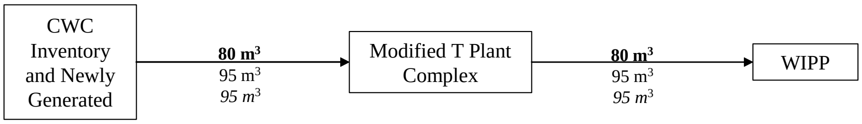


	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**23 m^3**	23 m^3	*23 m^3*
Receipts:	**0 m^3**	0 m^3	*0 m^3*
Waste Stream Total:	**23 m^3**	23 m^3	*23 m^3*
Total Processed:	**23 m^3**	23 m^3	*23 m^3*
Total Disposal:	**46 m^3**	46 m^3	*46 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.55a13
HSW EIS 02-24-03

Alternative Groups D & E

Stream 8
TRU - Commingled PCB Waste



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**80 m^3**	80 m^3	*80 m^3*
Receipts:	**0 m^3**	15 m^3	*15 m^3*
Waste Stream Total:	**80 m^3**	95 m^3	*95 m^3*
Total Processed:	**80 m^3**	95 m^3	*95 m^3*
Total Disposal:	**80 m^3**	95 m^3	*95 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

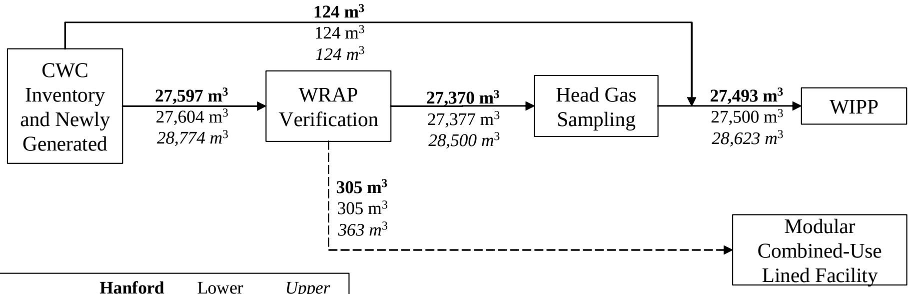
M0212-0286.55a14
HSW EIS 02-24-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Groups D & E

Stream 9

TRU – Newly Generated and Existing CH Standard Containers



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**849 m^3**	849 m^3	*849 m^3*
Receipts:	**26,870 m^3**	26,878 m^3	*28,048 m^3*
Waste Stream Total:	**27,719 m^3**	27,727 m^3	*28,897 m^3*
Total Processed:	**27,597 m^3**	27,604 m^3	*28,774 m^3*
Total Disposal:	**27,493 m^3**	27,500 m^3	*28,623 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

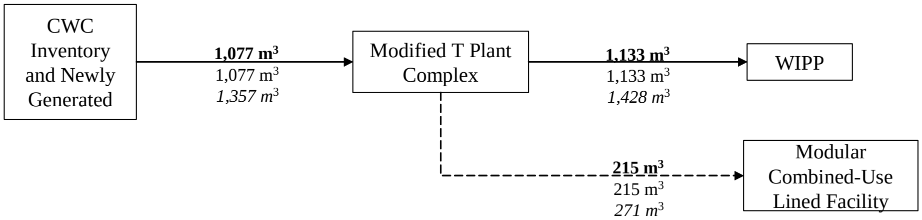
Note: It is assumed that WIPP or another offsite disposal facility will be available after 2032.

M0212-0286.55a15
R1 HSW EIS 02-24-03

Alternative Groups D & E

Stream 10A

TRU – Newly Generated and Existing CH Non-Standard Containers



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**585 m^3**	585 m^3	*585 m^3*
Receipts:	**492 m^3**	492 m^3	*772 m^3*
Waste Stream Total:	**1,077 m^3**	1,077 m^3	*1,357 m^3*
Total Processed:	**1,077 m^3**	1,077 m^3	*1,357 m^3*
Total Disposal:	**1,133 m^3**	1,133 m^3	*1,428 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

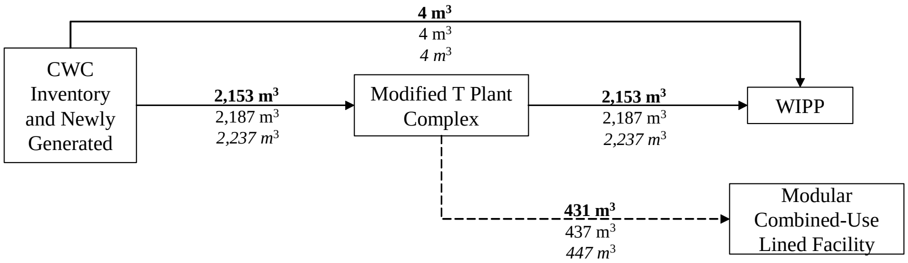
M0212-0286.55a16
R1 HSW EIS 02-24-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Groups D & E

Stream 10B

TRU – Newly Generated and Existing RH Waste



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**46 m^3**	46 m^3	*46 m^3*
Receipts:	**2,112 m^3**	2,145 m^3	*2,196 m^3*
Waste Stream Total:	**2,157 m^3**	2,191 m^3	*2,241 m^3*
Total Processed:	**2,153 m^3**	2,187 m^3	*2,237 m^3*
Total Disposal:	**2,157 m^3**	2,191 m^3	*2,241 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

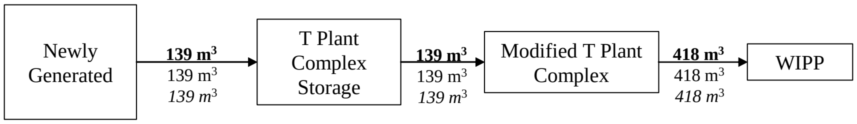
Note: It is assumed that WIPP or another offsite disposal facility will be available after 2032.

M0212-0286.55a17
R1 HSW EIS 02-24-03

Alternative Groups D & E

Stream 17

TRU – K Basins Sludge



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**0 m^3**	0 m^3	*0 m^3*
Receipts:	**139 m^3**	139 m^3	*139 m^3*
Waste Stream Total:	**139 m^3**	139 m^3	*139 m^3*
Total Processed:	**139 m^3**	139 m^3	*139 m^3*
Total Disposal:	**418 m^3**	418 m^3	*418 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

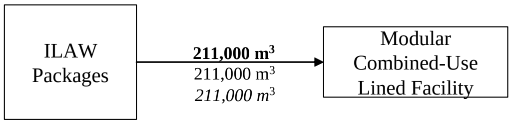
M0212-0286.55a18
HSW EIS 02-24-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

Alternative Groups D & E

Stream 21

WTP Wastes – ILAW Packages



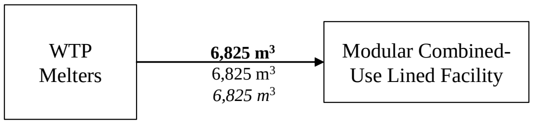
	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**0 m^3**	0 m^3	*0 m^3*
Receipts:	**211,000 m^3**	211,000 m^3	*211,000 m^3*
Waste Stream Total:	**211,000 m^3**	211,000 m^3	*211,000 m^3*
Total Processed:	**0 m^3**	0 m^3	*0 m^3*
Total Disposal:	**211,000 m^3**	211,000 m^3	*211,000 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

M0212-0286.55a19
R1 HSW EIS 02-24-03

Alternative Groups D & E

Stream 22

WTP Wastes – WTP Melters



	Hanford Only	Lower Bound	*Upper Bound*
Initial Inventory:	**0 m^3**	0 m^3	*0 m^3*
Receipts:	**6,825 m^3**	6,825 m^3	*6,825 m^3*
Waste Stream Total:	**6,825 m^3**	6,825 m^3	*6,825 m^3*
Total Processed:	**0 m^3**	0 m^3	*0 m^3*
Total Disposal:	**6,825 m^3**	6,825 m^3	*6,825 m^3*
Ending Inventory:	**0 m^3**	0 m^3	*0 m^3*

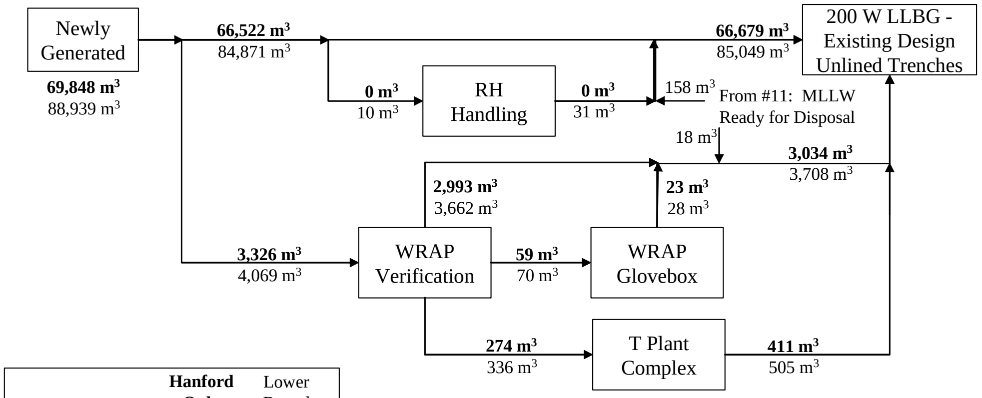
M0212-0286.55a20
R1 HSW EIS 02-24-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

No Action Alternative Group

Stream 1

LLW Category 1



	Hanford Only	Lower Bound
Disposed FY99-01:	**18,944 m^3**	18,944 m^3
Initial Inventory:	**0 m^3**	0 m^3
Receipts:	**69,848 m^3**	88,939 m^3
Waste Stream Total:	**88,792 m^3**	107,883 m^3
Total Verification:	**3,326 m^3**	4,069 m^3
Total Disposal:	**89,069 m^3**	108,205 m^3
Ending Inventory:	**0 m^3**	0 m^3

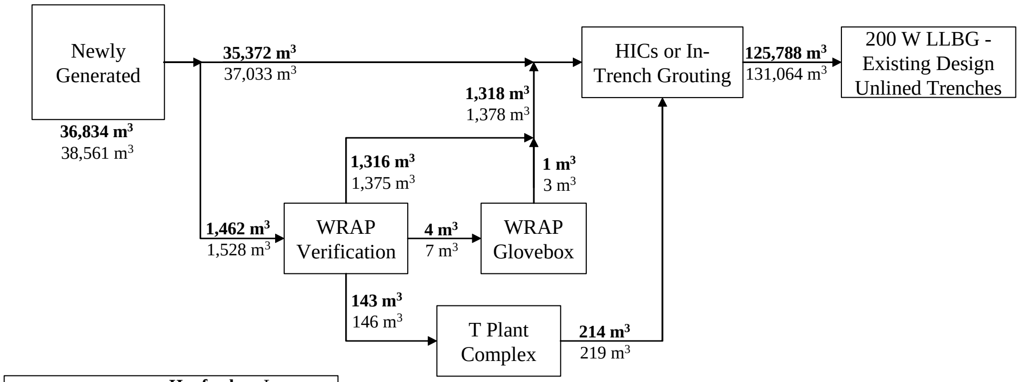
Note: Waste disposed from FY99 to FY01 is not shown in the diagram but is included in the summary of Total Disposal.

M0212-0286.55a21
HSW EIS 02-24-03

No Action Alternative Group

Stream 2

LLW Category 3



	Hanford Only	Lower Bound
Disposed FY99-01:	**2,773 m^3**	2,773 m^3
Initial Inventory:	**0 m^3**	0 m^3
Receipts:	**36,834 m^3**	38,561 m^3
Waste Stream Total:	**39,607 m^3**	41,334 m^3
Total Verification:	**1,462 m^3**	1,528 m^3
Total Stabilized:	**36,903 m^3**	38,630 m^3
Total Disposal:	**128,561 m^3**	133,837 m^3
Ending Inventory:	**0 m^3**	0 m^3

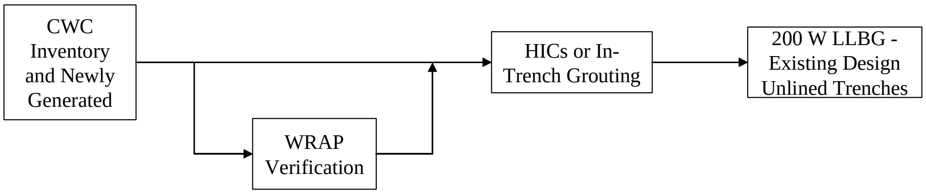
Note: Waste disposed from FY99 to FY01 is not shown in the diagram but is included in the summary of Total Disposal.

M0212-0286.55a22
HSW EIS 02-24-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

No Action Alternative Group

Stream 3
Greater Than Category 3 Waste

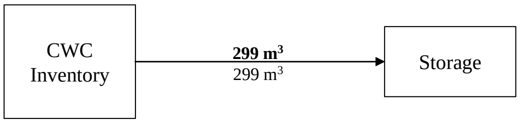


	Hanford Only	Lower Bound
Initial Inventory:	**<1 m^3**	<1 m^3
Receipts:	**0 m^3**	0 m^3
Waste Stream Total:	**<1 m^3**	<1 m^3
Total Stabilized:	**<1 m^3**	<1 m^3
Total Disposal:	**<1 m^3**	<1 m^3
Ending Inventory:	**0 m^3**	0 m^3

M0212-0286.55a23
HSW EIS 02-24-03

No Action Alternative Group

Stream 6
LLW – Non-Conforming



	Hanford Only	Lower Bound
Initial Inventory:	**299 m^3**	299 m^3
Receipts:	**0 m^3**	0 m^3
Waste Stream Total:	**299 m^3**	299 m^3
Total Treatment:	**299 m^3**	299 m^3
Total Disposal:	**0 m^3**	0 m^3
Ending Inventory:	**299 m^3**	299 m^3

M0212-0286.55a24
R1 HSW EIS 03-27-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

No Action Alternative Group

Stream 20

LLW – Previously Disposed of

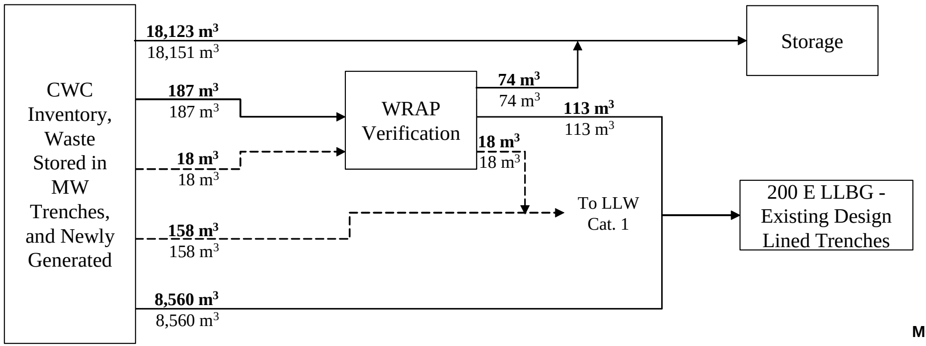
	Hanford Only	Lower Bound
Initial Inventory:	**283,067 m^3**	283,067 m^3
Receipts:	**0 m^3**	0 m^3
Waste Stream Total:	**283,067 m^3**	283,067 m^3
Total Treatment:	**0 m^3**	0 m^3
Total Disposal:	**283,067 m^3**	283,067 m^3
Ending Inventory:	**0 m^3**	0 m^3

M0212-0286.55a25
HSW EIS 02-24-03

No Action Alternative Group

Stream 11

MLLW Treated and Ready for Disposal



M0212-0286.55a26
R2 HSW EIS 05-23-03

	Hanford Only	Lower Bound
Disposed FY99-01:	**1,010 m^3**	1,010 m^3
Initial Inventory:	**1,102 m^3**	1,102 m^3
Receipts:	**25,942 m^3**	25,970 m^3
Waste Stream Total:	**28,054 m^3**	28,082 m^3
Total Treatment:	**0 m^3**	0 m^3
Total Disposal:	**9,683 m^3**	9,683 m^3
Ending Inventory:	**18,196 m^3**	18,225 m^3

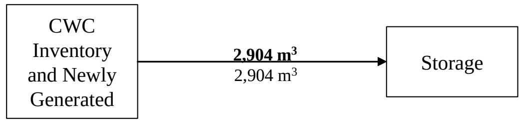
Notes: Dashed lines represent waste managed as MLLW expected to be reclassified as LLW.

Waste disposed from FY99 to FY01 is not shown in the diagram but is included in the summary of Total Disposal.

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

No Action Alternative Group

Stream 12
RH and Non-Standard Packages

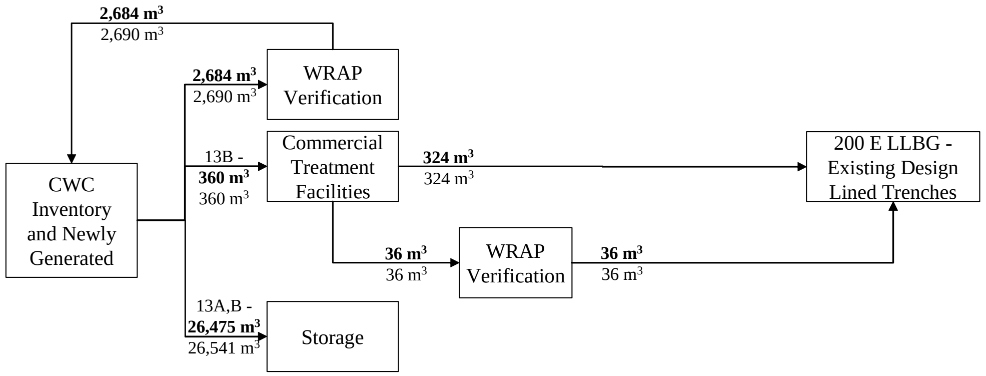


	Hanford Only	Lower Bound
Initial Inventory:	**65 m^3**	65 m^3
Receipts:	**2,839 m^3**	2,839 m^3
Waste Stream Total:	**2,904 m^3**	2,904 m^3
Total Treatment:	**0 m^3**	0 m^3
Total Disposal:	**0 m^3**	0 m^3
Ending Inventory:	**2,904 m^3**	2,904 m^3

M0212-0286.55a27
R1 HSW EIS 03-27-03

No Action Alternative Group

Stream 13A – CH Inorganic Solids and Debris
Stream 13B – CH Organic Solids and Debris



	Hanford Only	Lower Bound
Initial Inventory:	**5,725 m^3**	5,725 m^3
Receipts:	**21,110 m^3**	21,175 m^3
Waste Stream Total:	**26,835 m^3**	26,901 m^3
Total Treatment:	**360 m^3**	360 m^3
Total Disposal:	**360 m^3**	360 m^3
Ending Inventory:	**26,475 m^3**	26,541 m^3

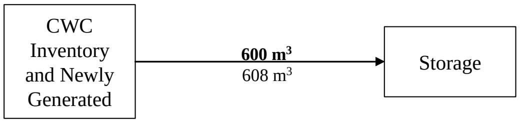
M0212-0286.55a28
R1 HSW EIS 03-27-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

No Action Alternative Group

Stream 14

Elemental Lead



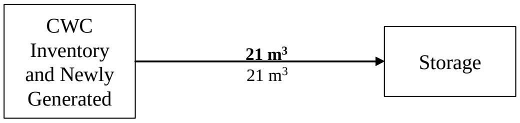
	Hanford Only	Lower Bound
Initial Inventory:	**445 m^3**	445 m^3
Receipts:	**155 m^3**	163 m^3
Waste Stream Total:	**600 m^3**	608 m^3
Total Treatment:	**0 m^3**	0 m^3
Total Disposal:	**0 m^3**	0 m^3
Ending Inventory:	**608 m^3**	608 m^3

M0212-0286.55a29
R1 HSW EIS 03-27-03

No Action Alternative Group

Stream 15

Elemental Mercury



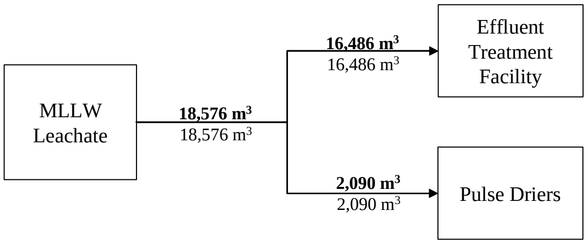
	Hanford Only	Lower Bound
Initial Inventory:	**13 m^3**	13 m^3
Receipts:	**8 m^3**	8 m^3
Waste Stream Total:	**21 m^3**	21 m^3
Total Treatment:	**0 m^3**	0 m^3
Total Disposal:	**0 m^3**	0 m^3
Ending Inventory:	**21 m^3**	21 m^3

M0212-0286.55a30
R1 HSW EIS 03-27-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

No Action Alternative Group

Stream 18
MLLW Trench Leachate

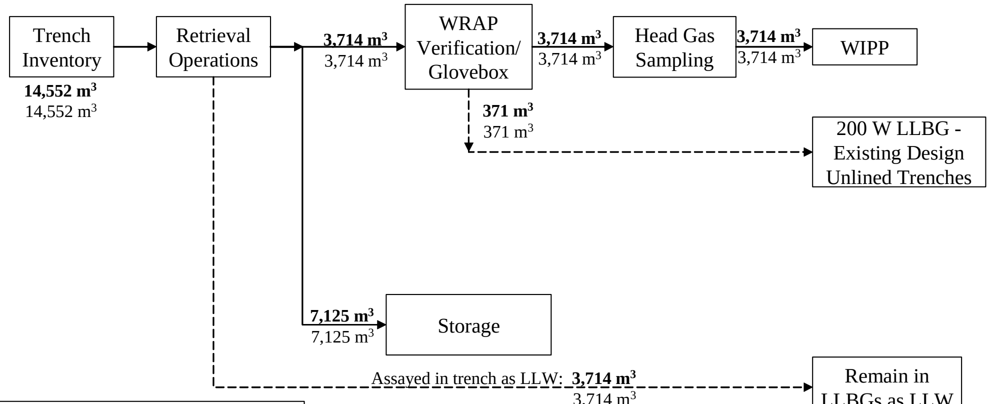


	Hanford Only	Lower Bound
Initial Inventory:	**0 m^3**	0 m^3
Total Generation:	**18,576 m^3**	18,576 m^3
Waste Stream Total:	**18,576 m^3**	18,576 m^3
Total Treatment/ Disposal:	**18,576 m^3**	18,576 m^3
Ending Inventory:	**0 m^3**	0 m^3

M0212-0286.55a31
HSW EIS 02-24-03

No Action Alternative Group

Stream 4
TRU - Waste from Trenches



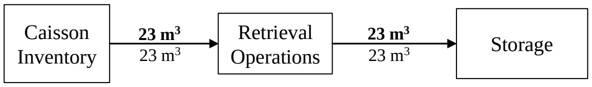
	Hanford Only	Lower Bound
Initial Inventory:	**14,552 m^3**	14,552 m^3
Receipts:	**0 m^3**	0 m^3
Waste Stream Total:	**14,552 m^3**	14,552 m^3
Total Processed:	**10,938 m^3**	10,938 m^3
Total Disposal:	**10,185 m^3**	10,185 m^3
Ending Inventory:	**0 m^3**	0 m^3

M0212-0286.55a32
R1 HSW EIS 03-27-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

No Action Alternative Group

Stream 5
TRU - Waste from Caissons

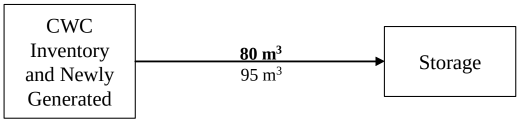


	Hanford Only	Lower Bound
Initial Inventory:	**23 m^3**	23 m^3
Receipts:	**0 m^3**	0 m^3
Waste Stream Total:	**23 m^3**	23 m^3
Total Processed:	**0 m^3**	0 m^3
Total Disposal:	**0 m^3**	0 m^3
Ending Inventory:	**23 m^3**	23 m^3

M0212-0286.55a33
R1 HSW EIS 03-27-03

No Action Alternative Group

Stream 8
TRU - Commingled PCB Waste



	Hanford Only	Lower Bound
Initial Inventory:	**80 m^3**	80 m^3
Receipts:	**0 m^3**	15 m^3
Waste Stream Total:	**80 m^3**	95 m^3
Total Processed:	**80 m^3**	95 m^3
Total Disposal:	**80 m^3**	95 m^3
Ending Inventory:	**0 m^3**	0 m^3

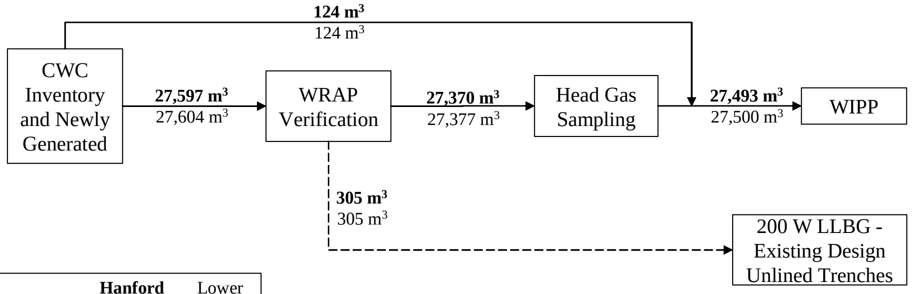
M0212-0286.55a34
R1 HSW EIS 03-27-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

No Action Alternative Group

Stream 9

TRU – Newly Generated and Existing CH Standard Containers



	Hanford Only	Lower Bound
Initial Inventory:	**849 m³**	849 m³
Receipts:	**26,870 m³**	26,878 m³
Waste Stream Total:	**27,719 m³**	27,727 m³
Total Processed:	**27,597 m³**	27,604 m³
Total Disposal:	**27,493 m³**	27,500 m³
Ending Inventory:	**0 m³**	0 m³

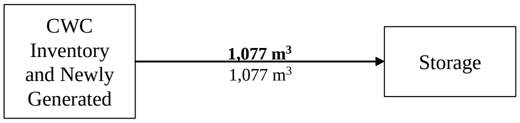
Note: It is assumed that WIPP or another offsite disposal facility will be available after 2032.

M0212-0286.55a35
HSW EIS 02-24-03

No Action Alternative Group

Stream 10A

TRU – Newly Generated and Existing CH Non-Standard Containers



	Hanford Only	Lower Bound
Initial Inventory:	**585 m³**	585 m³
Receipts:	**492 m³**	492 m³
Waste Stream Total:	**1,077 m³**	1,077 m³
Total Processed:	**0 m³**	0 m³
Total Disposal:	**0 m³**	0 m³
Ending Inventory:	**1,077 m³**	1,077 m³

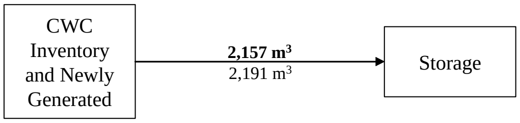
M0212-0286.55a36
R1 HSW EIS 03-27 -03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

No Action Alternative Group

Stream 10B

TRU – Newly Generated and Existing RH Waste



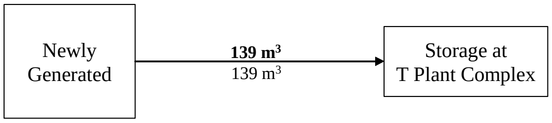
	Hanford Only	Lower Bound
Initial Inventory:	**46 m^3**	46 m^3
Receipts:	**2,112 m^3**	2,145 m^3
Waste Stream Total:	**2,157 m^3**	2,191 m^3
Total Processed:	**0 m^3**	0 m^3
Total Disposal:	**0 m^3**	0 m^3
Ending Inventory:	**2,157 m^3**	2,191 m^3

M0212-0286.55a37
R1 HSW EIS 03-27-03

No Action Alternative Group

Stream 17

TRU – K Basins Sludge



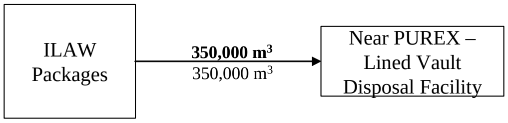
	Hanford Only	Lower Bound
Initial Inventory:	**0 m^3**	0 m^3
Receipts:	**139 m^3**	139 m^3
Waste Stream Total:	**139 m^3**	139 m^3
Total Processed:	**0 m^3**	0 m^3
Total Disposal:	**0 m^3**	0 m^3
Ending Inventory:	**139 m^3**	139 m^3

M0212-0286.55a38
R1 HSW EIS 03-27-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

No Action Alternative Group

Stream 21
WTP Wastes – ILAW Packages

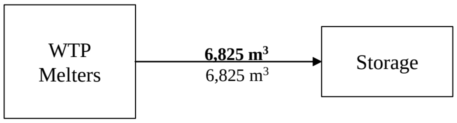


	Hanford Only	Lower Bound
Initial Inventory:	**0 m³**	0 m³
Receipts:	**350,000 m³**	350,000 m³
Waste Stream Total:	**350,000 m³**	350,000 m³
Total Processed:	**0 m³**	0 m³
Total Disposal:	**350,000 m³**	350,000 m³
Ending Inventory:	**0 m³**	0 m³

M0212-0286.55a39
R1 HSW EIS 02-24-03

No Action Alternative Group

Stream 22
WTP Wastes –WTP Melters



	Hanford Only	Lower Bound
Initial Inventory:	**0 m³**	0 m³
Receipts:	**6,825 m³**	6,825 m³
Waste Stream Total:	**6,825 m³**	6,825 m³
Total Processed:	**0 m³**	0 m³
Total Disposal:	**0 m³**	0 m³
Ending Inventory:	**6,825 m³**	6,825 m³

M0212-0286.55a40
R2 HSW EIS 03-27-03

*For definitions of acronyms, abbreviations, and terms, see list at the beginning of these flow diagrams.

B.7 References

Anderson, G. S., and H. S. Konynenbelt. 1995. *1995 Baseline Solid Waste Management System Description*. PNL-10743, Pacific Northwest Laboratory, Richland, Washington.

DOE-RL. 2001. *2001 Hanford Waste Management Strategic Plan*. DOE/RL-2001-15, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Sederburg, J. P. 1997. *Waste Management Project Technical Baseline Description*. HNF-SD-WM-RPT-288, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Appendix C

Description of Waste Volumes for the Hanford Site Solid (Radioactive and Hazardous) Waste Program EIS

Appendix C

Description of Waste Volumes for the Hanford Site Solid (Radioactive and Hazardous) Waste Program EIS

The waste volumes used in the Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement (HSW EIS) are based on analysis of the waste type options considered in the following sources: the Solid Waste Integrated Forecast Technical (SWIFT) Report (Barcot 1999, 2002), the Solid Waste Information and Tracking System (SWITS) (FH 2004), the Waste Management Programmatic Environmental Impact Statement (WM PEIS) (DOE 1997), Accelerating Cleanup: Paths to Closure (ACPC) (DOE 1998), the Transuranic Waste Performance Management Plan (DOE 2002), Tank Waste Remediation System (TWRS) EIS (DOE and Ecology 1996), and Conceptual Design Report Immobilized Low-Activity Waste Disposal Facility, Project W-520 (Burbank 2002). These sources are incorporated by reference and address low-level waste (LLW), mixed low-level waste (MLLW), and transuranic (TRU) waste that potentially could be shipped to Hanford for processing or disposal. In addition, a review of potential offsite waste receipts was conducted by the U.S. Department of Energy, Richland Operations Office (DOE-RL), to determine lower and upper bound cases of offsite receipts.

Throughout the development of the HSW EIS, the waste volumes have been periodically reviewed to ensure the volumes used for analysis are representative of the latest available information. A comparison to the most recent versions of the SWIFT report and the Integrated Planning, Accountability and Budgeting System (IPABS) (https://ipabs-is.em.doe.gov/ipabs/) showed that the LLW and MLLW volumes developed in fiscal year (FY) 1999 and FY 2000 were only slightly different than the most up-to-date information and that these volumes could continue to be used. Estimates for TRU waste, however, had increased substantially from previous estimates. Therefore, updated information was obtained from the SWIFT report (Barcot 2002) to more accurately reflect the currently projected quantity of waste to be managed. In addition, a recent study by DOE (DOE 2002) to accelerate disposal of TRU waste has considered the creation of a western hub to certify TRU waste from small-quantity sites for shipment to the Waste Isolation Pilot Plant (WIPP).

The HSW EIS used three different sets of volume data to assess the environmental impacts associated with 1) managing only wastes currently existing at Hanford or expected to be generated by Hanford activities and 2) receiving and managing waste from other DOE sites. The first set of data is defined as the Hanford Only volume and includes the following:

- Existing waste either previously disposed of or in storage as of October 1, 2001, according to the SWITS database version 01.01.00.

- Forecasted LLW and MLLW from onsite generators as defined in the 1999 SWIFT report (Barcot 1999).

- Forecasted TRU waste from onsite generators as defined in the 2002 SWIFT report (Barcot 2002).

- Estimates of immobilized low-activity waste (ILAW) and melters generated by the Waste Treatment Plant (WTP). ILAW estimates were obtained from the TWRS EIS (DOE and Ecology 1996) and RPP-7908 (Burbank 2002). Estimates for melters were obtained from an Interface Control Document (ICD) (BNFL 1999) prepared under a contract to privatize the vitrification of high-level tank waste. These estimates were later reviewed against current plans for a DOE-owned facility to ensure the numbers contained in the ICD provided a bounding analysis.

The second set of data is referred to as the Lower Bound volume. This data set includes all waste included in the Hanford Only case as well as wastes from offsite generators approved for shipment to Hanford. Estimates for future receipts of LLW and MLLW from offsite generators were obtained from the 1999 SWIFT report, while estimates for future TRU waste receipts were obtained from the 2002 SWIFT report.

The third set of data is defined as the Upper Bound volume and includes the Lower Bound volume as well as future offsite waste not reported in the SWIFT reports, but that may be managed at the Hanford Site. These potential additional offsite volumes were identified in the ACPC and the Transuranic Waste Performance Management Plan and reviewed by DOE-RL. The following section presents the three sets of volumes obtained from the sources mentioned above and describes the methodology for determining the appropriate volumes for the Upper Bound.

C.1 Volume Identification, Review, and Selection Methodology

As mentioned above, the waste volumes analyzed in the HSW EIS were obtained from a variety of sources. The criteria and assumptions used to develop the data in these sources varied depending when the data were developed and on the intended use of the data. For example, the data contained in the WM PEIS represent a 20-year period whereas the ACPC data represent the full life cycle of each site. In addition, the sources did not necessarily indicate where waste from a particular site would be dispositioned. Therefore, the sources were evaluated to determine the most appropriate data to use for each site. The data sources were reviewed using the following criteria:

- currency of the data (for example, which reference was the most recent)

- estimate duration (for example, was the forecast for the full life cycle or 20 years)

- previous shipments to Hanford (for example, did the waste generator have an established shipping agreement)

- previous shipments to Nevada Test Site (NTS) (for example, if the generator already shipped to NTS, it was likely that future shipments would continue to go to NTS).

Final selection of offsite forecast waste volume data was determined by a DOE-RL review. This review consisted of discussions with other DOE sites and DOE Headquarters to verify the amount of waste to be disposed of and to determine the likelihood of waste volumes being sent to Hanford. Unless alternate disposition pathways were clearly the preferred option, waste volumes were included in the Upper Bound volume to ensure a bounding assessment. Table C.1 contains a comparison of the various volume sources and the results of the DOE-RL review. The total waste volumes resulting from the DOE-RL review were used in the HSW EIS analyses. Sections C.2 through C.5 delineate the volumes by waste type that are used in the HSW EIS and the assumptions used in developing the volumes.

Table C.1. Comparison of Waste Management Programmatic Environmental Impact Statement, Accelerated Cleanup: Paths to Closure, and HSW EIS Waste Volumes (m^3)

Waste Type	Reporting/Generating Site	WM PEIS 20 Yrs	WM PEIS to 2050	ACPC Disposition Maps	HSW EIS		
					Hanford Only	Lower Bound	Upper Bound
LLW	Ames Laboratory (Ames, Iowa)	34	86	97		75	75
	Argonne National Laboratory-East	4,455	10,394	12,960		11,366	11,366
	Battelle Columbus Laboratory	9,192	9,192	1,478		774	774
	Bettis Atomic Power Laboratory					549	549
	Bettis Atomic Power Shipyards					1	1
	Brookhaven National Laboratory	23,179	30,934	1,090		1,574	14,894
	Energy Technology Engineering Center	3,401	3,401	2,355		1,428	1,428
	Fermi National Accelerator Laboratory			1,490		1,627	1,627
	Fernald Environmental Management Project	83,591	83,591				0
	General Atomics	337	337	704		0	0
	General Electric Vallecitos	20	20				20
	Grand Junction Projects Office	55	55				55
	Hanford Site[a]	148,530	230,924	98,760	411,765	411,765	411,765
	Idaho National Engineering and Environmental Laboratory	6,419	24,860	50,873			6,419
	Inhalation Toxicology Research Institute	670	1,693	2,344			670
	Knolls Atomic Power Shipyards					356	356
	Los Alamos National Laboratory	25,235	73,045				0
	Lawrence Berkeley National Laboratory	209	348	434		174	174
	Laboratory for Energy-Related Health Research/University of California at Davis	1,996		7,421		0	0
	Lawrence Livermore National Laboratory	10,975	27,310				10,975
	Massachusetts Institute of Technology/Bates Linear Accelerator Center			39		11	11
	Mound Plant	64,177	64,177				0
	Oak Ridge National Laboratory	78,883	202,219	259,830			78,883
	Paducah Gaseous Diffusion Plant	4,379	4,379			46	46
	Pantex Facility	1,205	1,329	1,198			1,205
	Portsmouth Gaseous Diffusion Plant	2,031	2,031			0	0
	Princeton Plasma Physics Laboratory	688	1,480	2,572		2,081	2,081
	Rocky Flats Plant	65,033	65,033	396			65,033
	Sandia National Laboratories	2,748	4,193	5,745			2,748
	Separations Process Research Unit	8,220	8,220				8,220
	Stanford Linear Accelerator Center			774		756	756
	West Valley Nuclear Services[b]	11,297	11,297				11,297
LLW Total		556,959	860,540	450,560	411,765	432,582	631,427

Table C.1. (contd)

Waste Type	Reporting/Generating Site	WM PEIS 20 Yrs	WM PEIS to 2050	ACPC Disposition Maps	HSW EIS		
MLLW	Battelle Columbus Laboratory			9		<1	<1
	Energy Technology Engineering Center	1,365	1,365				1,365
	Hanford Site	69,225	99,074	72,217	58,414	58,414	58,414
	Idaho National Engineering and Environmental Laboratory			196			196
	Knolls Atomic Power Laboratory					6	6
	Los Alamos National Laboratory	3,373	3,373				3,373
	Oak Ridge National Laboratory	25,462	55,323	68,625			55,323
	Paducah Gaseous Diffusion Plant	2,672	2,681	1,730			2,681
	Pearl Harbor Naval Shipyard					<1	<1
	Portsmouth Gaseous Diffusion Plant	2,933	2,933				2,933
	Princeton Plasma Physics Laboratory			2		91	91
	Puget Sound Naval Shipyard					3	3
	Rocky Flats Plant (SWIFT Maximum = 63,040)	68,144	68,146	67,934			68,144
	Sandia National Laboratories	158	160				159
	Savannah River Site	4,085	6,134	3,191			6,134
	West Valley Nuclear Services[b]	26	26				26
MLLW Total		177,443	239,215	213,904	58,414	58,515	198,852
TRU[c]	Battelle Columbus Laboratory					28	28
	Energy Technology Engineering Center					19	19
	Framatome ANP					9	9
	General Electric - Vallecitos Nuclear Center						78
	Hanford Site				45,748	45,748	45,748
	Lawrence Berkeley National Laboratory						3
	Lawrence Livermore National Laboratory						1,237
	Missouri University Research Reactor					2	2
	Nevada Test Site						182
TRU Waste Total					45,748	45,805	47,305
WTP Wastes	Immobilized Low-Activity Waste[d]				211,000	211,000	211,000
	Melters				6,825	6,825	6,825
WTP Total					217,825	217,825	217,825

(a) HSW EIS volumes for LLW include 283,067 m^3 of previously disposed of waste.

(b) These waste forecasts differ from those evaluated in DOE (2003); for explanation see Section C.1.

(c) WM PEIS did not report TRU waste volumes for these sites. At the end of 2003, Hanford had received all of the TRU waste from the Energy Technology Engineering Center and about one-sixth of the TRU waste from the Battelle Columbus Laboratories.

(d) The No Action Alternative assumes a volume of 350,000 m^3 for the cullet waste form.

DOE expects changes in waste forecasts from individual generators over time due to several factors, including improving methods of evaluation or changes in mission. For example, the *West Valley Demonstration Project Waste Management EIS* (WV EIS, DOE 2003) analyzed offsite disposal of 19,412 and 223 cubic meters of LLW and MLLW, respectively. Those quantities differ from the volumes used in this HSW EIS for waste that might be received from the West Valley Site for disposal at Hanford (11,297 and 26 cubic meters of LLW and MLLW, respectively). The differences in waste volumes (approximately 8,115 cubic meters of LLW and 200 cubic meters of MLLW) are not expected to change the impacts reported in this HSW EIS because they represent a small fraction of the total Upper Bound volumes analyzed for those waste types (631,427 cubic meters of LLW and 198,852 cubic meters of MLLW).

The WV EIS Alternative B, a non-preferred alternative, included Hanford among several sites that could potentially receive about 1,400 cubic meters of TRU waste for certification and storage until it can be shipped to WIPP. The West Valley TRU waste inventory was not included in the draft or revised draft HSW EIS because DOE did not contemplate this action at the time the HSW EIS inventory data were compiled. In response to public comments and to provide additional clarifying information, DOE has included in this final HSW EIS an evaluation of adding the West Valley TRU waste volume to the HSW EIS results related to transportation of waste to Hanford, onsite storage, certification, packaging, and transportation to WIPP from Hanford. Potential impacts from shipping additional TRU waste from West Valley to Hanford, and from Hanford to WIPP, are discussed in Section H.3.3.2.2. Potential impacts from storing and processing this additional TRU waste at Hanford are discussed in Section F.5. These revisions are not a result of any significant new circumstances or information that became available since publication of the revised draft EIS.

C.2 Low-Level Waste

The Hanford Only volume includes all inventory and disposed of waste as of October 2001 (i.e., the existing waste in the Low Level Burial Grounds [LLBGs] and in storage) and onsite life-cycle forecasted waste. Table C.2 displays the Hanford Only volume for LLW.

Table C.2. Hanford Only Volume for Low-Level Waste (m^3)

Previously Disposed of	Disposed of FY99-FY01	Storage Inventory (10/2001)	Onsite Waste Forecast (Barcot 1999)	Total
283,067	21,717	299	106,681	411,765

The assumptions used for preparing the LLW Hanford Only volume include the following:

- Forecast estimates were included for the years 2002 through 2046.

- Onsite forecasted volumes were obtained from the 1999 version of the SWIFT report for the time period 2002 through 2046. To ensure data consistency, the forecast volumes in the SWIFT report were compared with the most current estimates included in the 2002 version. The 2002 forecast for LLW is nearly identical to the 1999 forecast for the same time period. Therefore, updating the volume estimates would not substantially change the environmental impacts and the forecast from 1999 will continue to be used to minimize cost and schedule. The forecast volumes for FY 1999 to FY 2001 were deleted from the analysis, however, because these volumes are accounted for in the volume of waste disposed of or in storage.

- The storage inventory waste volume is current as of October 2001 and was obtained from the SWITS database.

- Estimates for previously disposed of LLW and waste disposed of from FY 1999 to FY 2001 were obtained from the SWITS database.

- All waste will be verified by sampling a fraction of the waste received at the Hanford Site.

The LLW Lower Bound volume includes the Hanford Only volume plus additional forecasted waste from offsite waste generators approved for shipment to the Hanford Site. Table C.3 displays the Lower Bound volume for LLW.

Table C.3. Lower Bound Volume for Low-Level Waste (m^3)

Previously Disposed of	**Disposed of FY99-FY01**	**Storage Inventory (10/2001)**	**Onsite Waste Forecast (Barcot 1999)**	**Offsite Waste Forecast (Barcot 1999)**	**Total**
283,067	21,717	299	106,681	20,818	432,582

The assumptions used for preparing the Lower Bound LLW volume include the following:

- Forecast estimates were included for the years 2002 through 2046.

- Offsite forecasted waste generators include Ames Laboratory (Ames, Iowa), Argonne National Laboratory-East, Battelle Columbus Laboratory, Bettis Atomic Power Laboratory, Bettis Atomic Power Shipyards, Brookhaven National Laboratory, Energy Technology Engineering Center (also known as Rockwell-Canoga Park), Fermi National Accelerator Laboratory, Knolls Atomic Power Shipyards, Lawrence Berkeley National Laboratory, Laboratory for Energy-Related Health Research/University of California at Davis, Massachusetts Institute of Technology, Princeton Plasma Physics Laboratory, Paducah Gaseous Diffusion Plant, Portsmouth Gaseous Diffusion Plant, and Stanford Linear Accelerator Center. These are approved generators (Bilson 1998).

- Offsite forecasted volumes were obtained from the 1999 version of the SWIFT report for the time period 2002 through 2046. To ensure data consistency, the forecast volumes in the SWIFT report were compared with the most current estimates included in the 2002 version. The 2002 forecast for LLW is nearly identical to the 1999 forecast for the same time period. Therefore, updating the volume estimates would not substantially change the environmental impacts and the forecast from 1999 will continue to be used to minimize cost and schedule. The forecast volumes for FY 1999 to FY 2001 were deleted from the analysis, however, because these volumes are accounted for in the volume of waste disposed of or in storage.

The LLW Upper Bound volume includes the Lower Bound volume plus additional forecasted waste from offsite waste generators that may ship to the Hanford Site. The Upper Bound volume is derived from the WM PEIS Option 2 with some variation as described in the following assumption section. Table C.4 displays the Upper Bound volume for LLW.

Table C.4. Upper Bound Volume for Low-Level Waste (m^3)

Previously Disposed of	Disposed of FY99-FY01	Storage Inventory (10/2001)	Onsite Waste Forecast (Barcot 1999)	Offsite Waste Forecast (Barcot 1999)	Additional Offsite Waste	Total
283,067	21,717	299	106,681	20,818	198,845	631,427

The assumptions used to arrive at the Upper Bound volume for LLW include the following:

- Potential receipts from offsite generators in addition to the Lower Bound volumes were reviewed by DOE-RL with the following generators to determine the appropriate estimates for analysis: Brookhaven National Laboratory, General Electric Vallecitos, Grand Junction Project Office, Idaho National Engineering and Environmental Laboratory, Inhalation Toxicology Research Institute, Lawrence Livermore National Laboratory, Oak Ridge National Laboratory, Pantex Facility, Rocky Flats Plant, Sandia National Laboratory, Separations Process Research Unit, and West Valley Nuclear Services. The Upper Bound volume includes both the Lower Bound volume estimates and the additional offsite wastes.

- The 1999 SWIFT report, the WM PEIS Option 2 waste volumes for Hanford and NTS, and the Environmental Management Integration (ACPC) disposition maps (DOE 1998) were used as the bases for the Upper Bound waste volume. These volumes were then further refined by DOE-RL and the generating sites to determine the volumes analyzed in the HSW EIS.

- Offsite waste volumes were included through 2046.

C.3 Mixed Low-Level Waste

The Hanford Only volume includes all inventory and disposed of waste as of October 2001 (i.e., the existing waste in the MLLW trenches and in storage) and onsite life-cycle forecasted waste. Table C.5 displays the Hanford Only volume for MLLW.

Table C.5. Hanford Only Volume for Mixed Low-Level Waste (m^3)

MLLW Trench Inventory (10/2001)	Storage Inventory (10/2001)	Onsite Waste Forecast (Barcot 1999)	Total
1,010	7,350	50,054	58,414

The assumptions used for preparing the Hanford Only MLLW volume include the following:

- Onsite forecasted volumes were obtained from the 1999 SWIFT report for the time period 2002 through 2046. To ensure data consistency, the forecast volumes in the 1999 SWIFT report were compared with the most current estimates included in 2002 report. The 2002 forecast for MLLW is nearly identical to the 1999 forecast for the same time period. Therefore, updating the volume estimates would not substantially change the environmental impacts and the 1999 estimates will continue to be used to minimize cost and schedule. The forecast volumes for FY 1999 to FY 2001 were deleted from the analysis, however, because these volumes are accounted for in the MLLW trench inventory or in the storage inventory.

- Inventory waste is current as of October 2001 and was obtained from the SWITS database.

- Estimates for waste disposed of from FY 1999 to FY 2001 were obtained from the SWITS database.

- Roughly half the onsite forecasted waste will require treatment before disposal at the Hanford Site. Large volumes of long-length contaminated equipment are expected to be received in a form that is treated and ready for disposal.

The Lower Bound volume includes the Hanford Only volume and additional forecasted offsite waste that has an approved site treatment plan. Table C.6 displays the Lower Bound volume for MLLW.

Table C.6. Lower Bound Volume for Mixed Low-Level Waste (m^3)

MLLW Trench Inventory (10/2001)	**Storage Inventory (10/2001)**	**Onsite Waste Forecast (Barcot 1999)**	**Offsite Waste Forecast (Barcot 1999)**	**Total**
1,010	7,350	50,054	101	58,515

The assumptions used for preparing the Lower Bound MLLW volume include the following:

- The following offsite generators forecast waste for shipment to Hanford in accordance with approved site treatment plans: Battelle Columbus Laboratory, Knolls Atomic Power Laboratory, Pearl Harbor Naval Shipyard, Princeton Plasma Physics Laboratory, and Puget Sound Naval Shipyard.

- Offsite forecasted volumes were obtained from the 1999 SWIFT report for the time period 2002 through 2046. To ensure data consistency, the forecast volumes in the 1999 SWIFT report were compared with the most current estimates included in 2002 report. The 2002 forecast for MLLW is nearly identical to the 1999 forecast for the same time period. Therefore, updating the volume estimates would not substantially change the environmental impacts and the 1999 estimates will continue to be used to minimize cost and schedule. The forecast volumes for FY 1999 to FY 2001 were deleted from the analysis, however, because these volumes are accounted for in the MLLW trench inventory or in the storage inventory.

- Some site treatment plans for the offsite generators show the waste will be treated at Hanford and be shipped back to the sites for disposal. However, as the amount of this offsite waste is small compared with the total, this waste is assumed to be disposed of at Hanford.

The Upper Bound volume includes the Lower Bound volume, plus additional forecasted waste from offsite waste generators that are not currently shipping waste to the Hanford Site but may ship in the future as a result of the WM PEIS. Table C.7 displays the Upper Bound volume for MLLW.

Table C.7. Upper Bound Volume for Mixed Low-Level Waste (m^3)

MLLW Trench Inventory (10/2001)	**Storage Inventory (10/2001)**	**Onsite Waste Forecast (Barcot 1999)**	**Offsite Waste Forecast (Barcot 1999)**	**Additional Offsite Waste**	**Total**
1,010	7,350	50,054	101	140,334	198,852

The assumptions used to arrive at the Upper Bound volume for MLLW are described in the following:

- Additional offsite waste generators as confirmed by DOE-RL include Energy Technology Engineering Center, Idaho National Engineering and Environmental Laboratory, Los Alamos National Laboratory, Oak Ridge National Laboratory, Paducah Gaseous Diffusion Plant, Portsmouth Gaseous Diffusion Plant, Rocky Flats Plant, Sandia National Laboratories, Savannah River Site, and the West Valley Nuclear Services.

- Offsite waste volumes represent waste expected through the Hanford life cycle (2046).

- All offsite waste will be disposed of at Hanford.

- Additional waste volumes received from offsite generators are assumed to be received, treated, and ready for disposal and will not require treatment at the Hanford Site.

- Initial estimates for additional offsite waste volumes were based on the life-cycle volume estimates used in Option D of the WM PEIS and the Environmental Management Integration (ACPC) disposition maps (DOE 1998). The estimates included waste to be dispositioned at Hanford or waste with no identified disposition pathway. Waste designated for commercial treatment and disposal was not included. These volumes were then further refined by DOE-RL and the generating sites to determine the volumes analyzed in the HSW EIS.

C.4 Transuranic Waste

The Hanford Only volume includes all inventory waste as of October 2001 (i.e., the existing waste in storage) and onsite life-cycle forecasted waste. Table C.8 displays the Hanford Only volume for TRU waste.

Table C.8. Hanford Only Waste Volumes for Transuranic Waste (m^3)

Storage Inventory (10/2001)	Onsite Waste Forecast (Barcot 2002)	Total
16,136	29,613	45,748

The assumptions used to arrive at the Hanford Only case for TRU waste are described in the following list:

- Forecasted volumes were obtained from the 2002 SWIFT report and collected for the life cycle of the Hanford Site (through 2046). The maximum forecast estimates were used to provide a bounding analysis.
- A comparison of the TRU waste volume estimates developed during FY 1999 and FY 2000 to the 2002 SWIFT report showed that the expected waste volumes had increased substantially over the development period of the HSW EIS. Therefore, the waste volumes for TRU waste were updated to reflect the current forecast estimates.
- Inventory waste is current as of October 2001 and was obtained from the SWITS database.
- The TRU waste will be processed and certified at the Hanford Site and sent to WIPP.

The Lower Bound volume includes the Hanford Only volume and additional offsite waste included in the 2002 SWIFT report. Table C.9 displays the Lower Bound volume for TRU waste.

Table C.9. Lower Bound Waste Volumes for Transuranic Waste (m^3)

Storage Inventory (10/2001)	Onsite Waste Forecast (Barcot 2002)	Offsite Waste Forecast (Barcot 2002)	Total
16,136	29,613	57	45,805

The assumptions used to arrive at the Lower Bound case for TRU waste are described in the following:

- Forecasted volumes from offsite generators were obtained from the 2002 SWIFT report and collected for the life cycle of the Hanford Site (through 2046). The maximum forecast estimates were used to provide a bounding analysis.
- Waste from offsite generators is included for Battelle Columbus Laboratory, Energy Technology Engineering Center (ETEC), Framatome ANP, and Missouri University Research Reactor.

- The TRU waste will be processed and certified at the Hanford Site and sent to WIPP.

The Upper Bound volume includes the Lower Bound volume, plus additional waste from offsite waste generators that may be received in the future if Hanford is selected to receive waste from small-quantity sites as the western hub as part of DOE's efforts to accelerate the disposal of TRU waste (DOE 2002). Table C.10 displays the Upper Bound volume for TRU waste.

Table C.10. Upper Bound Waste Volumes for Transuranic Waste (m^3)

Storage Inventory (10/2001)	Onsite Waste Forecast (Barcot 2002)	Offsite Waste Forecast (Barcot 2002)	Additional Offsite Waste	Total
16,136	29,613	57	1,500	47,305

The following assumptions were used to develop the Upper Bound volume for TRU waste:

- The volume of TRU waste expected to be received from small-quantity sites by the western hub was obtained from the Transuranic Waste Performance Management Plan (DOE 2002). It is assumed the wastes from small-quantity sites are in addition to the offsite wastes included in the Lower Bound volume. Decreasing the additional offsite waste volume (1500 m^3) by the offsite waste included in the Lower Bound (57 m^3) would not substantially change the environmental impacts.

C.5 Waste Treatment Plant Wastes

Waste volumes expected from the Waste Treatment Plant are shown in Table C.11. As these wastes will only be generated at Hanford, the Lower Bound and Upper Bound cases are not applicable. The volume of ILAW generated by the WTP, however, may vary depending on the vitrified waste form produced. For the No Action Alternative, ILAW would be produced in a cullet form and packaged in containers for retrievable disposal in vaults as outlined in the TWRS EIS (DOE and Ecology 1996). The EIS analysis assumed 140,000 containers would be required or an equivalent volume of approximately 350,000 m^3. For the Action Alternatives, ILAW was assumed to be in a monolithic form and packaged in 2.6-m^3 containers for disposal in trenches. Approximately 81,000 containers would be required, or an equivalent volume of approximately 211,000 m^3 (Burbank 2002).

Table C.11. Estimated Volumes of WTP Waste Streams through 2046

Waste Streams	No Action (cubic meters)	Action Alternatives (cubic meters)
ILAW	350,000	211,000
WTP Melters	6,825	6,825
Total WTP Waste	356,825	217,825

C.6 References

Barcot, R. A. 1999. *Solid Waste Integrated Forecast Technical (SWIFT) Report*. HNF-EP-0918, Rev. 5, Fluor Hanford, Inc., Richland, Washington.

Barcot, R. A. 2002. *Solid Waste Integrated Forecast Technical (SWIFT) Report.* HNF-EP-0918, Rev. 9, Fluor Hanford, Inc., Richland, Washington.

Bilson, H. E. 1998. Waste Programs Division DOE-RL to Hatch H.J., President, Fluor Hanford, Inc., FY 1998 Authorization Numbers (WRM), Correspondence 98-WPD-138.

BNFL. 1999. Tank Waste Remediation System Privatization Project, BNFL-5192-ID-03, Rev. 2c, Interface Control Documents ICD-03 Between DOE and BNFL Inc. for Radioactive Solid Wastes, May 1999, British Nuclear Fuels Ltd., Inc., Richland, Washington.

Burbank, D. A. 2002. *Conceptual Design Report Immobilized Low-Activity Waste Disposal Facility, Project W-520, Rev 0*. RPP-7908, Rev. 0A, CH2M HILL Hanford Group Inc., Richland, Washington.

DOE. 1997. *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste.* DOE/EIS-0200-F, Vol. 1-5, U.S. Department of Energy, Washington, D.C.

DOE. 1998. *Accelerating Cleanup*: *Paths to Closure.* U.S. Department of Energy, Office of Environmental Management (DOE-EM). Online at: http://www.em.doe.gov/closure/ptc_c.html

DOE. 2002. *Transuranic Waste Performance Management Plan*. U.S. Department of Energy, Carlsbad Field Office, Carlsbad, New Mexico. Online at: http://www.wipp.carlsbad.nm.us/suyw/july2002/FTWPMP.pdf

DOE. 2003. *West Valley Demonstration Project Waste Management Environmental Impact Statement***.** DOE/EIS-0337F, U.S. Department of Energy, West Valley Area Office, West Valley, New York. Online at: http://tis.eh.doe.gov/nepa/eis/eis0337/index.html

DOE and Ecology. 1996. *Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement*. DOE/EIS-0189, U.S. Department of Energy, Richland Operations Office, Richland, Washington and Washington State Department of Ecology, Olympia, Washington.

FH. 2004. *Hanford Site Solid Waste Management Environmental Impact Statement Technical Information Document*. HNF-4755, Rev. 2, Fluor Hanford, Inc., Richland, Washington.

Appendix D

Supplemental Information on the Low Level Burial Grounds, Environmental Restoration Disposal Facility, Borrow Pits, Trench Liners, and Disposal Facility Barriers

Appendix D

Supplemental Information on the Low Level Burial Grounds, Environmental Restoration Disposal Facility, Borrow Pits, Trench Liners, and Disposal Facility Barriers

This appendix contains information on the Low Level Burial Grounds (LLBGs), the Environmental Restoration Disposal Facility (ERDF), the borrow pits used for the closure covers of the LLBGs, liners used in disposal facilities, and barriers that will be placed over the disposal facilities after they are filled.

D.1 Low Level Burial Grounds

The LLBGs are eight separate waste disposal areas located in the 200 Areas. They are regulated under the Atomic Energy Act (AEA) of 1954 (42 USC 2011) and the trenches that contain MLLW are also regulated under Resource Conservation and Recovery Act (RCRA) (42 USC 6901; 40 CFR 261.8), and applicable state laws and regulations (WAC 173-303). The following sections summarize specific information concerning the LLBGs.

D.1.1 200 East Area Burial Grounds

Burial Ground 218-E-12B. Burial Ground 218-E-12B (Figure D.1) is located in the northeast corner of the 200 East Area. It covers approximately 70.1 ha (173.2 ac) and began receiving waste in 1962. Burial Ground 218-E-12B has three trenches containing retrievably stored transuranic (TRU) waste, but contains primarily low-level waste (LLW) generated by facilities in the 200 East Area. Trench 94, a portion of 12B, is reserved for the disposal of U.S. Navy defueled reactor compartments composed of various types of steel and lead shielding.

The reactor compartments contain polychlorinated biphenyls (PCBs) bulk product waste and may be disposed of under 40 CFR 761 as non-hazardous radioactive waste. However, the trench is regulated under the Washington State Dangerous Waste regulations for lead and is permitted for the disposal of mixed low-level waste.

Burial Ground 218-E-10. Burial Ground 218-E-10 (Figure D.2) is located in the northwest corner of the 200 East Area and is used primarily for LLW disposal, although it also contains MLLW. It began receiving waste in 1960 and covers approximately 36.1 ha (89.2 ac). Waste in this burial ground came from the 200 East and 100 N Areas facilities, and was primarily received in large concrete boxes.

D.1.2 200 West Area Burial Grounds

Burial Ground 218-W-3A. Burial Ground 218-W-3A (Figure D.3) began receiving waste in 1970. Located in the north-central section of 200 West Area, it covers approximately 20.4 ha (50.3 ac). Primarily, it receives LLW, but also contains MLLW, and retrievably stored TRU waste.

Burial Ground 218-W-3AE. Burial Ground 218-W-3AE (Figure D.4) covers approximately 20 ha (49.4 ac) and began receiving waste in 1981. It contains primarily LLW, although MLLW is present. This burial ground includes Trenches 05 and 10 that are wide-bottom stacking trenches, and Trench 26 that was dug with a wide bottom to dispose of LLW railroad cars and large tanks.

Burial Ground 218-W-4B. Burial Ground 218-W-4B (Figure D.5) began receiving wastes in 1968, and is located in the central portion of the 200 West Area. It consists of 14 trenches (one containing 12 caissons, of which 4 caissons contain TRU waste) and covers 3.5 ha (8.6 ac). The trenches in this burial ground contain unsegregated TRU waste and contact-handled (CH) TRU waste stored on an asphalt pad mostly in 55-gal drums. Trench 7 contains one of the earlier designs for retrievably stored TRU waste—the V trench. The concrete V trench stores waste containers on a 45-degree angle and is covered with a metal roof and soil. The TRU waste in Trench 11 contains either remote-handled (RH) or CH wastes. Trench 14 contains caissons that are underground storage structures for the disposal of 3.8-L (1-gal) to 18.9-L (5-gal) cans of RH waste.

Five caissons were planned for TRU waste and from 1970 to 1988 retrievably stored TRU waste was placed in four of them. The caissons have been isolated. One caisson has never been used. Seven caissons containing LLW were filled from 1968 to 1979 and are also found in this burial ground. No additional waste placement is planned for any of these caissons. All the trenches in this burial ground are covered with earth.

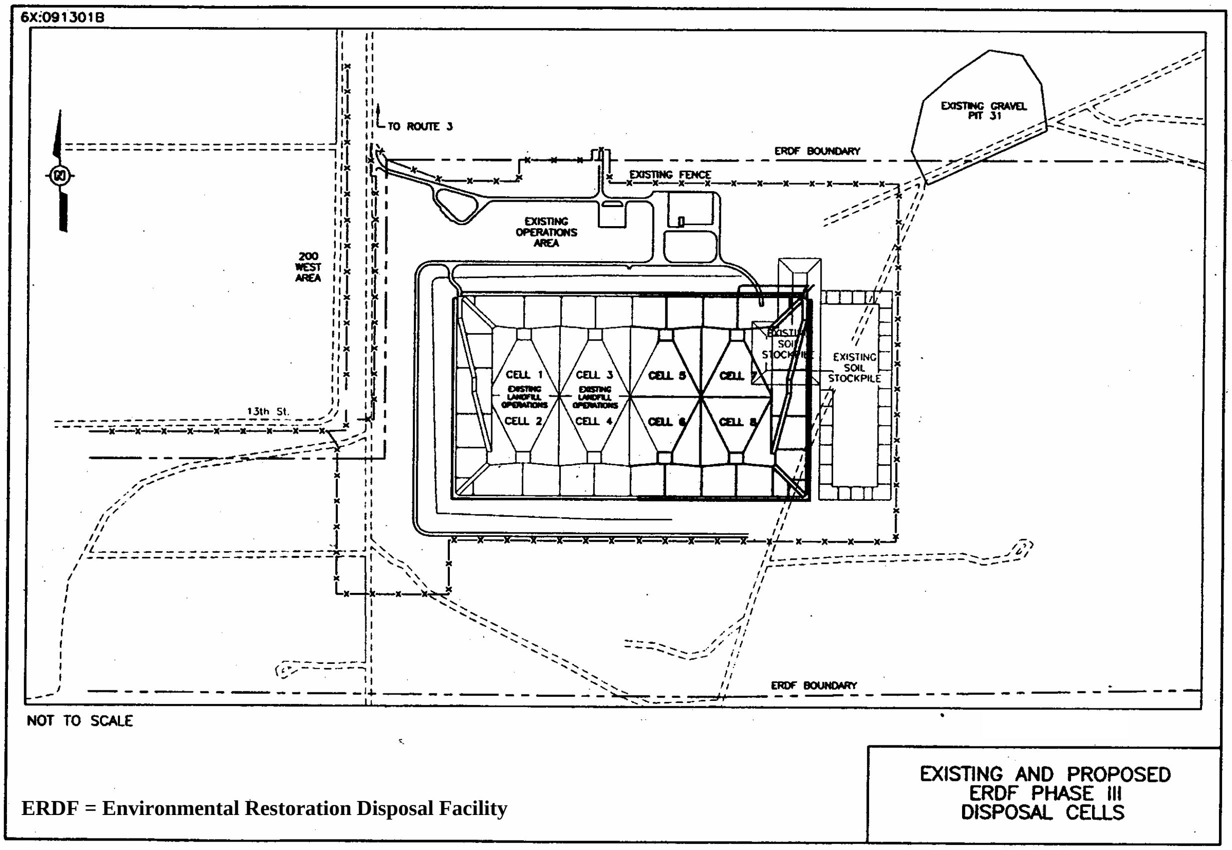
Burial Ground 218-W-4C. Burial Ground 218-W-4C (Figure D.6) started receiving waste in 1978. It covers approximately 20 ha (49.4 ac) and mainly receives LLW, although some MLLW and retrievably stored TRU wastes are also present. The most northern trench (Trench NC) contains core barrels from naval bases. Trench 1 contains mostly retrievably stored TRU waste, including drums generated from mining the 216-Z-9 Crib. Trench 4 also contains retrievably stored TRU waste. Trench 7 contains retrievably stored TRU boxes and drums of Test Reactor and Isotope Production General Atomics (TRIGA) fuel waste. Additional retrievably stored TRU wastes in boxes and drums are located in Trenches 19, 20, 24, and 29.

Burial Ground 218-W-5. The 218-W-5 Burial Ground (Figure D.7) began receiving wastes in 1986. It covers approximately 37.2 ha (91.9 ac) (excluding the expansion area) and accepts MLLW and LLW. The 218-W-5 Burial Ground currently contains two permitted MLLW trenches.

Burial Ground 218-W-6. Burial Ground 218-W-6 (Figure D.8) covers approximately 16 ha (39.5 ac). To date, it has not received any waste.

D.2 Environmental Restoration Disposal Facility

ERDF is Hanford's low-level and hazardous waste disposal facility for wastes from CERCLA cleanup activities. It is located on the Central Plateau, as can be noted in Figure 3.2 in Section 3. The facility is composed of a number of cells, as illustrated in Figure D.9. The first two cells were completed in 1996 and are 21 m (70 ft) deep, 152 m (500 ft) long and 152 m (500 ft) wide. Construction of cells 3 and 4 began in 1998 and were ready to begin receiving waste in the spring of 2000. Together, the four cells have a capacity of 4.7 billion kg (5.2 million tons). It is expected that the capacity will be filled in March of 2005 with the current operations. DOE is planning on adding four more cells to ERDF to double its capacity. It is currently planned to have those cells constructed and ready to receive waste in 2005.



ERDF = Environmental Restoration Disposal Facility

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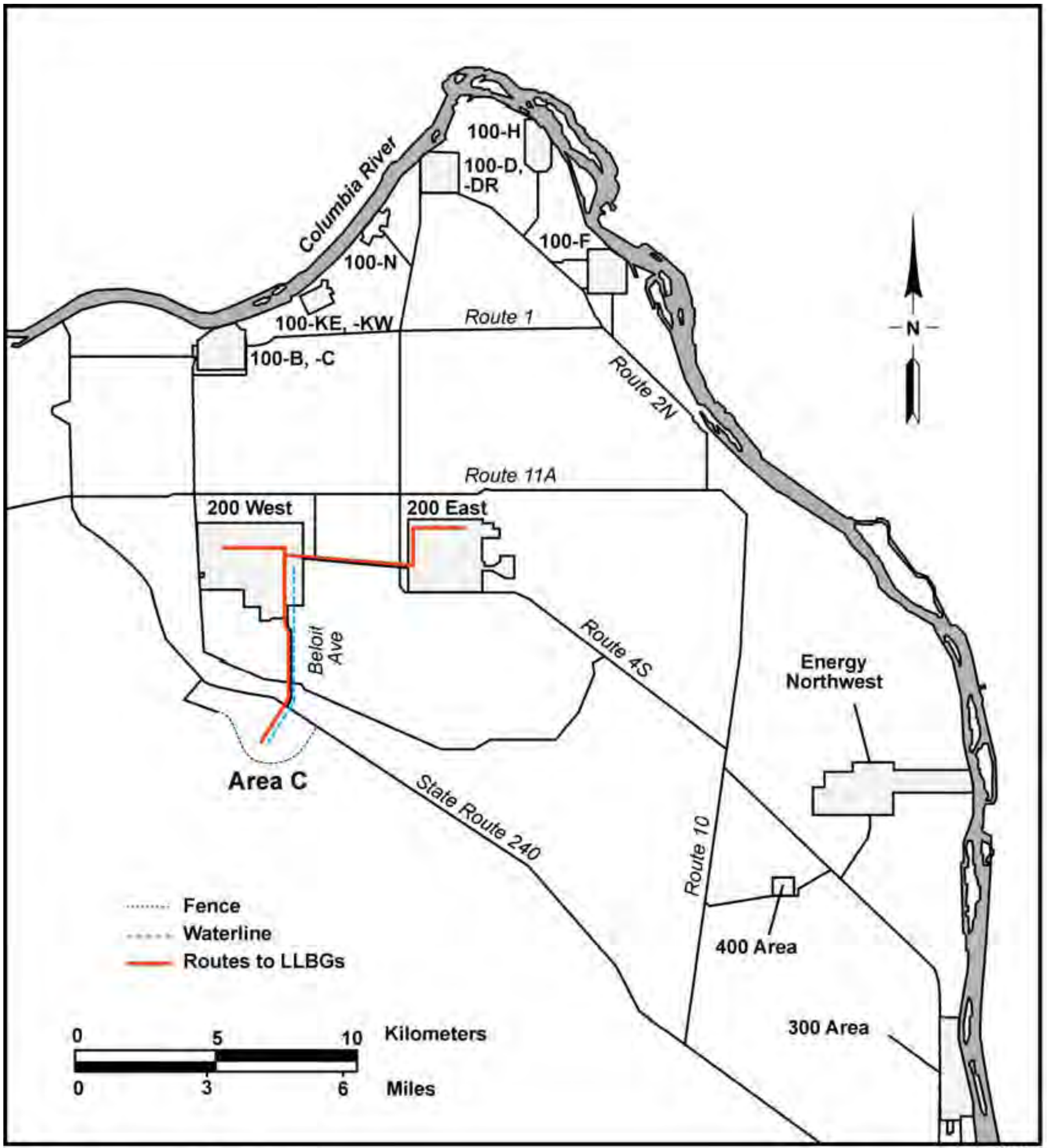
HSW EIS 03-21-03

Figure D.9. Existing and Proposed ERDF Disposal Cells

D.3 Borrow Pit Resource Excavation

Up to approximately 3,700,000 m^3 (approximately 5,000,000 yd^3) of sand, gravel, rock, and silt/loam will be required as a mineral resource for up to 178 ha (440 ac) of regulatory-compliant caps on LLBGs and other disposal facilities addressed in this EIS. It is anticipated that almost all of the onsite resources required for surface capping will come from Area C, shown in Figures D.10 and D.11. The only exception is materials for an asphalt layer, which would be transported from the Tri-Cities.



LLBGs - Low Level Burial Grounds

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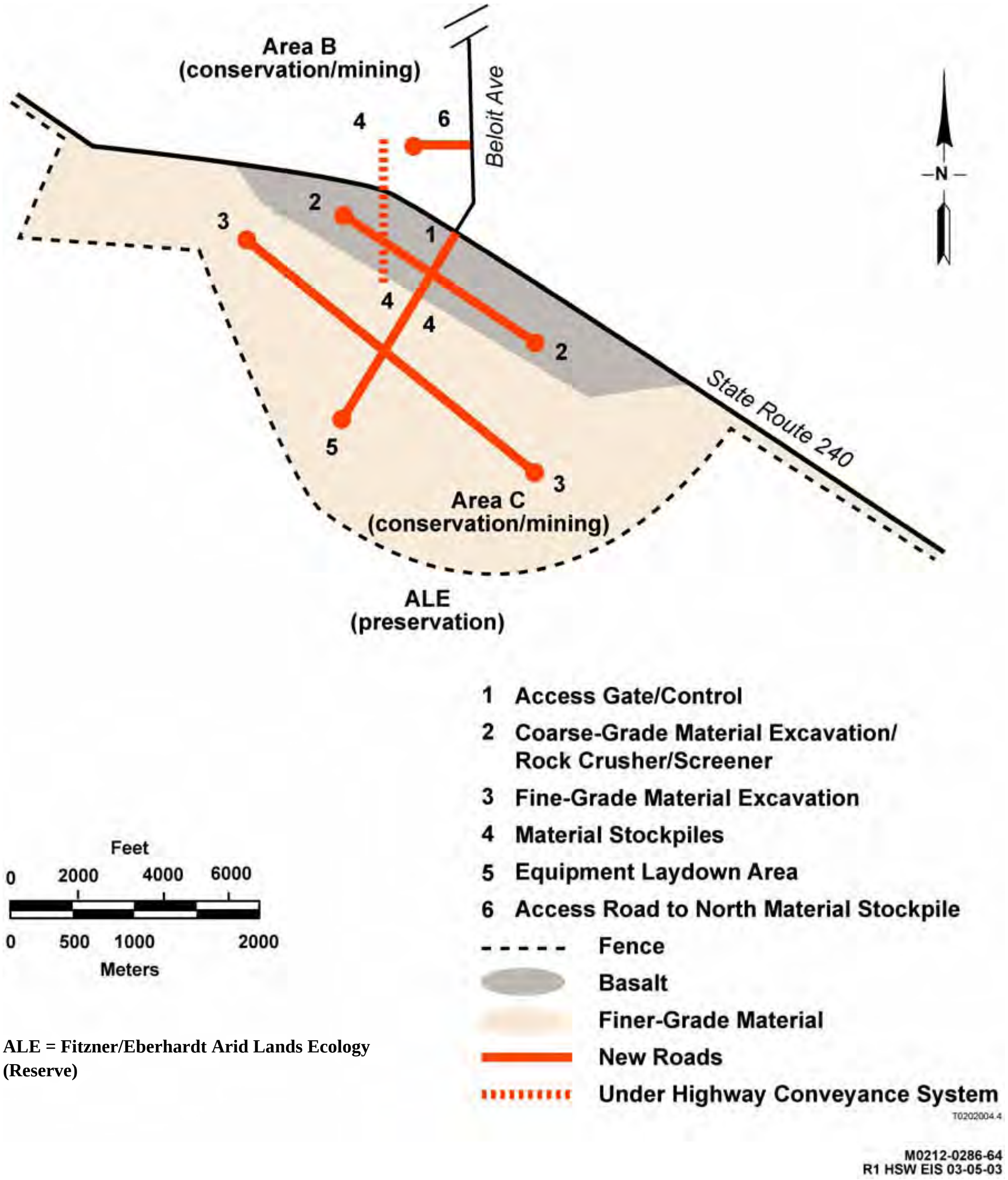
Figure D.10. Area C Location Relative to the 200 East and 200 West Burial Grounds



ALE = Fitzner/Eberhardt Arid Lands Ecology (Reserve)

Figure D.11. Borrow Pit Layout in Area C

Although the amount of resource material varies slightly depending upon the alternative chosen, the variance is not large considering that the areas between LLW and MLLW trenches would be required to be covered to minimize contaminant migration from precipitation events. The barrier edges would be extended far enough beyond the waste trenches to preclude reintrusion of precipitation and snowmelt back into the waste zones.

Area C is on the southeast side adjacent to State Route (SR) 240 and is accessed via the Rattlesnake Gate and Beloit Avenue. Area C is a large 926-ha (2287-ac) polygonal area located adjacent to the south side of SR 240 and is centered approximately at the intersection of Beloit Avenue and SR 240. The area is bounded by SR 240 and the Fitzner/Eberhardt Arid Lands Ecology (ALE) Reserve. Area C is not part of the Hanford Reach National Monument. A small portion of the northern portion of Area C has already been used as a borrow pit. It is anticipated that less than 7.5 percent (81 ha [200 ac]) of Area C will be required for capping resource material.

Area C is considered part of the Central Plateau in the *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (HCP EIS) and its use is designated as “conservation (mining)” (DOE 1999). The HCP EIS acknowledges that “mining of onsite geologic materials will be needed to construct surface barriers as required by Hanford Site remediation activities.”

The use of Area C as a borrow pit would have the following restrictions required by the Hanford Site procedures and best management practices:

1. A restoration plan would be written to direct how the site would be revegetated and restored.

2. Topsoil would be stripped and stockpiled for use in revegetation.

3. Excavation and bank cuts would be kept a minimum of 152 m (500 ft) from SR 240.

4. Areas prone to wind erosion (for example, active pit faces, haul roads, stockpiles) would be stabilized as needed with ballast or other means, such as routine wetting with water and a stabilization agent.

5. Approximately 8 km (5 mi) of new roads within Area C (see Figure D.10) would be built to expedite traffic and shorten haul roads. It is anticipated that the access road would intersect SR 240 directly across from the intersection of the highway from Beloit Avenue.

6. Immediately following the removal of material from each pit, cut banks would be sloped and the sides of the pits would be shaped with irregular boundaries to avoid straight lines and to more naturally blend with the surrounding terrain.

Borrow operations at Area C would consist of the following:

- **Infrastructure Upgrade** – Water and electricity would be extended from the vicinity of Beloit Avenue and 13th Street, a distance of 6.4 km (4 mi). New gravel roads would be installed within Area C to access the mineral resource, laydown areas, office areas, and resource stockpiles. Modular space would be used for offices, lunchrooms, and showers. A holding tank would be installed to receive sanitary wastewater from trailers. Portable toilets would be provided to all other areas of the site. A contract sanitary waste hauler would service the holding tank and portable toilets at least twice weekly. Site lighting would be provided via fixed lights on poles and portable, rechargeable light stands.

- **Resource Excavation** – Borrow pits would be excavated via a track hoe, scraper, bulldozer, and/or front-end loader and loaded either directly into trucks or onto conveyor systems. Conveyor systems would be used to move the resource to stockpile areas or to load trucks. Conveyor systems would be fitted with crushing, sorting, and screening systems to segregate fines from rock. Basalt would probably be blasted with standard controlled subsurface detonations. A one-shift operation with approximately 20 trucks would require a minimum of 12 years of borrow pit operation.

- **Under Highway Conveyance System** – Part of the conveyor system discussed above would be a more permanent system installed between the access gate and road in Area C and another conservation/mining area north of SR 240 (Area B, shown in Figure D.10). Area B is also an area designated as "conservation (mining)" by the HCP EIS and would be used only as a reservoir for resource material excavated from Area C to minimize the number of truck highway crossings that could be expected during peak capping demand periods; as such, it is only expected to be in use during the latter portion of the LLBG capping mission. The same crew that performed the water and power infrastructure upgrade would be used to install a new approximately 1-m- (36-in-) diameter approximately 24-m- (80-ft-) long culvert under SR 240 (see Figure D.10), using standard horizontal boring techniques used frequently in municipal applications. A screw auger type conveyance system could then be slipped through the culvert to convey resource material from Area C to Area B.

- **Resource Restoration** – Immediately after the mineral resource from a pit is depleted, restoration activities would proceed, including laying backside slopes and eliminating straight lines to match the surrounding environment. Stockpiled topsoil would then be redistributed into the borrow pit and the area replanted with native vegetation. If necessary, water would be sprinkled onto the site to promote seed germination. It is estimated this activity would add an additional 5 percent to the cost and labor of the borrow pit operation.

- **Hauling and Stockpiling** – A fleet of haul trucks would be used to haul resource material to stockpiles (if not directly conveyed) or the LLBGs in both 200 East and 200 West Areas. The numbers of haul trucks would be similar to those associated with hauling contaminated material to the Environmental Restoration and Disposal Facility. Haul trucks would be loaded either directly from borrow pit excavations or from stockpiles. Stockpiles would be staged 152 to 305 m (500 to 1,000 ft) from SR 240 in topographically low areas to minimize wind erosion.

- **Dust and Traffic Control** – Traffic and dust control required by Area C operations are important considerations because of the vicinity of SR 240 and potential safety hazards associated with traffic. The following precautions are planned as needed:

  - Haul trucks would be fitted with roll-out tarps. If necessary, an undercarriage and wheel wash-down system would be provided near the point where the trucks cross SR 240 to minimize fugitive dusts.

  - If necessary, a traffic light could also be installed at the intersection, with warning lights on each side of it to warn oncoming traffic.

- As needed, a water truck and soil binder additive system would be employed to continuously wet site gravel roads, queues, stockpiles, and working faces (this practice has proved to be extremely effective at Hanford soil cleanup sites). A sprinkler system might also be used to control dusts.

- Excavation and truck loading activities would be discontinued when winds are excessive.

- The exposed working face of a borrow pit would be limited.

- Stockpile profiles would be minimized wherever possible.

- Haul roads and queues would be rocked.

- Conveyor systems would be fitted with misting systems to minimize fugitive dusts.

Area C was selected for use as a borrow pit because of its proximity to the 200 Area waste disposal facilities, and the borrow pit would be designed to minimize dust and safety hazards.

D.4 Liner Options for Disposal Facilities

Liners in disposal facilities can delay water entering into the vadose zone and eventually into ground water. However, liners have the potential to adversely affect long-term performance by retaining water within the disposal facility around the waste thereby leaching radioactive and hazardous components from the waste. Options for application of liners to waste disposal are described in this section.

Mixed waste disposal facilities are required by RCRA and state regulation to contain a liner underneath the waste, and LLW facilities may also use liners to retain any rain or snow water that has fallen onto the disposal facilities and contacted waste materials. This water, which is called leachate, may contain hazardous and radioactive materials that have been leached from the waste. The leachate must be contained, removed, and treated in facilities designed to meet applicable standards. These standards require that the liner function during the active operational period and for a minimum of 30 years after closure of the disposal facility. Landfill liners are typically constructed of one or more layers of earthen materials (e.g., sand, silt clay, gravel, or cobbles), plastics (e.g., high-density polyethylene [HDPE]), or a combination of these materials). The primary objective of a landfill liner is to prevent any leachate from percolating down into the underlying aquifer. The liners that have been used in the existing disposal trenches are described and illustrated in Section 2.2.3.5. Other liner options are described below:

- no liners
- regulatory-compliant liners
- clay liners
- other types of liners.

As discussed in Section 5.3, the normal soils and geologic media would retard migration of most radionuclides and chemicals. The EIS analysis assumes no liners for independent LLW disposal facilities, which has been the standard practice for the LLBGs at Hanford where the annual precipitation is low. To ensure that analyses are conservative when evaluating the potential releases from LLW disposal, even in lined facilities, no credit is taken for the liner. Due to long time period of analysis and the relative short expected life of liners (30-100 years) it was conservative to model transport to ground water as if the liner did not exist. Liners effectively minimize transport of contaminants from the disposal facility during operations. However, there is no scientific consensus regarding the lifetime of liners.

The mixed waste trenches, ERDF, and all of the lined disposal facilities evaluated in the HSW EIS alternatives are designed with liners and groundwater monitoring systems that meet applicable technical standards. The liners are a combination of clay, drainable layers, and thick polymeric liners, as discussed in Volume I, Section 2.2.3.5.

Some disposal facilities use only a clay liner with its natural ability to retard water flows. Smectite or bentonite-type clays are suitable for this function because they have very low permeability to water and are less subject to geologic modification with time than polymeric liners. However, they can be subject to shrinkage and cracking as the water environment changes.

Another option for minimizing contaminant migration could be the use of a permeable reactive barrier in-lieu of the traditional double-lined system. Disposal facility trench design could optimize the physical and chemical characteristics in a trench bottom in order to maximize artificially created attenuation of radionuclides and hazardous waste components. Disposal site design could optimize the soil adsorption capacity by artificially creating a permeable reactive barrier in the trench bottom by adding such materials as flyash, zeolite clays, various oxides, zero valence metals (e.g., metallic iron), granulated activated carbon, phosphates, lime, and peat. Manipulating trench-bottom material pH could also assist in enhancing specific contaminants' retardation. The type and amount of additives, method of additive installation (e.g., layered adsorbents vs. a homogenous blend of adsorbents), and physical/ chemical manipulations deployed to create an artificial reactive barrier would depend primarily on such factors as waste composition (types and volumes) and climate. Preliminary field and laboratory tests have demonstrated that flyash and zeolite clays alone may improve the retention of most radionuclides and hazardous contaminants. Installing such a reactive permeable liner system under a mixed waste trench could provide a long-term solution to waste isolation as opposed to the uncertainty associated with long-term performance of landfill barriers, performance monitoring, and landfill liner systems. A permeable reactive barrier could be substantially lower in cost than a traditional double-lined system due to such factors as lower construction costs and elimination of the need to collect and treat leachate during the operating life cycle of the facility and could provide the ability to isolate waste for thousands of years.

D.5 Barrier Options

The Modified RCRA Subtitle C Barrier was selected for use in this EIS as the reference design barrier for LLW and MLLW disposal facilities and is discussed in Volume I, Section 2.2.3.6. A focused feasibility study (DOE-RL 1996) was performed to examine engineered barrier options that have broad application and are considered viable from the standpoint of effectiveness, implementability, and cost. The feasibility study evaluated a total of four conceptual barrier designs for different types of waste sites. The Hanford Barrier, the Modified RCRA Subtitle C Barrier, and the Modified RCRA Subtitle D Barrier were considered as the baseline designs for the purpose of the evaluation. A fourth barrier design, the

Standard RCRA Subtitle C Barrier, was also evaluated; it is commonly applied at other waste sites across the country. These four designs provide a range of barrier options to minimize health and environmental risks associated with a site and specific waste categories for design life periods of 1000, 500, 100, or 30 years, respectively. Design criteria for the 500- and 1000-year design life barriers include performance to extend beyond active institutional control and monitoring periods. An alternative approach, which is being considered for commercial radioactive waste disposal, is also discussed below.

D.5.1 Hanford Barrier

The Hanford Barrier was designed for disposal facilities with Greater than Category C (GTCC) LLW, GTCC MLLW, and/or wastes with significant inventories of TRU constituents. This barrier is designed to remain functional for a performance period of 1000 years and to provide the maximum practicable degree of containment and hydrologic protection of the evaluated designs. The Hanford Barrier is composed of nine layers of durable material (excluding the grading fill layer) with a combined thickness of 4.5 m (14.7 ft) (see Figure D.12). The barrier layers are designed to maximize evapotranspiration, and to minimize moisture infiltration and bio-intrusion, considering long-term variations in Hanford Site climate.

The primary structural differences between the Hanford Barrier and other barriers discussed in this report are increased thicknesses of the individual layers within the barrier and the inclusion of a coarse-fractured basalt layer to control bio-intrusion and to limit inadvertent human intrusion.

D.5.2 Standard RCRA Subtitle C Barrier

This barrier design can be used at disposal facilities containing hazardous constituents. This barrier is designed to provide containment and hydrologic protection for a minimum of 30 years, to include institutional control consisting of monitoring and necessary maintenance. The Standard RCRA Subtitle C Barrier is composed of five primary layers (not counting the grading fill layer) with a combined minimum thickness of 1.65 m (65 in.) (see Figure D.13). The barrier layers are designed to shed surface waters, and only minimally account for moisture retention and evapotranspiration capabilities. Bio-intrusion is mitigated primarily by institutional control, monitoring, and maintenance. However, EPA guidelines suggest using optional surface layer treatments for bio-intrusion considerations.

The Standard RCRA Subtitle C Barrier technology meets EPA’s minimum technology guidance (EPA 1989). The Standard RCRA Subtitle C Barrier has limited applications and use at the Hanford Site. Limitations include a design life that may be inadequate for the radioactive waste categories; an anticipated high surveillance and maintenance and operations cost caused by implementation of the low permeability layer design features in an arid climate condition; and maintenance and operations cost caused by surface water runon and runoff control, collection, and discharge facilities.

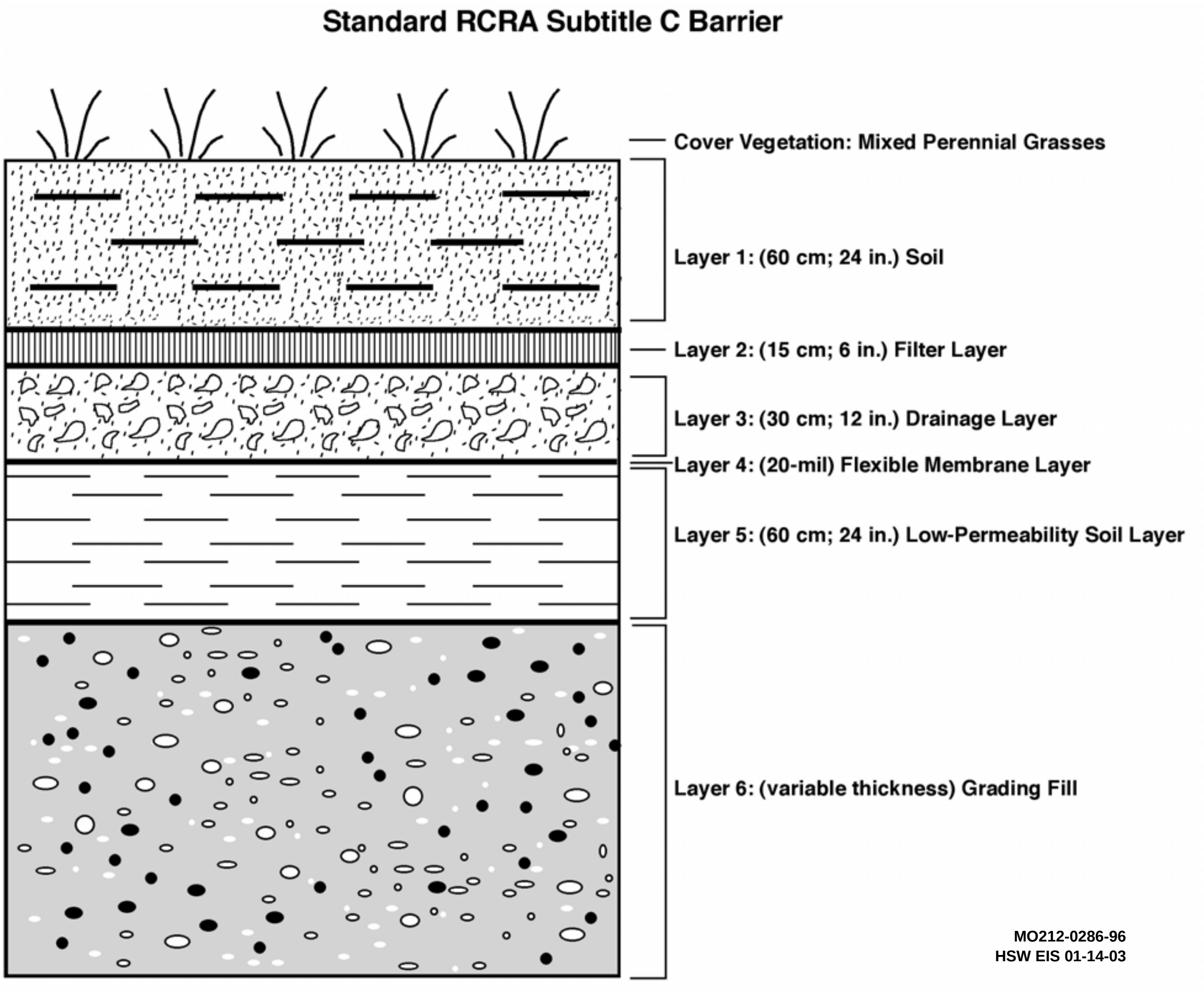


Figure D.13. Standard RCRA Subtitle C Barrier

D.5.3 Modified RCRA Subtitle D Barrier

This barrier is designed for non-radiological and non-hazardous solid waste disposal facilities, as well as Category 1 LLW sites where hazardous constituents are not present. The Modified RCRA Subtitle D Barrier as shown in Figure D.14 is composed of four layers of durable material with a combined minimum thickness of 0.90 m (2.9 ft) excluding the grading fill layer. It is designed to provide limited bio-intrusion and limited hydrologic protection (relative to the Hanford and Modified RCRA Subtitle C Barrier designs) for a performance period of 100 years. The performance period is consistent with the radionuclide concentrations and activity limits specified for Cat 1 LLW. The 100-year design life is also consistent with the minimum expected duration of active institutional control.

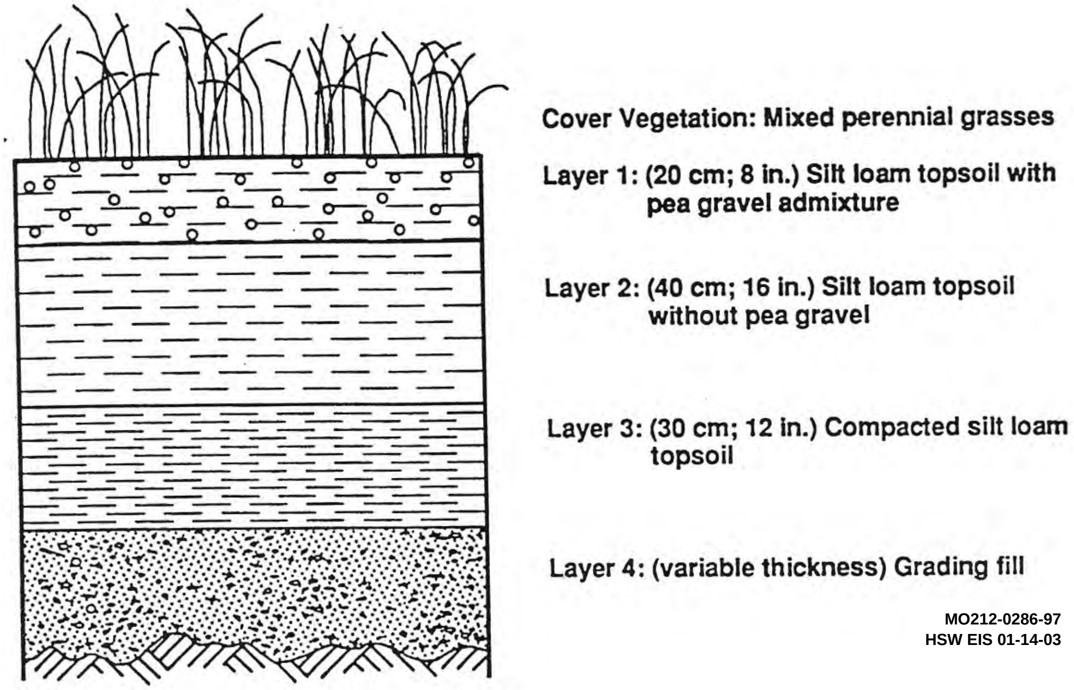


Figure D.14. Modified RCRA Subtitle D Barrier with Bentonite Mix

D.5.4 Conceptual Cover Barrier with Bentonite Mix

This barrier has been evaluated by WDOH (WDOH 1999) for use at the leased commercial disposal facility adjacent to the 200 Areas (the US Ecology, Inc. Site). The conceptual cover barrier is shown in Figure D.15. Some of the key characteristics of the barrier design are a 4-inch surface layer with 50 percent gravel, 36-inch silt loam layer, and a 12-inch bentonite clay (12 percent) low-permeability barrier.

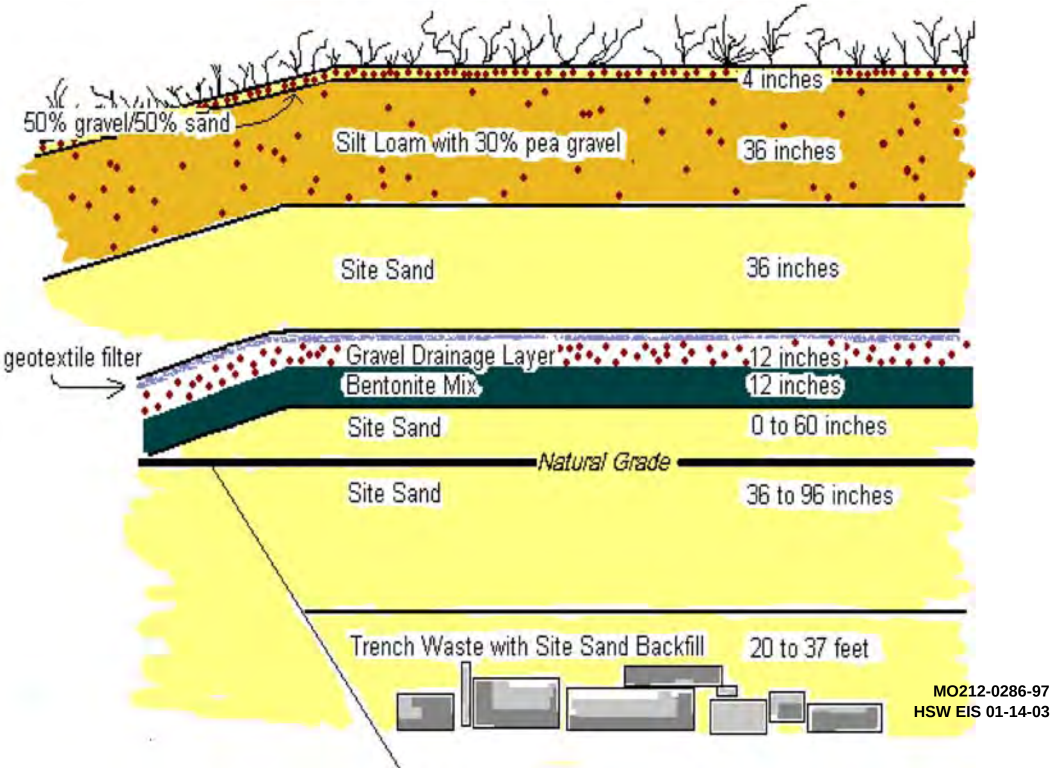


Figure D.15. US Ecology, Inc. Conceptual Cover Barrier

D.6 References

40 CFR 261. "Identification and Listing of Hazardous Waste." Code of Federal Regulations. Online at: http://www.access.gpo.gov/nara/cfr/waisidx_01/40cfr261_01.html

40 CFR 761. "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution In Commerce, and Use Prohibitions." Code of Federal Regulations. Online at: http://www.access.gpo.gov/nara/cfr/waisidx_01/40cfr761_01.html

42 USC 2011 et. seq. Atomic Energy Act of 1954. Online at: http://www4.law.cornell.edu

42 USC 6901 et seq. Resource Conservation and Recovery Act (RCRA) of 1976. Online at: http://www4.law.cornell.edu

DOE. 1999. *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*. DOE/EIS-0222-F, U.S. Department of Energy, Richland, Washington. Online at: http://www.hanford.gov/eis/hraeis/maintoc.htm

DOE-RL. 1996. *Focused Feasibility Study of Engineered Barriers for Waste Management Units in the 200 Areas*. DOE/RL-93-33, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Online at: http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D197226618

EPA. 1989. *Technical Guidance Document: Final Covers on Hazardous Waste Landfills and Surface Impoundments*. EPA/530/SW-89/047, Environmental Protection Agency, Office of Solid Waste, Washington, D.C.

WAC 173-303. *Dangerous Waste Regulations*. Washington Administrative Code, Olympia, Washington. Online at: http://www.leg.wa.gov/wac/index.cfm?fuseaction=chapterdigest&chapter=173-303

WDOH. 1999. *Technical Evaluation Report for the 1996 U.S. Ecology Site Stabilization and Closure Plan for the Low-Level Radioactive Waste Disposal Facility, Richland, Washington*. Washington State Department of Health, Division of Radiation Protection, Olympia, Washington.

Appendix E

Air Quality Analysis

Appendix E

Air Quality Analysis

This appendix provides information to support the non-radiological air quality impact analysis presented in Section 5.2. This analysis characterizes the routine emission of non-radiological pollutants by most Hanford Solid Waste (HSW) Program activities, the atmospheric dispersion of these pollutants, and the maximum air quality impacts to the public. The impacts associated with waste transportation activities and the emission of hazardous chemicals and radionuclides are not addressed in Section 5.2 or this appendix. Section 5.8 covers the air quality impacts associated with the transportation of radioactive and hazardous wastes. Section 5.11 and Appendix F report on the potential health impacts associated with the emission of chemicals and radionuclides.

The Clean Air Act (42 USC 7401) authorizes the U.S. Environmental Protection Agency (EPA) to set permissible levels of exposure for selected air pollutants using health-based criteria. These "criteria pollutants" include nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter with aerodynamic diameters of 10 μm or less (PM_{10}), carbon monoxide (CO), lead, and ozone. The maximum permissible exposure levels for these pollutants are set in National Primary and Secondary Ambient Air Quality Standards (40 CFR 50). The standards focus on short-term exposures (1-hour or 3-hour), workday exposures (8-hour), and long-term exposures (24-hour or annual). The standards for some pollutants focus on short-term exposures (for example, CO and ozone), and the standards for other pollutants focus on long-term exposures (for example, PM_{10} and NO_2). Primary standards are established to protect against adverse health effects. Secondary standards protect the public welfare from negative effects such as damage to crops, vegetation, and buildings, as well as decreased visibility. In addition, state and local governments can set additional or more restrictive standards. Washington State has defined such standards for particulate matter and sulfur dioxide. Section 4.2.3 indicates the standards applicable to the Hanford Site.

Carbon monoxide, particulate matter, sulfur dioxide, and nitrogen dioxide are produced from the combustion of fossil fuels. Particulate matter also is generated by the mechanical disturbance of ground materials by earthmoving activities, vehicle traffic over unpaved and paved roadways, and the action of the wind on disturbed soils. Two criteria pollutants, ozone(a) and lead, are not considered in this assessment because the level of their emissions, or that of essential precursor compounds, is negligible.

(a) Volatile organic compounds, a class of pollutant involved in ozone formation, would have a maximum project emission rate of less than 1 g/s. This release rate would not cause a detectable change in background concentration of this class of pollutants and therefore could not result in any detectable change in ozone concentrations within the local airshed.

To estimate maximum air quality impacts from HSW Program activities, the Industrial Source Complex Short-Term (ISCST3) Dispersion Model (EPA 1995b) was selected for use. The ISCST3 model is approved by the EPA for the calculation of the maximum air quality impacts of criteria pollutants. The model uses a steady-state Gaussian plume algorithm to estimate pollutant concentrations from a wide variety of sources associated with industrial complexes. The model is applicable for either flat or rolling terrain, modeling domains with a radius of 50 km (31 mi) or less from the point of release, and urban or rural environments.

Multiple years of hourly meteorological data from the Hanford Site were used in conducting ISCST3 modeling. These data provided an extended, climatologically representative period of local meteorology for computing atmospheric dispersion conditions. The hourly meteorological data covered a representative 4-year period (1993 through 1996) and included such parameters as wind transport direction, wind speed, atmospheric stability, mixing depth, and air temperature. All meteorological data were obtained from the Hanford Meteorology Station (HMS). The HMS is located between the 200 West and 200 East Areas; data from this station are representative of meteorological conditions at the HSW Program work sites in and around the 200 Areas. Area C is located about 6 km (4 mi) south of the HMS and data from the station are also representative of meteorological conditions at this work site. Wind measurements were made at 10 m (33 ft) above ground level on the 122-m (400-ft) tall instrumented tower located adjacent to the HMS. Wind transport directions were reported in the data set using 36 direction sectors (each sector is 10 degrees wide). Near-surface air temperature measurements were made at 1.5 m (5 ft) above ground level. Mixing-depth estimates were made using measurements from the HMS Doppler acoustic sodar, the HMS instrumented tower, and other sources of information. Atmospheric stability was computed using the U.S. Nuclear Regulatory Commission (NRC) ΔT method (NRC 1972). This methodology uses the wind speed and the difference between temperature measurements at 60 m (200 ft) and 10 m (30 ft) above the ground to estimate the atmospheric stability class.

The ISCST3 model uses meteorological data records to compute the maximum air quality impacts for various federal- and state-defined averaging periods and receptor locations. A Cartesian grid, polar grid, and an array of user-defined receptor points were all used in modeling air quality impacts. This dense network of receptors was used to capture air quality impacts to the public along the Hanford Site boundary, outside the boundary, and at points of public access within the boundaries of the site.

The characterization of pollutant emissions from HSW Program activities was a critical step in the air quality analysis. Criteria pollutant emissions would come from fugitive dust sources, diesel-fueled engines, and propane-fired equipment. The operation of vehicles and construction equipment would generate both exhaust and fugitive dust emissions. Potential pollutant-generating activities would include:

- construction or modification of waste-processing facilities (for example, T Plant, Central Waste Complex [CWC])
- construction of waste-disposal trenches (for example, LLW, MLLW, ILAW)
- waste-disposal operations

- excavation of backfill and capping material at the borrow pits
- transportation of capping materials from the borrow pit area to the disposal trenches
- backfill and capping activities at the disposal trenches
- leachate drying operations.

To simplify the modeling of air quality impacts, emissions from HSW Program activities were conservatively assumed to originate from only three source locations. These source locations were situated in the 200 West Area (near the southwestern edge of local project activities), 200 East Area (near the northwestern edge of local project activities), and Area C (at the borrow pit work site near State Route [SR] 240). These source locations were chosen because they represented the project work site in their major operating area that would generate the greatest air quality impacts to the public.

The 200 Area source locations each were represented using a 40-m by 40-m (130-ft by 130-ft) emissions area. The Area C source location was represented using two 40-m by 40-m emission areas. The emission area used to represent borrow pit operations was set on the southwest side of SR 240. The Area C emissions used to represent truck-loading operations was set on the northeast side of the highway. Both emissions areas were conservatively positioned so that they extend between 150 m (490 ft) and 95 m (310 ft) from SR 240. This is less than the 150-m minimum distance specified in project guidelines for conducting activities near SR 240. During Area C operations, most emissions would actually occur at distances between 300 m (980 ft) and 1.6 km (1 mi) from the highway. In modeling emissions from borrow pit operations, 4 diesel-powered vehicles (a scraper, bulldozer, front-end loader, and track hoe) were assumed to be operating at the borrow pit source location. In addition to the diesel exhaust, fugitive dust emissions from equipment operations and the material stockpile also were included in the source term. Detailed information on borrow pit operations is provided in the Technical Information Document (FH 2004).

The coordinates and sizes of all source locations were selected to provide conservative estimates of the maximum potential air quality impacts to the public that would result from activities to be conducted within each area. This included concentrating emissions from multiple activities into one source location, even though these emissions actually would occur at multiple work sites spread over a much larger work area. The transportation of backfill and capping materials also was handled in this manner. Twenty diesel-powered trucks were assumed to be in continuous operation during normal work periods to facilitate the transportation of the materials from Area C to the 200 Areas. Pollutant emissions associated with the operation of the trucks included exhaust emissions and fugitive dust. A conservative assumption was made that all truck emissions would be split between two fixed source locations: Area C and the 200 West Area. This assumption concentrated emissions rather than spreading them across a much broader area or line source, thereby maximizing estimates of air quality impacts.

Another conservative assumption involved not accounting for processes that would chemically decompose pollutants or remove pollutants from the atmosphere via deposition processes. In actuality, chemical decomposition and atmospheric-deposition processes would act to substantially reduce most pollutant concentrations and associated air quality impacts.

Based on ISCST3 model runs for pollutant releases in the 200 East and 200 West Areas, the locations where maximum air quality impacts to the public would occur were determined for various averaging periods. Table E.1 provides estimates of the maximum air quality impact locations and the associated dispersion factors. Multiplying a dispersion factor (s/m^3) by a maximum pollutant release rate (μg/s) generates an estimate of the maximum air-pollutant concentration (μg/m^3). For criteria pollutants with ambient air quality standards based on 8-hour or less averaging times, the maximum air quality impacts for emissions from the 200 Areas would occur at points of public access along SR 240. For criteria pollutants with 24-hour and annual standards, the greatest air quality impacts would occur at the site boundary, the closest point where a member of the public could potentially be located for an extended period of time. Long-term air quality impacts are not computed for SR 240 because this highway passes through Federal lands with restricted public access (between the Hanford Site and the Fitzner/Eberhardt Arid Lands Ecology Reserve).

Table E.1. 200 East and 200 West Area Emissions: Dispersion Factors Used to Determine Maximum Air Quality Impacts to the Public

Area	Averaging Time Period	Maximum Impact Location and Corresponding Public Access	Distance and Direction from Pollutant Release Location to Maximum Public Impact Location[(a)]	Dispersion Factor for Maximum Impact Location (s/m^3)[(b)]
200 East	1 hr	SR 240	8.5 km–SW	8.4E-5
	3 hr	SR 240	9.0 km–SSW	3.3E-5
	8 hr	SR 240	9.0 km–SSW	2.2E-5
	24 hr	Hanford Site boundary	15.3 km–WNW	9.3E-6
	Annual	Hanford Site boundary	13.9 km–WNW	8.9E-8
200 West	1 hr	SR 240	4.0 km–S	1.6E-4
	3 hr	SR 240	4.0 km–S	7.4E-5
	8 hr	SR 240	4.0 km–S	5.1E-5
	24 hr	Hanford Site boundary	8.5 km–WNW	1.6E-5
	Annual	Hanford Site boundary	11.5 km–W	1.5E-7

(a) Distance and direction determined by dispersion modeling. Pollutant-transport direction is reported using 16 compass sectors—starting with North (N) and continuing clockwise with NNE, NE, ENE, E (East), ESE, SE, SSE, S (South), SSW, SW, WSW, W (West), WNW, NW, and NNW.

(b) Values computed by the ISCST3 model. To convert to a concentration estimate (μg/m^3), a dispersion factor (s/m^3) is multiplied by the actual pollutant release rate (μg/s).

The 200 East and 200 West Area dispersion factors indicate that for a unit emission, releases from the 200 West Area would have a slightly greater air quality impact than would emissions from the 200 East Area. As a result, for project activities that could occur in either the 200 East or 200 West Areas, the bounding 200 West Area dispersion factor was used to estimate air quality impacts. For example, the lined modular facility proposed in Alternative Group D could be sited at locations in or near the 200 East or 200 West Areas, depending on the subalternative selected. The 200 West Area source location was used in the air quality analysis because it generated the greatest air quality impacts.

Table E.2 provides the locations where maximum air quality impacts to the public would occur for releases from the Area C borrow pit. The maximum short-term air quality impacts for emissions from the borrow pit would occur along SR 240, and the maximum long-term air quality impacts would occur at the site boundary. These impact locations are different from those for the 200 Areas.

HSW Program activities that would be associated with criteria pollutant emissions are shown in the timelines of Tables E.3 through E.8. These timelines show the expected years of various activities. A key for interpreting the timelines precedes Tables E.3 through E.8.

Table E.2. Area C Borrow Pit Emissions: Location and Dispersion Factors Used to Determine Maximum Air Quality Impacts

Averaging Time	Maximum Impact Location	Distance from Release to Maximum Public Impact Location[(a)]	Unit Dispersion Factors for Maximum Impact Location (s/m^3)[(b)]
1 hr	SR 240	<150 m NE	3.3E-3
3 hr	SR 240	<150 m NE	2.5E-3
8 hr	SR 240	<150 m NE	1.9E-3
24 hr	Hanford Site Boundary	14.4 km WNW	1.0E-5
Annual	Hanford Site Boundary	13.8 km WNW	9.2E-8

(a) Distance and direction determined by dispersion modeling. Pollutant-transport direction is reported using 16 compass sectors—starting with North (N) and continuing clockwise with NNE, NE, ENE, E (East), ESE, SE, SSE, S (South), SSW, SW, WSW, W (West), WNW, NW, and NNW.

(b) Values computed by the ISCST3 model. To convert to a concentration estimate ($\mu g/m^3$), the dispersion factor (s/m^3) is multiplied by the actual pollutant release rate ($\mu g/s$).

KEY to TIMELINE TABLES E.3-E.8

Column Headings: H = Hanford Only waste volume; L = Lower Bound waste volume; U = Upper Bound waste volume; and N = No Action waste volume that is disposed of (as opposed to stored).
NA = activity is not applicable to the alternative; NWPF = new waste processing facility.

CONSTRUCTION

LLW Trench – Number indicates the number of LLW trenches constructed during that year. The trench design can change by alternative. A fraction of a trench indicates that a less-than-full-sized trench, according to the design considered under the alternative, will be constructed.

MLLW Trench – Number indicates the number of MLLW trenches constructed during that year. The trench design can change by alternative. A fraction of a trench indicates that a less-than-full-sized trench, according to the design considered under the alternative, will be constructed. The "m" indicates the melter trench construction. "I" indicates immobilized low-activity waste (ILAW) trench (Alternative Groups A through E) or ILAW vault (No Action Alternative) construction. Six ILAW vaults are assumed to be constructed at a time.

CWC Bldgs – Number indicates the number of new CWC buildings to be constructed. Under the No Action Alternative, the first number indicates the number of CWC buildings constructed to store MLLW, and the second number indicates the number of CWC buildings constructed to store transuranic (TRU) waste. Also under the No Action Alternative, "melter pad construction" indicates the year that a pad would be constructed to store melters.

T Plant Modif – Check marks indicate years in which construction activity associated with T Plant modification for waste treatment occurs.

NWPF – Check marks indicate years in which construction of the new waste processing facility occurs.

LMF – Lined modular facility – also may be referred to as lined modular trench.

CAPPING

LLW – Check marks indicate the years that the LLW burial grounds will be capped.

MLLW – The number indicates the total number of MLLW trenches capped during that year. The first two trenches to be capped are the existing trenches (MLLW Trenches 31 and 34). The "m" indicates melter trench capping. The "I" indicates ILAW trench or vault capping.

OTHER

CWC Propane – The amount of propane required to power vehicles for routine operations at CWC are indicated as increasing or decreasing over time.

MLLW Propane – The number indicates the number of MLLW trenches that require leachate processing by pulse driers. The number does not include melter trench leachate processing, which occurs from 2026 through 2048 under all alternatives except the No Action Alternative.

Table E.3. Timeline of Alternative Group A Activities Resulting in Criteria Pollutant Emissions

	CONSTRUCTION									**CAPPING**						**OTHER**			
	LLW Trench			**MLLW/ Melter Trench**			**ILAW Trench**	**CWC Bldgs**	**T Plant Modif**	**LLW**			**MLLW/Melter/ ILAW**			**CWC Propane**	**MLLW Propane**		
Year	**H**	**L**	**U**	**H**	**L**	**U**		**NA**		**H**	**L**	**U**	**H**	**L**	**U**		**H**	**L**	**U**
2000																*			
																|			
																|			
	1	1	1			1										|			
																|			
2005															1	D			
			1				I						1	1	1	E			
				1	1		I									C			
				m	m	m										R			
									✓				1	1		E			
2010							I		✓							A			
			1				I		✓							S			
									✓							E			
							I									O			
2015	1	1					I									P			
																E			
																R			
			1				I						m	m	m	A			
							I									T			
2020																I			
																O			
							I									N			
							I									S			
																|			
2025							I									|			
							I									|	3	3	3
																|	3	3	3
																|	3	3	3
																|	3	3	3
2030																|	3	3	3
																|	3	3	3
													I	I	I	|	3	3	3
													I	I	I	▼	3	3	3
													I	I	I	No ops	3	3	3
2035													I	I	I		3	3	3
													I	I	I		3	3	2
													I	I	I		2	2	1
													I	I	I		2	2	1
													I	I	I		2	2	1
2040													I	I	I		1	1	1
													I	I	I		1	1	1
													I	I	I		1	1	1
										✓	✓	✓	I	I	I		1	1	1
										✓	✓	✓	I	I	I		1	1	1
2045										✓	✓	✓	I	I	I		1	1	1
										✓	✓	✓	I	I	I		1	1	1
													1	1	1		1	1	1
																	1	1	1
																	1	1	1
2050																	1	1	1

Table E.4. Timeline of Alternative Group B Activities Resulting in Criteria Pollutant Emissions

Year	CONSTRUCTION									CAPPING						OTHER			
	LLW Trench			MLLW/Melter Trench			ILAW Trench	CWC	NWPF	LLW			MLLW/ Melter/ILAW			CWC Propane	MLLW Propane		
	H	L	U	H	L	U		NA		H	L	U	H	L	U		H	L	U
2000																*			
																|			
	3	3	2													|			
	1	1	4	2	2	3										|			
	1	1	5	2	2	3									1	|			
2005	1	1	5	2	2	3							1	1		D			
			4	1.5	1.5	3	I								1	E			
	2	2	5			3	I								2	C			
			1	m	m	m									2	R			
	1	1	2						✓				1	1	1	E			
2010	1	1	1				I		✓						1	A			
	2	2	2				I		✓				2	2	1	S			
	2	2	3						✓							E			
	2	2	3										1	1	1				
			2				I						1	1	1	O			
2015	1	1	2				I								1	P			
	3	3	3										1	1		E			
	2	2	1												1	R			
			2				I						m	m	m	A			
	3	3	1				I									T			
2020	1	1	2										1	1		I			
	1	1	1												1	O			
	1	1					I									N			
			2				I									S			
	2	2														|			
2025	0.3	0.3					I									|			
	1	1	2				I									|	10	10	17
													1	1		|	10	10	17
															1	|	10	10	17
																|	10	10	17
2030			1													|	10	10	17
	0.3	0.3	1													|	10	10	17
													I	I	I,1	|	10	10	17
			1										I	I	I	|	10	10	17
	1	1											I	I	I	▼	10	10	17
2035													I	I	I	No ops	10	10	16
													I	I	I		9	9	16
													I	I	I		9	9	15
			1										I	I	I		9	9	13
													I	I	I		9	9	11
2040													I	I	I		8	8	10
													I	I	I		7	7	9
													I	I	I		6	6	8
			1							✓	✓	✓	I	I	I		6	6	8
										✓	✓	✓	I	I	I		5	5	7
2045										✓	✓	✓	I	I	I		4	4	6
										✓	✓	✓	I	I	I		4	4	5
													0.5	0.5	1		3	3	5
																	3	3	4
																	3	3	4
2050																	3	3	4

Table E.5. Timeline of Alternative Group C Activities Resulting in Criteria Pollutant Emissions

	CONSTRUCTION									CAPPING						OTHER			
	LLW Trench			MLLW/ Melter Trench			ILAW	CWC Bldgs	T Plant Modif	LLW			MLLW/Melter /ILAW			CWC Propane	MLLW Propane		
Year	**H**	**L**	**U**	**H**	**L**	**U**		**NA**		**H**	**L**	**U**	**H**	**L**	**U**		**H**	**L**	**U**
2000																*			
																|			
																|			
																|			
																|			
2005															1	D			
							I						1	1	1	E			
	1	1	1	1	1	1	I									C			
				m	m	m										R			
									✓				1	1		E			
2010							I		✓							A			
							I		✓							S			
									✓							E			
							I									O			
2015							I									P			
																E			
																R			
							I						m	m	m	A			
							I									T			
2020																I			
																O			
							I									N			
							I									S			
																|			
2025							I									|			
							I									|	3	3	3
																|	3	3	3
																|	3	3	3
																|	3	3	3
2030																|	3	3	3
																|	3	3	3
													I	I	I	|	3	3	3
													I	I	I	▼	3	3	3
													I	I	I	No ops	3	3	3
2035													I	I	I		3	3	3
													I	I	I		3	3	2
													I	I	I		2	2	1
													I	I	I		2	2	1
													I	I	I		2	2	1
2040													I	I	I		1	1	1
													I	I	I		1	1	1
													I	I	I		1	1	1
										✓	✓	✓	I	I	I		1	1	1
										✓	✓	✓	I	I	I		1	1	1
2045										✓	✓	✓	I	I	I		1	1	1
										✓	✓	✓	I	I	I		1	1	1
													1	1	1		1	1	1
																	1	1	1
																	1	1	1

Table E.6. Timeline of Alternative Group D Activities Resulting in Criteria Pollutant Emissions

	CONSTRUCTION								CAPPING						OTHER			
	LMF (LLW/MLLW modules)			LMF (ILAW and melter modules)			CWC Bldg	T Plant Modif	LMF (LLW/ MLLW modules)			LMF (ILAW and melter modules)			CWC Propane	MLLW Propane		
Year	H	L	U	H	L	U	NA		H	L	U	H	L	U		H	L	U
2000															*			
															|			
															|			
															|			
															|			
2005														1	D			
	✓	✓	✓	✓	✓	✓						1	1	1	E			
	✓	✓	✓	✓	✓	✓									C			
															R			
								✓				1	1		E			
2010								✓							A			
								✓							S			
								✓							E			
															O			
2015															P			
															E			
															R			
												m	m	m	A			
															T			
2020															I			
															O			
															N			
															S			
															|			
2025															|			
															|	3	3	3
															|	3	3	3
															|	3	3	3
															|	3	3	3
2030															|	3	3	3
															|	3	3	3
												I	I	I	|	3	3	3
												I	I	I	▼	3	3	3
												I	I	I	No ops	3	3	3
2035												I	I	I		3	3	3
												I	I	I		3	3	2
												I	I	I		2	2	1
												I	I	I		2	2	1
												I	I	I		2	2	1
2040												I	I	I		1	1	1
												I	I	I		1	1	1
												I	I	I		1	1	1
									✓	✓	✓	I	I	I		1	1	1
									✓	✓	✓	I	I	I		1	1	1
2045									✓	✓	✓	I	I	I		1	1	1
									✓	✓	✓	I	I	I		1	1	1
																1	1	1
																1	1	1
																1	1	1
2050																1	1	1

Table E.7. Timeline of Alternative Group E Activities Resulting in Criteria Pollutant Emissions

	CONSTRUCTION								CAPPING						OTHER			
	LLW & MLLW Trenches			ILAW and Melter Trenches			CWC Bldg	T Plant Modif	LLW & MLLW			ILAW and Melter			CWC Propane	MLLW Propane		
Year	H	L	U	H	L	U	NA		H	L	U	H	L	U		H	L	U
2000															*			
															|			
															|			
															|			
															|			
2005														1	D			
	✓	✓	✓	I	I	I						1	1	1	E			
	✓	✓	✓	Im	Im	Im									C			
															R			
								✓				1	1		E			
2010				I	I	I		✓							A			
				I	I	I		✓							S			
								✓							E			
				I	I	I									O			
2015				I	I	I									P			
															E			
															R			
				I	I	I						m	m	m	A			
				I	I	I									T			
2020															I			
															O			
				I	I	I									N			
				I	I	I									S			
															|			
2025				I	I	I									|			
				I	I	I									|	3	3	3
															|	3	3	3
															|	3	3	3
															|	3	3	3
2030															|	3	3	3
															|	3	3	3
												I	I	I	|	3	3	3
												I	I	I	▼	3	3	3
												I	I	I	No ops	3	3	3
2035												I	I	I		3	3	3
												I	I	I		3	3	2
												I	I	I		2	2	1
												I	I	I		2	2	1
												I	I	I		2	2	1
2040												I	I	I		1	1	1
												I	I	I		1	1	1
												I	I	I		1	1	1
									✓	✓	✓	I	I	I		1	1	1
									✓	✓	✓	I	I	I		1	1	1
2045									✓	✓	✓	I	I	I		1	1	1
									✓	✓	✓	I	I	I		1	1	1
																1	1	1
																1	1	1
																1	1	1
2050																1	1	1

Table E.8. Timeline of the No Action Alternative Resulting in Criteria Pollutant Emissions

	CONSTRUCTION							**CAPPING**			**OTHER**		
	LLW Trench		**MLLW/ Melter Trench**		**ILAW Vaults**	**CWC Bldgs LLW+MLLW/TRU**	**NWPF/T Plant**	**LLW**	**MLLW/ melter/ ILAW**		**CWC Propane**	**MLLW Propane**	
Year	**H**	**N**	**NA**	**NA**		**H & N**	**NA**	**NA**	**H**	**N**	**H & N**	**H**	**N**
2000											*		
											|		
	3	3									|		
	1	1			I						I		
	1	1									N		
2005	1	1			I	4/3					C		
					I	4/3					R		
	2	2				4/3			1	1	E		
					I	4/3 & melter pad					A		
	1	1			I	4/3					S		
2010	1	1				4/3			1	1	E		
	2	2			I	4/4							
	2	2			I	4/4					O		
	2	2				4/4					P		
	2	2			I						S		
2015	1	1									|		
	3	3			I						|		
	2	2									▼		
					I				m	m	*		
	3	3									C		
2020	1	1			I						O		
	1	1									N		
	1	1									S		
											T		
	2	2									A		
2025	0.3	0.3									N		
											T	2	2
												2	2
											L	2	2
											E	2	2
2030									I	I	V	2	2
	0.3	0.3							I	I	E	2	2
									I	I	L	2	2
									I	I		2	2
	1	1							I	I	O	2	2
2035									I	I	P	2	2
									I	I	S	2	2
									I	I	|	2	2
									I	I	|	1	1
									I	I	|	1	1
2040									I	I	|	1	1
											|	0	0
											|		
											|		
											|		
2045											▼		
											No ops		
2050													

E.1 Combustion Engine Emissions

For the facilities and operations evaluated in this study, diesel-fueled engines would be used in machines such as backhoes, forklifts, and air compressors. Propane fuel would be used in leachate-treatment equipment beginning in 2026 and for CWC vehicles. Gasoline would be used to fuel construction-support vehicles. However, these would generally be mobile sources and use very small quantities of fuel compared with the program's diesel-powered construction equipment. Therefore, criteria pollutant emissions from gasoline-fueled vehicles were not explicitly evaluated. Criteria pollutant emissions from diesel engines are estimated using the following equation:

$$A_{o,\,c,\,a} = F_{o,\,a} \text{ x } E_{c,\,f} \text{ x } D_a \qquad \text{(E.1)}$$

where $A_{o,\,c,\,a}$ = air concentration of criteria pollutant **c** with an averaging time **a** for operation **o** $\mu g/m^3$

$F_{o,\,a}$ = fuel-consumption rate for operation **o** and averaging time **a** L/s (or gal/s)

$E_{c,\,f}$ = generation rate for criteria pollutant **c** for fuel **f** $\mu g/L$ (or μg /gal)

D_a = dispersion factor for averaging time **a**, $\mu g/m^3$ per g/s.

Dispersion factors (D_a) were given in Tables E.1 and E.2. The generation rates for criteria pollutants ($E_{c,\,f}$) for diesel fuel and propane are shown in Table E.9. The rates of pollutant generation for diesel fuel for carbon monoxide, nitrogen dioxide, and particulates are based on average values for a variety of heavy-duty construction equipment (EPA 1991). The values for particulates listed in Table E.9 are total suspended particulates but are conservatively assumed to be PM_{10}. Sulfur dioxide emissions are based on the maximum permissible amount of sulfur allowed in diesel fuel (a 500-ppm limit). No credit is taken for the substantial reduction in the sulfur content of diesel fuel (a 15-ppm limit) scheduled to be phased in beginning June 2006 or a tightening of the emission standards for nitrogen dioxide and particulate matter scheduled to be phased in beginning 2007 (EPA 2000). The propane pollutant generation rates presented in Table E.9 are based on a propane industrial boiler (EPA 1996).

Fine material on road surfaces is emitted into the atmosphere as a result of vehicular traffic. The rate of particulate emissions is a function of the weight and the amount of dust on the road surface. Equations for computing the rate of particulate emissions are provided in EPA (1991) and Grelinger et al. (1988). Using information on the likely dust concentrations on paved roads at Hanford (0.4 g/m^2) and the average weight of the trucks, a rate of PM_{10} emissions at 16 g (0.564 oz) per vehicle mile traveled was conservatively estimated. For a 24-km (15-mi) roundtrip, this equates to a PM_{10} emission rate of 0.067 g/s per truck.

Table E.9. Emission Factors for Criteria Pollutants

Criteria Pollutant	Diesel-Fuel Pollutant Generation Rate (µg pollutant/L diesel fuel)	Propane Pollutant Generation Rate (µg pollutant/gal propane)
Carbon monoxide	1.5E+07	1.4E+06
Nitrogen dioxide	3.9E+07	8.6E+06
Particulates	3.5E+06	2.7E+05
Sulfur dioxide	8.2E+05	None

Fuel consumption rates ($F_{o,a}$ of Equation E.1) are shown in Table E.10 for diesel fuel and Table E.11 for propane. The fuel consumption rates vary according to the averaging time selected. The hourly emission rates consider operation of the equipment over the 1-, 3-, or 8-hour periods. For daily averaging times, the diesel-fueled engines are assumed to run for one shift per day (that is, one-third of a day). Therefore, the emission rates averaged over a day (24 hours) are one-third of the hourly rate. For the propane-fueled leachate treatment equipment that would be operated 24 hr/day, the hourly and daily fuel consumption rates are the same because they run full time, not just one-third of a day as with the diesel engines. Most operations do not occur over the full year. Therefore, the emission rate for annual averaging times was adjusted to the average over a year. In situations in which the operation does in fact occur for a 1-year period and daily operations are estimated from annual use, the assumption is that operations would occur 250 days/yr (5 days per week and 50 weeks per year).

For operational safety, diesel-fired backup generators would be located at some facilities, such as the T Plant. Pollutant emissions would occur during brief periods when the generators are fired up for testing and maintenance purposes. At Hanford, backup diesel-fired generators are routinely run only once per month for a period of about 30 minutes. As a result of the low frequency and short duration of backup generator operations, the maximum annual air quality impacts to the public from all HSW Program activities should not be affected by the limited testing of diesel-fired generators. Flexibility in scheduling the operation of the generators would prevent emissions from occurring during periods with unfavorable dispersion conditions. As a result, the diesel-fired backup generators would not be in operation under conditions when emissions from other pollutant sources would produce the program's maximum 1-, 3-, 8-, and 24-hour air quality impacts to the public.

E.2 Fugitive Dust

Fugitive dust would be generated during HSW Program activities as a result of various earthmoving activities and truck traffic. The release rate of particulates (with aerodynamic diameters of 30 μm or less) for earthmoving was estimated as 0.27 kg/(m^2-month) (EPA 1995a). This particulate emission rate was based on measurements made during the construction of apartments and shopping centers. The characteristics of the soil in this study are similar to soil conditions found in the 200 Areas. Assuming that the construction activities generating this level of particulate emissions were active 8 hr/day and 30 days/month, the particulate emission rate would amount to 3.1E-4 g/(m^2-s).

Much of the fugitive dust generated by construction activities would be at the larger end of the 30-μm range and would tend to settle rapidly (Seinfeld 1986). Experiments on dust suspension due to construction found that at 50 m (160 ft) downwind of the source, a maximum of 30 percent of the remaining suspended particulates at respirable height were in the PM_{10} range (Grelinger et al. 1988). Based on this factor, only 30 percent of the total suspended particulates were assumed to be emitted as PM_{10}.

Table E.10. Average Diesel Fuel Consumption Rates

Activity(a)	Diesel-Fuel Use (Liters)	Operation/ Construction Time	Note	Fuel Consumption Rate for Indicated Averaging Time (Liter/second)		
				Hourly	Daily	Annual
LLW Construction						
Alt. Group A – H & L	110,000	40 d	1 trench	0.095	0.032	0.0035
Alt. Group A – U	110,000	40 d	1 trench	0.095	0.032	0.0035
Alt. Group B – H & L	164,000	40 d	3 trenches(b)	0.14	0.047	0.0052
Alt. Group B – U	275,000	40 d	5 trenches(b)	0.24	0.080	0.0087
Alt. Group C – H & L	110,000	40 d	1 trench	0.095	0.032	0.0035
Alt. Group C – U	110,000	40 d	1 trench	0.095	0.032	0.0035
No Action Alternative	164,000	40 d	3 trenches(b)	0.14	0.047	0.0052
MLLW Construction						
Alt. Group A – H & L	200,000	1 yr	1.5 ha trench	0.028	0.0093	0.0063
Alt. Group A – U	400,000	1 yr	3.0 ha trench	0.056	0.019	0.013
Alt. Group B – H & L	300,000	28 wk	2x1.25ha trench(b)	0.25(c)	0.084(c)	0.0095
Alt. Group B – U	450,000	28 wk	3x1.25 ha trench(b)	0.38(c)	0.13(c)	0.014
Alt. Group C – H & L	200,000	1 yr	-	0.028	0.0093	0.0063
Alt. Group C – U	400,000	1 yr	-	0.056	0.019	0.013
No Action Alternative	150,000	28 wk	1 trench	0.13(c)	0.042(c)	0.0048
LMF Construction						
Alt. Group D – H & L	7,760,000	2 yr	(d)	0.54	0.18	0.12
Alt. Group D – U	7,960,000	2 yr	(d)	0.55	0.18	0.13
Alt. Group E – H & L	420,000	1 yr	(e)	0.058	0.019	0.013
Alt. Group E – U	840,000	1 yr	(e)	0.12	0.039	0.027
Melter & ILAW Construction						
Melter trench	450,000	40 wk	1 trench(f)	0.31(c)	0.042(c)	0.014
ILAW trench	7,000,000	2 yr	6 vaults/yr	0.49	0.16	0.11
ILAW vault	582,000	1 yr		0.081	0.027	0.018
CWC Construction						
No Action – per building	10,600(g)	120 d/bldg	4 bldgs(b) &	0.012(b)	0.0041(b)	0.0027(b)
No Action – melter pad	24,600	50 d	8 bldg/y (2008)	0.017	0.0057	0.00078
LLBG Capping						
All Action Alternatives(h)	912,000	1 yr	2046-2049	0.13	0.042	0.029
MLLW Capping(c)						
Alt. Group A – H & L	145,920	8 wk	1.5 ha trench	0.13	0.042	0.0046
Alt. Group A – U	273,600	15 wk	3 ha trench	0.13	0.042	0.0087
Alt. Group B – H & L	109,440	3 wk	2x1.25ha trench(b)	0.25	0.084	0.0035
Alt. Group B – U	109,440	3 wk	2x1.25ha trench(b)	0.25	0.084	0.0035
Alt. Group C – H & L	145,920	8 wk	-	0.13	0.042	0.0046
Alt. Group C – U	273,600	15 wk	-	0.13	0.042	0.0087
No Action Alternative	54,720	3 wk	1.25 ha trench	0.13	0.042	0.0017
Melter and ILAW Capping						
Melter	364,800	20 wk	2018	0.13	0.042	0.012
ILAW trenches	2,520,000	1 yr	-	0.35	0.12	0.080
ILAW vault	6,600,000	1 yr	-	0.92	0.31	0.21
LLW Backfilling						
Alt. Group A – H & L	820	1 yr	-	0.016(i)	0.0053(i)	0.000026
Alt. Group A – U	3,210	1 yr	-	0.032(i)	0.011(i)	0.00010
Alt. Group B – H & L	6,780	1 yr	3 trenches(b)	0.048(i)	0.016(i)	0.00021
Alt. Group B – U	11,300	1 yr	5 trenches(b)	0.079(i)	0.026(i)	0.00036

Table E.10. (contd)

Activity[a]	Diesel-Fuel Use (Liters)	Operation/ Construction Time	Note	Fuel Consumption Rate for Indicated Averaging Time (Liter/second)		
				Hourly	Daily	Annual
LLW Backfilling (cont.)						
Alt. Group C – H & L	820	1 yr	-	0.016	0.0053	0.000026
Alt. Group C – U	3,210	1 yr	-	0.032	0.011	0.00010
Alt. Group D – H & L	95,920	1 yr	[d]	0.048	0.021	0.0022
Alt. Group D – U	100,000	1 yr	[d]	0.064	0.027	0.0024
Alt. Group E – H & L	2,520	1 yr	[e]	0.016	0.0054	0.000080
Alt. Group E – U	6,610	1 yr	[e]	0.032	0.012	0.00021
No Action Alternative	6,780	1 yr	3 trenches[b]	0.048[i]	0.016[i]	0.00021
MLLW Backfilling						
Alt. Group A – H & L[k]	1,700	1 yr	2005-8 max years	0.00024	0.000079	0.000054
Alt. Group A – U[l]	3,400	1 yr	2004-5 max years	0.00047	0.00016	0.00011
Alt. Group B – H & L[m]	6,800	1 yr	2009-10 max years	0.00094	0.00031	0.00022
Alt. Group B – U[m]	13,600	1 yr	2007 max year	0.0019	0.00063	0.00043
Alt. Group C – H & L	1,700	1 yr	-	0.00024	0.000079	0.000054
Alt. Group C – U	3,400	1 yr	-	0.00047	0.00016	0.00011
No Action[n]	1,700	1 yr	2006-9 max years	0.00024	0.000079	0.000054
Melter and ILAW Backfilling						
Melter[o]	25,000	25 wk	-	0.0069	0.0023	0.00079
ILAW trench and vault	1,250,000	1 yr	-	0.032[j]	0.016[j]	0.040
Treatment Facility						
T Plant modification	1,200,000	4 yr	-	0.042	0.014	0.0095
NWPF construction	2,900,000	4 yr	-	0.10	0.034	0.023
Borrow Pit						
Utility extension	27,000	4 wk	Prior to ops	0.047	0.016	0.00086
Borrow operations	5,960,000	12.6 yr	As needed to cap	0.066	0.022	0.015

(a) Waste volume considered – Hanford Only (H), Lower Bound (L), and Upper Bound (U) waste volumes.
(b) Simultaneous construction/activity assumed.
(c) Assumed maximum of eight trucks operating on each trench at one time, except for ILAW capping.
(d) The sum of diesel used for LLW (Alt. A), MLLW(Alt. A), melter, and ILAW trenches construction.
(e) The sum of diesel used for Alternative Group A LLW and MLLW trenches construction.
(f) Assumed consumption for each multiple trench design and for two modules of the single ILAW trench design.
(g) Diesel required per building.
(h) Applies to the LMF under Alternative Groups D and E.
(i) Assumed maximum of one truck operating on each trench at a time.
(j) Assumed maximum of two trucks operating on each trench at a time.
(k) Other years Alternative Group A–L: 1000 L/yr 1999-2005 and 1200 L/yr 2008–2046.
(l) Other years Alternative Group A–U: 1100 L/yr 1999-2004 and 2300 L/yr 2005–2046.
(m) Assumed 6800 L/yr to backfill one current-design trench in one year.
(n) Other year No Action Alt.: 1000 L/yr 2000–2006.
(o) Melter trench backfilling could occur over 15 campaigns or all at once. All at once was assumed for conservatism (that is, highest emission rate of pollutants).

LMF = lined modular facility.
NWPF = new waste processing facility.
Source: FH (2004).

Table E.11. Average Propane Fuel Consumption Rates

Operation/ Alternative(a)	Maximum Propane Use	Time of Maximum Use(b)	Note(b)	Fuel Consumption Rate for Indicated Averaging Time (gal/s)		
				Hourly	**Daily**	**Annual**
MLLW Leachate Pulse Drier	**Ton/yr(c)**					
Alt. Group A – H & L	533	36 d/yr	2032; 50 hr/camp	0.14	0.14	0.0069
Alt. Group A – U	674	71 d/yr	2032; 96 hr/camp	0.18	0.18	0.0088
Alt. Group B – H & L	1,232	190 d/yr	2033; 32 hr/camp per tr; 7.5 trenches	0.13	0.13	0.016
Alt. Group B – U	2,072	1 yr	2033; 32 hr/camp per tr; 15 trenches	0.13	0.13	0.027
Alt. Group C – H & L	533	36 d/yr	2032; 50 hr/camp	0.14	0.14	0.0069
Alt. Group C – U	674	71 d/yr	2032; 96 hr/camp	0.18	0.18	0.0088
Alt. Group D – H & L	694	77 d/yr	2033; 108 hr/camp	0.19	0.19	0.0090
Alt. Group D – U	851	116 d/yr	2033; 158 hr/camp	0.23	0.23	0.011
Alt. Group E – H & L	694	77 d/yr	2033; 108 hr/camp	0.19	0.19	0.0090
Alt. Group E – U	851	116 d/yr	2033; 158 hr/camp	0.23	0.23	0.011
No Action Alternative	224	1 yr	32 hr/camp	0.057	0.057	0.0029
One existing trench	112	25 d/yr	32 hr/campaign	0.028	0.028	0.0015
Melter Leachate/Pulse Drier						
Melter	168	42 d/yr	60 hr/campaign	0.048	0.048	0.0022
CWC Vehicles	**Liter/yr(d)**					
Alt. Group A – H & L	7,600	1 yr	Max year 2002	0.00028	0.000093	0.000064
Alt. Group A – U	7,600	1 yr	Max year 2002	0.00028	0.000093	0.000064
Alt. Group B – H & L	7,600	1 yr	Max year 2002	0.00028	0.000093	0.000064
Alt. Group B – U	7,600	1 yr	Max year 2002	0.00028	0.000093	0.000064
Alt. Group C – H & L	7,600	1 yr	Max year 2002	0.00028	0.000093	0.000064
Alt. Group C – U	7,600	1 yr	Max year 2002	0.00028	0.000093	0.000064
Alt. Group D – H & L	7,600	1 yr	Max year 2002	0.00028	0.000093	0.000064
Alt. Group D – U	7,600	1 yr	Max year 2002	0.00028	0.000093	0.000064
Alt. Group E – H & L	7,600	1 yr	Max year 2002	0.00028	0.000093	0.000064
Alt. Group E – U	7,600	1 yr	Max year 2002	0.00028	0.000093	0.000064
No Action – H & L	32,400	1 yr	Max 2014-47	0.0012	0.00040	0.00027

(a) Waste volume considered – Hanford Only (H), Lower Bound (L), and Upper Bound (U) waste volumes.

(b) Pulse drier times and notes apply to MLLW trenches and/or modules other than the existing trenches and melter trench and/or module, unless specifically indicated. All campaigns are assumed to be carried out in series over the year.

(c) Conversion factor for propane = 409.8 gal/ton (Lide 2001).

(d) Conversion factor 1 liter = 0.265 gallons.

Camp = leachate processing campaign.

Camp per tr = campaign per trench.

Source: FH (2004).

All HSW Program activities would be conducted using dust-suppression techniques; however, no credit is taken for any reduction in PM_{10} emissions as a result of dust suppression. Dust control during large earthmoving activities would comply with nuisance-dust-emission control requirements. Earthmoving activities would be restricted on days with excessive wind speeds. The use of dust-suppression methods would depend on the soil that is being excavated, wind speed, and visual observations. Water sprays for dust suppression were found to be very effective in controlling PM_{10} emissions at the Hanford Site (DOE-RL 1996). Monitoring of the effectiveness of water sprays found air-particulate concentrations at the location of earthmoving activity to be under 90 $\mu g/m^3$ (DOE-RL 1996), well within the 24-hour ambient air quality standard for PM_{10} of 150 $\mu g/m^3$. Most values were even lower.

Although not governed by ambient air quality standards, a potential concern for public safety is a short-term, wind-blown dust event at the borrow pit that could limit visibility on SR 240 and cause problems for passing motorists. To guard against this, an aggressive dust-suppression program is planned for this area. This dust-control program would include the following as needed:

- spraying of active work areas with water and a soil adhesive
- rocking of 8 km (5 mi) of project roads and periodic spray with soil adhesive
- covering of materials in truck beds with rollout tarps prior to transport
- other dust-suppression activities when wind speeds are projected to exceed the threshold for substantial dust generation.

The estimation of the annual and 24-hour average PM_{10} emission values from earthmoving operations requires an estimate of the area being disturbed by earthmoving equipment. Estimates of the amount of area that would be disturbed by earthmoving activities are presented in Table E.12. The actual area that is actively being disturbed at any given time is estimated on a case-by-case basis. In general, for work sites where operation/construction times exceed a year, 2 percent of the annual disturbed area is assumed to be active at any one time. Work sites where the soil is actively disturbed for shorter periods of time have a correspondingly larger percentage of their total area being disturbed at any given time. For example, consider the 2.2 ha (5.4 ac) that would be disturbed over a period of 40 days for LLW construction activities under Alternative Group A. It was assumed that 2200 m^2 (2630 yd^2), about 10 percent of the total disturbed area, would be actively disturbed at any given moment during this construction activity. Estimates of fugitive dust from material stockpiles are conservatively determined by assuming that the entire stockpile, or an appropriate portion of the stockpile based on its size, is an active construction site.

E.3 Calculating Maximum Air Quality Impacts

The maximum air quality impacts associated with each major project activity were calculated by putting together previous information, including unit dispersion factors (from ISCST3 model runs), fuel consumption rates, sizes of disturbed areas, and emission factors. Table E.13 provides the maximum air quality impacts to the public for activities conducted in the 200 Areas under the assumptions noted for each activity in Tables E.10 and E.11. Construction and capping operations at the trenches (LLW, MLLW, and ILAW) and the transportation of capping materials would be substantial sources of pollutants and major contributors to maximum air quality impacts. Table E.14 indicates the maximum air quality impacts to the public from activities in the 200 Area. Table E.15 presents comparable information for Area C activities. Looking at the individual pollutants

- LLW and ILAW capping would be the largest contributors to PM_{10} air quality impacts. The transportation of capping materials to the trenches and trench construction activities (lined modular facility, LLW, and ILAW) also would represent substantial sources of PM_{10}.

- LMF construction and ILAW capping would generate the largest air quality impacts for SO_2 and CO. LLW and MLLW construction and capping activities (particularly under Alternative Group B) also would represent substantial sources of SO_2 and CO.

- ILAW capping activities (particularly under the No Action Alternative) and LMF construction would produce the largest air quality impact for NO_2.

The maximum air quality impacts from all project emissions in the 200 Areas were obtained by combining the data in Table E.13 with the project activity scheduling data presented in Tables E.3 through E.8. These estimates are presented in Table 5.5 and Tables 5.7 through 5.11 in Section 5.2.

Operations at the borrow pit and the emissions from the transportation of capping materials are the two largest sources of pollutants in the vicinity of Area C. Both activities generally would occur simultaneously. The maximum air quality impacts from emissions in Area C were obtained by combining the data in Table E.15 with the project activity scheduling data presented in Tables E.3 through E.8. These estimates are presented in Table 5.6 in Section 5.2.

Table E.12. Size of Disturbed Areas and Associated Durations for Various Activities/Alternatives

Activity[(a)]	Cumulative Disturbed Area (Hectares)	Duration of Operation/ Construction (Time)	Percentage of Total Area Actively Disturbed	Amount of Area Being Disturbed at Any Given Time (m^2)
LLW Construction				
Alt. Group A – H & L	2.2	40 d	10	2200
Alt. Group A – U	2.2	40 d	10	2200
Alt. Group B – H & L	3 x 0.55	40 d	10	1650
Alt. Group B – U	5 x 0.55	40 d	10	2750
Alt. Group C – H & L	2.2	40 d	10	2200
Alt. Group C – U	2.2	40 d	10	2200
No Action Alternative	3 x 0.55	40 d	10	1650
MLLW Construction				
Alt. Group A – H & L	1.50	1 yr	2.0	300
Alt. Group A – U	3.00	1 yr	2.0	600
Alt. Group B – H & L	2 x 0.60	28 wk	3.6	430
Alt. Group B – U	3 x 0.60	28 wk	3.6	640
Alt. Group C – H & L	1.50	1 yr	2.0	300
Alt. Group C – U	3.00	1 yr	2.0	600
No Action Alternative	0.60	28 wk	3.3	200
LMF Construction[(b)]				
Alt. Group D – H & L	3.7	2 yr	6.3	2350
Alt. Group D – U	5.2	2 yr	4.8	2500
Alt. Group E – H & L	3.7	2 yr	6.3	2350
Alt. Group E – U	5.2	2 yr	4.8	2500
Melter Construction				
Melter trench	6.0 [(c)]	40 wk	2.5	1500
ILAW Construction				
Alt. Group A – ILAW Trench	26.0	15 yr	1.0	2600
Alt. Group B – ILAW Trench	26.0	15 yr	1.0	2600
Alt. Group C – ILAW Trench	8.0	15 yr	1.0	800
Alt. Group D – ILAW Trench	8.0	15 yr	1.0	800
Alt. Group E – ILAW Trench	8.0	15 yr	1.0	800
No Action – ILAW Vaults	10.0	15 yr	1.0	1000
CWC Construction				
No Action – per building	1.00	1 yr	5	500
No Action – pad construction	0.100	50 d	20	200
LLBG Capping				
All Action Alternatives	93.50	4 yr	0.50	4700

Table E.12. (contd)

Activity[(a)]	Cumulative Disturbed Area (Hectares)	Duration of Operation/ Construction (Time)	Percentage of Total Area Actively Disturbed	Amount of Area Being Disturbed at Any Given Time(m^2)
MLLW Capping				
Alt. Group A – H & L	1.50	8 wk	10	1500
Alt. Group A – U	3.00	15 wk	5	1500
Alt. Group B – H & L	2 x 0.60	3 wk	10	1200
Alt. Group B – U	2 x 0.60	3 wk	10	1200
Alt. Group C – H & L	1.50	8 wk	10	1500
Alt. Group C – U	3.00	15 wk	5	1500
Alt. Group D – H & L	1.50	8 wk	10	1500
Alt. Group D – U	3.00	15 wk	5	1500
Alt. Group E – H & L	1.50	8 wk	10	1500
Alt. Group E – U	3.00	15 wk	5	1500
No Action Alternative	0.60	3 wk	10	600
Melter and ILAW Capping				
Melter	6.0	20 wk	3	1800
Alt. Group A – ILAW Trench	26.0	15 yr	1.0	2600
Alt. Group B – ILAW Trench	26.0	15 yr	1.0	2600
Alt. Group C – ILAW Trench	8.0	15 yr	1.0	800
Alt. Group D – ILAW Trench	8.0	15 yr	1.0	800
Alt. Group E – ILAW Trench	8.0	15 yr	1.0	800
No Action – ILAW Vaults	10.0	15 yr	1.0	1000
LLW Backfilling				
Alt. Group A – H & L	0.18	1 yr	2.0	40
Alt. Group A – U	0.71	1 yr	2.0	140
Alt. Group B – H & L	1.50	1 yr	2.0	300
Alt. Group B – U	2.50	1 yr	2.0	500
Alt. Group C – H & L	0.18	1 yr	2.0	40
Alt. Group C – U	0.71	1 yr	2.0	140
Alt. Group D – H & L	0.18	1 yr	2.0	40
Alt. Group D – U	0.71	1 yr	2.0	140
Alt. Group E – H & L	0.18	1 yr	2.0	40
Alt. Group E – U	0.71	1 yr	2.0	140
No Action Alternative	1.50	1 yr	2.0	300
MLLW Backfilling[(d)]				
Alt. Group A – H & L	0.15 max	1 yr	2.0	30
Alt. Group A – U	0.30 max	1 yr	2.0	60
Alt. Group B – H & L	0.60 max	1 yr	2.0	120
Alt. Group B – U	1.20 max	1 yr	2.0	240
Alt. Group C – H & L	0.15 max	1 yr	2.0	30
Alt. Group C – U	0.30 max	1 yr	2.0	60
Alt. Group D – H & L	0.15 max	1 yr	2.0	30
Alt. Group D – U	0.30 max	1 yr	2.0	60
Alt. Group E – H & L	0.15 max	1 yr	2.0	30
Alt. Group E – U	0.30 max	1 yr	2.0	60
No Action Alternative	0.15 max	1 yr	2.0	30
Melter	3.50[(c)]	6 wk	10	3500

Table E.12. (contd)

Activity(a)	Cumulative Disturbed Area (Hectares)	Duration of Operation/ Construction (Time)	Percentage of Total Area Actively Disturbed	Amount of Area Being Disturbed at Any Given Time (m^2)
Treatment Facility				
T Plant Modification (Alt A,C,D,E)	3.50	4 yr	1.0	350
NWPF Construction (Alt B)	3.50	4 yr	1.0	350
Borrow Activity				
Borrow operations	81.0	12 yr	0.20	1600

(a) Waste volume considered – Hanford Only (H), Lower Bound (L) and Upper Bound (U) waste volumes.
(b) Without ILAW or melter construction portions.
(c) Includes road construction.
(d) Waste area only; all-at-once backfilling considered to maximize emission rate of particulates.
NWPF = new waste processing facility.
Source: FH (2004).

Table E.13. Maximum Air Quality Impacts to the Public from Major Activities with a Source Location in the 200 West or 200 East Areas

	Maximum Air Quality Impacts ($\mu g/m^3$) for the Indicated Averaging Periods								
	PM_{10}(c)		**SO_2**				**CO**		**NO_2**
Activity(a)	**24 hr**	**Annual**	**1 hr**	**3 hr**	**24 hr**	**Annual**	**1 hr**	**8 hr**	**Annual**
LLW Construction									
Alt. Group A – H&L	12	0.013	12	5.8	0.42	4.3E-4	230	73	0.020
Alt. Group A – U	12	0.013	12	5.8	0.42	4.3E-4	230	73	0.020
Alt. Group B – H&L	11	0.011	18	8.5	0.62	6.4E-4	340	110	0.030
Alt. Group B – U	18	0.018	31	15	1.0	1.1E-3	580	180	0.051
Alt. Group C – H&L	12	0.013	12	5.8	0.42	4.3E-4	230	73	0.020
Alt. Group C – U	12	0.013	12	5.8	0.42	4.3E-4	230	73	0.020
No Action Alternative	11	0.011	18	8.5	0.62	6.4E-4	340	110	0.030
MLLW Construction									
Alt. Group A – H&L	2.0	0.017	3.7	1.7	0.12	7.7E-4	67	21	0.037
Alt. Group A – U	3.9	0.034	7.3	3.4	0.25	1.6E-3	130	43	0.076
Alt. Group B – H&L	6.8	0.015	33	15	1.1	1.2E-3	600	190	0.056
Alt. Group B – U	10	0.023	50	23	1.7	1.7E-3	910	290	0.082
Alt. Group C – H&L	1.1	0.010	1.9	0.76	0.071	4.6E-4	35	9.2	0.022
Alt. Group C – U	2.3	0.020	3.9	1.5	0.14	9.5E-4	71	18	0.045
No Action Alternative	3.3	0.0074	17	7.9	0.55	5.9E-4	310	99	0.028
LMF Construction									
Alt. Group D – H&L	11	0.070	71(b)	33(b)	2.4(b)	0.015(b)	1300(b)	410(b)	0.70
Alt. Group D – U	11	0.070	71(b)	33(b)	2.4(b)	0.015(b)	1300(b)	410(b)	0.70
Alt. Group E – H&L	1.8	0.014	7.6	3.5	0.25	1.6E-3	140	44	0.076
Alt. Group E – U	3.6	0.028	16	7.3	0.51	3.3E-3	290	92	0.16

Table E.13. (contd)

Activity[a]	Maximum Air Quality Impacts (μg/m^3) for the Indicated Averaging Periods[b]								
	PM$_{10}$[c]		SO$_2$				CO		NO$_2$
	24 hr	Annual	1 hr	3 hr	24 hr	Annual	1 hr	8 hr	Annual
Melter & ILAW Construction									
Melter trench	5.6	0.035	21	8.4	0.32	1.0E-3	390	100	0.049
ILAW Alt. Groups A, B	21	0.17	64	30	2.1	0.014	1200	370	0.64
ILAW portions only Alt. Groups C, D, E	13	0.094	64	30	2.1	0.014	1200	370	0.64
ILAW No Action	3.7	0.032	5.6	2.2	0.21	1.3E-3	100	27	0.062
CWC Construction									
No Action – per bldg	2.6	0.024	1.6	0.73	0.054	3.3E-4	29	9.2	0.016
No Action – melter pad	1.3	0.0016	2.2	1.0	0.075	9.6E-5	41	13	4.6E-3
Transporting Capping Materials									
All Alternatives	24	0.23[b]	4.2	1.9	0.42	3.9E-3	130	42	0.081
LLBG Capping									
All Action Alts	25[b]	0.23[b]	17	7.9	0.55	3.6E-3	310	99	0.17
MLLW Capping[d]									
Alt. Group A – H&L	9.6	0.013	17	7.9	0.55	5.7E-4	310	99	0.027
Alt. Group A – U	9.6	0.024	17	7.9	0.55	1.1E-3	310	99	0.051
Alt. Group B – H&L	10	4.9E-3	33	15	1.1	4.3E-4	600	190	0.020
Alt. Group B – U	10	4.9E-3	33	15	1.1	4.3E-4	600	190	0.020
Alt. Group C – H&L	5.6	7.6E-3	9.0	3.5	0.32	3.4E-4	160	43	0.016
Alt. Group C – U	5.6	0.014	9.0	3.5	0.32	6.3E-4	160	43	0.030
No Action	3.0	1.5E-3	9.0	3.5	0.32	1.2E-4	160	43	5.9E-3
Melter & ILAW Capping									
Melter trench	6.4	0.022	9.0	3.5	0.32	8.8E-4	160	43	0.042
ILAW Alt. Groups A, B	19	0.16	46	21	1.6	9.8E-3	840	270	0.47
ILAW Alt. Groups C, D, E	11	0.078	46	21	1.6	9.8E-3	840	270	0.47
ILAW No Action	13	0.092	63	25	2.4[b]	0.015[b]	1200	300	0.73[b]
LLW Backfilling									
Alt. Group A – H&L	0.49	1.8E-3	2.1	0.97	0.070	3.2E-6	38	12	1.5E-4
Alt. Group A – U	1.3	6.4E-3	4.2	1.9	0.14	1.2E-5	77	24	5.9E-4
Alt. Group B – H&L	2.3	0.014	6.3	2.9	0.21	2.6E-5	120	37	1.2E-3
Alt. Group B – U	3.9	0.023	10	4.8	0.34	4.4E-5	190	60	2.1E-3
Alt. Group C – H&L	0.49	1.8E-3	2.1	0.97	0.070	3.2E-6	38	12	1.5E-4
Alt. Group C – U	1.3	6.4E-3	4.2	1.9	0.14	1.2E-5	77	24	5.9E-4
Alt. Group D – H&L	1.4	3.0E-3	6.3	2.9	0.28	2.7E-4	120	37	0.013
Alt. Group D – U	2.2	7.6E-3	8.4	3.9	0.35	3.0E-4	150	49	0.014
Alt. Group E – H&L	0.49	1.8E-3	2.1	0.97	0.071	9.8E-6	38	12	4.7E-4
Alt. Group E – U	1.3	6.4E-3	4.2	1.9	0.16	2.6E-5	77	24	1.2E-3
No Action	1.4	8.1E-3	3.3	1.3	0.12	1.5E-5	120	16	7.3E-4

Table E.13. (contd)

Activity[a]	Maximum Air Quality Impacts (μg/m^3) for the Indicated Averaging Periods[b]								
	PM_{10}[c]		SO_2				CO		NO_2
	24 hr	Annual	1 hr	3 hr	24 hr	Annual	1 hr	8 hr	Annual
MLLW Backfilling€									
Alt. Group A – H&L	0.15	1.4E-3	0.031	0.015	1.0E-3	6.6E-6	0.58	0.18	3.2E-4
Alt. Group A – U	0.30	2.8E-3	0.062	0.029	2.1E-3	1.4E-5	1.1	0.36	6.4E-4
Alt. Group B – H&L	0.59	5.5E-3	0.12	0.057	4.1E-3	2.7E-5	2.3	0.72	1.3E-3
Alt. Group B – U	1.2	0.011	0.25	0.12	8.3E-3	5.3E-5	4.6	1.5	2.5E-3
Alt. Group C – H&L	0.086	8.2E-4	0.017	6.5E-3	6.0E-4	3.9E-6	0.30	0.079	1.9E-4
Alt. Group C – U	0.17	1.6E-3	0.032	1.3E-2	1.2E-3	8.0E-6	0.59	0.16	3.8E-4
No Action	0.086	8.2E-4	0.017	6.5E-3	6.0E-4	3.9E-6	0.30	0.079	1.9E-4
Melter Trench	9.8	0.011	0.48	0.19	0.018	5.8E-5	8.7	2.3	2.7E-3
ILAW trench & vault	0.90	0.021	4.2	1.9	0.21	4.9E-3	77	24	0.23
Treatment Plant									
T Plant mod	2.5	0.021	5.5	2.5	0.18	1.2E-3	100	32	0.056
NWPF const	3.6	0.028	13	6.1	0.45	2.8E-3	240	77	0.13
MLLW Leachate									
Alt. Group A – H&L	0.62	2.8E-4	NA	NA	NA	NA	33	11	0.0090
Alt. Group A – U	0.78	3.6E-4	NA	NA	NA	NA	42	13	0.011
Alt. Group B – H&L	0.58	6.5E-4	NA	NA	NA	NA	31	9.8	0.021
Alt. Group B – U	0.55	1.1E-3	NA	NA	NA	NA	29	9.3	0.035
Alt. Group C – H&L	0.62	2.8E-4	NA	NA	NA	NA	33	11	0.0090
Alt. Group C – U	0.78	3.6E-4	NA	NA	NA	NA	42	13	0.011
Alt. Group D – H&L	0.82	3.7E-4	NA	NA	NA	NA	44	14	0.012
Alt. Group D – U	0.99	4.5E-4	NA	NA	NA	NA	53	17	0.014
Alt. Group E – H&L	0.82	3.7E-4	NA	NA	NA	NA	44	14	0.012
Alt. Group E – U	0.99	4.5E-4	NA	NA	NA	NA	53	17	0.014
No Action	0.25	1.2E-4	NA	NA	NA	NA	13	4.2	0.0038
Melter trench	0.12	5.3E-5	NA	NA	NA	NA	5.8	1.5	0.0017
CWC Vehicles									
Alt. Groups A-E	4.0E-4	2.6E-6	NA	NA	NA	NA	0.065	0.021	3.6E-4
No Action Alternative	1.7E-3	1.1E-5	NA	NA	NA	NA	0.28	0.089	1.6E-3

(a) Waste volume considered – Hanford Only (H), Lower Bound (L) and Upper Bound (U) waste volumes.

(b) Indicates the overall maximum air quality impact for each averaging period from any single activity. (Summarized in Table E.14.)

(c) Includes both fugitive dust and diesel combustion particulates.

(d) For Alternative Groups D & E, see Low Level Burial Ground (LLBG) capping; MLLW is in the lined modular facility (LMF). LMF capping impacts are the same as the LLBG capping impacts during the maximum year.

(e) For Alternative Groups D & E, see Low Level Waste (LLW) backfilling; MLLW is in the LMF. LMF backfilling impacts are the same as the LLW backfilling impacts during the maximum year.

NA = not applicable; there are no SO_2 emissions from the propane used for this activity.

Table E.14. Maximum Impacts from Any Single Activity Conducted in the 200 Areas

	PM_{10}		SO_2				CO		NO_2
	24 hr	**Annual**	**1 hr**	**3 hr**	**24 hr**	**Annual**	**1 hr**	**8 hr**	**Annual**
Ambient Air Quality Standard ($\mu g/m^3$)	150	50	1,000	1,300	260	50	40,000	10,000	100
Maximum Impact – single activity ($\mu g/m^3$)	25	0.23	71	33	2.4	0.015	1300	410	0.73
Maximum Impact – single activity (Percent of Standard)	17	0.46	7.1	2.5	0.92	0.030	3.2	4.1	0.73
Activity creating maximum impact(a)	a	a, d	b	b	b, c	b, c	b	b	c

Note: All alternatives are considered in selecting the activities with the maximum air quality impacts.

(a) Activities creating maximum impacts:
- a. LLBG capping
- b. LMF trench construction
- c. ILAW vault capping
- d. transportation of capping materials.

Table E.15. Maximum Air Quality Impacts to the Public from Activities with an Area C Source Location

Activity(a)	Maximum Air Quality Impacts ($\mu g/m^3$) for the Indicated Averaging Periods								
	PM_{10}		SO_2				CO		NO_2
	24 hr	**Annual**	**1 hr**	**3 hr**	**24 hr**	**Annual**	**1 hr**	**8 hr**	**Annual**
Utility Extensions									
All Alternatives	0.56	2.8E-4	130	96	0.13	6.5E-05	2300	1300	3.1E-03
Operations									
All Alternatives	5.6	0.049	180(b)	140(b)	0.18	1.1E-03	3300(b)	1900(b)	0.054(b)
Propane Emissions									
All Alternatives	0.056	3.8E-4	-	-	-	-	320	180	0.052
Transportation of Capping Materials									
All Alternatives	15(b)	0.14(b)	85	65	0.26(b)	2.4E-03(b)	2700	1600	0.050

(a) Waste volume considered – Hanford Only (H), Lower Bound (L) and Upper Bound (U) waste volumes.

(b) Indicates the maximum air quality impact for each averaging period.

E.4 Clean Air Act General Conformity Review

DOE guidance suggests a method to formally report how EIS actions relate to the Clean Air Act (CAA) (42 USC 7401), which implements General Conformity Requirements (DOE 2000). The CAA General Conformity Requirements method is, in general, another means to validate the acceptability of the release estimates resulting from an action. The guidance requires that a conformity review be conducted to determine if detailed analyses and reporting would be required for EIS actions to be conducted. It is intended to ensure that actions would not further impair or sustain current excesses of criteria pollutant levels. This review would allow faster implementation of the action once a record of decision or finding of no significant impact is issued. It is important to note that the emissions reported in a conformity review may be narrower than sources considered in an EIS air quality assessment (DOE 2000).

The conformity review process consists of answering four questions (see Table E.16). DOE (2000) recommends that a conformity review be conducted for each EIS alternative. Normally, a conformity review is not needed for the No Action Alternative (DOE 2000). The results of the conformity review are presented in Table E.16. As a result of the conformity review process, it has been determined that a Conformity Determination need not be conducted.

Table E.16. Clean Air Act Conformity Review for the Alternatives

Question	All Alternative Groups
1. Are criteria pollutants emitted?	Yes.
2. Would criteria pollutant emissions occur in a non-attainment or maintenance area?	No, the Hanford Site is an attainment or unclassified area.[a]
3. Is the action(s) exempt from the Clean Air Act Conformity Requirements?	No; therefore, the actions are not exempt outright from air quality requirements.
4. What are the estimated emissions and how do they compare with the non-attainment (or maintenance) area threshold emission rates and emission inventory?	The Hanford Site is in an attainment or unclassified area. Also, the estimated maximum releases do not exceed Clean Air Act Criteria Pollutant standards.

(a) Ecology (2001).

E.5 References

40 CFR 50. "National Primary and Secondary Ambient Air Quality Standards." Code of Federal Regulations. Online at: http://www.access.gpo.gov/nara/cfr/waisidx_01/40cfr50_01.html

42 USC 7401, et seq. Clean Air Act, as amended. Online at: http://www4.law.cornell.edu/uscode/42/7401.html

DOE. 2000. *Clean Air Act General Conformity Requirements and the National Environmental Policy Act Process*. U.S. Department of Energy, Environment, Safety, and Health, Office of NEPA Policy and Assistance. Online at: http://tis.eh.doe.gov/nepa/tools/guidance/caaguidance.pdf

DOE-RL. 1996. *100 Area Excavation Treatability Study Report.* DOE/RL-94-16, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology. 2001. "Hanford Air Operating Permit." Washington State Department of Ecology Publication Number 00-05-006. Olympia, Washington. Online at: http://www.ecy.wa.gov/programs/nwp/pdf/final%201.pdf

EPA. 1991. *Compilation of Air Pollution Emission Factors Vol II Mobile Sources. Supplement A.* AP-42, U.S. Environmental Protection Agency, Ann Arbor, Michigan.

EPA. 1995a. Section 13.2.3: Heavy Equipment Operation." Chapter 13 in *Compilation of Air Pollutant Emissions Factors*. *AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources*. AP-42, U.S. Environmental Protection Agency, Triangle Research Park, N.C. Online at: http://www.epa.gov/ttn/chief/ap42/

EPA. 1995b. *User's Guide for the Industrial Source Complex (ICS3) Dispersion Models. Volumes 1 & 2. User Instructions.* EPA-454/B-95-003a, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina.

EPA. 1996. "Liquefied petroleum gas combustion," *External Combustion Sources, Vol I (Chapter 1.5, Supplement B), Compilation of Air Pollution Emission Factors*. AP-42, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina. Online at: http://www.epa.gov/ttn/chief/ap42/ch01/final/c01s05.pdf

EPA. 2000. *Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements.* EPA 420-F-00-057, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina. Online at: http://www.epa.gov/otaq/regs/hd2007/frm/f00057.pdf

FH. 2004. *Hanford Site Solid Waste Management Environmental Impact Statement Technical Information Document*. HNF-4755, Rev. 2., U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Grelinger, M. A., G. Muleski, J. S. Kinsey, C. Cowherd, and D. Hecht. 1988. *Gap Filling PM10 Emission Factors for Selected Open Area Dust Sources*. EPA-450/4-88-003, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina.

Lide, D. R. (ed). 2001. *CRC Handbook of Chemistry and Physics, 2001-2002,* 82nd ed., CRC Press, Boca Raton, Florida.

NRC. 1972. *Onsite Meteorological Programs.* Regulatory Guide 1.23 (Safety Guide 23). U.S. Nuclear Regulatory Commission, Washington, D.C. Online at: http://www.nrc.gov/reading-rm/doc-collections/reg-guides/power-reactors/active/index.html

Seinfeld, J. H. 1986. *Atmospheric Chemistry and Physics of Air Pollution*. John Wiley and Sons, Inc.: New York.

Appendix F

Methods for Evaluating Impacts on Health from Radionuclides and Chemicals

Appendix F

Methods for Evaluating Impacts on Health from Radionuclides and Chemicals

This appendix describes details of the methodology used to evaluate health impacts for the alternatives considered in the Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement (HSW EIS). Unless otherwise specified, the data used for the analysis are provided in the *Hanford Site Solid Waste Management, Environmental Impact Statement Technical Information Document* (FH 2004); the Solid Waste Information Tracking System (SWITS) database from Anderson and Hagel (1996), Hagel (1999), and FH (2004); or the *Solid Waste Integrated Forecast Technical (SWIFT) Report* (Barcot 1999, 2002).

F.1 Normal Operation Impact Assessment Methods

Under normal waste management operations, atmospheric releases of radionuclides and chemicals could occur. This section describes methods used to estimate annual quantities released, atmospheric transport, exposure scenarios, and a health impacts assessment of these releases.

The methods used are based on source and waste stream information presented in Volume I, Section 3 and on the affected environment from Volume I, Section 4. The atmospheric transport and health impacts were evaluated using the Multimedia Environmental Pollutant Assessment System (MEPAS) computer program, Version 4.0 (Droppo and Buck 1996; Strenge and Chamberlain 1995). This version is an enhancement of earlier versions (for instance, Version 3.1 [Buck et al.1995] and Version 3.2 [Buck et al. 1997]) and is designed to operate under the Framework for Risk Analysis in Multimedia Environmental Systems (FRAMES) described by Whelan et al. (1997). The MEPAS program was selected because it is capable of evaluating health impacts from radionuclides and chemicals, and it can model time-varying releases, deposition, and accumulation in soil. Doses to hypothetical maximally exposed individuals are intended to bound potential impacts but not to reflect an expected set of typical circumstances.

The atmospheric dispersion models in the MEPAS program provide nearly identical results to those generated using the U.S. Environmental Protection Agency (EPA) CAP88 program, as verified in a benchmarking study performed on the MEPAS, MMSOILS, and RESRAD computer programs (Mills et al. 1997). The RESRAD program uses the CAP88 program for atmospheric transport calculations (Cheng et al.1995).

F.1.1 Pollutant Releases to the Atmosphere

Pollutant releases to the atmosphere may occur from any of the facilities handling or containing any of the several waste streams identified for this HSW EIS, as described in Volume I, Section 2. The release rate must be evaluated as a function of time during the period of operation because the volumes of waste processed vary by year. For a given facility and year, the annual release is determined by the quantity of waste processed or stored in the facility during the year, the average concentration of each pollutant in the waste while in the facility, and the fraction of the pollutant that is released to the atmosphere. The annual release from a given facility can be expressed as in Equation F.1.

$$R_i = \sum_{i=1}^{n} V\, C_i\, F_i \qquad \text{(F.1)}$$

where R_i = release rate of pollutant i from a facility during a given year (Ci/yr or kg/yr)
V = volume of waste stream processed in a facility (m^3/yr)
C_i = average concentration of pollutant i in a waste stream (Ci/m^3 or kg/m^3)
F_i = release fraction for pollutant i from a waste stream processed in a given facility (dimensionless)
n = number of waste streams processed in the facility.

The waste stream volumes are described in Volume I, Section 2 and in Appendixes B and C. Table F.1 is a cross reference for Tables F.2 through F.18, which provide concentration data for each waste stream for each alternative group. The presumed average concentration of constituents in each waste stream also is provided in Tables F.2 through F.18. Waste stream designations are given in Appendix B. The radionuclides included in each waste stream are those that contribute greater than 0.1 percent to inhalation or ingestion dose based on the concentration in the given waste stream. Short-lived radionuclides that are generated from a longer-lived radionuclide (for example, yttrium-90 from strontium-90) in the inventory are not included in the lists because their contributions are included with the parent radionuclide in the dose analysis.

The analysis of health impacts is performed for each facility using the facility release characteristics (for example, stack height and exit velocity) and annual release rates as inputs to the atmospheric transport analysis. The transport and exposure pathway analyses evaluate downwind transport, deposition, soil resuspension, soil accumulation, and transfer through exposure pathways to the exposed individuals.

The release fractions were defined for each facility and pollutant using information and methods from past analyses. Facilities not included in the list are not expected to release contaminants under normal operating conditions.

Release fractions were estimated for each facility managing wastes that are evaluated within the scope of this HSW EIS. These facilities and the waste streams associated with each facility are described in Volume I, Section 2 and Appendixes B and C. Generally, the release fraction estimation is based on previous studies involving the existing facilities or on values for similar facilities. Guidance from 40 CFR 61, Appendix D (consistent with WAC 246-247), also is used for release fraction estimates for the Waste Receiving and Processing Facility (WRAP), the T Plant Complex, the new waste processing facility, and leachate treatment by pulse driers. That guidance includes the following conventions:

- Radioactive materials in sealed packages that remain unopened and have not leaked during the assessment period were not included in the calculation.
- The release fraction for gaseous material is 1.
- The release fraction for liquids and particulate solids is 1.0E-03.
- The release fraction for solids is 1.0E-06.
- Credit can be taken for particulate filtration installed between the place of use and the point of release (except for gaseous radionuclides).

Table F.1. Summary of Waste Stream Concentration Tables

Stream No.[(a)]	**Waste Stream Description**[(b)]	**Table Number**
1	LLW Cat 1	F.2
2	LLW Cat 3	F.3
1 and 2	LLW from Offsite Sources	F.4
2C2	LLW Cat 3 for T Plant Processing from Offsite	F.5
4	TRU-RH Waste from Trenches	F.6
4	TRU-CH Waste from Trenches	F.7
5	TRU-RH Waste from Caissons	F.8
8	TRU – Commingled PCB Waste	F.9
9	TRU – Newly Generated and Existing CH Standard Containers	F.10
10A	TRU – Newly Generated and Existing CH Non-Standard Containers	F.10
10B	TRU – Newly Generated and Existing RH Waste	F.11
11	MLLW Treated and Ready for Disposal	F.12
12	RH and Non-Standard Packages	F.13
13	CH Organic and Inorganic Solids and Debris	F.14
14	Elemental Lead	F.15
15	Elemental Mercury	F.16
17	TRU – K Basins Sludge	F.17
18	MLLW Trench Leachate	F.18

(a) Waste stream designations are as described in Appendix B.
(b) Cat = Category; CH = contact-handled; LLW = low-level waste; MLLW = mixed low-level waste; PCB = polychlorinated biphenyl; RH = remote-handled; TRU = transuranic.

Table F.2. Stream 1: Low-Level Waste Category 1

Constituent	Concentration, Ci/m^3
Americium-241	6.4E-06
Cobalt-60	1.0E-03
Cesium-137	1.0E-04
Iron-55	2.4E-03
Manganese-54	3.2E-03
Nickel-63	8.6E-04
Plutonium-238	2.2E-06
Plutonium-239	3.1E-05
Plutonium-240	7.8E-06
Plutonium-241	2.1E-04
Strontium-90	1.2E-04
Tritium	4.4E+00

Table F.3. Stream 2: Low-Level Waste Category 3

Constituent	Concentration, Ci/m^3
Americium-241	7.9E-03
Curium-244	1.0E-03
Cesium-137	9.8E+00
Plutonium-238	2.0E-03
Plutonium-239	9.4E-03
Plutonium-240	3.7E-03
Plutonium-241	2.2E-01
Strontium-90	1.2E+01
Tritium	1.6E-03
Uranium-234	1.8E-02
Uranium-235	5.4E-04
Uranium-236	2.4E-03
Uranium-238	3.0E-02

Table F.4. Streams 1 and 2: Low-Level Waste from Offsite Sources

Radionuclide	Source Site[(a)] and Waste Stream Concentrations, Ci/m^3											
	BNL	**GE VAL**	**GJPO**	**INEEL**	**ITRI**	**LLNL**	**ORR**	**PNTX**	**RFETS**	**SNL**	**SPRU**	**WV**
Tritium	9.6E-05	NR	NR	6.6E+01	1.7E-02	7.0E-03	8.6E+0	5.8E-04	2.4E-05	1.1E+0	1.4E-04	4.8E-01
Carbon-14	NR	NR	NR	2.3E-03	2.9E-03	1.7E-06	4.3E-05	NR	NR	4.0E-04	1.3E-11	4.0E-04
Cobalt-60	1.4E-06	6.2E-04	NR	8.2E+01	NR	NR	3.2E-02	NR	NR	9.5E-01	7.0E-05	9.5E-01
Nickel-59	NR	NR	NR	4.4E-01	NR	NR	1.4E-07	NR	NR	4.7E-03	8.7E-08	4.7E-03
Nickel-63	NR	NR	NR	1.6E+01	NR	NR	5.8E-01	NR	NR	2.1E-01	3.8E-06	2.1E-01
Strontium-90	3.4E-04	3.1E-03	NR	1.1E-02	NR	NR	2.2E-03	NR	4.7E-11	2.5E-01	4.2E-04	2.5E-01
Technetium-99	NR	NR	NR	1.4E-05	NR	NR	2.6E-07	NR	NR	4.2E-05	9.6E-10	4.2E-05
Cesium-137	5.5E-04	2.2E-03	5.5E-14	2.2E-01	NR	NR	2.2E-01	NR	1.7E-08	1.6E-01	6.8E-04	1.6E-01
Uranium-234	7.5E-08	NR	NR	3.0E-06	NR	NR	1.6E-04	7.4E-06	3.2E-07	1.4E-04	3.6E-06	1.4E-04
Uranium-235	2.6E-08	NR	NR	4.4E-05	NR	NR	7.2E-04	1.2E-06	9.4E-11	7.1E-06	1.6E-07	7.1E-06
Uranium-238	5.8E-08	NR	NR	1.8E-03	5.84E-04	4.96E-04	7.8E-05	7.8E-05	2.6E-07	3.2E-04	1.2E-05	3.2E-04

(a) BNL = Brookhaven National Laboratory
GE VAL = General Electric – Vallecitos
GJPO = Grand Junction Project Office
INEEL = Idaho National Engineering and Environmental Laboratory
ITRI = Inhalation Toxicology Research Institute
LLNL = Lawrence Livermore National Laboratory
ORR = Oak Ridge Reservation
PNTX = Pantex Facility
RFETS = Rocky Flats Environmental Technology Site
SNL = Sandia National Laboratories
SPRU = Separations Process Research Unit
WV = West Valley Nuclear Services

NR = none reported.

Table F.5. Stream 2C2: Low-Level Waste Category 3 for T Plant Processing from Offsite Sources

Radionuclide	**Source Site[(a)] and Waste Stream Concentrations, Ci/m^3**											
	BNL	**GE VAL**	**GJPO**	**INEEL**	**ITRI**	**LLNL**	**ORR**	**PNTX**	**RFETS**	**SNL**	**SPRU**	**WV**
Tritium	3.0E-05	NR	NR	2.1E+01	5.4E-03	2.2E-03	2.7E+0	1.8E-04	7.8E-06	3.6E-01	4.6E-05	1.5E-01
Carbon-14	NR	NR	NR	7.3E-04	9.2E-04	5.4E-07	1.4E-05	NR	NR	1.2E-04	4.2E-12	1.2E-04
Cobalt-60	4.4E-07	2.0E-04	NR	2.6E+01	NR	NR	1.0E-02	NR	NR	3.0E-01	2.2E-05	3.0E-01
Nickel-59	NR	NR	NR	1.4E-01	NR	NR	4.4E-08	NR	NR	1.4E-03	2.8E-08	1.4E-03
Nickel-63	NR	NR	NR	4.9E+0	NR	NR	1.8E-01	NR	NR	6.7E-02	1.2E-06	6.7E-02
Strontium-90	1.0E-04	9.9E-04	NR	3.6E-03	NR	NR	7.2E-04	NR	1.5E-11	8.0E-02	1.3E-04	8.0E-02
Technetium-99	NR	NR	NR	4.4E-06	NR	NR	8.1E-08	NR	NR	1.3E-05	3.0E-10	1.3E-05
Cesium-137	1.8E-04	6.8E-04	5.5E-14	7.0E-02	NR	NR	6.8E-02	NR	5.4E-09	5.3E-02	2.2E-04	5.3E-02
Uranium-234	2.4E-08	NR	NR	9.7E-07	NR	NR	5.0E-05	2.3E-06	10E-08	4.4E-05	1.1E-06	4.4E-05
Uranium-235	8.4E-09	NR	NR	1.4E-05	NR	NR	2.2E-06	4.0E-07	3.0E-11	2.2E-06	5.2E-08	2.2E-06
Uranium-238	1.8E-08	NR	NR	6.0E-04	1.8E-04	1.6E-04	2.4E-05	2.5E-05	8.4E-08	1.0E-04	3.6E-06	1.0E-04

(a) BNL = Brookhaven National Laboratory
GE VAL = General Electric – Vallecitos
GJPO = Grand Junction Project Office
INEEL = Idaho National Engineering and Environmental Laboratory
ITRI = Inhalation Toxicology Research Institute
LLNL = Lawrence Livermore National Laboratory
ORR = Oak Ridge Reservation
PNTX = Pantex Facility
RFETS = Rocky Flats Environmental Technology Site
SNL = Sandia National Laboratories
SPRU = Separations Process Research Unit
WV = West Valley Nuclear Services

NR = none reported.

Table F.6. Stream 4: TRU-RH Waste from Trenches

Constituent	Concentration	Units
Americium-241	6.4E+01	Ci/m^3
Plutonium-238	1.4E+01	Ci/m^3
Plutonium-239	5.5E+01	Ci/m^3
Plutonium-240	3.1E+01	Ci/m^3
Plutonium-241	1.2E+03	Ci/m^3
Beryllium	5.0E-01	kg/m^3
Sodium hydroxide	5.0E-01	kg/m^3
Xylene	4.8E+00	kg/m^3

Table F.7. Stream 4: TRU-CH Waste from Trenches

Constituent	Concentration, Ci/m^3
Americium-241	2.6E-01
Plutonium-238	1.0E+00
Plutonium-239	5.6E-01
Plutonium-240	2.2E+01

Table F.8. Stream 5: TRU-RH Waste from Caissons

Constituent	Concentration, Ci/m^3
Americium-241	5.6E+00
Cesium-137	5.0E+01
Cobalt-60	9.1E+00
Plutonium-238	9.0E-01
Plutonium-239	1.3E+01
Plutonium-240	3.2E+00
Plutonium-241	2.6E+01
Plutonium-242	1.2E-03
Strontium-90	4.6E+01
Uranium-233	1.0E-02
Uranium-234	1.3E-03
Uranium-235	3.9E-05
Uranium-238	9.6E-04

Table F.9. Stream 8: TRU – Commingled Polychlorinated Biphenyl Waste

Constituent	Concentration	Units
Americium-241	3.2E+00	Ci/m^3
Plutonium-238	7.2E-01	Ci/m^3
Plutonium-239	2.7E+00	Ci/m^3
Plutonium-240	1.5E+00	Ci/m^3
Plutonium-241	5.8E+01	Ci/m^3
Beryllium	5.0E-01	kg/m^3
Polychlorinated biphenyls (PCBs)	1.8E+00	kg/m^3
Sodium hydroxide	5.0E-01	kg/m^3
Xylene	4.8E+00	kg/m^3

Table F.10. Streams 9 and 10A: TRU – Newly Generated and Existing CH Standard and Non-Standard Containers

Constituent	Concentration	Units
Americium-241	3.2E+00	Ci/m^3
Plutonium-238	7.2E-01	Ci/m^3
Plutonium-239	2.7E+00	Ci/m^3
Plutonium-240	1.5E+00	Ci/m^3
Plutonium-241	5.8E+01	Ci/m^3
Acetone	7.7E-04	kg/m^3
Beryllium	5.0E-01	kg/m^3
Carbon tetrachloride	1.3E-01	kg/m^3
Dichloromethane	5.7E-03	kg/m^3
Hydraulic fluid	2.3E-01	kg/m^3
Mercury	4.8E-03	kg/m^3
Sodium hydroxide	5.0E-01	kg/m^3
1,1,1-Trichloroethane	7.8E-04	kg/m^3
Xylene	4.0E-03	kg/m^3

Table F.11. Stream 10B: TRU – Newly Generated and Existing RH Waste

Constituent	Concentration	Units
Cesium-137	7.4E+00	Ci/m^3
Cobalt-60	3.1E-01	Ci/m^3
Iron-55	2.8E+00	Ci/m^3
Strontium-90	2.4E+00	Ci/m^3
Tritium	3.9E-03	Ci/m^3
Acetone	7.7E-04	kg/m^3
Beryllium	5.0E-01	kg/m^3
Carbon tetrachloride	1.3E-01	kg/m^3
Dichloromethane	5.7E-03	kg/m^3
Hydraulic fluid	2.3E-01	kg/m^3
Mercury	4.8E-03	kg/m^3
Sodium hydroxide	5.0E-01	kg/m^3
1,1,1-Trichloroethane	7.8E-04	kg/m^3
Xylene	4.0E-03	kg/m^3

Table F.12. Stream 11: MLLW Treated and Ready for Disposal

Constituent	Concentration	Units
Americium-241	3.1E-05	Ci/m^3
Cesium-137	3.5E-03	Ci/m^3
Cobalt-60	6.3E-01	Ci/m^3
Curium-244	5.6E-04	Ci/m^3
Iron-55	1.1E-01	Ci/m^3
Neptunium-237	2.4E-06	Ci/m^3
Nickel-63	1.2E+0	Ci/m^3
Plutonium-238	2.9E-04	Ci/m^3
Plutonium-239	1.2E-04	Ci/m^3
Plutonium-240	2.1E-05	Ci/m^3
Plutonium-241	7.4E-04	Ci/m^3
Radium-224	1.6E-02	Ci/m^3
Strontium-90	1.0E-02	Ci/m^3
Tritium	3.9E-03	Ci/m^3

Table F.12. (contd)

Constituent	Concentration	Units
Thorium-228	4.8E-05	Ci/m^3
Thorium-232	1.4E-06	Ci/m^3
Thorium-234	2.4E-02	Ci/m^3
Uranium-234	2.8E-04	Ci/m^3
Uranium-235	4.6E-06	Ci/m^3
Uranium-236	5.4E-06	Ci/m^3
Uranium-238	7.2E-05	Ci/m^3
Acetone	2.0E-01	kg/m^3
Beryllium	5.3E+00	kg/m^3
Bromodichloromethane	1.2E-03	kg/m^3
Carbon tetrachloride	4.2E-01	kg/m^3
Hydraulic fluid	3.6E-01	kg/m^3
Toluene	3.4E-01	kg/m^3
Formic acid	9.4E-01	kg/m^3
Dichloromethane	2.0E-01	kg/m^3
Diesel fuel	1.6E-01	kg/m^3
Methyl ethyl ketone (MEK)	1.6E-01	kg/m^3
Mercury	4.9E-02	kg/m^3
Nitric acid	6.7E+00	kg/m^3
Polychlorinated biphenyls (PCBs)	5.8E-01	kg/m^3
p-chloroaniline	5.6E-01	kg/m^3
Sodium hydroxide	9.6E+00	kg/m^3
1,1,1-Trichloroethane	7.4 E-01	kg/m^3
Xylene	6.2E-02	kg/m^3

Table F.13. Stream 12: RH and Non-Standard Packages

Constituent	Concentration	Units
Cesium-137	7.4E+00	Ci/m^3
Cobalt-60	3.1E-01	Ci/m^3
Iron-55	2.8E+00	Ci/m^3
Strontium-90	2.4E+00	Ci/m^3
Tritium	3.9E-03	Ci/m^3
Acetone	2.0E-01	kg/m^3
Beryllium	5.3E+00	kg/m^3
Nitric acid	6.7E+00	kg/m^3
Sodium hydroxide	9.6E+00	kg/m^3
Toluene	1.0E+01	kg/m^3
Xylene	1.0E+00	kg/m^3

Table F.14. Stream 13: CH Organic and Inorganic Solids and Debris

Constituent	Concentration	Units
Americium-241	3.1E-05	Ci/m^3
Cesium-137	3.5E-03	Ci/m^3
Cobalt-60	6.3E-01	Ci/m^3
Curium-244	5.6E-04	Ci/m^3
Iron-55	1.1E-01	Ci/m^3
Nickel-63	1.2E+00	Ci/m^3
Neptunium-237	2.4E-06	Ci/m^3
Plutonium-238	2.9E-04	Ci/m^3
Plutonium-239	1.2E-04	Ci/m^3
Plutonium-240	2.1E-05	Ci/m^3
Plutonium-241	7.4E-04	Ci/m^3
Radium-224	1.6E-02	Ci/m^3
Strontium-90	1.0E-02	Ci/m^3
Thorium-228	4.8E-05	Ci/m^3
Thorium-232	1.4E-06	Ci/m^3
Thorium-234	2.4E-02	Ci/m^3

Table F.14. (contd)

Constituent	Concentration	Units
Tritium	3.9E-03	Ci/m^3
Uranium-234	2.8E-04	Ci/m^3
Uranium-235	4.6E-06	Ci/m^3
Uranium-236	5.4E-06	Ci/m^3
Uranium-238	7.2E-05	Ci/m^3
Acetone	2.0E-01	kg/m^3
Beryllium	5.3E+00	kg/m^3
Bromodichloromethane	1.2E-03	kg/m^3
Carbon tetrachloride	4.2E-01	kg/m^3
Dichloromethane	2.0E-01	kg/m^3
Diesel fuel	1.6E-01	kg/m^3
Formic acid	9.4E-01	kg/m^3
Hydraulic fluid	3.6E-01	kg/m^3
Methyl ethyl ketone (MEK)	1.6E-01	kg/m^3
Mercury	4.9E-02	kg/m^3
Nitrate	2.3E-01	kg/m^3
Nitric acid	6.7E+0	kg/m^3
Polychlorinated biphenyls (PCBs)	5.8E-01	kg/m^3
p-chloroaniline	5.6E-01	kg/m^3
Sodium hydroxide	9.6E+00	kg/m^3
Toluene	3.4E-01	kg/m^3
1,1,1-Trichloroethane	7.4E-01	kg/m^3
Xylene	6.2E-02	kg/m^3

Table F.15. Stream 14: Elemental Lead

Constituent	**Concentration**	**Units**
Americium-241	6.1E-05	Ci/m^3
Cerium-144	3.0E-03	Ci/m^3
Cesium-134	4.6E-05	Ci/m^3
Cesium-137	1.2E-02	Ci/m^3
Cobalt-60	1.2E-03	Ci/m^3
Neptunium-237	9.5E-07	Ci/m^3
Plutonium-238	9.3E-06	Ci/m^3
Plutonium-239	9.4E-05	Ci/m^3
Plutonium-240	4.0E-04	Ci/m^3
Plutonium-241	6.4E-04	Ci/m^3
Radium-224	4.2E-05	Ci/m^3
Radium-226	1.9E-04	Ci/m^3
Ruthenium-106	8.2E-04	Ci/m^3
Strontium-90	8.6E-03	Ci/m^3
Thorium-228	1.9E-03	Ci/m^3
Thorium-232	1.1E-06	Ci/m^3
Tritium	2.1E-05	Ci/m^3
Uranium-234	6.9E-06	Ci/m^3
Uranium-238	1.0E-05	Ci/m^3
Lead	9.8E+02	kg/m^3

Table F.16. Stream 15: Elemental Mercury

Constituent	Concentration	Units
Americium-241	5.3E-06	Ci/m^3
Cerium-144	4.6E-04	Ci/m^3
Cesium-134	3.6E-06	Ci/m^3
Cesium-137	8.4E-04	Ci/m^3
Cobalt-60	4.6E-05	Ci/m^3
Plutonium-238	5.6E-06	Ci/m^3
Plutonium-239	2.7E-03	Ci/m^3
Plutonium-240	1.0E-05	Ci/m^3
Plutonium-241	4.0E-04	Ci/m^3
Ruthenium-106	1.6E-04	Ci/m^3
Strontium-90	1.2E-04	Ci/m^3
Thorium-232	1.2E-05	Ci/m^3
Tritium	7.0E-07	Ci/m^3
Mercury	1.3E+02	kg/m^3

Table F.17. Stream 17: K Basins Sludge

Constituent	Concentration	Units
Americium-241	1.6E+01	Ci/m^3
Cesium-134	2.0E-01	Ci/m^3
Cesium-137	2.7E+02	Ci/m^3
Cobalt-60	5.4E-01	Ci/m^3
Neptunium-237	1.6E-03	Ci/m^3
Plutonium –238	2.6E+00	Ci/m^3
Plutonium-239	9.0E+00	Ci/m^3
Plutonium-240	5.0E+00	Ci/m^3
Strontium-90	2.7E+02	Ci/m^3
Technetium-99	4.2E-01	Ci/m^3
Uranium-234	3.4E-02	Ci/m^3
Uranium-235	1.2E-03	Ci/m^3
Uranium-236	4.0E-03	Ci/m^3
Uranium-238	2.5E-02	Ci/m^3
Polychlorinated biphenyls (PCBs)	1.6E-02	kg/m^3

Table F.18. Stream 18: MLLW Trench Leachate

Constituent	Concentration, Ci/m^3
Americium-241	1.4E-11
Cesium-137	3.6E-11
Cobalt-60	6.5E-09
Curium-244	2.6E-10
Iron-55	1.2E-09
Neptunium-237	1.1E-12
Nickel-63	1.2E-08
Plutonium –238	1.3E-10
Plutonium-239	5.6E-11
Plutonium-240	9.8E-12
Plutonium-241	3.4E-10
Radium-224	7.7E-09
Strontium-90	1.0E-10
Thorium-228	2.0E-11
Thorium-232	6.6E-13
Thorium-234	1.1E-08
Tritium	4.0E-11
Uranium-234	1.3E-10
Uranium-235	2.1E-12
Uranium-236	2.4E-12
Uranium-238	3.2E-11

F.1.1.1 Release Fractions for the Waste Receiving and Processing Facility

Potential releases from the WRAP have been characterized in the Notice of Construction (NOC) reports for hazardous chemicals (DOE-RL 1993a) and radionuclides (DOE-RL 1993b). Release fractions for radionuclides are based on 40 CFR 61, Appendix D (consistent with WAC 246-247). Releases of particulate solids from the WRAP gloveboxes include a factor of 1.0E-03, with an additional 5.0E-07 reduction for double high-efficiency particulate air (HEPA) filtration efficiency. The net release fraction is then 5.0E-10 for particulate material and 1.0 for volatile radionuclides (such as tritium and carbon-14).

Release fractions for non-radioactive volatile organic compounds (VOCs) were based on the vapor pressure and molecular weight of the chemical (DOE-RL 1993a, Appendix A). The releases were postulated to occur when a container was opened (within a glovebox) and the volatile chemicals were emptied onto a holding pan with a diameter of 0.5 m (1.6 ft). The theoretical vaporization rate from this geometry was used to estimate the release rate over a one-year period. If the theoretical release rate indicated a greater release than the total inventory processed in a year, the chemical was assumed to be totally released (release fraction is 1.0).

The analysis presented in the WRAP NOC included consideration of the total mass fraction of each chemical in the annual processing inventory. A similar approach was used in the current analysis, except that the mass fraction was set to 1.0, representing a case where the chemical is the only one in the container emptied onto the holding pan. Also, the WRAP NOC analysis assumed the chemical would remain on the holding pan for the entire year. In the current analysis, the time was set to one day, and the theoretical release was divided by the amount of the chemical in one drum (average value). This process is in contrast to the NOC analysis that compared the release over a year to the total amount processed in a year. The net difference between the two analyses is that the current analysis is based on one drum, and the NOC analysis is based on a year of operation. The current analysis was based on one drum because the processing rates may change for each alternative group and the analysis could be performed in a more straightforward manner if the processing rate were not involved in the release fraction estimation. A summary of the release fraction evaluation for the WRAP is shown in Table F.19. The release fraction for volatile chemicals indicates the dependence on physical properties. Gases represent chemicals that have a vapor pressure above one atmosphere at ambient conditions.

Release fractions for specific VOCs are presented in Table F.20. As previously discussed, the release fraction is dependent on the waste stream because the release is based on the total amount of a chemical in one drum. The release fractions are based on total glovebox throughput of the waste type in the WRAP. For example, if a waste stream of transuranic (TRU) waste is defined as going to the gloveboxes, the release fraction does not include the processing fraction (0.1), and the release fraction for most VOCs would be 1.0. If the throughput is defined as the amount going to the WRAP, the release fraction must include the processing fraction (0.1). The processing fraction is multiplied by the listed release fraction in Table F.20 to find the correct release fraction for total throughput of the WRAP.

Table F.19. Release Fraction Values for the WRAP

Constituents Type	Form	Release Fraction
Radioactive material	Gases	1.0
	Particulates	5.0E-10
Chemicals	Gases	1.0
	VOCs[(a)]	0.12 VM/drum amount[(b)]
	Inorganic chemicals	5.0E-10

(a) VOCs = volatile organic compounds.
(b) Average amount in one drum expressed in kg/drum, vapor pressure (V) in atmospheres, and molecular weight (M) in g. The release fraction is limited to a maximum value of 1.0.

Table F.20. Release Fractions for Volatile Organic Compounds from the WRAP

Chemical Name	Waste Stream Description	
	TRU Waste, New and Stored	**MLLW**
1,1,1-Trichloroethane	1.0	1.0
Acetone	1.0	1.0
Bromodichloromethane	1.0	1.0
Carbon tetrachloride	1.0	1.0
p-chloroaniline	1.0	2.6E-03
Dichloromethane	None Reported	1.0
Diesel fuel	None Reported	3.4E-02
Formic acid	1.0	1.0
Hydraulic fluid	1.1E-04	7.5E-05
Mercury	6.4E-02	6.3E-03
Methyl ethyl ketone (MEK)	1.0	1.0
Polychlorinated biphenyls (PCBs)	4.0E-05	3.0E-05
Toluene	1.0	1.0
Xylene	1.0	1.0

The total estimated releases from the WRAP for each alternative group are given in Tables F.21 and F.22 for radionuclides and chemicals, respectively. The tables present releases for the Lower Bound and Upper Bound waste volumes for Alternative Groups A and B. The releases of radionuclides for the Hanford Only waste volume are just slightly smaller than those for the Lower Bound waste volume and are not shown. For chemicals, the releases for the Hanford Only waste volume are essentially identical to the Lower Bound waste volume because processing of MLLW for the two cases is nearly identical. The releases for Alternative Groups C, D, and E are essentially the same as those for Alternative Group A and are not shown.

F.1.1.2 Release Fractions for the Existing T Plant Complex

The release fractions are based on the value in 40 CFR 61, Appendix D (consistent with WAC 246-247), for particulate and solid contamination modified to include HEPA filtration. The 2706-T facility has single HEPA filtration and the 221-T facility has double HEPA filtration. The HEPA filtration efficiency for the 2706-T single HEPA filter is set to 99.95 percent. The analyses for releases from the existing T Plant Complex are based on all processing being done in the 2706-T facility. A summary of the release fractions for the T Plant Complex is given in Table F.23. The release fractions for specific VOCs are the same as for the WRAP (see Table F.20).

Table F.21. Airborne Radionuclide Releases from the WRAP

Radionuclide	Total Release, Ci				
	Alternative Group A		Alternative Group B		No Action
	Lower Bound Volume	Upper Bound Volume	Lower Bound Volume	Upper Bound Volume	
Americium-241	2.2E-06	2.2E-06	2.2E-06	2.2E-06	2.2E-06
Cesium-137	1.9E-08	1.3E-07	1.9E-08	2.2E-08	1.9E-08
Cobalt-60	1.2E-08	9.3E-08	1.2E-08	9.3E-08	1.2E-08
Curium-244	3.5E-11	2.0E-10	3.5E-11	2.0E-10	3.5E-11
Iron-55	7.1E-10	4.4E-09	7.1E-10	4.4E-09	7.1E-10
Manganese-54	1.3E-13	1.3E-13	1.3E-13	1.3E-13	1.3E-13
Nickel-63	1.1E-07	6.3E-07	1.1E-07	6.3E-07	1.1E-07
Neptunium-237	2.6E-13	1.4E-12	2.6E-13	1.4E-12	2.6E-13
Plutonium-238	6.9E-07	6.9E-07	6.9E-07	6.9E-07	6.9E-07
Plutonium-239	2.9E-06	2.9E-06	2.9E-06	2.9E-06	2.9E-06
Plutonium-240	1.7E-06	1.7E-06	1.7E-06	1.7E-06	1.7E-06
Plutonium-241	3.3E-05	3.3E-05	3.3E-05	3.3E-05	3.3E-05
Radium-224	2.4E-13	1.2E-12	2.4E-13	1.2E-12	2.4E-13
Strontium-90	2.4E-08	1.7E-07	2.4E-08	2.8E-08	2.4E-08
Thorium-234	1.0E-10	6.2E-10	1.0E-10	1.4E-10	1.0E-10
Tritium	1.4E+02	2.7E+02	1.4E+02	2.7E+02	1.4E+02
Uranium-234	1.2E-10	5.5E-10	1.2E-10	2.5E-10	1.2E-10
Uranium-235	2.2E-12	1.7E-11	2.2E-12	8.3E-12	2.2E-12
Uranium-236	8.3E-12	4.9E-11	8.3E-12	1.1E-11	8.3E-12
Uranium-238	1.0E-10	6.2E-10	1.0E-10	1.4E-10	1.0E-10

The total estimated releases from the T Plant Complex for the alternative groups are shown in Tables F.24 and F.25 for radionuclides and chemicals, respectively. The releases shown for Alternative Group A are for wastes processed in existing facilities and do not include releases in the modified T Plant. Releases from the modified T Plant are described in the following section. The tables present releases for the Lower Bound and Upper Bound waste volumes for Alternative Groups A and B. The releases of radionuclides for the Hanford Only waste volume are just slightly smaller than those for the Lower Bound waste volume and are not shown. For chemicals, the releases for the Hanford Only waste volume are essentially identical to the Lower Bound waste volume because processing MLLW for the two waste volumes is nearly identical. The releases for Alternative Groups C, D, and E are essentially the same as those for Alternative Group A and are not shown.

Table F.22. Total Chemical Atmospheric Releases from the WRAP

Chemical Name	Total Release, kg				
	Alternative Group A		Alternative Group B		No Action
	Lower Bound Volume	Upper Bound Volume	Lower Bound Volume	Upper Bound Volume	
Acetone	4.5E+01	2.3E+02	4.5E+01	2.3E+02	4.5E+01
Beryllium	7.7E-07	3.2E-06	7.7E-07	3.2E-06	7.7E-07
Bromodichloromethane	2.5E-01	1.3E+0	2.5E-01	1.3E+0	2.5E-01
Carbon tetrachloride	1.9E+02	5.7E+02	1.9E+02	5.7E+02	1.9E+02
Dichloromethane	4.9E+01	2.4E+02	4.9E+01	2.4E+02	4.9E+01
Diesel fuel	1.2E+0	6.1E+0	1.2E+0	6.1 E+0	1.2E+0
Formic acid	2.0E+02	1.1E+03	2.0E+02	1.1E+03	2.0E+02
Hydraulic fluid	2.6E-02	5.0E-02	2.6E-02	4.9E-02	2.6E-02
Mercury (elemental)	3.1E-01	5.9E-01	3.1E-01	5.7E-01	3.1E-01
Methyl ethyl ketone (MEK)	3.4E+01	1.8E+02	3.4E+01	1.8E+02	3.4E+01
Nitrate	2.3E-08	2.3E-08	2.3E-08	2.3E-08	2.3E-08
Nitric acid	7.2E-07	3.8E-06	7.2E-07	3.8E-06	7.2E-07
Polychlorinated biphenyls (PCBs)	3.8E-03	1.9E-02	3.7E-03	1.9E-02	3.7E-03
p-chloroaniline	3.1E-01	1.6E+00	3.1E-01	1.6E+00	3.1E-01
Sodium hydroxide	1.2E-06	5.6E-06	1.2E-06	5.6E-06	1.2E-06
Toluene	7.4E+01	3.9E+02	7.4E+01	3.9E+02	7.4E+01
1,1,1-Trichloroethane	1.6E+02	8.3E+02	1.6E+02	8.3E+02	1.6E+02
Xylene	1.6E+01	7.3E+01	1.6E+01	7.3E+01	1.6E+01

Table F.23. Release Fraction Values for the 2706-T Facility in the T Plant Complex

Operation	Form	Release Fraction	Filter Factor	Net Release Fraction
2706-T Facility	Gases	1.0E+00	1.0E+00	1.0E+00
	Particulates	1.0E-03	5.0E-04	5.0E-07
	Solids	1.0E-06	5.0E-04	5.0E-10

Table F.24. Total Radionuclide Atmospheric Release from the T Plant Complex

	Total Release, Ci				
	Alternative Group A		Alternative Group B		
Radionuclide	Lower Bound Volume	Upper Bound Volume	Lower Bound Volume	Upper Bound Volume	No Action
Americium-241	8.8E-07	8.9E-07	8.8E-07	8.9E-07	8.8E-07
Cesium-137	4.5E-04	4.6E-04	4.5E-04	4.6E-04	4.5E-04
Cobalt-60	4.2E-06	5.4E-05	4.2E-06	5.4E-05	4.2E-06
Curium-244	4.6E-08	1.0E-07	4.6E-08	1.0E-07	4.6E-08
Iron-55	2.6E-07	1.5E-06	2.6E-07	1.5E-06	2.6E-07
Manganese-54	4.1E-10	4.1E-10	4.1E-10	4.1E-10	4.1E-10
Neptunium-237	8.7E-11	4.5E-10	8.7E-11	4.5E-10	8.7E-11
Nickel-63	3.8E-05	2.7E-04	3.8E-05	2.7E-04	3.8E-05
Plutonium-238	1.3E-07	1.7E-07	1.3E-07	1.7E-07	1.3E-07
Plutonium-239	7.0E-07	7.2E-07	7.0E-07	7.2E-07	7.0E-07
Plutonium-240	2.7E-07	2.8E-07	2.7E-07	2.8E-07	2.7E-07
Plutonium-241	6.5E-06	6.6E-06	6.5E-06	6.6E-06	6.5E-06
Strontium-90	5.7E-04	5.7E-04	5.7E-04	5.7E-04	5.7E-04
Thorium-228	8.1E-11	4.1E-10	8.1E-11	4.1E-10	8.1E-11
Thorium-232	5.2E-11	2.7E-10	5.2E-11	2.7E-10	5.2E-11
Thorium-234	2.2E-06	2.2E-06	2.2E-06	2.2E-06	2.2E-06
Tritium	6.4E+02	1.1E+03	6.4E+02	1.1E+03	6.4E+02
Uranium-234	1.4E-06	1.4E-06	1.4E-06	1.4E-06	1.4E-06
Uranium-235	4.0E-08	4.1E-08	4.0E-08	4.1E-08	4.0E-08
Uranium-236	1.8E-07	1.8E-07	1.8E-07	1.8E-07	1.8E-07
Uranium-238	2.2E-06	2.2E-06	2.2E-06	2.2E-06	2.2E-06

Table F.25. Total Chemical Atmospheric Releases from the T Plant Complex

Chemical Name	Total Release, kg				
	Alternative Group A		Alternative Group B		No Action
	Lower Bound Volume	Upper Bound Volume	Lower Bound Volume	Upper Bound Volume	
Acetone	1.5E+01	7.7E+01	1.5E+01	7.6E+01	1.5E+01
Beryllium	1.9E-04	9.9E-04	1.9E-04	9.8E-04	1.3E-05
Bromodichloromethane	8.3E-02	4.3E-01	8.3E-02	4.3E-01	8.3E-02
Carbon tetrachloride	3.0E+01	1.6E+02	3.0E+01	1.6E+02	3.0E+01
Dichloromethane	1.5E+01	7.8E+01	1.5E+01	7.7E+01	1.5E+01
Diesel fuel	3.9E-01	2.0E+00	3.9E-01	2.0E+00	3.9E-01
Formic acid	6.8E+01	3.5E+02	6.8E+01	3.5E+02	6.8E+01
Hydraulic fluid	2.0E-03	1.0E-02	2.0E-03	1.0E-02	2.0E-03
Mercury (elemental)	2.2E-02	1.2E-01	2.2E-02	1.2E-01	2.2E-02
Methyl ethyl ketone (MEK)	1.2E+01	6.0E+01	1.2E+01	5.9E+01	1.2E+01
Nitrate	7.8E-06	7.8E-06	7.8E-06	7.8E-06	7.8E-06
Nitric acid	2.4E-04	1.3E-03	2.4E-04	1.2E-03	1.6E-05
Polychlorinated biphenyls (PCBs)	1.2E-03	6.5E-03	1.2E-03	6.4E-03	1.2E-03
p-chloroaniline	1.0E-01	5.4E-01	1.0E-01	5.3E-01	1.0E-01
Sodium hydroxide	3.5E-04	1.8E-03	3.5E-04	1.8E-03	2.3E-05
Toluene	2.5E+01	1.3E+02	2.5E+01	1.3E+02	2.5E+01
1,1,1-Trichloroethane	5.3E+01	2.8E+02	5.3E+01	2.7E+02	5.3E+01
Xylene	4.5E+00	2.3E+01	4.5E+00	2.3E+01	4.5E+00

F.1.1.3 The New Waste Processing Facility and Modified T Plant Complex

Handling wastes in the new waste processing facility and the modified T Plant Complex would be conducted in a manner similar to that in the WRAP except that some operations would be performed remotely. Therefore, the release fractions applicable to the WRAP were also used to estimate releases from waste processed in the new waste processing facility and the modified T Plant Complex. Double HEPA filtration was assumed for these facilities. Because some mixed waste may be processed in these facilities, the release fractions for hazardous chemicals are also needed. The release fractions are summarized in Table F.26. The release fractions for specific VOCs are the same as those presented for the WRAP (see Table F.20).

Table F.26. Release Fraction Values for the New Waste Processing Facility and the Modified T Plant Complex

Constituent Type	Form	Release Fraction
Radioactive material	Gases	1.0
	Particulates	5.0E-10
Chemicals	Gases	1.0
	VOCs(a)	0.12VM/drum amount(b)
	Inorganic chemicals	5.0E-10

(a) VOCs = volatile organic compounds.

(b) Average amount in one drum expressed in kg/drum, vapor pressure (V) is in atmospheres and molecular weight (M) is in g. The release fraction is limited to a maximum value of 1.0.

The total estimated releases from the modified T Plant Complex for Alternative Group A are given in Tables F.27 and F.28 for radionuclides and chemicals, respectively. Total releases of radionuclides for the new waste processing facility for Alternative Group B are shown in Table F.29. Chemical releases for the new waste processing facility for Alternative Group B are shown in Table F.30. Releases are estimated to be the same for the Lower and Upper Bound waste volume estimates because waste stream processing in these facilities are the same for both options. The releases for Alternative Groups C, D, and E are essentially the same as those for Alternative Group A and are not shown.

Table F.27. Total Radionuclide Atmospheric Release from the Modified T Plant Complex for Alternative Group A (Lower Bound and Upper Bound Waste Volumes)

Radionuclide	Total Release, Ci
Americium-241	3.1E-04
Cesium-134	4.2E-11
Cesium-137	2.3E-05
Cobalt-60	3.8E-08
Iron-55	1.3E-08
Plutonium-238	4.0E-05
Plutonium-239	1.9E-04
Plutonium-240	1.1E-04
Plutonium-241	1.2E-03
Strontium-90	1.6E-05
Technetium-99	2.9E-08
Tritium	4.4E+02
Uranium-234	5.7E-09
Uranium-235	8.3E-11
Uranium-236	2.8E-10
Uranium-238	1.8E-09

Table F.28. Total Chemical Atmospheric Releases from the Modified T Plant Complex for Alternative Group A

Chemical Name	Total Release, kg
Acetone	5.8E+02
Beryllium	1.0E-05
Carbon tetrachloride	4.3E+02
Dichloromethane	1.9E+01
Hydraulic fluid	8.3E-02
Mercury (elemental)	1.0E+00
Nitric acid	9.7E-06
Polychlorinated biphenyls (PCBs)	6.8E-03
Sodium hydroxide	1.6E-05
Toluene	3.1E+04
1,1,1-Trichloroethane	2.6E+00
Xylene	3.7E+04

Table F.29. Atmospheric Radionuclide Releases from the New Waste Processing Facility for Alternative Group B

Radionuclide	Total Release, Ci
Americium-241	2.3E-04
Cerium-144	5.9E-15
Cesium-134	7.9E-12
Cesium-137	1.8E-05
Cobalt-60	1.0E-06
Curium-244	4.8E-09
Iron-55	2.9E-08
Neptunium-237	1.6E-10
Plutonium-238	2.9E-05
Plutonium-239	1.4E-04
Plutonium-240	8.1E-05
Plutonium-241	7.7E-04
Strontium-90	1.4E-05
Technetium-99	2.9E-08
Thorium-234	3.1E-09
Tritium	5.1E+01
Uranium-234	1.0E-08
Uranium-235	1.7E-10
Uranium-236	3.7E-10
Uranium-238	3.1E-09

Table F.30. Total Chemical Atmospheric Releases from the New Waste Processing Facility for Alternative Group B

Chemical Name	Total Release, kg
Acetone	7.9E+03
Beryllium	1.0E-04
Bromodichloromethane	4.2E+01
Carbon tetrachloride	4.3E+02
Dichloromethane	7.5E+03
Diesel Fuel	2.0E+02
Formic Acid	3.4E+04
Hydraulic fluid	1.0E+03
Lead	4.8E-04
Mercury (elemental)	4.2E+01
Methyl ethyl ketone (MEK)	5.8E+03
Nitrate	4.2E-06
Nitric acid	1.3E-04
Polychlorinated biphenyls (PCBs)	6.3E-01
p-chloroaniline	5.2E+01
Sodium hydroxide	1.8E-04
Toluene	3.4E+04
1,1,1-Trichloroethane	2.7E+04
Xylene	4.6E+03

F.1.1.4 Pulse Drier Operation

The treatment of trench leachate would be performed in the Effluent Treatment Facility until that facility is decommissioned in 2025. Starting in 2026, the plan is to treat leachate using pulse driers installed near the trenches. Releases from drier operations are estimated using a release fraction of 0.001 (40 CFR 61, Appendix D) and a HEPA filtration factor of 5.0E-04. The net release fraction of 5.0E-07 is applied to radionuclides in the leachate from the trenches except for tritium and carbon-14, which are assumed to be totally released. The leachate is not expected to contain substantial amounts of volatile hazardous chemicals. The total annual release from leachate treatment using pulse driers is given in Table F.31 for Alternative Groups A and B. Releases for Alternative Groups C and D and for the No Action Alternative are given in Table F.32. Releases for Alternative Group E are expected to be the same as those for Alternative Group D and are not shown.

Table F.31. Atmospheric Radionuclide Release from Pulse Drier Leachate Treatment—Alternative Groups A and B

Radionuclide	Total Release, Ci					
	Alternative Group A			Alternative Group B		
	Hanford Only	Lower Bound	Upper Bound	Hanford Only	Lower Bound	Upper Bound
Americium-241	4.6E-13	1.1E-12	1.5E-12	3.4E-12	4.0E-12	6.7E-12
Cesium-137	3.0E-13	6.8E-13	9.9E-13	2.2E-12	2.6E-12	4.3E-12
Cobalt-60	9.8E-13	2.3E-12	3.3E-12	7.3E-12	8.5E-12	1.4E-11
Curium-244	1.2E-12	2.7E-12	3.9E-12	8.7E-12	1.0E-11	1.7E-11
Iron-55	2.5E-15	5.7E-15	8.2E-15	1.8E-14	2.1E-14	3.6E-14
Neptunium-237	2.2E-14	5.1E-14	7.5E-14	1.7E-13	1.9E-13	3.3E-13
Nickel-63	1.8E-10	4.2E-10	6.1E-10	1.4E-09	1.6E-09	2.7E-09
Plutonium-238	2.0E-12	4.5E-12	6.6E-12	1.5E-11	1.7E-11	2.9E-11
Plutonium-239	1.1E-12	2.6E-12	3.8E-12	8.5E-12	9.9E-12	1.7E-11
Plutonium-240	2.1E-13	4.8E-13	7.0E-13	1.6E-12	1.8E-12	3.0E-12
Plutonium-241	1.1E-12	2.5E-12	3.6E-12	7.9E-12	9.3E-12	1.6E-11
Strontium-90	8.6E-13	2.0E-12	2.9E-12	6.4E-12	7.5E-12	1.3E-11
Tritium	1.9E-07	4.3E-07	6.3E-07	1.4E-06	1.6E-06	2.7E-06
Uranium-234	2.7E-12	6.1E-12	8.9E-12	2.0E-11	2.3E-11	3.9E-11
Uranium-235	4.2E-14	9.8E-14	1.4E-13	3.2E-13	3.7E-13	6.2E-13
Uranium-236	5.0E-14	1.1E-13	1.7E-13	3.7E-13	4.3E-13	7.2E-13
Uranium-238	6.6E-13	1.5E-12	2.2E-12	4.9E-12	5.8E-12	9.6E-12

Table F.32. Atmospheric Radionuclide Release from Pulse Drier Leachate Treatment—Alternative Groups C and D and the No Action Alternative

Radionuclide	Total Release, Ci						
	Alternative Group C			Alternative Group D			No Action
	Hanford Only	Lower Bound	Upper Bound	Hanford Only	Lower Bound	Upper Bound	
Americium-241	4.6E-13	4.8E-13	9.6E-13	1.2E-12	1.3E-12	3.0E-12	1.5E-13
Cesium-137	3.0E-13	3.1E-13	6.2E-13	7.6E-13	8.4E-13	1.9E-12	1.2E-13
Cobalt-60	9.8E-13	1.0E-12	2.1E-12	2.5E-12	2.8E-12	6.3E-12	5.8E-13
Curium-244	1.2E-12	1.2E-12	2.4E-12	3.0E-12	3.3E-12	7.5E-12	4.9E-13
Iron-55	2.5E-15	2.6E-15	5.1E-15	6.3E-15	7.0E-15	1.6E-14	1.8E-15
Neptunium-237	2.2E-14	2.3E-14	4.7E-14	5.7E-14	6.4E-14	1.4E-13	7.6E-15
Nickel-63	1.8E-10	1.9E-10	3.8E-10	4.7E-10	5.2E-10	1.2E-09	6.5E-11
Plutonium –238	2.0E-12	2.1E-12	4.1E-12	5.1E-12	5.6E-12	1.3E-11	7.0E-13
Plutonium-239	1.1E-12	1.2E-12	2.4E-12	2.9E-12	3.3E-12	7.3E-12	3.9E-13
Plutonium-240	2.1E-13	2.2E-13	4.3E-13	5.3E-13	5.9E-13	1.3E-12	7.0E-14
Plutonium-241	1.1E-12	1.1E-12	2.2E-12	2.7E-12	3.1E-12	6.9E-12	4.7E-13
Strontium-90	8.6E-13	9.0E-13	1.8E-12	2.2E-12	2.5E-12	5.6E-12	3.3E-13
Tritium	1.9E-07	2.0E-07	3.9E-07	4.8E-07	5.4E-07	1.2E-06	8.5E-08
Uranium-234	2.7E-12	2.8E-12	5.6E-12	6.8E-12	7.6E-12	1.7E-11	9.0E-13
Uranium-235	4.2E-14	4.4E-14	8.9E-14	1.1E-13	1.2E-13	2.7E-13	1.4E-14
Uranium-236	5.0E-14	5.2E-14	1.0E-13	1.3E-13	1.4E-13	3.2E-13	1.7E-14
Uranium-238	6.6E-13	6.9E-13	1.4E-12	1.7E-12	1.9E-12	4.3E-12	2.2E-13

F.1.2 Release Point Characteristics

The atmospheric transport analysis requires definition of release point characteristics for each facility that has a release to air. The characteristics are presented in Table F.33 for the WRAP, 2706-T facility, the modified T Plant Complex, and pulse driers. Values for the WRAP were taken from the NOC (DOE-RL 2001a); for the 2706-T facility, from Meyer (1998); for the modified T Plant Complex, from the NOC (DOE-RL 2001b) and Rokkan et al. (2001); and pulse drier characteristics were taken from FH (2004). For all facilities, the temperature of outside air is set to the annual average value of 12°C (53.6°F).

Table F.33. Release Point Characteristics

Parameter	Units	WRAP and New Waste Processing Facility	2706-T Facility	Modified T Plant Complex	Pulse Driers
Stack height	m	14	8.5	61	5
Exit area	m^2	0.5	0.39	1.8	0.20
Exit velocity	m/s	15.4	15[(a)]	8.3	1.5
Exit air temperature	°C	32.2	25.6	23.9	74
Height of building	m	7	7.62	25	4.3
(a) The average exit velocity was set to one half the maximum value for the 2706-T facility.					

F.1.3 Atmospheric Transport

The transport and deposition of material released to the atmosphere was evaluated using the atmospheric transport component of MEPAS Version 4.0. This component implements the models from earlier versions of MEPAS, as described by Droppo and Buck (1996). The models are similar to and consistent with the models recommended by EPA in the Industrial Source Complex dispersion model (EPA 1995). Also, the atmospheric dispersion models in the MEPAS program provide nearly identical results to those generated using the EPA CAP88 program, as verified in a benchmarking study performed on the MEPAS, MMSOILS, and RESRAD computer programs (Mills et al. 1997). The RESRAD program uses the CAP88 program for atmospheric transport calculations (Cheng et al.1995).

The MEPAS model uses a data set of the annual joint frequency of occurrence of wind speed, wind direction, and atmospheric stability from the 200 Area Hanford Meteorology Station. The data set used for the present analysis was the 14-year average for the years 1983 through 1996 (Hoitink and Burk 1997) as presented in Tables F.34 and F.35. This data set is used in the atmospheric transport and deposition model to evaluate the air concentration and deposition rate as a function of direction and downwind distance. The pollutant concentrations in air and deposition rates are expressed as annual average values. The annual joint frequency data set is based on heights of 9.1 m (30 ft) and 60 m (197 ft) for Tables F.34 and F.35, respectively. The MEPAS code adjusts the data to represent the actual release height defined in Table F.33.

The population dose values were estimated from the calculated individual doses by multiplying by a conversion factor relating the population weighted χ/Q value to the χ/Q value at the location of the offsite maximally exposed individual (7.0E+04 person-s/m^3). This conversion factor also was used to estimate population health impacts from carcinogenic chemicals. The population distribution is given in Table F.36 as extracted from the 2000 Census (Census 2002, 2003a, 2003b) for the current analysis.

Table F.34. Joint Frequency Distributions for the 200 Areas at 9.1-m (30-ft) Towers, 1983–1996 Historical Data

Average Wind Speed (m/s)	**Atmospheric Stability Class**	**Percentage of Time Wind Blows from the 200 Area Toward the Direction Indicated**															
		S	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**	**N**	**NNE**	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**
0.89	A	0.28	0.31	0.34	0.25	0.23	0.22	0.18	0.13	0.11	0.1	0.08	0.07	0.1	0.1	0.16	0.21
	B	0.14	0.15	0.16	0.11	0.11	0.09	0.08	0.05	0.05	0.04	0.04	0.04	0.05	0.07	0.09	0.12
	C	0.15	0.15	0.14	0.1	0.09	0.09	0.09	0.06	0.04	0.04	0.05	0.05	0.06	0.07	0.1	0.13
	D	0.87	0.76	0.72	0.55	0.6	0.65	0.64	0.42	0.36	0.31	0.35	0.38	0.49	0.59	0.77	0.83
	E	0.4	0.29	0.27	0.26	0.3	0.35	0.46	0.41	0.36	0.35	0.44	0.49	0.55	0.66	0.65	0.57
	F	0.25	0.16	0.15	0.15	0.15	0.2	0.25	0.24	0.26	0.29	0.35	0.36	0.43	0.45	0.42	0.33
	G	0.1	0.09	0.1	0.07	0.08	0.08	0.1	0.1	0.1	0.1	0.14	0.11	0.14	0.15	0.17	0.15
2.65	A	0.64	0.45	0.35	0.32	0.35	0.37	0.34	0.23	0.17	0.2	0.27	0.2	0.17	0.26	0.6	0.7
	B	0.26	0.17	0.11	0.1	0.1	0.12	0.1	0.07	0.06	0.06	0.09	0.07	0.07	0.14	0.29	0.31
	C	0.22	0.13	0.1	0.08	0.08	0.09	0.1	0.05	0.05	0.05	0.06	0.06	0.06	0.1	0.25	0.28
	D	0.64	0.46	0.3	0.27	0.31	0.36	0.43	0.29	0.23	0.24	0.3	0.39	0.55	1.05	1.72	1.12
	E	0.29	0.16	0.11	0.1	0.21	0.28	0.35	0.41	0.31	0.29	0.53	0.98	1.68	2.09	1.71	0.77
	F	0.15	0.07	0.05	0.06	0.09	0.11	0.3	0.33	0.31	0.37	0.65	1.23	1.74	1.89	1.57	0.59
	G	0.04	0.03	0.02	0.02	0.04	0.04	0.13	0.18	0.19	0.2	0.32	0.65	0.68	0.78	0.69	0.19
4.7	A	0.19	0.22	0.11	0.04	0.04	0.03	0.04	0.04	0.05	0.13	0.31	0.36	0.21	0.23	0.61	0.3
	B	0.04	0.04	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.04	0.06	0.1	0.08	0.09	0.22	0.09
	C	0.04	0.03	0.02	0.01	0	0	0.01	0.01	0.02	0.04	0.05	0.08	0.07	0.08	0.2	0.09
	D	0.14	0.13	0.06	0.04	0.05	0.04	0.07	0.09	0.11	0.19	0.34	0.52	0.57	1.11	1.45	0.37
	E	0.07	0.06	0.04	0.02	0.02	0.02	0.06	0.1	0.11	0.15	0.37	0.66	1.09	1.95	1.78	0.25
	F	0.02	0.01	0.01	0.01	0.01	0.01	0.04	0.09	0.04	0.03	0.08	0.3	0.33	0.53	0.72	0.11
	G	0	0	0	0	0	0	0.02	0.04	0.01	0.02	0.04	0.18	0.1	0.16	0.32	0.03
7.15	A	0.03	0.06	0.04	0.01	0	0	0.01	0.01	0.02	0.06	0.23	0.33	0.15	0.17	0.44	0.11
	B	0.01	0.01	0.01	0	0	0	0	0	0.01	0.03	0.06	0.08	0.03	0.05	0.12	0.02
	C	0.01	0.01	0.01	0	0	0	0	0	0.01	0.02	0.04	0.07	0.03	0.03	0.08	0.02
	D	0.03	0.05	0.03	0.01	0	0	0.01	0.03	0.06	0.16	0.38	0.35	0.24	0.6	0.85	0.11
	E	0.01	0.05	0.02	0	0	0	0	0.02	0.05	0.11	0.25	0.23	0.15	0.47	0.93	0.06
	F	0	0	0	0	0	0	0	0.01	0	0	0.01	0.02	0.01	0.01	0.02	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table F.35. Joint Frequency Distributions for the 200 Areas at 60-m (197-ft) Aboveground Level, 1983–1996 Historical Data

Average Wind Speed m/s	**Atmospheric Stability Class**	**Percentage of Time Wind Blows from the 200 Area Toward the Direction Indicated**															
		S	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**	**N**	**NNE**	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**
0.89	A	0.11	0.13	0.15	0.11	0.11	0.12	0.07	0.05	0.03	0.02	0.04	0.03	0.05	0.03	0.05	0.07
	B	0.09	0.09	0.08	0.07	0.07	0.06	0.06	0.03	0.02	0.03	0.02	0.02	0.02	0.03	0.05	0.07
	C	0.09	0.08	0.1	0.08	0.07	0.06	0.06	0.04	0.02	0.02	0.02	0.02	0.03	0.04	0.04	0.08
	D	0.58	0.53	0.51	0.43	0.45	0.49	0.52	0.35	0.24	0.22	0.22	0.2	0.27	0.35	0.44	0.54
	E	0.29	0.22	0.2	0.18	0.22	0.28	0.32	0.25	0.18	0.17	0.17	0.17	0.23	0.25	0.31	0.32
	F	0.2	0.13	0.12	0.11	0.14	0.14	0.19	0.14	0.13	0.12	0.13	0.12	0.17	0.19	0.23	0.21
	G	0.07	0.05	0.05	0.05	0.06	0.07	0.1	0.07	0.07	0.06	0.08	0.09	0.09	0.11	0.12	0.1
2.65	A	0.61	0.5	0.46	0.41	0.43	0.41	0.43	0.3	0.2	0.18	0.18	0.17	0.12	0.16	0.43	0.58
	B	0.25	0.2	0.16	0.12	0.14	0.13	0.12	0.1	0.07	0.06	0.07	0.05	0.06	0.09	0.22	0.27
	C	0.23	0.16	0.13	0.09	0.1	0.1	0.12	0.07	0.05	0.06	0.06	0.05	0.04	0.08	0.21	0.28
	D	0.79	0.56	0.39	0.32	0.39	0.37	0.5	0.34	0.22	0.23	0.24	0.25	0.35	0.63	1.29	1.1
	E	0.37	0.23	0.18	0.16	0.22	0.23	0.34	0.34	0.18	0.18	0.25	0.34	0.5	0.8	0.95	0.66
	F	0.28	0.13	0.11	0.08	0.1	0.12	0.22	0.23	0.18	0.17	0.23	0.3	0.53	0.79	0.81	0.6
	G	0.09	0.05	0.04	0.03	0.04	0.03	0.08	0.11	0.1	0.1	0.13	0.19	0.33	0.41	0.32	0.23
4.7	A	0.32	0.29	0.18	0.08	0.08	0.06	0.09	0.09	0.09	0.15	0.28	0.27	0.14	0.19	0.64	0.41
	B	0.09	0.08	0.04	0.03	0.03	0.02	0.02	0.03	0.03	0.04	0.08	0.09	0.05	0.09	0.28	0.15
	C	0.06	0.05	0.03	0.02	0.02	0.01	0.02	0.02	0.02	0.04	0.05	0.07	0.05	0.07	0.21	0.13
	D	0.2	0.16	0.09	0.06	0.08	0.08	0.13	0.14	0.12	0.16	0.26	0.31	0.31	0.83	1.55	0.48
	E	0.21	0.1	0.09	0.06	0.09	0.08	0.15	0.21	0.13	0.15	0.27	0.54	0.95	1.72	1.52	0.45
	F	0.14	0.06	0.04	0.02	0.04	0.03	0.09	0.2	0.08	0.06	0.15	0.35	0.78	1.34	1.41	0.49
	G	0.04	0.01	0	0	0	0	0.03	0.05	0.03	0.03	0.06	0.15	0.33	0.47	0.64	0.27

Table F.35. (contd)

Average Wind Speed m/s	Atmospheric Stability Class	Percentage of Time Wind Blows from the 200 Area Toward the Direction Indicated															
		S	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**	**N**	**NNE**	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**
7.15	A	0.05	0.11	0.07	0.02	0.01	0	0.01	0.02	0.02	0.09	0.29	0.37	0.15	0.16	0.48	0.11
	B	0.02	0.02	0.02	0.01	0	0	0	0.01	0.01	0.03	0.05	0.09	0.04	0.06	0.14	0.03
	C	0.01	0.01	0.01	0	0	0	0	0.01	0.01	0.03	0.05	0.07	0.04	0.05	0.12	0.02
	D	0.06	0.08	0.04	0.02	0.01	0.01	0.04	0.08	0.08	0.17	0.34	0.46	0.39	0.85	1.18	0.15
	E	0.07	0.05	0.04	0.02	0.02	0.01	0.05	0.1	0.09	0.14	0.31	0.64	0.9	2.11	1.71	0.15
	F	0.04	0.03	0.03	0.01	0.01	0	0.03	0.08	0.03	0.03	0.06	0.23	0.39	0.88	1.3	0.15
	G	0	0	0	0	0	0	0.02	0.04	0.01	0	0.01	0.05	0.08	0.2	0.61	0.1
9.8	A	0.01	0.03	0.04	0.01	0	0	0	0	0.01	0.03	0.16	0.21	0.06	0.1	0.31	0.03
	B	0	0.01	0	0	0	0	0	0	0	0.01	0.05	0.05	0.01	0.03	0.08	0.01
	C	0	0	0	0	0	0	0	0	0	0.01	0.04	0.04	0.02	0.03	0.05	0.01
	D	0.02	0.03	0.02	0.01	0	0	0	0.02	0.04	0.11	0.29	0.28	0.15	0.51	0.68	0.04
	E	0.02	0.04	0.02	0	0	0	0.01	0.02	0.04	0.09	0.24	0.28	0.2	0.78	1.04	0.03
	F	0	0	0	0	0	0	0	0.01	0.01	0	0.02	0.03	0.04	0.08	0.19	0.01
	G	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0.03	0.08	0
12.7	A	0	0	0.01	0	0	0	0	0	0	0.02	0.09	0.1	0.02	0.02	0.16	0.01
	B	0	0.01	0	0	0	0	0	0	0	0.01	0.04	0.03	0.01	0.01	0.05	0
	C	0	0	0	0	0	0	0	0	0	0.01	0.02	0.02	0	0.01	0.04	0
	D	0.01	0.02	0.01	0.01	0	0	0	0.01	0.01	0.1	0.23	0.12	0.04	0.24	0.48	0.01
	E	0	0.02	0.01	0	0	0	0	0	0.02	0.07	0.13	0.08	0.04	0.19	0.39	0
	F	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table F.35. (contd)

Average Wind Speed m/s	Atmospheric Stability Class	Percentage of Time Wind Blows from the 200 Area Toward the Direction Indicated															
		S	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**	**N**	**NNE**	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**
15.6	A	0	0	0	0	0	0	0	0	0	0	0.02	0.02	0	0	0.02	0
	B	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0	0	0.01	0
	C	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0	0	0.01	0
	D	0	0	0	0	0	0	0	0	0	0.04	0.08	0.03	0.01	0.03	0.06	0
	E	0	0	0	0	0	0	0	0	0	0.03	0.04	0.01	0.01	0.03	0.05	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D	0	0	0	0	0	0	0	0	0	0.01	0.03	0.01	0	0	0	0
	E	0	0	0	0	0	0	0	0	0	0.01	0.01	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table F.36. Population Within 80 km (50 mi) of the 200 Areas

Downwind Sector	Distance Interval, mi					
	0–10	10–20	20–30	30–40	40–50	Total
S	0	959	790	175	4281	6205
SSW	0	180	12,966	293	298	13,737
SW	0	33	30,654	3205	95	33,987
WSW	1	53	2309	23,398	7055	32,816
W	7	37	188	10,558	118,630	129,420
WNW	0	1365	33	10	6178	7586
NW	11	3358	933	92	2336	6730
NNW	4	320	751	1713	7123	9911
N	0	170	2980	438	3018	6606
NNE	0	29	1085	4150	27,277	32,541
NE	0	115	10821	3651	670	15,257
ENE	0	347	1184	1705	220	3456
E	0	548	2387	1953	325	5213
ESE	0	305	1851	514	1301	3971
SE	0	213	51,919	96,942	1250	150,324
SSE	0	2316	17,659	905	7655	28,535
Total	23	10,348	138,510	149,702	187,712	486,295

F.1.4 Exposure Scenarios

Two exposure scenarios have been used to evaluate the potential impacts to humans from the waste remediation activities: industrial and resident gardener (agricultural). For waterborne pathways, an additional analysis was performed for the resident gardener scenario to include a sauna/sweat lodge exposure pathway (indicated in the result tables of this appendix as the hypothetical resident gardener with sauna/sweat lodge). These scenarios were chosen to represent a range of habits and conditions for potential exposures. The industrial and resident gardener scenarios are based on the recommendations presented in the *Hanford Site Risk Assessment Methodology* (HSRAM) (DOE-RL 1995) as adopted by the Tri-Party Agreement (Ecology et al. 1989). These scenarios are based on the concept of reasonable maximum exposure as recommended by EPA (EPA 1989) for which the most conservative parameter is not always used. The resident gardener with a sauna/sweat lodge scenario also includes exposure to waterborne contamination used in a sweat lodge (Harris and Harper 1997; DOE-RL 1998) or sauna. The resident gardener with a sauna/sweat lodge scenario is only applied to waterborne pathways because the airborne pathways do not contribute to the sauna/sweat lodge exposure pathways.

The present analysis has used the HSRAM scenarios and exposure parameter values as published (DOE-RL 1995). These scenarios and parameters provide a conservative estimate of potential exposures of individuals living on or near the Hanford Site. When the annual radiation dose is evaluated, the HSRAM scenarios are modified to reflect exposure for a one-year period instead of an extended exposure duration. The lifetime impacts can be estimated by multiplying the annual values by the exposure duration for the scenario (20 years for the industrial scenario and 30 years for the resident gardener scenario).

Exposure assessments are performed for atmospheric releases (from normal operations) and for long-term transport via groundwater. For normal operations, the exposure assessment uses the results from the atmospheric transport analysis as the starting point for evaluation of pollutant concentrations in exposure media (for example, air, soil, and foods). The analysis begins with the first release from a facility and continues until the releases have stopped and the individuals have been exposed for the prescribed duration for the specific exposure scenario. The operating and waste-handling periods for the facility being considered determine the release period. During the release period, the transported material may be deposited into soil resulting in a gradual increase over time in concentrations of pollutants in soil. The accumulation in soil is evaluated explicitly by the MEPAS program and is used to determine the annual maximum radiation dose and the exposures for each of the exposure scenarios.

For long-term transport via groundwater, the exposure assessment uses the estimated water concentration at the point of exposure (for example, a point of analysis 1 kilometer from the 200 East Area, a point of analysis 1 kilometer from the 200 West Area, a point of analysis 1 kilometer from the ERDF site, and another point of analysis near the Columbia River). This water is used as the source of domestic water for irrigation of food crops, animal product feed, and animal drinking water (for the resident gardener scenario).

Two exposure scenarios are summarized in the following sections. The scenarios are described for exposure pathways involving atmospheric releases as well as releases resulting in groundwater contamination. The atmospheric pathways are evaluated to estimate health impacts for releases to air from normal operations; waterborne pathways are evaluated to estimate health impacts from releases to soil and transport via groundwater to the environment. A discussion of each exposure pathway follows the scenario descriptions.

F.1.4.1 Industrial Scenario

The industrial scenario is intended to represent potential exposures to workers in a commercial or industrial setting. The scenario primarily involves indoor activities, but outdoor activities (such as soil contact) also are included. The workers are assumed to wear no protective clothing. The scenario is not intended to represent exposure of remediation workers. For atmospheric releases, the worker is assumed to be located 100 m (328 ft) east of the release point. The specific exposure pathways included in the industrial scenario are listed in Table F.37 for radionuclides, chemicals, and the atmospheric transport medium. Parameter values for the pathways are presented in Table F.38.

Table F.37. Industrial Scenario Exposure Pathways

Transport Medium	Exposure Pathway	Chemical	Radionuclide
Air (with deposition to soil)	Ingestion	Yes	Yes
	External	No	Yes
	Dermal absorption	Yes	No
	Soil suspension – inhalation	Yes	Yes
	Air inhalation	Yes	Yes

Table F.38. Industrial Scenario Parameter Values

Exposure Parameters[(a)]					
Source	**Exposure Pathway**	**Intake Rate**	**Exposure Frequency, d/yr**	**Conversion Factors**	**Other Factors**
Air (with deposition to soil)	Soil ingestion	50 mg/d	146	1.0E-06 kg/mg	NA
	Soil external	8 hr/d	146	NA	0.8[(b)]
	Soil dermal absorption	0.2 mg/cm^2/d	146	1.0E-06 kg/mg	5000 cm^2[(c)]
	Soil suspension – inhalation	20 m^3/d	250	1.0E-09 kg/μg	50 μg/m^3 [(d)]
	Air inhalation	20 m^3/d	250	NA	NA

(a) For all cases, the body weight is 70 kg (155 lb). The exposure period is 1 year for annual dose estimates and 20 years for other analyses.
(b) Average shielding factor for external exposure to contaminated soil.
(c) Skin surface area contacted with soil by the worker.
(d) Average particulate loading in air.
NA = not applicable.

F.1.4.2 Resident Gardener Scenario

The resident gardener scenario is intended to represent potential exposures to an individual living near the Hanford Site and raising food and animal products for home consumption. The agriculture scenario from the HSRAM is applied to atmospheric and groundwater transport pathways. This scenario is the same as the agricultural scenario representing the point of maximum offsite air concentration for routine releases. The specific exposure pathways for radionuclides and chemicals that are included in the resident gardener scenario are listed in Table F.39. Parameter values for each exposure pathway are presented in Table F.40.

Several different exposure pathways are considered in the health impacts analyses. The pathways included in a specific analysis depend on the transport medium, scenario, and pollutant type (that is, chemical or radionuclide), as indicated in the previous section. Details of each exposure pathway are presented here by transport medium. In general, the parameter values for a pathway are taken from DOE-RL (1995), Harris and Harper (1997), and DOE-RL (1998) for the sauna/sweat lodge pathway.

Table F.39. Resident Gardener Scenario Exposure Pathways

Transport Medium	Exposure Pathway	Chemical	Radionuclide
Soil (air deposition)	Ingestion	Yes	Yes
	External	No	Yes
	Dermal absorption	Yes	No
	Biota – dairy	Yes	Yes
	Biota – meat	Yes	Yes
	Biota – game (deer)	Yes	Yes
	Biota – fruit	Yes	Yes
	Biota – vegetables	Yes	Yes
	Suspension – inhalation	Yes	Yes
Air	Inhalation	Yes	Yes
	Biota – dairy	Yes	Yes
	Biota – meat	Yes	Yes
	Biota – game (deer)	Yes	Yes
	Biota – fruit	Yes	Yes
	Biota – vegetables	Yes	Yes
Groundwater	Ingestion	Yes	Yes
	Dermal absorption (bathing)	Yes	No
	Biota – dairy	Yes	Yes
	Biota – meat	Yes	Yes
	Biota – game (deer)	Yes	Yes
	Biota – fruit	Yes	Yes
	Biota – vegetables	Yes	Yes
	Inhalation indoor	Yes	Yes

Table F.40. Resident Gardener Scenario Parameter Values

Source	Exposure Pathway	Intake Rate	Exposure Frequency, d/yr	Conversion Factors	Other Factors
Exposure Parameters[(a)]					
Soil	Ingestion	100 mg/d	365	1.0E-06 kg/mg	NA
	External	24 hr/d	365	NA	0.8[(b)]
	Dermal absorption	0.2 mg/cm^2/d	180	1.0E-06 kg/mg	5000 cm$^{2(c)}$
	Inhalation	20 m^3/d	365	1.0E-09 kg/µg	50 µg/m$^{3(d)}$
Air	Inhalation	20 m^3/d	365	NA	NA
Groundwater	Ingestion	2 L/d	365	NA	NA
	Inhalation (sauna or sweat lodge)	20 m^3/d	365	NA	1.9 L/m$^{3(e)}$ VOC 0.3 L/m$^{3(f)}$ non-volatile 1 hr/d[(g)] 4 L/d
	Dermal absorption	0.17 hr/d	365	1.0E-03 L/cm^3	20,000 cm$^{2(f)}$
Biota	Dairy	300 g/d	365	1.0E-03 kg/g	NA
	Meat	75 g/d	365	1.0E-03 kg/g	NA
	Game	15 g/d	365	1.0E-03 kg/g	NA
	Fruit	42 g/d	365	1.0E-03 kg/g	NA
	Vegetable	80 g/d	365	1.0E-03 kg/g	NA

(a) For all cases the body weight is 70 kg (155 lb). The exposure period is for 1-year annual dose estimates and 30 years for other analyses.
(b) Average shielding factor for external exposure to contaminated soil.
(c) Skin surface area contacted with soil by the worker.
(d) Average particulate loading in air.
(e) The sauna or sweat lodge transfer factor (1.9 L/m^3) for VOCs assumes 4 L/d water use in a hemisphere of a 2-m (6.6-ft) diameter with complete suspension of all contaminants.
(f) Skin surface area contacted during bathing with domestic water.
(g) Ratio of indoor air concentration to water concentration for volatilization from indoor water uses.
NA = not applicable.

F.1.4.3 Soil (Air or Irrigation Water Deposition) Transport Medium

Deposition of airborne activity on soil would result in exposure to individuals who come in contact with the soil, breathe resuspended particles from the soil, or eat foods grown in the soil. The contamination deposited onto soil is modeled as a pollutant concentration per unit area of soil. Some of the soil exposure pathways require concentration to be expressed in units of soil mass (mg/kg or pCi/kg dry soil). For these pathways, the conversion to soil mass is made using the conversion factor 60 kg/m^2 that is based on uniform distribution of the contaminant in the top 4 cm (1.6 in) of soil having a density of

1.5 g/cm^3. This thickness is representative of the distribution of contaminants in residential soil (such as lawns) for deposition occurring over extended periods (for instance, several years). For agricultural pathways, the conversion is based on uniform distribution in 15 cm (6 in) of soil (plow layer) with a conversion factor of 225 kg/m^2.

The parameter values for each exposure pathway related to soil as a medium were presented in Tables F.38 and F.40 for the two exposure scenarios. Notes on the exposure pathways follow.

Soil Ingestion. The individual is assumed to inadvertently ingest contaminated soil as part of daily activities defined for the scenarios. The resident gardener ingests soil at 100 mg/day for the entire year, while the industrial worker ingests 50 mg/day while on the job for 146 days per year. It is assumed the worker is exposed to soil for only 146 of the 250 workdays per year.

Soil External Exposure. Radionuclides deposited onto soil may cause external radiation exposure to individuals near the contamination. The industrial worker is assumed to be exposed 8 hours per day for 146 days per year. The resident gardener is assumed to be exposed 24 hours per day for 365 days per year.

Soil Dermal Contact. The dermal contact pathway is evaluated only for chemicals (as recommended in DOE-RL1995). The individuals are assumed to have 1 contact event per day (a 12-hour period) with soil adhering to the skin at a surface density of 0.2 mg/cm^2 of skin for the industrial and resident gardener scenarios. The area of skin contacted is assumed to be 5000 cm^2 for all scenarios. The industrial worker is assumed to be exposed 146 days per year; the resident gardener is assumed to be exposed 180 days per year.

Soil Resuspension Inhalation. Material deposited on the ground is assumed to be available for resuspension and inhalation by individuals in proximity to the contamination. The industrial worker and resident gardener scenarios assume the individual inhales 20 m^3 (706 ft^3) of contaminated air per day. The airborne concentration of soil is evaluated using the mass loading factor approach with a particulate air concentration to 50 $\mu g/m^3$ of soil in air.

Food Crops. Food crops are evaluated as fruits and vegetables for the resident gardener scenario. The crops are contaminated when soil contamination (from airborne deposition or irrigation water application) transfers to the edible parts of the plant by root uptake. The resident gardener is assumed to eat food crops at a rate of 42 g/day (1.48 oz/day) of fruit and 80 g/day (2.82 oz/day) of vegetables throughout each year of the 30-year exposure period. The soil concentration is based on a soil mixing depth of 15 cm (5.9 in.) and a soil density of 1.5 g/cm^3, which is equivalent to an areal soil density of 225 kg/m^2.

Game (Deer). For the resident gardener scenario, the individual is assumed to hunt and kill one deer during the year. The deer becomes contaminated when foraging on plants grown in contaminated soil. The HSRAM scenario applies a hunter success rate of 19 percent for a season. This percentage is appropriate when the exposure duration is many years (30 years for HSRAM), but is not appropriate when considering a one-year period. The annual dose analysis must assume the hunter is successful (a success rate equal to 100 percent for the year of exposure). Also, the HSRAM intake rate for deer meat is based on the amount of animal fat in the consumed meat. Although this assumption may be appropriate for organic chemical pollutants that are lipophilic, it is not generally appropriate for radionuclides. Also, the exposure pathway models for radionuclides evaluate the activity in the edible meat, not fat. The intake rate for deer meat, therefore, must be adjusted to represent the amount of meat ingested. This value is 15 g/day (0.53 oz/d), as calculated and reported for the recreational scenario of the Columbia River Comprehensive Impact Assessment (CRCIA) project (DOE-RL 1998).

Meat and Milk Ingestion. Individuals in the resident gardener scenario are assumed to ingest 75 g/day (2.65 oz/day) of meat (other than game) and 300 g/day (10.6 oz/day) of dairy products (represented as milk). The animal product becomes contaminated when the animal eats feed crops contaminated by root uptake from contaminated soil.

F.1.4.4 Air Transport Medium

Airborne activity may result in inhalation exposure plus direct transfer to plant surfaces, resulting in intake of contaminated food crops and animal products (from animals that eat contaminated feed crops). The parameter values for each exposure pathway related to air as a medium were presented in Tables F.37 through F.40 for the two exposure scenarios. Notes on the exposure pathways follow.

Inhalation. For the two HSRAM scenarios, the individual inhales 20 m^3 (706 ft^3) of air during the time the individual is present. For the industrial worker, this volume of air is inhaled during an 8-hour period, during which the individual is engaged in enhanced physical activity. For the resident gardener, the air is inhaled during a 24-hour period at average daily inhalation rates. The industrial worker is exposed 250 days per year; the resident gardener is exposed 365 days per year.

Food Crops. Food crops are evaluated as fruits and vegetables for the resident gardener scenario. The crops are contaminated when airborne contamination transfers directly to the plant surface and is incorporated into edible parts of the plant. Parameters for this pathway are defined in Section F.1.4.3.

Game (Deer). For the resident gardener scenario, the individual is assumed to hunt and kill one deer during the year. The dose for this pathway is evaluated as described under Section F.1.4.3. Deer are potentially contaminated for the air transport medium when they eat plants contaminated from direct air deposition onto plant surfaces plus root uptake of airborne deposition onto soil.

Meat and Milk Ingestion. The animals are exposed from eating feed crops that may be contaminated by direct air deposition plus root uptake of airborne deposition onto soil. Parameters for these pathways are defined in Section F.1.4.3.

F.1.4.5 Waterborne Transport Medium

Waterborne activity may result in exposure from domestic water uses and irrigation water uses. Groundwater used to supply drinking water for domestic water for residences can result in exposure via water ingestion, inhalation of volatile chemicals released during showering and washing, and dermal contact during bathing. The parameter values for each exposure pathway related to groundwater as a medium were presented in Table F.39. Notes on the exposure pathways follow.

Ingestion of Drinking Water. The resident gardener consumes 2 L/day (0.53 gal/day) during each day of the year.

Indoor Air Inhalation. Individuals may be exposed to contaminated indoor air from volatilization of chemicals from indoor uses of domestic water. This exposure includes air inhalation while showering. The resident gardener is exposed daily with a breathing rate of 20 m^3 (706 ft^3) per day.

Sauna or Sweat Lodge Air Inhalation. Individuals who participate in sauna or sweat lodge activity may be exposed to contaminated air from the contaminants in water used to generate humidity. The amount of a pollutant transferred to air from the water is dependent on the physical properties (volatility) of the pollutant and the amount of water used. The typical use of water is 4 L (1.01 gal) over a 1-hour period. Volatile chemicals could be totally transferred to the air. Using a sauna or sweat lodge volume based on a 2-m (6.6-ft) diameter hemisphere (Harris and Harper 1997), the transfer factor is 1.9 L/m^3 (4 L [1.01 gal]) water per volume of 2-m (6.6-ft) diameter hemisphere. This value relates the air concentration inside the sauna or sweat lodge to the water concentration used to generate the humidity.

The transfer of non-volatile compounds (and most radionuclides) is determined by the amount of water vapor that can be held in the air. Excess water vapor (and associated non-volatile pollutants) would condense and be removed from the air. The estimated transfer factor of 0.3 L/m^3 is based on recommendations of Harris and Harper (1997) and is intended to maximize the concentration of non-volatile compounds in the air.

Water Dermal Contact. Individuals may be exposed to contaminated water while bathing. Dermal absorption of chemicals in shower water is evaluated using methods recommended by the EPA (EPA 1992). Residents are exposed each day of the year.

Food Crops, Game (Deer), Meat, and Milk Ingestion. Parameter values for these exposure pathways are as defined in Section F.1.4.3.

F.1.5 Soil Accumulation Model

The accumulation of pollutants in soil is represented using a box model with loss rate constants to represent radioactive decay, leaching, and volatilization of volatile and semi-volatile compounds.

The losses from volatilization are represented by a loss rate constant that was evaluated based on physical properties of the chemical. The loss rate constants were evaluated using the volatilization model of Streile et al. (1996) with soil parameters defined for Hanford agricultural soil (Sandy Loam). The evaluation was performed using the MEPAS 4.0 source term component under the FRAMES operating system (Whelan et al. 1997). The estimated half-times are presented in Table F.41.

Table F.41. Volatilization Half-Times for Soil

Chemical	Soil Half-Time Volatilization (Days)
Acetone	4.0E+02
Bromodichloromethane	3.8E+02
Carbon tetrachloride	1.2E+02
Dichloromethane	5.1E+01
Diesel fuel	8.5E+03
Hydraulic fluid	8.7E+03
Methyl ethyl ketone	8.4E+02
Polychlorinated biphenyls (PCBs)	4.4E+04
p-chloroaniline	1.4E+04
Toluene	2.7E+02
1,1,1 Trichloroethane	2.3E+02
Xylene	2.2E+02

The losses from radioactive decay (and progeny generation) are evaluated using the general decay algorithm of Strenge (1997).

The leaching losses from the surface soil layer are evaluated from the distribution coefficient (K_d) value, as shown in Equation F.2.

$$\lambda_{\mathrm{i}} = \frac{I}{\mathrm{h}\,\theta\,(1 + \frac{\beta_{\mathrm{d}}}{\theta}\,\mathrm{k}_{di}\ )} \tag{F.2}$$

where λ_i = loss rate constant for pollutant i from surface soils (1/yr)
I = total infiltration rate (cm/yr)
h = thickness of the surface-soil layer (cm)
θ = moisture content of the surface-soil layer (fraction)
β_d = bulk density of the surface-soil layer (g/cm^3)
k_{di} = distribution coefficient for pollutant i (mL/g).

Evaluation of the leach rate constant requires an estimate of the K_d for each contaminant. The following paragraphs describe the method used to evaluate the K_d values for radionuclides and chemicals.

Values used for the distribution coefficient were selected to give low leach rate constants (high retention times). This selection would result in a conservative (high) estimate of radiation dose or chemical intake for those exposure pathways that involve accumulation in soil. The parameters for agricultural soil are used for all exposure pathways, as a simplification to the analysis and a further conservatism for the residential exposure pathways. Residential soil would be expected to involve mixing in a smaller depth (represented in Equation F.2 by parameter h). A smaller value for soil depth would result in a faster leach rate and lower equilibrium concentrations. Residential and industrial soils are assumed to be subject to the same infiltration rate as agricultural lands because of lawn watering.

F.1.5.1 Evaluation of Distribution Coefficient for Organic Chemicals

The general algorithm for estimation of K_d values for organic chemicals is taken from Strenge and Peterson (1989), as shown in Equations F.3 and F.4:

$$K_d = 0.0001 K_{oc} S_d \qquad \text{(F.3)}$$

where K_d = distribution coefficient (mL/g)
K_{oc} = carbon matter water distribution coefficient (mL/g)
S_d = soil distribution coefficient (dimensionless)
0.0001 = empirical coefficient.

The soil distribution coefficient is evaluated based on soil properties as follows:

$$S_d = 57.735\ (\%\ organic\ matter) + 2.0\ (\%\ clay) + 0.4\ (\%\ silt) + 0.005\ (\%\ sand) \qquad \text{(F.4)}$$

where the empirical coefficients have units of 1 percent.

As this equation indicates, the soil composition is important to the evaluation of the K_d. For the present analysis, the soil type is based on an agricultural soil composed of typical Hanford soil, with the carbon matter composition based on typical agricultural soils. Surface soils of Hanford are dominated by Rupert Sand, Ephrata Sandy Loam, and Burbank Loamy Sand (see Section 4.3.4). The approximate composition of these soils is indicated in Table F.42.

The properties of Sandy Loam provide higher estimates of K_d than the other two soil types because clay results in a higher contribution to the soil distribution coefficient than sand or silt. Typical agricultural soils contain about 1.2 percent organic carbon (Connor and Shacklette 1975). Assuming the weight of organic carbon is about half of the weight of the organic matter, the total content of organic matter is about 2.4 percent.

Table F.42. Soil Classification Composition

Soil Classification	% Sand	% Silt	% Clay
Sand	92	5	3
Loamy Sand	83	11	6
Sandy Loam	65	25	10

The estimate of S_d and K_d is based on Sandy Loam with a carbon matter content of 2.4 percent, with the carbon matter percent value replacing sand. The net composition is 62.6 percent sand, 25 percent silt, 10 percent clay, and 2.4 percent carbon matter. This soil composition results in a value of 169 for S_d.

The K_{oc} values are taken from the MEPAS chemical database. Evaluation of K_d values is indicated in Table F.43 for the hazardous chemicals in the waste stream inventories.

Table F.43. Soil-Related Properties of Hazardous Chemicals

Chemical	K_{oc}	K_d
Beryllium	--	1.0E+02
Nitric acid	--	1.0E+01
Sodium nitrate	--	1.0E+01
Sodium hydroxide	--	1.0E+01
1,1,1 trichloroethane	1.5E+02	2.6E+0
Polychlorinated biphenyls	6.1E+05	1.0E+04
p-chloroaniline	4.2^{E}+01	7.0E-01
Carbon tetrachloride	5.0E+02	8.4E+0
Hydraulic fluid	1.4E+04	2.4E+02
Toluene	3.0E+02	5.0E+00
Formic acid	1.8E-01	3.0E-03
Dichloromethane	8.8E+00	1.4E-01
Acetone	5.8E-01	9.7E-02
Methyl ethyl ketone (MEK)	4.5E+00	7.6E-02
Diesel fuels	4.5E+03	7.6E+01
Xylene	2.4E+02	4.0E+00
Mercury	--	8.0E+04
Bromodichloromethane	1.0E+02	1.8E+00
-- = A K_{oc} value is not needed for inorganic chemicals.		

F.1.5.2 Evaluation of Distribution Coefficients for Radionuclides and Inorganic Chemicals

The distribution coefficient values for radionuclides and inorganic chemicals were selected based on a literature review of values for the inorganic chemicals and radionuclide elements in the waste stream inventories. The selected K_d values are listed in Table F.44.

The K_d value for sodium nitrate, sodium hydroxide, and nitric acid are based on the value used for potassium-40; the value for mercury is the same as the value for lead. The values are based primarily on chemical similarity and solubility. The value for beryllium is a default value set to cause very little leaching (a conservative estimate for impacts).

Table F.44. Distribution Coefficients of Radionuclides and Inorganic Chemicals

Analyte Name[(a)]	Distribution Coefficient (mg/g)
Americium	5,000
Beryllium	100
Bismuth	900
Cesium	100
Cobalt	100
Curium	1,500
Iron	100
Lead	80,000
Manganese	2,400
Mercury	80,000
Neptunium	1,500
Nickel	2,400
Nitrate	10
Nitrite	10
Plutonium	5,000
Polonium	1,100
Protactinium	3,600
Radium	500
Radon	0.1
Sodium hydroxide	10
Strontium	180
Thorium	600,000
Tritium	0.7
Uranium	7
Yttrium	15,00

(a) The distribution coefficient applies to all isotopes of the listed element.

F.1.6 Health Impacts

The evaluation of annual radiation dose is based on radiation dose conversion factors as published in Federal Guidance Reports (FGRs) 11 and 12 (Eckerman et al.1988; Eckerman and Ryman 1993). These dose factors are based on recommendations of the International Commission on Radiological Protection (ICRP) as given in ICRP Publication 30 (ICRP 1979, 1980, 1981, 1988). The resulting doses represent the effective dose equivalent received over a commitment period of 50 years following intake in the first year.

For non-carcinogenic chemicals, the health endpoint is the hazard quotient defined by EPA as the average daily intake of a chemical divided by the reference dose (RfD) for that chemical. The hazard quotient is evaluated for both inhalation exposures and ingestion exposures with RfD determined for each route. For carcinogenic chemicals, the health endpoint is the lifetime cancer incidence from the defined total intake.

The evaluation of radiation dose as the endpoint in the analysis is a deviation from the guidance in the HSRAM report (DOE-RL 1995). The HSRAM report describes evaluation of the lifetime cancer incidence risk from radionuclides using slope factors. The slope factors relate intake (pCi) to the lifetime cancer incidence risk. However, the present analysis requires evaluation of annual radiation dose. The use of slope factors has, therefore, been replaced in the present analysis by use of radiation dose conversion factors.

F.1.7 Basis for Radiological Health Consequences

Estimates of consequences from radiological exposures to workers and the public are based on recommendations of the EPA, as presented in FGR 13 (Eckerman et al. 1999). The consequences in terms of latent cancer fatalities (LCFs) and total detrimental health effects are presented in Table F.45 for both adult workers and the general population. The total incidence of detrimental health effects includes both fatal and non-fatal cancers and severe hereditary effects.

Table F.45. Summary of Basis for Health Consequences from Radiological Exposures from Federal Guidance Report 13 (from Eckerman et al. [1999])

Type of Health Effect	Effects per Unit Radiation Dose(a)	Radiation Dose to Produce 1 Effect(a)
Latent Cancer Fatality – All Individuals	6×10^{-4} /person-rem	1700 person-rem
Total Detriment(b) All individuals	8.5×10^{-4} /person-rem	1200 person-rem

(a) To convert person-rem to person-Sv, multiply by 0.01.
(b) Total detriment includes fatal and non-fatal cancers and severe hereditary effects.

The EPA recommendations are similar to those of the ICRP (1991), which are shown in Table F.46. Again, the total incidence of detrimental health effects includes both fatal and non-fatal cancers and severe hereditary effects. The higher rates for health effects in the general population account for the presence of more sensitive individuals, such as children, compared to the relatively homogeneous population of healthy adults in the workforce. These health effects coefficients are used to estimate the number of LCFs in populations, or the risk of an LCF to an individual, for the purposes of comparing the alternatives and activities discussed in this HSW EIS. The ICRP health effects coefficients have been adopted by the National Council on Radiation Protection and Measurements (NCRP 1993) and are similar to those developed by other organizations (for example, UNSCEAR 1988; Eckerman et al. 1999). Use of the health effects coefficients developed by these other organizations would result in conclusions regarding health effects similar to those presented in this HSW EIS.

Table F.46. Basis for Health Consequences from Radiological Exposures (from ICRP [1991])

Type of Health Effect	Effects per Unit Radiation Dose[(a)]	Radiation Dose to Produce 1 Effect[(a)]
Latent Cancer Fatality		
Adult Workers	4 x 10^{-4} /person-rem	2500 person-rem
General Population	5 x 10^{-4} /person-rem	2000 person-rem
Total Detriment[(b)]		
Adult Workers	5.6 x 10^{-4} /person-rem	1800 person-rem
General Population	7.3 x 10^{-4} /person-rem	1400 person-rem

(a) To convert person-rem to person-Sv, multiply by 0.01.
(b) Total detriment includes fatal and non-fatal cancers and severe hereditary effects.

The health effects coefficients are based on radiation exposures to specific populations and for different doses, dose rates, and pathways than those normally encountered in the environment. As a result, the health effects coefficients in Table F.46 are subject to substantial uncertainty when applied to very low or very high doses, and when extrapolated to estimate health effects in populations different from those used to develop them. The NCRP (1997) has estimated the range (90 percent confidence interval) of these health effects coefficients to be approximately a factor of two above and below the median values presented in Table F.46.

For some hypothetical radiological accidents discussed in this HSW EIS, the estimated doses to onsite or offsite individuals may be greater than the doses to which these health effects coefficients were intended to apply. Depending upon the radionuclides involved and the exposure pathways considered, the LCF risk may be as much as twice that listed in Table F.45 for doses greater than 20 rem but less than a few hundred rem. For doses greater than a few hundred rem, there is a potential for short-term health effects other than cancer and hereditary effects (again, depending upon the radionuclides and exposure pathways associated with a particular accident scenario). For a further discussion of uncertainties, see Section 3.5 in Volume I of this EIS.

The estimation of health effects in a given population is determined by applying the health effects coefficients to the collective dose for that population. Collective dose is defined as the sum of doses to all individuals in the population who may exhibit a wide range of susceptibility to radiation-induced health effects. The health effects coefficients are, therefore, associated with substantial uncertainty when applied to dose estimates for individuals whose sensitivity may differ from the population average. However, as stated in ICRP (1991), assumptions used to develop the health effects coefficients were intended to be sufficiently conservative that they would be "…unlikely to underestimate the risks."

F.1.8 Comparison of Radiation Risk Results for Children—Estimated Using Federal Guidance Reports 11 and 13

All dose results in this HSW EIS have been estimated using the internal radiation dose conversion factors recommended in FGR 11 (Eckerman et al.1988). As an approximation, radiation risks were estimated using an individual dose-to-risk conversion factor of 0.0006 risk of induction of a latent cancer fatality per rem of dose, as recommended by EPA (Eckerman et al. 1999). All estimates presented in this HSW EIS are based on exposure of adults.

Radiation doses and risks to children are different from those to adults for the same concentrations of contaminants in the environment because children generally eat and drink less than adults (except possibly for milk) so their bodies metabolize contaminants differently than adults, and their organs have different masses than adult organs. In addition, children may have different sensitivities than adults to radiation for a given radiation dose. Eckerman et al. (1999) provides tables of ingestion dose and risk to children for a unit intake of radionuclides that may be used to evaluate the potential differences in dose and risk to children and adults for given groundwater concentrations of radionuclides of interest in this HSW EIS.

The radiation risks for adults in this HSW EIS are estimated using predicted radionuclide concentrations in waster, assumed drinking rates, radionuclide-specific radiation dose conversion factors, and a dose-to-risk conversion. A similar calculation can be done using a drinking rate appropriate for children and the radionuclide-specific risk conversion factor. The ratios of annual dose and risks estimated for children, using a 1 L/day drinking water intake rate, to the annual risk for adults, as calculated in this HSW EIS, are presented in Table F.47.

The HSW EIS approach would over-estimate the risk to children from ingestion of iodine-129, but slightly underestimate the dose. Doses and risks to children from carbon-14 would be about twice as high as those for adults; however, carbon-14 was found to be a minor contributor to dose for all the alternative groups. Risks to children from technetium-99 would be an order of magnitude greater, and doses would be a factor of 6 greater. Technetium-99 was found to be a major contributor to drinking water dose for several millennia, and, although the risk to children would be higher, the annual dose was found to not exceed the DOE 4 mrem/yr drinking water standard using the higher factor. The methods used for adults were approximately the same as those for children for isotopes of uranium.

Table F.47. Ratios of Dose and Risk to Children over Dose and Risk to Adults from 1-Year Ingestion of Contaminated Drinking Water

Radionuclide	Dose Ratio (Child/Adult)	Risk Ratio (Child/Adult)
Carbon-14	1.4	2.3
Technetium-99	6.0	11
Iodine-129	1.4	0.2
Uranium-233	0.88	1.1
Uranium-234	0.87	1.1
Uranium-235	0.90	1.2
Uranium-236	0.87	1.1
Uranium-238	0.88	1.1

F.2 Accident Impact Assessment Methods

In this HSW EIS, estimates of accident consequences for Hanford waste management facilities and operations are based on analyses of accident scenarios identified in existing Hanford nuclear facility safety analyses, including Bushore (2001), Tomaszewski (2001), Vail (2001a, 2001b, 2001c), and WHC (1991). Details of the accident analyses are presented in these documents and are summarized in Volume I, Section 5.11.

The accident consequences presented in this HSW EIS differ from those in the Hanford safety documents because of differences and calculation adjustments that are described in the following paragraphs. Adjustments were made to the analysis results to update calculations and to meet the needs of the environmental impact analysis rather than those of the safety analyses for which the analyses were originally prepared. Except for those changes and adjustments specifically noted, all calculations and assumptions remain the same.

Changes and adjustments to safety document calculations include the following:

- Updated Hanford meteorological data were used to estimate atmospheric dispersion factors. Composite joint frequency data, including the years 1983 through 1996, were used for this HSW EIS analysis.

- The environmental impact analysis used 95th percentile atmospheric dispersion factors, whereas safety analyses typically use 99.5 percentile atmospheric dispersion factors. (Building wake and plume meander factors used in the safety analyses remain incorporated in this HSW EIS consequence estimates.)

- The locations of the maximally exposed individual (MEI) member of the public and the MEI non-involved worker were changed from those in the safety analyses. For this HSW EIS analysis, the MEI was located at the nearest publicly accessible location on U.S. State Route 240 (generally a 3- to 5-km [1.9- to 3.1-mi] distant), and the MEI non-involved worker was located 100 m (109 yd) away. For the safety analyses, the MEI member of the public was located at the Hanford Site boundary, typically a distance of 12 km (7.4 mi), and the co-located worker was at the nearest facility, typically a distance of 800 m (872 yd). The difference in the locations of hypothetically exposed individuals is the most important reason for differences in the dose estimates between this HSW EIS and the Hanford safety analyses.

- Only the period of plume passage was considered for exposure pathways and doses in this HSW EIS analysis. Thus, inhalation is the most important exposure pathway, particularly for TRU waste radionuclides with much smaller contributions from immersion and ground deposition.

- Doses are presented only as total effective dose equivalent (TEDE) in this HSW EIS.

- This HSW EIS presents estimates of dose and radiological impact (as the probability of LCFs) to exposed individuals, whereas the safety analyses present only estimates of dose.

- This HSW EIS presents estimates of collective dose and radiological impact (as the postulated number of LCFs) to the exposed population of the general public from an accident scenario. Safety analyses do not present this information.

- The environmental impact analysis used an updated list of temporary emergency exposure limits (TEELs) to evaluate potential impacts from exposure to non-radiological hazardous chemicals. Additional information on TEELs is presented in Section F.2.3.

- This HSW EIS presents estimated impacts from industrial and occupational accidents. Safety analyses do not present this information. Additional information for each alternative group is presented in Volume I, Section 4.10 and in the industrial accidents sections of Volume I, Section 5.11.

F.2.1 Adjustment Method

The method for adjusting dose results presented in the safety analyses for the environmental impact analysis is shown in the following equations. It is a simple ratio of acute release atmospheric dispersion factors (E/Q) and the calculated doses. The E/Q is a measure of atmospheric dispersion for short-term (acute) atmospheric releases using Gaussian dispersion plume modeling, with units of s/m^3. For a given point or location at some distance from the source, it represents the time-integrated air concentration ($Ci \cdot s/m^3$) divided by the total release from the source (Ci). E/Qs are typically used for releases lasting no longer than 8 to 24 hours. The effective dose equivalent (EDE) used in the safety analyses is equivalent to the TEDE used in the environmental impact analysis.

$$\frac{TEDE_{EIS}}{EDE_{SA}} = \frac{E/Q_{EIS}}{E/Q_{SA}} \qquad \text{(F.5)}$$

or

$$TEDE_{EIS} = EDE_{SA} * \frac{E/Q_{EIS}}{E/Q_{SA}} \qquad \text{(F.6)}$$

where EIS = used in this EIS
SA = used in the safety analyses.

A similar method was used for estimating collective dose to the population within 80 km (50 mi), except that a population-weighted atmospheric dispersion factor was used instead of the single-point dispersion factor. Collective dose estimates were based on the atmospheric dispersion and dose to the MEI member of the public presented in the safety analyses.

$$TEDE_{pop,EIS} = EDE_{MEI,SA} * \frac{E/Q_{pop,EIS}}{E/Q_{MEI,SA}} \quad \text{(F.7)}$$

where pop,EIS = population-weighted atmospheric factor used in this EIS

MEI,SA = maximally exposed individual member of the public used in the safety analyses.

A similar method was used for adjusting air concentrations at the point of exposure of individuals to non-radiological hazardous chemicals. These adjusted air concentrations were then compared to the revised TEELs list,

$$C_{EIS} = C_{SA} * \frac{E/Q_{pop,EIS}}{E/Q_{MEI,SA}} \quad \text{(F.8)}$$

where C is the air concentration of a particular hazardous chemical at the point of exposure.

Table F.46 presents the atmospheric dispersion parameters used in the accident analysis for the onsite non-involved worker and offsite locations of the exposed individuals and population.

F.2.2 Accident Frequency

As the first step in the safety analysis process, a preliminary hazard analysis is performed to identify the range of potential accident scenarios applicable to each facility. Each accident scenario in the complete suite of events is then assigned to one of several relative frequency and consequence categories. For this purpose, accident scenarios are often binned into one of three frequency ranges: “anticipated” (events having an expected frequency between 0.01 and 1.0 per year), “unlikely” (events having an expected frequency between 1 x 10^{-4} and 1 x 10^{-2} per year), and “extremely unlikely” (events having an expected frequency between 1 x 10^{-6} and 1 x 10^{-4} per year). Events having an expected frequency less than 1 x 10^{-6} per year are considered “incredible” and are typically not evaluated in detail for safety analyses. From the set of accident scenarios, one or more are selected from each frequency range for further detailed analysis. The accidents selected for detailed evaluation include the events that are considered to have the highest potential consequences for each frequency category, although other accidents in each frequency category may be analyzed to better represent the range of potential impacts and types of accident scenarios (such as fires, handling accidents, or external events such as earthquakes).

As noted previously in this section, the accident analyses presented in the HSW EIS are based on safety analysis reports for existing waste management facilities, or on preliminary evaluations prepared for proposed facilities. Frequencies reported in the HSW EIS for specific accidents are taken directly from those evaluations, where available. However, this HSW EIS presents the accident consequences without regard to frequency of occurrence, and estimated accident frequencies were not incorporated into the reported consequences or risk estimates.

F.2.3 Non-Radiological Impact Endpoints

Estimates of consequences of exposure to potentially hazardous chemicals were based on one-hour exposures, consistent with the assumptions of the Emergency Response Planning Guidelines (ERPGs). Also used were TEELs that are interim, temporary, or equivalent exposure limits for chemicals for which official ERPGs have not yet been developed. At its April 1996 meeting in Knoxville, Tennessee, the DOE Subcommittee on Consequence Assessment and Protective Actions (SCAPA) adopted the term TEEL. These exposure limits must be regarded as dynamic; if new concentration limits are issued (for example, ERPG, permissible exposure level, or threshold limit value) or if new or additional toxicity data are found, the TEEL would be revised. At the time of this analysis, TEEL values were provided for over 1340 additional chemicals. ERPGs adopted through January 1, 2000, are located on the SCAPA Internet Web site (DOE 2002). The most recent TEELs list revision is *ERPGs and TEELs for Chemicals of Concern: Rev 19* (Craig 2002).

Potential consequences of exposure to hazardous materials are evaluated by comparing them to the air concentrations of the applicable ERPG or TEEL. Definitions for the different TEEL levels are based on those for ERPGs that follow:

- ERPG-1 – The maximum concentration in air below which it is believed nearly all individuals could be exposed for up to one hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor

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

- ERPG-3 – The maximum concentration in air below which it is believed nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening 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.

It is recommended that, for the application of TEELs, the concentration at the receptor point of interest be calculated as the peak 15-minute, time-weighted average concentration. It should be emphasized that TEELs are default values, following the published methodology on the SCAPA web page (DOE 2002) explicitly.

F.2.3.1 Impacts from Industrial Accidents

Impacts of potential industrial and occupational accidents were predicted using five-year average statistics for the DOE, Richland Operations Office, reported in Computerized Accident/Incident Reporting System, or CAIRS, for the years 1996 to 2000 (DOE 2001). The baseline statistics, applied separately for construction and operations activities, are presented in Volume I, Section 4.10. Impacts are presented as the predicted number of total recordable cases, lost workday cases, lost workdays, and fatalities for construction and operation activities, based on the number of worker-years for that activity. A full-time worker is assumed to work 2000 hours per year.

F.3 Intruder Impact Assessment Methods

In the assessment of intruder impacts, inadvertent intrusion is defined as an inadvertent activity that results in direct contact with the waste from a LLW disposal facility. Two types of inadvertent intrusions are considered: 1) excavation of a basement for construction of a dwelling and 2) drilling a well. In each case, the waste would be extracted from the disposal facility and the extracted waste, with the exception of activated metal and concrete (or grout), is assumed to be indistinguishable from soil. Pathways by which an intruder might be exposed to radiation from the exhumed waste include the following:

- ingestion of vegetables grown in the contaminated soil
- ingestion of soil
- inhalation of radionuclides on dust suspended in the air by gardening activities or wind
- external exposure to direct radiation from contaminated soil while working in the garden or residing in the house built on top of the waste disposal facility.

Calculations were performed via a spreadsheet using dose rate per unit concentration conversion factors contained in performance assessments for the disposal of LLW in the LLBGs and peak radionuclide concentrations (WHC 1995, 1998). Peak radionuclide concentrations are shown in Table F.48 along with a short description of the waste origin. The peak concentration values are based on information extracted from the Solid Waste Information Tracking System, or SWITS, database (Anderson and Hagel 1996; Hagel 1999) and decay corrected to 2046. These radionuclides would not all occur within the same waste container or even within the same disposal facility. Therefore, the peak values represent a hypothetical maximum waste package.

Table F.48. Peak Radionuclide Concentrations in Disposal Facilities (Year 2046)

Radionuclide	Peak Waste Concentration, Ci/m^3	Probable Waste Description
Tritium	6.9E+02	Failed tritium targets
Carbon-14[(a)]	4.2E+0	Naval core basket
Cobalt-60[(a)]	5.1E-01	Naval core basket
Nickel-59[(a)]	5.9E+0	Naval core basket
Nickel-63[(a)]	4.9E+02	Naval core basket
Strontium-90	1.0E+03	B Plant filters during encapsulation of strontium fluoride
Technetium-99	7.9E-02	Discarded uranium oxide
Iodine-129	5.2E-03	PUREX debris
Cesium-137	4.1E+02	B Plant filters during encapsulation of cesium chloride
Uranium-234	2.4E-01	Discarded uranium oxide
Uranium-235	6.0E-02	Discarded uranium oxide
Uranium-236	2.5E-01	Discarded uranium oxide
Uranium-238	1.5E-01	Discarded uranium oxide

(a) The activity is in activated metal.

F.3.1 Human Intrusion Exposure Scenarios

Estimation of impacts from inadvertent human intrusion that were considered in this analysis included the following hypothetical scenarios: well drilling, post-well drilling gardening, excavation, post-excavation gardening, and the deep-root garden. The parameters and values employed for radiation dose and associated impacts are presented as follows:

- Well Drilling – A 30-cm (12-in) diameter well is driven through the waste.
- Post-Well Drilling Gardening – Waste from the well hole is mixed with topsoil in which vegetables are grown. The vegetables are consumed as well as incidental soil.
- Excavation – 300 m^3 (11,000 ft^3) of waste is exhumed during construction of a nominal 139-m^3 (1500-ft^2) house with a basement.
- Post-Excavation Gardening – Waste from the basement excavation is mixed with soil in which vegetables are grown. The vegetables are consumed as well as incidental soil.
- Deep-Root Garden – Crop roots, including fruit and nut trees or other natural plant roots (such as alfalfa), penetrate the waste zone, thereby contaminating crops or fodder that are consumed in the human food chain.

For Category 1 LLW, waste is buried at a depth of about 3 m (10 ft) and would be accessible by excavation, drilling, or root penetration of fruit and nut trees and alfalfa. Thus, all five scenarios apply.

For Category 3 LLW, waste is buried at a sufficient depth of 5 m (16 ft) or more to eliminate excavation for a dwelling house. However, root penetration by fruit and nut trees would still be possible as a feasible, albeit minor, means of interacting with the waste. (WAC 173-340 states that for soil cleanup levels based on human exposure via direct contact, the point of compliance is established in the soils throughout the site from the ground surface to 3.8 m [15 ft] below the ground surface. This estimate represents a reasonable depth of soil that could be excavated and distributed at the soil surface as a result of site development activities.) Thus, only the drilling and post-drilling scenarios are applicable based on depth of the waste. However, Category 3 LLW is contained within concrete high-integrity containers (HICs) and it is considered highly improbable that drilling through HICs would occur. Regardless, this scenario was selected to reasonably bound consequences of intrusion impacts from wastes under consideration in this HSW EIS.

Evaluation of this intrusion scenario was performed for 100, 500, and 1000 years after 2046. No allowance was given for the Modified RCRA Subtitle C Barrier to be used in capping HSW disposal facilities in Alternative Groups A and B. Thus the drilling scenario, as evaluated, applies to all alternative groups under consideration.

In the well drilling operation, 0.35 m^3 (12 ft^3) of waste (from a 0.3-m [12-in.] diameter well assumed to be drilled through 5 m [16 ft] of waste) is brought to the surface and spread over a 2500-m^2 (0.6-ac) garden. The resulting redistribution factor results in a value of 1.4E-04 m^3 of waste per m^2 (4.6E-04 ft^3 of waste per ft^2). It is assumed the exhumed soil is thoroughly mixed to a depth of 15 cm (6 in).

The area of the garden is a size that would reasonably supply the resident's vegetable diet (Napier et al. 1984) and has been used in other assessments (for example, Kincaid et al. 1995). The mixing depth of 15 cm (6 in) is considered a typical plowing depth for most farming practices. An attempt was made to be reasonably conservative in the selection of values so that the dose estimates would be bounding.

Inhalation and external exposures are based on the following exposure times: the gardener is assumed to spend 1800 hr/yr outside in the garden and 4380 hr/yr inside. The remaining 2580 hr/yr are spent elsewhere on the property.

A mathematical model was used to calculate the amount of each radionuclide that would be brought to the surface by human intrusion. Estimates of annual frequencies of yearly probabilities for borehole drilling into the disposal facility with the highest consequence impacts were calculated. The annual probabilities were derived by multiplying the annual borehole frequency per square kilometer, 0.01/km/yr, by the surface area occupied by the waste container. This value is more than three times higher than the number recommended by EPA in 40 CFR 191. For example, in 1976, a 48.9 m^3 box containing 100,000 Ci of cesium-137 was disposed of in the 218-E-10 LLBG for a concentration of 2040 Ci/m^3 in HEPA filters from the B Plant. That concentration of cesium-137 would physically decay to a concentration of about 410 Ci/m^3 by 2046. This box was assumed to be cubical in shape and, therefore, approximately 3.66 m (12 ft) on a side. This provides an estimate of 13.4 m^2 (1.3E-05 km^2) of surface area for the container into which the borehole can be drilled. Thus the probability of randomly drilling into and hitting the container holding the highest radioactivity concentration of cesium-137 would be roughly 1.3E-07 per year.

F.3.2 Radiological Analysis

The dose-rate-per-unit waste concentration factors (mrem/yr per Ci/m^3) for 13 radionuclides are given in Table F.49 for the post-well drilling scenario and in Table F.50 for the excavation scenario. The analysis used the Kennedy and Strenge (1992) concentration ratios and assumed the intrusion to begin at 100, 500, and 1000 years after 2046. The dose-rate-per-unit waste concentration factors were evaluated by setting the initial concentration (that is, at year 2046) of a radionuclide in the waste to 1 Ci/m^3 and then evaluating the intruder scenario at the specified time. The evaluation was based on the amount of the radionuclide present at the specified time (and any progeny radionuclides that may have grown in from the parent radionuclide). The dose-rate-per-unit waste concentration factors were evaluated for all radionuclides assumed to be present in the waste streams contributing to disposal facility activity. The dose-rate-per-unit waste concentration factors were then multiplied by the given initial concentration of radionuclides of interest to estimate the final dose results. For given radionuclides, doses were calculated as a function of time, using the assumption of leaching or not leaching of radionuclides from the soil during crop growth. For each radionuclide, the exposure pathway providing the largest dose is also shown in the tables.

The dose-rate-per-unit waste concentration factors change with time because of decay of the parent radionuclide and leaching of radionuclides from the surface soil. The unit dose factors given in Tables F.49 and F.50 in the "Without Soil Leaching" column are impacted only by radioactive decay and progeny ingrowth. These dose factors generally decrease with time as the parent decays, although progeny ingrowth may cause an increase with time. For example, the uranium-235 dose-rate-per-unit waste concentration factors increase with time because of the ingrowth of protactinium-231. The dose-rate-per-unit waste concentration factors for *with soil leaching* are impacted by decay and leaching and are less than or equal to the corresponding value for no leaching.

Table F.49. Dose-Rate-per-Unit Waste Concentration Factors (mrem/yr per Ci/m^3) for the Post-Well Drilling Scenario, Time Since Year 2046

Radionuclide	Without Soil Leaching			Dominant Exposure Pathway
	100 yr	300 yr	500 yr	
Tritium	5.1E-06	6.4E-11	8.0E-16	Soil Ing.
Carbon-14	5.1E+00	5.0E+00	4.8E+00	Vegetable
Cobalt-60	6.2E-03	2.4E-14	9.0E-26	External
Nickel-59	1.2E-01	1.2E-01	1.2E-01	External
Nickel-63	7.8E-02	2.0E-02	4.9E-03	Vegetable
Strontium-90	3.0E+01	2.4E-01	1.8E-03	Vegetable
Technetium-99	2.0E+01	2.0E+01	2.0E+01	Vegetable
Iodine-129	5.4E+01	5.4E+01	5.4E+01	Vegetable
Cesium-137	8.4E+01	8.5E-01	8.6E-03	External
Uranium-234	5.2E+01	5.2E+01	5.2E+01	Inhalation
Uranium-235	1.7E+02	1.8E+02	2.0E+02	External
Uranium-236	4.9E+01	4.9E+01	4.9E+01	Inhalation
Uranium-238	8.2E+01	8.2E+01	8.2E+01	Inhalation

Table F.50. Dose-Rate-per-Unit Waste Concentration Factors (mrem/yr per Ci/m^3) for the Excavation Scenario, Time Since Year 2046

Radionuclide	Without Soil Leaching			Dominant Exposure Pathway
	100 yr	300 yr	500 yr	
Tritium	1.0E-03	1.4E-08	1.7E-13	Soil Ing.
Carbon-14	1.1E+03	1.0E+03	1.0E+03	Vegetable
Cobalt-60	1.3E+00	5.0E-12	1.9E-23	External
Nickel-59	2.5E+03	2.5E+01	2.5E+01	External
Nickel-63	1.6E+01	4.2E+00	1.0E+00	Vegetable
Strontium-90	6.4E+03	5.0E+01	4.0E-01	Vegetable
Technetium-99	4.2E+03	4.2E+03	4.2E+03	Vegetable
Iodine-129	1.2E+04	1.2E+04	1.2E+04	Vegetable
Cesium-137	1.8E+04	1.8E+02	1.8E+00	External
Uranium-234	1.1E+04	1.1E+04	1.1E+04	Inhalation
Uranium-235	3.6E+04	3.9E+04	4.2E+04	External
Uranium-236	1.0E+04	1.0E+04	1.0E+04	Inhalation
Uranium-238	1.8E+04	1.8E+04	1.8E+04	Inhalation

F.4 Impacts from Waterborne Pathways

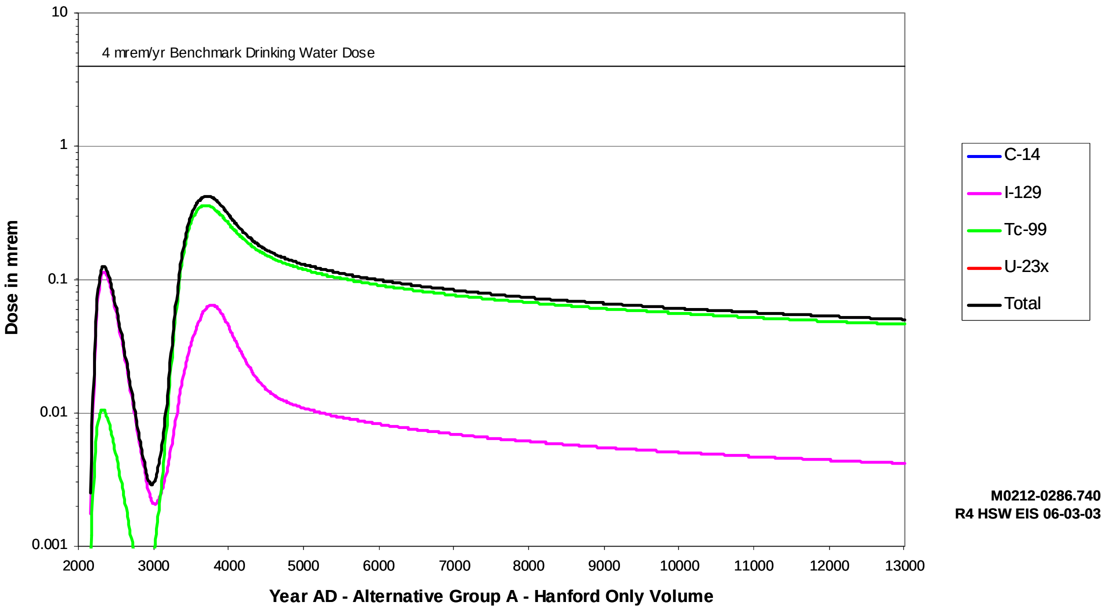
This section presents results in addition to those presented in Volume I, Section 5.11 for the groundwater analyses, including examples of contributions to impacts by waste type and radionuclide and summaries of potential impacts to the resident gardener at the 1-km points of analysis and the Columbia River point of analysis for all alternative groups.

Graphs of contributions to drinking water dose by radionuclide are presented in the following figures for all alternative groups and for the Hanford Only and Upper Bound waste volumes. For the No Action Alternative, the results are presented only for the Hanford Only waste volume because the results are very similar to those for the Lower Bound waste volume. The content for each figure is indicated in Table F.51.

Table F.51. Content of Figures for Groundwater Analysis Results

Alternative Group	Line of Analysis				
	200 West	**ERDF**	**200 East NW**	**200 East SE**	**Columbia River**
Group A	F.1	NA	F.2	F.3	F.4
Group B	F.5	NA	F.6	NA	F.7
Group C	F.8	NA	F.9	F.10	F.11
Group D_1	F.12	NA	F.13	F.14	F.15
Group D_2	F.16	NA	F.17	NA	F.18
Group D_3	F.19	F.20	F.21	NA	F.22
Group E_1	F.23	F.24	F.25	NA	F.26
Group E_2	F.27	F.28	F.29	F.30	F.31
Group E_3	F.32	F.33	F.34	F.35	F.36
No Action	F.37	NA	F.38	NA	F.39

NA = not applicable.



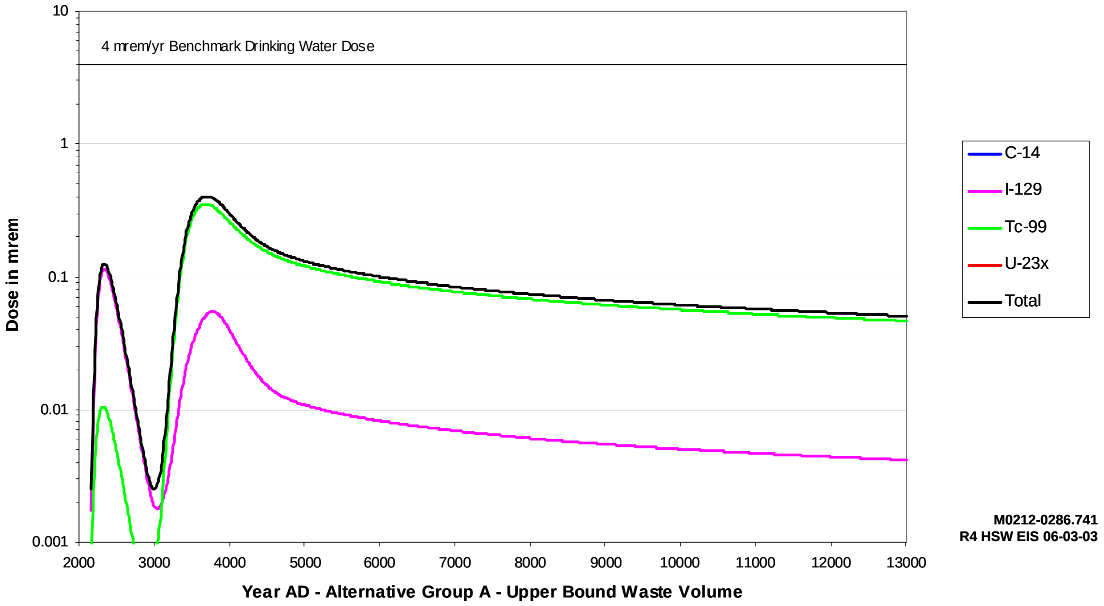
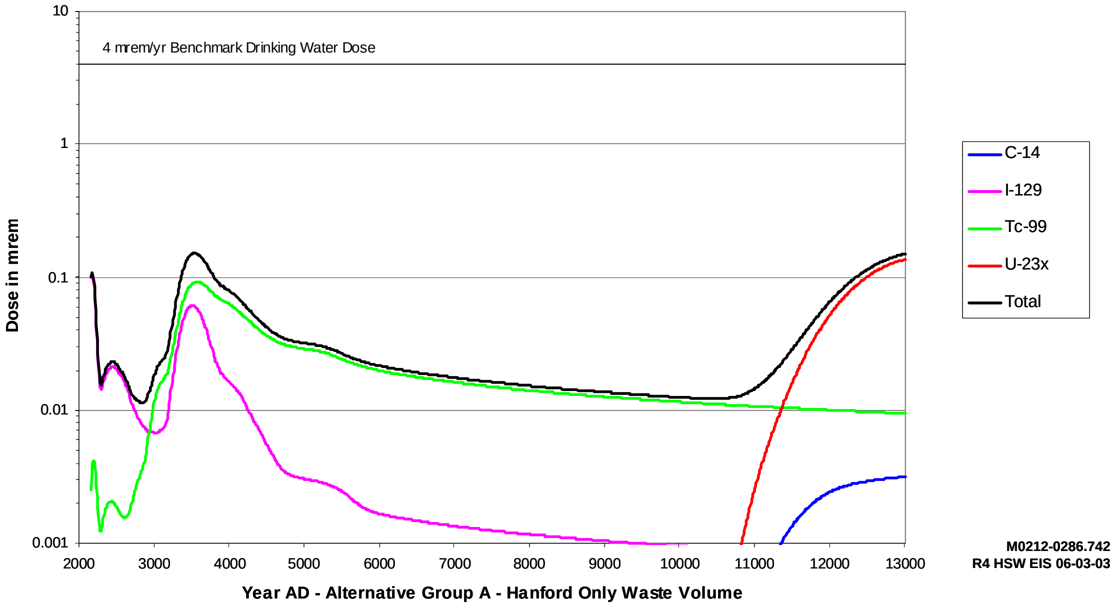


Figure F.1. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient from the 200 West Area, Alternative Group A



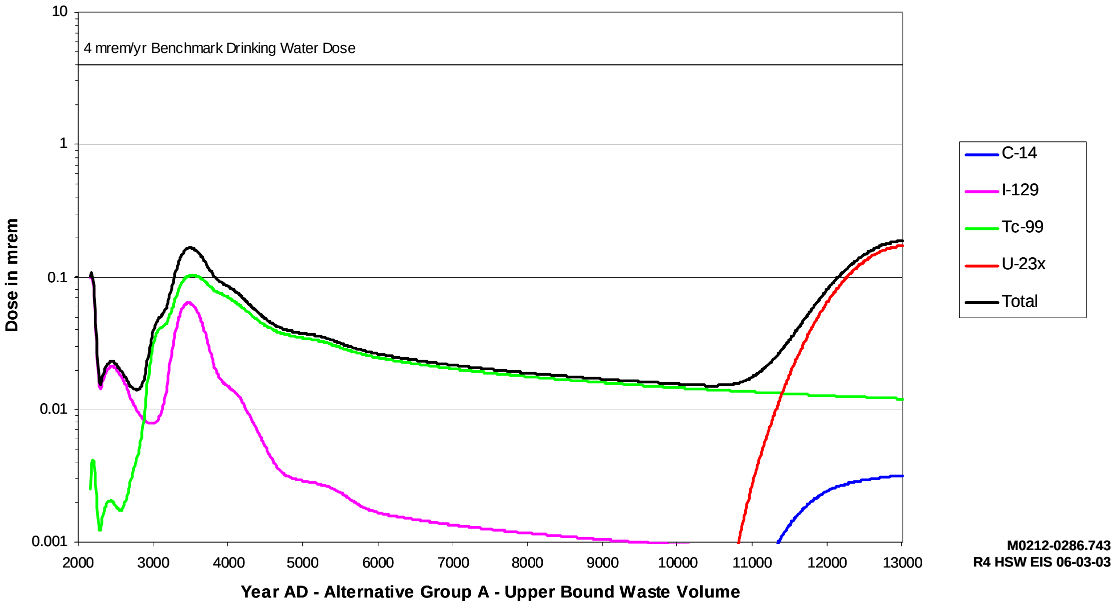
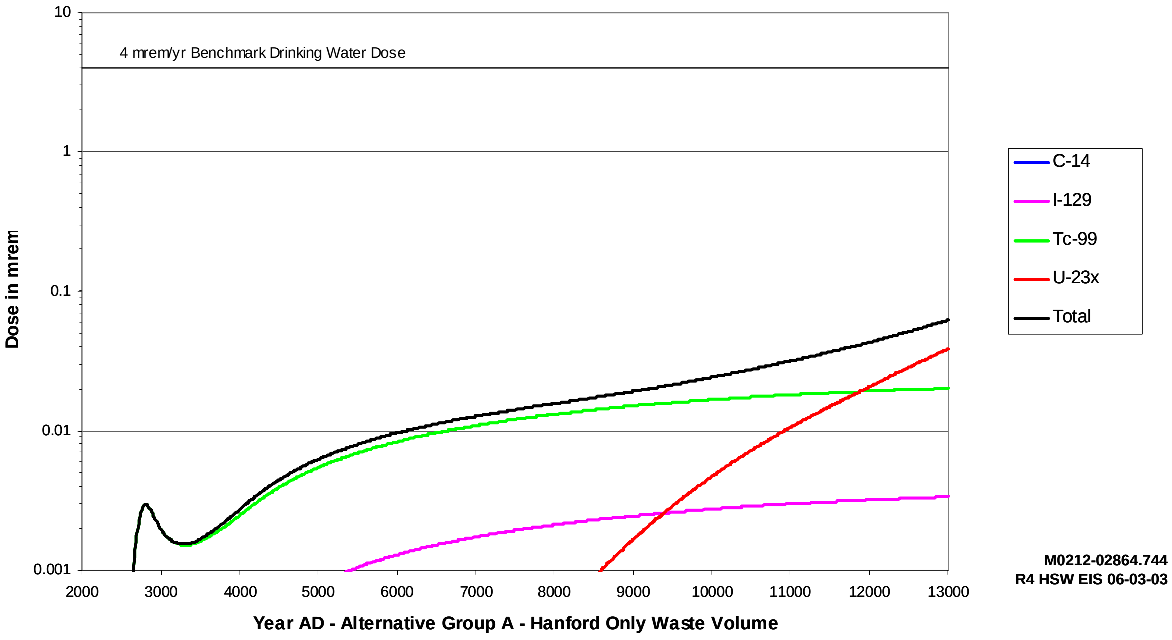


Figure F.2. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient Northwest of 200 East Area, Alternative Group A



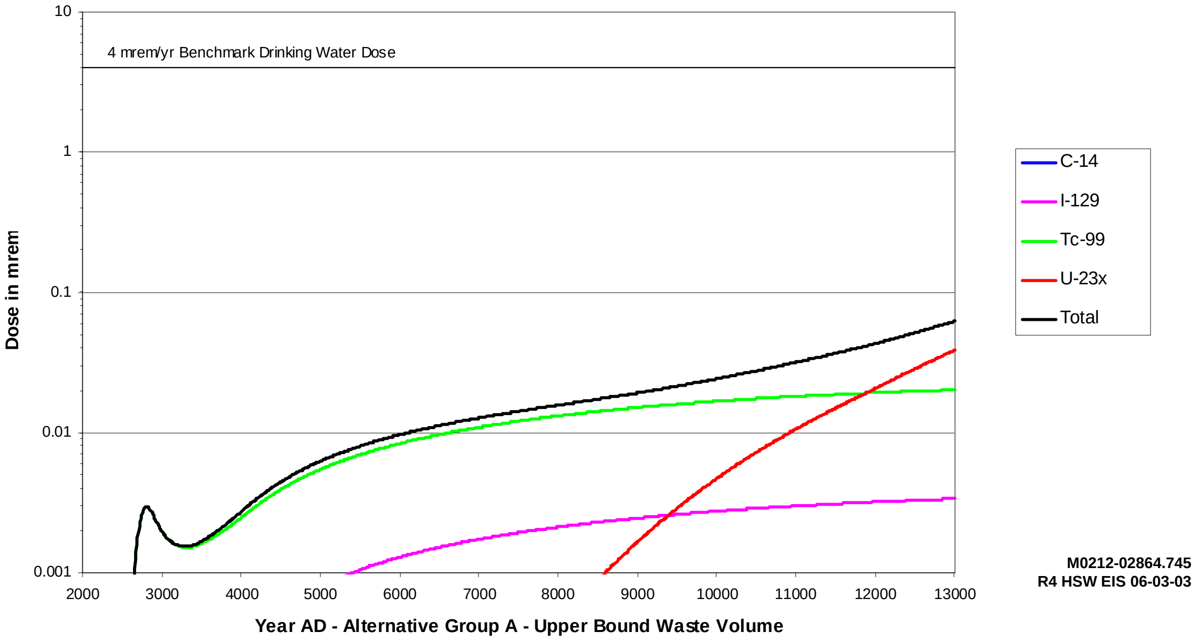


Figure F.3. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient Southeast of 200 East Area, Alternative Group A

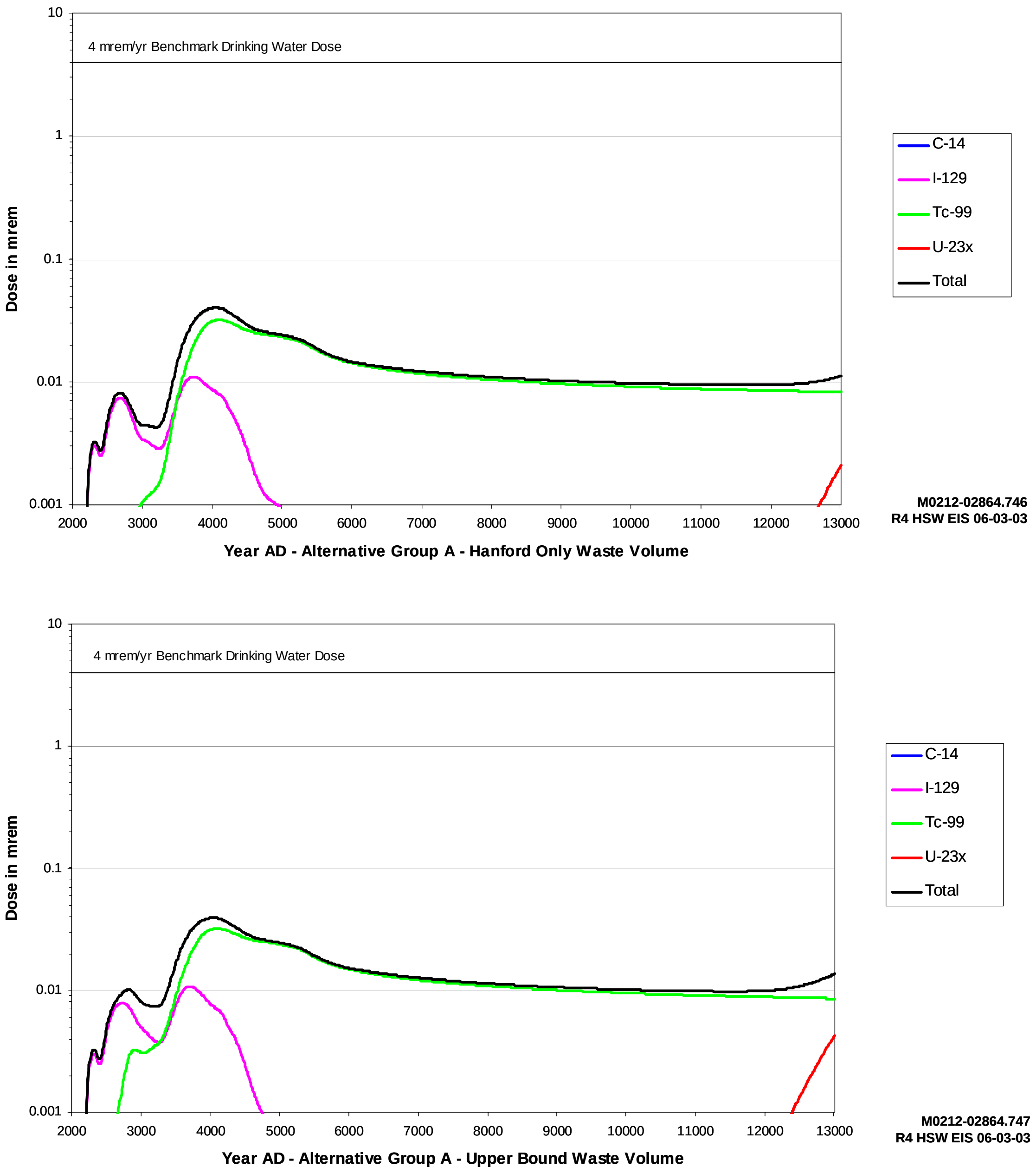
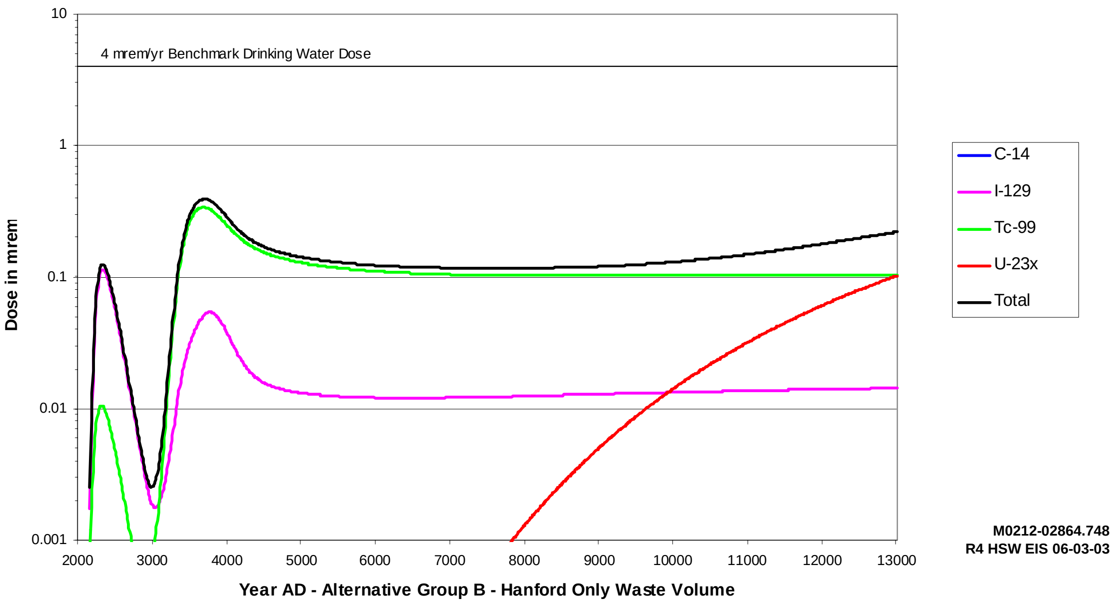


Figure F.4. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well Adjacent to the Columbia River Alternative Group A



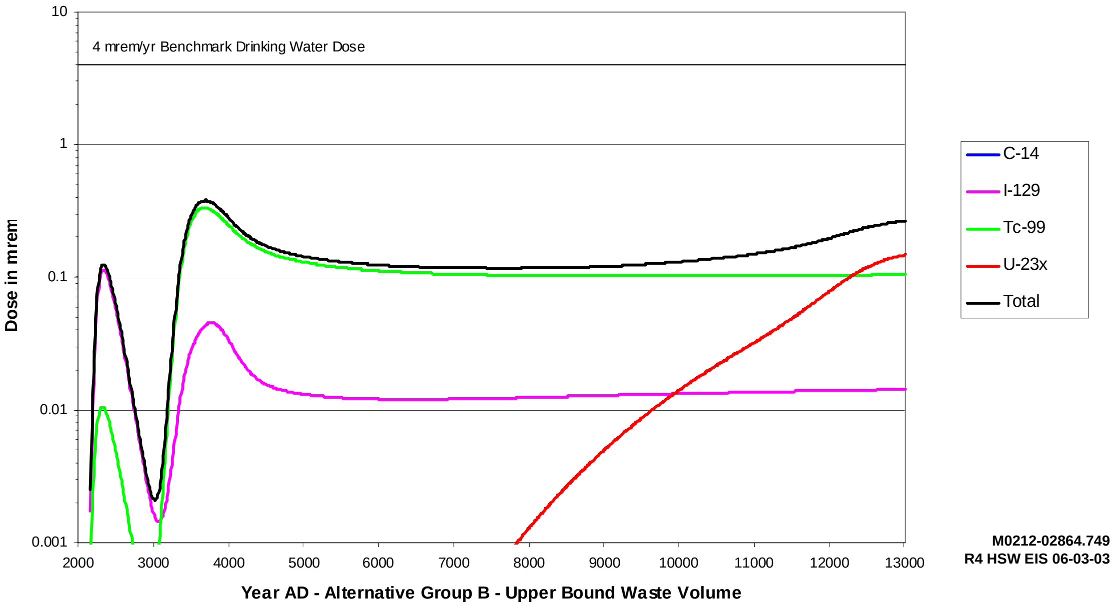
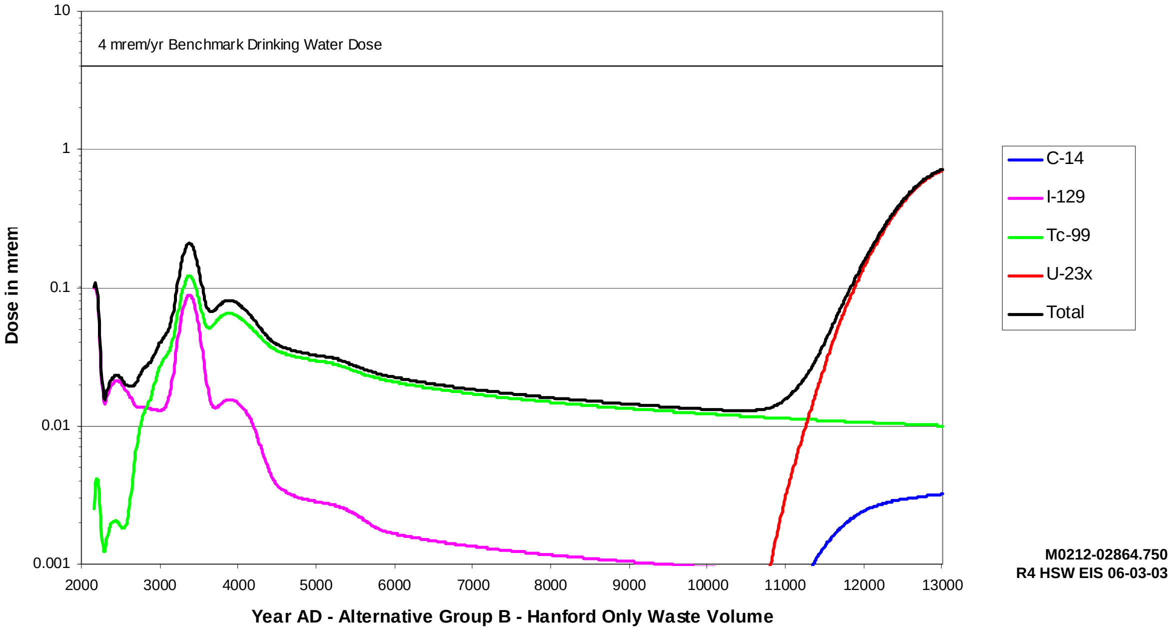


Figure F.5. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient from 200 West Area, Alternative Group B



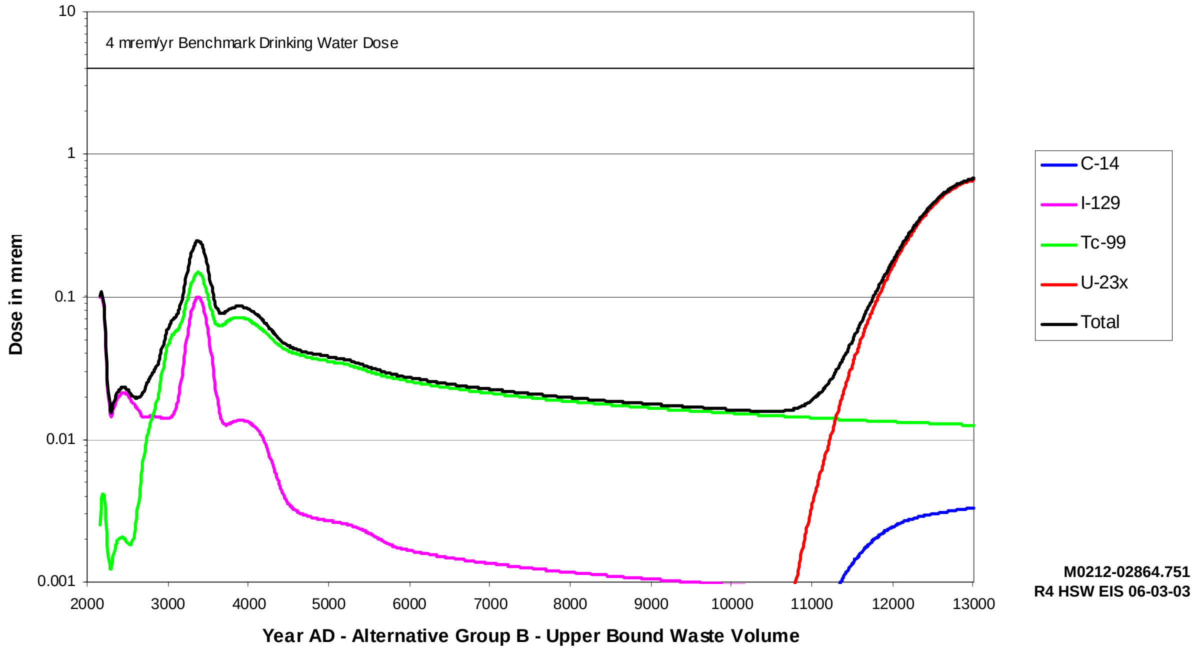
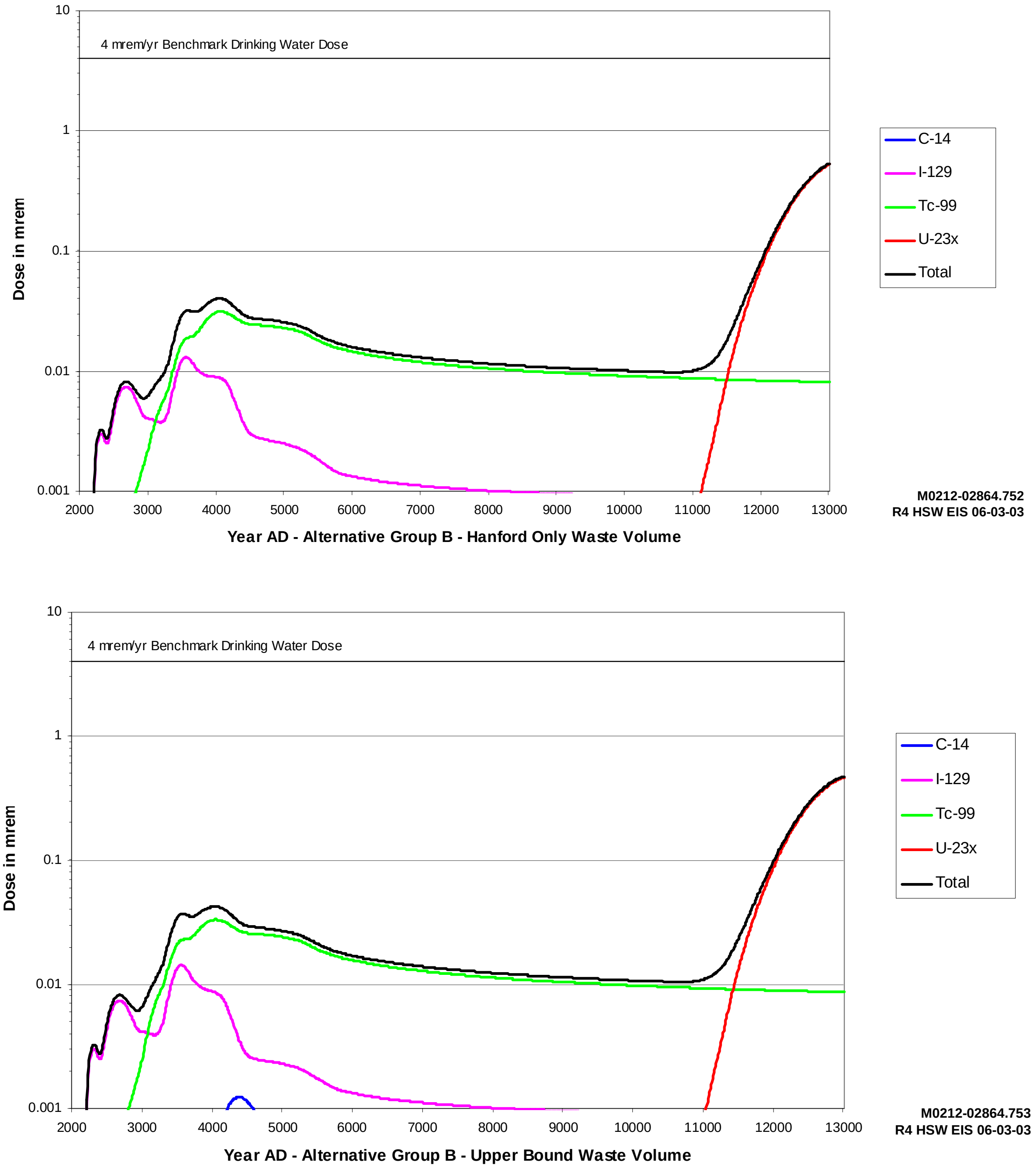


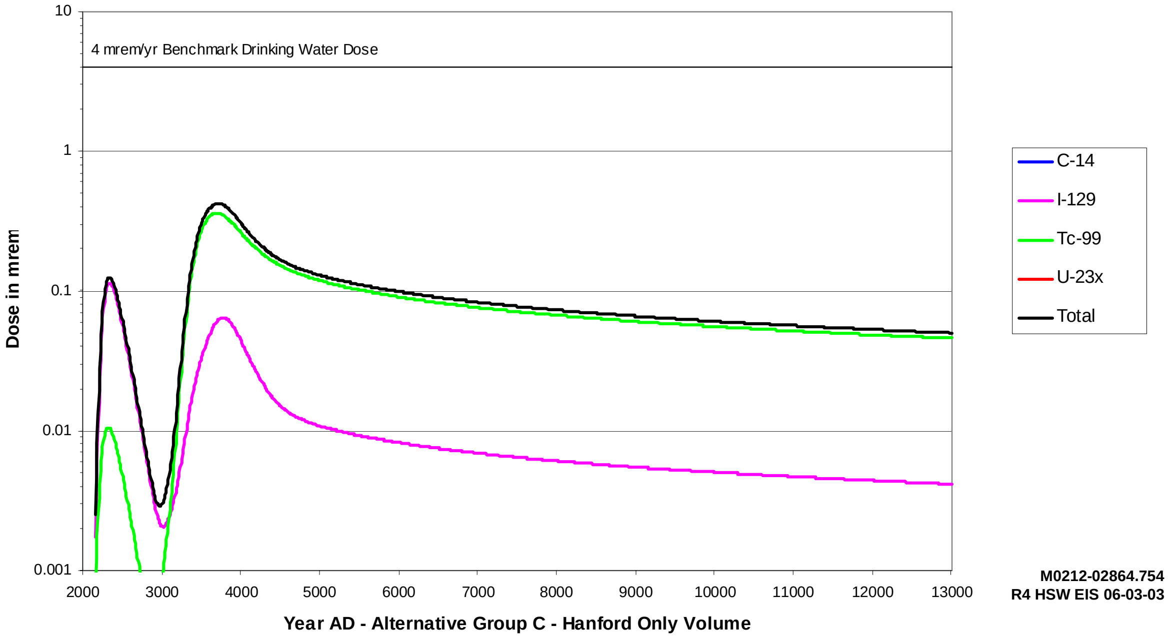
Figure F.6. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient Northwest of 200 East Area, Alternative Group B



M0212-02864.752
R4 HSW EIS 06-03-03

M0212-02864.753
R4 HSW EIS 06-03-03

Figure F.7. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well Adjacent to the Columbia River, Alternative Group B



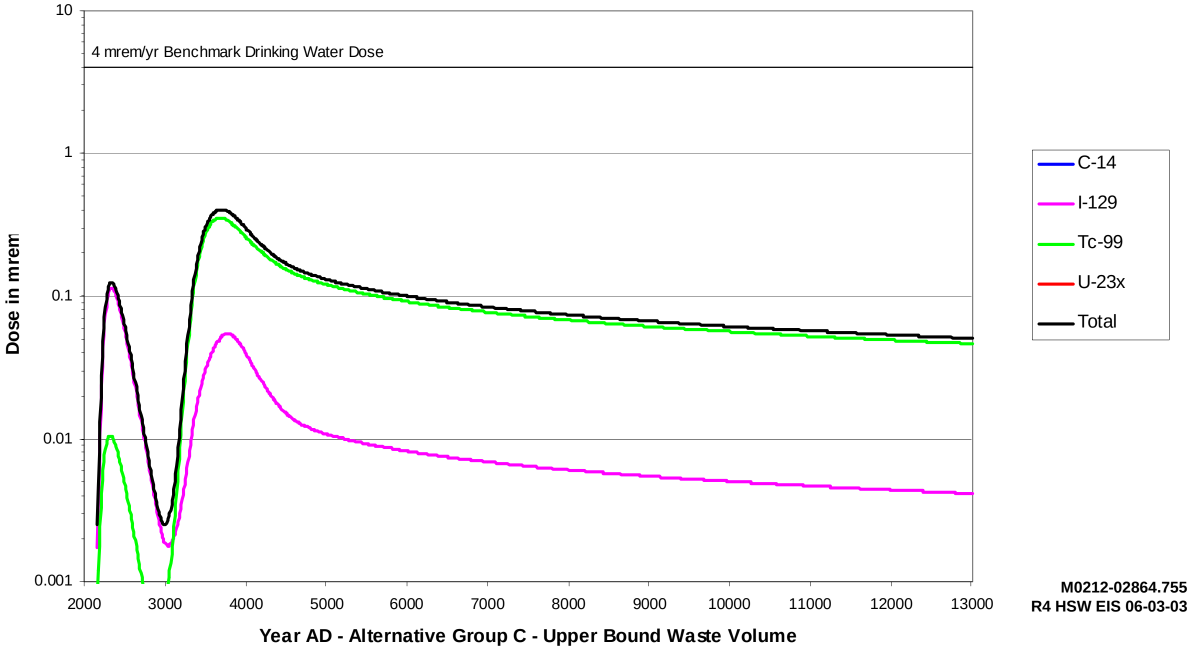
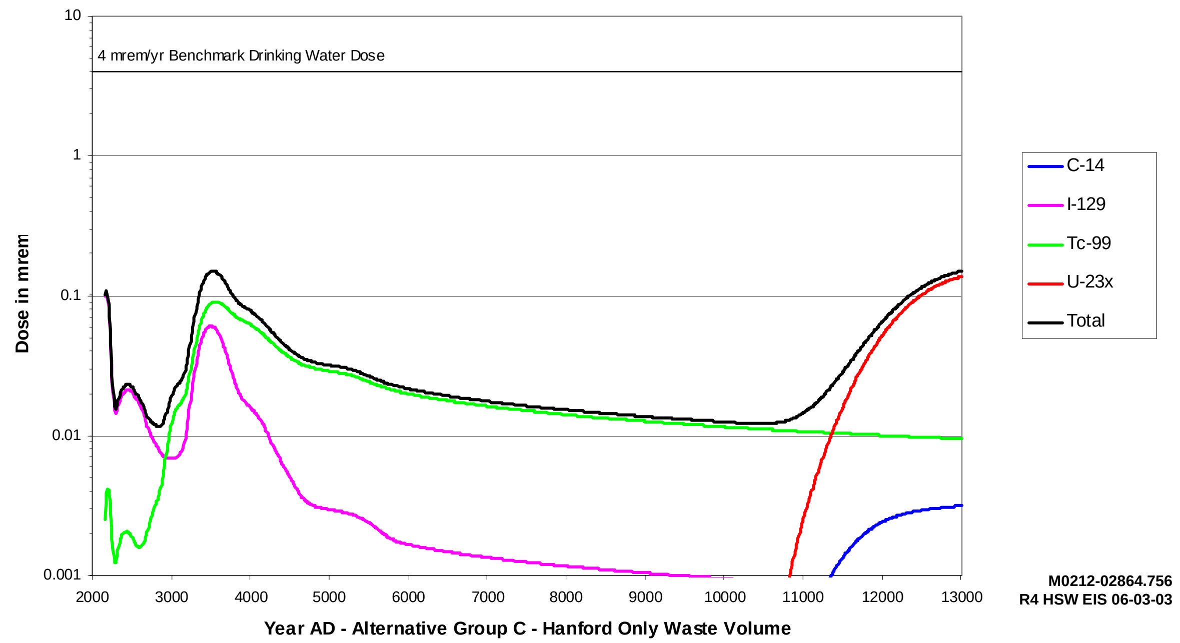


Figure F.8. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient from 200 West Area, Alternative Group C



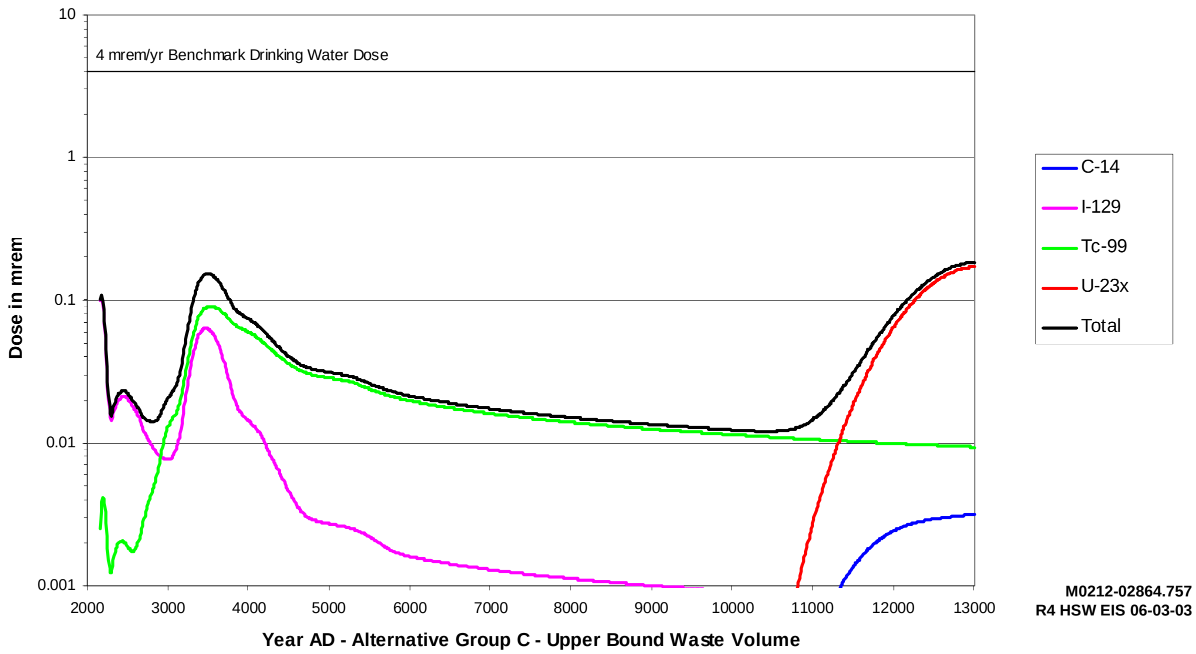
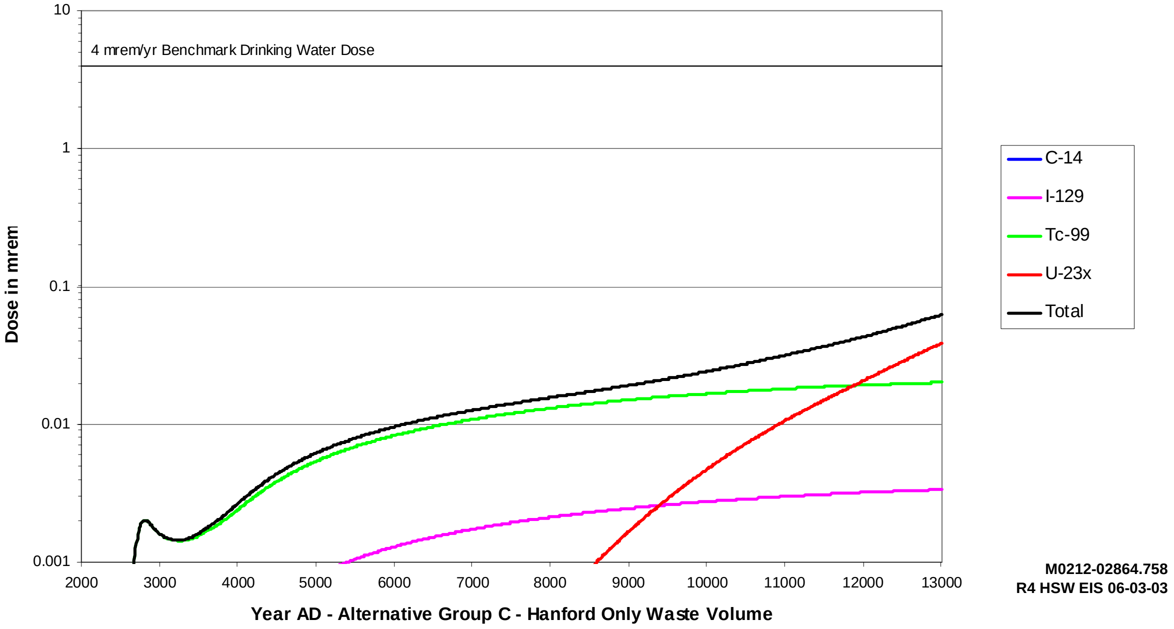


Figure F.9. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient Northwest of 200 East Area, Alternative Group C



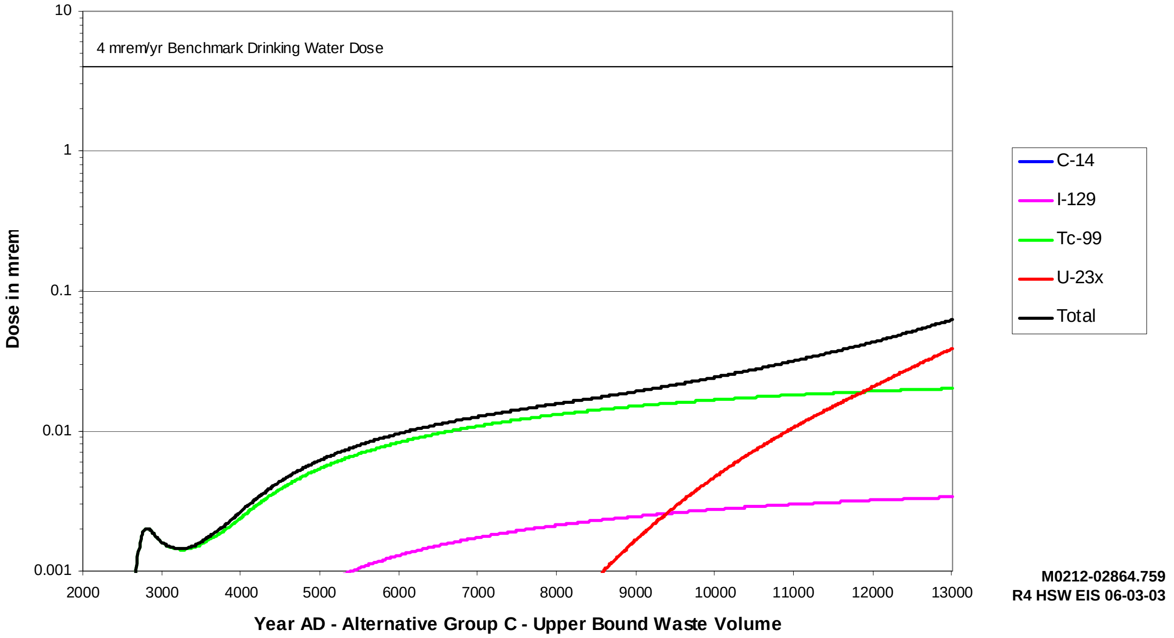


Figure F.10. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient Southeast of 200 East Area, Alternative Group C

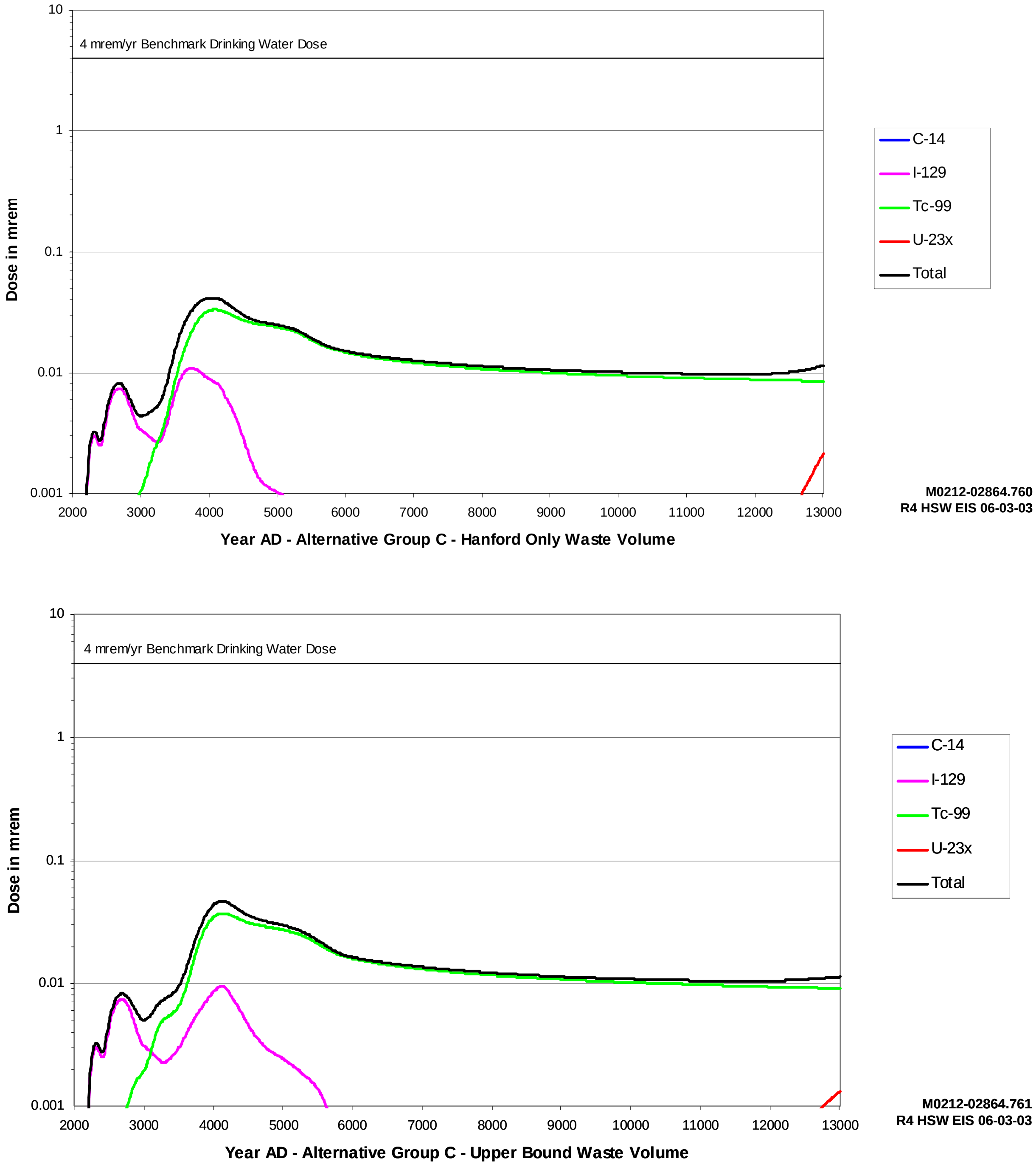


Figure F.11. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well Adjacent to the Columbia River, Alternative Group C

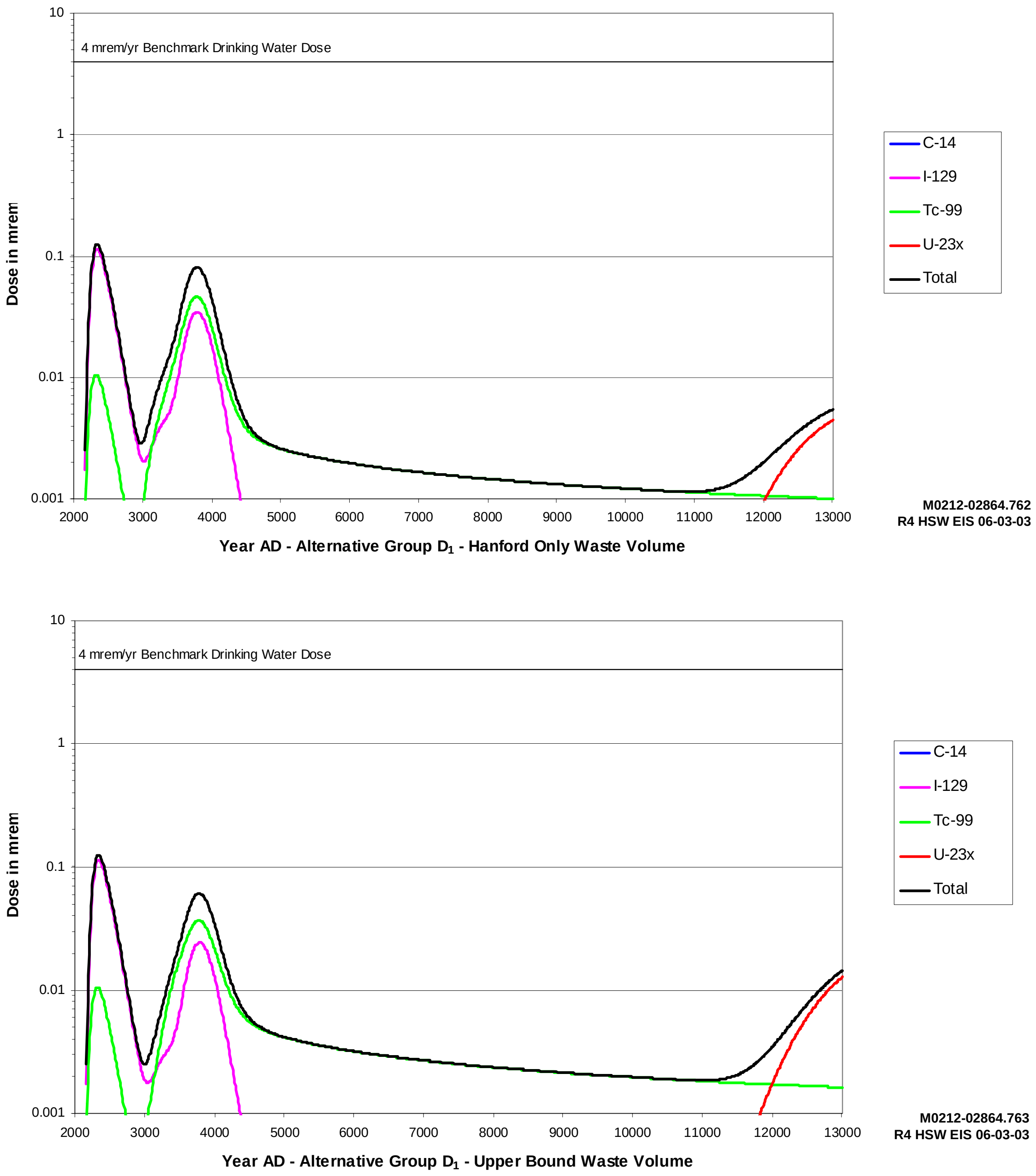


Figure F.12. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient from 200 West Area, Alternative Group D_1

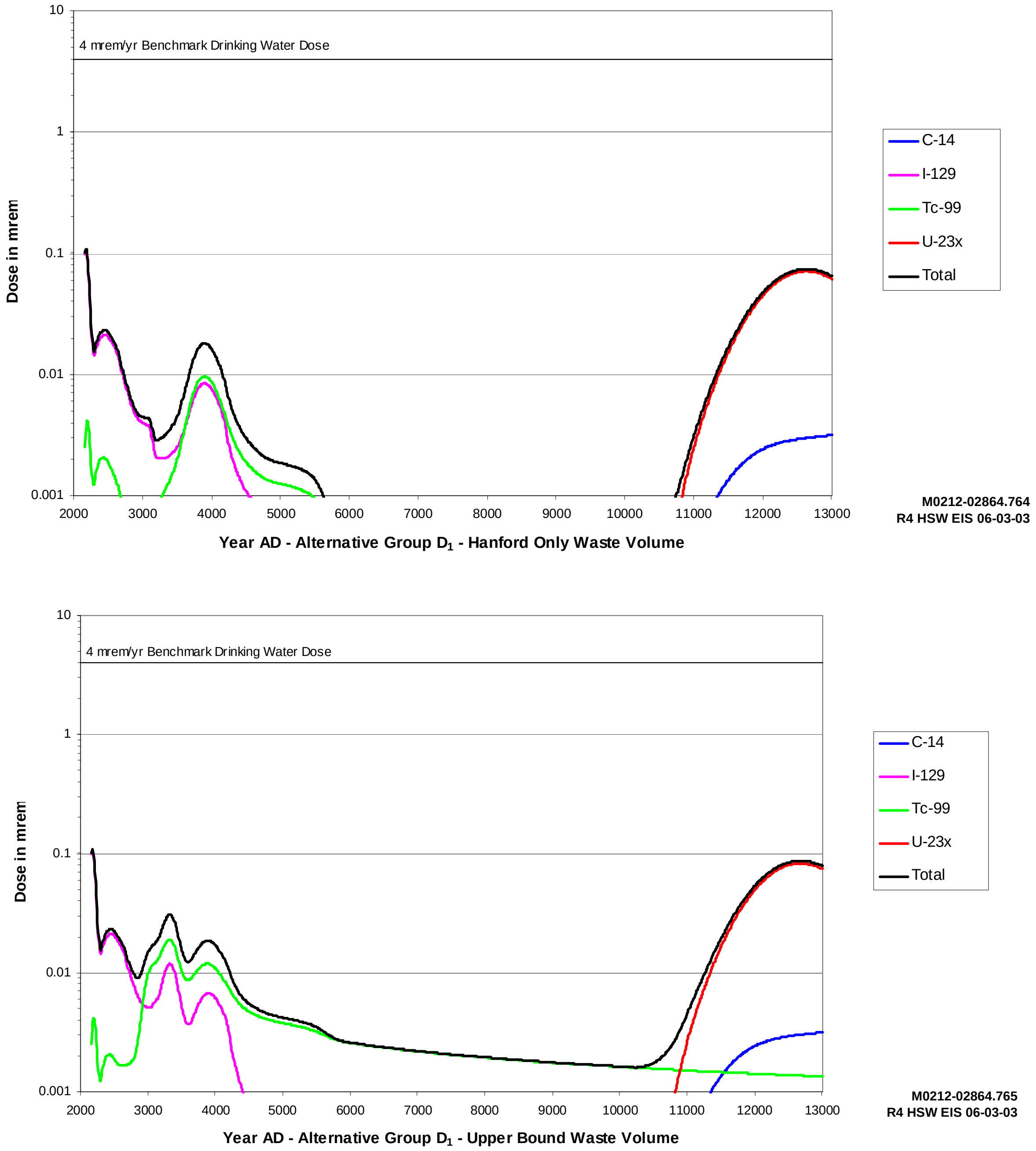
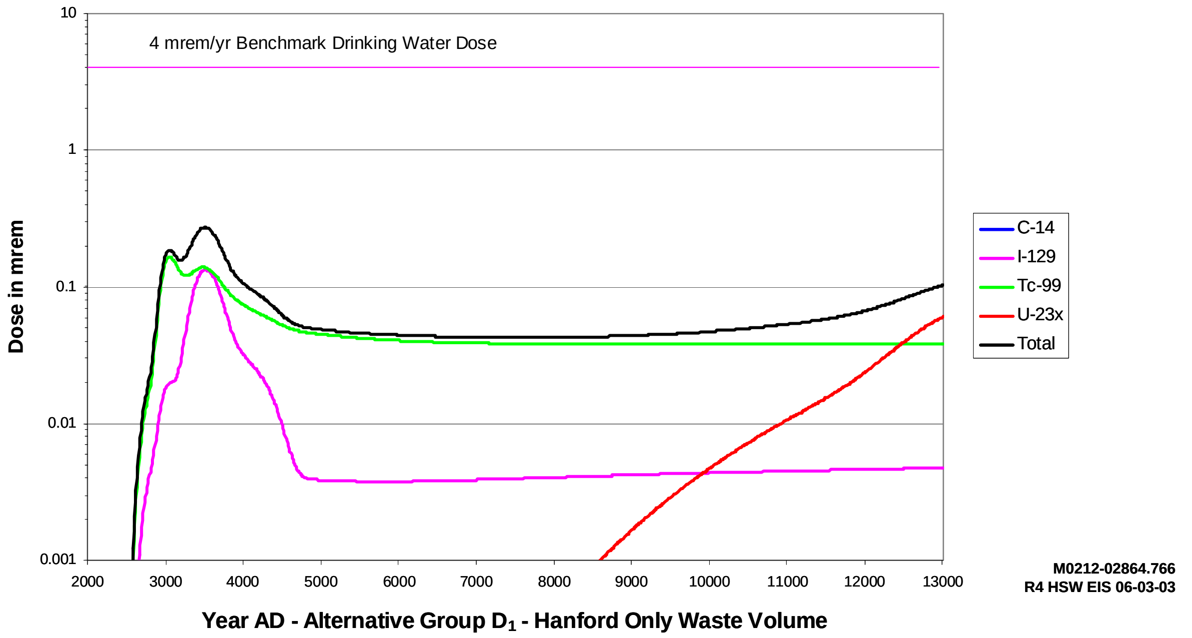


Figure F.13. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient Northwest of 200 East Area, Alternative Group D_1



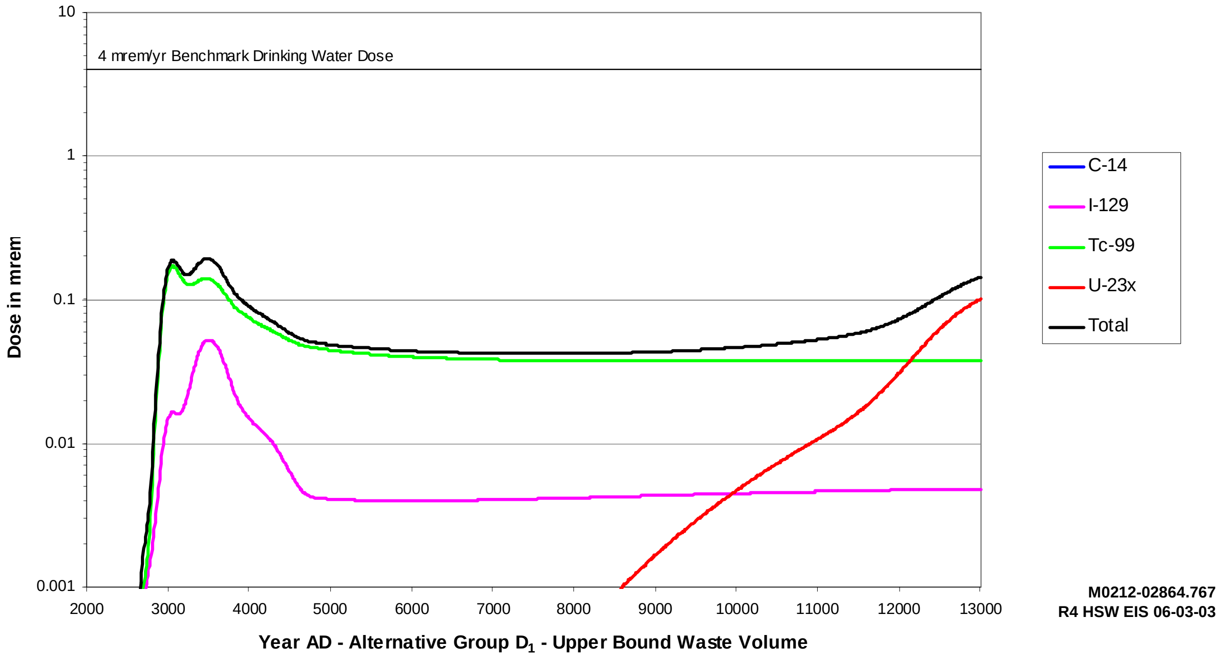


Figure F.14. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient Southeast of 200 East Area, Alternative Group D_1

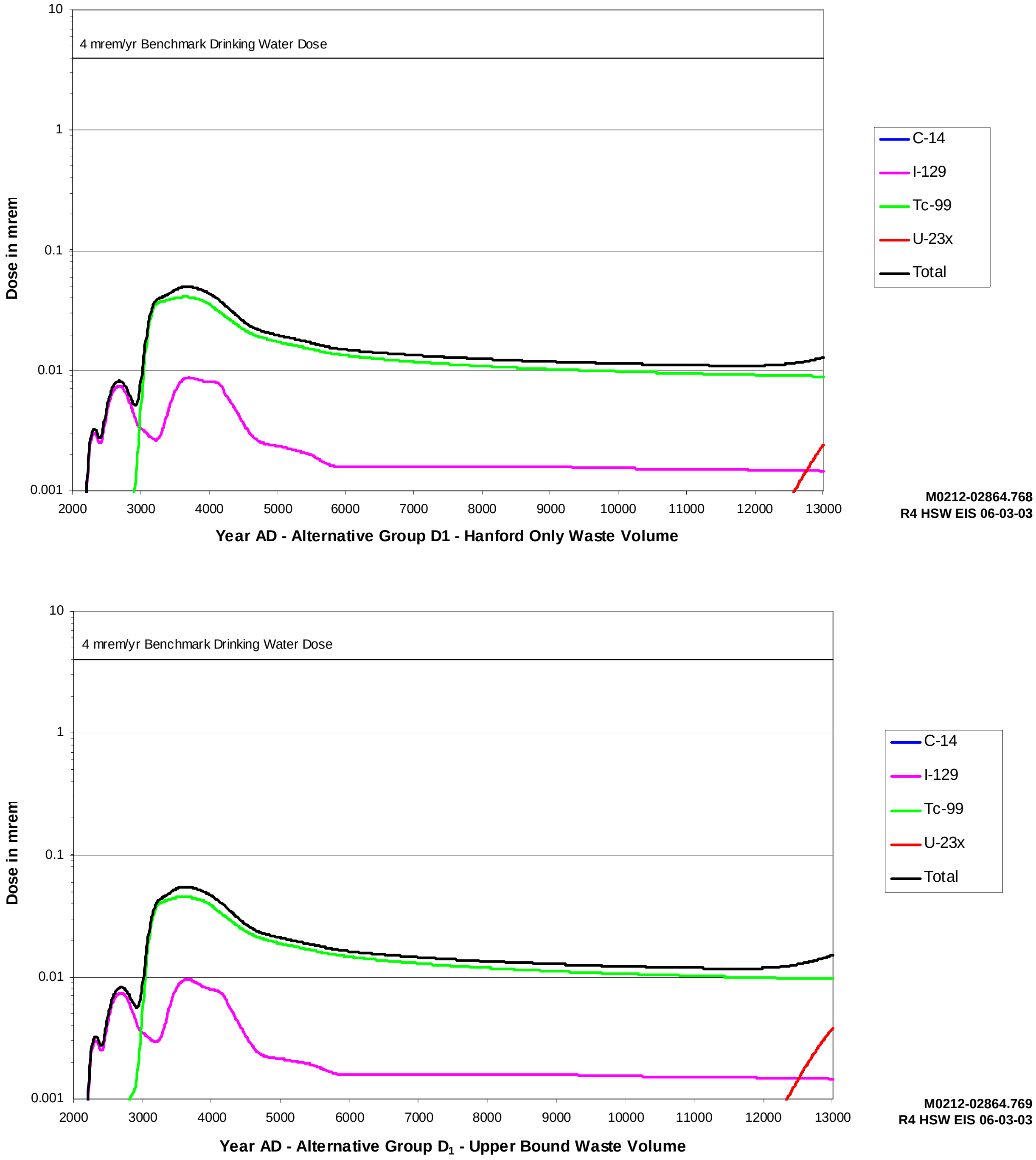


Figure F.15. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well Adjacent to the Columbia River, Alternative Group D_1

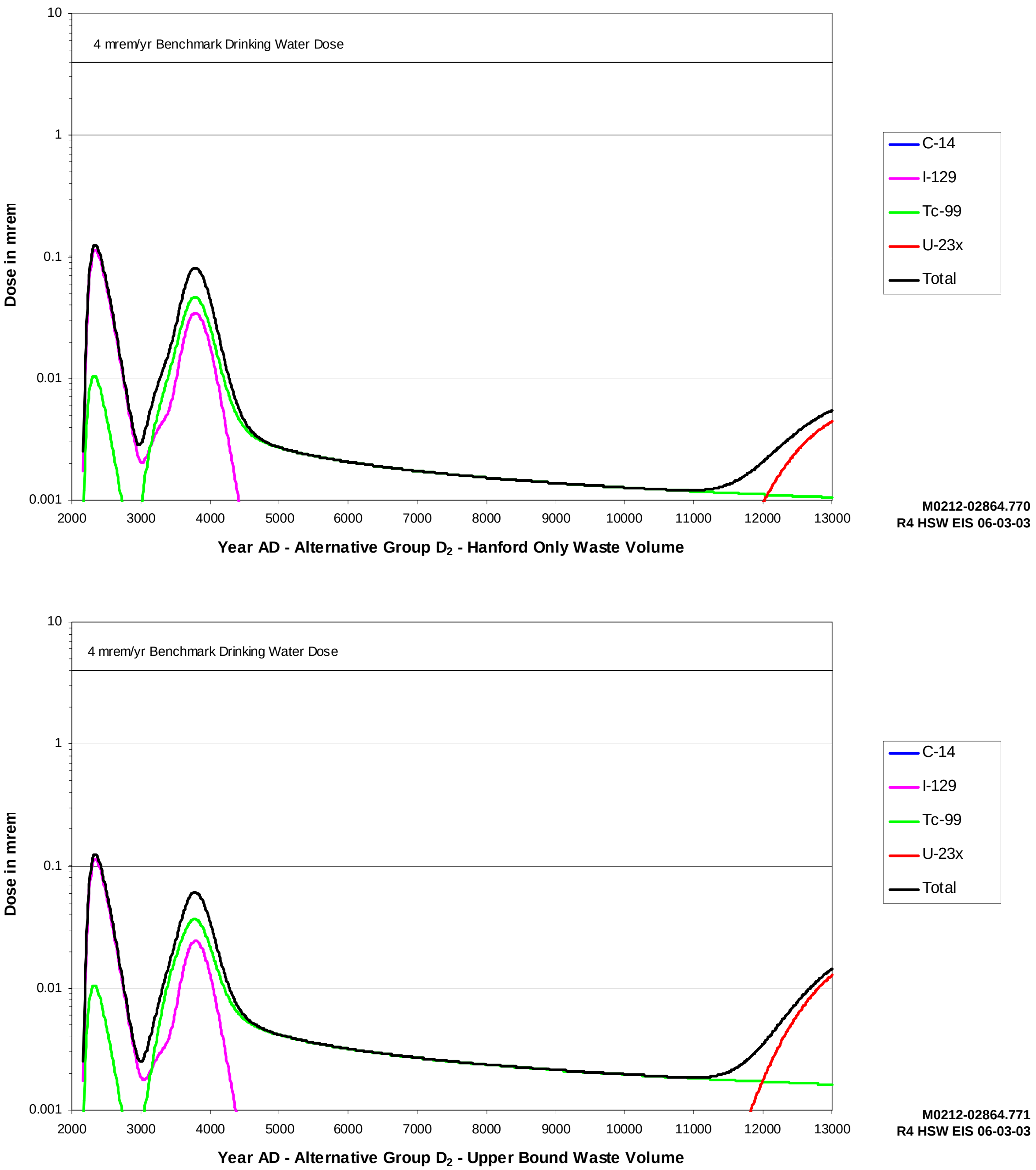


Figure F.16. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient from 200 West Area, Alternative Group D_2

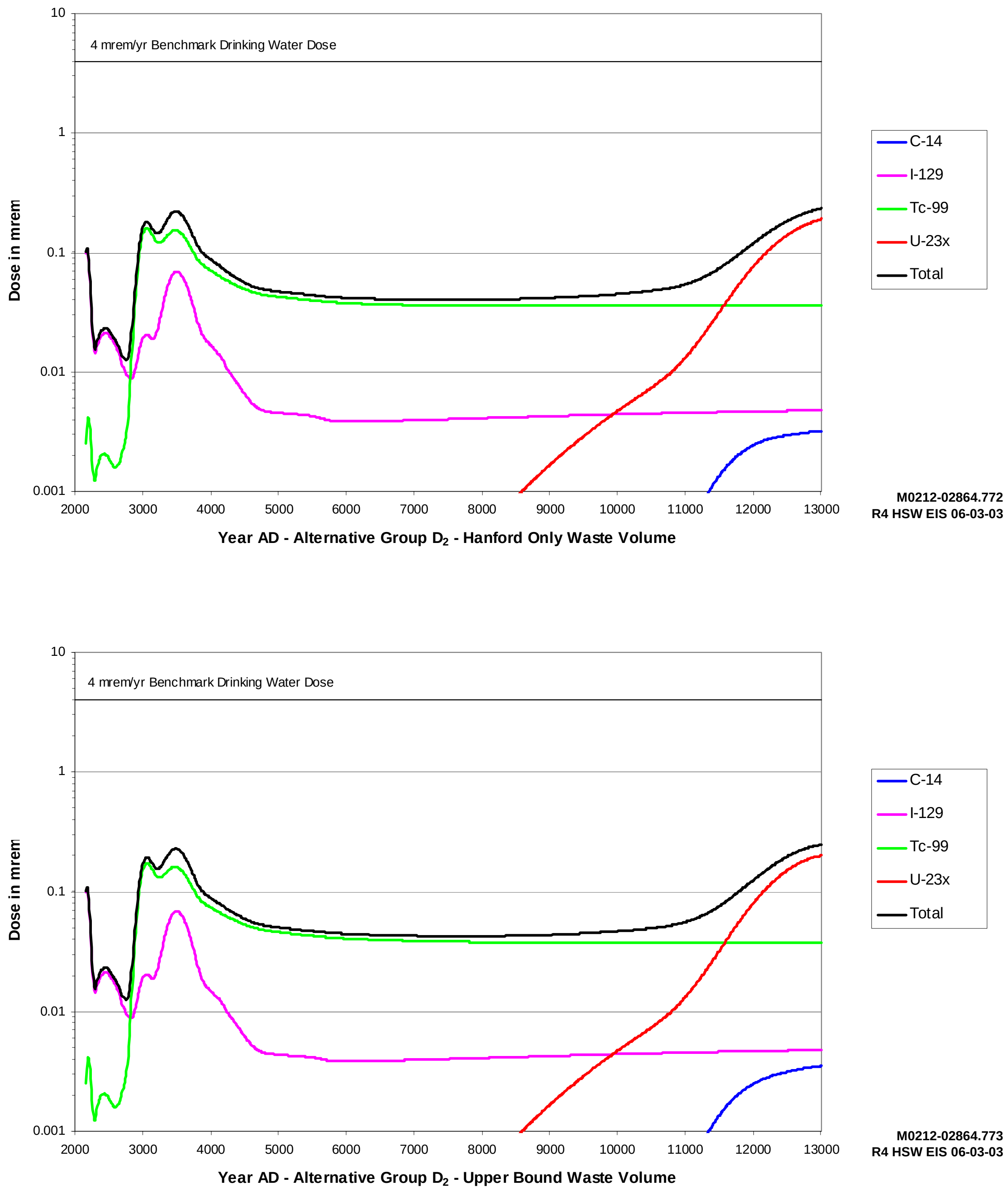


Figure F.17. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient Northwest of 200 East Area, Alternative Group D_2

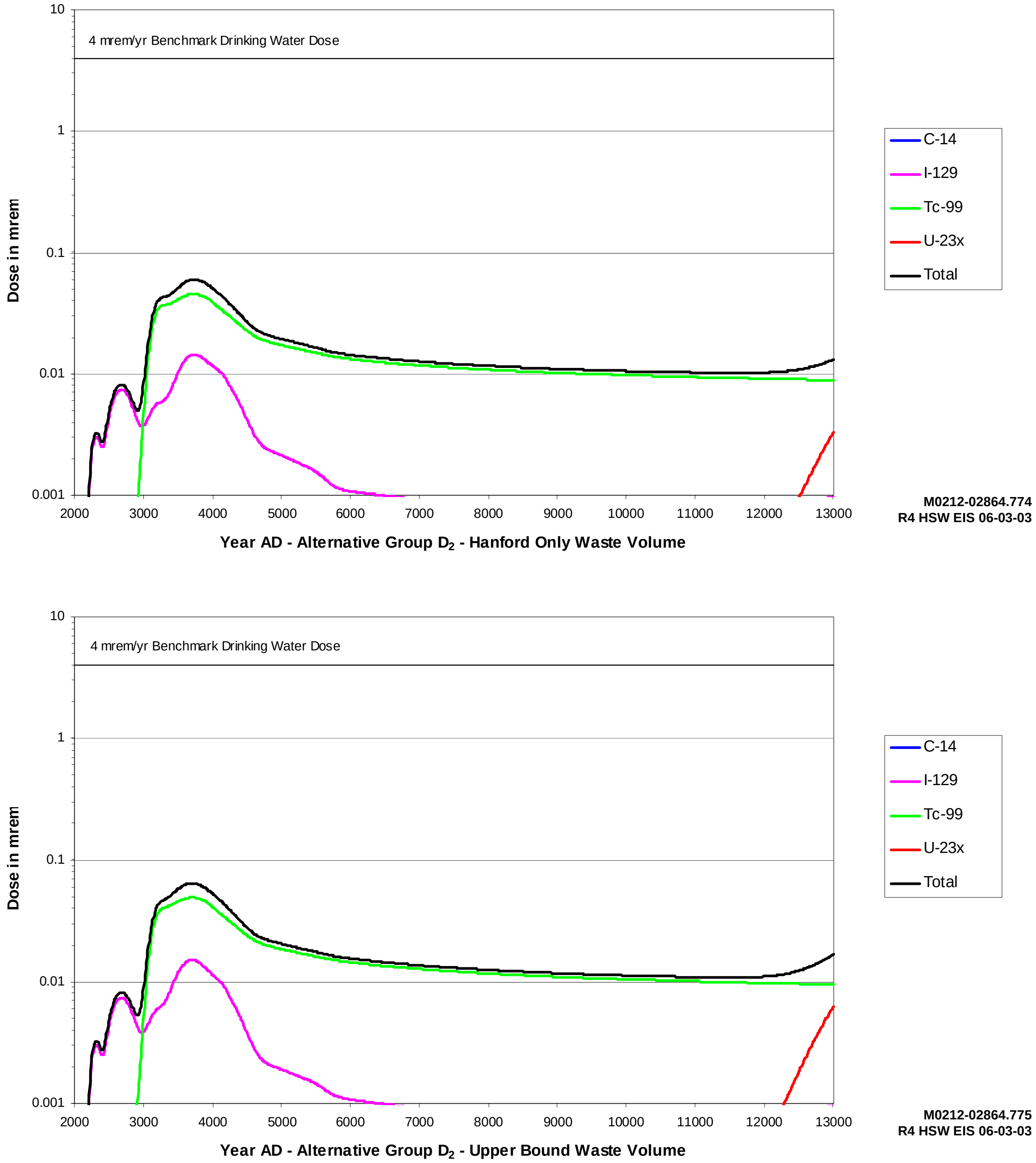
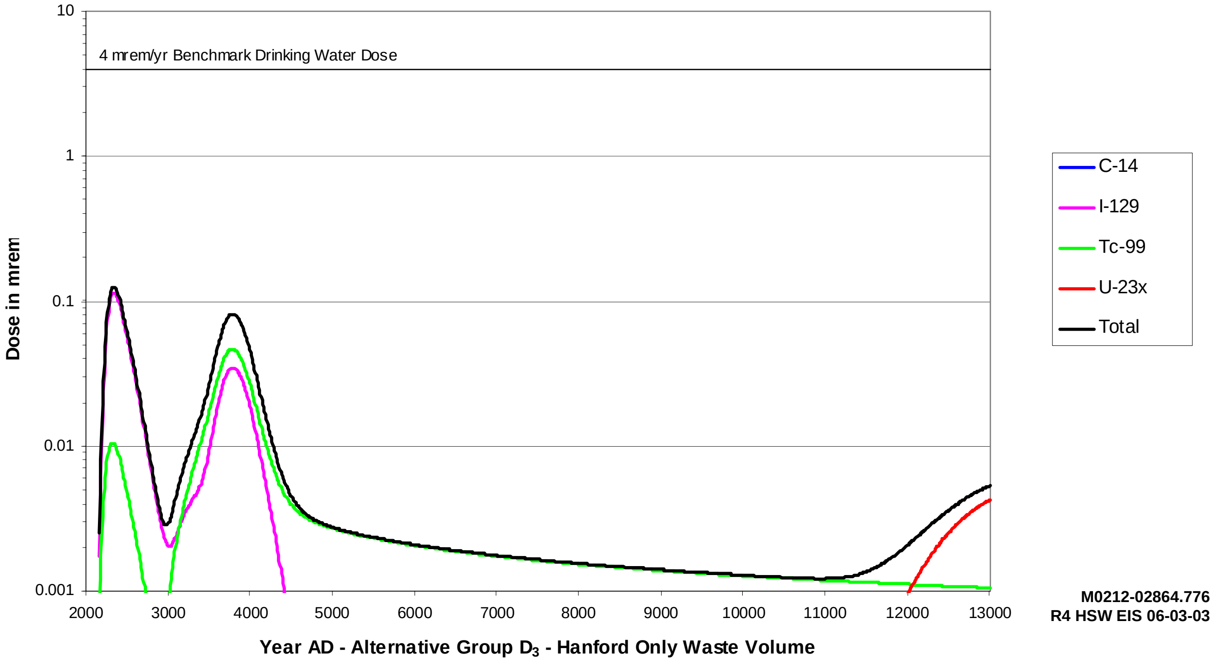


Figure F.18. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well Adjacent to the Columbia River, Alternative Group D_2



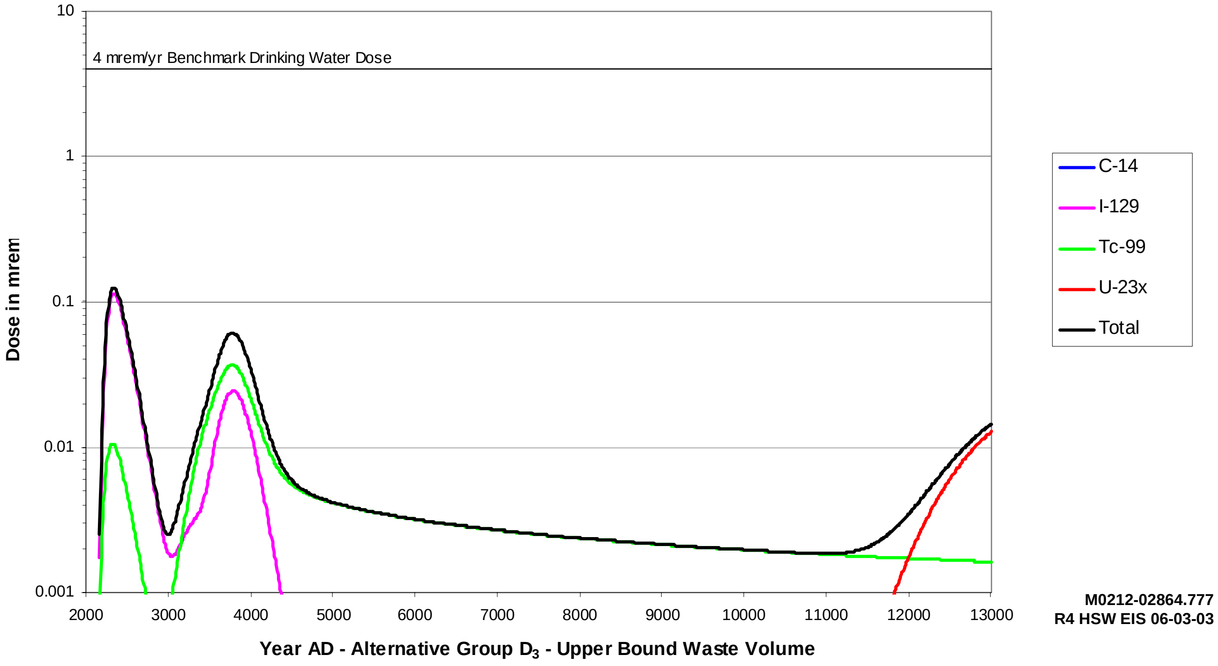
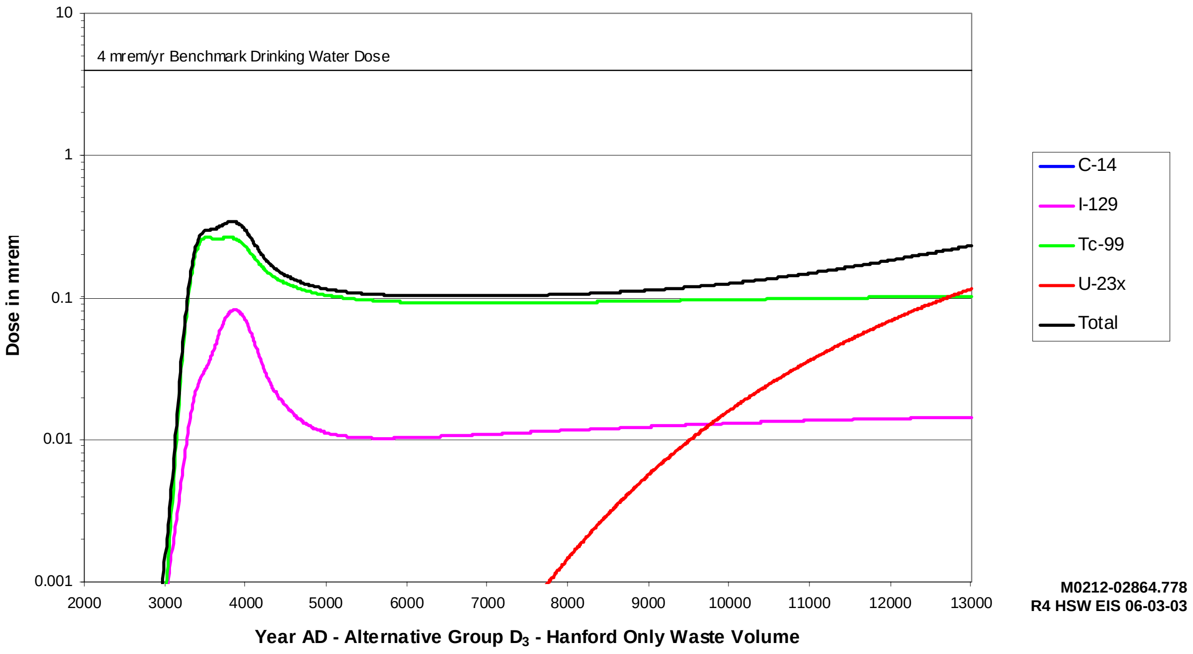


Figure F.19. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient from 200 West Area, Alternative Group D_3



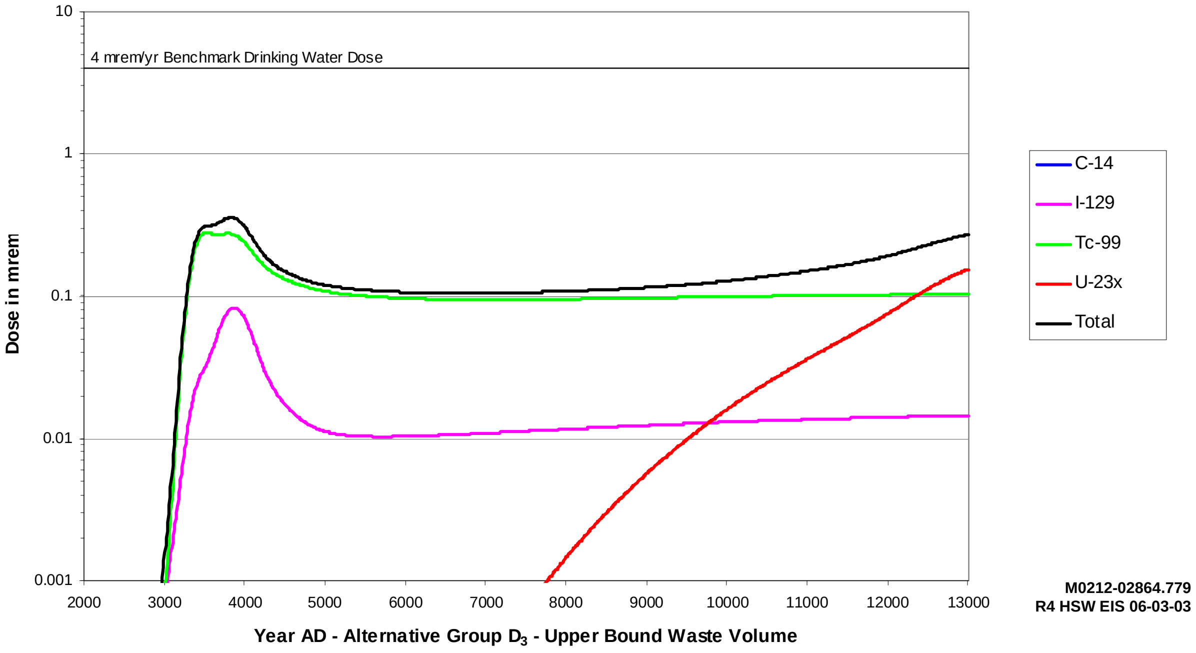
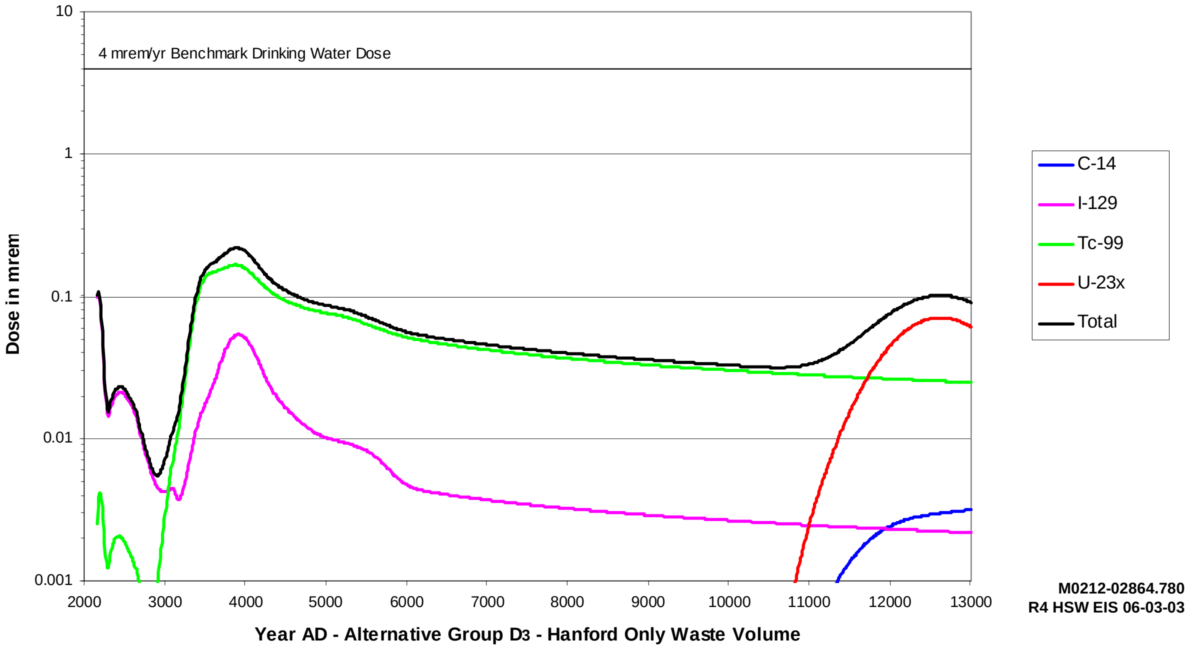


Figure F.20. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient from ERDF, Alternative Group D_3



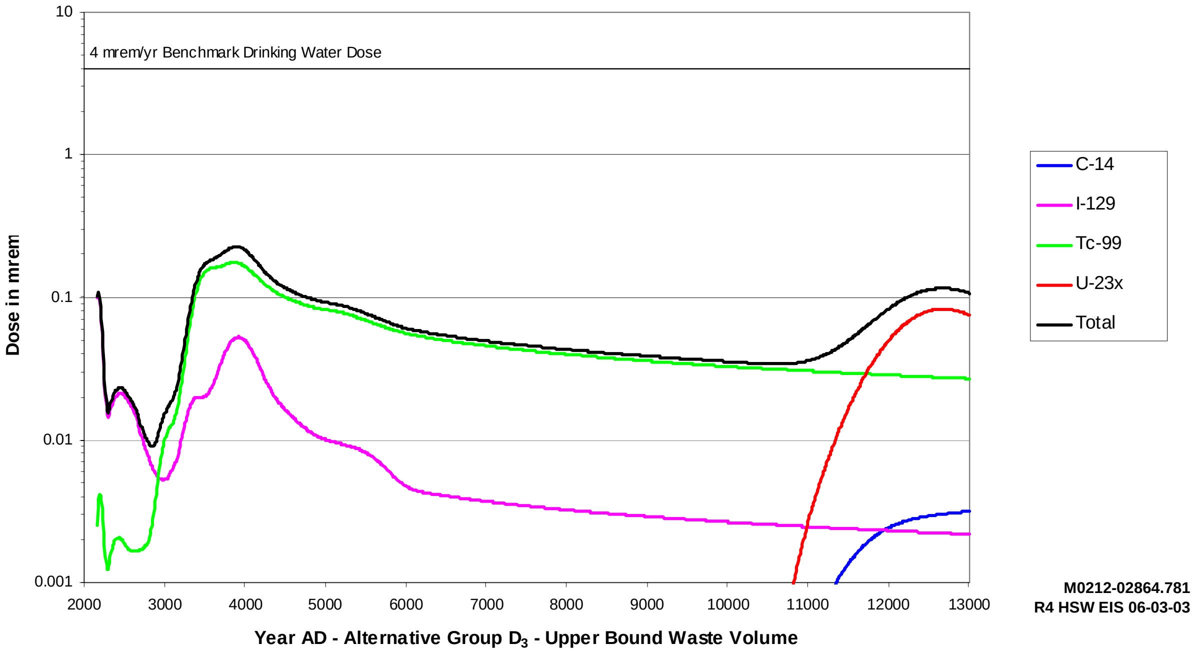
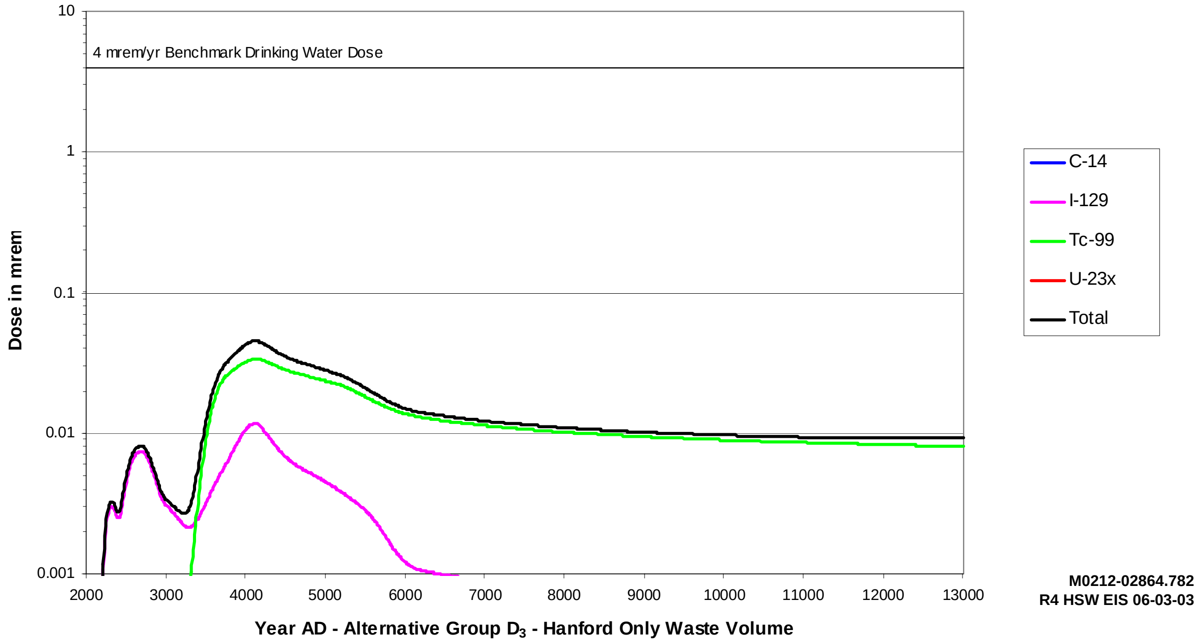


Figure F.21. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient Northwest of 200 East Area, Alternative Group D_3



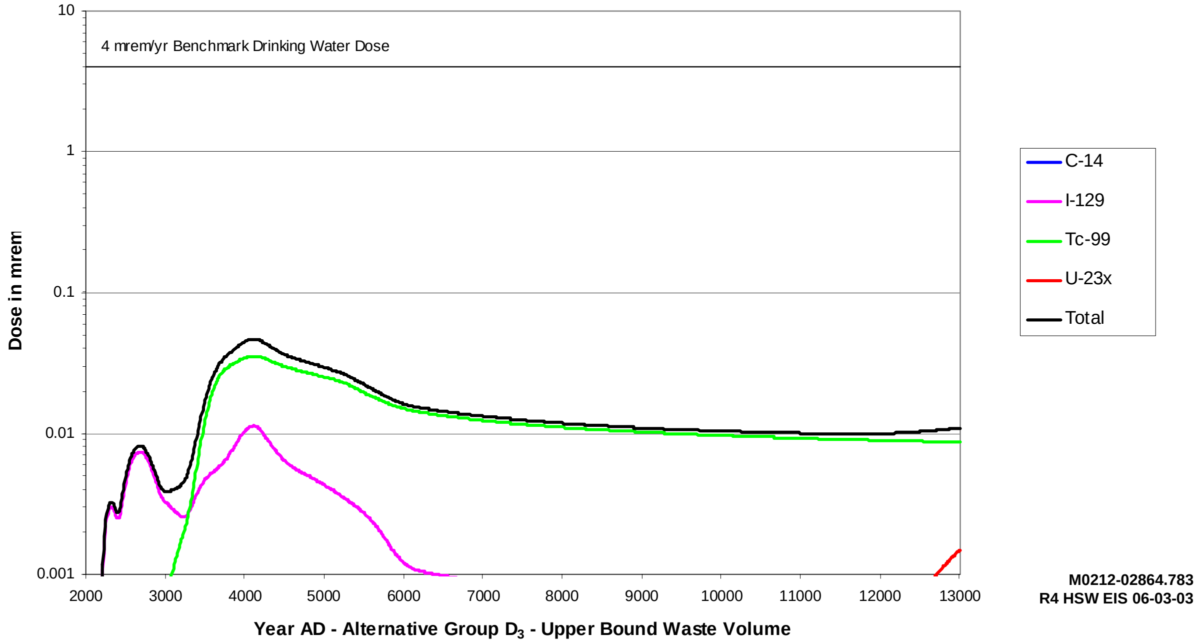
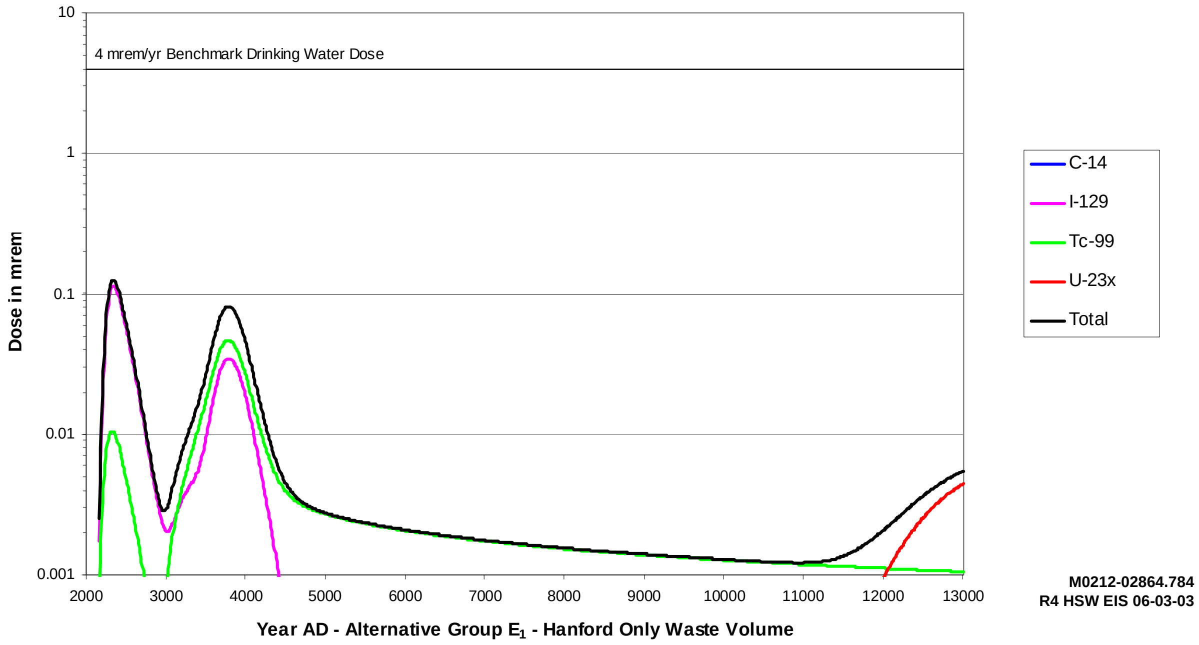


Figure F.22. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well Adjacent to the Columbia River, Alternative Group D_3



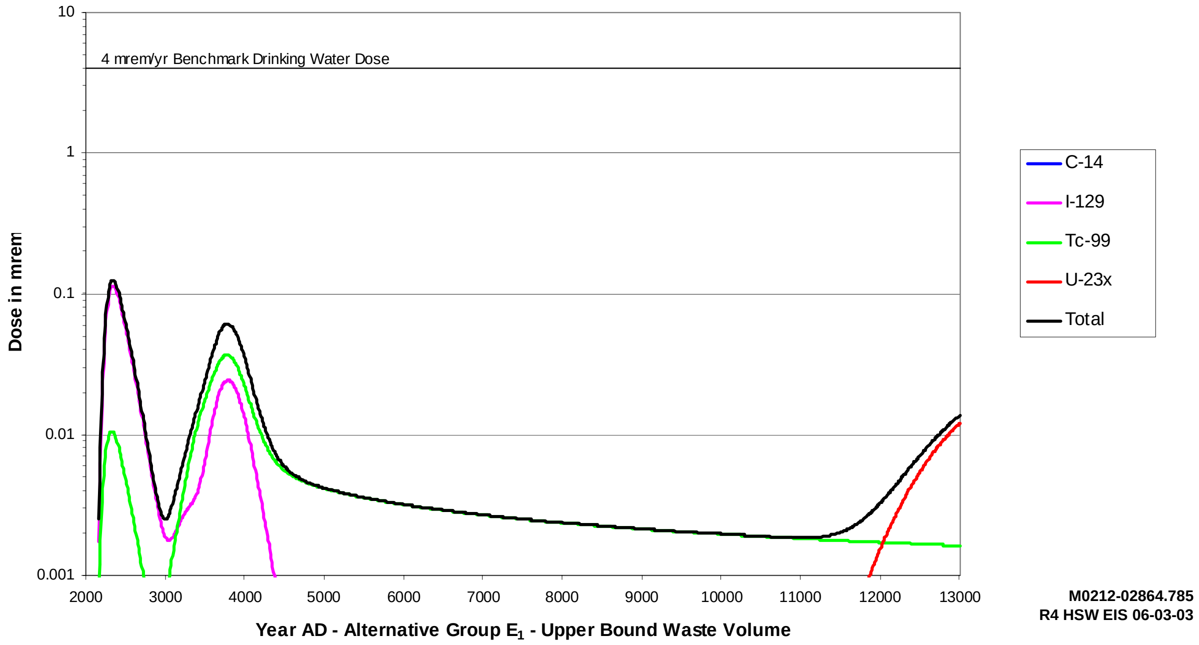


Figure F.23. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient from 200 West Area, Alternative Group E_1

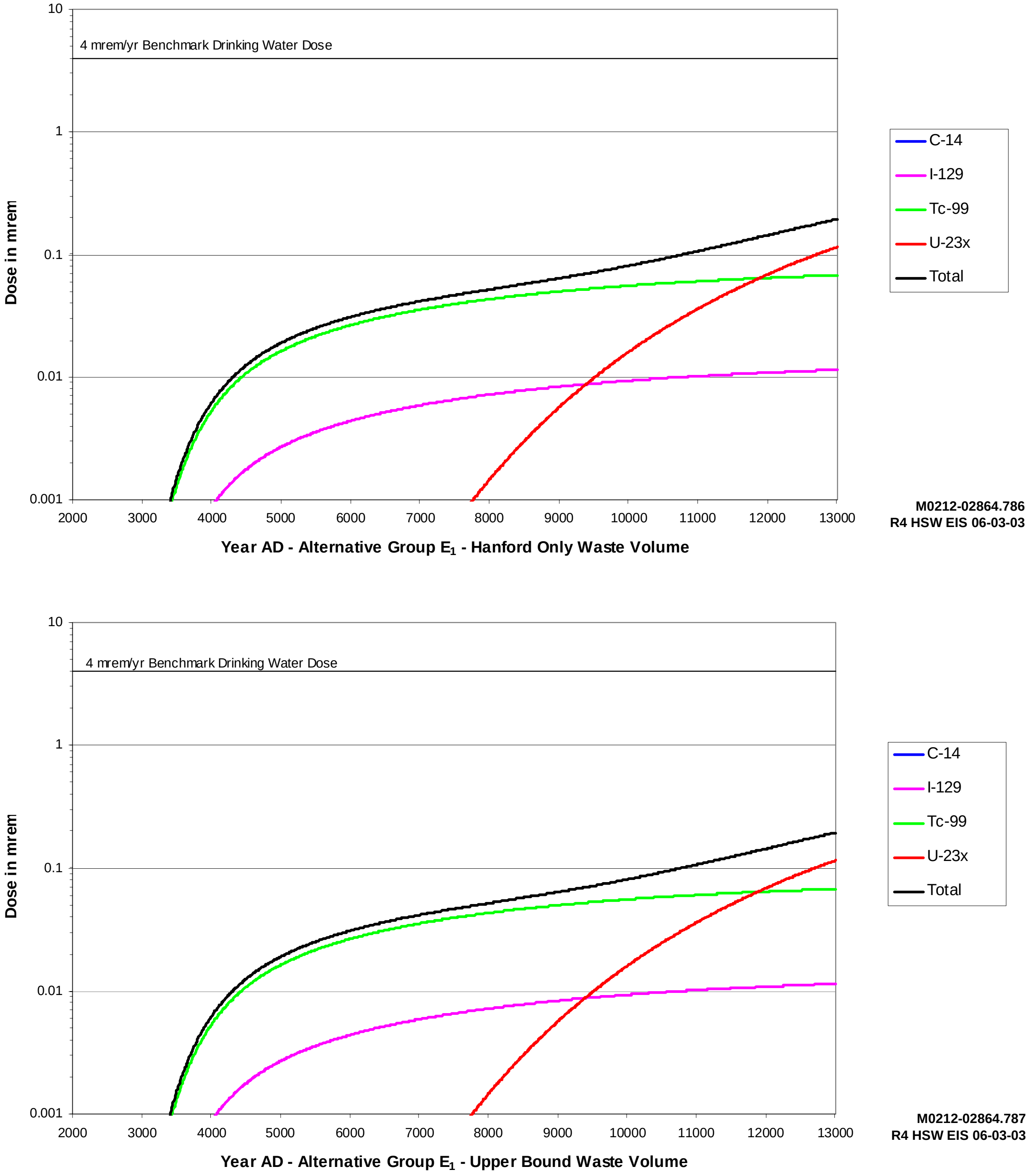
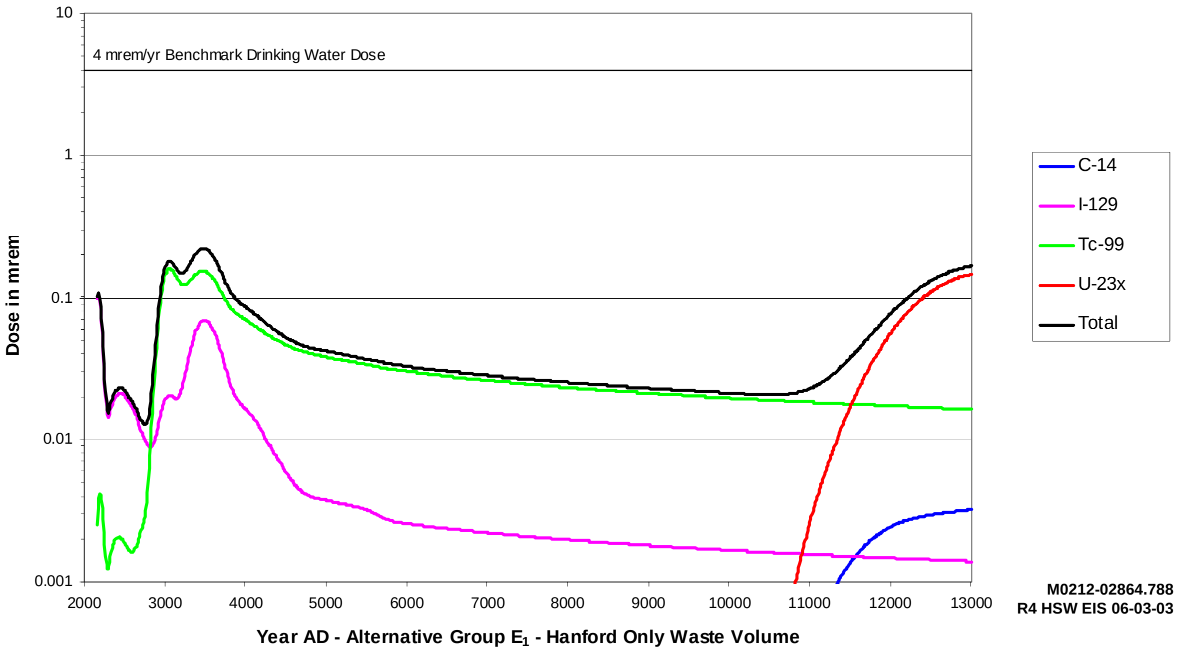


Figure F.24. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient from ERDF, Alternative Group E_1



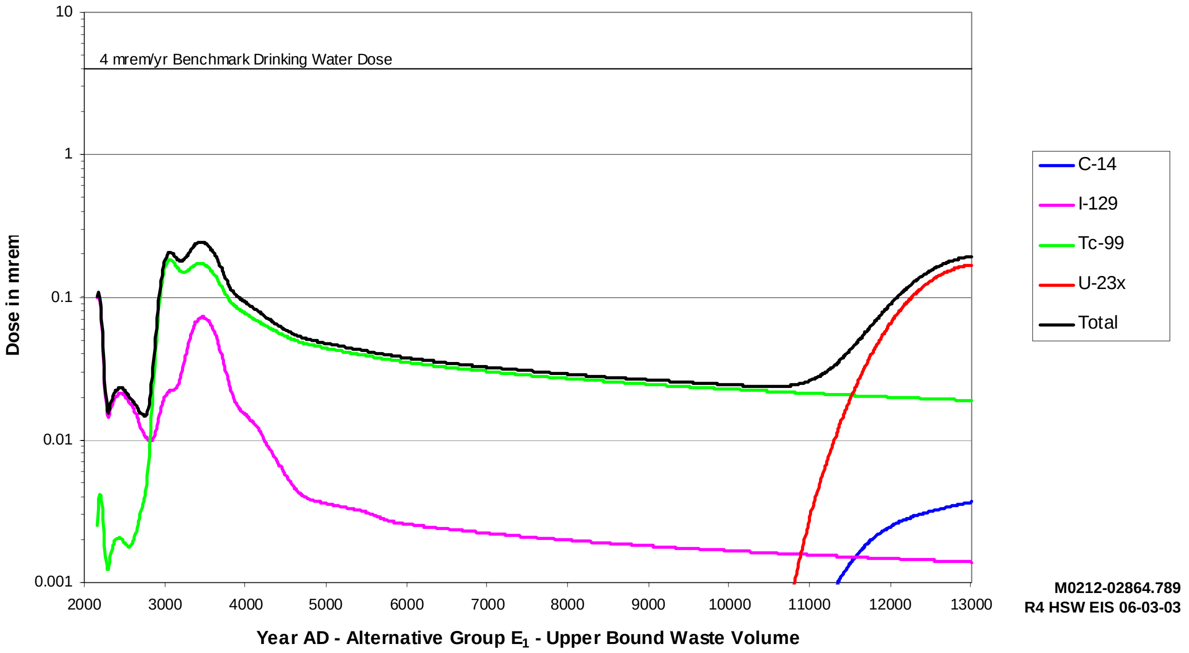
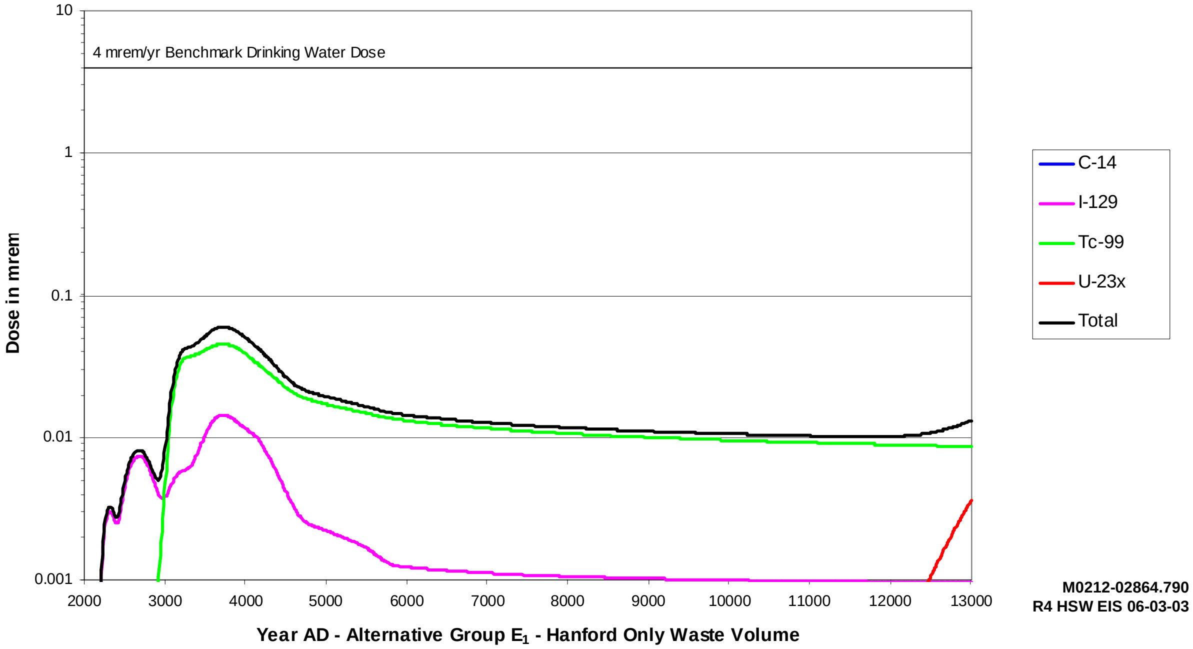


Figure F.25. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient Northwest of 200 East Area, Alternative Group E_1



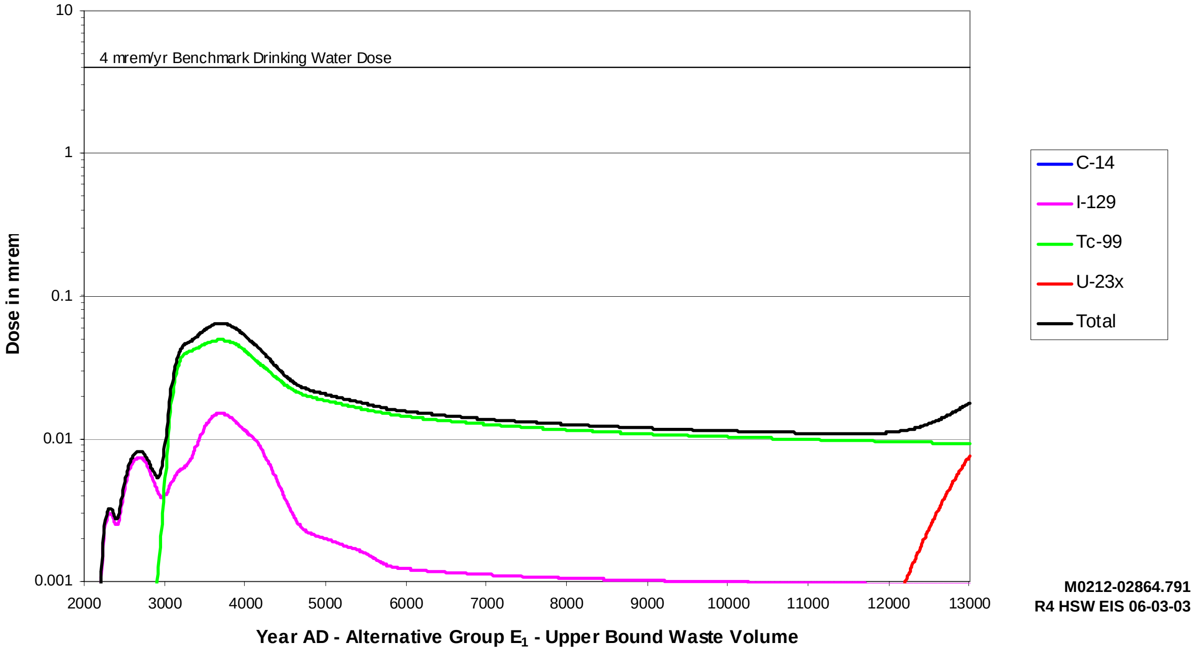
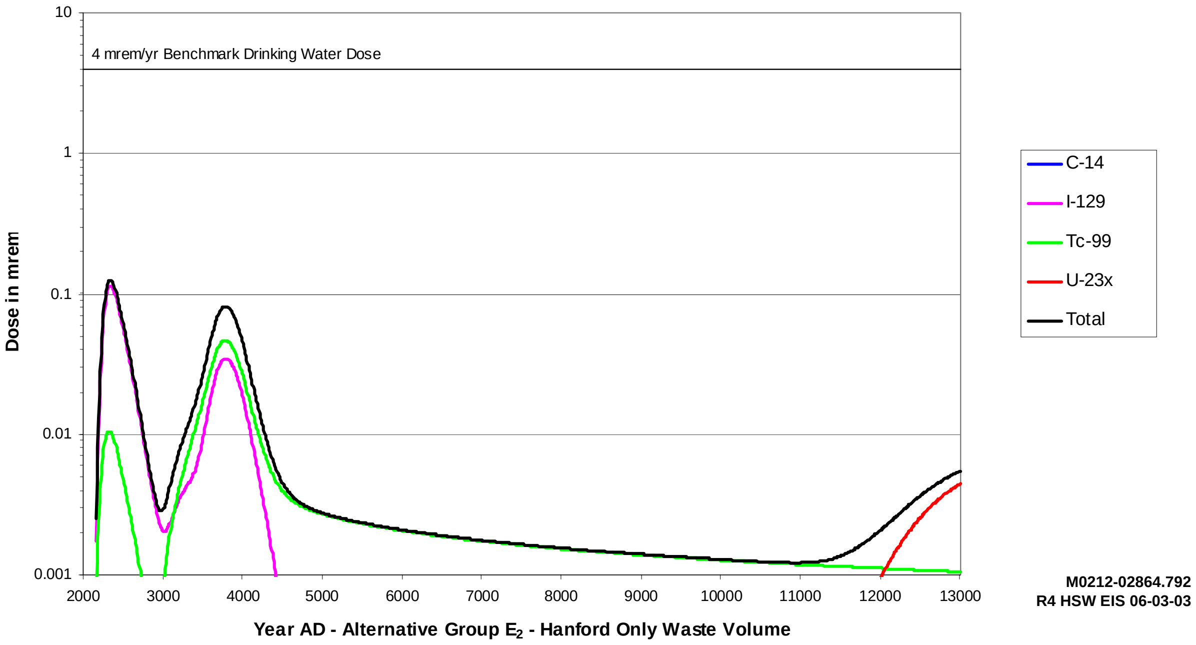


Figure F.26. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well Adjacent to the Columbia River, Alternative Group E_1



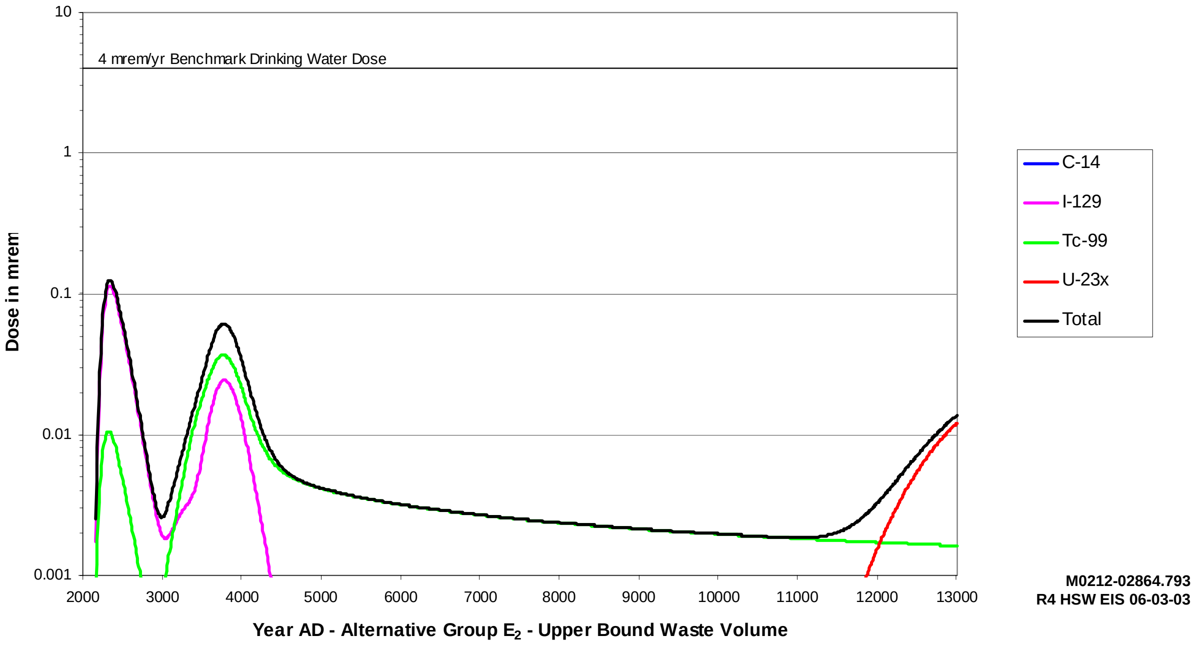
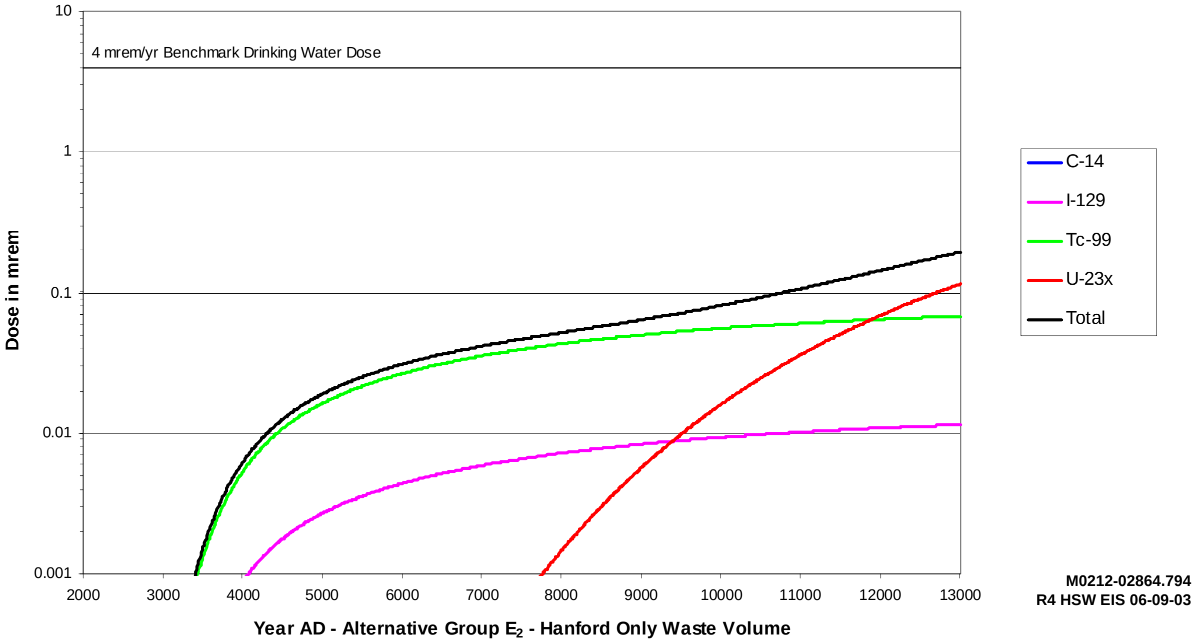


Figure F.27. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient from 200 West Area, Alternative Group E_2



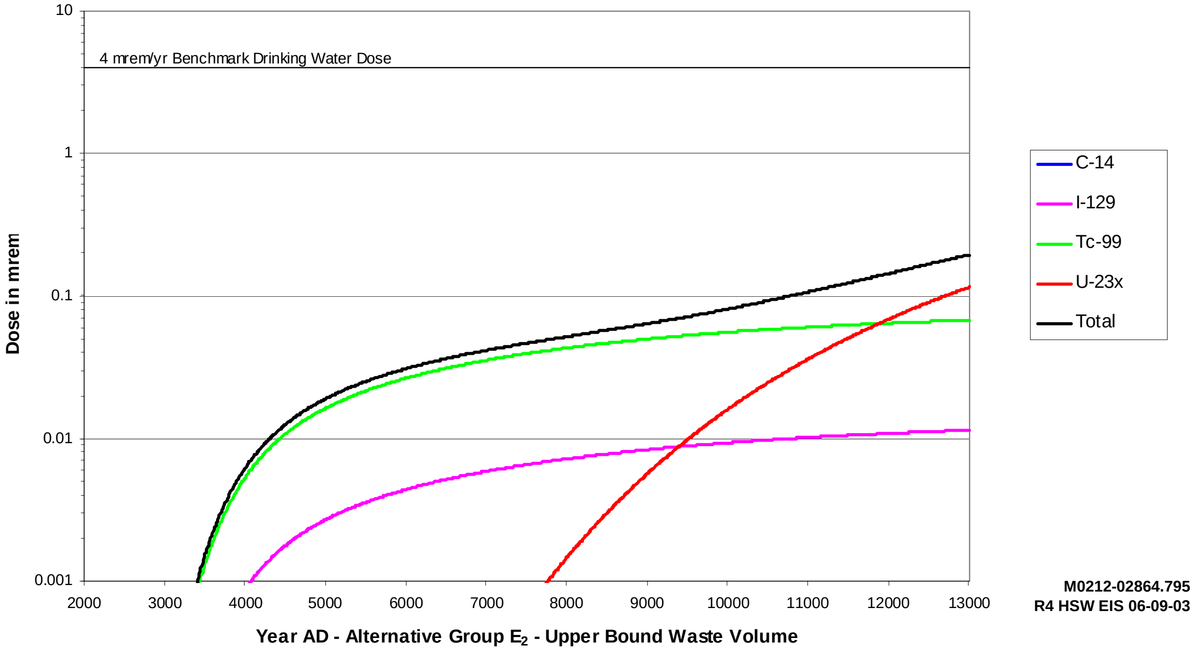


Figure F.28. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient from ERDF, Alternative Group E_2

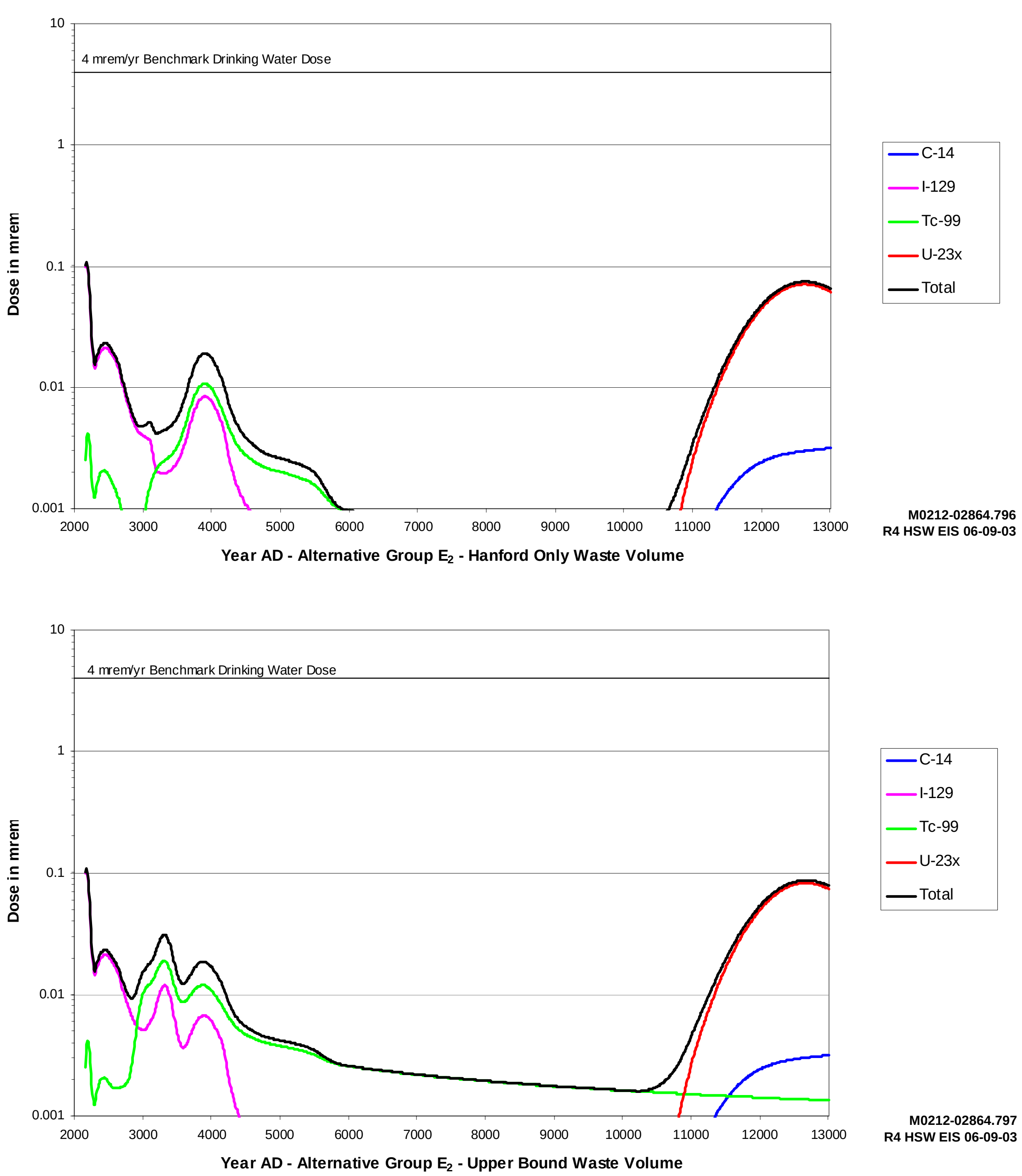
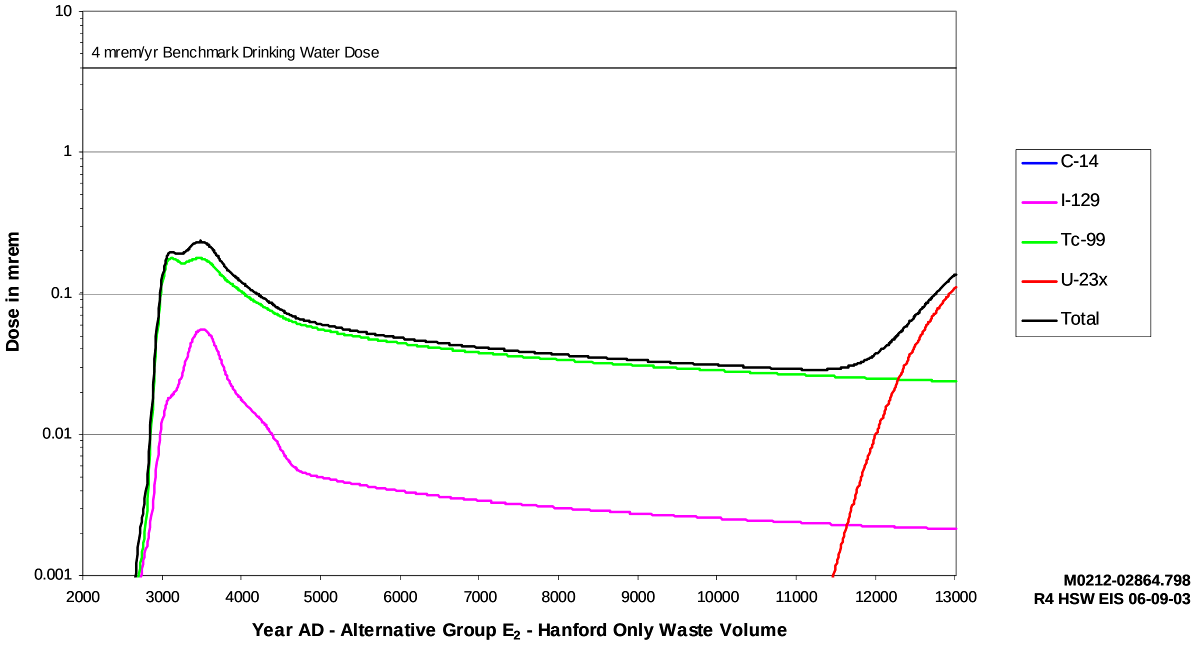


Figure F.29. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient Northwest of 200 East Area, Alternative Group E_2



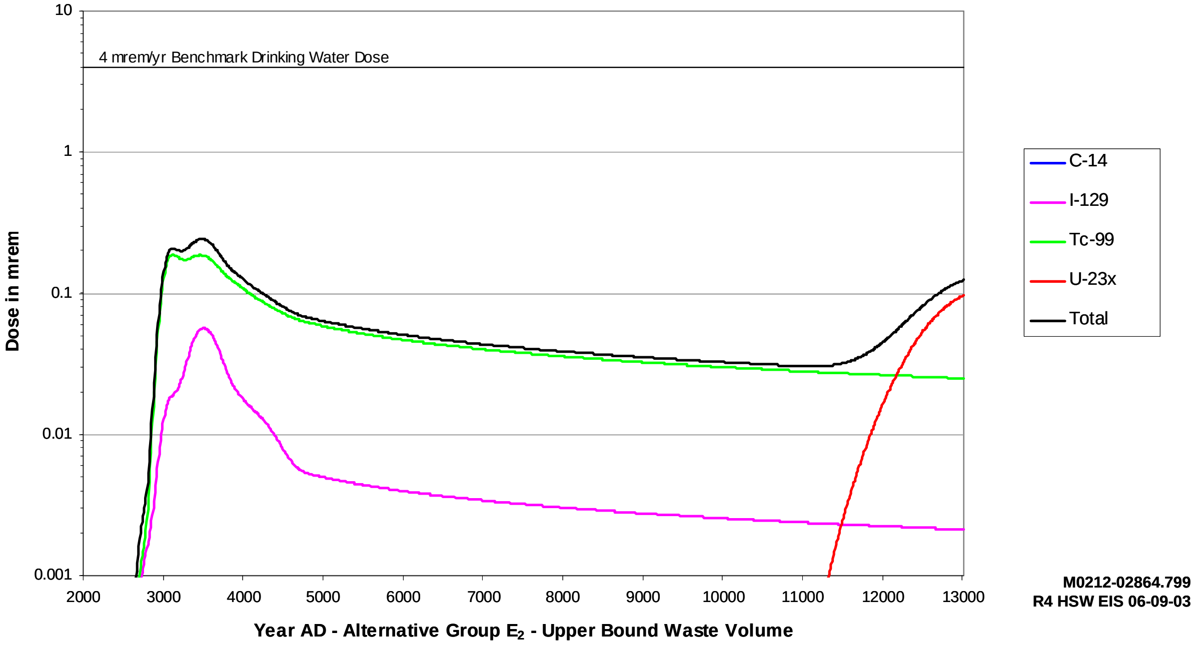
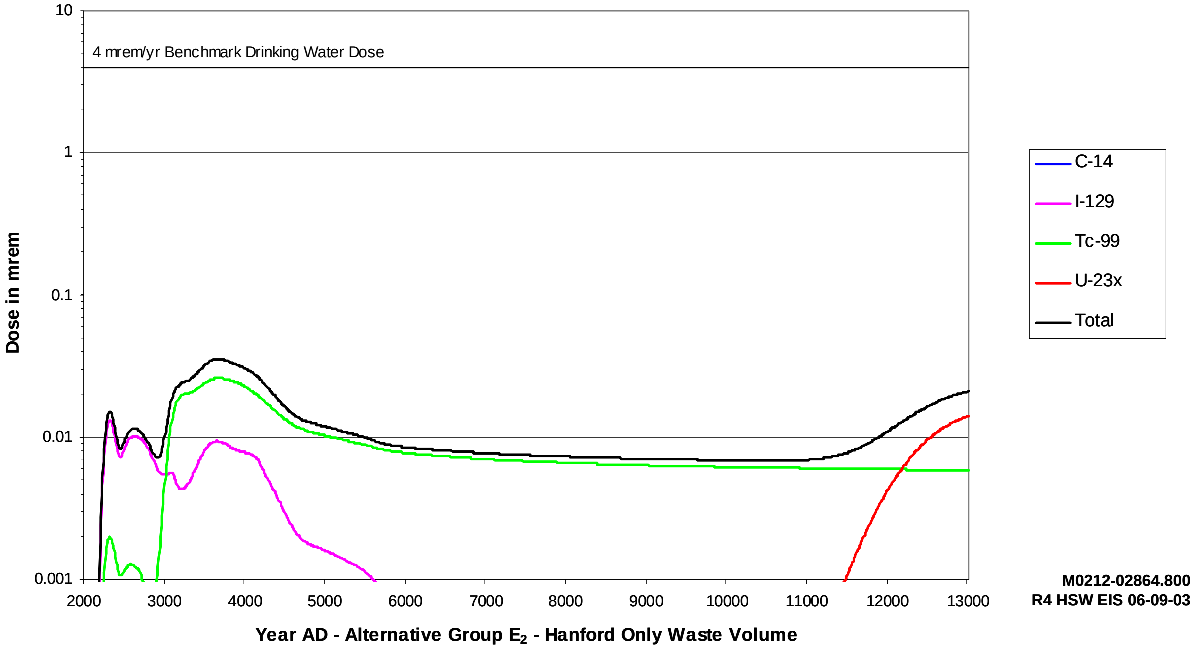


Figure F.30. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient Southeast of 200 East Area, Alternative Group E_2



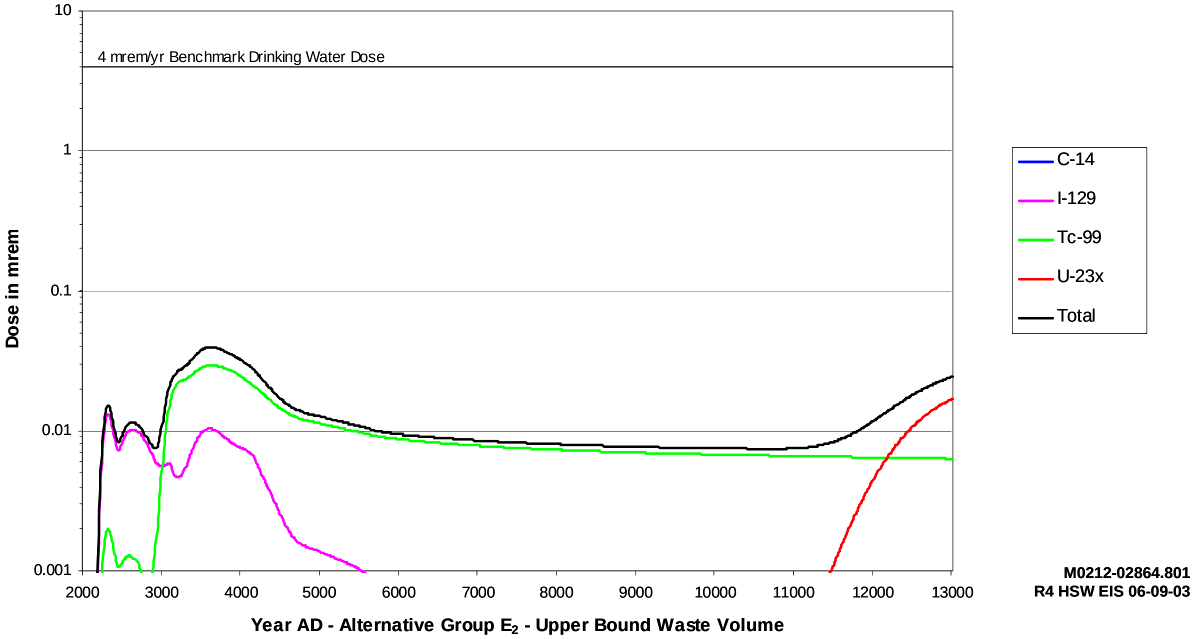
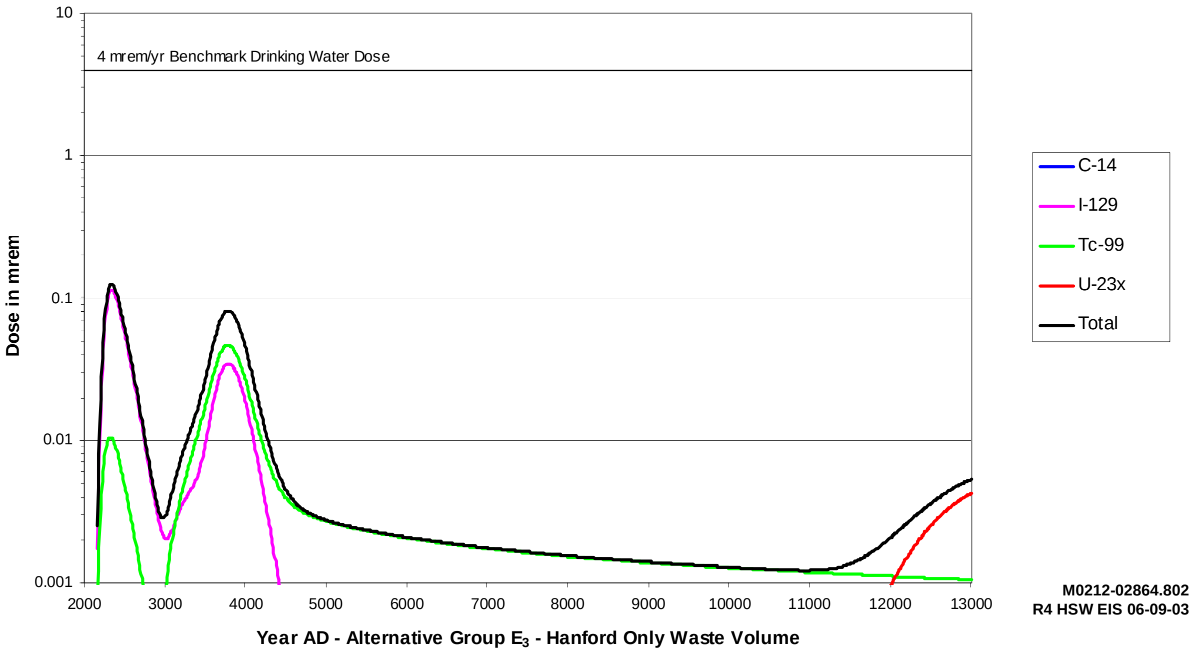


Figure F.31. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well Adjacent to the Columbia River, Alternative Group E_2



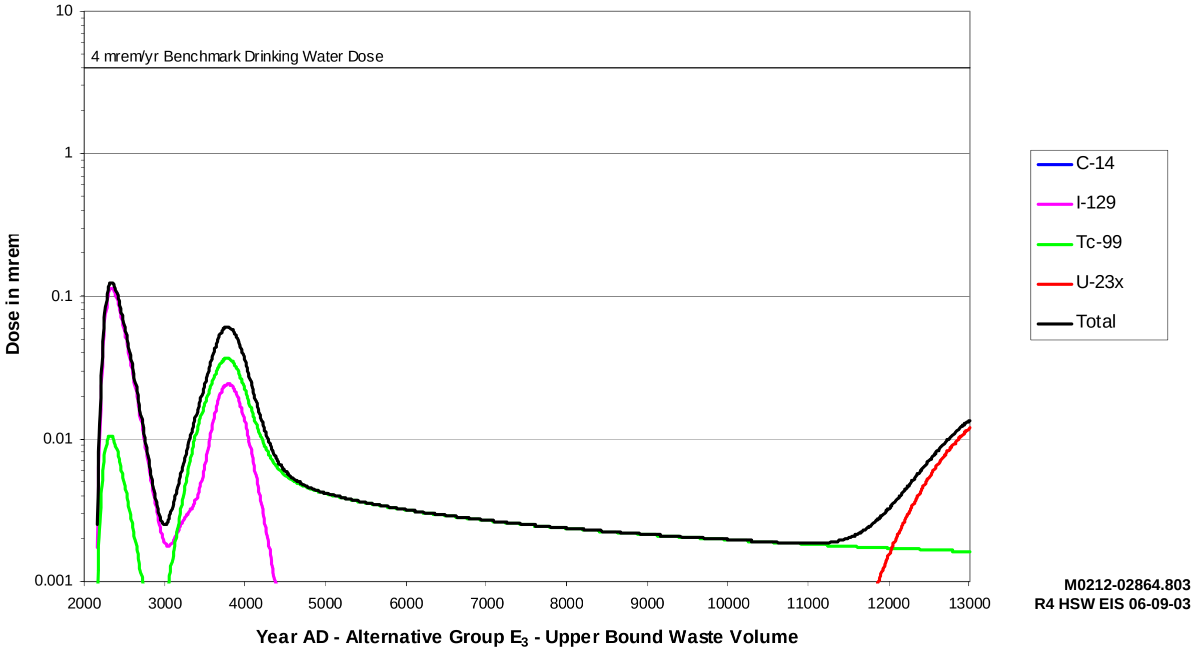
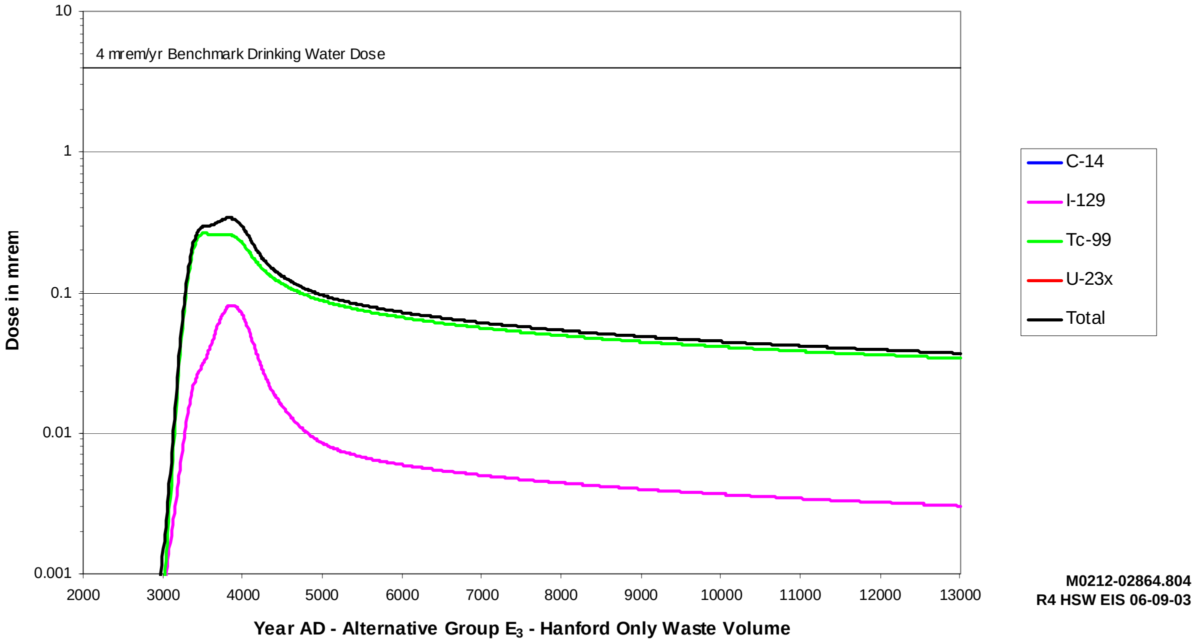


Figure F.32. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient from 200 West Area, Alternative Group E_3



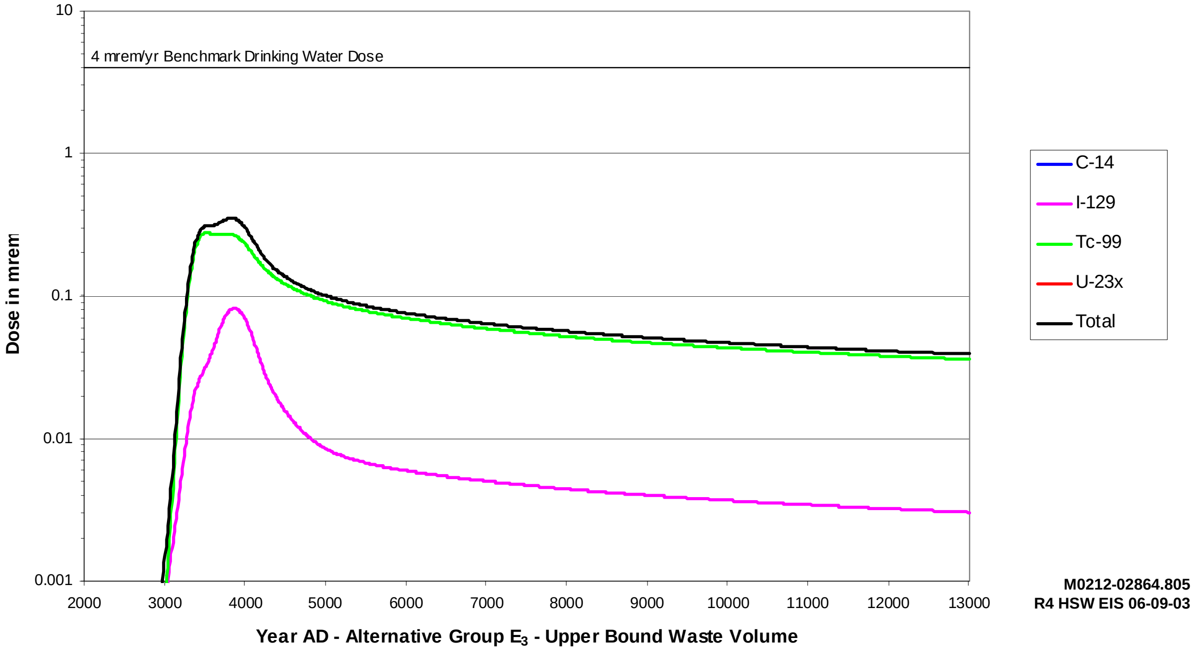
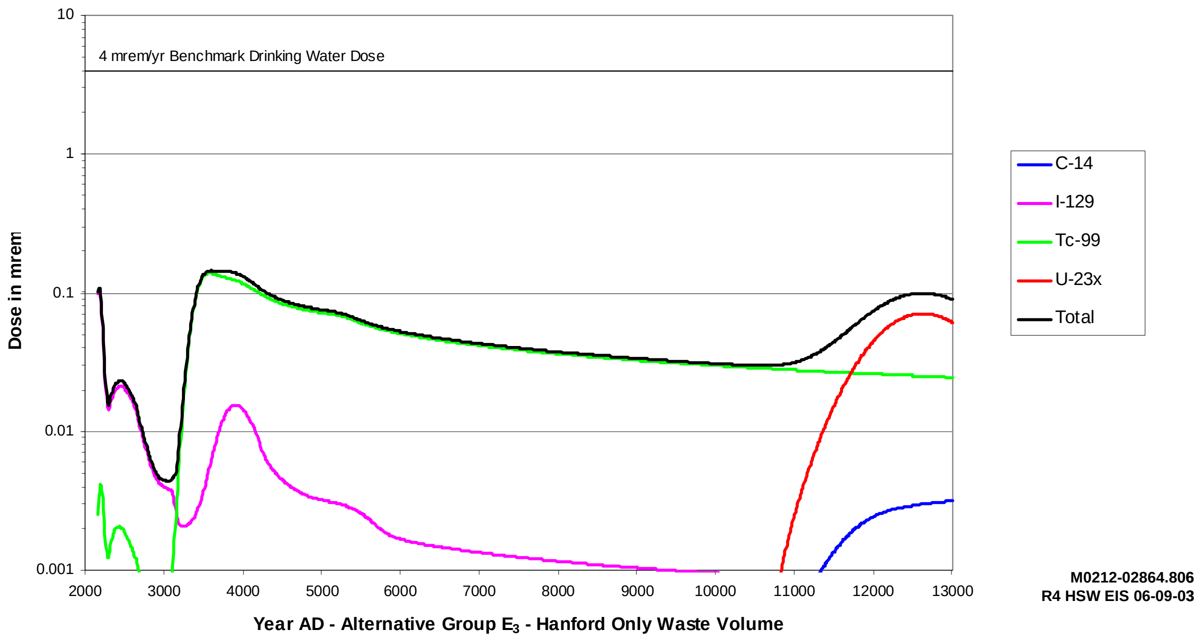


Figure F.33. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient from ERDF, Alternative Group E_3



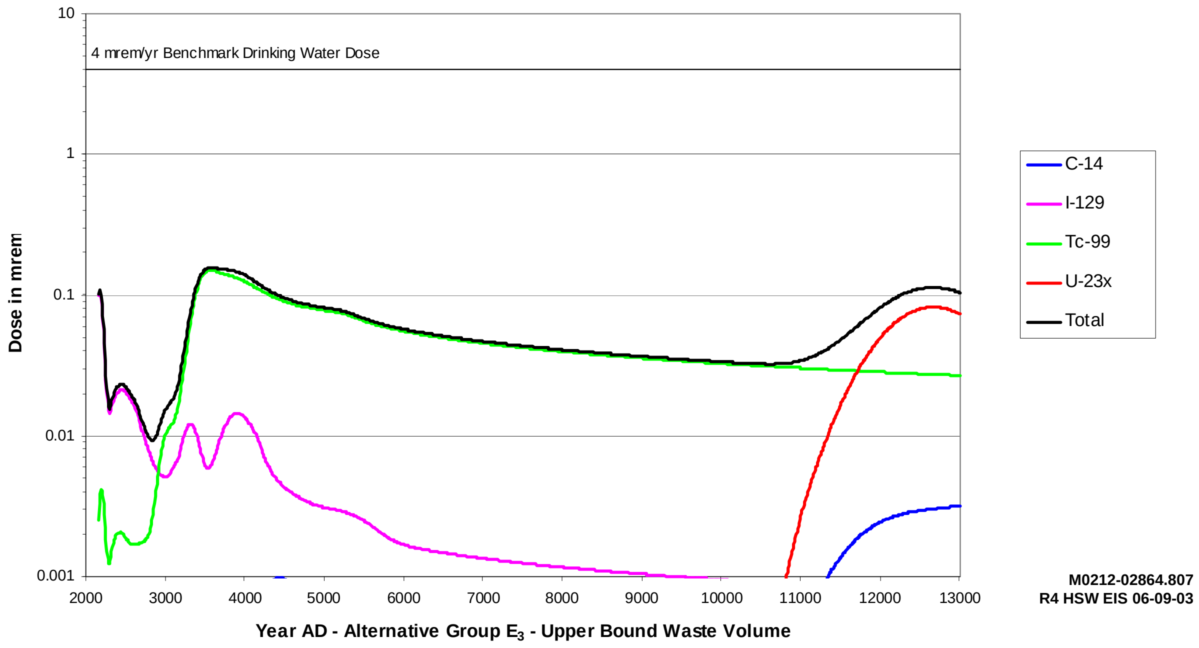
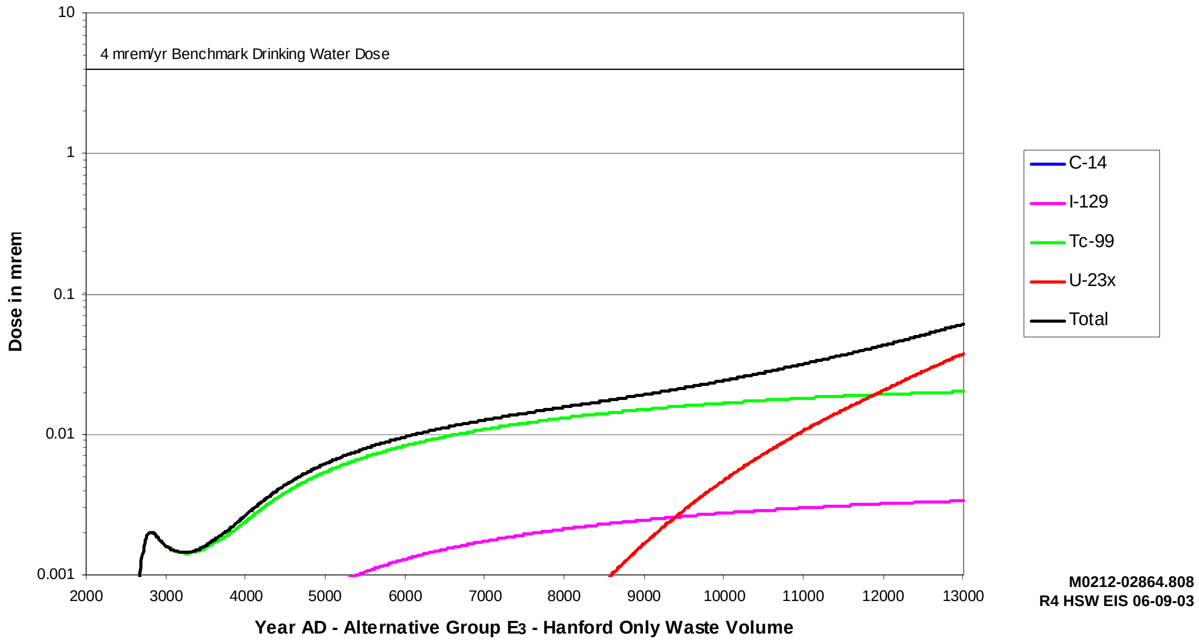


Figure F.34. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient Northwest of 200 East Area, Alternative Group E_3



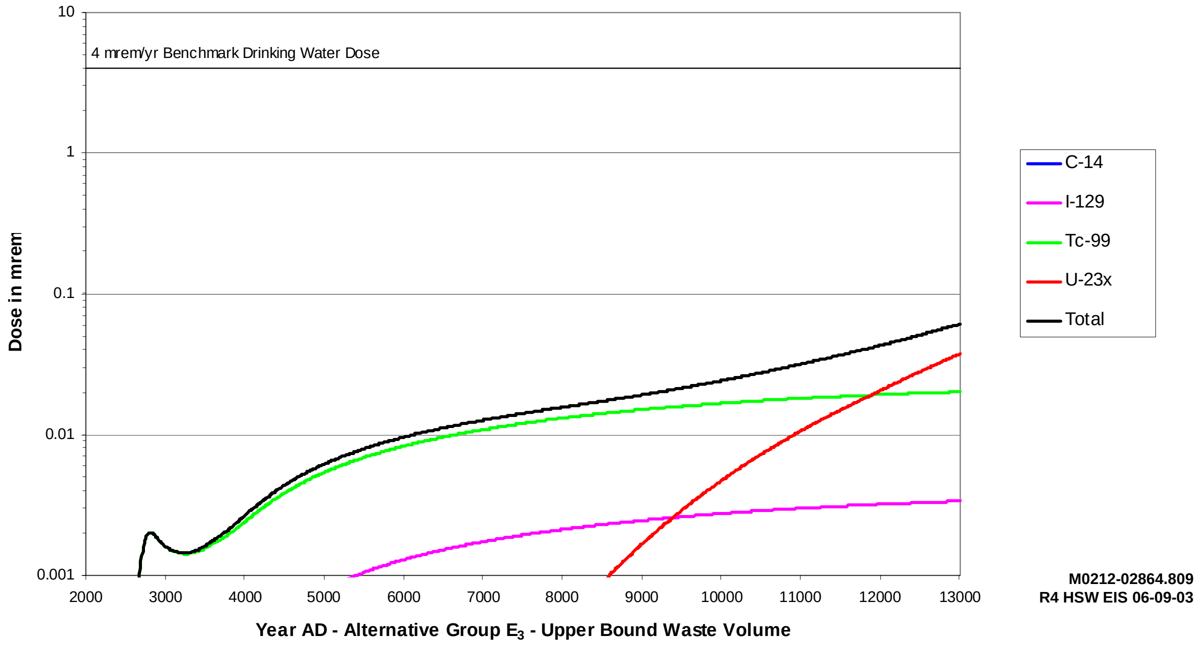
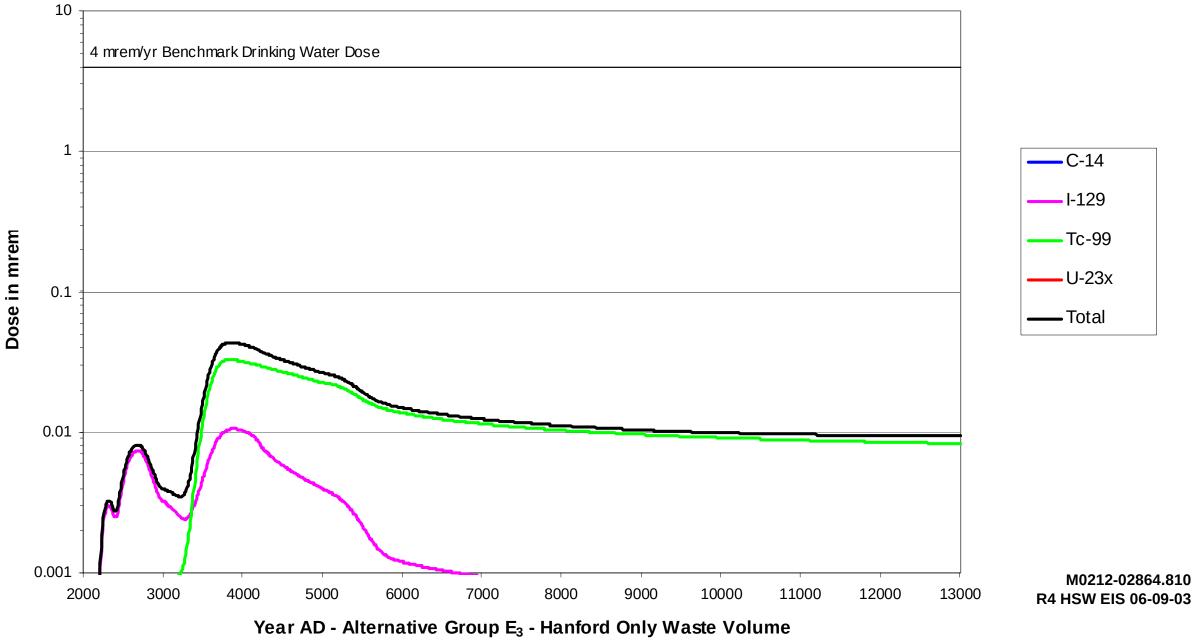


Figure F.35. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient Southeast of 200 East Area, Alternative Group E_3



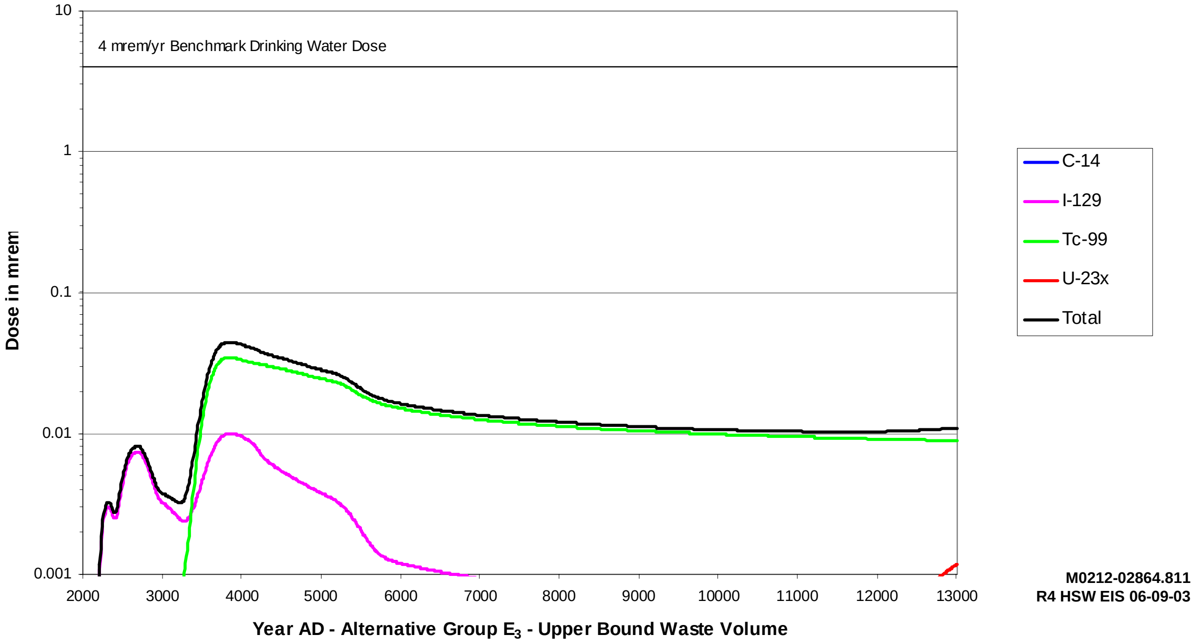


Figure F.36. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well Adjacent to the Columbia River, Alternative Group E_3

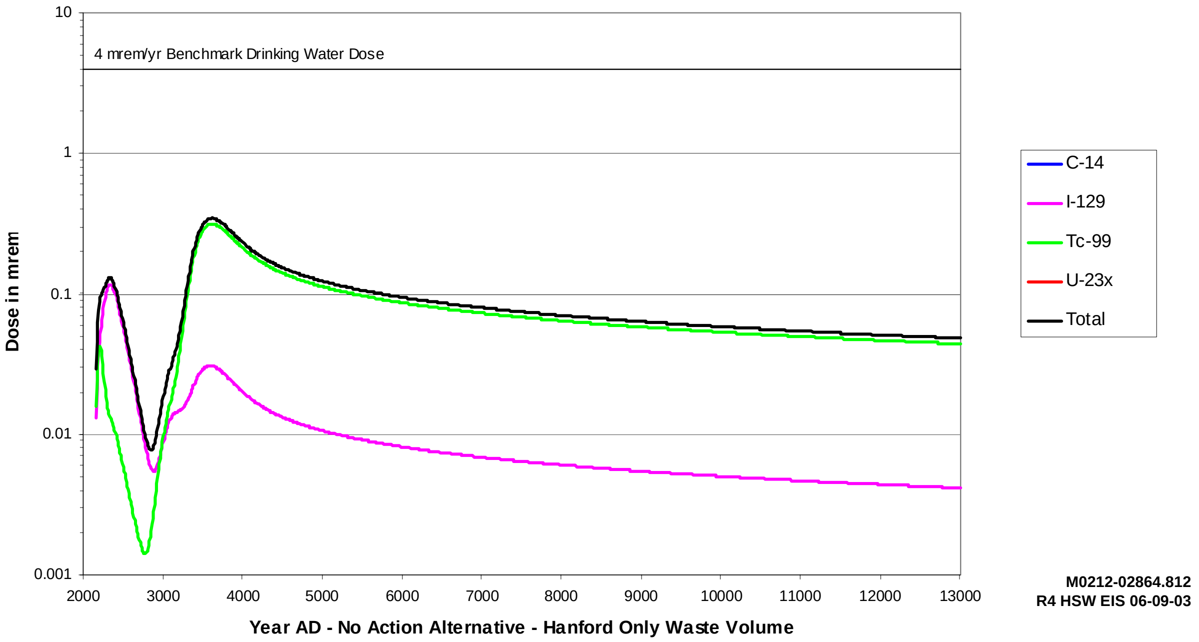


Figure F.37. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient from 200 West Area, No Action Alternative

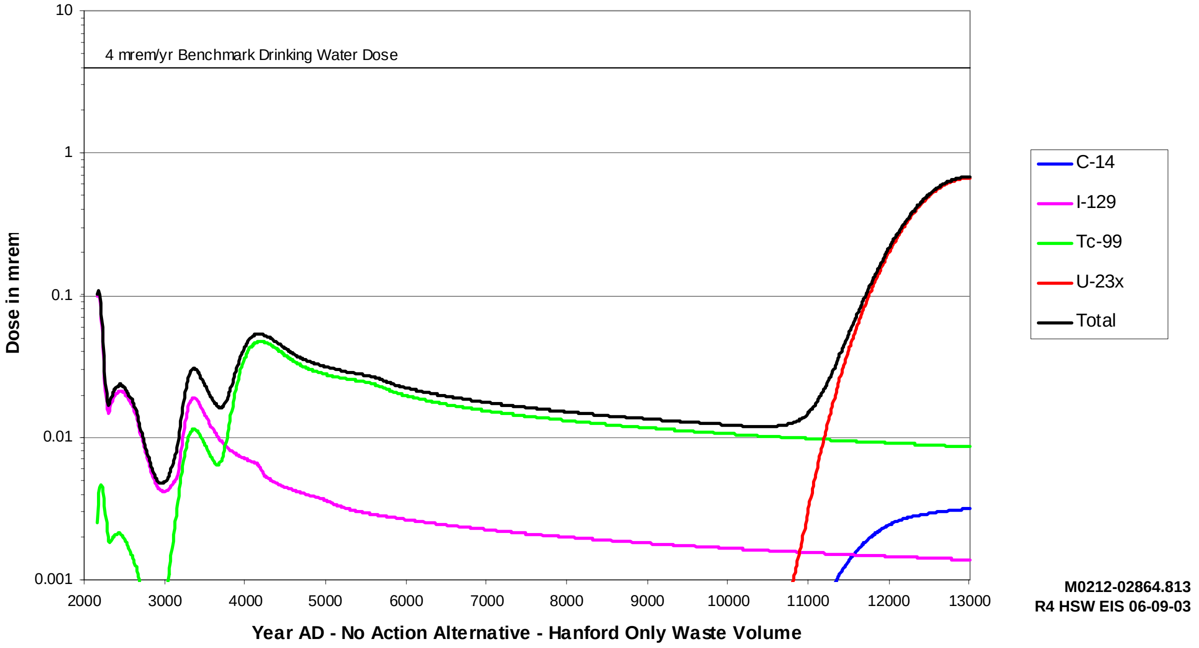


Figure F.38. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well 1 km Downgradient Northwest of 200 East Area, No Action Alternative

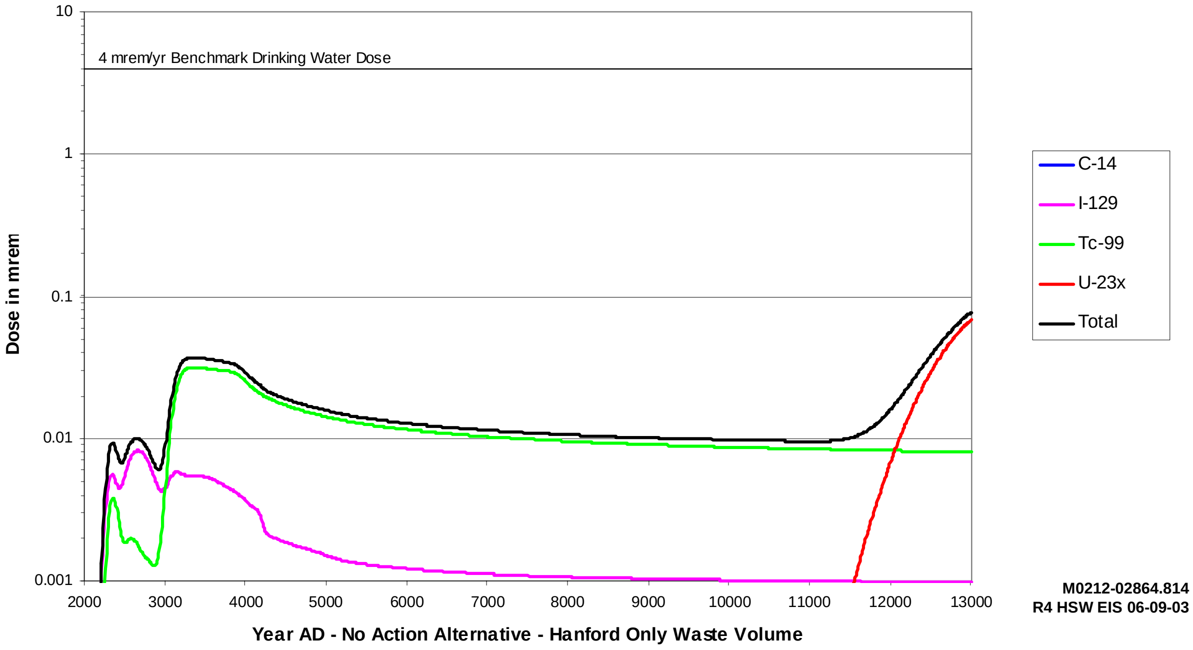


Figure F.39. Hypothetical Annual Drinking Water Dose at Various Times over 10,000 Years in Water from a Well Adjacent to the Columbia River, No Action Alternative

The radiation doses received from groundwater are evaluated using dose conversion factors specific to radionuclides and exposure scenarios. The dose factors used for drinking water ingestion, resident gardener, and resident gardener with sauna/sweat lodge are given in Table F.52.

Table F.52. Exposure Scenario Dose Factors for Use of Groundwater

Radionuclide	**Annual Dose Factor by Exposure Scenario (mrem/yr per pCi/L)**		
	Drinking Water	**Resident Gardener**	**Resident Gardener with Sauna**
Carbon-14	1.5E-03	4.0E-02	4.4E-02
Technetium-99	1.0E-03	3.6E-03	1.7E-02
Iodine-129	2.0E-01	6.2E-01	9.0E-01
Uranium-233	2.1E-01	2.6E-01	2.2E+02
Uranium-234	2.0E-01	2.5E-01	2.2E+02
Uranium-235	1.9E-01	2.4E-01	2.0E+02
Uranium-236	2.0E-01	2.4E-01	2.0E+02
Uranium-238	1.8E-01	2.2E-01	1.9E+02

A summary of groundwater dose results as a function of time is presented in Volume I, Section 5.11.2 for each alternative group. This section of the appendix presents tables of the peak impacts and the time of peak impact by waste stream and period of disposal. These tables also present the health impact estimates for the resident gardener scenario with the sauna/sweat lodge included. The contents of Tables F.54 through F.140 are indexed in Table F.53.

Table F.53. Content of Tables for Groundwater Analysis Results

	200 East Area 1-km Point of Analysis			**200 West Area 1- km Point of Analysis**			**Columbia River Point of Analysis**		
	Waste Volume			**Waste Volume**			**Waste Volume**		
Alternative	**Hanford**	**Lower**	**Upper**	**Hanford**	**Lower**	**Upper**	**Hanford**	**Lower**	**Upper**
Group A	F.54	F.55	F.56	F.57	F.58	F.59	F.60	F.61	F.62
Group B	F.63	F.64	F.65	F.66	F.67	F.68	F.69	F.70	F.71
Group C	F.72	F.73	F.74	F.75	F.76	F.77	F.78	F.79	F.80
Group D_1	F.81	F.82	F.83	F.84	F.85	F.86	F.87	F.88	F.89
Group D_2	F.90	F.91	F.92	F.93	F.94	F.95	F.96	F.97	F.98
Group D_3	F.99	F.100	F.101	F.102	F.103	F.104	F.105	F.106	F.107
Group E_1	F.108	F.109	F.110	F.111	F.112	F.113	F.114	F.115	F.116
Group E_2	F.117	F.118	F.119	F.120	F.121	F.122	F.123	F.124	F.125
Group E_3	F.126	F.127	F.128	F.129	F.130	F.131	F.132	F.133	F.134
No Action	F.135	F.136	NA	F.137	F.138	NA	F.139	F.140	NA
NA = not applicable.									

Table F.54. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group A, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,810	5.8E-06	1.7E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.5E-06	1.0E-04	6E-08
MLLW	200 West Area	Resident Gardener	1,810	7.3E-05	2.2E-03	1E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1,810	1.6E-05	4.8E-04	3E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.6E-05	4.9E-04	3E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,810	2.0E-04	5.9E-03	4E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	2,070	9.3E-06	2.8E-04	2E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	1.7E-04	5.0E-03	3E-06
MLLW	200 East Area	Resident Gardener	1,370	4.8E-04	1.4E-02	9E-06
ILAW	200 East Area	Resident Gardener	10,000	1.0E-04	3.0E-03	2E-06
Melters	200 East Area	Resident Gardener	670	1.0E-05	3.0E-04	2E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,070	3.4E-05	1.0E-03	6E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	7.6E-04	2.3E-02	1E-05
MLLW	200 East Area	Resident Gardener + Sauna	10,000	1.4E-02	4.1E-01	3E-04
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.5E-02	1.0E-00	6E-04
Melters	200 East Area	Resident Gardener + Sauna	10,000	7.7E-04	2.4E-02	2E-05

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.55. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group A, Lower Bound Waste Volume

Waste Category	**Source Location**	**Exposure Scenario**	**Maximum Annual Dose**		**Lifetime Dose, rem**	**Probability of an LCF**[b]
			Years Post-2046[a]	**Dose, rem**		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,810	7.0E-06	2.1E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.5E-06	1.0E-04	6E-08
MLLW	200 West Area	Resident Gardener	1,810	5.0E-05	1.0E-03	8E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1,810	2.0E-05	5.9E-04	4E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.6E-05	4.9E-04	3E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,810	2.0E-04	5.0E-03	3E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	2,070	1.1E-05	3.4E-04	2E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	1.7E-04	5.0E-03	3E-06
MLLW	200 East Area	Resident Gardener	1,810	5.0E-05	1.0E-03	8E-07
ILAW	200 East Area	Resident Gardener	10,000	1.0E-04	3.0E-03	2E-06
Melters	200 East Area	Resident Gardener	980	2.4E-06	7.1E-05	4E-08
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,070	4.2E-05	1.3E-03	8E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	7.6E-04	2.3E-02	1E-05
MLLW	200 East Area	Resident Gardener + Sauna	10,000	2.0E-02	5.0E-01	3E-04
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.5E-02	1E-00	6E-04
Melters	200 East Area	Resident Gardener + Sauna	10,000	7.8E-04	2.3E-02	1E-05

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.56. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group A, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,810	7.3E-06	2.2E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.5E-06	1.0E-04	6E-08
MLLW	200 West Area	Resident Gardener	1,810	3.1E-05	3.3E-03	2E-06
	200 East Area	Resident Gardener	1,230	1.1E-04	3.4E-03	2E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1,810	2.1E-05	6.2E-04	4E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.6E-05	4.9E-04	3E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,810	1.1E-04	3.3E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	6.4E-03	1.9E-01	1E-04
Projected New Waste (>2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	2,070	1.1E-05	3.4E-04	2E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	1.7E-04	5.0E-03	3E-06
MLLW	200 East Area	Resident Gardener	1,370	5.4E-04	1.6E-02	1E-05
ILAW	200 East Area	Resident Gardener	10,000	1.0E-04	3.0E-03	2E-06
Melters	200 East Area	Resident Gardener	670	1.0E-05	3.0E-04	2E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,070	4.2E-05	1.3E-03	8E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	7.6E-04	2.3E-02	1E-05
MLLW	200 East Area	Resident Gardener + Sauna	10,000	2.5E-02	7.4E-01	4E-04
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.5E-02	1.0E-00	6E-04
Melters	200 East Area	Resident Gardener + Sauna	10,000	7.7E-04	2.3E-02	1E-05

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.57. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group A, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose: Years Post-2046[(a)]	Maximum Annual Dose: Dose, rem	Lifetime Dose, rem	Probability of an LCF[(b)]
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)						
LLW Cat 1	200 West Area	Resident Gardener	1700	2.7E-05	8.2E-04	5E-07
LLW Cat 3	200 West Area	Resident Gardener	1230	2.4E-05	7.3E-04	4E-07
MLLW	200 West Area	Resident Gardener	1700	2.2E-04	6.5E-03	4E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1700	7.6E-05	2.3E-03	1E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1230	1.2E-04	3.5E-03	2E-06
MLLW	200 West Area	Resident Gardener + Sauna	1700	7.4E-04	2.2E-02	1E-05
Projected New Waste (>2007)[(c)]						
LLW Cat 1	200 West Area	Resident Gardener	1910	4.8E-05	1.5E-03	9E-07
LLW Cat 3	200 West Area	Resident Gardener	1230	1.2E-03	3.5E-02	2E-05
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1910	1.8E-04	5.4E-03	3E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1230	5.3E-03	1.6E-01	1E-04

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.58. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area 1-km Well from Radionuclides in the Groundwater Over 10,000 Years for Alternative Group A, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)						
LLW Cat 1	200 West Area	Resident Gardener	1700	3.3E-05	1.0E-03	6E-07
LLW Cat 3	200 West Area	Resident Gardener	1230	2.4E-05	7.3E-04	4E-07
MLLW	200 West Area	Resident Gardener	1700	2.2E-04	6.5E-03	4E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	700	9.3E-05	2.8E-03	2E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1230	1.2E-04	3.5E-03	2E-06
MLLW	200 West Area	Resident Gardener + Sauna	1700	7.4E-04	2.2E-02	1E-05
Projected New Waste (>2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1910	5.9E-05	1.8E-03	1E-06
LLW Cat 3	200 West Area	Resident Gardener	1230	1.2E-03	3.5E-02	2E-05
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1910	2.2E-04	6.5E-03	4E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1230	5.3E-03	1.6E-01	1E-04

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.59. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group A, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose: Years Post-2046[(a)]	Maximum Annual Dose: Dose, rem	Lifetime Dose, rem	Probability of an LCF[(b)]
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)						
LLW Cat 1	200 West Area	Resident Gardener	1700	3.4E-05	1.0E-03	6E-07
LLW Cat 3	200 West Area	Resident Gardener	1230	2.4E-05	7.3E-04	4E-07
MLLW	200 West Area	Resident Gardener	1700	1.5E-04	4.4E-03	3E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1700	9.8E-05	3.0E-03	2E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1230	1.2E-04	3.5E-03	2E-06
MLLW	200 West Area	Resident Gardener + Sauna	1700	5.2E-04	1.6E-02	9E-06
Projected New Waste (>2007)[(c)]						
LLW Cat 1	200 West Area	Resident Gardener	1910	5.9E-05	1.8E-03	1E-06
LLW Cat 3	200 West Area	Resident Gardener	1230	1.2E-03	3.5E-02	2E-05
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1910	2.2E-04	6.6E-03	4E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1230	5.3E-03	1.6E-01	1E-04

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.60. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group A, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	2,000	2.4E-06	7.2E-05	4E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.7E-06	5.1E-05	3E-08
MLLW	200 West Area	Resident Gardener	2,000	1.9E-05	5.7E-04	3E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	6.7E-06	2.0E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	8.0E-06	2.4E-04	1E-07
MLLW	200 West Area	Resident Gardener + Sauna	2,000	6.4E-05	1.9E-03	1E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	2,260	4.5E-06	1.3E-04	8E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	8.2E-05	2.5E-03	2E-06
MLLW	200 East Area	Resident Gardener	1,590	6.4E-05	1.9E-03	1E-06
ILAW	200 East Area	Resident Gardener	10,000	1.3E-05	3.8E-04	2E-07
Melters	200 East Area	Resident Gardener	940	1.2E-06	3.7E-05	2E-08
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,260	1.7E-05	5.0E-04	3E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	3.7E-04	1.1E-02	7E-06
MLLW	200 East Area	Resident Gardener + Sauna	10,000	2.9E-04	8.7E-03	5E-06
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.3E-05	9.8E-02	6E-05
Melters	200 East Area	Resident Gardener + Sauna	10,000	1.1E-05	3.2E-04	2E-07

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.61. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group A, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF(b)
			Years Post-2046(a)	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)(c)						
LLW Cat 1	200 West Area	Resident Gardener	2,000	2.9E-06	8.7E-05	5E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.7E-06	5.1E-05	3E-08
MLLW	200 West Area	Resident Gardener	2,000	1.9E-05	5.7E-04	3E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	8.1E-06	2.4E-04	2E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	8.0E-06	2.4E-04	1E-07
MLLW	200 West Area	Resident Gardener + Sauna	2,000	6.5E-05	1.9E-03	1E-06
Projected New Waste (>2007)(c)						
LLW Cat 1	200 West Area	Resident Gardener	2,260	5.5E-06	1.6E-04	8E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	8.2E-05	2.5E-03	1E-06
MLLW	200 East Area	Resident Gardener	1,580	6.4E-05	1.9E-03	1E-06
ILAW	200 East Area	Resident Gardener	10,000	1.3E-05	3.8E-04	2E-07
Melters	200 East Area	Resident Gardener	940	1.2E-06	3.7E-05	2E-08
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,260	2.0E-05	6.1E-04	4E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	3.7E-04	1.1E-02	7E-06
MLLW	200 East Area	Resident Gardener + Sauna	1,590	3.0E-04	9.0E-03	5E-06
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.3E-05	9.8E-02	6E-05
Melters	200 East Area	Resident Gardener + Sauna	10,000	1.1E-05	4.6E-04	3E-07

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.62. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater Over 10,000 Years for Alternative Group A, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.1E-05	6.4E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.1E-05	9.4E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	2,000	3.0E-06	9.1E-05	5E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.7E-06	5.1E-05	3E-08
MLLW	200 West Area	Resident Gardener	2,000	1.3E-05	3.9E-04	2E-07
	200 East Area	Resident Gardener	10,000	1.8E-05	3.9E-04	2E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	8.6E-06	2.6E-04	2E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	8.0E-06	2.4E-04	1E-07
MLLW	200 West Area	Resident Gardener + Sauna	2,000	4.6E-05	1.4E-03	8E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.9E-04	5.8E-03	4E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	2,260	5.5E-06	1.7E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,710	8.2E-05	2.5E-03	2E-06
MLLW	200 East Area	Resident Gardener	1,590	6.9E-05	2.1E-03	1E-06
ILAW	200 East Area	Resident Gardener	10,000	1.3E-05	3.8E-04	2E-07
Melters	200 East Area	Resident Gardener	940	1.2E-06	3.7E-05	2E-08
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,260	2.0E-05	6.1E-04	4E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	3.7E-04	1.1E-02	7E-06
MLLW	200 East Area	Resident Gardener + Sauna	10,000	3.9E-04	2.3E+02	1E-01
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.3E-05	9.8E-02	6E-05
Melters	200 East Area	Resident Gardener + Sauna	10,000	1.1E-05	3.2E-04	2E-07

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.63. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group B, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[(b)]
			Years Post-2046[(a)]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)[(c)]						
LLW Cat 1	200 West Area	Resident Gardener	1,810	5.5E-06	1.7E-04	1E-07
	200 East Area	Resident Gardener	1,230	8.5E-07	2.5E-05	2E-08
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.3E-06	1.0E-04	6E-08
	200 East Area	Resident Gardener	620	6.0E-06	1.8E-04	1E-07
MLLW	200 West Area	Resident Gardener	1,810	2.7E-05	8.0E-04	5E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1,810	1.5E-05	4.6E-04	3E-07
	200 East Area	Resident Gardener + Sauna	10,000	3.0E-04	9.0E-03	5E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.6E-05	4.7E-04	3E-07
	200 East Area	Resident Gardener + Sauna	620	2.9E-05	8.6E-04	5E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,810	9.1E-05	2.7E-03	2E-06
Projected New Waste (>2007)[(c)]						
LLW Cat 1	200 West Area	Resident Gardener	1,920	9.5E-06	2.8E-04	2E-07
	200 East Area	Resident Gardener	1,320	1.1E-06	3.2E-05	2E-08
LLW Cat 3	200 West Area	Resident Gardener	1,450	1.6E-04	4.9E-03	3E-06
	200 East Area	Resident Gardener	10,000	3.0E-04	9.1E-03	5E-06
MLLW	200 East Area	Resident Gardener	1,250	7.2E-04	2.1E-02	1E-05
Melters	200 East Area	Resident Gardener	680	2.6E-07	7.7E-06	5E-09
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1,920	3.5E-05	1.1E-03	6E-07
	200 East Area	Resident Gardener + Sauna	1,320	3.9E-06	1.2E-04	7E-08
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	7.3E-04	2.2E-02	1E-05
	200 East Area	Resident Gardener + Sauna	10,000	2.4E-01	7.3E+00	4E-03
MLLW	200 East Area	Resident Gardener + Sauna	10,000	3.8E-02	1.1E+00	7E-04
Melters	200 East Area	Resident Gardener + Sauna	680	1.2E-06	3.6E-05	2E-08

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.64. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group B, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose: Years Post-2046[a]	Maximum Annual Dose: Dose, rem	Lifetime Dose, rem	Probability of an LCF[b]
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,810	6.8E-06	2.0E-04	1E-07
	200 East Area	Resident Gardener	1,230	1.0E-06	3.1E-05	2E-08
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.3E-06	1.0E-04	6E-08
	200 East Area	Resident Gardener	620	4.2E-07	1.3E-05	8E-09
MLLW	200 West Area	Resident Gardener	1,810	2.7E-05	1.3E+02	8E-02
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1,810	1.9E-05	5.6E-04	3E-07
	200 East Area	Resident Gardener + Sauna	10,000	3.5E-04	1.0E-02	6E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.6E-05	4.7E-04	3E-07
	200 East Area	Resident Gardener + Sauna	10,000	2.3E-06	6.8E-05	4E-08
MLLW	200 West Area	Resident Gardener + Sauna	1,810	9.1E-05	1.3E+02	8E-02
Projected New Waste (>2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,920	1.2E-05	3.5E-04	2E-07
	200 East Area	Resident Gardener	1,320	1.3E-06	3.8E-05	2E-08
LLW Cat 3	200 West Area	Resident Gardener	1,450	1.6E-04	4.9E-03	3E-06
	200 East Area	Resident Gardener	10,000	3.1E-04	9.3E-03	6E-06
MLLW	200 East Area	Resident Gardener	10,000	7.6E-04	2.3E-02	1E-05
Melters	200 East Area	Resident Gardener	680	2.6E-07	7.7E-06	5E-09
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1,920	4.3E-05	1.3E-03	8E-07
	200 East Area	Resident Gardener + Sauna	10,000	7.5E-04	2.2E-02	1E-05
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	7.3E-04	2.2E-02	1E-05
	200 East Area	Resident Gardener + Sauna	10,000	2.5E-01	7.5E+00	5E-03
MLLW	200 East Area	Resident Gardener + Sauna	10,000	7.6E-02	2.3E+00	1E-03
Melters	200 East Area	Resident Gardener + Sauna	680	1.2E-06	3.6E-05	2E-08

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.65. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group B, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF(b)
			Years Post-2046(a)	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)(c)						
LLW Cat 1	200 West Area	Resident Gardener	1,810	6.3E-06	1.9E-04	1E-07
	200 East Area	Resident Gardener	1,230	3.9E-06	1.2E-04	7E-08
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.3E-06	1.0E-04	6E-08
	200 East Area	Resident Gardener	620	4.4E-07	1.3E-05	8E-09
MLLW	200 West Area	Resident Gardener	1,810	1.6E-05	4.7E-04	3E-07
	200 East Area	Resident Gardener	670	4.0E-05	1.2E-03	7E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1,810	1.8E-05	5.4E-04	3E-07
	200 East Area	Resident Gardener + Sauna	10,000	5.5E-05	1.6E-03	1E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.6E-05	4.7E-04	3E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.7E-05	5.0E-04	3E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,810	5.9E-05	1.8E-03	1E-06
	200 East Area	Resident Gardener + Sauna	670	2.2E-04	6.6E-03	4E-06
Projected New Waste (>2007)(c)						
LLW Cat 1	200 West Area	Resident Gardener	1,920	1.0E-05	3.1E-04	2E-07
	200 East Area	Resident Gardener	1,210	6.1E-06	1.8E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	1.6E-04	4.9E-03	3E-05
	200 East Area	Resident Gardener	10,000	3.1E-04	9.4E-03	6E-06
MLLW	200 East Area	Resident Gardener	1,250	8.4E-04	2.5E-02	2E-05
Melters	200 East Area	Resident Gardener	680	2.6E-07	7.7E-06	5E-09
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1,920	3.9E-05	1.2E-03	7E-07
	200 East Area	Resident Gardener + Sauna	1,210	2.3E-05	7.0E-04	4E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	7.3E-04	2.2E-02	1E-05
	200 East Area	Resident Gardener + Sauna	10,000	2.5E-01	7.6E+00	5E-03
MLLW	200 East Area	Resident Gardener + Sauna	1,810	5.1E-02	1.5E+00	9E-04
Melters	200 East Area	Resident Gardener + Sauna	680	1.2E-06	3.6E-05	2E-08

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.66. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group B, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)						
LLW Cat 1	200 West Area	Resident Gardener	1,700	2.6E-05	7.9E-04	5E-07
LLW Cat 3	200 West Area	Resident Gardener	1,230	2.3E-05	7.0E-04	4E-07
MLLW	200 West Area	Resident Gardener	1,700	1.3E-04	3.8E-03	2E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1,700	7.3E-05	2.2E-03	1E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,230	1.1E-04	3.3E-03	2E-06
MLLW	200 West Area	Resident Gardener + Sauna	1,700	4.3E-04	1.3E-02	8E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,770	5.0E-05	1.5E-03	9E-07
LLW Cat 3	200 West Area	Resident Gardener	1,230	1.1E-03	3.4E-02	2E-05
ILAW	200 West Area	Resident Gardener	10,000	3.1E-04	9.2E-03	6E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1,770	1.8E-04	5.5E-03	3E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,230	5.1E-03	1.5E-01	9E-05
ILAW	200 West Area	Resident Gardener + Sauna	10,000	1.1E-01	3.3E-00	2E-03

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.67. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group B, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	**Dose, rem**		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)						
LLW Cat 1	200 West Area	Resident Gardener	1,700	3.2E-05	9.6E-04	6E-07
LLW Cat 3	200 West Area	Resident Gardener	1,230	2.3E-05	7.0E-04	4E-07
MLLW	200 West Area	Resident Gardener	1,700	1.3E-04	3.8E-03	2E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1,700	8.9E-05	2.7E-03	2E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,230	1.1E-04	3.3E-03	2E-06
MLLW	200 West Area	Resident Gardener + Sauna	1,700	4.3E-04	1.3E-02	8E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,770	6.1E-05	1.8E-03	1E-06
LLW Cat 3	200 West Area	Resident Gardener	1,230	1.1E-03	3.4E-02	2E-05
ILAW	200 West Area	Resident Gardener	10,000	3.1E-04	9.2E-03	6E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	2.4E-02	7.3E-01	4E-04
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,230	5.1E-03	1.5E-01	9E-05
ILAW	200 West Area	Resident Gardener + Sauna	10,000	1.1E-01	3.3E-00	2E-03

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.68. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group B, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF(b)
			Years Post-2046(a)	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)						
LLW Cat 1	200 West Area	Resident Gardener	1,700	3.0E-05	8.9E-04	5E-07
LLW Cat 3	200 West Area	Resident Gardener	1,230	2.3E-05	7.0E-04	4E-07
MLLW	200 West Area	Resident Gardener	1,700	7.4E-05	2.2E-03	1E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1,700	8.5E-05	2.5E-03	2E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,230	1.1E-04	3.3E-03	2E-06
MLLW	200 West Area	Resident Gardener + Sauna	1,700	2.8E-04	8.3E-03	5E-06
Projected New Waste (>2007)(c)						
LLW Cat 1	200 West Area	Resident Gardener	1,770	5.5E-05	1.6E-03	1E-06
LLW Cat 3	200 West Area	Resident Gardener	1,230	1.1E-03	3.4E-02	2E-05
ILAW	200 West Area	Resident Gardener	10,000	3.1E-04	9.2E-03	6E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	2.1E-02	6.2E-01	4E-04
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,230	5.1E-03	1.5E-01	9E-05
ILAW	200 West Area	Resident Gardener + Sauna	10,000	1.1E-01	3.3E-00	2E-03

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.69. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group B, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF(b)
			Years Post-2046(a)	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)(c)						
LLW Cat 1	200 West Area	Resident Gardener	2,000	2.3E-06	6.9E-05	4E-08
	200 East Area	Resident Gardener	1,400	1.4E-07	4.3E-06	3E-09
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.6E-06	4.9E-05	3E-08
	200 East Area	Resident Gardener	860	1.4E-06	4.2E-05	3E-08
MLLW	200 West Area	Resident Gardener	2,000	1.1E-05	3.3E-04	2E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	6.4E-06	1.9E-04	1E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-05	3.7E-04	2E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	7.7E-06	2.3E-04	1E-07
	200 East Area	Resident Gardener + Sauna	860	6.7E-06	2.0E-04	1E-07
MLLW	200 West Area	Resident Gardener + Sauna	2,000	3.8E-05	1.1E-03	7E-07
Projected New Waste (>2007)(c)						
LLW Cat 1	200 West Area	Resident Gardener	2,110	4.5E-06	1.4E-04	8E-08
	200 East Area	Resident Gardener	2,330	1.2E-05	3.5E-04	2E-07
LLW Cat 3	200 West Area	Resident Gardener	1,710	7.9E-05	2.4E-03	1E-06
	200 East Area	Resident Gardener	10,000	2.9E-04	8.6E-03	5E-06
MLLW	200 East Area	Resident Gardener	1,430	8.5E-05	2.5E-03	2E-06
ILAW	200 West Area	Resident Gardener	10,000	1.0E-05	3.0E-04	2E-07
Melters	200 East Area	Resident Gardener	940	3.2E-08	9.5E-07	6E-10
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,110	1.7E-05	5.0E-04	3E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.4E-04	1.9E-02	1E-05
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	3.6E-04	1.1E-02	6E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.4E-01	7.3E+00	4E-03
MLLW	200 East Area	Resident Gardener + Sauna	10,000	5.4E-04	1.6E-02	1E-05
ILAW	200 West Area	Resident Gardener + Sauna	10,000	2.6E-05	7.8E-02	5E-05
Melters	200 East Area	Resident Gardener + Sauna	940	1.5E-07	4.5E-06	3E-09

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.70. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group B, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	2,000	2.8E-06	8.4E-05	5E-08
	200 East Area	Resident Gardener	1,400	1.7E-07	5.2E-06	3E-09
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.6E-06	4.9E-05	3E-08
	200 East Area	Resident Gardener	860	9.8E-08	2.9E-06	2E-09
MLLW	200 West Area	Resident Gardener	2,000	1.1E-05	3.4E-04	2E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	7.8E-06	2.3E-04	1E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.3E-05	3.9E-04	2E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	7.7E-06	2.3E-04	1E-07
	200 East Area	Resident Gardener + Sauna	860	4.6E-07	1.4E-05	8E-09
MLLW	200 West Area	Resident Gardener + Sauna	2,000	3.8E-05	1.1E-03	7E-07
Projected New Waste (>2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	2,110	5.5E-06	1.7E-04	1E-07
	200 East Area	Resident Gardener	2,250	1.4E-05	4.2E-04	3E-07
LLW Cat 3	200 West Area	Resident Gardener	1,710	7.9E-05	2.4E-03	1E-06
	200 East Area	Resident Gardener	10,000	3.0E-04	8.9E-03	5E-06
MLLW	200 East Area	Resident Gardener	1,430	8.6E-05	2.6E-03	2E-06
ILAW	200 West Area	Resident Gardener	10,000	1.0E-05	3.0E-04	2E-07
Melters	200 East Area	Resident Gardener	940	3.2E-08	9.5E-07	6E-10
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,110	2.0E-05	6.1E-04	4E-07
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-04	2.2E-02	1E-05
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	3.6E-04	1.1E-02	6E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.5E-01	7.5E+00	5E-03
MLLW	200 East Area	Resident Gardener + Sauna	10,000	1.0E-03	3.1E-02	2E-05
ILAW	200 West Area	Resident Gardener + Sauna	10,000	2.6E-05	7.8E-02	5E-05
Melters	200 East Area	Resident Gardener + Sauna	940	1.5E-07	4.5E-06	3E-09

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.71. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group B, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF(b)
			Years Post-2046(a)	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)						
LLW Cat 1	200 West Area	Resident Gardener	2,000	2.6E-06	7.8E-05	5E-08
	200 East Area	Resident Gardener	1,400	6.6E-07	2.0E-05	1E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.6E-06	4.9E-05	3E-08
	200 East Area	Resident Gardener	860	9.8E-08	2.9E-06	2E-09
MLLW	200 West Area	Resident Gardener	940	6.6E-06	2.0E-04	1E-07
	200 East Area	Resident Gardener	1,400	5.1E-06	1.5E-04	9E-08
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	7.4E-06	2.2E-04	1E-07
	200 East Area	Resident Gardener + Sauna	1,400	5.3E-05	1.6E-03	1E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	7.7E-06	2.3E-04	1E-07
	200 East Area	Resident Gardener + Sauna	860	6.4E-07	1.9E-05	1E-08
MLLW	200 West Area	Resident Gardener + Sauna	2,000	2.5E-05	7.5E-04	5E-07
	200 East Area	Resident Gardener + Sauna	940	3.1E-05	9.3E-04	6E-07
Projected New Waste (>2007)(c)						
LLW Cat 1	200 West Area	Resident Gardener	2,110	5.0E-06	1.5E-04	9E-08
	200 East Area	Resident Gardener	10,000	6.1E-06	1.8E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,710	7.9E-05	2.4E-03	1E-06
	200 East Area	Resident Gardener	10,000	3.0E-04	8.9E-03	5E-06
MLLW	200 East Area	Resident Gardener	1,430	9.9E-05	3.0E-03	2E-06
ILAW	200 West Area	Resident Gardener	10,000	1.0E-05	3.0E-04	2E-07
Melters	200 East Area	Resident Gardener	940	3.2E-08	9.5E-07	6E-10
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,110	1.9E-05	5.6E-04	3E-07
	200 East Area	Resident Gardener + Sauna	10,000	4.0E-03	1.2E-01	7E-05
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	3.6E-04	1.1E-02	6E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.5E-01	7.6E+00	5E-03
MLLW	200 East Area	Resident Gardener + Sauna	10,000	7.5E-04	2.3E-02	1E-05
ILAW	200 West Area	Resident Gardener + Sauna	10,000	2.6E-05	7.8E-02	5E-05
Melters	200 East Area	Resident Gardener + Sauna	940	1.5E-07	4.5E-06	3E-09

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.72. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group C, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose: Years Post-2046[(a)]	Maximum Annual Dose: Dose, rem	Lifetime Dose, rem	Probability of an LCF[(b)]
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)[(c)]						
LLW Cat 1	200 West Area	Resident Gardener	1,810	5.8E-06	1.7E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.5E-06	1.0E-04	6E-08
MLLW	200 West Area	Resident Gardener	1,700	2.2E-04	6.5E-03	4E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1,810	1.6E-05	4.8E-04	3E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.6E-05	4.9E-04	3E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,700	7.4E-04	2.2E-02	1E-05
Projected New Waste (>2007)[(c)]						
LLW Cat 1	200 West Area	Resident Gardener	2,070	6.3E-06	1.9E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,460	1.7E-04	5.0E-03	3E-06
MLLW	200 East Area	Resident Gardener	1,370	4.8E-04	1.4E-02	9E-06
ILAW	200 East Area	Resident Gardener	10,000	1.0E-04	3.0E-03	2E-06
Melters	200 East Area	Resident Gardener	680	6.9E-06	2.1E-04	1E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,070	3.0E-05	9.0E-04	5E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,460	7.6E-04	2.3E-02	1E-05
MLLW	200 East Area	Resident Gardener + Sauna	10,000	1.4E-02	4.1E-01	3E-04
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.5E-02	1.0E-00	6E-04
Melters	200 East Area	Resident Gardener + Sauna	10,000	7.7E-04	2.3E-02	1E-05

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.73. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group C, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	**Dose, rem**		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,810	7.0E-06	2.1E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.5E-06	1.0E-04	6E-08
MLLW	200 West Area	Resident Gardener	1,700	2.2E-04	6.5E-03	4E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1,810	2.0E-05	5.9E-04	4E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.6E-05	4.9E-04	3E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,700	7.4E-04	2.2E-02	1E-05
Projected New Waste (>2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	2,070	7.7E-06	2.3E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	1.7E-04	5.0E-03	3E-06
MLLW	200 East Area	Resident Gardener	1,370	4.8E-04	1.5E-02	9E-06
ILAW	200 East Area	Resident Gardener	10,000	1.0E-04	3.0E-03	2E-06
Melters	200 East Area	Resident Gardener	680	6.9E-06	2.1E-04	1E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,070	3.7E-05	1.1E-03	7E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	7.6E-04	2.3E-02	1E-05
MLLW	200 East Area	Resident Gardener + Sauna	10,000	1.5E-02	4.6E-01	3E-04
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.5E-02	1.0E-00	6E-04
Melters	200 East Area	Resident Gardener + Sauna	10,000	8.0E-04	2.4E-02	1E-05

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.74. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group C, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,810	7.3E-06	2.2E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.5E-06	1.0E-04	6E-08
MLLW	200 West Area	Resident Gardener	1,810	4.1E-05	1.2E-03	7E-07
	200 East Area	Resident Gardener	10,000	2.6E-04	7.9E-03	5E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1,810	2.1E-05	6.2E-04	4E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.6E-05	4.9E-04	3E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,810	5.2E-04	1.6E-02	9E-06
	200 East Area	Resident Gardener + Sauna	10,000	6.4E-03	1.9E-01	1E-04
Projected New Waste (>2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	2,070	7.7E-06	2.3E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	1.7E-04	5.0E-03	3E-06
MLLW	200 East Area	Resident Gardener	1,370	5.4E-04	1.6E-02	1E-05
ILAW	200 East Area	Resident Gardener	10,000	1.0E-04	3.0E-03	2E-06
Melters	200 East Area	Resident Gardener	680	6.9E-06	2.1E-04	1E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,070	3.7E-05	1.1E-03	7E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	7.6E-04	2.3E-02	1E-05
MLLW	200 East Area	Resident Gardener + Sauna	10,000	2.5E-02	7.4E-01	4E-04
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.5E-02	1.0E-00	6E-04
Melters	200 East Area	Resident Gardener + Sauna	10,000	8.0E-04	2.4E-02	1E-05

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.75. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group C, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose Years Post-2046[a]	Maximum Annual Dose Dose, rem	Lifetime Dose, rem	Probability of an LCF[b]
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)						
LLW Cat 1	200 West Area	Resident Gardener	1700	2.7E-05	8.2E-04	5E-07
LLW Cat 3	200 West Area	Resident Gardener	1230	2.4E-05	7.3E-04	4E-07
MLLW	200 West Area	Resident Gardener	1700	2.2E-04	6.5E-03	4E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1700	7.6E-05	2.3E-03	1E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1230	1.2E-04	3.5E-03	2E-06
MLLW	200 West Area	Resident Gardener + Sauna	1700	7.4E-04	2.2E-02	1E-05
Projected New Waste (>2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1910	4.8E-05	1.5E-03	9E-07
LLW Cat 3	200 West Area	Resident Gardener	1230	1.2E-03	3.5E-02	2E-05
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1910	1.8E-04	5.4E-03	3E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1230	5.3E-03	1.6E-01	1E-04

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.76. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group C, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[(b)]
			Years Post-2046[(a)]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)						
LLW Cat 1	200 West Area	Resident Gardener	1700	3.3E-05	1.0E-03	6E-07
LLW Cat 3	200 West Area	Resident Gardener	1230	2.4E-05	7.3E-04	4E-07
MLLW	200 West Area	Resident Gardener	1700	2.2E-04	6.5E-03	4E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1700	9.3E-05	2.8E-03	2E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1230	1.2E-04	3.5E-03	2E-06
MLLW	200 West Area	Resident Gardener + Sauna	1700	7.4E-04	2.2E-02	1E-05
Projected New Waste (>2007)[(c)]						
LLW Cat 1	200 West Area	Resident Gardener	1910	5.9E-05	1.8E-03	1E-06
LLW Cat 3	200 West Area	Resident Gardener	1230	1.2E-03	3.5E-02	2E-05
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1910	2.2E-04	6.5E-03	4E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1230	5.3E-03	1.6E-01	1E-04

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.77. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group C, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[(b)]
			Years Post-2046[(a)]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)						
LLW Cat 1	200 West Area	Resident Gardener	1700	3.4E-05	1.0E-03	6E-07
LLW Cat 3	200 West Area	Resident Gardener	1230	2.4E-05	7.3E-04	4E-07
MLLW	200 West Area	Resident Gardener	1700	1.5E-04	4.4E-03	3E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1700	9.8E-05	3.0E-03	2E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1230	1.2E-04	3.5E-03	2E-06
MLLW	200 West Area	Resident Gardener + Sauna	1700	5.2E-04	1.6E-02	9E-06
Projected New Waste (>2007)[(c)]						
LLW Cat 1	200 West Area	Resident Gardener	1910	5.9E-05	1.8E-03	1E-06
LLW Cat 3	200 West Area	Resident Gardener	1230	1.2E-03	3.5E-02	2E-05
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1910	2.2E-04	6.6E-03	4E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1230	5.3E-03	1.6E-01	1E-04

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.78. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group C, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose: Years Post-2046[(a)]	Maximum Annual Dose: Dose, rem	Lifetime Dose, rem	Probability of an LCF[(b)]
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)[(c)]						
LLW Cat 1	200 West Area	Resident Gardener	2,000	2.4E-06	7.2E-05	4E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.7E-06	5.1E-05	3E-08
MLLW	200 West Area	Resident Gardener	2,000	1.9E-05	5.7E-04	3E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	6.7E-06	2.0E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	8.0E-06	2.4E-04	1E-07
MLLW	200 West Area	Resident Gardener + Sauna	2,000	6.4E-05	1.9E-03	1E-06
Projected New Waste (>2007)[(c)]						
LLW Cat 1	200 West Area	Resident Gardener	2,260	4.5E-06	1.3E-04	8E-08
LLW Cat 3	200 West Area	Resident Gardener	1,720	7.6E-05	2.3E-03	1E-06
MLLW	200 East Area	Resident Gardener	1,590	6.4E-05	1.9E-03	1E-06
ILAW	200 East Area	Resident Gardener	10,000	1.3E-05	3.8E-04	2E-07
Melters	200 East Area	Resident Gardener	820	7.5E-07	2.2E-05	1E-08
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,260	1.7E-05	5.0E-04	3E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,720	3.6E-04	1.1E-02	7E-06
MLLW	200 East Area	Resident Gardener + Sauna	1,590	2.9E-04	8.7E-03	5E-06
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.3E-05	9.8E-02	6E-05
Melters	200 East Area	Resident Gardener + Sauna	10,000	1.3E-05	3.9E-04	2E-07

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.79. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group C, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	2,000	2.9E-06	8.7E-05	5E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.7E-06	5.1E-05	3E-08
MLLW	200 West Area	Resident Gardener	2,000	1.9E-05	5.7E-04	3E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	8.1E-06	2.4E-04	2E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	8.0E-06	2.4E-04	1E-07
MLLW	200 West Area	Resident Gardener + Sauna	2,000	6.5E-05	1.9E-03	1E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	2,260	5.5E-06	1.6E-04	8E-08
LLW Cat 3	200 West Area	Resident Gardener	1,720	7.8E-05	2.3E-03	1E-06
MLLW	200 East Area	Resident Gardener	1,580	6.4E-05	1.9E-03	1E-06
ILAW	200 East Area	Resident Gardener	10,000	1.3E-05	3.8E-04	2E-07
Melters	200 East Area	Resident Gardener	820	7.6E-07	2.3E-05	1E-08
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,260	2.0E-05	6.1E-04	3E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,720	3.6E-04	1.1E-02	5E-06
MLLW	200 East Area	Resident Gardener + Sauna	1,590	3.0E-04	9.0E-03	5E-06
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.3E-05	9.8E-02	5E-05
Melters	200 East Area	Resident Gardener + Sauna	10,000	1.3E-05	3.9E-04	2E-07

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.80. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group C, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	2,000	3.0E-06	9.1E-05	5E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.7E-06	5.1E-05	3E-08
MLLW	200 West Area	Resident Gardener	2,000	1.3E-05	3.9E-04	2E-07
	200 East Area	Resident Gardener	940	4.1E-06	1.2E-04	7E-08
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	8.6E-06	2.6E-04	2E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	8.0E-06	2.4E-04	1E-07
MLLW	200 West Area	Resident Gardener + Sauna	2,000	4.6E-05	1.4E-03	8E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-04	4.4E-03	3E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	2,260	5.5E-06	1.7E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,710	7.8E-05	2.3E-03	1E-06
MLLW	200 East Area	Resident Gardener	1,590	6.9E-05	2.1E-03	1E-06
ILAW	200 East Area	Resident Gardener	10,000	1.3E-05	3.8E-04	2E-07
Melters	200 East Area	Resident Gardener	820	7.5E-07	2.2E-05	1E-08
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,260	2.0E-05	6.1E-04	4E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	3.6E-04	1.1E-02	7E-06
MLLW	200 East Area	Resident Gardener + Sauna	1,590	3.9E-04	1.2E-02	7E-06
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.3E-05	9.8E-02	6E-05
Melters	200 East Area	Resident Gardener + Sauna	10,000	1.3E-05	3.9E-04	2E-07

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.81. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D$_1$, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF$^{(b)}$
			Years Post-2046$^{(a)}$	**Dose, rem**		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)$^{(c)}$						
LLW Cat 1	200 West Area	Resident Gardener	1,810	5.8E-06	1.7E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.5E-06	1.0E-04	6E-08
MLLW	200 West Area	Resident Gardener	1,810	4.6E-05	1.4E-03	8E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	3.5E-05	1.0E-03	6E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.7E-05	5.0E-04	3E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,810	1.5E-04	4.6E-03	3E-06
Projected New Waste (>2007)$^{(c)}$						
LLW Cat 1	200 East Area	Resident Gardener	1,380	3.4E-05	1.0E-03	6E-07
LLW Cat 3	200 East Area	Resident Gardener	620	5.4E-04	1.6E-02	1E-05
MLLW	200 East Area	Resident Gardener	1,380	6.3E-04	1.9E-02	1E-05
ILAW	200 East Area	Resident Gardener	10,000	1.0E-04	3.0E-03	2E-06
Melters	200 East Area	Resident Gardener	980	2.4E-06	7.1E-05	4E-08
LLW Cat 1	200 East Area	Resident Gardener + Sauna	10,000	4.7E-03	1.4E-01	9E-05
LLW Cat 3	200 East Area	Resident Gardener + Sauna	620	2.4E-03	7.3E-02	4E-05
MLLW	200 East Area	Resident Gardener + Sauna	1,380	8.6E-03	2.6E-01	2E-04
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.5E-02	1.0E-00	6E-04
Melters	200 East Area	Resident Gardener + Sauna	10,000	5.6E-04	1.7E-02	1E-05

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.82. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D_1, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,810	7.1E-06	2.1E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.5E-06	1.0E-04	6E-08
MLLW	200 West Area	Resident Gardener	1,810	4.6E-05	1.4E-03	8E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	3.6E-05	1.1E-03	7E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.7E-05	5.0E-04	3E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,810	1.5E-04	4.6E-03	3E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 East Area	Resident Gardener	1,380	4.2E-05	1.3E-03	8E-07
LLW Cat 3	200 East Area	Resident Gardener	620	5.4E-04	1.6E-02	1E-05
MLLW	200 East Area	Resident Gardener	1,380	3.2E-04	9.6E-03	6E-06
ILAW	200 East Area	Resident Gardener	10,000	1.0E-04	3.0E-03	2E-06
Melters	200 East Area	Resident Gardener	980	2.4E-06	7.1E-05	4E-08
LLW Cat 1	200 East Area	Resident Gardener + Sauna	10,000	5.5E-01	1.7E+01	1E-02
LLW Cat 3	200 East Area	Resident Gardener + Sauna	620	2.4E-03	7.3E-02	4E-05
MLLW	200 East Area	Resident Gardener + Sauna	10,000	7.6E-03	2.3E-01	1E-04
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.5E-02	1.0E-00	6E-04
Melters	200 East Area	Resident Gardener + Sauna	10,000	5.7E-04	1.7E-02	1E-05

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.83. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D_1, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,810	7.4E-06	2.2E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.5E-06	1.0E-04	6E-08
MLLW	200 West Area	Resident Gardener	1,810	3.1E-05	9.3E-04	6E-07
	200 East Area	Resident Gardener	10,000	1.1E-04	3.4E-03	2E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	7.6E-05	2.3E-03	1E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.7E-05	5.0E-04	3E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,810	1.1E-04	3.3E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	6.4E-03	1.9E-01	1E-04
Projected New Waste (>2007)[c]						
LLW Cat 1	200 East Area	Resident Gardener	1,380	4.3E-05	1.3E-03	8E-07
LLW Cat 3	200 East Area	Resident Gardener	620	5.5E-04	1.6E-02	1E-05
MLLW	200 East Area	Resident Gardener	1,380	4.1E-04	1.2E-02	7E-06
ILAW	200 East Area	Resident Gardener	10,000	1.0E-04	3.0E-03	2E-06
Melters	200 East Area	Resident Gardener	980	2.4E-06	7.1E-05	4E-08
LLW Cat 1	200 East Area	Resident Gardener + Sauna	1,380	1.6E-04	4.7E-03	3E-06
LLW Cat 3	200 East Area	Resident Gardener + Sauna	620	2.4E-03	7.3E-02	4E-05
MLLW	200 East Area	Resident Gardener + Sauna	10,000	1.7E-02	5.1E-01	3E-04
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.5E-02	1.0E-00	6E-04
Melters	200 East Area	Resident Gardener + Sauna	10,000	5.7E-04	1.7E-02	1E-05

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.84. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D_1, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,700	2.9E-05	8.6E-04	5E-07
LLW Cat 3	200 West Area	Resident Gardener	1,230	2.4E-05	7.3E-04	4E-07
MLLW	200 West Area	Resident Gardener	1,700	2.2E-04	6.5E-03	4E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-02	2E-05
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,230	1.4E-04	4.2E-03	3E-06
MLLW	200 West Area	Resident Gardener + Sauna	1,700	7.4E-04	2.2E-02	1E-05

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.85. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D_1, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,700	3.5E-05	1.0E-03	6E-07
LLW Cat 3	200 West Area	Resident Gardener	1,230	2.4E-05	7.3E-04	4E-07
MLLW	200 West Area	Resident Gardener	1,700	2.2E-04	6.5E-03	4E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	1.4E-03	4.3E-02	3E-05
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,230	1.4E-04	4.2E-03	3E-06
MLLW	200 West Area	Resident Gardener + Sauna	1,700	7.4E-04	2.2E-02	1E-05

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.86. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D_1, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1700	3.4E-05	1.0E-03	6E-07
LLW Cat 3	200 West Area	Resident Gardener	1230	2.4E-05	7.3E-04	4E-07
MLLW	200 West Area	Resident Gardener	1700	1.5E-04	4.4E-03	3E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1700	9.8E-05	3.0E-03	2E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1230	1.2E-04	3.5E-03	2E-06
MLLW	200 West Area	Resident Gardener + Sauna	1700	5.2E-04	1.6E-02	9E-06

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.87. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D_1, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	2,000	2.4E-06	7.2E-05	4E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.7E-06	5.1E-05	3E-08
MLLW	200 West Area	Resident Gardener	2,000	1.9E-05	5.7E-04	3E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	7.0E-06	2.1E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	8.0E-06	2.4E-04	1E-07
MLLW	200 West Area	Resident Gardener + Sauna	2,000	6.4E-05	1.9E-03	1E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 East Area	Resident Gardener	1,510	4.0E-06	1.2E-04	7E-08
LLW Cat 3	200 East Area	Resident Gardener	860	1.2E-04	3.6E-03	2E-06
MLLW	200 East Area	Resident Gardener	1,510	3.9E-05	1.2E-03	7E-07
ILAW	200 East Area	Resident Gardener	10,000	1.3E-05	3.8E-04	2E-07
Melters	200 East Area	Resident Gardener	10,000	1.9E-09	5.6E-08	3E-11
LLW Cat 1	200 East Area	Resident Gardener + Sauna	10,000	6.3E-05	1.9E-03	1E-06
LLW Cat 3	200 East Area	Resident Gardener + Sauna	820	5.6E-04	1.7E-02	1E-05
MLLW	200 East Area	Resident Gardener + Sauna	1,510	2.2E-04	6.5E-03	4E-06
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.3E-05	9.8E-02	6E-05
Melters	200 East Area	Resident Gardener + Sauna	10,000	1.6E-06	4.8E-05	3E-08

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.88. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D_1, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[(b)]
			Years Post-2046[(a)]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)[(c)]						
LLW Cat 1	200 West Area	Resident Gardener	2,000	2.9E-06	8.7E-05	5E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.7E-06	5.1E-05	3E-08
MLLW	200 West Area	Resident Gardener	2,000	1.9E-05	5.7E-04	3E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	8.5E-06	2.6E-04	2E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	8.0E-06	2.4E-04	1E-07
MLLW	200 West Area	Resident Gardener + Sauna	2,000	6.4E-05	1.9E-03	1E-06
Projected New Waste (>2007)[(c)]						
LLW Cat 1	200 East Area	Resident Gardener	1,510	4.9E-06	1.5E-04	9E-08
LLW Cat 3	200 East Area	Resident Gardener	820	6.7E-05	2.0E-03	1E-06
MLLW	200 East Area	Resident Gardener	1,510	3.6E-05	1.1E-03	6E-07
ILAW	200 East Area	Resident Gardener	10,000	1.3E-05	3.8E-04	2E-07
Melters	200 East Area	Resident Gardener	850	1.4E-06	4.2E-05	3E-08
LLW Cat 1	200 East Area	Resident Gardener + Sauna	10,000	7.3E-05	2.2E-03	1E-06
LLW Cat 3	200 East Area	Resident Gardener + Sauna	820	3.0E-04	9.0E-03	5E-06
MLLW	200 East Area	Resident Gardener + Sauna	1,510	2.0E-04	6.0E-03	4E-06
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.3E-05	9.8E-02	6E-05
Melters	200 East Area	Resident Gardener + Sauna	10,000	1.4E-05	4.1E-04	2E-07

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.89. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D_1, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF(b)
			Years Post-2046(a)	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)-(c)						
LLW Cat 1	200 West Area	Resident Gardener	2,000	3.0E-06	9.1E-05	5E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.7E-06	5.1E-05	3E-08
MLLW	200 West Area	Resident Gardener	2,000	1.3E-05	3.9E-04	2E-07
	200 East Area	Resident Gardener	1,400	1.7E-05	5.0E-04	3E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	8.6E-06	2.6E-04	2E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	8.0E-06	2.4E-04	1E-07
MLLW	200 West Area	Resident Gardener + Sauna	2,000	4.6E-05	1.4E-03	8E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.9E-04	5.7E-03	3E-06
Projected New Waste (>2007)(c)						
LLW Cat 1	200 East Area	Resident Gardener	1,510	4.9E-06	1.5E-04	9E-08
LLW Cat 3	200 East Area	Resident Gardener	820	6.7E-05	2.0E-03	1E-06
MLLW	200 East Area	Resident Gardener	1,510	1.1E-04	3.2E-03	2E-06
ILAW	200 East Area	Resident Gardener	10,000	1.3E-05	3.8E-04	2E-07
Melters	200 East Area	Resident Gardener	10,000	4.4E-08	1.3E-06	8E-10
LLW Cat 1	200 East Area	Resident Gardener + Sauna	1,510	1.8E-05	5.4E-04	3E-07
LLW Cat 3	200 East Area	Resident Gardener + Sauna	820	3.0E-04	9.0E-03	5E-06
MLLW	200 East Area	Resident Gardener + Sauna	1,510	5.3E-04	1.6E-02	1E-05
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.3E-05	9.8E-02	6E-05
Melters	200 East Area	Resident Gardener + Sauna	10,000	7.1E-06	2.1E-04	1E-07

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.90. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D_2, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,810	5.8E-06	1.7E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.5E-06	1.0E-04	6E-08
MLLW	200 West Area	Resident Gardener	1,450	3.8E-06	1.1E-04	7E-08
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	3.5E-05	1.0E-03	6E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.7E-05	5.0E-04	3E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,450	1.8E-05	5.4E-04	3E-07
Projected New Waste (>2007)[c]						
LLW Cat 1	200 East Area	Resident Gardener	1,320	2.8E-05	8.4E-04	5E-07
LLW Cat 3	200 East Area	Resident Gardener	620	5.4E-04	1.6E-02	1E-06
MLLW	200 East Area	Resident Gardener	1,370	4.8E-04	1.4E-02	9E-06
ILAW	200 East Area	Resident Gardener	10,000	1.0E-04	3.0E-03	2E-06
Melters	200 East Area	Resident Gardener	980	2.4E-06	7.1E-05	4E-08
LLW Cat 1	200 East Area	Resident Gardener + Sauna	10,000	7.5E-03	2.3E-01	1E-04
LLW Cat 3	200 East Area	Resident Gardener + Sauna	620	2.4E-03	7.3E-02	4E-05
MLLW	200 East Area	Resident Gardener + Sauna	1,370	1.1E-02	3.3E-01	2E-04
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.5E-02	1.0E-00	6E-04
Melters	200 East Area	Resident Gardener + Sauna	10,000	9.0E-04	2.7E-02	2E-05

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.91. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group $D_{2,}$ Lower Bound Waste Volume

Waste Category	**Source Location**	**Exposure Scenario**	**Maximum Annual Dose**		**Lifetime Dose, rem**	**Probability of an LCF**[b]
			Years Post-2046[a]	**Dose, rem**		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,810	7.1E-06	2.1E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.5E-06	1.0E-04	6E-08
MLLW	200 West Area	Resident Gardener	1,810	4.6E-05	1.4E-03	8E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	3.6E-05	1.1E-03	7E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.7E-05	5.0E-04	3E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,810	1.6E-04	4.7E-03	3E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 East Area	Resident Gardener	1,320	3.4E-05	1.0E-03	6E-07
LLW Cat 3	200 East Area	Resident Gardener	620	5.4E-04	1.6E-02	1E-05
MLLW	200 East Area	Resident Gardener	1370	4.8E-04	1.4E-02	9E-06
ILAW	200 East Area	Resident Gardener	10,000	1.0E-04	3.0E-03	2E-06
Melters	200 East Area	Resident Gardener	980	2.4E-06	7.1E-05	4E-08
LLW Cat 1	200 East Area	Resident Gardener + Sauna	10,000	8.9E-03	2.7E-01	2E-04
LLW Cat 3	200 East Area	Resident Gardener + Sauna	620	2.4E-03	7.3E-02	4E-05
MLLW	200 East Area	Resident Gardener + Sauna	1,370	1.1E-02	3.3E-01	2E-04
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.5E-02	1.0E-00	6E-04
Melters	200 East Area	Resident Gardener + Sauna	10,000	9.0E-04	2.7E-02	2E-05

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.92. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D_2, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,810	7.4E-06	2.2E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.5E-06	1.0E-04	6E-08
MLLW	200 West Area	Resident Gardener	1,810	3.1E-05	9.3E-04	6E-07
	200 East Area	Resident Gardener	1,230	1.1E-04	3.4E-03	2E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	1.1E-04	3.4E-03	2E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.7E-05	5.0E-04	3E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,810	1.1E-04	3.3E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	6.4E-03	1.9E-01	1E-04
Projected New Waste (>2007)[c]						
LLW Cat 1	200 East Area	Resident Gardener	1,320	3.6E-05	1.1E-03	6E-07
LLW Cat 3	200 East Area	Resident Gardener	620	5.5E-04	1.7E-02	1E-05
MLLW	200 East Area	Resident Gardener	1,370	5.4E-04	1.6E-02	1E-05
ILAW	200 East Area	Resident Gardener	10,000	1.0E-04	3.0E-03	2E-06
Melters	200 East Area	Resident Gardener	980	2.4E-06	7.1E-05	4E-08
LLW Cat 1	200 East Area	Resident Gardener + Sauna	1,320	1.3E-04	3.8E-03	2E-06
LLW Cat 3	200 East Area	Resident Gardener + Sauna	620	2.5E-03	7.5E-02	5E-05
MLLW	200 East Area	Resident Gardener + Sauna	10,000	2.5E-02	7.5E-01	5E-04
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.5E-02	1.0E-00	6E-04
Melters	200 East Area	Resident Gardener + Sauna	10,000	8.9E-04	2.7E-02	2E-05

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.93. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D_2, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose: Years Post-2046[(a)]	Maximum Annual Dose: Dose, rem	Lifetime Dose, rem	Probability of an LCF[(b)]
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)[(c)]						
LLW Cat 1	200 West Area	Resident Gardener	1,700	2.9E-05	8.6E-04	5E-07
LLW Cat 3	200 West Area	Resident Gardener	1,230	2.4E-05	7.3E-04	4E-07
MLLW	200 West Area	Resident Gardener	1,700	2.2E-04	6.5E-03	4E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-02	2E-05
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,230	1.2E-04	3.5E-03	2E-06
MLLW	200 West Area	Resident Gardener + Sauna	1,700	7.4E-04	2.2E-02	1E-05

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.94. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D_2, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose: Years Post-2046[(a)]	Maximum Annual Dose: Dose, rem	Lifetime Dose, rem	Probability of an LCF[(b)]
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)[(c)]						
LLW Cat 1	200 West Area	Resident Gardener	1,700	3.5E-05	1.0E-03	6E-07
LLW Cat 3	200 West Area	Resident Gardener	1,230	2.4E-05	7.3E-04	4E-07
MLLW	200 West Area	Resident Gardener	1700	2.2E-04	6.5E-03	4E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	1.4E-03	4.3E-02	3E-05
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,230	1.2E-04	3.5E-03	2E-06
MLLW	200 West Area	Resident Gardener + Sauna	1,700	7.4E-04	2.2E-02	1E-05

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.95. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D_2, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1700	3.4E-05	1.0E-03	6E-07
LLW Cat 3	200 West Area	Resident Gardener	1230	2.4E-05	7.3E-04	4E-07
MLLW	200 West Area	Resident Gardener	1700	1.5E-04	4.4E-03	3E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1700	9.8E-05	3.0E-03	2E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1230	1.2E-04	3.5E-03	2E-06
MLLW	200 West Area	Resident Gardener + Sauna	1700	5.2E-04	1.6E-02	9E-06

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.96. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D_2, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF(b)
			Years Post-2046(a)	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)(c)						
LLW Cat 1	200 West Area	Resident Gardener	2,000	2.4E-06	7.2E-05	4E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.7E-06	5.1E-05	3E-08
MLLW	200 West Area	Resident Gardener	2,000	1.8E-06	5.5E-05	3E-08
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	7.0E-06	2.1E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	8.0E-06	2.4E-04	1E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,710	8.7E-06	2.6E-04	2E-07
Projected New Waste (>2007)(c)						
LLW Cat 1	200 East Area	Resident Gardener	1,530	7.6E-06	2.3E-04	1E-07
LLW Cat 3	200 East Area	Resident Gardener	860	1.3E-04	3.8E-03	2E-06
MLLW	200 East Area	Resident Gardener	1,590	6.4E-05	1.9E-03	1E-06
ILAW	200 East Area	Resident Gardener	10,000	1.3E-05	3.8E-04	2E-07
Melters	200 East Area	Resident Gardener	2,110	6.5E-08	2.0E-06	1E-09
LLW Cat 1	200 East Area	Resident Gardener + Sauna	10,000	8.7E-05	2.6E-03	2E-06
LLW Cat 3	200 East Area	Resident Gardener + Sauna	860	5.7E-04	1.7E-02	1E-05
MLLW	200 East Area	Resident Gardener + Sauna	1,590	2.7E-04	8.2E-03	5E-06
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.3E-05	9.8E-02	6E-05
Melters	200 East Area	Resident Gardener + Sauna	10,000	9.7E-06	2.9E-04	2E-07

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.97. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D_2, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose Years Post-2046[(a)]	Maximum Annual Dose Dose, rem	Lifetime Dose, rem	Probability of an LCF[(b)]
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)[(c)]						
LLW Cat 1	200 West Area	Resident Gardener	2,000	2.9E-06	8.7E-05	5E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.7E-06	5.1E-05	3E-08
MLLW	200 West Area	Resident Gardener	2,000	1.9E-05	5.7E-04	3E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	8.5E-06	2.6E-04	2E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	8.0E-06	2.4E-04	1E-07
MLLW	200 West Area	Resident Gardener + Sauna	2,000	6.5E-05	1.9E-03	1E-06
Projected New Waste (>2007)[(c)]						
LLW Cat 1	200 East Area	Resident Gardener	1,530	9.3E-06	2.8E-04	2E-07
LLW Cat 3	200 East Area	Resident Gardener	860	1.3E-04	3.8E-03	2E-06
MLLW	200 East Area	Resident Gardener	1,580	6.4E-05	1.9E-03	1E-06
ILAW	200 East Area	Resident Gardener	10,000	1.3E-05	3.8E-04	2E-07
Melters	200 East Area	Resident Gardener	850	1.4E-06	4.2E-05	3E-08
LLW Cat 1	200 East Area	Resident Gardener + Sauna	10,000	1.1E-04	3.3E-03	2E-06
LLW Cat 3	200 East Area	Resident Gardener + Sauna	860	5.7E-04	1.7E-02	1E-05
MLLW	200 East Area	Resident Gardener + Sauna	1,580	2.7E-04	8.2E-03	5E-06
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.3E-05	9.8E-02	6E-05
Melters	200 East Area	Resident Gardener + Sauna	10,000	8.1E-06	2.4E-04	2E-07

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.98. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D_2, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	2,000	3.0E-06	9.1E-05	5E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.7E-06	5.1E-05	3E-08
MLLW	200 West Area	Resident Gardener	2,000	1.3E-05	3.9E-04	2E-07
	200 East Area	Resident Gardener	1,400	1.7E-05	5.0E-04	3E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	9.8E-06	2.9E-04	2E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	8.0E-06	2.4E-04	1E-07
MLLW	200 West Area	Resident Gardener + Sauna	2,000	4.6E-05	1.4E-03	8E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.9E-04	5.7E-03	3E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 East Area	Resident Gardener	1,530	9.3E-06	2.8E-04	2E-07
LLW Cat 3	200 East Area	Resident Gardener	860	1.3E-04	3.8E-03	2E-06
MLLW	200 East Area	Resident Gardener	1,580	6.9E-05	2.1E-03	1E-06
ILAW	200 East Area	Resident Gardener	10,000	1.3E-05	3.8E-04	2E-07
Melters	200 East Area	Resident Gardener	2,110	6.5E-08	2.0E-06	1E-09
LLW Cat 1	200 East Area	Resident Gardener + Sauna	10,000	1.2E-04	3.5E-03	2E-06
LLW Cat 3	200 East Area	Resident Gardener + Sauna	860	5.7E-04	1.7E-02	1E-05
MLLW	200 East Area	Resident Gardener + Sauna	1,590	3.9E-04	1.2E-02	7E-06
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.3E-05	9.8E-02	6E-05
Melters	200 East Area	Resident Gardener + Sauna	10,000	9.7E-06	2.9E-04	2E-07

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.99. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D_3, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,810	5.8E-06	1.7E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.5E-06	1.0E-04	6E-08
MLLW	200 West Area	Resident Gardener	1,450	3.8E-06	1.1E-04	7E-08
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1,810	1.6E-05	4.8E-04	3E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.6E-05	4.9E-04	3E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,450	1.8E-05	5.3E-04	3E-07
Projected New Waste (>2007)[c]						
LLW Cat 1	200 ERDF Site	Resident Gardener	1,800	2.7E-05	8.2E-04	5E-07
LLW Cat 3	200 ERDF Site	Resident Gardener	1,130	4.8E-04	1.4E-02	9E-06
MLLW	200 ERDF Site	Resident Gardener	1,800	2.7E-04	8.0E-03	5E-06
ILAW	200 ERDF Site	Resident Gardener	10,000	3.5E-04	1.0E-02	6E-06
Melters	200 ERDF Site	Resident Gardener	1,130	5.3E-06	1.6E-04	1E-07
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	1,800	1.0E-04	3.0E-03	2E-06
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	1,130	2.1E-03	6.4E-02	4E-05
MLLW	200 ERDF Site	Resident Gardener + Sauna	1,800	9.3E-04	2.8E-02	2E-05
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	1.2E-01	3.6E-00	2E-03
Melters	200 ERDF Site	Resident Gardener + Sauna	1,130	2.5E-05	7.6E-04	5E-07

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.100. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D_3, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	**Dose, rem**		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,810	7.0E-06	2.1E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.5E-06	1.0E-04	6E-08
MLLW	200 West Area	Resident Gardener	1,450	3.8E-06	1.1E-04	7E-08
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1,810	2.0E-05	5.9E-04	4E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.6E-05	4.9E-04	3E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,450	1.8E-05	5.3E-04	3E-07
Projected New Waste (>2007)[c]						
LLW Cat 1	200 ERDF Site	Resident Gardener	1,800	3.3E-05	1.0E-03	6E-07
LLW Cat 3	200 ERDF Site	Resident Gardener	1,130	4.8E-04	1.4E-02	9E-06
MLLW	200 ERDF Site	Resident Gardener	1,800	2.7E-04	8.0E-03	5E-06
ILAW	200 ERDF Site	Resident Gardener	10,000	3.5E-04	1.0E-02	6E-06
Melters	200 ERDF Site	Resident Gardener	1,130	5.3E-06	1.6E-04	1E-07
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	1,800	1.2E-04	3.7E-03	2E-06
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	1,130	2.1E-03	6.4E-02	4E-05
MLLW	200 ERDF Site	Resident Gardener + Sauna	1,800	9.3E-04	2.8E-02	2E-05
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	1.2E-01	3.6E-00	2E-03
Melters	200 ERDF Site	Resident Gardener + Sauna	1,130	2.5E-05	7.6E-04	5E-07

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.101. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D_3, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,810	7.4E-06	2.2E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.5E-06	1.0E-04	6E-08
MLLW	200 West Area	Resident Gardener	1,810	3.1E-05	9.3E-04	6E-07
	200 East Area	Resident Gardener	10,000	1.1E-04	3.4E-03	2E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	1.3E-04	4.0E-03	2E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.7E-05	5.0E-04	3E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,810	1.1E-04	3.3E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	6.4E-03	1.9E-01	1E-04
Projected New Waste (>2007)[c]						
LLW Cat 1	200 ERDF Site	Resident Gardener	1,800	3.3E-05	1.0E-03	6E-07
LLW Cat 3	200 ERDF Site	Resident Gardener	1,130	4.8E-04	1.4E-02	9E-06
MLLW	200 ERDF Site	Resident Gardener	1,790	2.9E-04	8.7E-03	5E-06
ILAW	200 ERDF Site	Resident Gardener	10,000	3.5E-04	1.0E-02	6E-06
Melters	200 ERDF Site	Resident Gardener	1,130	5.3E-06	1.6E-04	1E-07
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	1,800	1.3E-04	3.8E-03	2E-06
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	1,130	2.1E-03	6.4E-02	4E-05
MLLW	200 ERDF Site	Resident Gardener + Sauna	1,790	1.0E-03	3.1E-02	2E-05
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	1.2E-01	3.6E-00	2E-03
Melters	200 ERDF Site	Resident Gardener + Sauna	1,130	2.5E-05	7.6E-04	5E-07

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.102. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area and 200 ERDF Site 1-km Wells from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D_3, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)						
LLW Cat 1	200 West Area	Resident Gardener	1,700	2.7E-05	8.2E-04	5E-07
LLW Cat 3	200 West Area	Resident Gardener	1,230	2.4E-05	7.3E-04	4E-07
MLLW	200 West Area	Resident Gardener	1,700	2.2E-04	6.5E-03	4E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1,700	7.6E-05	2.3E-03	1E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,230	1.2E-04	3.5E-03	2E-06
MLLW	200 West Area	Resident Gardener + Sauna	1,700	7.4E-04	2.2E-02	1E-05
Projected New Waste (>2007)[c]						
LLW Cat 1	200 ERDF Site	Resident Gardener	1,740	5.0E-05	1.5E-03	9E-07
LLW Cat 3	200 ERDF Site	Resident Gardener	1,070	8.9E-04	2.7E-02	2E-05
MLLW	200 ERDF Site	Resident Gardener	1,740	4.9E-04	1.5E-02	9E-06
ILAW	200 ERDF Site	Resident Gardener	10,000	3.5E-04	1.0E-02	6E-06
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	1,740	1.9E-04	5.6E-03	3E-06
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	1,070	4.0E-03	1.2E-01	7E-05
MLLW	200 ERDF Site	Resident Gardener + Sauna	1,740	1.7E-03	5.1E-02	3E-05
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	1.2E-01	3.6E-00	2E-03

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.103. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area and 200 ERDF Site 1-km Wells from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D_3, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[(b)]
			Years Post-2046[(a)]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)						
LLW Cat 1	200 West Area	Resident Gardener	1,700	3.3E-05	1.0E-03	6E-07
LLW Cat 3	200 West Area	Resident Gardener	1,230	2.4E-05	7.3E-04	4E-07
MLLW	200 West Area	Resident Gardener	1,700	2.2E-04	6.5E-03	4E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1,700	9.3E-05	2.8E-03	2E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,230	1.2E-04	3.5E-03	2E-06
MLLW	200 West Area	Resident Gardener + Sauna	1,700	7.4E-04	2.2E-02	1E-05
Projected New Waste (>2007)[(c)]						
LLW Cat 1	200 ERDF Site	Resident Gardener	1,740	6.1E-05	1.8E-03	1E-06
LLW Cat 3	200 ERDF Site	Resident Gardener	1,070	8.9E-04	2.7E-02	2E-05
MLLW	200 ERDF Site	Resident Gardener	1,740	4.9E-04	1.5E-02	9E-06
ILAW	200 ERDF Site	Resident Gardener	10,000	3.5E-04	1.0E-02	6E-06
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	1,740	2.3E-04	6.8E-03	4E-06
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	1,070	4.0E-03	1.2E-01	7E-05
MLLW	200 ERDF Site	Resident Gardener + Sauna	1,740	1.7E-03	5.2E-02	3E-05
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	1.2E-01	3.6E-00	2E-03

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.104. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area and 200 ERDF Site 1-km Wells from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D_3, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)						
LLW Cat 1	200 West Area	Resident Gardener	1,700	4.0E-05	1.2E-03	7E-07
LLW Cat 3	200 West Area	Resident Gardener	1,230	2.4E-05	7.3E-04	4E-07
MLLW	200 West Area	Resident Gardener	1,690	1.5E-04	4.4E-03	3E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	4.8E-03	1.5E-01	9E-05
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,230	1.2E-04	3.5E-03	2E-06
MLLW	200 West Area	Resident Gardener + Sauna	1,690	5.2E-04	1.6E-02	9E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 ERDF Site	Resident Gardener	1,740	6.1E-05	1.8E-03	1E-06
LLW Cat 3	200 ERDF Site	Resident Gardener	1,070	8.9E-04	2.7E-02	2E-05
MLLW	200 ERDF Site	Resident Gardener	1,740	5.3E-04	1.6E-02	1E-05
ILAW	200 ERDF Site	Resident Gardener	10,000	3.5E-04	1.0E-02	6E-06
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	10,000	1.0E-02	3.1E-01	2E-04
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	1,070	4.0E-03	1.2E-01	7E-05
MLLW	200 ERDF Site	Resident Gardener + Sauna	1,740	1.9E-03	5.7E-02	3E-05
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	1.2E-01	3.6E-00	2E-03

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.105. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D_3, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF(b)
			Years Post-2046(a)	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)(c)						
LLW Cat 1	200 West Area	Resident Gardener	2,000	2.4E-06	7.2E-05	4E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.7E-06	5.1E-05	3E-08
MLLW	200 West Area	Resident Gardener	1,710	1.8E-06	5.5E-05	3E-08
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	6.7E-06	2.0E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	8.0E-06	2.4E-04	1E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,710	8.7E-06	2.6E-04	2E-07
Projected New Waste (>2007)(c)						
LLW Cat 1	200 ERDF Site	Resident Gardener	2,010	4.4E-06	1.3E-04	8E-08
LLW Cat 3	200 ERDF Site	Resident Gardener	1,420	7.8E-05	2.3E-03	1E-06
MLLW	200 ERDF Site	Resident Gardener	2,010	4.3E-05	1.3E-03	8E-07
ILAW	200 ERDF Site	Resident Gardener	10,000	1.2E-05	3.5E-04	2E-07
Melters	200 ERDF Site	Resident Gardener	1,420	8.7E-07	2.6E-05	2E-08
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	2,010	1.6E-05	4.9E-04	3E-07
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	1,420	3.5E-04	1.1E-02	6E-06
MLLW	200 ERDF Site	Resident Gardener + Sauna	2,010	1.5E-04	4.6E-03	3E-06
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	3.0E-05	9.0E-02	5E-05
Melters	200 ERDF Site	Resident Gardener + Sauna	1,420	4.1E-06	1.2E-04	7.0E-08

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.106. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D_3, Lower Bound Waste Volume

Waste Category	**Source Location**	**Exposure Scenario**	**Maximum Annual Dose**		**Lifetime Dose, rem**	**Probability of an LCF**[b]
			Years Post-2046[a]	**Dose, rem**		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	2,000	2.9E-06	8.7E-05	5E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.7E-06	5.1E-05	3E-08
MLLW	200 West Area	Resident Gardener	2,000	1.9E-05	5.7E-04	3E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	8.1E-06	2.4E-04	2E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	8.0E-06	2.4E-04	1E-07
MLLW	200 West Area	Resident Gardener + Sauna	2,000	6.5E-05	1.9E-03	1E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 ERDF Site	Resident Gardener	2,010	5.4E-06	1.6E-04	1E-07
LLW Cat 3	200 ERDF Site	Resident Gardener	1,420	7.8E-05	2.3E-03	1E-06
MLLW	200 ERDF Site	Resident Gardener	2,010	4.4E-05	1.3E-03	8E-07
ILAW	200 ERDF Site	Resident Gardener	10,000	1.2E-05	3.5E-04	2E-07
Melters	200 ERDF Site	Resident Gardener	1,420	8.7E-07	2.6E-05	2E-08
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	2,010	2.0E-05	6.0E-04	4E-07
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	1,420	3.5E-04	1.1E-02	6E-06
MLLW	200 ERDF Site	Resident Gardener + Sauna	2,010	1.5E-04	4.6E-03	3E-06
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	3.0E-05	9.0E-02	5E-05
Melters	200 ERDF Site	Resident Gardener + Sauna	1,420	4.1E-06	1.2E-04	7E-08

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.107. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group D_3, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	2,000	3.0E-06	9.1E-05	6E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.7E-06	5.1E-05	3E-08
MLLW	200 West Area	Resident Gardener	2,000	1.3E-05	3.9E-04	2E-07
	200 East Area	Resident Gardener	10,000	1.7E-05	5.0E-04	3E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	1.4E-05	4.3E-04	3E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,720	8.0E-06	2.4E-04	1E-07
MLLW	200 West Area	Resident Gardener + Sauna	2,000	4.6E-05	1.4E-03	8E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.9E-04	5.7E-03	3E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 ERDF Site	Resident Gardener	2,010	5.4E-06	1.6E-04	1E-07
LLW Cat 3	200 ERDF Site	Resident Gardener	1,420	7.8E-05	2.3E-03	1E-06
MLLW	200 ERDF Site	Resident Gardener	2,010	4.7E-05	1.4E-03	9E-07
ILAW	200 ERDF Site	Resident Gardener	10,000	1.2E-05	3.5E-04	2E-07
Melters	200 ERDF Site	Resident Gardener	1,420	8.7E-07	2.6E-05	2E-08
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	10,000	4.2E-03	1.2E-01	8E-05
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	1,420	3.5E-04	1.1E-02	6E-06
MLLW	200 ERDF Site	Resident Gardener + Sauna	2,010	1.7E-04	5.1E-03	3E-06
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	3.0E-05	9.0E-02	5E-05
Melters	200 ERDF Site	Resident Gardener + Sauna	1,420	4.1E-06	1.2E-04	7E-08

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.108. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group E_1, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,810	5.8E-06	1.7E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.5E-06	1.0E-04	6E-08
MLLW	200 West Area	Resident Gardener	1,810	4.6E-05	1.4E-03	8E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	3.5E-05	1.0E-03	6E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.7E-05	5.0E-04	3E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,810	1.6E-04	4.7E-03	3E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 ERDF Site	Resident Gardener	1,320	2.8E-05	8.4E-04	5E-07
LLW Cat 3	200 ERDF Site	Resident Gardener	620	5.4E-04	1.6E-02	1E-05
MLLW	200 ERDF Site	Resident Gardener	1,370	4.8E-04	1.4E-02	9E-06
ILAW	200 ERDF Site	Resident Gardener	10,000	3.5E-04	1.0E-02	6E-06
Melters	200 ERDF Site	Resident Gardener	1,130	5.3E-06	1.6E-04	1E-07
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	10,000	7.6E-03	2.3E-01	1E-04
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	620	2.4E-03	7.3E-02	4E-05
MLLW	200 ERDF Site	Resident Gardener + Sauna	1,370	1.1E-02	3.3E-01	2E-04
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	1.2E-01	3.6E-00	2E-03
Melters	200 ERDF Site	Resident Gardener + Sauna	1,130	2.5E-05	7.6E-04	5E-07

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.109. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group E_1, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,810	7.1E-06	2.1E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.5E-06	1.0E-04	6E-08
MLLW	200 West Area	Resident Gardener	1,810	4.6E-05	1.4E-03	8E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	3.6E-05	1.1E-03	7E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.7E-05	5.0E-04	3E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,810	1.6E-04	4.7E-03	3E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 ERDF Site	Resident Gardener	1,320	3.4E-05	1.0E-03	6E-07
LLW Cat 3	200 ERDF Site	Resident Gardener	620	5.4E-04	1.6E-02	1E-05
MLLW	200 ERDF Site	Resident Gardener	1,370	5.0E-04	1.5E-02	9E-06
ILAW	200 ERDF Site	Resident Gardener	10,000	3.5E-04	1.0E-02	6E-06
Melters	200 ERDF Site	Resident Gardener	1,130	5.3E-06	1.6E-04	1E-07
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	10,000	9.0E-03	2.7E-01	2E-04
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	620	2.5E-03	7.4E-02	4E-05
MLLW	200 ERDF Site	Resident Gardener + Sauna	10,000	3.0E-02	8.9E-01	5E-04
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	1.2E-01	3.6E-00	2E-03
Melters	200 ERDF Site	Resident Gardener + Sauna	1,130	2.5E-05	7.6E-04	5E-07

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.110. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group E_1, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[(b)]
			Years Post-2046[(a)]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)[(c)]						
LLW Cat 1	200 West Area	Resident Gardener	1,810	7.3E-06	2.2E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.5E-06	1.0E-04	6E-08
MLLW	200 West Area	Resident Gardener	1,810	3.1E-05	9.3E-04	6E-07
	200 East Area	Resident Gardener	10,000	1.1E-04	3.4E-03	2E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	4.3E-05	1.3E-03	8E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.7E-05	5.0E-04	3E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,810	1.1E-04	3.3E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	6.4E-03	1.9E-01	1E-04
Projected New Waste (>2007)[(c)]						
LLW Cat 1	200 ERDF Site	Resident Gardener	1,320	3.4E-05	1.0E-03	6E-07
LLW Cat 3	200 ERDF Site	Resident Gardener	620	5.4E-04	1.6E-02	1E-05
MLLW	200 ERDF Site	Resident Gardener	1,370	5.2E-04	1.6E-02	9E-06
ILAW	200 ERDF Site	Resident Gardener	10,000	3.5E-04	1.0E-02	6E-06
Melters	200 ERDF Site	Resident Gardener	1,130	5.3E-06	1.6E-04	1E-07
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	10,000	1.4E-02	4.3E-01	3E-04
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	620	2.4E-03	7.2E-02	4E-05
MLLW	200 ERDF Site	Resident Gardener + Sauna	1,370	1.2E-02	3.5E-01	2E-04
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	1.2E-01	3.6E-00	2E-03
Melters	200 ERDF Site	Resident Gardener + Sauna	1,130	2.5E-05	7.6E-04	5E-07

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.111. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area and 200 ERDF Site 1-km Wells from Radionuclides in the Groundwater over 10,000 Years for Alternative Group E_1, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,700	2.9E-05	8.6E-04	5E-07
LLW Cat 3	200 West Area	Resident Gardener	1,230	2.4E-05	7.3E-04	4E-07
MLLW	200 West Area	Resident Gardener	1,700	2.2E-04	6.5E-03	4E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	1.3E-03	3.9E-02	2E-05
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,230	1.4E-04	4.2E-03	3E-06
MLLW	200 West Area	Resident Gardener + Sauna	1,700	7.4E-04	2.2E-02	1E-05
Projected New Waste (>2007)[c]						
ILAW	200 ERDF Site	Resident Gardener	10,000	3.5E-04	1.0E-02	6E-06
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	1.2E-01	3.6E-00	2E-03

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.112. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area and 200 ERDF Site 1-km Wells from Radionuclides in the Groundwater over 10,000 Years for Alternative Group E_1, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose: Years Post-2046[(a)]	Maximum Annual Dose: Dose, rem	Lifetime Dose, rem	Probability of an LCF[(b)]
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)[(c)]						
LLW Cat 1	200 West Area	Resident Gardener	1,700	3.5E-05	1.0E-03	6E-07
LLW Cat 3	200 West Area	Resident Gardener	1,230	2.4E-05	7.3E-04	4E-07
MLLW	200 West Area	Resident Gardener	1,700	2.2E-04	6.5E-03	4E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	1.4E-03	4.3E-02	3E-05
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,230	1.2E-04	3.5E-03	2E-06
MLLW	200 West Area	Resident Gardener + Sauna	1,700	7.4E-04	2.2E-02	1E-05
Projected New Waste (>2007)[(c)]						
ILAW	200 ERDF Site	Resident Gardener	10,000	3.5E-04	1.0E-02	6E-06
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	1.2E-01	3.6E-00	2E-03

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.113. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area and 200 ERDF Site 1-km Wells from Radionuclides in the Groundwater over 10,000 Years for Alternative Group E_1, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	**1.9E-02**	1E-05
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,700	3.7E-05	1.1E-03	7E-07
LLW Cat 3	200 West Area	Resident Gardener	1,230	2.4E-05	7.3E-04	4E-07
MLLW	200 West Area	Resident Gardener	1,230	4.0E-05	1.2E-03	7E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	2.2E-03	6.6E-02	4E-05
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,230	1.2E-04	3.5E-03	2E-06
MLLW	200 West Area	Resident Gardener + Sauna	1,230	2.2E-04	6.5E-03	4E-06
Projected New Waste (>2007)[c]						
ILAW	200 ERDF Site	Resident Gardener	10,000	3.5E-04	1.0E-02	6E-06
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	1.2E-01	3.6E-00	2E-03

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.114. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group $E_{1,}$ Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	2,000	2.4E-06	7.2E-05	4E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.7E-06	5.1E-05	3E-08
MLLW	200 West Area	Resident Gardener	2,000	1.9E-05	5.7E-04	3E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	7.0E-06	2.1E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	8.0E-06	2.4E-04	1E-07
MLLW	200 West Area	Resident Gardener + Sauna	2,000	6.4E-05	1.9E-03	1E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 ERDF Site	Resident Gardener	1,530	7.7E-06	2.3E-04	1E-07
LLW Cat 3	200 ERDF Site	Resident Gardener	860	1.3E-04	3.8E-03	2E-06
MLLW	200 ERDF Site	Resident Gardener	1,580	6.4E-05	1.9E-03	1E-06
ILAW	200 ERDF Site	Resident Gardener	10,000	1.2E-05	3.5E-04	2E-07
Melters	200 ERDF Site	Resident Gardener	1,420	8.7E-07	2.6E-05	2E-08
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	10,000	1.4E-04	4.1E-03	3E-06
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	860	5.7E-04	1.7E-02	1E-05
MLLW	200 ERDF Site	Resident Gardener + Sauna	1,580	2.7E-04	8.2E-03	5E-06
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	3.0E-05	9.0E-02	5E-05
Melters	200 ERDF Site	Resident Gardener + Sauna	1,420	4.5E-06	1.3E-04	8E-08

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.115. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group E_1, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF(b)
			Years Post-2046(a)	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)(c)						
LLW Cat 1	200 West Area	Resident Gardener	2,000	2.9E-06	8.7E-05	5E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.7E-06	5.1E-05	3E-08
MLLW	200 West Area	Resident Gardener	2,000	1.9E-05	5.7E-04	3E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	8.5E-06	2.6E-04	2E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	8.0E-06	2.4E-04	1E-07
MLLW	200 West Area	Resident Gardener + Sauna	2,000	6.5E-05	1.9E-03	1E-06
Projected New Waste (>2007)(c)						
LLW Cat 1	200 ERDF Site	Resident Gardener	1,530	9.3E-06	2.8E-04	2E-07
LLW Cat 3	200 ERDF Site	Resident Gardener	860	1.3E-04	3.8E-03	2E-06
MLLW	200 ERDF Site	Resident Gardener	1,580	6.4E-05	1.9E-03	1E-06
ILAW	200 ERDF Site	Resident Gardener	10,000	1.2E-05	3.5E-04	2E-07
Melters	200 ERDF Site	Resident Gardener	1,420	8.7E-07	2.6E-05	2E-08
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	10,000	1.6E-04	4.8E-03	3E-06
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	850	5.7E-04	1.7E-02	1E-05
MLLW	200 ERDF Site	Resident Gardener + Sauna	1,580	2.7E-04	8.2E-03	5E-06
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	3.0E-05	9.0E-02	5E-05
Melters	200 ERDF Site	Resident Gardener + Sauna	1,420	4.5E-06	1.3E-04	8E-08

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.116. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group E_1, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	2,000	3.0E-06	9.1E-05	5E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.7E-06	5.1E-05	3E-08
MLLW	200 West Area	Resident Gardener	2,000	1.3E-05	3.9E-04	2E-07
	200 East Area	Resident Gardener	1,400	1.7E-05	5.0E-04	3E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	9.0E-06	2.7E-04	2E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	8.0E-06	2.4E-04	1E-07
MLLW	200 West Area	Resident Gardener + Sauna	2,000	4.6E-05	1.4E-03	8E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.9E-04	5.7E-03	3E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 ERDF Site	Resident Gardener	1,530	9.6E-06	2.9E-04	2E-07
LLW Cat 3	200 ERDF Site	Resident Gardener	860	1.3E-04	3.8E-03	2E-06
MLLW	200 ERDF Site	Resident Gardener	1,570	6.9E-05	2.1E-03	1E-06
ILAW	200 ERDF Site	Resident Gardener	10,000	1.2E-05	3.5E-04	2E-07
Melters	200 ERDF Site	Resident Gardener	1,420	8.7E-07	2.6E-05	2E-08
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	10,000	3.4E-04	1.0E-02	6E-06
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	860	5.7E-04	1.7E-02	1E-05
MLLW	200 ERDF Site	Resident Gardener + Sauna	1,570	3.9E-04	1.2E-02	7E-06
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	3.0E-05	9.0E-02	5E-05
Melters	200 ERDF Site	Resident Gardener + Sauna	1,420	4.5E-06	1.3E-04	8E-08

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.117. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group E_2, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,810	5.8E-06	1.7E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.5E-06	1.0E-04	6E-08
MLLW	200 West Area	Resident Gardener	1,810	4.6E-05	1.4E-03	8E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	3.5E-05	1.0E-03	6E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.7E-05	5.0E-04	3E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,810	1.6E-04	4.7E-03	3E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 ERDF Site	Resident Gardener	1,380	4.1E-05	1.2E-03	7E-07
LLW Cat 3	200 ERDF Site	Resident Gardener	620	1.6E-04	4.8E-03	3E-06
MLLW	200 ERDF Site	Resident Gardener	1,380	3.4E-04	1.0E-02	6E-06
ILAW	200 ERDF Site	Resident Gardener	10,000	3.5E-04	1.0E-02	6E-06
Melters	200 ERDF Site	Resident Gardener	1,130	5.3E-06	1.6E-04	1E-07
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	10,000	4.8E-03	1.4E-01	9E-05
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	620	7.7E-04	2.3E-02	1E-05
MLLW	200 ERDF Site	Resident Gardener + Sauna	10,000	7.7E-03	2.3E-01	1E-04
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	1.2E-01	3.6E-00	2E-03
Melters	200 ERDF Site	Resident Gardener + Sauna	1,130	2.5E-05	7.6E-04	5E-07

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.118. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group E_2, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,810	7.1E-06	2.1E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.5E-06	1.0E-04	6E-08
MLLW	200 West Area	Resident Gardener	1,810	4.6E-05	1.4E-03	8E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	3.6E-05	1.1E-03	7E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.7E-05	5.0E-04	3E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,810	1.6E-04	4.7E-03	3E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 ERDF Site	Resident Gardener	1,380	4.9E-05	1.5E-03	9E-07
LLW Cat 3	200 ERDF Site	Resident Gardener	620	1.6E-04	4.8E-03	3E-06
MLLW	200 ERDF Site	Resident Gardener	1,380	3.5E-04	1.0E-02	6E-06
ILAW	200 ERDF Site	Resident Gardener	10,000	3.5E-04	1.0E-02	6E-06
Melters	200 ERDF Site	Resident Gardener	1,130	5.3E-06	1.6E-04	1E-07
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	10,000	5.5E-03	1.7E-01	1E-04
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	620	7.7E-04	2.3E-02	1E-05
MLLW	200 ERDF Site	Resident Gardener + Sauna	10,000	7.7E-03	2.3E-01	1E-04
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	1.2E-01	3.6E-00	2E-03
Melters	200 ERDF Site	Resident Gardener + Sauna	1,130	2.5E-05	7.6E-04	5E-07

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.119. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group E_2, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,810	7.3E-06	2.2E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.5E-06	1.0E-04	6E-08
MLLW	200 West Area	Resident Gardener	1,810	3.1E-05	9.3E-04	6E-07
	200 East Area	Resident Gardener	1,230	1.1E-04	3.4E-03	2E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	4.3E-05	1.3E-03	8E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.7E-05	5.0E-04	3E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,810	1.1E-04	3.3E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	6.4E-03	1.9E-01	1E-04
Projected New Waste (>2007)[c]						
LLW Cat 1	200 ERDF Site	Resident Gardener	1,380	4.2E-05	1.3E-03	8E-07
LLW Cat 3	200 ERDF Site	Resident Gardener	620	1.7E-04	5.0E-03	3E-06
MLLW	200 ERDF Site	Resident Gardener	1,380	3.8E-04	1.2E-02	7E-06
ILAW	200 ERDF Site	Resident Gardener	10,000	3.5E-04	1.0E-02	6E-06
Melters	200 ERDF Site	Resident Gardener	1,130	5.3E-06	1.6E-04	1E-07
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	10,000	9.4E-03	2.8E-01	2E-04
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	620	8.0E-04	2.4E-02	1E-05
MLLW	200 ERDF Site	Resident Gardener + Sauna	10,000	1.7E-02	5.1E-01	3E-04
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	1.2E-01	3.6E-00	2E-03
Melters	200 ERDF Site	Resident Gardener + Sauna	1,130	2.5E-05	7.6E-04	5E-07

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.120. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area and 200 ERDF Site 1-km Wells from Radionuclides in the Groundwater over 10,000 Years for Alternative Group E_2, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,700	2.9E-05	8.6E-04	5E-07
LLW Cat 3	200 West Area	Resident Gardener	1,230	2.4E-05	7.3E-04	4E-07
MLLW	200 West Area	Resident Gardener	1,700	2.2E-04	6.5E-03	4E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	1.3E-03	3.9E-02	2E-05
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,230	1.2E-04	3.5E-03	2E-06
MLLW	200 West Area	Resident Gardener + Sauna	1,700	7.4E-04	2.2E-02	1E-05
Projected New Waste (>2007)[c]						
ILAW	200 ERDF Site	Resident Gardener	10,000	3.5E-04	1.0E-02	6E-06
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	1.2E-01	3.6E-00	2E-03

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.121. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area and 200 ERDF Site 1-km Wells from Radionuclides in the Groundwater over 10,000 Years for Alternative Group E_2, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)						
LLW Cat 1	200 West Area	Resident Gardener	1,700	3.5E-05	1.0E-03	6E-07
LLW Cat 3	200 West Area	Resident Gardener	680	1.3E-05	3.8E-04	2E-07
MLLW	200 West Area	Resident Gardener	1,700	2.2E-04	6.5E-03	4E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	1.3E-03	4.0E-02	2E-05
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,230	1.2E-04	3.5E-03	2E-06
MLLW	200 West Area	Resident Gardener + Sauna	1,700	7.4E-04	2.2E-02	1E-05
Projected New Waste (>2007)[c]						
ILAW	200 ERDF Site	Resident Gardener	10,000	3.5E-04	1.0E-02	6E-06
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	1.2E-01	3.6E-00	2E-03

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.122. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area and 200 ERDF Site 1-km Wells from Radionuclides in the Groundwater over 10,000 Years for Alternative Group E_2, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[(b)]
			Years Post-2046[(a)]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)						
LLW Cat 1	200 West Area	Resident Gardener	1,700	3.7E-05	1.1E-03	7E-07
LLW Cat 3	200 West Area	Resident Gardener	1,230	2.4E-05	7.3E-04	4E-07
MLLW	200 West Area	Resident Gardener	1,690	1.5E-04	4.4E-03	3E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	10,000	2.2E-03	6.6E-02	4E-05
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,230	1.3E-04	3.8E-03	2E-06
MLLW	200 West Area	Resident Gardener + Sauna	1,690	5.2E-04	1.6E-02	9E-06
Projected New Waste (>2007)[(c)]						
ILAW	200 ERDF Site	Resident Gardener	10,000	3.5E-04	1.0E-02	6E-06
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	1.2E-01	3.6E-00	2E-03

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.123. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group E_2, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	2,000	2.4E-06	7.2E-05	4E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.7E-06	5.1E-05	3E-08
MLLW	200 West Area	Resident Gardener	2,000	1.9E-05	5.7E-04	3E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	7.0E-06	2.1E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	8.0E-06	2.4E-04	1E-07
MLLW	200 West Area	Resident Gardener + Sauna	2,000	6.4E-05	1.9E-03	1E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 ERDF Site	Resident Gardener	10,000	5.4E-06	1.6E-04	1E-07
LLW Cat 3	200 ERDF Site	Resident Gardener	820	6.2E-05	1.9E-03	1E-06
MLLW	200 ERDF Site	Resident Gardener	1,500	3.9E-05	1.2E-03	7E-07
ILAW	200 ERDF Site	Resident Gardener	10,000	1.2E-05	3.5E-04	2E-07
Melters	200 ERDF Site	Resident Gardener	1,420	8.7E-07	2.6E-05	2E-08
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	10,000	4.7E-03	1.4E-01	9E-05
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	820	3.1E-04	9.3E-03	6E-06
MLLW	200 ERDF Site	Resident Gardener + Sauna	1,500	2.2E-04	6.5E-03	4E-06
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	3.0E-05	9.0E-02	5E-05
Melters	200 ERDF Site	Resident Gardener + Sauna	1,420	4.1E-06	1.2E-04	7E-08

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.124. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group E_2, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF(b)
			Years Post-2046(a)	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)(c)						
LLW Cat 1	200 West Area	Resident Gardener	2,000	2.9E-06	8.7E-05	5E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.7E-06	5.1E-05	3E-08
MLLW	200 West Area	Resident Gardener	2,000	1.9E-05	5.7E-04	3E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	8.5E-06	2.6E-04	2E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	8.0E-06	2.4E-04	1E-07
MLLW	200 West Area	Resident Gardener + Sauna	2,000	6.5E-05	1.9E-03	1E-06
Projected New Waste (>2007)(c)						
LLW Cat 1	200 ERDF Site	Resident Gardener	10,000	5.5E-03	1.7E-01	1E-04
LLW Cat 3	200 ERDF Site	Resident Gardener	820	6.7E-05	2.0E-03	1E-06
MLLW	200 ERDF Site	Resident Gardener	1,500	3.9E-05	1.2E-03	7E-07
ILAW	200 ERDF Site	Resident Gardener	10,000	1.2E-05	3.5E-04	2E-07
Melters	200 ERDF Site	Resident Gardener	1420	8.7E-07	2.6E-05	2E-08
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	10,000	5.6E-03	1.7E-01	1E-04
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	820	3.2E-04	9.7E-03	6E-06
MLLW	200 ERDF Site	Resident Gardener + Sauna	1,500	2.2E-04	6.5E-03	4E-06
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	3.0E-05	9.0E-02	5E-05
Melters	200 ERDF Site	Resident Gardener + Sauna	1,420	4.1E-06	1.2E-04	7E-08

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.125. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group E_2, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	2,000	3.0E-06	9.1E-05	5E-08
LLW Cat 3	200 West Area	Resident Gardener	1710	1.7E-06	5.1E-05	3E-08
MLLW	200 West Area	Resident Gardener	2,000	1.3E-05	3.9E-04	2E-07
	200 East Area	Resident Gardener	1,400	1.7E-05	5.0E-04	3E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	9.0E-06	2.7E-04	2E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	8.0E-06	2.4E-04	1E-07
MLLW	200 West Area	Resident Gardener + Sauna	2,000	4.6E-05	1.4E-03	8E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.9E-04	5.7E-03	3E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 ERDF Site	Resident Gardener	10,000	1.1E-05	3.2E-04	2E-07
LLW Cat 3	200 ERDF Site	Resident Gardener	820	6.2E-05	1.9E-03	1E-06
MLLW	200 ERDF Site	Resident Gardener	1,500	4.2E-05	1.3E-03	8E-07
ILAW	200 ERDF Site	Resident Gardener	10,000	1.2E-05	3.5E-04	2E-07
Melters	200 ERDF Site	Resident Gardener	1,420	8.7E-07	2.6E-05	2E-08
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	10,000	9.2E-03	2.8E-01	2E-04
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	820	3.0E-04	9.0E-03	5E-06
MLLW	200 ERDF Site	Resident Gardener + Sauna	1,510	3.7E-04	1.1E-02	7E-06
ILAW	200 ERDF Site	Resident Gardener + Sauna	10,000	3.0E-05	9.0E-02	5E-05
Melters	200 ERDF Site	Resident Gardener + Sauna	1,420	4.1E-06	1.2E-04	7E-08

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.126. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group E$_3$, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,810	5.8E-06	1.7E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.5E-06	1.0E-04	6E-08
MLLW	200 West Area	Resident Gardener	1,810	4.6E-05	1.4E-03	8E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1,810	1.6E-05	4.8E-04	3E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.6E-05	4.9E-04	3E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,810	1.6E-04	4.7E-03	3E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 ERDF Site	Resident Gardener	1,800	5.5E-05	1.7E-03	1E-06
LLW Cat 3	200 ERDF Site	Resident Gardener	1,130	4.5E-04	1.4E-02	8E-06
MLLW	200 ERDF Site	Resident Gardener	1,450	2.2E-05	6.6E-04	4E-07
ILAW	200 East Area	Resident Gardener	10,000	1.0E-04	3.0E-03	2E-06
Melters	200 East Area	Resident Gardener	680	7.5E-06	2.3E-04	1E-07
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	1,800	1.3E-04	3.9E-03	2E-06
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	1,130	2.1E-03	6.3E-02	4E-05
MLLW	200 ERDF Site	Resident Gardener + Sauna	1,450	1.0E-04	3.1E-03	2E-06
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.5E-02	1.0E-00	6E-04
Melters	200 East Area	Resident Gardener + Sauna	10,000	5.6E-04	1.7E-02	1E-05

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.127. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group E_3, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,810	7.0E-06	2.1E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.5E-06	1.0E-04	6E-08
MLLW	200 West Area	Resident Gardener	1,810	4.6E-05	1.4E-03	8E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1,810	2.0E-05	5.9E-04	4E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.6E-05	4.9E-04	3E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,810	1.6E-04	4.7E-03	3E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 ERDF Site	Resident Gardener	1,800	6.7E-05	2.0E-03	1E-06
LLW Cat 3	200 ERDF Site	Resident Gardener	1,130	4.5E-04	1.4E-02	8E-06
MLLW	200 ERDF Site	Resident Gardener	1,450	2.2E-05	6.6E-04	4E-07
ILAW	200 East Area	Resident Gardener	10,000	1.0E-04	3.0E-03	2E-06
Melters	200 East Area	Resident Gardener	680	7.5E-06	2.3E-04	1E-07
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	1,800	1.6E-04	4.8E-03	3E-06
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	1,130	2.1E-03	6.3E-02	4E-05
MLLW	200 ERDF Site	Resident Gardener + Sauna	1,450	1.0E-04	3.1E-03	2E-06
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.5E-02	1.0E-00	6E-04
Melters	200 East Area	Resident Gardener + Sauna	10,000	5.6E-04	1.7E-02	1E-05

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.128. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group E_3, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.0E-06	6.1E-05	4E-08
	200 East Area	Resident Gardener	10,000	7.0E-05	2.1E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.7E-06	2.6E-04	2E-07
	200 East Area	Resident Gardener + Sauna	10,000	6.1E-02	1.8E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-04	6E-07
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	8E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.2E-03	3.7E-03	2E-06
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.2E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.6E-04	7.8E-03	5E-06
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,810	7.3E-06	2.2E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener	1,450	3.5E-06	1.0E-04	6E-08
MLLW	200 West Area	Resident Gardener	1,810	3.1E-05	9.3E-04	6E-07
	200 East Area	Resident Gardener	10,000	1.1E-04	3.4E-03	2E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1,810	2.1E-05	6.2E-04	4E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,450	1.6E-05	4.9E-04	3E-07
MLLW	200 West Area	Resident Gardener + Sauna	1,810	1.1E-04	3.3E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	6.4E-03	1.9E-01	1E-04
Projected New Waste (>2007)[c]						
LLW Cat 1	200 ERDF Site	Resident Gardener	1,800	6.8E-05	2.0E-03	1E-06
LLW Cat 3	200 ERDF Site	Resident Gardener	1,130	4.5E-04	1.4E-02	8E-06
MLLW	200 ERDF Site	Resident Gardener	1,360	4.6E-05	1.4E-03	8E-07
ILAW	200 East Area	Resident Gardener	10,000	1.0E-04	3.0E-03	2E-06
Melters	200 East Area	Resident Gardener	680	6.9E-06	2.1E-04	1E-07
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	1,800	1.6E-04	4.8E-03	3E-06
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	1,130	2.1E-03	6.3E-02	4E-05
MLLW	200 ERDF Site	Resident Gardener + Sauna	1,360	2.2E-04	6.5E-03	4E-06
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.5E-02	1.0E-00	6E-04
Melters	200 East Area	Resident Gardener + Sauna	10,000	5.6E-04	1.7E-02	1E-05

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.129. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area and 200 ERDF Site 1-km Wells from Radionuclides in the Groundwater over 10,000 Years for Alternative Group E_3, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose Years Post-2046[(a)]	Maximum Annual Dose Dose, rem	Lifetime Dose, rem	Probability of an LCF[(b)]
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)						
LLW Cat 1	200 West Area	Resident Gardener	1700	2.7E-05	8.2E-04	5E-07
LLW Cat 3	200 West Area	Resident Gardener	1230	2.4E-05	7.3E-04	4E-07
MLLW	200 West Area	Resident Gardener	1700	2.2E-04	6.5E-03	4E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1700	7.6E-05	2.3E-03	1E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1230	1.2E-04	3.5E-03	2E-06
MLLW	200 West Area	Resident Gardener + Sauna	1700	7.4E-04	2.2E-02	1E-05
Projected New Waste (>2007)[(c)]						
LLW Cat 1	200 ERDF Site	Resident Gardener	1740	5.1E-05	1.5E-03	9E-07
LLW Cat 3	200 ERDF Site	Resident Gardener	1070	8.9E-04	2.7E-02	2E-05
MLLW	200 ERDF Site	Resident Gardener	1740	4.9E-04	1.5E-02	9E-06
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	1070	1.9E-04	5.6E-03	3E-06
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	1070	4.0E-03	1.2E-01	7E-05
MLLW	200 ERDF Site	Resident Gardener + Sauna	1740	1.7E-03	5.1E-02	3E-05

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.130. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area and 200 ERDF Site 1-km Wells from Radionuclides in the Groundwater over 10,000 Years for Alternative Group E_3, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)						
LLW Cat 1	200 West Area	Resident Gardener	1700	3.3E-05	1.0E-03	6E-07
LLW Cat 3	200 West Area	Resident Gardener	1230	2.4E-05	7.3E-04	4E-07
MLLW	200 West Area	Resident Gardener	1700	2.2E-04	6.5E-03	4E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1700	9.3E-05	2.8E-03	2E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1230	1.2E-04	3.5E-03	2E-06
MLLW	200 West Area	Resident Gardener + Sauna	1700	7.4E-04	2.2E-02	1E-05
Projected New Waste (>2007)[c]						
LLW Cat 1	200 ERDF Site	Resident Gardener	1740	6.2E-05	1.9E-03	1E-06
LLW Cat 3	200 ERDF Site	Resident Gardener	1070	8.9E-04	2.7E-02	2E-05
MLLW	200 ERDF Site	Resident Gardener	1740	4.9E-04	1.5E-02	9E-06
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	1740	2.3E-04	6.8E-03	4E-06
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	1070	4.0E-03	1.2E-01	7E-05
MLLW	200 ERDF Site	Resident Gardener + Sauna	1740	1.7E-03	5.2E-02	3E-05

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.
(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.
(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.131. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area and 200 ERDF Site 1-km Wells from Radionuclides in the Groundwater over 10,000 Years for Alternative Group E_3, Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	9E-07
1970–1988	200 West Area	Resident Gardener	290	1.8E-05	5.5E-04	3E-07
	200 West Area	Resident Gardener + Sauna	290	2.7E-05	8.1E-04	5E-07
1988–1995	200 West Area	Resident Gardener	250	3.6E-04	1.1E-02	7E-06
	200 West Area	Resident Gardener + Sauna	250	6.3E-04	1.9E-02	1E-05
Newly Generated Waste (1996–2007)						
LLW Cat 1	200 West Area	Resident Gardener	1700	3.4E-05	1.0E-03	6E-07
LLW Cat 3	200 West Area	Resident Gardener	1230	2.4E-05	7.3E-04	4E-07
MLLW	200 West Area	Resident Gardener	1690	1.5E-04	4.4E-03	3E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1700	9.8E-05	3.0E-03	2E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1230	1.2E-04	3.5E-03	2E-06
MLLW	200 West Area	Resident Gardener + Sauna	1690	5.2E-04	1.6E-02	9E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 ERDF Site	Resident Gardener	1740	6.2E-05	1.9E-03	1E-06
LLW Cat 3	200 ERDF Site	Resident Gardener	1070	9.0E-04	2.7E-02	2E-05
MLLW	200 ERDF Site	Resident Gardener	1740	5.3E-04	1.6E-02	1E-05
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	1740	2.3E-04	6.9E-03	4E-06
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	1070	4.0E-03	1.2E-01	7E-05
MLLW	200 ERDF Site	Resident Gardener + Sauna	1740	1.9E-03	5.7E-02	3E-05

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.132. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group E_3, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	2,000	2.4E-06	7.2E-05	4E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.7E-06	5.1E-05	3E-08
MLLW	200 West Area	Resident Gardener	2,000	1.9E-05	5.7E-04	3E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	6.7E-06	2.0E-04	1E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	8.0E-06	2.4E-04	1E-07
MLLW	200 West Area	Resident Gardener + Sauna	2,000	6.4E-05	1.9E-03	1E-06
Projected New Waste (>2007)[c]						
LLW Cat 1	200 ERDF Site	Resident Gardener	1,660	4.6E-06	1.4E-04	8E-08
LLW Cat 3	200 ERDF Site	Resident Gardener	1,520	7.7E-05	2.3E-03	1E-06
MLLW	200 ERDF Site	Resident Gardener	1,650	4.2E-05	1.3E-03	8E-07
ILAW	200 East Area	Resident Gardener	10,000	1.3E-05	3.8E-04	2E-07
Melters	200 East Area	Resident Gardener	820	7.5E-07	2.2E-05	1E-08
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	1,660	1.7E-05	5.1E-04	3E-07
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	1,420	3.5E-04	1.1E-02	6E-06
MLLW	200 ERDF Site	Resident Gardener + Sauna	1,650	1.4E-04	4.2E-03	3E-06
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.3E-05	9.8E-02	6E-05
Melters	200 East Area	Resident Gardener + Sauna	820	3.9E-06	1.2E-04	7E-08

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.
(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.
(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.133. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group E_3, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[(b)]
			Years Post-2046[(a)]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)[(c)]						
LLW Cat 1	200 West Area	Resident Gardener	2,000	2.9E-06	8.7E-05	5E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.7E-06	5.1E-05	3E-08
MLLW	200 West Area	Resident Gardener	2,000	1.9E-05	5.7E-04	3E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	8.1E-06	2.4E-04	2E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	8.0E-06	2.4E-04	1E-07
MLLW	200 West Area	Resident Gardener + Sauna	2,000	6.5E-05	1.9E-03	1E-06
Projected New Waste (>2007)[(c)]						
LLW Cat 1	200 ERDF Site	Resident Gardener	1,660	5.7E-06	1.7E-04	1E-07
LLW Cat 3	200 ERDF Site	Resident Gardener	1,420	7.8E-05	2.4E-03	1E-06
MLLW	200 ERDF Site	Resident Gardener	1,650	4.5E-05	1.4E-03	8E-07
ILAW	200 East Area	Resident Gardener	10,000	1.3E-05	3.8E-04	2E-07
Melters	200 East Area	Resident Gardener	940	1.2E-06	3.7E-05	2E-08
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	1,660	2.1E-05	6.3E-04	4E-07
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	1,420	3.5E-04	1.1E-02	6E-06
MLLW	200 ERDF Site	Resident Gardener + Sauna	1,650	1.6E-04	4.7E-03	3E-06
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.3E-05	9.8E-02	6E-05
Melters	200 East Area	Resident Gardener + Sauna	940	6.2E-06	1.9E-04	1E-07

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.134. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for Alternative Group $E_{3,}$ Upper Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF$^{(b)}$
			Years Post-2046$^{(a)}$	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.6E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	6E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	8E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	5E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.4E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.2E-05	6.5E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	3E-08
	200 West Area	Resident Gardener + Sauna	600	3.2E-05	9.6E-04	6E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.5E-05	4.6E-04	3E-07
Newly Generated Waste (1996–2007)$^{(c)}$						
LLW Cat 1	200 West Area	Resident Gardener	2,000	3.0E-06	9.1E-05	5E-08
LLW Cat 3	200 West Area	Resident Gardener	1,710	1.7E-06	5.1E-05	3E-08
MLLW	200 West Area	Resident Gardener	2,000	1.3E-05	3.9E-04	2E-07
	200 East Area	Resident Gardener	10,000	1.6E-05	4.7E-04	3E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	2,000	8.6E-06	2.6E-04	2E-07
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,710	8.0E-06	2.4E-04	1E-07
MLLW	200 West Area	Resident Gardener + Sauna	2,000	4.6E-05	1.4E-03	8E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.8E-04	5.5E-03	3E-06
Projected New Waste (>2007)$^{(c)}$						
LLW Cat 1	200 ERDF Site	Resident Gardener	1,660	5.7E-06	1.7E-04	1E-07
LLW Cat 3	200 ERDF Site	Resident Gardener	1,520	7.7E-05	2.3E-03	1E-06
MLLW	200 ERDF Site	Resident Gardener	1,660	4.9E-05	1.5E-03	9E-07
ILAW	200 East Area	Resident Gardener	10,000	1.3E-05	3.8E-04	2E-07
Melters	200 East Area	Resident Gardener	820	7.5E-07	2.2E-05	1E-08
LLW Cat 1	200 ERDF Site	Resident Gardener + Sauna	1,660	2.1E-05	6.3E-04	4E-07
LLW Cat 3	200 ERDF Site	Resident Gardener + Sauna	1,420	3.5E-04	1.1E-02	6E-06
MLLW	200 ERDF Site	Resident Gardener + Sauna	1,660	1.8E-04	5.3E-03	3E-06
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.3E-05	9.8E-02	6E-05
Melters	200 East Area	Resident Gardener + Sauna	820	3.9E-06	1.2E-04	7E-08

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.135. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for the No Action Alternative, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.1E-06	6.4E-05	3E-08
	200 East Area	Resident Gardener	10,000	8.7E-05	2.6E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.8E-06	2.6E-04	1E-07
	200 East Area	Resident Gardener + Sauna	10,000	7.5E-02	2.3E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-03	5E-06
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	7E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.3E-03	3.8E-02	2E-05
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	9E-07
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.3E-03	2E-06
	200 East Area	Resident Gardener + Sauna	110	2.6E-02	7.8E-01	4E-04
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	1,220	1.9E-05	5.7E-04	3E-07
	200 East Area	Resident Gardener	1,220	1.9E-05	5.7E-04	3E-07
LLW Cat 3	200 West Area	Resident Gardener	680	8.6E-04	2.6E-02	2E-05
	200 East Area	Resident Gardener	10,000	6.6E-04	2.0E-02	1E-05
MLLW	200 West Area	Resident Gardener	1,220	1.5E-05	4.4E-04	3E-07
ILAW	200 East Area	Resident Gardener	10,000	1.0E-04	3.0E-03	2E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	1,220	6.5E-05	1.9E-03	1E-06
	200 East Area	Resident Gardener + Sauna	10,000	1.6E-03	4.7E-02	3E-05
LLW Cat 3	200 West Area	Resident Gardener + Sauna	680	4.0E-03	1.2E-01	7E-05
	200 East Area	Resident Gardener + Sauna	10,000	5.7E-01	1.7E+01	1E-02
MLLW	200 West Area	Resident Gardener + Sauna	1,220	5.0E-05	1.5E-03	9E-07
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.5E-02	1.0E-00	6E-04

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.136. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 East Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for the No Action Alternative, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	350	2.1E-06	6.4E-05	3E-08
	200 East Area	Resident Gardener	10,000	8.7E-05	2.6E-03	1E-06
	200 West Area	Resident Gardener + Sauna	350	8.8E-06	2.6E-04	1E-07
	200 East Area	Resident Gardener + Sauna	10,000	7.5E-02	2.3E+00	1E-03
1970–1988	200 West Area	Resident Gardener	420	3.0E-06	9.1E-05	5E-08
	200 East Area	Resident Gardener	110	3.2E-04	9.7E-03	5E-06
	200 West Area	Resident Gardener + Sauna	420	4.4E-06	1.3E-04	7E-08
	200 East Area	Resident Gardener + Sauna	10,000	1.3E-03	3.8E-02	2E-05
1988–1995	200 West Area	Resident Gardener	360	6.2E-05	1.9E-03	9E-07
	200 East Area	Resident Gardener	110	1.7E-02	5.2E-01	3E-04
	200 West Area	Resident Gardener + Sauna	360	1.1E-04	3.3E-03	2E-06
	200 East Area	Resident Gardener + Sauna	110	2.6E-02	7.8E-01	4E-04
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	360	2.9E-05	8.8E-04	5E-07
	200 East Area	Resident Gardener	110	1.1E-05	3.2E-04	2E-07
LLW Cat 3	200 West Area	Resident Gardener	1460	1.7E-04	5.0E-03	3E-06
	200 East Area	Resident Gardener	10,000	7.1E-04	2.1E-02	1E-05
MLLW	200 West Area	Resident Gardener	1,220	1.5E-05	4.4E-04	3E-07
ILAW	200 East Area	Resident Gardener	10,000	1.0E-04	3.0E-03	2E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	360	1.0E-04	3.0E-03	2E-06
	200 East Area	Resident Gardener + Sauna	10,000	1.9E-03	5.8E-02	4E-05
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1,460	7.4E-04	2.2E-02	1E-05
	200 East Area	Resident Gardener + Sauna	10,000	5.9E-01	1.8E+01	1E-02
MLLW	200 West Area	Resident Gardener + Sauna	1,220	5.0E-05	1.5E-03	9E-07
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.5E-02	1.0E-00	6E-04

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.137. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for the No Action Alternative, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	8E-07
1970–1988	200 West Area	Resident Gardener	250	2.4E-05	7.3E-04	4E-07
	200 West Area	Resident Gardener + Sauna	250	3.6E-05	1.1E-03	5E-07
1988–1995	200 West Area	Resident Gardener	210	5.2E-04	1.6E-02	8E-06
	200 West Area	Resident Gardener + Sauna	210	9.0E-04	2.7E-02	1E-05
Newly Generated Waste (1996–2007)						
LLW Cat 1	200 West Area	Resident Gardener	210	2.0E-04	6.0E-03	4E-06
LLW Cat 3	200 West Area	Resident Gardener	1230	1.2E-03	3.5E-02	2E-05
MLLW	200 West Area	Resident Gardener	1070	9.6E-05	2.9E-03	2E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	210	6.8E-04	2.0E-02	1E-05
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1230	5.2E-03	1.6E-01	9E-05
MLLW	200 West Area	Resident Gardener + Sauna	1070	3.3E-04	9.8E-03	6E-06

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

Table F.138. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the 200 West Area 1-km Well from Radionuclides in the Groundwater over 10,000 Years for the No Action Alternative, Lower Bound Waste Volume

Waste Category	**Source Location**	**Exposure Scenario**	**Maximum Annual Dose** Years Post-2046[a]	**Maximum Annual Dose** Dose, rem	**Lifetime Dose, rem**	**Probability of an LCF[b]**
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	190	1.2E-05	3.6E-04	2E-07
	200 West Area	Resident Gardener + Sauna	190	5.0E-05	1.5E-03	8E-07
1970–1988	200 West Area	Resident Gardener	250	2.4E-05	7.3E-04	4E-07
	200 West Area	Resident Gardener + Sauna	250	3.6E-05	1.1E-03	5E-07
1988–1995	200 West Area	Resident Gardener	210	5.2E-04	1.6E-02	8E-06
	200 West Area	Resident Gardener + Sauna	210	9.0E-04	2.7E-02	1E-05
Newly Generated Waste (1996–2007)						
LLW Cat 1	200 West Area	Resident Gardener	210	2.4E-04	7.3E-03	4E-06
LLW Cat 3	200 West Area	Resident Gardener	1230	1.2E-03	3.5E-02	2E-05
MLLW	200 West Area	Resident Gardener	1070	9.6E-05	2.9E-03	2E-06
LLW Cat 1	200 West Area	Resident Gardener + Sauna	210	8.3E-04	2.5E-02	2E-05
LLW Cat 3	200 West Area	Resident Gardener + Sauna	1230	5.2E-03	1.6E-01	9E-05
MLLW	200 West Area	Resident Gardener + Sauna	1070	3.2E-04	9.7E-03	6E-06

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

Table F.139. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for the No Action Alternative, Hanford Only Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.7E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	5E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	7E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	4E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.3E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.3E-05	7.0E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	2E-08
	200 West Area	Resident Gardener + Sauna	10,000	4.9E-02	1.5E+00	7E-04
	200 East Area	Resident Gardener + Sauna	10,000	6.5E-04	0.0E+00	4E-07
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	600	8.4E-06	2.5E-04	2E-07
	200 East Area	Resident Gardener	260	7.7E-07	2.3E-05	1E-08
LLW Cat 3	200 West Area	Resident Gardener	930	1.1E-04	3.3E-03	2E-06
	200 East Area	Resident Gardener	10,000	3.1E-05	9.4E-04	6E-07
MLLW	200 West Area	Resident Gardener	1,420	5.9E-06	1.8E-04	1E-07
ILAW	200 East Area	Resident Gardener	10,000	1.3E-05	3.8E-04	2E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	600	3.0E-05	9.0E-04	5E-07
	200 East Area	Resident Gardener + Sauna	10,000	9.5E-05	2.8E-03	2E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	940	4.9E-04	1.5E-02	9E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.3E-02	6.9E-01	4E-04
MLLW	200 West Area	Resident Gardener + Sauna	1,420	2.0E-05	6.0E-04	4E-07
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.3E-05	9.8E-02	6E-05

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

Table F.140. Potential Individual Human Health Impacts to a Hypothetical Resident Gardener at the Columbia River Well from Radionuclides in the Groundwater over 10,000 Years for the No Action Alternative, Lower Bound Waste Volume

Waste Category	Source Location	Exposure Scenario	Maximum Annual Dose		Lifetime Dose, rem	Probability of an LCF[b]
			Years Post-2046[a]	Dose, rem		
Previously Disposed of Low-Level Waste						
Pre-1970	200 West Area	Resident Gardener	530	7.6E-07	2.3E-05	1E-08
	200 East Area	Resident Gardener	260	6.7E-06	2.0E-04	1E-07
	200 West Area	Resident Gardener + Sauna	530	3.1E-06	9.4E-05	5E-08
	200 East Area	Resident Gardener + Sauna	10,000	4.5E-03	1.4E-01	7E-05
1970–1988	200 West Area	Resident Gardener	610	1.2E-06	3.7E-05	2E-08
	200 East Area	Resident Gardener	260	2.9E-05	8.7E-04	4E-07
	200 West Area	Resident Gardener + Sauna	610	1.8E-06	5.5E-05	3E-08
	200 East Area	Resident Gardener + Sauna	10,000	7.3E-05	2.2E-03	1E-06
1988–1995	200 West Area	Resident Gardener	600	2.3E-05	7.0E-04	4E-07
	200 East Area	Resident Gardener	260	1.4E-06	4.2E-05	2E-08
	200 West Area	Resident Gardener + Sauna	10,000	4.9E-02	1.5E+00	7E-04
	200 East Area	Resident Gardener + Sauna	10,000	2.2E-05	6.5E-04	3E-07
Newly Generated Waste (1996–2007)[c]						
LLW Cat 1	200 West Area	Resident Gardener	600	1.0E-05	3.1E-04	2E-07
	200 East Area	Resident Gardener	260	9.4E-07	2.8E-05	2E-08
LLW Cat 3	200 West Area	Resident Gardener	930	1.1E-04	3.3E-03	2E-06
	200 East Area	Resident Gardener	10,000	2.9E-05	8.6E-04	5E-07
MLLW	200 West Area	Resident Gardener	1,420	5.9E-06	1.8E-04	1E-07
ILAW	200 East Area	Resident Gardener	10,000	1.3E-05	3.8E-04	2E-07
LLW Cat 1	200 West Area	Resident Gardener + Sauna	600	3.6E-05	1.1E-03	7E-07
	200 East Area	Resident Gardener + Sauna	10,000	1.1E-04	3.4E-03	2E-06
LLW Cat 3	200 West Area	Resident Gardener + Sauna	940	4.9E-04	1.5E-02	9E-06
	200 East Area	Resident Gardener + Sauna	10,000	2.4E-02	7.2E-01	4E-04
MLLW	200 West Area	Resident Gardener + Sauna	1,420	2.0E-05	6.0E-04	4E-07
ILAW	200 East Area	Resident Gardener + Sauna	10,000	3.3E-05	9.8E-02	6E-05

(a) The number of years post-2046 in which the maximum annual dose occurs over the 10,000-yr period.

(b) Health impacts are expressed as lifetime risk of fatal cancer from the indicated lifetime radiation dose. The probability of a LCF is the calculated value using the appropriate linear health effects conversion factor. The actual probability cannot be greater than one.

(c) Results are not reported for cases that had no inventory reported for the waste.

F.5 Potential Health Impacts of West Valley TRU Wastes Processed or Stored at Hanford

This section presents the potential impacts of receiving TRU wastes from the West Valley Demonstration Project in New York State for processing and/or storage at Hanford before shipment to the Waste Isolation Pilot Project (WIPP) in New Mexico. DOE does not prefer to ship TRU wastes from West Valley to Hanford for processing and/or storage before shipment to WIPP (see Volume I, Section 1.5.2 and Volume II, Appendix C, Section C.1 for further discussion of West Valley waste). Nonetheless, potential health impacts to workers and to the public from atmospheric releases were estimated in the event that, at a later date, DOE needs to ship West Valley TRU wastes to be processed and certified at Hanford. The West Valley TRU wastes were estimated to consist of about 1130 cubic meters of contact-handled (CH) TRU waste and 250 cubic meters of remote-handled (RH) TRU waste (DOE 2003). The concentration of radionuclides in the West Valley TRU waste is indicated in Table F.141.

For purposes of this analysis, it was assumed that CH TRU waste would be processed through the WRAP facility and the RH TRU waste would be processed through the T-Plant complex. The wastes were assumed to be shipped to Hanford between 2004 and 2008. The routine impacts of processing the West Valley TRU wastes are presented in the following sections. Potential accident risks associated with managing West Valley TRU wastes at Hanford would be small and would not differ from the estimates presented in Volume I, Section 5.11.

Table F.141. West Valley TRU Wastes Radionuclide Concentrations (after DOE [2003], Appendix D, Table D.13)

Radionuclide	CH TRU (Ci/m3)	RH TRU (Ci/m3)
Co-60	2.1E-04	0
Sr-90	3.3E-03	1.8E+01
Cs-137	3.3E-03	1.9E+01
Th-228	0	5.5E-03
U-232	0	5.5E-03
Pu-238	3.1E+01[a]	1.2E+00
Pu-239	5.1E+00	3.4E-01
Pu-240	1.4E+00	2.5E-01
Pu-241	6.5E+01	7.4E+00
Pu-242	2.3E-04	0
Am-241	1.2E+00	4.1E-01
Am-242	0	2.9E-03
Am-242m	0	2.9E-03
Am-243	0	1.8E-02
Cm-244	0	3.7E-02

(a) The 330 Pu-238 value from DOE (2003) was reduced in the HSW EIS to agree with plutonium isotopic ratios found elsewhere in DOE (2003).

F.5.1 Worker Health Impacts

The estimate of occupational exposure from the West Valley TRU wastes was based on the relative increase in volume for the WRAP and T-Plant Complex over that calculated for the Upper Bound waste volume described earlier. Table F.142 summarizes these potential occupational impacts from the West Valley TRU wastes if shipped to Hanford for processing before shipment to WIPP. The workforce impacts from processing West Valley TRU wastes at Hanford are small compared to the range of total workforce impacts of 765 to 873 person-rem for the HSW EIS alternative groups (Volume I, Section 5.11.1)

Table F.142. Occupational Exposure from Processing West Valley TRU Wastes at Hanford

Waste Type	Facility	Workforce Dose, person-rem	Workforce LCF
CH TRU	WRAP	0.52	0 (3E-4)
RH TRU	T-Plant Complex	0.63	0 (4E-4)

F.5.2 Routine Atmospheric Release – Public Health Impacts

The specific health impacts to the non-involved worker and general public from the West Valley TRU wastes are shown in Table F.143, with contributions from these wastes only. As can be seen in Table F.143, radiological impacts on workers and the public in terms of dose would be small, and there would be no associated fatalities. These impacts, when combined with those for the HSW EIS alternative groups, would still result in small radiological impacts. For example, the maximum total population probability of an LCF is just 2E-4 (Alternative Group B, Upper Bound waste volume). The impacts from processing West Valley TRU wastes could increase that total by about 1 percent and would not change the conclusions presented for any of the HSW EIS alternative groups.

Table F.143. Non-Involved Worker and Public Health Impacts from Routine Atmospheric Releases of Radionuclides—West Valley TRU Wastes Only

Exposed Group	Exposure Scenario[(a)]	Facility	Lifetime Dose[(b)] (mrem)	Probability of LCF[(c)]	Maximum Annual Dose	
					Year	mrem
Worker Onsite (non-involved)	Industrial	WRAP	1.1E-03	7E-10	2004	2.7E-04
		Modified T Plant Complex	1.7E-05	1E-11	2006	4.6E-06
MEI Offsite	Resident Gardener	WRAP	3.6E-05	2E-11	2004	9.1E-06
		Modified T Plant Complex	1.4E-06	8E-13	2004	3.2E-07
		Total	3.8E-05	2E-11	2004	9.5E-06
			(person-rem)	**Number of LCFs[(d)]**	**Year**	**(person-rem)**
Population[(e)]	Population within 80 km (50 mi)	WRAP	4.3E-03	0 (3E-6)	2004	8.3E-04
		Modified T Plant Complex	1.6E-04	0 (1E-7)	2004	2.9E-05
		Total	4.4E-03	0 (3E-6)	2004	8.6E-04

(a) The exposure duration for the industrial scenario is 20 years and for the resident gardener, 30 years. The exposure scenarios are described in Volume II, Appendix F.
(b) The lifetime dose is the radiation dose received from intake during the exposure period and up to 50 years after exposure due to radionuclides deposited in the body during the exposure period.
(c) LCF = latent cancer fatality.
(d) The value in parentheses is the calculated value based on the population dose and the appropriate health effects conversion factor. The actual number of LCFs must be a whole number (deaths).
(e) The population lifetime impacts are based on exposure for the same exposure pathways impacting the resident gardener MEI.

F.6 References

40 CFR 61. “National Emission Standards for Hazardous Air Pollutants.” Code of Federal Regulations. Online at: http://www.access.gpo.gov/nara/cfr/waisidx_02/40cfr61_02.html

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. Online at: http://www.access.gpo.gov/nara/cfr/waisidx_01/40cfr191_01.html

Anderson, J. D. and D. L. Hagel. 1996. *Summary of Radioactive Solid Waste Received in the 200 Areas During Calendar Year 1995*. WHC-EP-0125-8, Westinghouse Hanford Company, Richland, Washington.

Barcot, R. A. 1999. *Solid Waste Integrated Forecast Technical (SWIFT) Report*. HNF-EP-0918, Rev. 5, Fluor Hanford, Inc., Richland, Washington.

Barcot, R. A. 2002. *Solid Waste Integrated Forecast Technical (SWIFT) Report*. HNF-EP-0918, Rev. 9, Fluor Hanford, Inc., Richland, Washington.

Buck, J. W., G. Whelan, J. G. Droppo, Jr., D. L. Strenge, K. J. Castleton, J. P. McDonald, C. Sato, and G. P. Streile. 1995. *Multimedia Environmental Pollutant Assessment System (MEPAS) Application Guidance: Guidelines for Evaluating MEPAS input Parameters for Version 3.1*. PNL-10395, Pacific Northwest National Laboratory, Richland, Washington.

Buck, J. W., D. L. Strenge, B. L. Hoopes, J. P. McDonald, K. J. Castleton, M. A. Pelton, and G. M. Gelston. 1997. *Description of Multimedia Environmental Pollutant Assessment System (MEPAS). Version 3.2*. *Modification for the Nuclear Regulatory Commission*. NUREG/CR-6566 (PNNL-11676), Nuclear Regulatory Commission Washington D.C.

Bushore, R. P. 2001. *Interim Safety Basis for Solid Waste Facilities (T Plant)*. HNF-SD-WM-ISB-006, Rev. 2, Fluor Hanford, Inc., Richland, Washington.

Census. 2002. *Census 2000 Summary File 3 – Washington.* U.S. Census Bureau, Washington D.C. Online at: http://www2.census.gov/census_2000/datasets/Summary_File_3/Washington

Census. 2003a. *Glossary - Definition and Explanations–decennial census terms*. U.S. Census Bureau, Washington D.C. Online at: http://www.census.gov/main/www/glossary.html (Last revised February 11, 2003. Accessed September 5, 2003).

Census. 2003b. *Poverty 1999. Census 2000 Brief. C2KBR-19. Issued May 2003*. U.S. Census Bureau, Washington D.C. Online at: http://www.census.gov/prod/2003pubs/c2kbr-19.pdf (Accessed September 8, 2003)

Cheng, J. J., J. G. Droppo, E. R. Faillace, E. Granapragasam, R. Johns, G. Laniak, C. Lew, W. Mills, L. Owens, D. L. Strenge, J. F. Sutherland, G. Whelan, and C. Yu. 1995. *Benchmarking Analysis of Three Multimedia Models: RESRAD, MMSOILS, and MEPAS*. DOE/ORO-2033, U.S. Department of Energy, Washington, D.C. Online at: https://www.osti.gov/dublincore/doeecd/servlets/purl/192408-9sPZLn/webviewable/192408.pdf

Connor, J. J. and H. T. Shacklette. 1975. "Background Geochemistry of Some Rocks, Soils, Plants, and Vegetables in the Conterminous United States." Statistical Studies in Field Geochemistry. Geological Survey Professional Paper 574-F. U.S. Department of the Interior, Washington, D.C.

Craig, D. K. 2002. *ERPGs and TEELs for Chemicals of Concern, Rev. 19*. WSMS-SAE-02-0171, Westinghouse Safety Management Systems, Aiken, South Carolina. Online at: http://tis.eh.doe.gov/web/chem_safety/teel.html

DOE. 2001. *DOE Computerized Accident/Incident Reporting System (CAIRS)*. Online at http://tis.eh.doe.gov/cairs (data downloaded August 2001).

DOE. 2002. DOE Subcommittee on Consequence Assessment & Protective Actions (SCAPA). Brookhaven National Laboratory, Upton, New York. Online at: http://www.bnl.gov/scapa

DOE. 2003. *West Valley Demonstration Project Waste Management Environmental Impact Statement*. DOE/EIS-0337F, U.S. Department of Energy, West Valley Area Office, West Valley, New York. Online at: http://tis.eh.doe.gov/nepa/eis/eis0337/index.html

DOE-RL. 1993a. *Non-Radioactive Air Emissions Notice of Construction for the Waste Receiving and Processing Facility*. DOE/RL-93-18, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL. 1993b. *Radioactive Air Emissions Notice of Construction for the Waste Receiving and Processing Facility*. DOE/RL-93-15, U.S. Department of Energy, Richland Operations Office, Richland Operations Office, Richland, Washington.

DOE-RL. 1995. *Hanford Site Risk Assessment Methodology*. DOE/RL-91-45, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL. 1998. *Screening Assessment and Requirements for a Comprehensive Assessment: Columbia River Comprehensive Impact Assessment*. DOE/RL-96-16, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL. 2001a. *Radioactive Air Emissions Notice of Construction Application for the Waste Receiving and Processing Facility*. DOE/RL-2000-34, Rev 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL. 2001b. *Radioactive Air Emissions Notice of Construction for the T Plant Complex Fuel Removal Project*. DOE/RL-2000-64, Rev 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Online at: http://198.232.211.23/pdwdocs/fsd0001/osti/2001/I0000430.pdf

Droppo, J. G., Jr. and J. W. Buck. 1996. Supplemental Mathematical Formulations. Atmospheric pathway: *The Multimedia Environmental Pollutant Assessment System (MEPAS)*. PNNL-11080, Pacific Northwest National Laboratory, Richland, Washington.

Eckerman, K. F., A. B. Wolbarst, and A. C. B. Richardson. 1988. *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion. Federal Guidance Report No. 11*. EPA-520/1-88-020, U.S. Environmental Protection Agency, Washington, D.C.

Eckerman, K. F. and J. C. Ryman. 1993. *External Exposure to Radionuclides in Air, Water, and Soil, Federal Guidance Report No. 12*. EPA 402-R-93-081, U.S. Environmental Protection Agency, Washington, D.C.

Eckerman, K. F., R. W. Leggett, C. B. Nelson, J. S. Puskin, and A. C. B. Richardson. 1999. *Cancer Risk Coefficients for Environmental Exposure to Radionuclides.* Federal Guidance Report No. 13. EPA 402-R-99-001. Office of Radiation and Indoor Air, U.S. Environmental Protection Agency, Washington, D.C. Online at: http://riskassessment.ornl.gov/keydocs/fgr13.pdf

Ecology, EPA, and DOE. 1989. *Hanford Federal Facility Agreement and Consent Order*. 89-10 (As Amended). Washington State Department of Ecology, U.S. Environmental Protection Agency, U.S. Department of Energy, Richland, Washington. Online at: http://www.hanford.gov/tpa/tpahome.htm

EPA. 1989. *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A) Interim Final*. EPA/540/1-89/002, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C. Online at: http://www.epa.gov/superfund/programs/risk/ragsa/index.htm

EPA. 1992. *Dermal Exposure Assessment: Principles and Applications*. EPA/600/8-91/011B, U.S. Environmental Protection Agency, Washington, D.C. Online at: http://www.epa.gov/NCEA/pdfs/dermalexp.pdf

EPA. 1995. *User's Guide for the Industrial Source Complex (ICS3) Dispersion Models. Volumes 1 & 2. User Instructions*. EPA-454/B-95-003a, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina.

FH. 2004. *Hanford Site Solid Waste Management, Environmental Impact Statement Technical Information Document*. HNF-4755, Rev. 2, Fluor Hanford, Richland, Washington.

Hagel, D. L. 1999. *Summary of Radioactive Solid Waste Received in the 200 Areas During Calendar Year 1998*. HNF-EP-0125-11, Fluor Hanford, Richland, Washington.

Harris, S. G. and B. L. Harper. 1997. "A Native American Exposure Scenario." *Risk Analysis* 17:6,789-795.

Hoitink, D. J. and K. W. Burk. 1997. *Climatological Data Summary 1996, with Historical Data*. PNNL-11471, Pacific Northwest National Laboratory, Richland, Washington. Online at: https://www.osti.gov/dublincore/doeecd/servlets/purl/656504-LW5BaO/webviewable/656504.pdf

ICRP. 1979. "Limits for Intakes of Radionuclides by Workers." (ICRP Publication 30, Part 1). *Annals of the ICRP*, Vol. 2, No. 3/4. International Commission on Radiological Protection, Pergamon Press, New York.

ICRP. 1980. "Limits for Intakes of Radionuclides by Workers." (ICRP Publication 30, Part 2). *Annals of the ICRP*, Vol. 4, No. 3/4. International Commission on Radiological Protection, Pergamon Press, New York.

ICRP. 1981. "Limits for Intakes of Radionuclides by Workers." (ICRP Publication 30, Supplement A to Part 3). *Annals of the ICRP*, Vol. 7, No. 1-3. International Commission on Radiological Protection, Pergamon Press, New York.

ICRP. 1988. "Limits for Intakes of Radionuclides by Workers: an addendum." (ICRP Publication 30, Part 4). *Annals of the ICRP*, Vol. 19, No. 4. International Commission on Radiological Protection, Pergamon Press, New York.

ICRP. 1991. "1990 Recommendations of the International Commission on Radiological Protection." *ICRP Publication 60. Annals of the ICRP*, Vol. 21, No. 1-3. International Commission on Radiological Protection. Pergamon Press, New York.

Kennedy, W. E., Jr. and D. L. Strenge. 1992. *Residual Radioactive Contamination from Decommissioning*. NUREG/CR-5512, Vol. 1. U.S. Nuclear Regulatory Commission, Washington, D.C.

Kincaid, C. T., J. W. Shade, G. A. Whyatt, M. G. Piepho, K. Rhoads, J. A. Voogd, J. H. Westsik, Jr., M. D. Freshley, K. A. Blanchard, and G. B. Lauzon. 1995. *Performance Assessment of Grouted Double-Shell Tank Waste Disposal at Hanford*. WHC-SD-WM-EE-004, Rev. 1, Volumes 1 & 2, Westinghouse Hanford Company, Richland, Washington.

Meyer, M. F. 1998. *Interim Safety Analysis for Solid Waste Facilities (T Plant)*. HNF-SD-WM-ISB-006, Rev. 1, Waste Management Federal Services of Hanford, Inc., Richland, Washington.

Mills, W. B., J. J. Cheng, J. G. Droppo, Jr., E. R. Faillace, E. K. Gnanapragasam, R. A. Johns, G. F. Laniak, C. S. Lew, D. L. Strenge, J. F. Sutherland, G. Whelan, and C. Yu. 1997. "Multimedia Benchmarking Analysis for Three Risk Assessment Models: RESRAD, MMSOILS, and MEPAS." *Risk Analysis*, 17(2):187-202.

Napier, B. A., R. A. Peloquin, W. E. Kennedy, Jr., and S. M. Neuder. 1984. *Intruder Dose Pathway Analysis for the Onsite Disposal of Radioactive Wastes: The ONSITE/MAXI1 Computer Program*. NUREG/CR-3620, U.S. Nuclear Regulatory Commission, Washington, D.C.

NCRP. 1993. *Limitation of Exposure to Ionizing Radiation: Recommendations of the National Council on Radiation Protection and Measurements*. NCRP Report No. 116, National Council on Radiation Protection and Measurements, Bethesda, Maryland.

NCRP. 1997. *Uncertainties in Fatal Cancer Risk Estimates Used in Radiation Protection: Recommendations of the National Council on Radiation Protection and Measurements*. NCRP Report No. 126, National Council on Radiation Protection and Measurements, Bethesda, Maryland.

Rokkan, D. J., K. Rhoads, and L. H. Staven. 2001. *Radionuclide Air Emissions Report for the Hanford Site, Calendar Year 2000*. DOE/RL-2001-32, Rev. 0, U.S. Department of Energy, Richland, Washington. Online at: http://198.232.211.23/pdwdocs/fsd0001/osti/2001/I0000483.pdf

Streile, G. P., K. D. Shields, J. L. Stroh, L. M. Bagaasen, G. Whelan, J. P. McDonald, J. G. Droppo, and J. W. Buck. 1996. *The Multimedia Environmental Pollutant Assessment System (MEPAS): Source-Term Release Formulations*. PNNL-11248, Pacific Northwest National Laboratory, Richland, Washington. Online at: http://www.osti.gov/dublincore/ecd/servlets/purl/435301-C3hEnq/webviewable/435301.pdf

Strenge, D. L. 1997. "A General Algorithm for Radioactive Decay with Branching and Loss from a Medium." *Health Physics*, 73(6): 953-957.

Strenge, D. L. and P. J. Chamberlain. 1995. *Multimedia Environmental Pollutant Assessment System (MEPAS): Exposure Pathway and Human Health Impact Assessment Models*. PNL-10523, Pacific Northwest Laboratory, Richland, Washington.

Strenge, D. L. and S. R. Peterson. 1989. *Chemical Data Bases for the Multimedia Environmental Pollutant Assessment System (MEPAS): Version 1*. PNL-7145, Pacific Northwest Laboratory, Richland, Washington.

Tomaszewski, T. A. 2001. *WRAP Final Safety Analysis Report*. HNF-SD-W026-SAR-002, Rev. 2, Fluor Hanford, Inc., Richland, Washington.

UNSCEAR. 1988. *Sources, Effects, and Risks of Ionizing Radiation, United Nations Scientific Committee on the Effects of Atomic Radiation. Report to the General Assembly with Annexes*. United Nations Publications, New York.

Vail, T. S. 2001a. *Central Waste Complex Interim Safety Basis*. HNF-SD-WM-ISB-007, Rev. 1-E, Fluor Hanford, Inc., Richland, Washington.

Vail, T. S. 2001b. *Solid Waste Burial Grounds Interim Safety Basis*. HNF-SD-WM-ISM-002, Rev. 3-B, Fluor Hanford, Inc., Richland, Washington.

Vail, T. S. 2001c. *Solid Waste Burial Grounds Interim Safety Analysis*. HNF-SD-WM-SARR-028, Rev. 3-C, Fluor Hanford, Inc., Richland, Washington.

WAC 173-340. "Model Toxics Control Act – Cleanup." Washington Administrative Code, Olympia, Washington. Online at: http://www.leg.wa.gov/wac/index.cfm?fuseaction=Section&Section=173-340

WAC 246-247. "Radiation Protection – Air Emissions." Washington Administrative Code, Olympia, Washington. Online at: http://www.leg.wa.gov/wac/index.cfm?fuseaction=chapterdigest&chapter=246-247

WHC. 1991. *Hazard Classification and Preliminary Safety Evaluation for Waste Receiving and Processing (WRAP) Module 2 Project W100*. WHC-SD-W100-PSE-001, Rev 0, October 1991, Westinghouse Hanford Company, Richland, Washington.

WHC. 1995. *Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds*. WHC-EP-0645, Westinghouse Hanford Company, Richland, Washington.

WHC. 1998. *Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds*. WHC-SD-WM-TI-730, Westinghouse Hanford Company, Richland, Washington.

Whelan, G., K. J. Castleton, J. W. Buck, G. M. Gelston, B. L. Hoopes, M. A. Pelton, D. L. Strenge, and R. N. Kickert. 1997. *Concepts of a Framework for Risk Analysis in Multimedia Environmental Systems (FRAMES)*. PNNL-11748, Pacific Northwest National Laboratory, Richland, Washington.

Appendix G

Groundwater Quality Impacts

Appendix G

Groundwater Quality Impacts

The purpose of this appendix is to describe the analysis used to calculate concentrations of key contaminants that could potentially reach the groundwater from the Low Level Burial Grounds (LLBGs) defined in each of the Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement (HSW EIS) alternative groups. The analysis also assesses the potential impacts to accessible surface water resources from contaminated groundwater. Calculated concentrations of key contaminants are compared with drinking water standards as a benchmark against which water quality may be assessed. These calculations also provide the basis for estimates of potential human health risk and ecological risk for comparison among the alternative groups. Human health and risk consequences are discussed in Section 5.11 (in Volume I of this EIS).

Wastes considered in this assessment include previously disposed of wastes and wastes to be disposed of in the Hanford solid waste (HSW) disposal facilities (for purposes of analysis, it was assumed that new disposal facilities would be operational by October 2007):

- Previously disposed of low-level waste (LLW) (that is, wastes disposed of before 1996), which includes:
  - LLW disposed of in LLBGs between 1962 and 1970 (referred to as pre-1970 LLW in this section)
  - LLW disposed of in LLBGs after 1970, but before October 1987 (referred to as 1970–1987 LLW in this section)
  - LLW disposed of in LLBGs after October 1987, but before 1995 (referred to as 1988–1995 LLW in this section)
- Category (Cat) 1 LLW, which includes:
  - Cat 1 LLW disposed of in the LLBGs after 1995 including Cat 1 LLW forecasted to be disposed of through 2007 (referred to as Cat 1 LLW [1996–2007] in this section)
  - Cat 1 LLW disposed of after 2007 including Cat 1 LLW forecasted to be disposed of through 2046 (referred to as Cat 1 LLW disposed of after 2007 in this section).

- Cat 3 LLW, which includes:
  - Cat 3 and greater-than-Cat 3 (GTC3) LLW disposed of in the LLBGs after 1995 including Cat 3 LLW forecasted to be disposed of through 2007 (referred to as Cat 3 LLW [1996–2007] in this section)
  - Cat 3 and GTC3 LLW disposed of after 2007 including Cat 3 LLW forecasted to be disposed of through 2046 (referred to as Cat 3 LLW disposed of after 2007 in this section).
- Mixed low-level waste (MLLW), which includes:
  - MLLW disposed of after 1996 including MLLW forecasted to be disposed of through 2007 (referred to as MLLW [1996–2007] in this section)
  - MLLW disposed of after 2007 including MLLW forecasted to be disposed of through 2046 (referred to as MLLW disposed of after 2007 in this section).
- Melters from the tank waste treatment program
- Immobilized low-activity waste (ILAW) from the tank waste treatment program.

Inventories of retrievably stored transuranic (TRU) wastes in trenches and caissons located in the LLBGs were not evaluated for their potential groundwater impacts because the TRU wastes will be retrieved and sent to the Waste Isolation Pilot Plant for disposal. TRU wastes are in containers, and the containers are not expected to be breached before retrieval, hence the contents would not be released to the environment. No substantial releases to the vadose zone or groundwater from retrievably stored TRU wastes in HSW facilities have been detected. Additionally, current procedures on the retrieval of these wastes require inspection of waste container integrity and containment. Any detected compromise of containment and/or integrity of the containers would require characterictization and mitigation of any potential releases below retrievably stored TRU waste facilities as a part of site closure.

The groundwater exposure pathway analyzed considers the long-term release of contaminants from the variety of LLW and MLLW, analyzed groundwater transport through the vadose zone underlying the potential sources, and lateral transport through the unconfined aquifer immediately underlying the vadose zone to the Columbia River. The LLBGs are all located in the 200 Areas and the physical area of potential groundwater impacts is the unconfined aquifer bounded laterally by the Rattlesnake Hills in the west and southwest, by the Columbia River in the north and east, and by the Yakima River to the south (see Volume I, Section 4.5, Figure 4.16).

This groundwater assessment was performed using a combination of screening techniques and numerical modeling. The groundwater modeling results predict contaminant concentrations in the groundwater associated with selected alternatives from assumed site closure at 2046 up to 10,000 years after LLBG closure. Although not specifically required by current regulations for LLW management, this assessment examined potential groundwater quality impacts for up to 10,000 years after the operational period. Current requirements for performance assessment of LLW disposal facilities, as prescribed in DOE Order 435.1 (DOE 2001), focus on potential impacts during the first 1000 years after disposal.

Contaminants released from disposal facilities and other sources (for example, tank wastes, canyon facilities, the US Ecology, Inc. commercial LLW facilities) are included in an assessment of combined potential impacts in Section 5.14 (in Volume I of this EIS).

G.1 Methodology and Approach

The approach and steps taken to assess potential impacts to the groundwater system are provided in this section. The alternatives considered in this assessment are described in detail in Section 3.3 (in Volume I of this EIS).

The analysis framework of this groundwater quality assessment considers three major elements: source-term release, vadose zone transport, and groundwater transport. In addition, this analysis framework considers the eventual impact of predicted concentration levels in groundwater on the water quality of the Columbia River.

G.1.1 Lines of Analysis

The lines of analysis (LOAs) used in this comparative assessment were located on the Hanford Site along lines approximately 1 km (0.6 mi) downgradient of aggregate Hanford solid waste (HSW) disposal areas within the 200 East and West Areas, ERDF, and near the Columbia River located downgradient from all disposal site areas (see Figure G.1). Additional analyses of potential groundwater quality

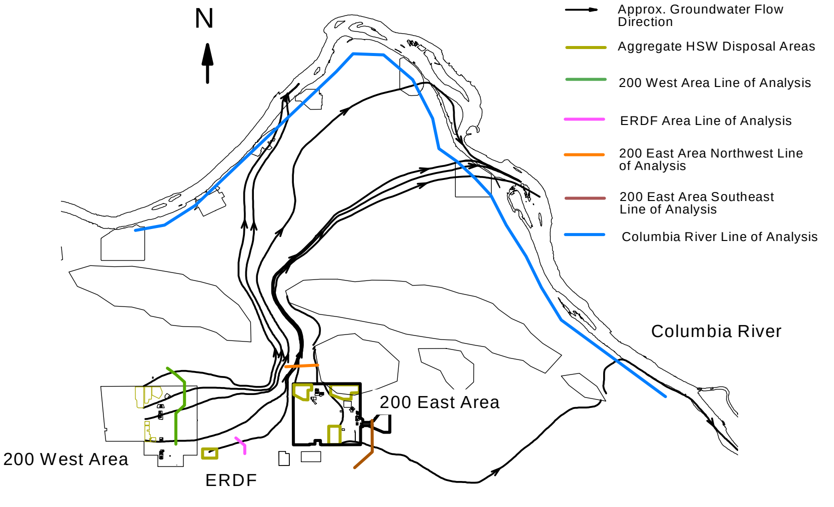


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Figure G.1. Lines of Analysis Downgradient of Aggregate Hanford Solid Waste Disposal Areas impacts for a new combined-use facility (as presented for Alternative Groups D_1, D_2, and D_3), are presented in Section G.5 and provide a perspective on the relative impact at waste management boundaries about 100 m downgradient of the aggregate waste disposal area versus potential impacts at the 1-km LOAs. A similar impact analysis is provided for LLW and MLLW disposed of before 2007 for another perspective.

LOAs were selected based on transport results of unit releases at selected HSW disposal site locations. LOAs approximately 1 km (0.6 mi) downgradient from the overall waste disposal facilities in each area are not meant to represent points of compliance, but rather common locations to facilitate comparison of potential impacts from waste management selections and locations defined for each alternative group.

Predicted constituent concentrations presented for each alternative group from specific water category releases represent maximum concentrations estimated along these LOAs. Because of the variation in the location of the different waste types and category releases for a given alternative group, the estimated maximum concentrations calculated from a specific waste category release may not correspond to the same point on the line analysis for every waste category and alternative group. For the sake of being conservative, however, combined concentration levels presented for each LOA and alternative group reflect the summation of predicted concentration levels regardless of their position on the LOA.

Delineation of potential waste impacts in the 200 East Area required two different LOAs. One LOA, designated as the 200 East Northwest (NW) LOA, is used to evaluate concentrations in groundwater migrating northwest of the 200 East Area. Another LOA, designated as the 200 East Southeast (SE) LOA, is used to evaluate concentrations in groundwater migrating southeast of the 200 East Area.

G.1.2 Overall Analytical Approach

To estimate the concentration of contaminants in the groundwater, it was necessary to link the results of process models of waste release, transport through the vadose zone, and transport through the groundwater system. Two general approaches are available to link these models. One approach involves simulating a contaminant inventory distribution through each of the three process models. The other approach involves simulating a unit release through each of the three process models and superimposing these results with a specific constituent inventory distribution.

The first approach requires that each of the calculations be performed sequentially with each simulation representing a unique inventory distribution and parameter set. This approach is preferred when the number of combinations of inventory distributions and parameter sets is small compared with the total number of simulations required.

The second approach involves development of system output or response and, from that, a unit release that can be simulated for each source area, parameter set, and process model. (In this case, the process models include estimating source release, vadose zone flow and transport, and groundwater flow and transport.) Unit releases in each of the process models can be simulated independently. Then, by making the assumption of linearity, the unit release responses from each individual source area, via each of the process models, can be combined or superimposed using the convolution integral approach

(Lee 1999). The convolution calculational approach is preferred when the number of combinations of inventory distributions and parameter sets is large compared with the number of vadose zone and groundwater flow and transport scenarios that need to be simulated. This second approach was selected for this analysis.

The convolution approach and the implicit assumption of linearity provide a reasonable approach in approximating the long-term release of constituents from solid waste disposal facilities for the following reasons:

- The waste zone environment of solid waste sources in HSW disposal facilities has been characterized as a low-organic, low salt, near neutral geochemical environment (Kincaid et al. 1998) and, as such, processes such as non-linear adsorption and other complex chemical reactions are not expected to have a substantial effect on contaminant release and transport through the vadose zone and groundwater water at the scales of interest (that is, 100 m downgradient of the waste facilities to the Columbia River).

- Wastes disposed of in HSW disposal facilities are largely dry solids and do not have any substantial amount of liquids or complex chemical fluids that could enhance migration of constituents to the underlying water table.

- Waste releases are expected to occur over long periods of time and will likely reach the water table when the effect of past artifical discharges has dissipated and the unconfined aquifer returns to more natural conditions. Using estimates of infiltration through the vadose zone to the underlying groundwater that would reflect long-term average rates of natural recharge would appear reasonable.

The convolution approach used also incorporates the process of solubility control that is assumed to be important in the source release for some constituents. The effect of this process is approximated by applying appropriate solubility controls in the source-term release component of the analysis. This approach can be effectively used without disrupting the superposition process. Solubility-controlled release models were used in the calculation of source-term release of the uranium isotopes in each of the alternatives.

In the convolution integral calculational approach, the concentration in the groundwater at a specific location, *i*, at time, *t*, ($C_{i,t}$) can be estimated using Equations G.1 and G.2:

$$C_{i,t} = \sum_{s=1}^{n} \mathrm{M}_s \sum_{\mathrm{T}=1}^{t} (\mathrm{f}_{s,\mathrm{T}}\, c_{s,i,t-\mathrm{T}+1}) \qquad \text{(G.1)}$$

$$\mathrm{f}_{s,t} = \sum_{\mathrm{T}=1}^{t} (r_{s,\mathrm{T}}\, f_{s,t-\mathrm{T}+1}) \qquad \text{(G.2)}$$

where $C_{i,t}$ = Concentration at location, *i*, at time, *t*

M_s = Inventory at source, *s*

$c_{s,i,t}$ = Groundwater concentration at *i* based on a unit release from *s* (Coupled Fluid, Energy, and Solute Transport [CFEST] model output)

$r_{s,t}$ = Fractional release of unit inventory in source *s* at time *t* (Release model output)

$f_{s,t}$ = Flux to water table from source, *s*, at time, *t*, based on unit release from *s* (Subsurface Transport Over Multiple Phases [STOMP] model output)

n = number of sources

T = time integration variable.

and where $c_{s,i,t}$ and $f_{s,t}$ are the discrete response functions estimated with the vadose zone and groundwater models based on a unit release. These discrete responses can be quickly combined with Equations G.1 and G.2 (that is, superimposed) in a variety of combinations to estimate system responses to different inventory distributions and parameter sets. (Note that equations G.1 and G.2 are discrete-approximation representations of the classic convolution integral calculational approach used in the calculation of superposition of responses in linear response systems.) The form of equation G.1 was also used to estimate the time-varying flux of a contaminant to the Columbia River by substituting the groundwater concentration based on a unit release from *s* with the calculated flux to the river based on a unit release from *s*. This river flux was combined with average annual river flows in the Columbia River to estimate river concentration levels that provided the basis for potential human health impacts and ecosystem risk from exposure to Columbia River water.

Potential impacts from the subsurface transport pathway were analyzed for the LLBGs. The contaminant inventory for the LLBGs was assumed to be released to the vadose zone according to an appropriate release model. Transport within the vadose zone was estimated with a steady-state, one-dimensional variably saturated vadose zone transport model by assuming a unit release for a range of recharge rates. Travel times for releases of unit mass were defined by arrival of 50 percent of each unit mass. These travel times were used to translate mass releases from the LLBGs into mass releases at the water table in the aquifer. The time-varying mass flux arriving at the water table reflects the entire time history of the mass release from the source area, as well as the calculated travel time in the vadose zone.

Estimates of contaminant release transport from the LLBGs to the groundwater were evaluated. This evaluation was done by first calculating transport of 10-year releases of a unit of dry mass into the unconfined aquifer at the approximate locations of the LLBGs at the water table. These transport calculations were made with a steady-state, three-dimensional saturated groundwater flow and transient transport model. These calculated concentrations, based on a unit release, were then used in the convolution integral calculational method to translate transport of mass releases from the LLW through the vadose zone and the aquifer to specified locations downgradient from the source areas. The concentrations in the groundwater plumes for each radionuclide were translated into doses using methods described in Appendix F.

The sequence of calculations used in the long-term assessment required estimating the potential groundwater quality impacts using a suite of process models that estimated source-term release, vadose zone flow and transport, and groundwater flow and transport. The computational framework for these process models and relationship of software elements, which are schematically illustrated in Figure G.2, are as follows:

1. Microsoft®Excel worksheet
2. Dynamically linked library version of the STOMP code (White and Oostrom 1996, 1997; Nichols et al. 1997)
3. Coupled Fluid Energy and Solute Transport (CFEST) code (Gupta et al. 1987; CFEST, Co. 1997)

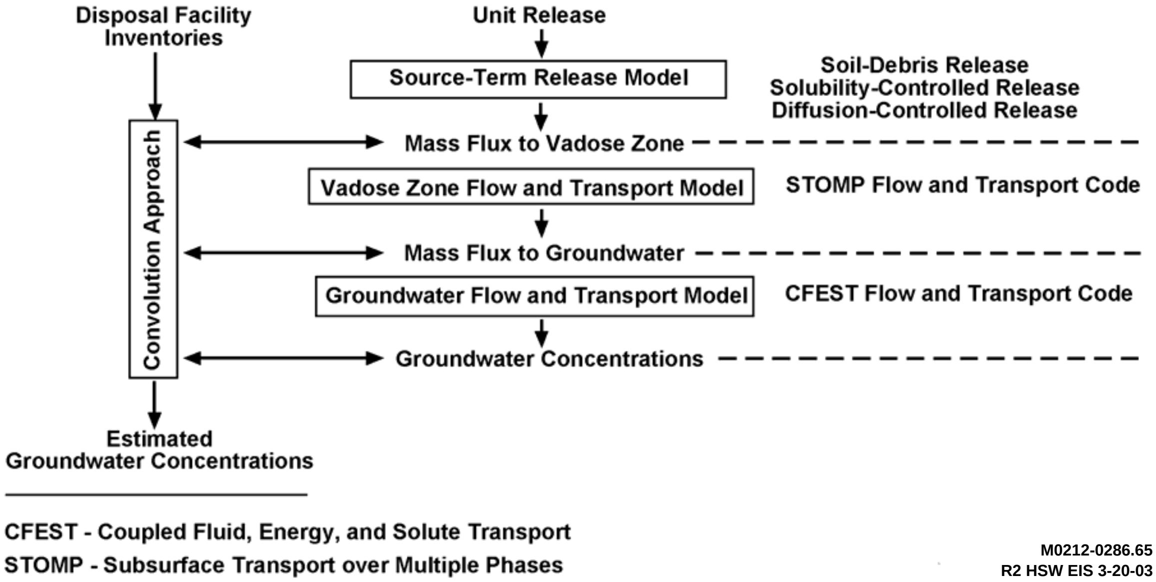

Figure G.2. Schematic Representation of Computational Framework and Codes Used in this HSW EIS

The concentrations in the groundwater plumes for each radionuclide were translated into potential human health impacts, which are summarized in 5.11 and Appendix F.

The methodologies for calculating source-term release, vadose zone transport, and groundwater transport are described in the following sections. Assumptions (for example, geometry, initial conditions, boundary conditions, and parameters) for each calculation are identified and discussed. The implementation of each model for each alternative is described.

G.1.3 Source-Term Release

The source-term is the quantification of when and what constituents (by mass or activity) would be released. This source-term includes the water flux into the vadose zone that results from precipitation infiltrating the waste and mass or activity solubilized from dissolution of waste in the LLBGs. This section addresses the approach and methods used for source-term release that involve:

- grouping of constituents into categories based on their mobility and screening to determine which constituents should be considered in this analysis
- aggregating potential sources into common source areas
- developing the contaminant inventories for each source area
- selecting appropriate source-term release models to calculate mass flux and fluid flux release as a function of time.

G.1.3.1 Constituent Grouping and Screening

The LLBGs contain over 100 radioactive and non-radioactive constituents that potentially could impact groundwater. Screening of these constituents considered a number of aspects that included 1) their potential for dose or risk, 2) their estimated amount of inventory, and 3) their relative mobility in the subsurface system within a 10,000-year period of analysis.

The assessment was the beneficiary of preceding analyses and field observations including the performance assessments for 200 West and 200 East post-1988 burial grounds (Wood et al. 1995, 1996), the remedial investigation and feasibility study of the ERDF (DOE 1994), the disposal of ILAW originating from the single- and double-shell tanks (Mann et al. 1997) and (Mann et al. 2001), and the Composite Analysis of the 200 Area Plateau (Kincaid et al. 1998). These and other analyses included development of inventory data and application of screening or significance criteria to identify those radionuclides that could be expected to substantially contribute to either the dose or risk calculated in the respective analysis. Clearly, those radionuclides identified as potentially significant in these published analyses are also expected to be key radionuclides in this assessment.

To establish their relative mobility, the constituents were grouped based on their mobility in the vadose zone and underlying unconfined aquifer. Contaminant mobility classes were used rather than the individual mobility of each contaminant because of the uncertainty involved in determining the mobility of individual constituents. The mobility classes were selected based on relatively narrow ranges of mobility.

Some of the constituents, such as iodine and technetium, would move at the rate of water whether in the vadose zone or underlying groundwater. The movement of other constituents in water, such as americium and cesium, would be slowed or retarded by the process of sorption onto soil and rock. A parameter that is commonly used to represent a measure of this sorption is referred to as the distribution coefficient or K_d. This parameter is defined as the ratio of the quantity of the solute adsorbed per gram of solid to the amount of solute remaining in solution (Kaplan et al. 1996). Values of K_d for the constituents range from 0 mL/g (in which the contaminant movement in water is not retarded) to more than 40 mL/g (in which the contaminant moves much slower than water).

The LLW inventory constituents were grouped according to established K_ds for each constituent, or an assumed conservative K_d where a range of K_ds is known for a particular constituent. The constituent groups, based on mobility and examples of common constituents, are described in the following text.

A summary of all constituents and associated groupings (based on K_d values) is provided in Table G.1. The constituent classes used for modeling include:

Mobility Class 1 – Contaminants were modeled as non-sorbing (that is, $K_d = 0$) and would not be retarded in the soil-water system. Contaminant K_d values in this group ranged from 0 to 0.59 mL/g and include all the isotopes of iodine, technetium, selenium, chlorine, and tritium.

Mobility Class 2 – Contaminants were modeled as slightly sorbing (that is, $K_d = 0.6$) and would be slightly retarded in the soil-water system. Contaminant K_d values in this group ranged from 0.6 to 0.99 mL/g and include all the isotopes of uranium and carbon.

Mobility Class 3 – Contaminants were modeled as slightly more sorbing (that is, $K_d = 1$). Contaminant K_d values in this group ranged from 1 to 9.9 mL/g and include all the isotopes of barium.

Mobility Class 4 – Contaminants were modeled as moderately sorbing (that is, $K_d = 10$). Contaminant K_d values in this group ranged from 10 to 39.9 mL/g and include all the isotopes of neptunium, palladium, protactinium, radium, and strontium.

Mobility Class 5 – Contaminants were modeled as strongly sorbing (that is, $K_d = 40$). Contaminant K_d values in this group were 40 mL/g or greater and include all the isotopes of actinium, americium, cobalt, curium, cesium, iron, europium, gallium, niobium, nickel, lead, plutonium, samarium, tin, thorium, and zirconium.

The constituent listing in Table G.1 was further evaluated using estimates of constituent transport times through the thick vadose zone to the unconfined aquifer during the 10,000-year period of analysis. For purposes of this analysis, the infiltration rate selected was 0.5 cm/yr. This rate was assumed, based on recharge estimates for different site surface conditions by Fayer et al. (1999), to reflect a conservative estimate of infiltration for surface conditions that would be expected to persist at the LLBGs during the post-closure period. Estimates by Fayer et al. (1999) indicate that infiltration rates for surface conditions that have a Modified Resource Conservation and Recovery Act (RCRA) Subtitle C Barrier system would be below the assumed 0.5 cm/yr rate used in this screening analysis.

Based on this assumed infiltration rate and estimated levels of sorption and associated retardation for each of the classes above, estimated travel times of all constituents in Mobility Classes 3, 4, and 5 through the thick vadose zone to the unconfined aquifer beneath the LLBGs were calculated to be well beyond the 10,000-year period of analysis. Using the same vadose zone recharge rate of 0.5 cm/yr, average travel times to the water table for constituents within Mobility Classes 3, 4, and 5 are estimated to range from 30,000 to 50,000 years, 250,000 to 400,000 years, and 800,000 to 1 million years, respectively. Thus all constituents in these classes were eliminated from further consideration.

Table G.1. Constituents Categorized by Mobility (K_d) Classes

Constituent	**Best K_d Estimate**	**Range of K_d Estimates**	**Reference**	**Half-Life (years)**
Mobility Class 1 (K_d = 0.0 mL/g)				
H-3	0	0–0.5	Kincaid et al. (1998)	1.2E+01
Tc-99	0	0–0.6 0–0.1	Kincaid et al. (1998) Cantrell et al. (2002)	2.1E+05
I-129	0.3	0.2–15 0–2	Kincaid et al. (1998) Cantrell et al. (2002)	1.5E+07
Cl-36	0	0–0.6	Kincaid et al. (1998)	3.8E+05
Se-79	0	0–0.78	Kincaid et al. (1998)	6.5E+05
Mobility Class 2 (K_d = 0.6 mL/g)				
C-14	0.5	0.5–1,000	Kincaid et al. (1998)	5.7E+03
U-232 U-233 U-234 U-235 U-236 U-238	0.6	0.1–79.9 0.2–4	Kincaid et al. (1998) Cantrell et al. (2002)	6.9E+01 1.5E+05 2.4E+05 7.0E+08 2.3E+07 4.5E+09
Mobility Class 3 (K_d = 1.0 mL/g)				
Ba-133	1	NA	Wood et al. (1995)	1.0E+01
Mobility Class 4 (K_d = 10.0 mL/g)				
Np-237	15	2.4–21.9	Kincaid et al. (1998)	2.1E+06
Pa-231	15	2.4–21.9	Kincaid et al. (1998)	3.3E+04
Pd-107	10	NA	DOE and Ecology (1996)	6.5E+06
Ra-226	20	5–173	Kincaid et al. (1998)	1.6E+03
Sr-90	20	5–173 10–20	Kincaid et al. (1998) Cantrell et al. (2002)	2.8E+01
Mobility Class 5 (K_d = 40.0 mL/g)				
Ac-227	300	67–1,330	Kincaid et al. (1998)	2.1E.01
Am-241 Am-242m Am-243	300	67–1,330	Kincaid et al. (1998)	4.3E+02 1.5E+02 7.4E+03
Co-60	1200	1,200–12,500	Kincaid et al. (1998)	5.3E+00
Cm-243 Cm-244 Cm-245 Cm-246 Cm-248	300	67–1,330	Kincaid et al. (1998)	2.9E+01 1.8E+01 8.4E+03 4.7E+03 3.4E+05
Cs-135 Cs-137	1500	540–3,180	Kincaid et al. (1998)	2.3E+06 3.0E+01
Eu-152	300	67–1,330	Kincaid et al. (1998)	1.3E+01
Gd-152	100	NA	Wood et al. (1996)	1.1E+14
Nb-94	300	50–2,350	Kincaid et al. (1998)	2.0E+04
Ni-63	300	50–2,350	Kincaid et al. (1998)	1.0E+02

Table G.1. (contd)

Constituent	Best K_d Estimate	Range of K_d Estimates	Reference	Half Life (years)
Mobility Class 5 (K_d = 40.0 mL/g) - continued				
Pb-210	2000	13,000–79,000	Kincaid et al. (1998)	2.2E+01
Pu-238 Pu-229 Pu-240 Pu-242 Pu-244	200	80 – >1,980	Kincaid et al. (1998)	8.7E+01 2.4E+04 6.5E+03 3.7E+05 8.1E+07
Th-229 Th-230 Th-232	1000	40 – >2,000	Kincaid et al. (1998)	7.3E+03 7.7E+04 1.4E+10
Sm-147	100	NA	Wood et al. (1996)	1.1E+11
Sn-126	50	50–2,350	Kincaid et al. (1998)	9.9E+04
Zr-93	1000	40 – >2,000	Kincaid et al. (1998)	1.5E+06
NA = not applicable.				

Of the suite of remaining waste constituents, technetium-99 and iodine-129 in Mobility Class 1 and carbon-14 and the uranium isotopes in Mobility Class 2 were considered to be in sufficient quantity and mobile enough to warrant a detailed analysis of potential groundwater impacts. Although three of the constituents in Mobility Class 1—selenium, chloride, and tritium—are considered very mobile, they were screened out for other factors. Selenium and chloride were not considered in the assessment because the total inventories for both of these constituents were estimated to be less than 1 x 10^{-2} Ci. Tritium was not evaluated because of its relatively short half-life.

Estimated inventories of hazardous chemical constituents associated with LLW and MLLW disposed of after 1988 being considered under each alternative group would be expected to be found at trace levels. MLLW, which would be expected to contain the majority of hazardous chemical constituents, would undergo predisposal solidification to stabilized waste forms and containment and thermal treatment to remove organic chemical components of the MLLW. This waste treatment would be done to meet current waste acceptance criteria and land disposal restrictions before being disposed of in permitted MLLW facilities. Consequently, potential groundwater quality impacts from these constituents would not be expected to be substantial.

Analysis of MLLW inventories for this assessment did identify two exceptions that included lead and mercury inventories associated with the projected MLLW that were estimated at 336 kg (741 lb) and 2.5 kg (5.5 lb), respectively. Because of its affinity to be sorbed into Hanford sediments, lead falls within Mobility Class 5 (K_d = 40 mL/g) and would not release to groundwater within the 10,000-year period of interest. The inventory estimated for mercury is assumed to be small enough that it would not release to groundwater in substantial concentrations. Even the most conservative estimates of release would yield estimated groundwater concentrations at levels two orders of magnitude below the current drinking water standard for mercury of 0.002 mg/L.

LLW disposed of before October 1987 may contain hazardous chemical constituents, but no specific requirements existed to account for or report the content of hazardous chemical constituents in this category of LLW. As a consequence, analysis of these constituents and estimated impacts based on the limited amount of information on estimated inventories and waste disposal locations would be subject to uncertainty at this time. These facilities are part of the LLW and MLLW facilities in the LLW Management Areas (MA) 1 through 4 that are currently being monitored under RCRA interim status programs. Final closure or remedial investigation of these facilities under RCRA and/or CERCLA guidelines could involve further analysis of the potential impacts of the chemical components of these inventories.

In response to comments received during the public comment periods on the drafts of the HSW EIS, efforts were made to develop an estimate of quantities of potentially hazardous chemicals in previously buried LLW so that potential impacts of such chemicals on groundwater quality could be evaluated. The estimation of these inventories, which used a waste stream analysis estimation method, is summarized in the Technical Information Document (FH 2004). This initial assessment of the estimated hazardous chemical inventory in pre-1988 buried wastes is provided in Section G.6.

G.1.3.2 Source Inventories

The source inventories of key constituents that provided the basis for potential groundwater quality impacts described in this appendix and Section 5.3 are summarized by alternative group in Appendix B. The inventory associated with the specific constituents for each of alternatives was partitioned between the 200 East and West Areas roughly in proportion to estimated disposal areas in the LLBGs that had already received LLW or will receive newly generated LLW. Estimates of LLBG areas for all the alternatives are summarized in Volume 1, Section 5.1, Table 5.1. Distribution of LLBGs for each waste category assumed in the release modeling, described in the section below, in the HSW disposal site areas by alternative are given in Table G.2. The broad categories considered include previously disposed of LLW, newly generated Cat 1 and Cat 3 LLW, and MLLW. The relative percentages of LLBG areas for these three categories provide the basis for the partitioning of LLW volumes and associated constituent inventories. For purposes of this analysis, the GTC3 LLW were considered part of the Cat 3 LLW inventory. Although no specific GTC3 LLW is expected in forecasted wastes, for purposes of this analysis, it was assumed that about 1 m^3 (1.4 yd^3) of GTC3 LLW containing mostly cesium-137 and other non-mobile nuclides would be part of the inventory considered. The inventory of this category is included in the Cat 3 LLW and is not discussed separately.

G.1.3.3 Release Models

Source-release models were selected and used to approximate contaminant releases from the variety of LLW types considered in this analysis. The models considered included a soil-debris release model and a cement release model.

Table G.2. Assumed Distribution of LLBG Areas (ha) of Previously Disposed of LLW, Cat 1 LLW, Cat 3 LLW, MLLW, and Melters in the 200 East and 200 West Areas by Alternative Group

	Previously Disposed of LLW						**Category 1 LLW**				**Category 3 LLW**				**MLLW**				**Melters**
	1962–1970 LLW		**1970–1988 LLW**		**1988–1995**		**1996–2007**		**After 2007**		**1996–2007**		**After 2007**		**1996 to date and future**		**After 2007**		
Disposal Alternative	**200 East**	**200 West**	**200 East**	**200 West**	**200 East**	**200 West**	**200 East**	**200 West**	**200 East**	**200 West**	**200 East**	**200 West**	**200 East**	**200 West or ERDF**	**200 East**	**200 West or ERDF**	**200 East**	**200 West or ERDF**	**200 East or ERDF**
A (Lower Bound Volume)	7.1	2.2	20.9	16.6	19.6	39.7		39.7		4.4		39.7		4.4		1.7		1.5	6.0
A (Hanford Only Volume)	7.1	2.2	20.9	16.6	19.6	39.7		39.7		4.4		39.7		4.4		1.7		1.5	6.0
A (Upper Bound Volume)	7.1	2.2	20.9	16.6	19.6	39.7		39.7		8.9		39.7		8.9	3.5	1.7		3.0	6.0
B (Lower Bound Volume)	7.1	2.2	20.9	16.6	19.6	39.7		39.7	0.7	16.7		39.7	0.7	16.7		1.7	5.7		6.0
B (Hanford Only Volume)	7.1	2.2	20.9	16.6	19.6	39.7		39.7	0.7	16.7		39.7	0.7	16.7		1.7	5.7		6.0
B (Upper Bound Volume)	7.1	2.2	20.9	16.6	19.6	39.7		39.7	4.0	25.1		39.7	1.1	28.0	3.5	1.7	10.2		6.0
C (Lower Bound and Hanford Volume)	7.1	2.2	20.9	16.6	19.6	39.7		39.7		4.4		39.7	0.0	4.4		1.7	1.5		6.0
C (Hanford Only Volume)	7.1	2.2	20.9	16.6	19.6	39.7		39.7		4.4		39.7	0.0	4.4		1.7	1.5		6.0
C (Upper Bound Volume)	7.1	2.2	20.9	16.6	19.6	39.7		39.7		8.9		39.7	0.0	8.9	3.5	1.7	3.0		6.0
D_1, D_2, and D_3 (Lower Bound Volume)	7.1	2.2	20.9	16.6	19.6	39.7		39.7	3.0			39.7	3.0			1.7	1.1		6.0
D_1, D_2, and D_3 (Hanford Only Volume)	7.1	2.2	20.9	16.6	19.6	39.7		39.7	3.0			39.7	3.0			1.7	1.1		6.0
D_1, D_2, and D_3 (Upper Bound Volume)	7.1	2.2	20.9	16.6	19.6	39.7		39.7	6.2			39.7	6.2		3.5	1.7	3.0		6.0
E_1, E_2, and E_3 (Lower Bound Volume)	7.1	2.2	20.9	16.6	19.6	39.7		39.7	3.0			39.7	3.0			1.7	1.1		6.0
E_1, E_2, and E_3 (Hanford Only Volume)	7.1	2.2	20.9	16.6	19.6	39.7		39.7	3.0			39.7	3.0			1.7	1.1		6.0
E_1, E_2, and E_3 (Upper Bound Volume)	7.1	2.2	20.9	16.6	19.6	39.7		39.7	6.2			39.7	6.2		3.5	1.7	3.0		6.0
No Action	7.1	2.2	20.9	16.6	19.6	39.7		39.7		39.7		39.7				1.7			

G.1.3.3.1 Soil-Debris Model

In the soil-debris model, LLW is assumed to be mixed with soils. Waste sources included in this model were assumed to be permeable to percolating water. Thus, all surfaces of the waste were assumed to come into contact with percolating water. If contaminant inventories in the source were high enough, leaching of the contaminant through the bottom of the source was controlled by the solubility of the contaminant in soil water. Otherwise, leaching was controlled by partitioning of the radionuclides between aqueous and sorbed phases. The inventory was assumed to be perfectly mixed throughout the source volume during the entire release period—assuming perfectly mixed conditions reduced the likelihood that solubility would control the release. The mathematical basis of this release model is described in detailed in Appendix D of Kincaid et al. (1998).

The soil-debris model was used to estimate release of all non-grouted contaminants from previously disposed of LLW, Cat 1 LLW, Cat 3 LLW, and MLLW. The key parameter in the use of the soil-debris release model, besides the depth of the waste, is the rate of infiltrating water through the LLBGs. Table G.3 provides a summary of assumed waste depths and infiltration rates used in the soil-debris model for each alternative.

This assessment focuses on the long-term release of contaminants from new LLBGs during the post-closure period. This assumption of minimal leaching and migration prior to site closure is reasonable for the majority of LLW and MLLW being considered. Containment and waste forms used in Cat 1 and Cat 3 LLW would be expected to be sufficient to contain and isolate disposed of LLW during the operational period. MLLW facilities, which involve the collection and management of leachate during and following the operational period, are also expected to control the amount of waste leaching during the period of operations. Thus, an infiltration rate of 0.5 cm/yr was used for the Cat 1 LLW, Cat 3 LLW, and MLLW within the No Action Alternative.

Because less rigorous requirements for waste contaminant and content were in effect prior to 1988, contaminants contained in solid LLW disposed of in LLBGs before 1988 offer the highest potential for leaching and release into the vadose zone prior to site closure. This analysis evaluated the potential impacts of these earlier disposals by evaluating the effect of higher infiltration rates during the period of operations. The leaching of these categories of LLW prior to site closure has the potential to be influenced by relatively high infiltration rates during and shortly after the disposal period when bare soil conditions persist. Infiltration rates into coarse surface sediments maintained free of vegetation, as would be expected during and shortly after the disposal period, is estimated to be in the order of 5 cm/yr, based on data from a non-vegetated, gravel-covered lysimeter study conducted on the Hanford Site (Fayer and Walters 1995; Fayer et al. 1999). Eventually, infiltration through the LLBGs would be expected to be reduced to lower levels as surface cover conditions return to a more natural vegetative state.

For the No Action Alternative, an infiltration rate used in release modeling of the pre-1970 and 1970-1988 LLW was increased to 0.5 cm/yr after the operational period and during the post-closure period. This infiltration rate is a reasonable rate (Fayer and Walters 1995; Fayer et al. 1999) to use in the post-closure period when natural vegetative cover would be expected to persist.

Table G.3. Summary of Waste Depth and Infiltration Rates Used in the Soil-Debris Release Model

	Waste Depth (meters)	Infiltration Used in Waste Release Models (cm/yr)							
		Prior to 2046	**2046–2546**	**2547–2646**	**2647–2746**	**2747–2846**	**2847–2976**	**2947–2946**	**3046–12046**
Action Alternatives									
Wastes Disposed of Before 1995									
Pre-1970	6	5	0.01	0.05	0.1	0.2	0.3	0.4	0.5
1970–1987	6	5	0.01	0.05	0.1	0.2	0.3	0.4	0.5
1988–1995	6	5	0.01	0.05	0.1	0.2	0.3	0.4	0.5
Wastes Disposed of Between 1996 and 2007	6	NA	0.01	0.05	0.1	0.2	0.3	0.4	0.5
Wastes Disposed of After 2007									
Alt Group A	15.6	NA	0.01	0.05	0.1	0.2	0.3	0.4	0.5
Alt Group B	6	NA	0.01	0.05	0.1	0.2	0.3	0.4	0.5
Alt Group C	15.6	NA	0.01	0.05	0.1	0.2	0.3	0.4	0.5
Alt Group D_1	15.6	NA	0.01	0.05	0.1	0.2	0.3	0.4	0.5
Alt Group D_2	15.6	NA	0.01	0.05	0.1	0.2	0.3	0.4	0.5
Alt Group D_3	15.6	NA	0.01	0.05	0.1	0.2	0.3	0.4	0.5
Alt Group E_1	15.6	NA	0.01	0.05	0.1	0.2	0.3	0.4	0.5
Alt Group E_2	15.6	NA	0.01	0.05	0.1	0.2	0.3	0.4	0.5
Alt Group E_3	15.6	NA	0.01	0.05	0.1	0.2	0.3	0.4	0.5
Melter Trench (All Alternatives Groups)	18.6	NA	0.01	0.05	0.1	0.2	0.3	0.4	0.5
No Action Alternative									
Wastes Disposed of Before 1995									
Pre-1970	6	5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1970–1987	6	5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1988–1995	6	5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Wastes Disposed of After 1996	6	NA	0.5	0.5	0.5	0.5	0.5	0.5	0.5

NA = No specific infiltration rate is applicable for release of waste disposed of after 1995 during the period of operation for the alternative groups. Because of assumptions related to waste containment and active management of leachate collection during the operational period, no waste release is assumed to occur until after the start of the post-closure period in year 2046.

For all LLW and MLLW under all action alternatives, it is assumed that LLBGs would have a long-term surface barrier at site closure that would limit infiltration rates through the disposed of wastes. The assumed barrier is a Modified RCRA Subtitle C Barrier system. Recharge from this barrier system is expected to be very low and comparable to long-term recharge estimates for the Hanford Protective Barrier. A recent analysis by Fayer et al. (1999) for ILAW disposal has estimated a long-term infiltration at 0.01 cm/yr through this type of a system with an established natural (that is, shrub-steppe plant community) cover condition.

No guidance is available for specifying barrier performance after its design life. However, an immediate decrease in performance is not expected, and it is likely that this specific barrier will perform as designed far beyond its design life. Without data to understand and predict long-term performance of the specific barrier, a conservative assumption is the performance of the barrier would degrade stepwise after reaching its design life, and until the recharge rate matches the natural recharge rate in the surrounding environment. This approach is based on the assumption that a degraded cover will eventually return to its natural state and behave like the surrounding environment. The period of degradation was assumed to be the same as the design life. At the time of site closure, all waste disposal facilities are assumed to be covered with the Modified RCRA Subtitle C Barrier system. To approximate the effect of the cover on waste release, the following assumed infiltration rates, as illustrated in Figure G.3, were used in the waste release modeling. For 500 years after site closure, an infiltration rate of 0.01 cm/yr was used to approximate the effect of cover emplacement over the wastes and its potential impact on reducing infiltration. After 500 years, the cover is assumed to begin to degrade. Between 500 to 1000 years after site closure, infiltration rates were increased from 0.01 cm/yr to 0.5 cm/yr to approximate a 500-year period of cover degradation and a return infiltration rate reflective of natural vegetated surface soil conditions over the wastes. The final rate of 0.5 cm/yr was used for the remaining 9000-year period of analysis.

Additional analyses were performed to provide perspective on potential impacts using two assumptions: 1) no cover system is installed and 2) a cover system is used and remains intact for 10,000 years (see Section G.4.)

A number of the alternatives considered specify the use of liner systems to control waste release during the period of operations. However, no credit for the effect of these liner systems was considered in this long-term analysis. Although the liner systems as described in Section 3.1 might last (that is, contain leachate for removal) for several hundreds of years if properly managed, this analysis assumed that the emplaced liners would fail during the 100-year active institutional control period and would have little effect on the long-term waste release during the 10,000-year period of analysis.

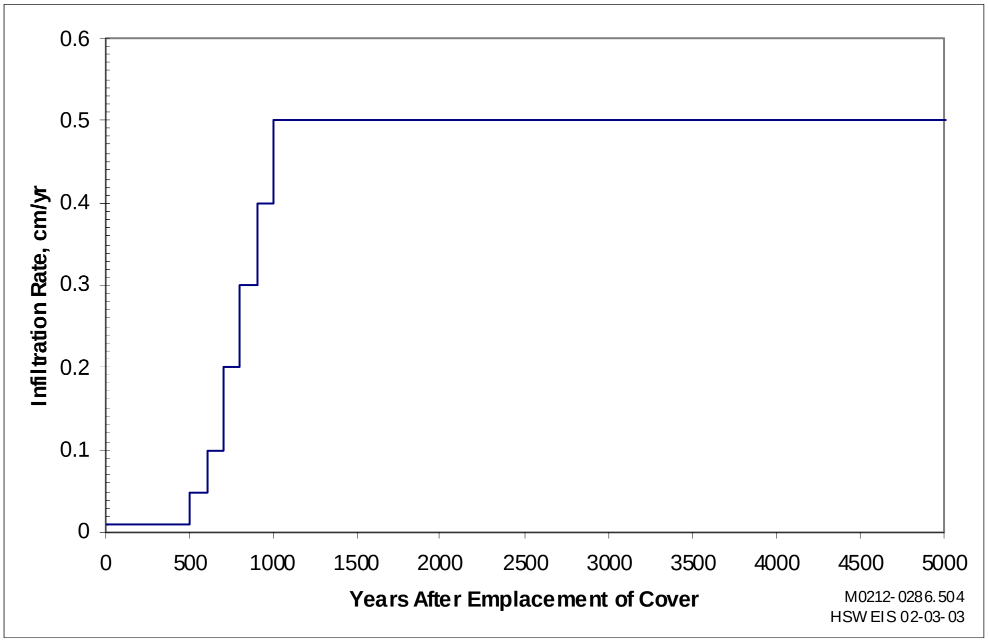

Figure G.3. Changes in Infiltration Rates Assumed in Source-Term Release to Approximate the Modified RCRA Subtitle C Barrier System Degradation

In the case of uranium isotope release calculations, sufficient inventories of uranium in a number of LLW categories were estimated with the soil-debris model using solubility controls. For all LLW categories except Cat 3 LLW, a solubility-controlled concentration of 64 mg/L was used for all uranium isotopes. This estimate was developed and described for Hanford-specific conditions in Wood et al. (1996) for use in the performance assessment of solid waste burial grounds in the 200 East Area. In the Cat 3 LLW, the geochemical environment created by the presence of cement associated with the high-integrity containers (HIC) and the in-trench grouting is expected to reduce the release of uranium at much lower concentration limits. The solubility-controlled concentration used for Cat 3 LLW was 0.23 mg/L, which was based on an estimate (2.34×10^{-4} g/L) developed and described in Wood et al. (1996) for use in the performance assessment of solid waste burial grounds in the 200 East Area.

To account for the expected delay in release of Cat 3 LLW, because it is contained within HICs or grouted in place, the soil-debris release model used a 300-year delay before releases were initiated. This delay is consistent with the estimated 300-year lifetime of LLW containment effectiveness of the HIC or in-trench grouting.

For some categories (Cat 3 LLW and Cat 3 MLLW) in each of the alternatives, LLW containing elevated levels of technetium-99 will be placed in a grout matrix before being placed in the LLBGs. For this type of grouted waste, a release model referred to as the cement-release model was used to approximate the source release. The underlying basis of the cement-release model assumes that (1) the permeability of the grouted waste is much lower than that of the surrounding soil, (2) the permeability of the waste is low enough that advective water flow within the waste form is essentially zero, and (3) the pore space connectivity in the cementitious waste form is sufficiently high enough to allow contaminant mobility within the waste form by diffusion. The mathematical basis of this release model is also described in detail in Appendix D of Kincaid et al. (1998).

G.1.3.3.2 Cement-Release Model

In the cement-release model, percolating water is assumed to move around the grouted waste, and contaminants are leached only from the outer surface. As this occurs, contaminants inside the waste form are assumed to diffuse toward the outer surface. Therefore, overall contaminant release from the source zone is assumed to be controlled by the effective diffusion coefficient of the contaminant in the waste form.

Specific values of the effective diffusion coefficient in cement-release model type waste forms for each radionuclide were chosen from the values originally reported by Serne et al. (1989). These values had previously been incorporated into a computer database known as the Multimedia-Modeling Environmental Database Editor (MMEDE) (Warren and Strenge 1994). For the source-term calculation effort of this analysis, the MMEDE database was queried to produce an electronic file of tabulated diffusion coefficients for relevant radionuclides (that was subsequently incorporated into the source-term calculation spreadsheet). This study used diffusion coefficient values as reported in Buck et al. (1997). Diffusion coefficients of 1×10^{-11} and 1×10^{-12} cm^2 s^{-1} for technetium-99 and iodine-129, respectively, were used. For some radionuclides (for which no specific values were available), the diffusion coefficient was fixed at a reasonable conservatively high default value (5×10^{-8} cm^2 s^{-1}).

Effect of Organic Chemicals on Long-Term Groundwater Quality Impacts

The effect of chemicals, particularly organic chemicals, on enhancing the mobility of normally sorbed or immobile constituents in transport was raised as an important technical issue for solid waste disposal facilities during public review and comment of the first draft HSW EIS. Detailed evaluations of tabulations of metal-organic complex stability constants for organic compounds (Martell 1971; Martell and Smith 1977; Smith and Martell 1982) suggest that most of the stability constants are weak for organics typically contained in LLW and MLLW. The more typical organic compounds found in LLW and MLLW are non-polar and relatively hydrophobic molecules. Organics that fit into this category (that is, carbon tetrachloride, trichloroethane, and other volatile organics) generally cannot form a complex with metals and radionuclides and enhance their mobility. However, such non-polar and/or hydrophobic organic compounds if disposed in large quantities and in high concentration could potentially affect radionuclide and metal migration by creating a reducing zone in the sediments or groundwater especially if biological activity is occurring. Field evidence suggests that this has not occurred to any significant extent at any waste site at Hanford (see Serne and Wood 1990 and references therein). Thus this type of enhanced transport is not expected to be important in affecting field-scale transport of constituents of concern from HSW EIS disposal sites. A small subset of organic compounds, commonly referred to as complexing/chelating agents, do have the ability to enhance the mobility of some normally sorbed or immobile constituents. Some notable examples of such agents include EDTA, HEDTA, DTPA, oxalic acid, and tributyl phosphate. The ability of these complexing agents to affect the general mobility of normally immobile or sorbed radionuclides and metals is a function of many factors, including:

- the type and amount of organic complexing agent is present
- the stability of the complex and the kinetics of its formation and disassociation back to free molecules
- pH, REDOX, and microbiological conditions
- the amount of free liquids or fluids contained within the wastes.

In one instance onsite, the presence of complexing agents (EDTA and/or ferro-ferric-cyanide) in a liquid waste stream discharged to the ground is suspected of enhancing the transport of a cobalt-60 plume from the northern part of the 200 East Area. However, the combination of complexing agents and liquid discharge at this waste site is unique and cannot be interpreted as being representative of geochemical or vadose zone flow and transport conditions that would be expected at solid waste burial grounds.

At this time, there is no specific evidence that would support enhanced movement of moderately to strongly sorbed radionuclides or metals (for example. cesium, strontium, europium, uranium, or plutonium) due to the presence of organic complexing agents in solid wastes within LLBGs. In fact, no field-scale evidence has been found at other solid LLW sites across North America that would support this hypothesis (Serne et al. 1990; Serne et al. 1995). Estimated inventories of hazardous chemical constituents and particular organic complexing agents associated with LLW and MLLW disposed of after 1988 are thought to be quite small. MLLW, which would be expected to contain the majority of chemical constituents, will undergo predisposal solidification to stabilize waste forms and thermal treatment to remove organic chemical components of the MLLW. This waste treatment would be done to meet current waste acceptance criteria and land disposal restrictions before disposal in permitted MLLW facilities. Consequently, the effect of organic complexing agents and potential groundwater quality impacts from organic chemicals, in general, would not be expected to be substantial for solid wastes.

LLW disposed of prior to October 1987 might contain chemical constituents and organic complexing agents, but because no specific requirements existed to account for or to report their content, it is difficult to assess impacts. As a consequence, analysis of these constituents and estimated impacts based on the limited amount of information on estimated inventories and waste disposal location would be subject to large uncertainty at this time. These facilities are part of the LLW and MLLW facilities in LLW Management Areas 1–4 that currently are being monitored under RCRA interim status programs. Final closure or remedial investigations of these facilities under RCRA and/or CERCLA guidelines could involve further evaluation and eventually require analysis of the impacts of the chemical components of these disposed inventories.

Relation of the HSW-EIS to Current Performance Assessments for LLW and MLLW Disposal

The long-term radiological impacts of solid wastes disposed of in LLBGs in the 200 East and West Areas since October 1987 have been evaluated in two active performance assessments (*Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds* [Wood et al. 1995] and *Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds* [Wood et al. 1996]). These performance assessments were approved by DOE; a copy of the disposal authorization statement is attached to this appendix.

The proposed disposal of immobilized low-activity waste (ILAW) derived from the tank Waste Treatment Plant in a disposal facility sited southwest of the PUREX Plant within the 200 East Area also has been evaluated using a performance assessment (Mann et al. 2001). This performance assessment also was approved, as shown in the attached disposal authorization statement. Ongoing maintenance for all three of these performance assessments includes continual evaluation and production of annual reports on new data and information on projected disposal inventories, geochemical, and waste form performance data and information and their relevance to current performance assessment results and conclusions (Wood and Van Vliet 2002; Mann 2002).

Projected waste inventories, selection of disposal methods, or trench designs that might result from this HSW EIS would be addressed under performance assessment compliance requirements as specified in DOE Order 435.1 (DOE 2001). Long-term performance assessment of radiological impacts from disposal facilities is a part of several requirements specified under DOE Order 435.1 for Hanford Site low-level waste disposal facilities to ensure the protection of workers, the public, and the environment.

Analysis of the most current baseline disposal practices that use conventional trenches for both solid wastes and ILAW show that for current waste inventory projections, operational waste acceptance criteria and waste acceptance practices continue to be compliant with performance objectives.

G.1.4 Vadose Zone Modeling

Contaminants released from the various LLBGs were transported downward through the vadose zone to the water table. The primary mechanism for transport in the vadose zone was water flow in response to gravitational and capillary forces. After the LLW disposal operations cease, steady-state hydraulic conditions resulting from different surface covers (including re-vegetation) that affect recharge were represented in the model. Recharge directly from precipitation or snowmelt infiltrates into the vadose zone. The recharge rate varies for the assumed surface cover conditions for each of the LLBGs. The data used in the vadose zone model are described in the remainder of this section.

The vadose zone was modeled as a stratified one-dimensional column. In this analysis, it was not appropriate to represent the vadose zone as multidimensional because of the large number of LLBG sites modeled and the limited characterization of the vadose zone. Multidimensional modeling of the vadose zone has been performed for some waste sources and types (Mann et al. 1997; Mann et al. 2001) but was not practical for this analysis for the large number of sites in question. A one-dimensional approach would also be expected to yield results that would be more conservative than those produced with multi-dimensional approaches which consider lateral spreading of infiltration and contaminant transport.

The remainder of this section describes the stratigraphy, hydraulic properties, recharge, and geochemical conditions used in this analysis.

G.1.4.1 Stratigraphy

Because of the large number of sites to be modeled in this assessment, the technical approach used for the vadose zone stratigraphy was similar to the approach used in the Composite Analysis by Kincaid et al. (1998). The stratigraphy used was an approximation that was consistent with the major geologic formations found in the vadose zone beneath the Central Plateau in the areas of question and was based on work documented in Thorne and Chamness (1992), Thorne et al. (1993), and Thorne et al. (1994). In the composite analysis, the stratigraphies for several areas of the 200 East and 200 West Areas were defined as a set of strata consistent with the nearest available well log from 18 well logs (Kincaid et al. 1998). Each of the well logs included location, ground surface elevation, and the thickness of the various major sediment types.

A summary of the geologic well logs used in the composite analysis appears in Table G.4. At each profile location, seven sediment types, and one rock type (basalt) were identified and used to define the stratigraphy. The acronyms of the sediment types provided in Table G.5 are associated with the following sediment types: 200 West Area Hanford Sand (WHS) sediment, 200 West Area Early Palouse (WEP) sediment, 200 West Area Plio Pleistocene (WPP) sediment, 200 West Area Ringold (WR) sediment, 200 East Area Hanford Sand (EHS) sediment, 200 East Area Ringold (ER) sediment, and 200 East Area Hanford Gravel (LEHG or EHG) sediment. East Hanford Gravel sediment type also appears in the table as LEHG, but the same soil moisture characteristics are applied to both. At most, four different sediment types occurred above the basalt at any location. In the vadose zone model, the basalt rock type was regarded as impermeable and was used to define the default bottom of the vadose zone profile. If the water table fell below the top of the basalt, as in the case for LLBGs located in the northern part of the 200 East Area, the vadose zone was still assumed to be limited to the basalt surface.

Two of the composite well logs developed for the composite analysis were selected for use in this assessment based on their proximity to the LLBGs. The specific well logs used to approximate the vadose zone stratigraphy at the LLBGs, which are noted in the first two rows of the table, are 218-E-12B in the 200 East Area and 218-W-5 in the 200 West Area and the ERDF.

G.1.4.2 Hydraulic Properties

Modeling water flow and radionuclide transport through the vadose zone required a description of the relationship among moisture content, pressure head, and unsaturated hydraulic conductivity. These relationships, called soil moisture characteristics, are highly nonlinear. In this analysis, non-hysteretic relationships were assumed for Hanford Site soils because few measurements to characterize hysteresis have been made for such soils, and it is believed to be of secondary importance. The hydraulic properties

Table G.4. Geologic Well Logs for the Vadose Zone Model

Composite Well Log	Surface Elevation (m)	Northing (m)[(a)]	Easting (m)[(b)]	Sediment 1[(c)]	Thickness (m)	Sediment 2	Thickness (m)	Sediment 3	Thickness (m)	Sediment 4[(d)]	Thickness (m)
218-W-5[(e)]	224.9	137024	565658	WHS	19	WEP	4	WPP	7	WR	85
218-E-12B[(f)]	191.9	137238	574643	EHG	10	EHS	6	LEHG	54	ER	0.01
218-E-10	190.7	137468	572924	EHG	10	EHS	6	LEHG	59	ER	0.01
299-E13-20	226.4	134313	573610	EHG	10	EHS	6	LEHG	80	ER	60
299-E19-1	224.1	135086	572820	EHG	10	EHS	6	LEHG	91	ER	51
299-E24-7	218.2	135561	574407	EHG	10	EHS	6	LEHG	60	ER	56
299-E25-2	205.9	136062	575514	EHG	10	EHS	6	LEHG	60	ER	36
299-E26-8	188.8	136687	575522	EHG	10	EHS	6	LEHG	44	ER	14
299-E28-16	214.3	136562	573135	EHG	10	EHS	6	LEHG	71	ER	12
299-E28-22	213.5	136321	574041	EHG	10	EHS	6	LEHG	83	ER	17
299-W6-1	214.1	137510	567214	WHS	14	WPP	4	WR	121		
299-W11-2	217.8	136671	567407	WHS	34	WEP	4	WPP	7	WR	110
299-W14-7	206.6	135655	567034	WHS	38	WPP	2	WR	118		
299-W14-8A	221.0	135688	568013	WHS	47	WEP	5	WPP	5	WR	106
299-W15-15	212.8	135752	566089	WHS	42	WEP	3	WPP	8	WR	100
299-W18-21	203.8	134979	566098	WHS	36	WEP	5	WPP	3	WR	100
299-W21-1	213.1	134397	568141	WHS	53	WEP	8	WPP	8	WR	100
299-W22-24	211.0	134411	567648	WHS	42	WEP	13	WPP	12	WR	104

(a) Refers to north coordinate in Washington State Plane NAD83 coordinate system.
(b) Refers to east coordinate in Washington State Plane NAD83 coordinate system.
(c) Refers to the upper sediment layer.
(d) Refers to the lowest sediment layer simulated.
(e) Composite well log used in analysis of the 200 West Area LLBGs.
(f) Composite well log used in analysis of the 200 East Area LLBGs.

EHS = 200 East Area Hanford Gravel Sediment.
LEHG = Lower 200 East Area Hanford Gravel Sediment.
ER = 200 East Area Ringold Sediment.
WHS = 200 West Area Hanford Sand Sediment.
WPP = 200 West Area Plio-Pleistocene Sediment.
WEP = 200 West Area Lower Palouse Sediment.
WR = 200 West Area Ringold Sediment.

Table G.5. Sediment Types and Unsaturated Flow Model Parameters Used in the Composite Analysis[a]

Sediment Name (Code)	van Genuchten alpha (-)	van Genuchten n (1/cm)	Residual Water Content (cm^3/cm^3)	Saturated Water Content (cm^3/cm^3)	Saturated Hydraulic Conductivity (cm/s)	Bulk Density (g/cm^3)	Gravel %[b]
200 East Area Hanford Gravel (EHG)	8.11E-03	1.58	0.0146	0.119	1.76E-03	1.97	41.70
Lower 200 East Area Hanford Gravel (LEHG)	8.11E-03	1.58	0.0146	0.119	1.76E-03	1.97	41.70
200 East Area Hanford Sand (EHS)	1.30E-01	2.10	0.0257	0.337	1.19E-02	1.78	17.30
200 East Area Ringold (ER)	8.19E-03	1.53	0.0262	0.124	3.97E-04	2.04	43.30
200 West Area Hanford Sand (WHS)	1.44E-02	2.20	0.0519	0.382	3.98E-04	1.64	3.60
200 West Area Early Palouse (WEP)	6.27E-03	2.53	0.0300	0.379	9.69E-05	1.68	2.00
200 West Area Plio-Pleistocene (WPP)	1.55E-02	1.78	0.0616	0.337	5.79E-02	1.65	8.40
200 West Area Ringold (WR)	3.14E-02	1.65	0.0236	0.226	5.76E-02	2.04	43.30

(a) Data are from Khaleel and Freeman (1995). A normal distribution was assumed for the parameters “van Genuchten n,” “Residual Water Contents,” and “Saturated Water Content,” and the mean was calculated accordingly. A log-normal distribution was assumed for the parameters “van Genuchten alpha” and “Saturated Hydraulic Conductivity,” and the mean was calculated accordingly. If the sample size was less than 10, the parameters “van Genuchten alpha” and “Saturated Hydraulic Conductivity” were determined using the geometric mean.

(b) Only fine particles were assumed to contribute to sorption of contaminants of concern. The impact of larger particles was corrected using gravel percent.

of Hanford Site soils are highly variable, both between the Hanford and Ringold formations and within each of the formations (Khaleel and Freeman 1995). For purposes of this analysis, the values of each of the parameters provided in the table were the values used.

In this analysis, different sediment types were used to define the one-dimensional columns beneath the LLBGs. The hydraulic properties of the sediment types were assumed to be uniform with each sediment layer. Preferential flow paths in the form of wells and clastic dikes were not considered in this analysis because use of one-dimensional models cannot represent their local influence in a three-dimensional environment. The potential influence of preferential flow paths, especially clastic dikes, has been addressed in the performance assessments for the solid waste burial grounds (Wood et al. 1995; Wood et al. 1996) and, more recently, by Ward et al. (1997) for post-1988 LLW. Wood et al. (1995) and Wood et al. (1996) concluded that clastic dikes were insufficiently large and insufficiently continuous to provide a true preferential pathway.

The model of soil hydraulic properties based on the van Genuchten (1980) and Mualem (1976) analytical expressions was used as the basis for the relationships among moisture content, pressure head, and unsaturated hydraulic conductivity. This model has been applied in previous vadose zone studies at the Hanford Site. Parameters for the van Genuchten and Mualem models have been determined by fitting experimental data for Hanford Site sediments to the classic analytic expressions of these models. These results are described in several Hanford Site documents, but the parameters used in this analysis were compiled by Khaleel and Freeman (1995).

For this analysis, unsaturated flow parameters were established for each of the vadose zone sediment types previously defined. Sediment types and the associated unsaturated flow modeling parameters used in this analysis are those shown in Table G.5. It should be noted that laboratory-measured moisture retention and saturated conductivity data in Table G.5 have been corrected for the gravel fraction (greater than 2 mm) present in the bulk sample.

G.1.4.3 Recharge Rates

This assessment primarily focuses on the long-term transport of contaminants from the LLBGs through the underlying vadose zone to the unconfined aquifer after the end of the operational period in 2046. For wastes disposed of after 1995, which are assumed to have sufficient containment to delay waste release and transport through the vadose zone until after the site closure, the assumption is reasonable. For these waste releases, initial conditions were based on expected conditions after the operational period and assumed a steady-state natural recharge condition with no contaminants in the vadose zone. The assumed long-term recharge that would govern the migration of contaminants through the vadose zone to the underlying water table would be controlled by the expected regional surface conditions surrounding the LLBGs. For conditions dominated by natural vegetation, this is conservatively estimated to be in the order of 0.5 cm/year, as currently estimated, for vegetative surface conditions (Fayer and Walters 1995; Fayer et al. 1999). The net recharge or infiltration rate would vary, representing a range of surface cover conditions from undisturbed surfaces with natural vegetation, to disturbed surfaces maintained free of vegetation, to engineered surface barriers designed for long-term service.

Because waste containment as described above was not systemically used prior to 1995, release of contaminants contained in solid LLW disposed of in LLBGs prior to 1995 were estimated by evaluating the effect of higher infiltration rates through the waste and vadose zone during operations. Results of analyses of earlier disposal facilities used release and vadose zone infiltration rates of 5 cm/yr, a rate reflective of managed bare surface soil conditions over the older disposal areas during the operations phase. This assumption for mobile contaminants (such as technetium-99 and iodine-129) disposed of before 1995 resulted in arrival of these contaminants several hundred years before mobile contaminants disposed of after 1995.

G.1.4.4 Distribution Coefficients

In this analysis, the linear sorption isotherm model was used in transport calculations. This model was selected because it was the only approach for which model parameters (distribution coefficients) were available for the LLBG contaminants. The distribution coefficients (K_d) used for the vadose zone analysis are summarized in Table G.1 (see Section G.1.3.1).

G.1.4.5 Vadose Zone Model Implementation

The vadose zone flow and transport model was implemented with the STOMP code (White and Oostrom 1996; White and Oostrom 1997; Nichols et al. 1997). Implementation of the vadose zone model with a unit release resulted in estimates of the annual contaminant flux to the water table that were used in the convolution integral method for linear superposition described previously.

The STOMP code was developed under the Volatile Organic Compounds (VOCs) Arid Demonstration Project through the DOE Office of Technology Development (White and Oostrom 1997). STOMP is based on the numerical solution of the three-dimensional Richards' equation for fluid flow (Richards 1931) and the advection-dispersion equation for contaminant transport. Although STOMP is capable of three-dimensional simulations, it is also designed to be efficient in performing one- and two-dimensional simulations. The code is based on an integral-volume, finite-difference method and is designed to simulate a wide variety of multidimensional, nonlinear, nonisothermal, and multiphase situations. STOMP was selected for this analysis because of computational efficiency and flexibility, its prior application to the Hanford Site vadose zone (Ward et al. 1997), and its thorough documentation (Nichols et al. 1997), (White and Oostrom 1997), and (White and Oostrom 1996).

Because of the large number of sites to be modeled in this assessment, the technical approach used for the vadose zone stratigraphy was similar to the approach used in the composite analysis by Kincaid et al. (1998). The stratigraphy used was an approximation that was consistent with the major geologic formations found in the vadose zone beneath the Central Plateau in the areas of question and was based on work documented in Thorne and Chamness (1992), Thorne et al. (1993), and Thorne et al. (1994). A summary of the geologic well logs used in the composite analysis appears in Table G.5. To approximate the vadose zone at the LLBGs in the 200 East and West Areas, two of the composite well logs developed for the composite analysis were selected for use in this assessment based on their proximity to the LLBGs. The specific well logs used to approximate the vadose zone stratigraphy at the LLBGs, which are noted in the first two rows of the table, are 218-E-12B in the 200 East Area and 218-W-5 in the 200 West Area and the ERDF.

Water table elevations for future conditions at the LLBGs were calculated with the groundwater flow model. This information was used in the vadose zone transport calculations to define the bottom of the vadose zone. The elevation of the top of the vadose zone at the LLBGs was calculated from land surface elevations and depth to the bottom of the source, which was tabulated for the LLBG areas.

Results of vadose zone transport of a unit release to the water table for the assumed long-term recharge rate of 0.5 cm/year using assumed soil columns and properties in the 200 East and West Areas is presented in Figure G.4. Average travel times for the releases of unit mass of contaminants within Mobility Class 1, as defined by the arrival of 50 percent of each unit mass, is on the order of 500 to 600 years in the 200 East Area and 800 to 900 years in the 200 West Area.

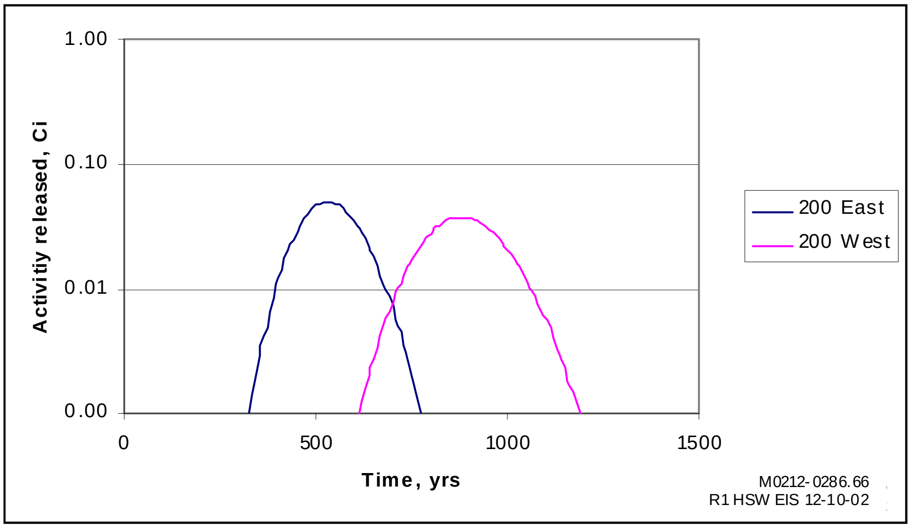

Figure G.4. STOMP Code Results for Releases to the Water Table for a Unit Release from LLBGs for an Assumed Recharge Rate of 0.5 cm/yr

G.1.5 Groundwater Modeling

Contaminant transport through the saturated unconfined aquifer was simulated with the sitewide groundwater flow and transport model, described in Cole et al. (2001a) for the 200 East and the 200 West LLBGs.

A three-dimensional conceptual model was developed for the unconfined aquifer that included stratigraphy, the upper and lower aquifer boundaries, and a table of material units and corresponding flow and transport parameters. The conceptual model was used to guide the setup of the numerical model. A grid spacing of 375 m (1230 ft) was established for the Hanford Site and overlain onto a site map containing physical features and the LLBGs.

G.1.5.1 Conceptual Model

G.1.5.1.1 Hydrogeologic Framework

Hydrogeologic units defined for use in the model were designated by numbers and are briefly described in Table G.6. More detailed descriptions of the sediments were presented in Volume I, Section 4.5 of this HSW EIS, and a graphic comparison of the model units taken from Thorne et al. (1993) against the stratigraphic column defined in Lindsey (1995) is shown in Figure G.5.

Although nine hydrogeologic units were defined, only seven (Units 1, 4, 5, 6, 7, 8, and 9) are found below the water table during post-Hanford conditions (Cole et al. 1997). Odd-numbered Ringold model units (5, 7, and 9) are predominantly coarse-grained sediments. Even-numbered Ringold model units (4, 6, and 8) are predominantly fine-grained sediments with low permeability. The Hanford formation

Table G.6. Major Hydrogeologic Units Used in the Sitewide Three-Dimensional Model

Unit Number	Hydrogeologic Unit	Lithologic Description
1	Hanford Formation	Fluvial gravels and coarse sands
2	Palouse Soils	Fine-grained sediments and eolian silts
3	Plio-Pleistocene Unit	Buried soil horizon containing caliche and basaltic gravels
4	Upper Ringold Formation	Fine-grained fluvial/lacustrine sediments
5	Middle Ringold (Units E and C)	Semi-indurated coarse-grained fluvial sediments
6	Middle Ringold (Lower Ringold Mud)	Fine-grained sediments with some interbedded coarse-grained sediments
7	Middle Ringold (Units B and D)	Coarse-grained sediments
8	Lower Mud Sequence (Lower Ringold and part of Basal Ringold Muds)	Lower blue or green clay or mud sequence
9	Basal Ringold (Unit A)	Fluvial sand and gravel
10	Columbia River Basalt	Basalt

combined with the pre-Missoula gravel deposits were designated as Model Unit 1. Model Units 2 and 3 correspond to the early Palouse soil and Plio-Pleistocene deposits, respectively. These units lie above the current water table. The predominantly mud facies of the upper Ringold unit identified by Lindsey (1995) was designated Model Unit 4. However, a difference in the definition of model units was the lower, predominantly sand, portion of the upper Ringold unit described in Lindsey (1995) was grouped with Model Unit 5 that also includes Ringold gravel/sand Units E and C. This action was taken because the predominantly sand portion of the upper Ringold is expected to have hydraulic properties similar to Units E and C. The lower mud unit identified by Lindsey (1995) was designated Model Units 6 and 8. Where they exist, the gravel and sand Units B and D, found within the lower Ringold, were designated Model Unit 7. Gravels of Ringold Unit A were designated Model Unit 9, and the underlying basalt was designated Model Unit 10. However, the basalt was assigned a very low hydraulic conductivity and was essentially impermeable in the model.

The lateral extent and thickness distribution of each hydrogeologic unit were defined based on information from drillers' well logs, geologists' logs, geophysical logs, and an understanding of the geologic environment. These interpreted areal distributions and thicknesses were then integrated into EarthVision™ (Dynamic Graphics, Inc., Alameda, California), a three-dimensional, visualization software package that was used to construct a database of the three-dimensional hydrogeologic framework.

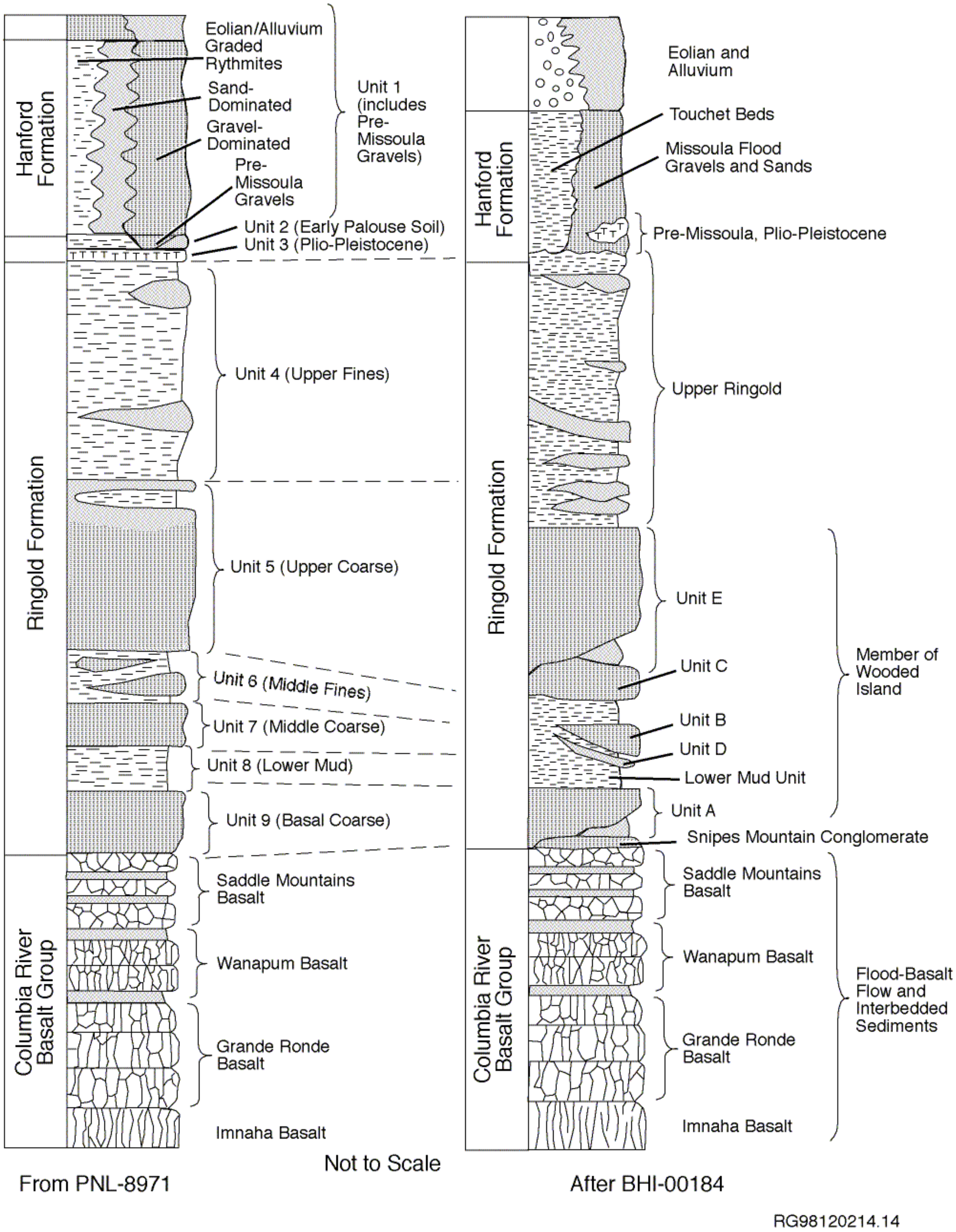

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Figure G.5. Comparison of Generalized Hydrogeologic and Geologic Stratigraphy (from Thorne et al. [1993] and after Lindsey [1995])

G.1.5.1.2 Recharge and Flow System Boundary Conditions

The past development of the sitewide model considered both natural and artificial recharge to the aquifer. Natural recharge to the unconfined aquifer system occurs from infiltration of 1) runoff from elevated regions along the western boundary of the Hanford Site; 2) spring discharges originating from the basalt-confined aquifer system, also along the western boundary; and 3) precipitation falling across the site. Some recharge also occurs along the Yakima River in the southern portion of the site. Natural recharge from runoff and irrigation in the Cold Creek and Dry Creek Valleys, upgradient of the site, also provides a source of groundwater inflow. Natural recharge from precipitation on the site is highly variable, both spatially and temporally, and depends on local climate, soil type, and vegetation.

The other source of recharge to the unconfined aquifer has historically come from wastewater disposal. The large volume of artificial recharge from wastewater discharged to disposal facilities on the Hanford Site over the past 60 years has substantially impacted groundwater flow and contaminant transport in the unconfined aquifer system. This volume of artificial recharge decreased significantly in the past 10 years, and the water table has been declining steadily over several years. The unconfined aquifer system eventually will be expected to reach more natural conditions after site closure. Because flow conditions simulated for this assessment focused on conditions that are likely to exist after Hanford Site closure and well into the future, the effect of past and current wastewater discharges on the unconfined aquifer system were not considered in this assessment.

Peripheral boundaries defined for the three-dimensional model are shown in Figure G.6, together with the three-dimensional flow-model grid. The flow system is bounded by the Columbia River on the north and east and by the Yakima River and basalt ridges on the south and west. The Columbia River represents a point of regional discharge for the unconfined aquifer system. The amount of groundwater discharging to the river is a function of local hydraulic gradient between the groundwater elevation adjacent to the river and the river-stage elevation. This hydraulic gradient is highly variable because the river stage is affected by releases from upstream dams.

Because of the regional-scale nature and long-time frame being considered in the current assessment, site-wide flow and transport modeling efforts did not attempt to consider the short-term and local-scale transient effects of the Columbia River system on the unconfined aquifer. However, the long-term effect of the Columbia River as a regional discharge area for the unconfined aquifer system was approximated in the three-dimensional model with a constant-head boundary applied at the uppermost nodes of the model at the approximate locations of the river's left bank and channel midpoint. Nodes representing the thickness of the aquifer below the nodes representing mid-point of the river channel were treated as no-flow boundaries. This boundary condition is used to approximate the location of the groundwater divide that exists beneath the Columbia River where groundwater from the Hanford Site and the other side of the river discharge into the Columbia. The long-term, average river-stage elevations for the Columbia River implemented in the sitewide model were based on results from previous work performed by Walters et al. (1994) for the Columbia River with the CHARIMA river simulation model. The Yakima River was also represented as a specified-head boundary at surface nodes approximating its location. Like the Columbia River, nodes representing the thickness of the aquifer below the Yakima River channel were treated as no-flow boundaries. Short-term fluctuations in the river levels do not influence modeling results.

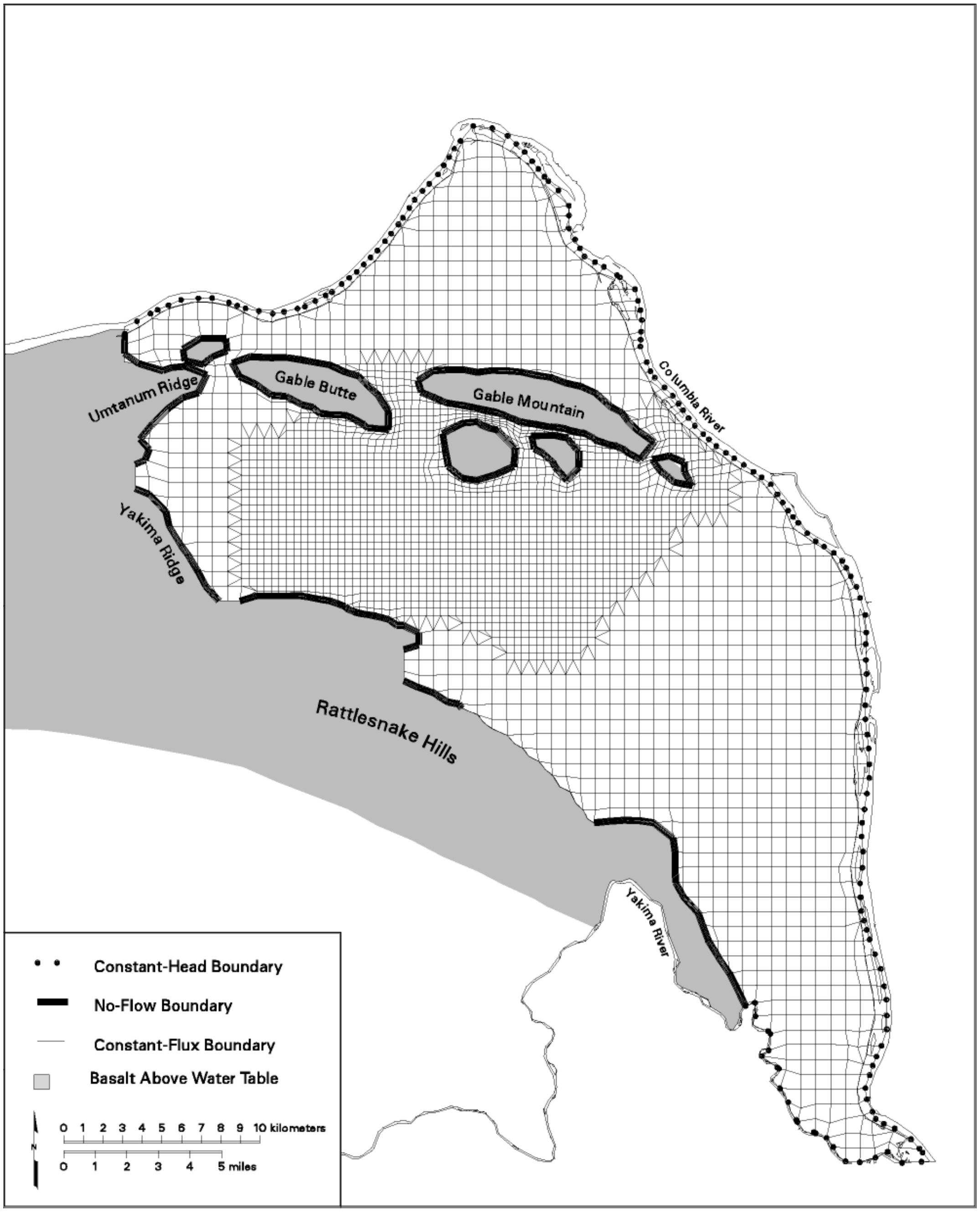

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Figure G.6. Peripheral Boundaries Defined for the Three-Dimensional Model (after Cole et al. [1997])

At Cold Creek and Dry Creek Valleys, the unconfined aquifer system extends westward beyond the boundary of the model. To approximate the groundwater flux entering the modeled area from these valleys, both constant-head and constant-flux boundary conditions were defined. A constant-head boundary condition was specified for Cold Creek Valley for the steady-state model calibration runs. The fluxes resulting from the specified-head boundaries in the calibrated steady-state model were then used in the steady-state flow simulation of flow conditions after Hanford Site closure. The constant-flux boundary was used because it better represents the response of the boundary to a declining water table than does a constant-head boundary. Discharges from Dry Creek Valley in the model area, resulting from infiltration of precipitation and spring discharges, are approximated using the same methods.

The basalt underlying the unconfined aquifer sediments represents a lower boundary to the unconfined aquifer system. The potential for interflow (recharge and discharge) between the basalt-confined aquifer system and the unconfined aquifer system is largely unquantified but is postulated to be small relative to the other flow components estimated for the unconfined aquifer system. Therefore, interflow with underlying basalt units was not included in the current three-dimensional model. The basalt was defined in the model as an essentially impermeable unit underlying the sediments.

G.1.5.1.3 Flow and Transport Properties

To model groundwater flow, the distribution of hydraulic properties, including horizontal and vertical hydraulic conductivity, storativity, and specific yield, was needed for each hydrogeologic unit defined in the model. In addition, to simulate movement of contaminant plumes, transport properties were needed, including contaminant-specific distribution coefficients, bulk density, effective porosity, and longitudinal and transverse dispersivities.

In the original model calibration procedure described in Wurstner et al. (1995), measured values of aquifer transmissivity were used in a two-dimensional model with an inverse model-calibration procedure to determine the transmissivity distribution. Hydraulic head conditions for 1979 were used in the inverse calibration because measured hydraulic heads were relatively stable at that time. Details concerning the updated calibration of the two-dimensional model are provided in Cole et al. (1997). The resulting transmissivity distribution for the unconfined aquifer system is shown in Figure G.7.

Hydraulic conductivities were assigned to the three-dimensional model units so that the total aquifer transmissivity from inverse calibration was preserved at every location. The vertical distribution of hydraulic conductivity at each spatial location was determined, based on the transmissivity value and other information, including facies descriptions and hydraulic property values measured for similar facies. A complete description of the seven-step process used to vertically distribute the transmissivity among the model hydrogeologic units is described in Cole et al. (1997).

The current version of the sitewide model relies on a three-dimensional representation of the aquifer system that was calibrated to Hanford Sitewide groundwater monitoring data collected during Hanford operations from 1943 to the present. The calibration procedure and results for this model are described in

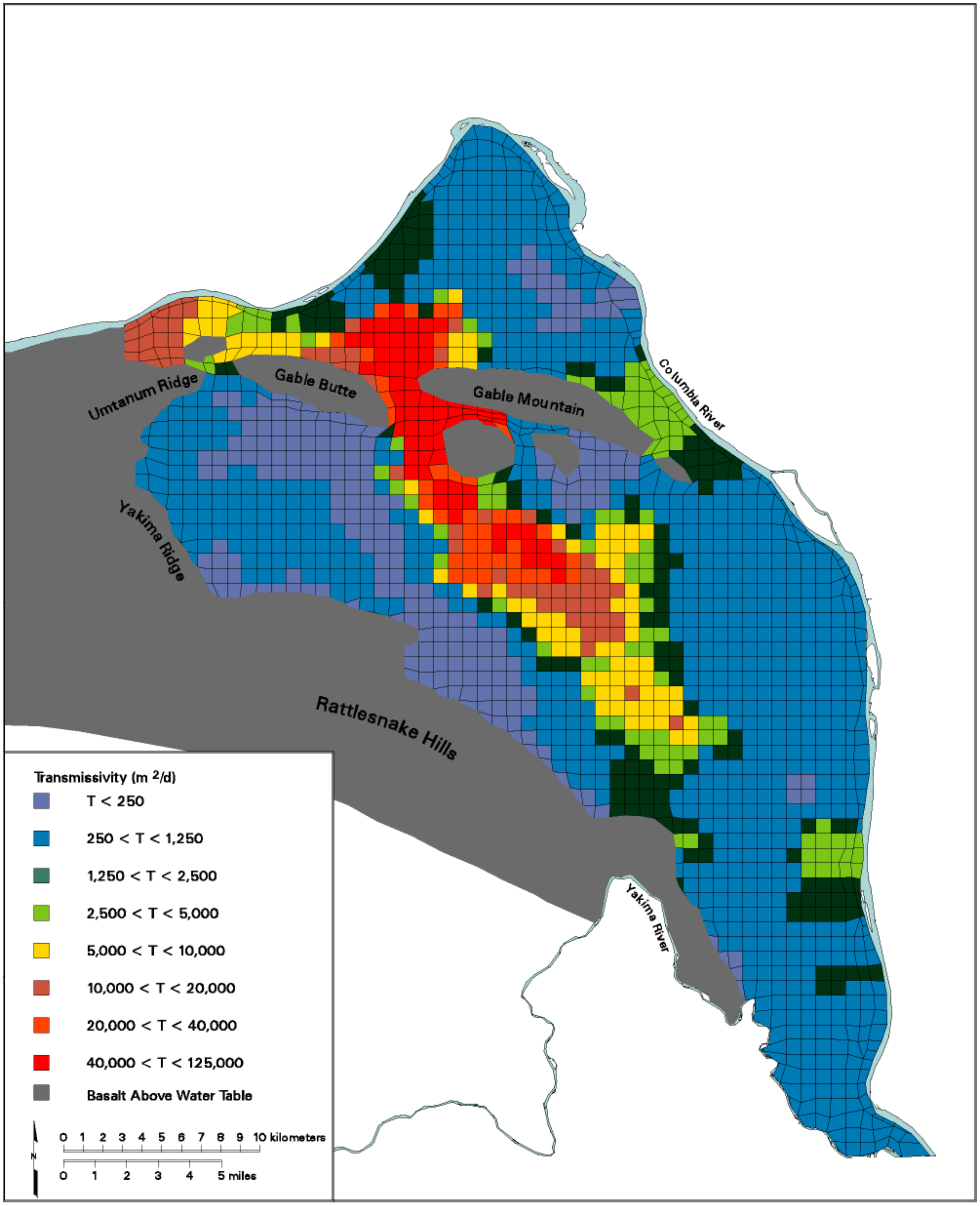

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Figure G.7. Transmissivity Distribution for the Unconfined Aquifer System Based on Two-Dimensional Inverse Model Calibration (after Wurstner et al. [1995])

Cole et al. (2001a). This recent work is part of a broader effort to develop and implement a stochastic uncertainty estimation methodology in future assessments and analyses using the sitewide groundwater model (Cole et al. 2001b). Resulting distribution of hydraulic conductivities from this recent calibration effort is provided in Figures G.8 and G.9.

Information on transport properties used in past modeling studies at the Hanford Site is provided in Wurstner et al. (1995). Estimates of model parameters were developed to account for contaminant dispersion and adsorption in all transport simulations. Specific model parameters examined included longitudinal and transverse dispersivity (D_L and D_T) and contaminant retardation factors (R_f). Calculation of effective R_f required estimates of contaminant-specific distribution coefficients, as well as estimates of effective bulk density and porosity of the aquifer materials. The remainder of this section briefly summarizes estimated transport properties.

For this analysis, a longitudinal dispersivity, D_L, of a little less than 100 m (95 m) (310 ft) was selected using this typical approach for estimating longitudinal dispersivity based on the scale of interest. Although transport results produced in this analysis span a range of scales, the key scale of interest is the minimum distance between some of the source areas in the Central Plateau and the location of the buffer zone boundary surrounding this area. For some sources in 200 East Area, the distance of interest is on the order of 1 to 2 km away. Thus, a dispersivity value used in the original analysis was selected to be approximately equal to 10 percent of the minimum travel distance of interest of about 1 km (0.6 mi).

The longitudinal dispersivity was also consistent to be within the range of recommended grid Peclet numbers ($Pe < 4$) for acceptable solutions. The 95-m (310-ft) estimate is about one-quarter of the grid spacing in the finest part of the model grid in the Central Plateau where the smallest grid spacing is about 375 m x 375 m (1230 ft x 1230 ft).

The corresponding transverse dispersivity used in the analysis was selected to be consistent with general available regulatory and technical guidance. EPA guidance (Mills et al. 1985) on the subject suggests a 1 to 3 ratio for D_T to D_L. Freeze and Cherry (1979) report that transverse dispersivities used are normally lower than the longitudinal dispersivity by a factor of 5 to 20 (that is, 0.2 to 0.05). Walton (1985) states that reported ratios of D_T to D_L vary from 1 to 24 but that common values are 0.2 and 0.1. Considering this information, a transverse dispersivity, $D_{T,}$ used in Composite Analysis simulations was assumed to be about 20 m (65.6 ft), which is approximately 20 percent of the selected longitudinal dispersivity.

The longitudinal dispersivity was also consistent and within the range of recommended grid Peclet numbers ($Pe < 4$) for acceptable solutions. The 95-m (310-ft) estimate is about one-quarter of the grid spacing in the finest part of the model grid in the Central Plateau where the smallest grid spacing is about 375 m x 375 m (1230 ft x 1230 ft).

In addition to the estimated distribution coefficient, calculation of contaminant-specific retardation factors used in the model requires estimates of the effective bulk density and porosity. For purposes of these calculations, a bulk density of 1.9 g/cm^3 was used for all simulations. The effective porosity was

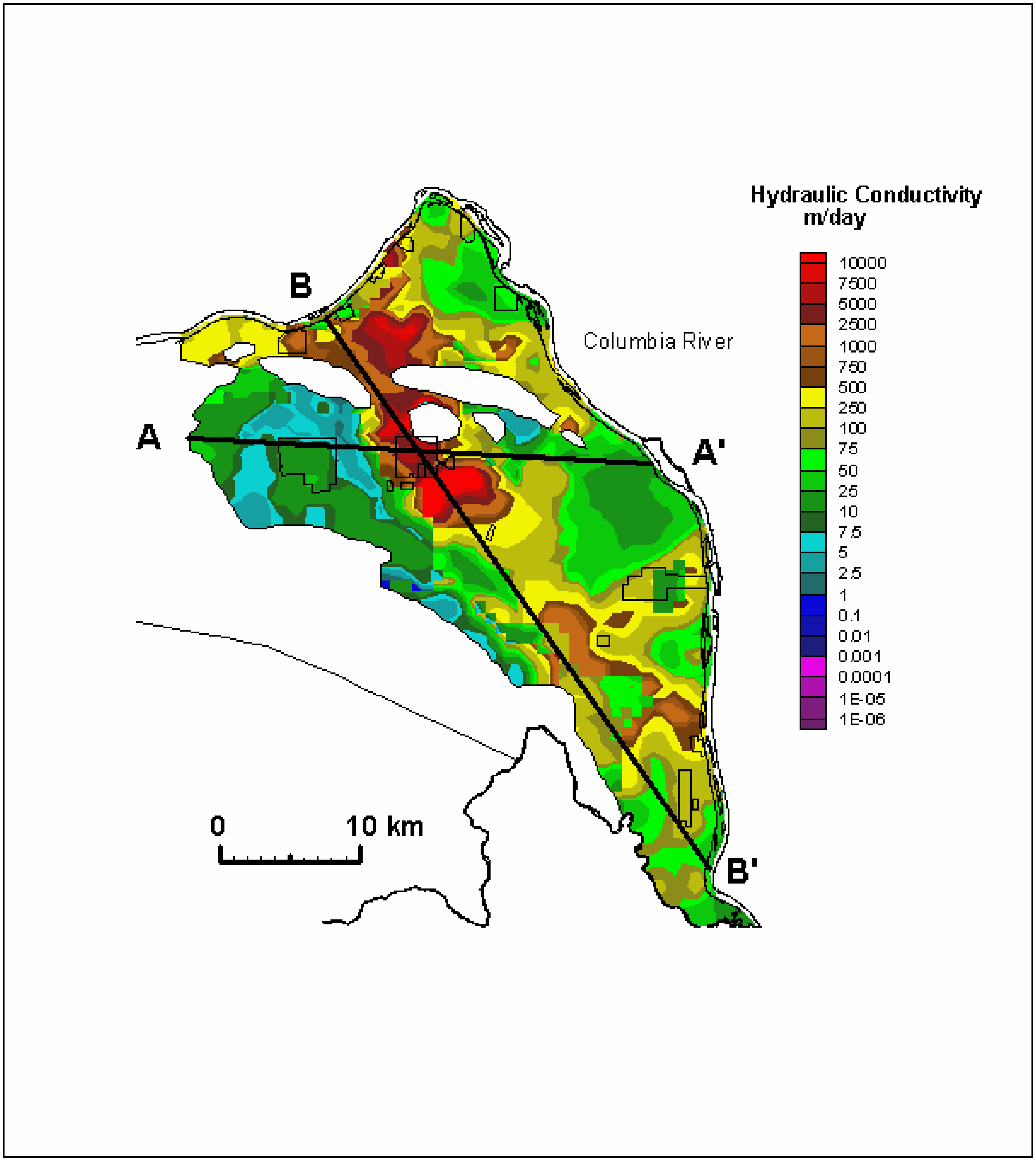

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Figure G.8. Distribution of Estimated Hydraulic Conductivities at Water Table from Best-Fit Inverse Calibration of Sitewide Groundwater Model (after Cole et al. [2001a])

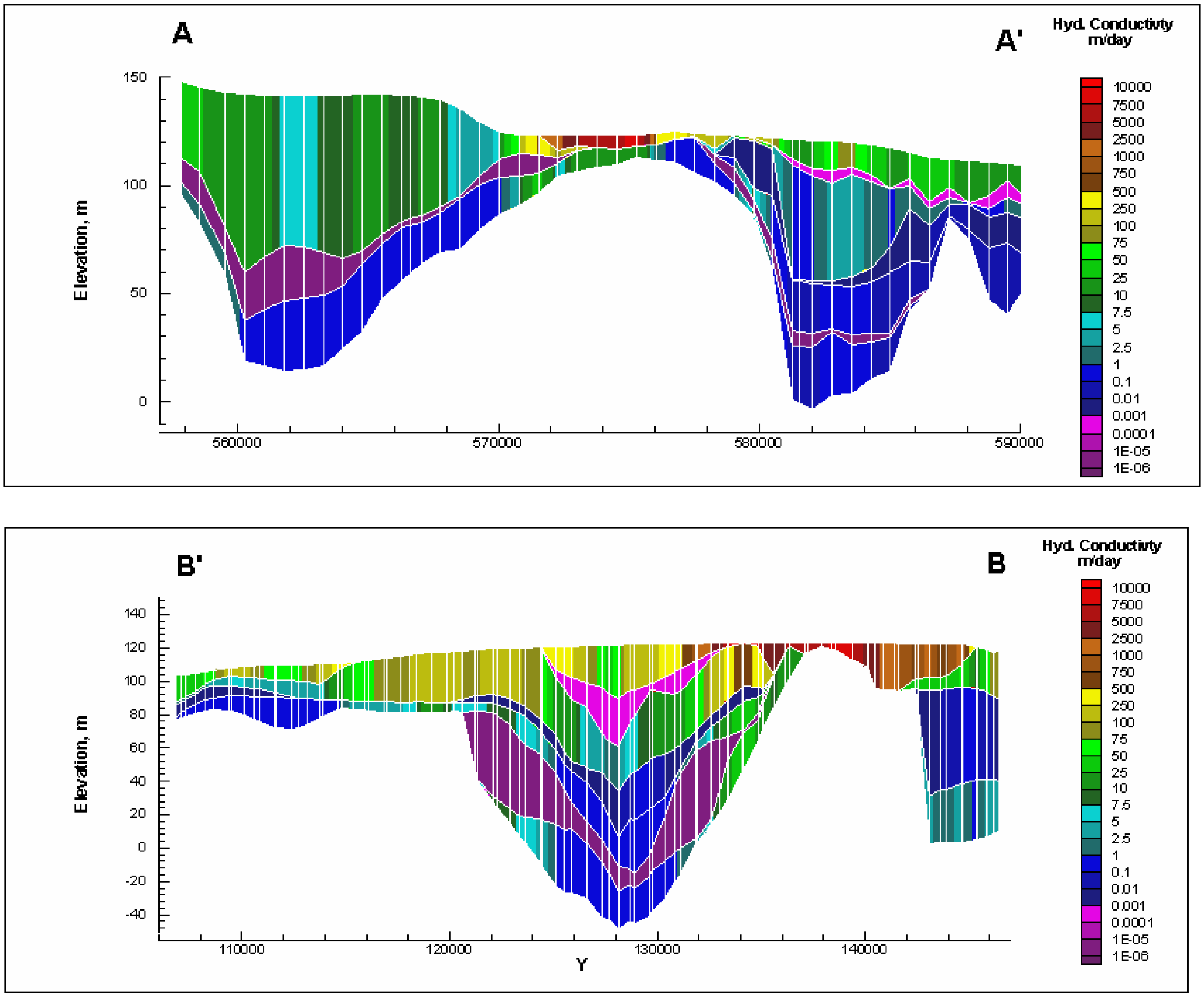

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Figure G.9. Distribution of Estimated Hydraulic Conductivities Along Section Lines A-A' and B-B' from Best-Fit Inverse Calibration of Sitewide Groundwater Model (after Cole et al. [2001a])

estimated from specific yields obtained from multiple well aquifer tests. These values range from 0.01 to 0.37. Laboratory measurements of porosity that range from 0.19 to 0.41 were available for samples from a few Hanford Site wells and were also considered. The few tracer tests conducted indicate effective porosities ranging from 0.1 to 0.25. Within the model, a porosity value of 0.1 was used for the Ringold Formation (Model Units 4 through 9) and a porosity value of 0.25 was used for the Hanford formation (Model Unit 1). For the expected lower water table conditions during the post-Hanford period, the Early Palouse and Plio-Pleistocene hydrogeologic units (Model Units 2 and 3) only existed above the projected water table and were not considered in the analysis. Values of distribution coefficient, bulk density, effective porosity, and dispersivity used in this analysis are discussed in more detail in Cole et al. (1997).

G.1.5.2 Simulation of Post-Closure Flow Conditions

Past projections of water table conditions after site closure have estimated the impact of Hanford operations ceasing and the resulting changes in artificial discharges that have been used extensively as a part of site waste management practices. Simulations of transient-flow conditions from 1944 through the year 3050 were conducted by Bryce et al. (2002). The three-dimensional model shows an overall decline in the hydraulic head and hydraulic gradient across the entire water table within the modeled region. Results of these simulations suggest that the water table would reach steady state between 100 to 350 years in different areas over the Hanford Site. These results were generally consistent with findings for the similar conditions in earlier modeling by Cole et al. (1997) and Kincaid et al. (1998).

Given the expected long delay of contaminants reaching the water from the LLBGs, the hydrologic framework of all groundwater transport calculations was based on a postulated post-Hanford, steady-state water table as estimated with the three-dimensional model. These conditions would only reflect estimated boundary condition fluxes (for example, natural recharge and lateral boundary fluxes) and not the effect of past and current wastewater discharges on the unconfined aquifer system.

Flow modeling results also suggest that as water levels drop in the vicinity of central areas in the model where the basalt crops out above the water table, the saturated thickness of the unconfined aquifer will decrease and the aquifer may actually dry out in certain areas. This thinning/drying of the aquifer is predicted to occur in the area just north of the 200 East Area between Gable Butte and the outcrop south of Gable Mountain, and there is the potential of this northern area of the unconfined aquifer becoming hydrologically separated from the area south of Gable Mountain and Gable Butte. Because of the uncertainty in the potential natural recharge and boundary fluxes from upgradient areas, the potential for movement of contaminants either through the gap or to the east toward the Columbia River is also uncertain. To address this uncertainty, two predicted water tables for these post-Hanford steady-state conditions, as illustrated in Figures G.10 and G.11, were considered.

The first scenario, shown in Figure G.10, estimates flow conditions where basalt sub-crops estimated to be above the water table north of the Central Plateau are consistent with those used in the most recent assessments by Bryce et al. (2002). Under this scenario, the overall flow attributes of the water table surface lead to groundwater flow and transport through the gap between Gable Mountain and Gable Butte from most areas in the 200 East and 200 West Areas. This scenario was the flow condition used in all groundwater flow and transport calculations presented in the following sections.

In the second scenario, shown in Figure G.11, flow conditions are reflective of assumed basalt sub-crops just north of the 200 East Area that are more widespread and effectively cut off the flow and transport from both the 200 East and 200 West Areas to the north through the gap between Gable Mountain and Gable Butte. The overall flow attributes of this water table surface leads to a predominant easterly flow direction from nearly all areas within the 200 East and 200 West Areas. The effect of this scenario on calculated results, while not considered in all results presented in Section G.2, is briefly discussed in the following section and in a discussion of results for Alternative Group A in Section G.2.1.

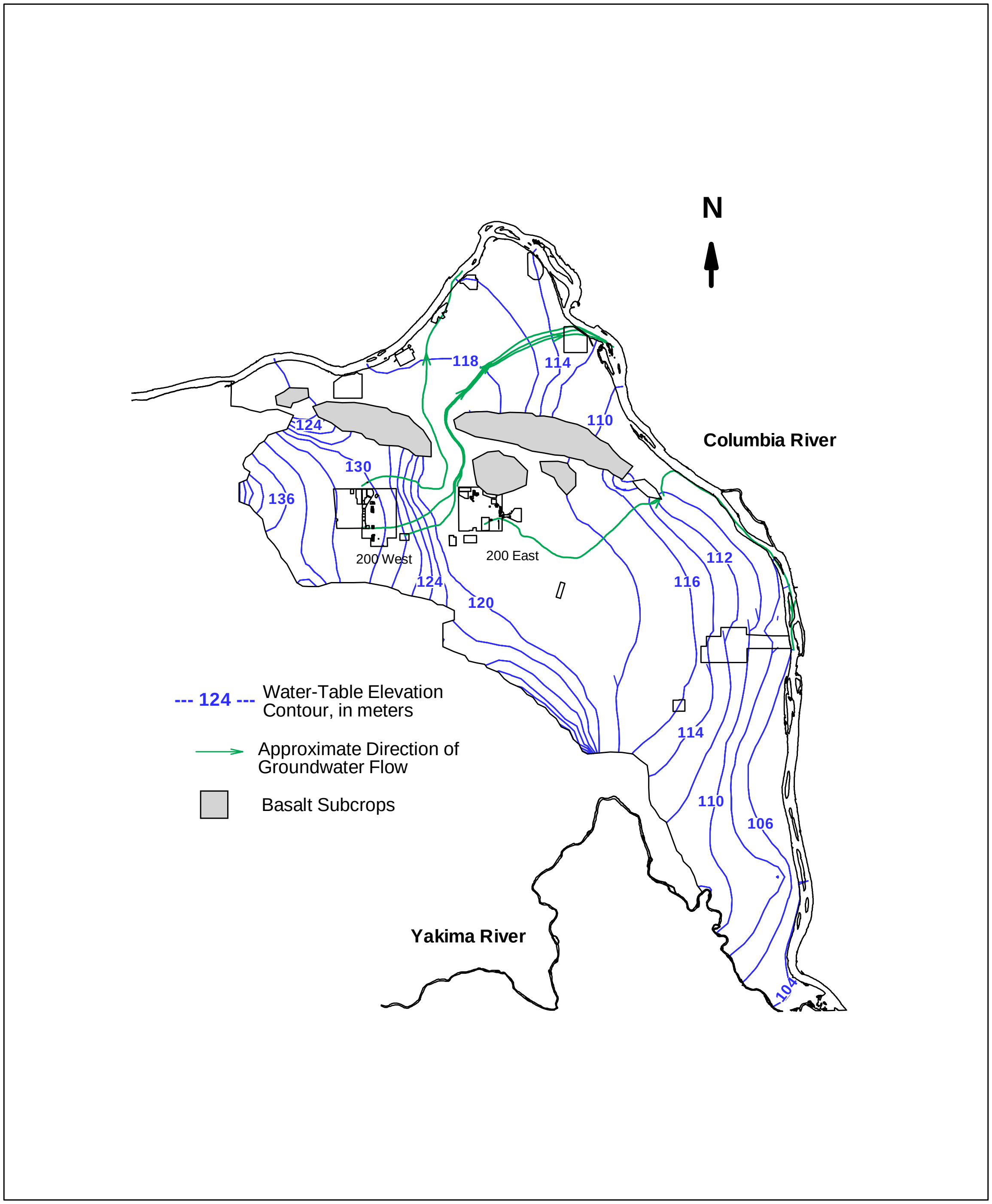

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Figure G.10. Predicted Post-Hanford Water Table Conditions (Predominant Northerly Flow)

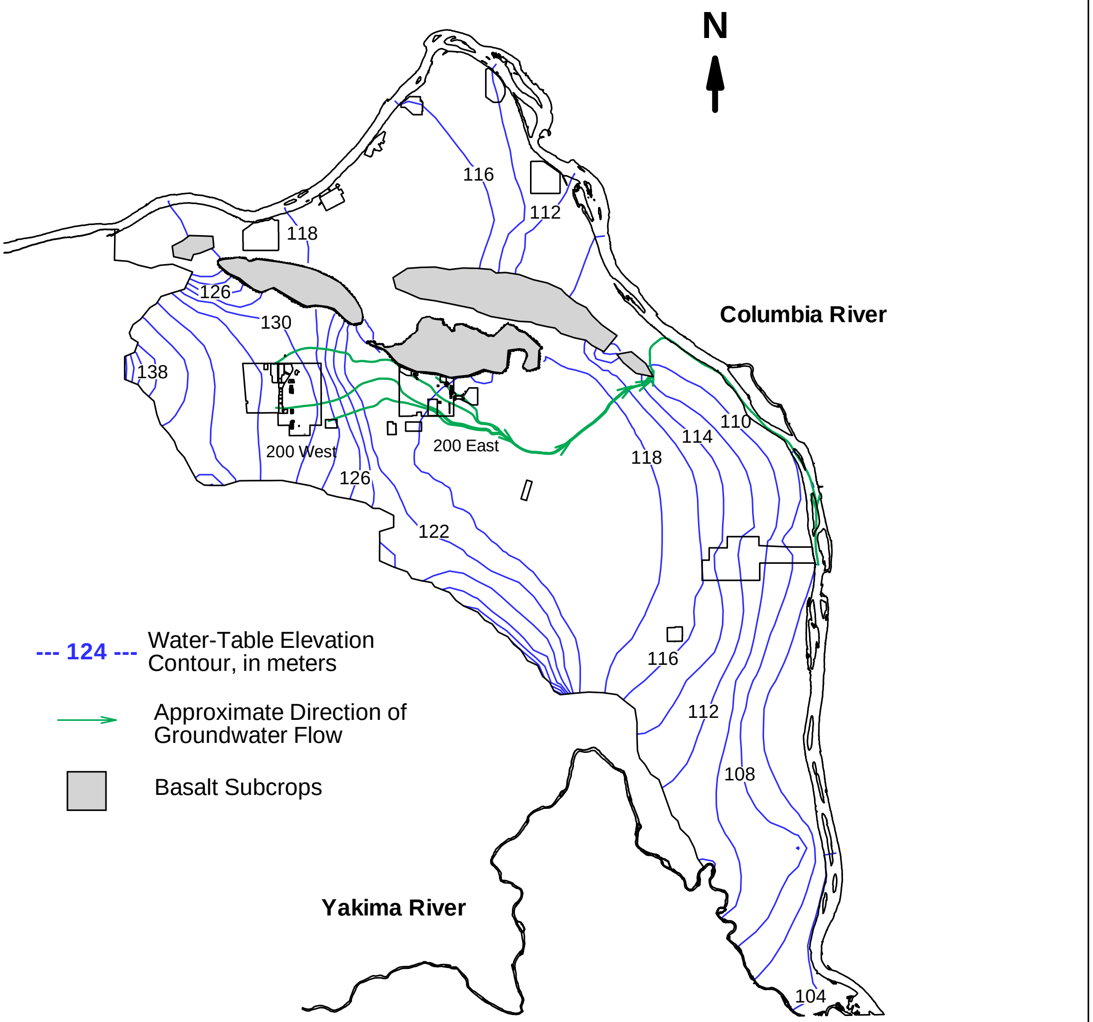

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Figure G.11. Predicted Post-Hanford Water Table Conditions (Predominant Easterly Flow)

G.1.5.3 Simulation of Unit Releases

To allow groundwater transport calculations to be used in the convolution approach for linear superposition (see Section G.1.2), a unit release was simulated with the three-dimensional model and the estimated post-Hanford, steady-state water table condition. These simulation results are used to relate the effect of known release (1 curie over a 10-year period) to predicted concentrations at various points in the aquifer system. Example results of simulated groundwater concentrations in response to a unit release of a long-lived, mobile (non-sorbing) contaminant over a period of 10 years from MLLW disposal sites in the 200 West and 200 East Areas are illustrated in Figures G.12 and G.13, respectively. These simulations were made using the groundwater conceptual model with a predominant northerly flow pattern out of the Central Plateau.

The same calculations were also made using the alternative groundwater conceptual model with easterly flow from the 200 East Area. Results of this model at the same MLLW disposal locations in the 200 West and East Areas are illustrated in Figures G.14 and G.15, respectively.

Results of these unit releases were evaluated to identify the maximum concentrations over time for use in the convolution approach along the LOAs downgradient of the 200 East and West Areas and ERDF HSW disposal areas (see Figure G.6) as appropriate for each alternative group. Because the location of different waste categories within each of the aggregate HSW disposal areas varies as specified for each alternative group, the locations of maximum concentration along the LOAs may not necessarily correspond to the same location for each waste category specified within and across alternative groups. This is particularly true for breakthrough curves developed for LOAs near the Columbia River where the location of maximum concentration varies in time as the simulated plumes migrate north to the Columbia River. The specific calculations presented here were used to evaluate groundwater transport of contaminants in Group 1 (technetium-99 and iodine-129). Similar calculations were made to evaluate groundwater transport of the same Group 1 contaminants and for contaminants in Group 2 (carbon-14 and uranium isotopes) for other waste category locations in the overall convolution approach.

A comparison of unit release breakthrough curves for Group 1 constituents at the 200 East and West Area, ERDF, and Columbia River LOAs for the two alternative groundwater conceptual models are presented in a series of plots in Figures G.16 and G.17 for all waste categories to illustrate differences in results for the two-groundwater conceptual models. Under the first alternative model, potential impacts from LLW disposed of in the 200 East Area LLBGs are evaluated at the 200 East Area NW LOA. Potential impacts from LLW disposed of near the PUREX Plant are evaluated at the 200 East Area SE LOA. Under the second alternative, where groundwater flow is toward the east from the 200 Areas, potential impacts from LLW disposed of in the 200 East Area LLBGs or near the PUREX Plant are evaluated at the 200 East Area SE LOA.

Results of these unit releases were evaluated to identify the maximum concentrations over time for use in the convolution approach along the LOAs downgradient of the 200 East and West Areas and the ERDF HSW disposal areas (see Figure G.1) as appropriate for each alternative group. Because the location of different waste categories within each of the aggregate HSW disposal areas varies as specified for each alternative group, the locations of maximum concentration along the LOAs may not necessarily correspond to the same location for each waste category specified within and across alternative groups.

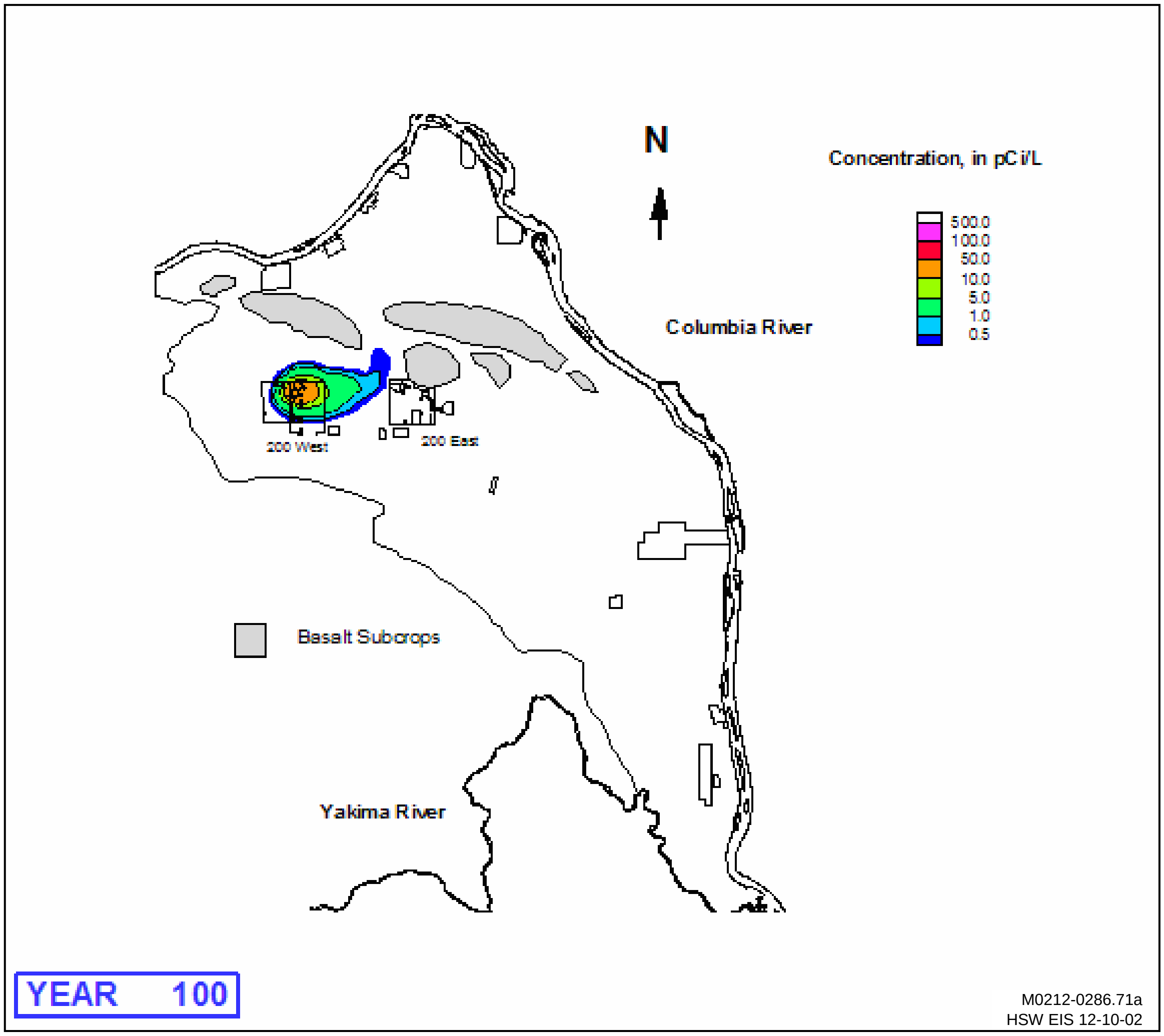

Figure G.12a. Simulated Transport of a 10-Year Unit Release (1 Curie) of a Contaminant Representative of Mobility Class 1[a] from MLLW in the 200 West Area at 100 Years After Release Using a Groundwater Model with a Predominant Northerly Flow from the Central Plateau

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(a) These simulation results relate the effect of an assumed release (1 curie over a period of 10 years) of a hypothetical, long-lived contaminant in Mobility Class 1 to predicted concentrations at various points in the aquifer system. These results provide the basis for the groundwater transport component of the convolution approach described in Section G.1.2.

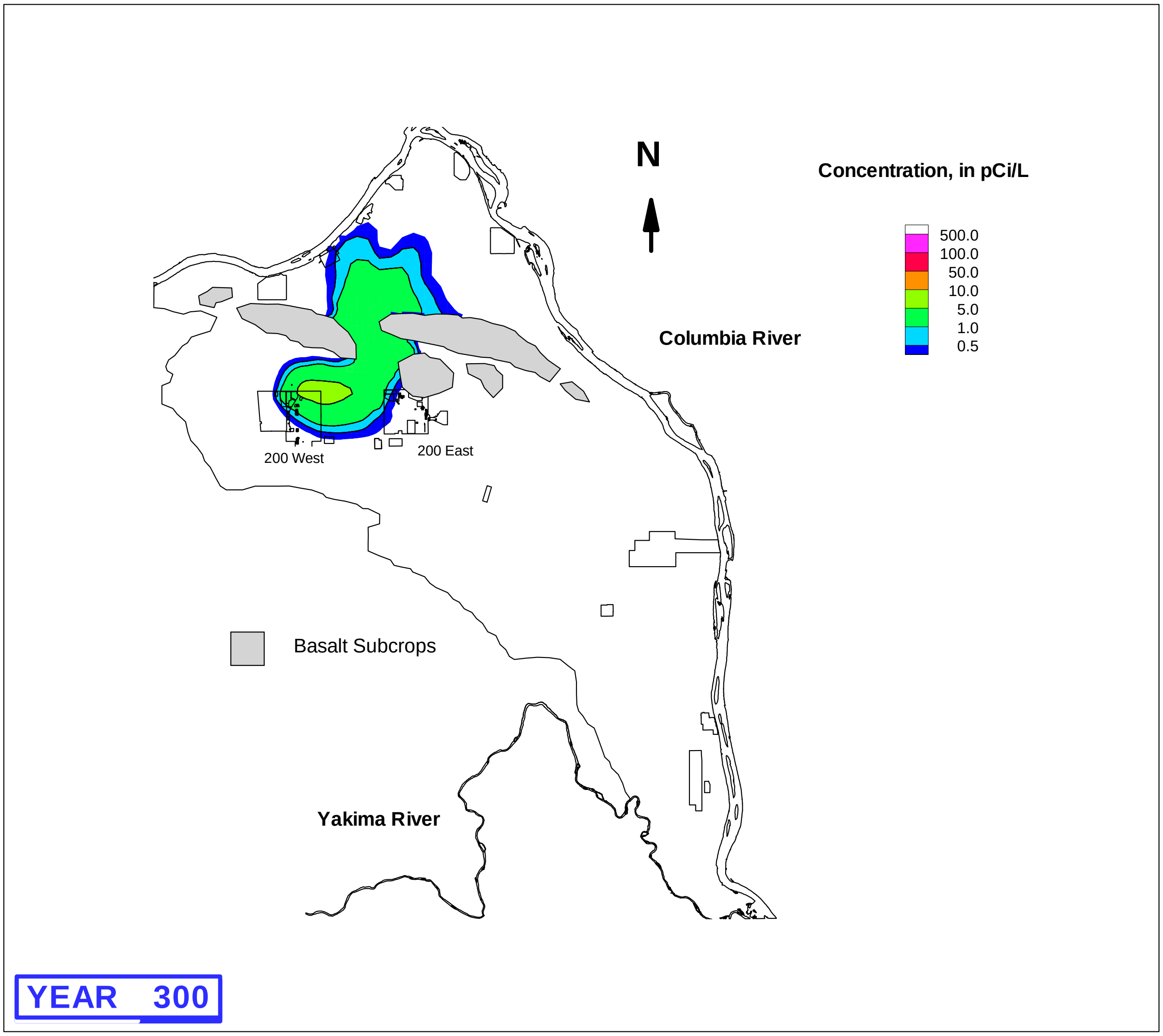

Figure G.12b. Simulated Transport of a 10-Year Unit Release (1 Curie) of a Contaminant Representative of Mobility Class 1(a) from MLLW in the 200 West Area at 300 Years After Release Using a Groundwater Model with a Predominant Northerly Flow from the Central Plateau

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(a) These simulation results relate the effect of an assumed release (1 curie over a period of 10 years) of a hypothetical, long-lived contaminant in Mobility Class 1 to predicted concentrations at various points in the aquifer system of an unretarded long-lived contaminant. These results provide the basis for the groundwater transport component of the convolution approach described in Section G.1.2.

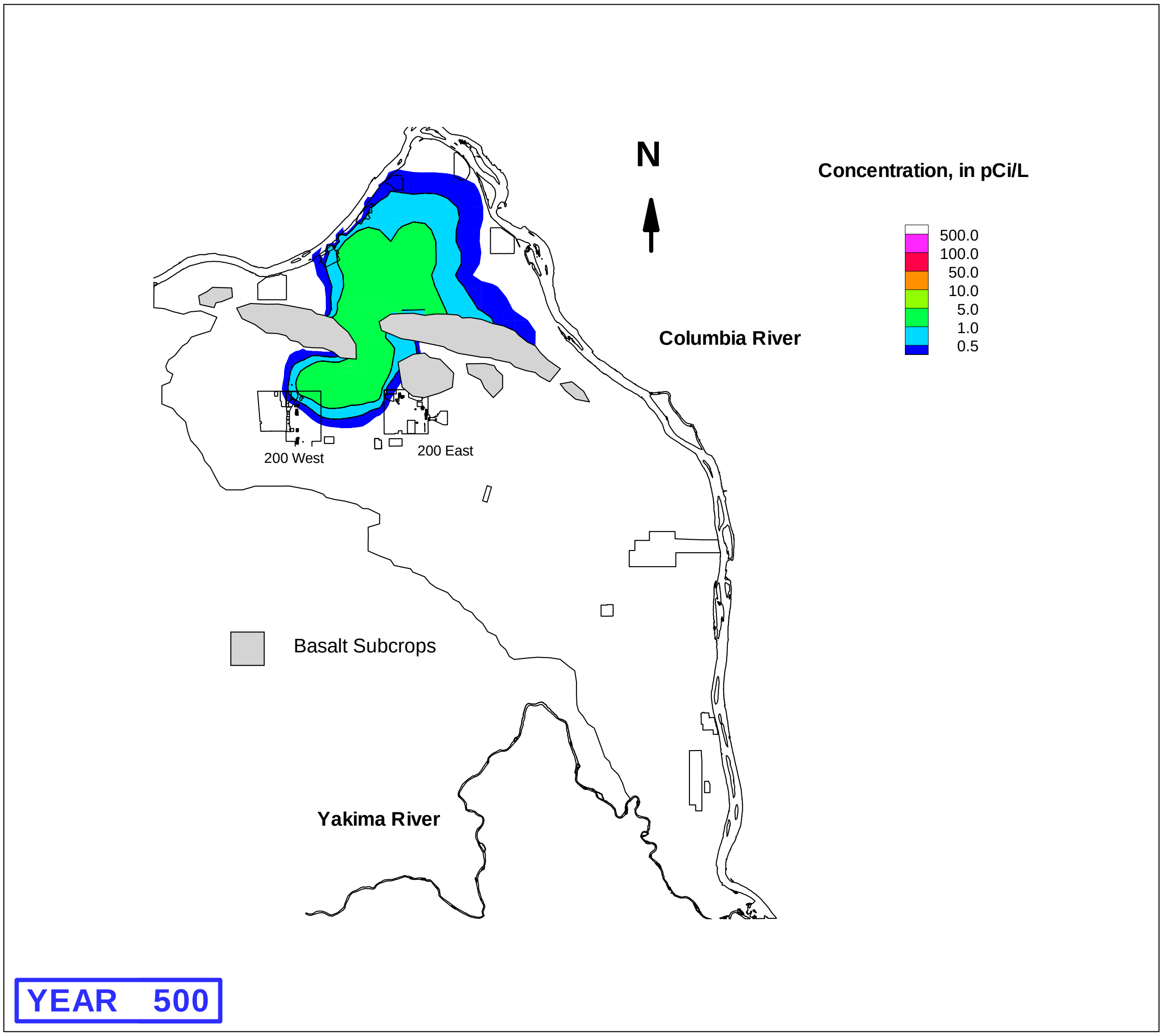

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Figure G.12c. Simulated Transport of a 10-Year Unit Release (1 Curie) of a Contaminant Representative of Mobility Class 1[(a)] from MLLW in the 200 West Area at 500 Years After Release Using a Groundwater Model with a Predominant Northerly Flow from the Central Plateau

---

(a) These simulation results relate the effect of an assumed release (1 curie over a period of 10 years) of a hypothetical, long-lived contaminant in Mobility Class 1 to predicted concentrations at various points in the aquifer system. These results provide the basis for the groundwater transport component of the convolution approach described in Section G.1.2.

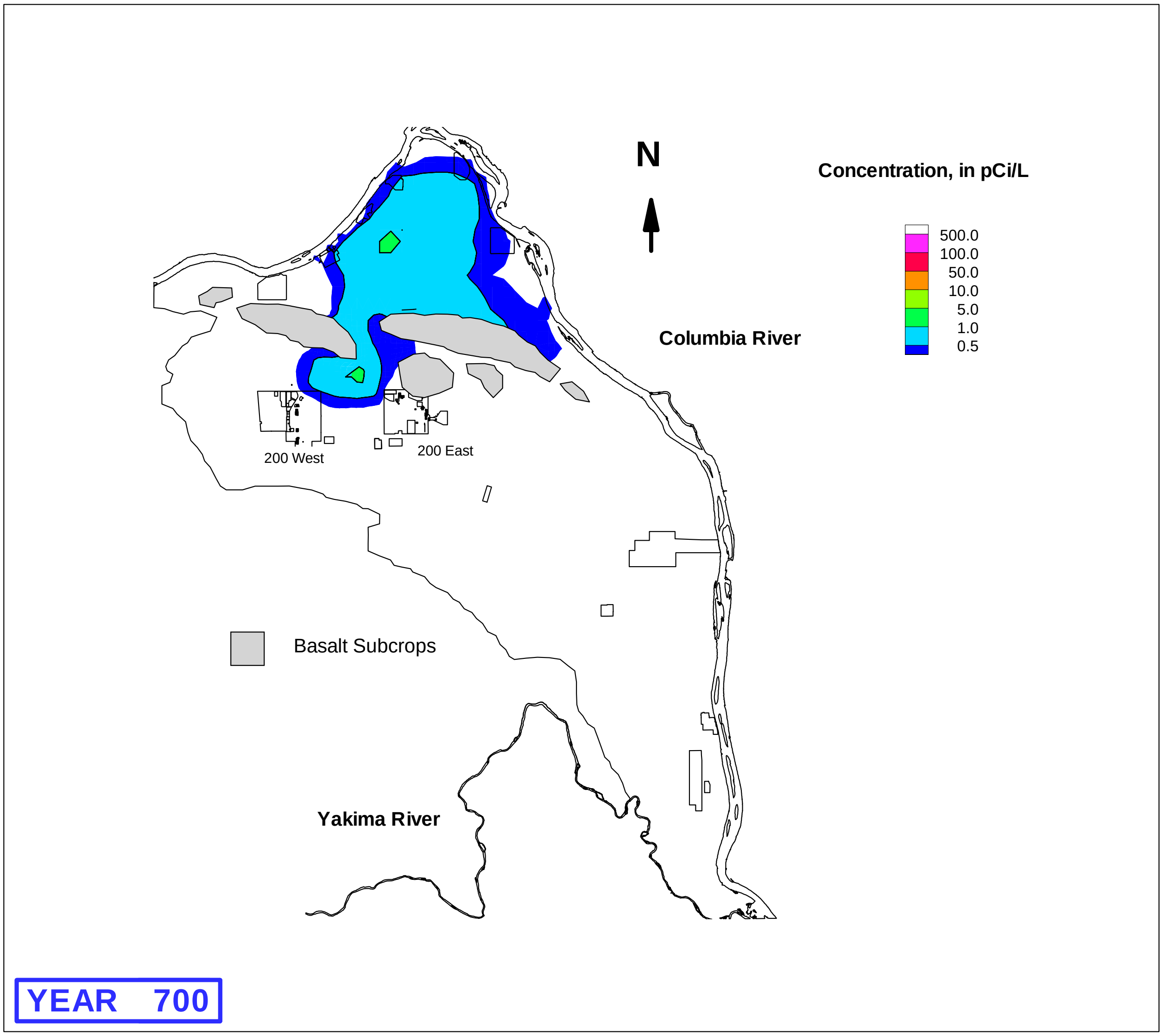

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Figure G.12d. Simulated Transport of a 10-Year Unit Release (1 Curie) of a Contaminant Representative of Mobility Class 1[(a)] from MLLW in the 200 West Area at 700 Years After Release Using a Groundwater Model with a Predominant Northerly Flow from the Central Plateau

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(a) These simulation results relate the effect of an assumed release (1 curie over a period of 10 years) of a hypothetical, long-lived contaminant in Mobility Class 1 to predicted concentrations at various points in the aquifer system. These results provide the basis for the groundwater transport component of the convolution approach described in Section G.1.2.

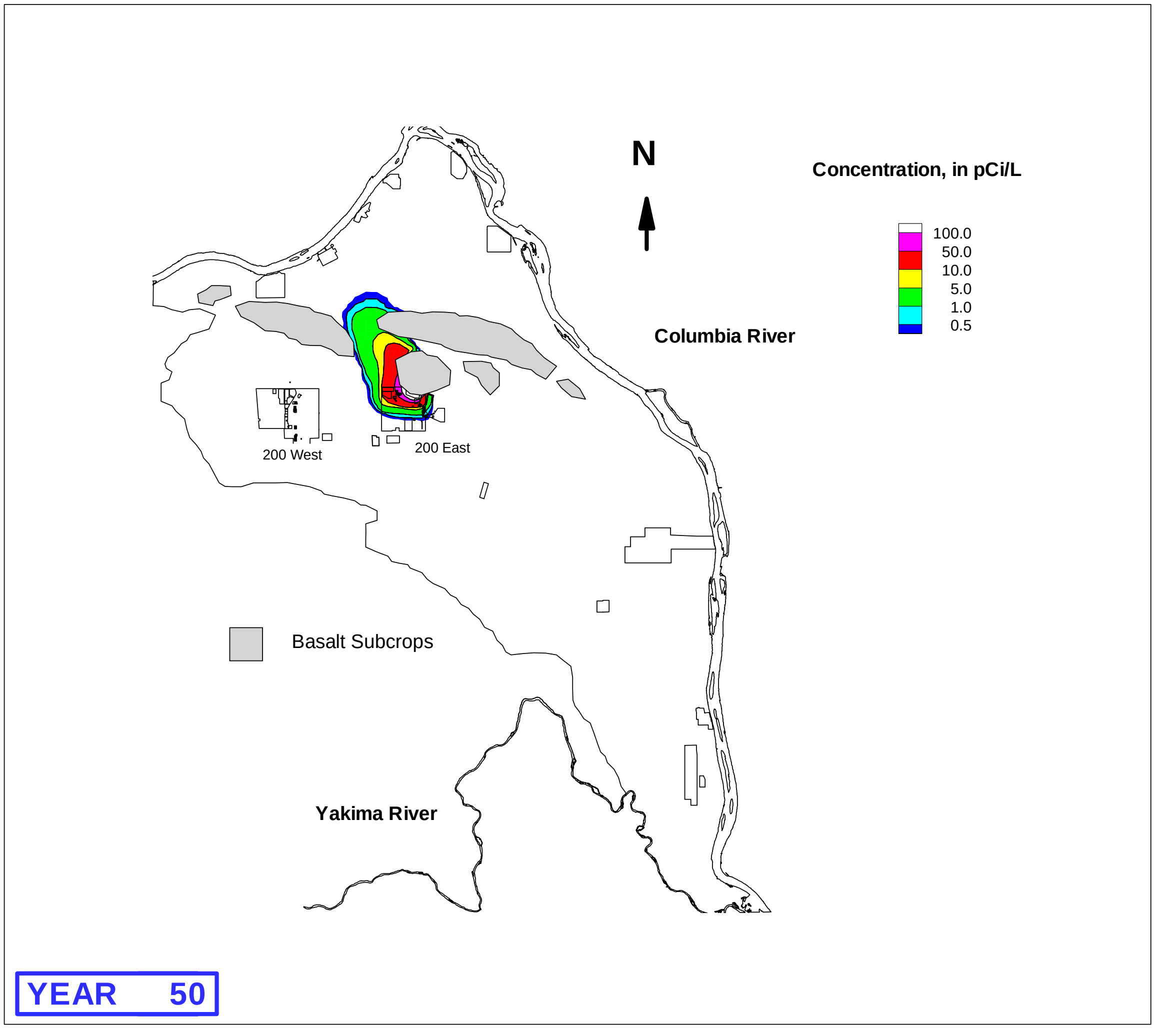

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Figure G.13a. Simulated Transport of a 10-Year Unit Release (1 Curie) of a Contaminant Representative of Mobility Class 1[(a)] from MLLW in the 200 East Area at 50 Years After Release Using a Groundwater Model with a Predominant Northerly Flow from the Central Plateau

---

(a) These simulation results relate the effect of an assumed release (1 curie over a period of 10 years) of a hypothetical, long-lived contaminant in Mobility Class 1 to predicted concentrations at various points in the aquifer system. These results provide the basis for the groundwater transport component of the convolution approach described in Section G.1.2.

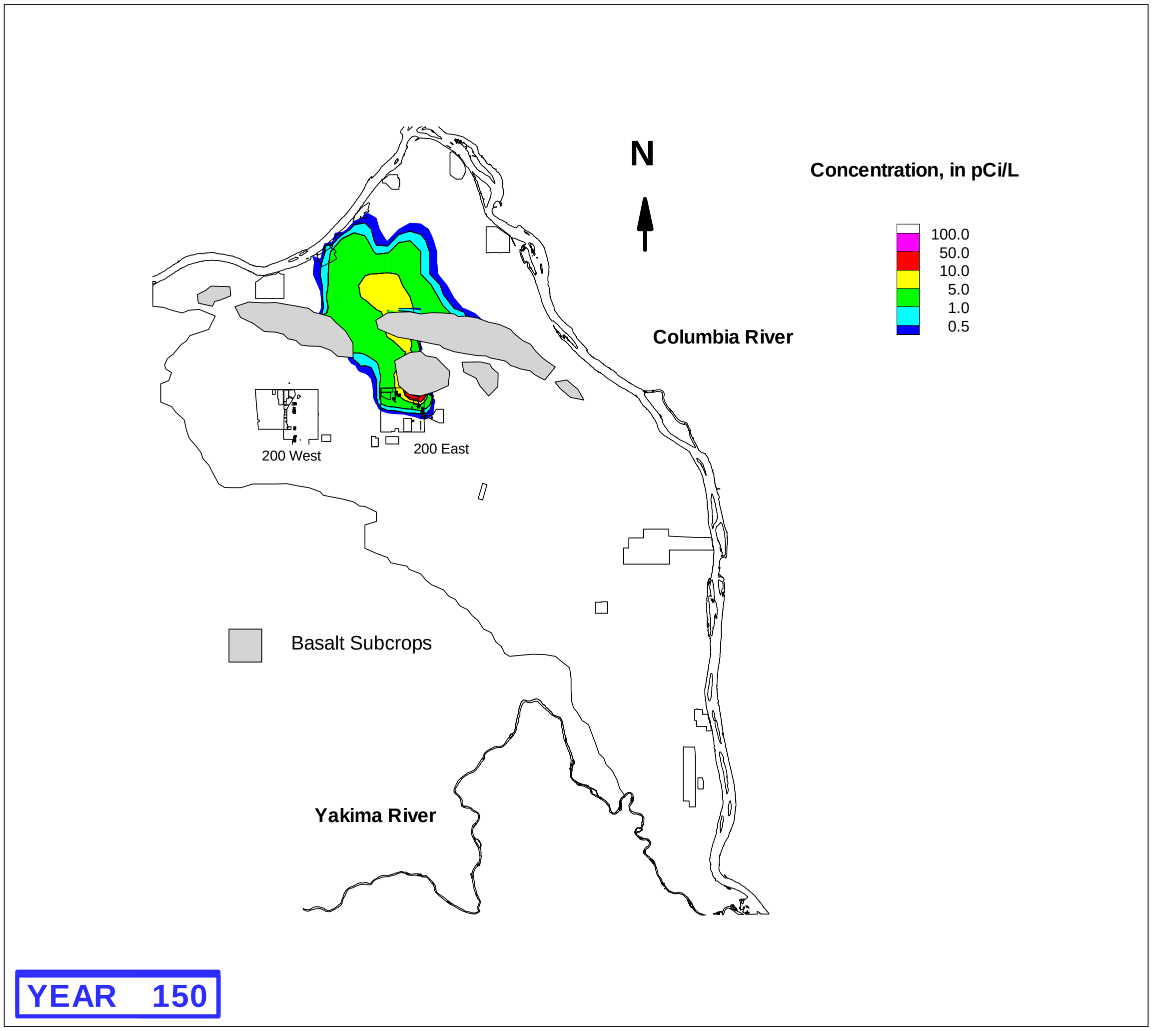

Figure G.13b. Simulated Transport of a 10-Year Unit Release (1 Curie) of a Contaminant Representative of Mobility Class 1[(a)] from MLLW in the 200 East Area at 150 Years After Release Using a Groundwater Model with a Predominant Northerly Flow from the Central Plateau

---

(a) These simulation results relate the effect of an assumed release (1 curie over a period of 10 years) of a hypothetical, long-lived contaminant in Mobility Class 1 to predicted concentrations at various points in the aquifer system. These results provide the basis for the groundwater transport component of the convolution approach described in Section G.1.2.

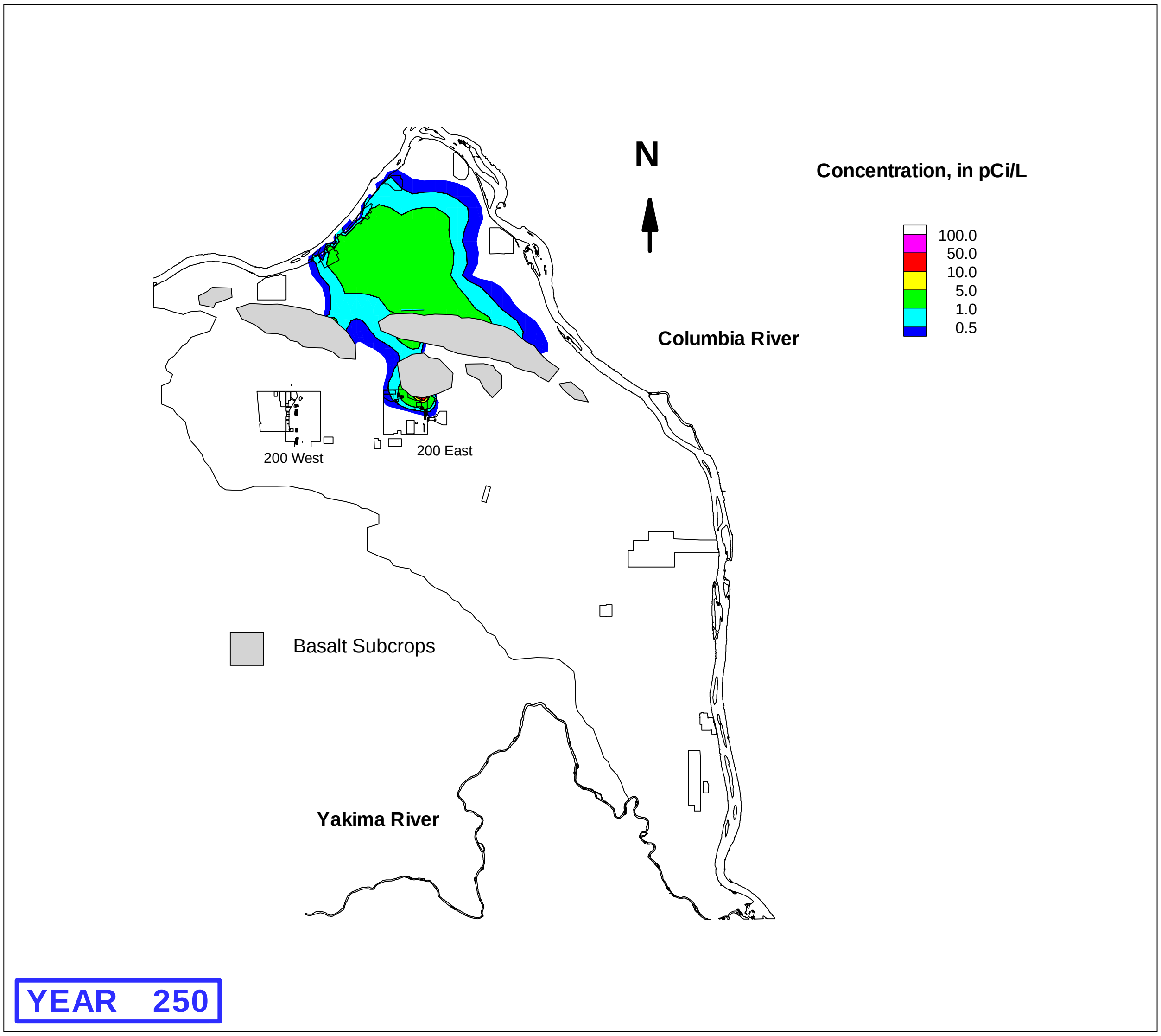

Figure G.13c. Simulated Transport of a 10-Year Unit Release (1 Curie) of a Contaminant Representative of Group 1[a] from MLLW in the 200 East Area at 250 Years After Release Using a Groundwater Model with a Predominant Northerly Flow from the Central Plateau

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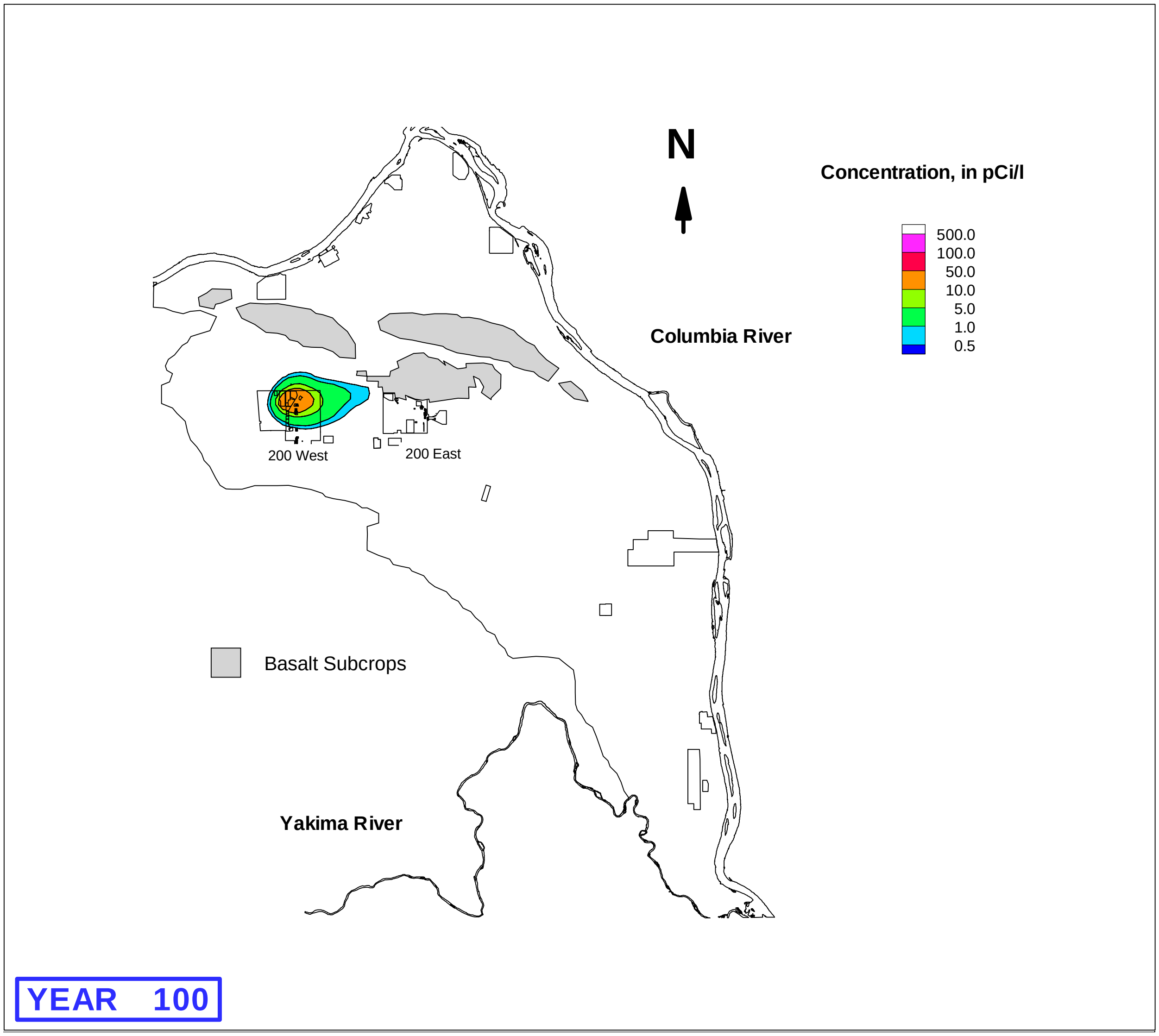
(a) These simulation results relate the effect of an assumed release (1 curie over a period of 10 years) of a hypothetical, long-lived contaminant in Mobility Class 1 to predicted concentrations at various points in the aquifer system. These results provide the basis for the groundwater transport component of the convolution approach described in Section G.1.2.



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HSW EIS 12-10-02

Figure G.14a. Simulated Transport of a 10-Year Unit Release (1 Curie) of a Contaminant Representative of Mobility Class 1[a] from MLLW in the 200 West Area at 100 Years After Release Using a Groundwater Model with a Predominant Easterly Flow from the Central Plateau

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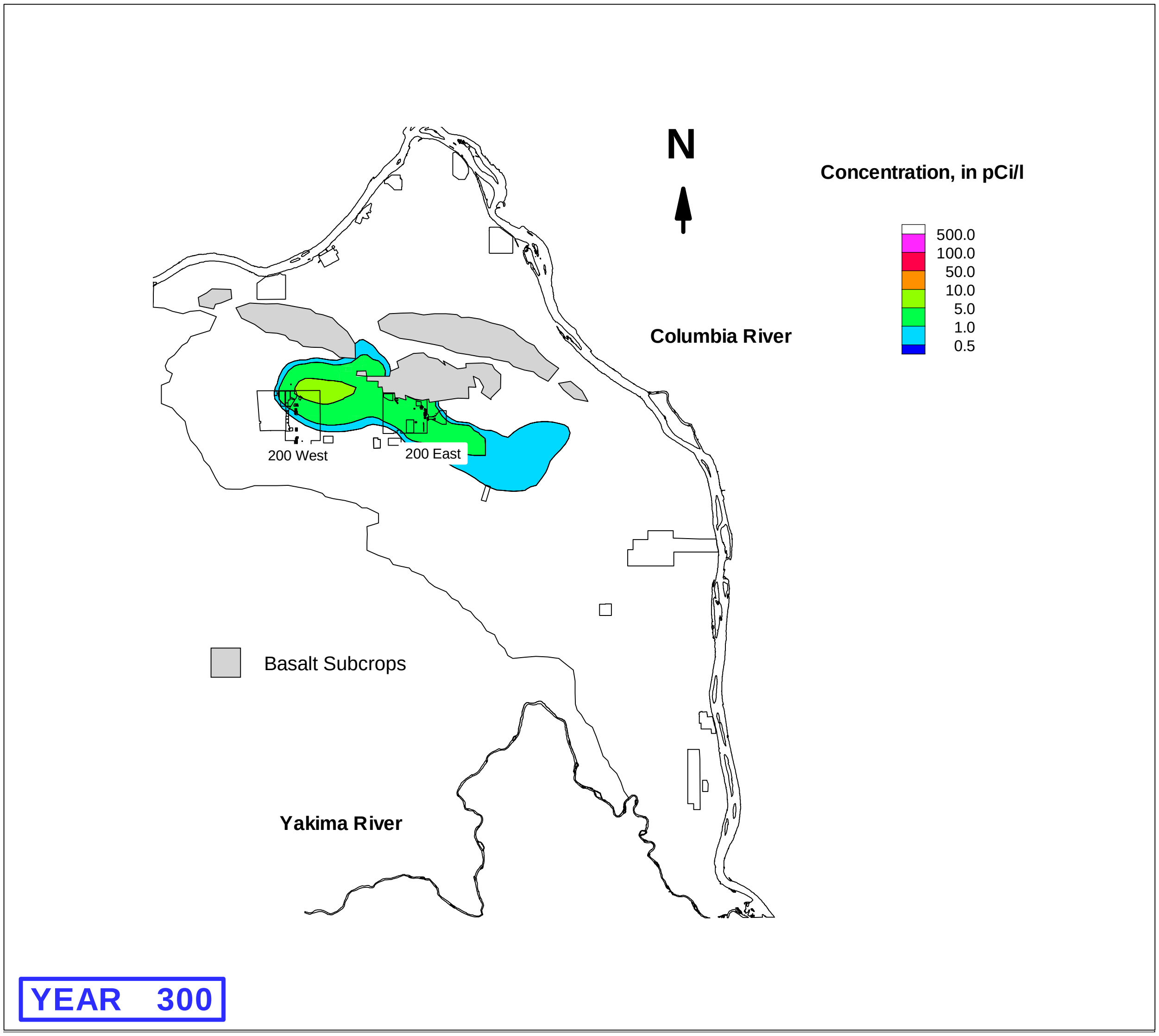
(a) These simulation results relate the effect of an assumed release (1 curie over a period of 10 years) of a hypothetical, long-lived contaminant in Mobility Class 1 to predicted concentrations at various points in the aquifer system. These results provide the basis for the groundwater transport component of the convolution approach described in Section G.1.2.



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HSW EIS 12-10-02

Figure G.14b. Simulated Transport of a 10-Year Unit Release (1 Curie) of a Contaminant Representative of Mobility Class 1[(a)] from MLLW in the 200 West Area at 300 Years After Release Using a Groundwater Model with a Predominant Easterly Flow from the Central Plateau

---

(a) These simulation results relate the effect of an assumed release (1 curie over a period of 10 years) of a hypothetical, long-lived contaminant in Mobility Class 1 to predicted concentrations at various points in the aquifer system. These results provide the basis for the groundwater transport component of the convolution approach described in Section G.1.2.

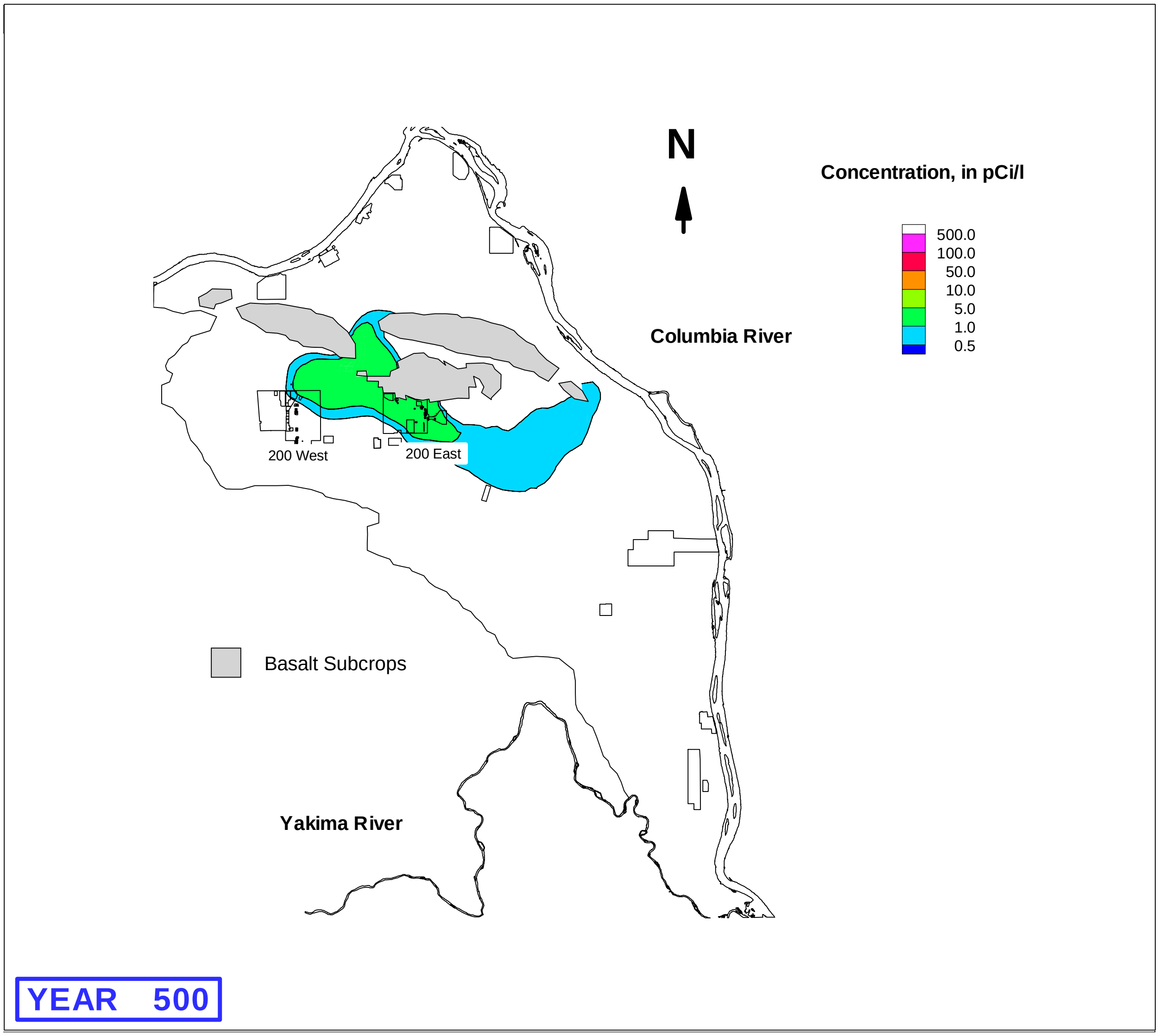

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Figure G.14c. Simulated Transport of a 10-Year Unit Release (1 Curie) of a Contaminant Representative of Mobility Class 1[a] from MLLW in the 200 West Area at 500 Years After Release Using a Groundwater Model with a Predominant Easterly Flow from the Central Plateau

---

(a) These simulation results relate the effect of an assumed release (1 curie over a period of 10 years) of a hypothetical, long-lived contaminant in Mobility Class 1 to predicted concentrations at various points in the aquifer system. These results provide the basis for the groundwater transport component of the convolution approach described in Section G.1.2.

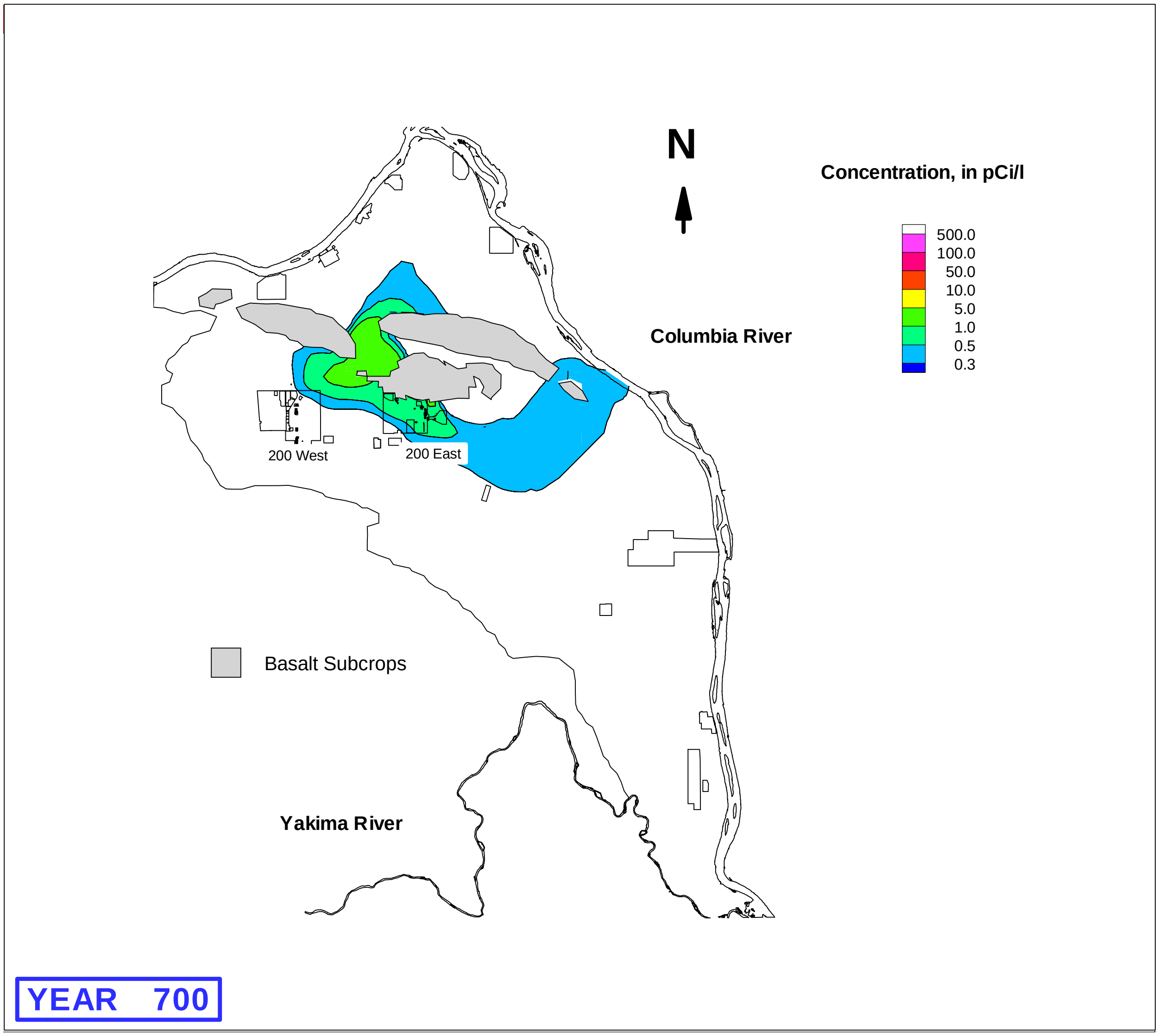


Figure G.14d. Simulated Transport of a 10-Year Unit Release (1 Curie) of a Contaminant Representative of Mobility Class 1[(a)] from MLLW in the 200 West Area at 700 Years After Release Using a Groundwater Model with a Predominant Easterly Flow from the Central Plateau

---

(a) These simulation results relate the effect of an assumed release (1 curie over a period of 10 years) of a hypothetical, long-lived contaminant in Mobility Class 1 to predicted concentrations at various points in the aquifer system. These results provide the basis for the groundwater transport component of the convolution approach described in Section G.1.2.

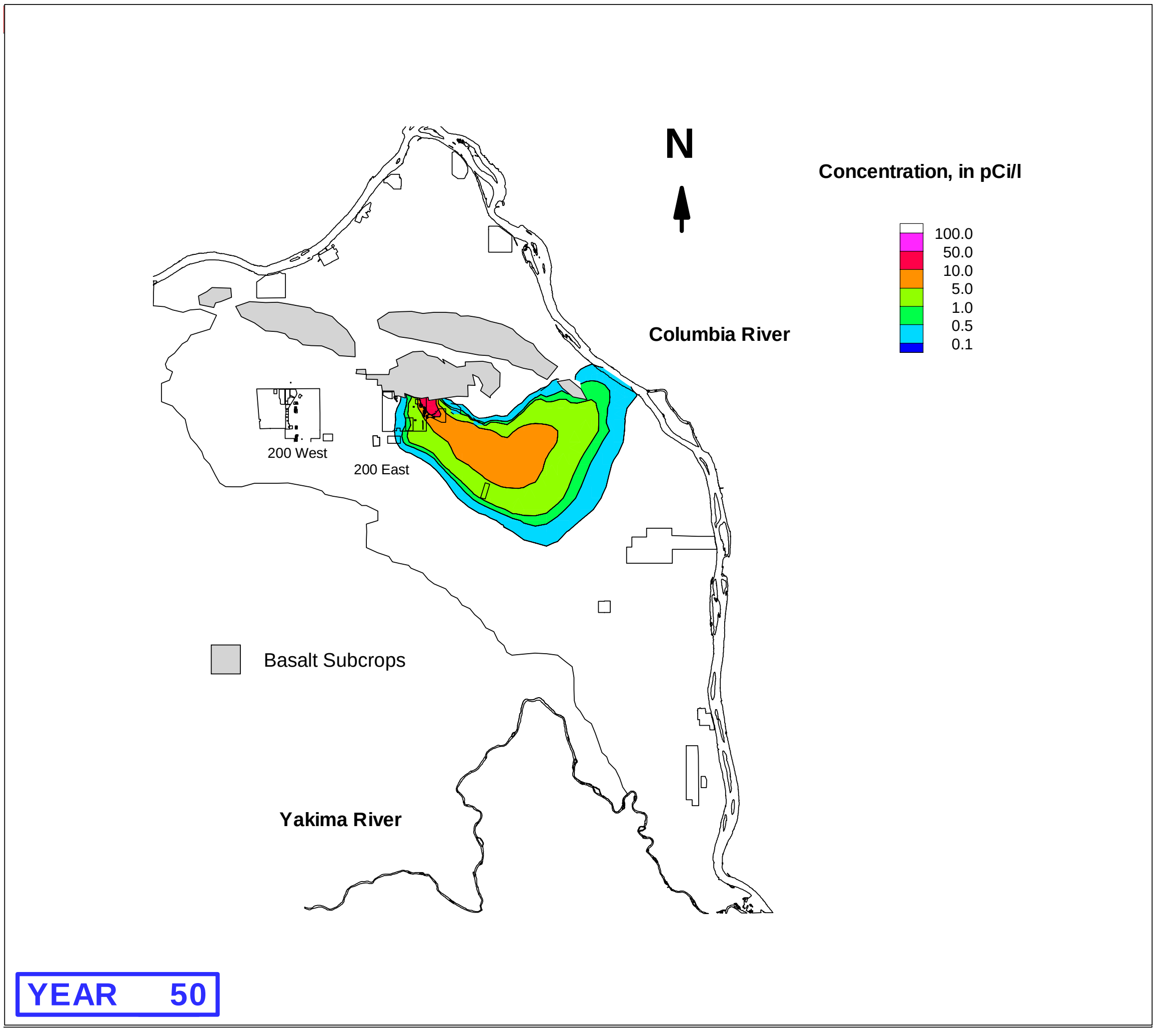
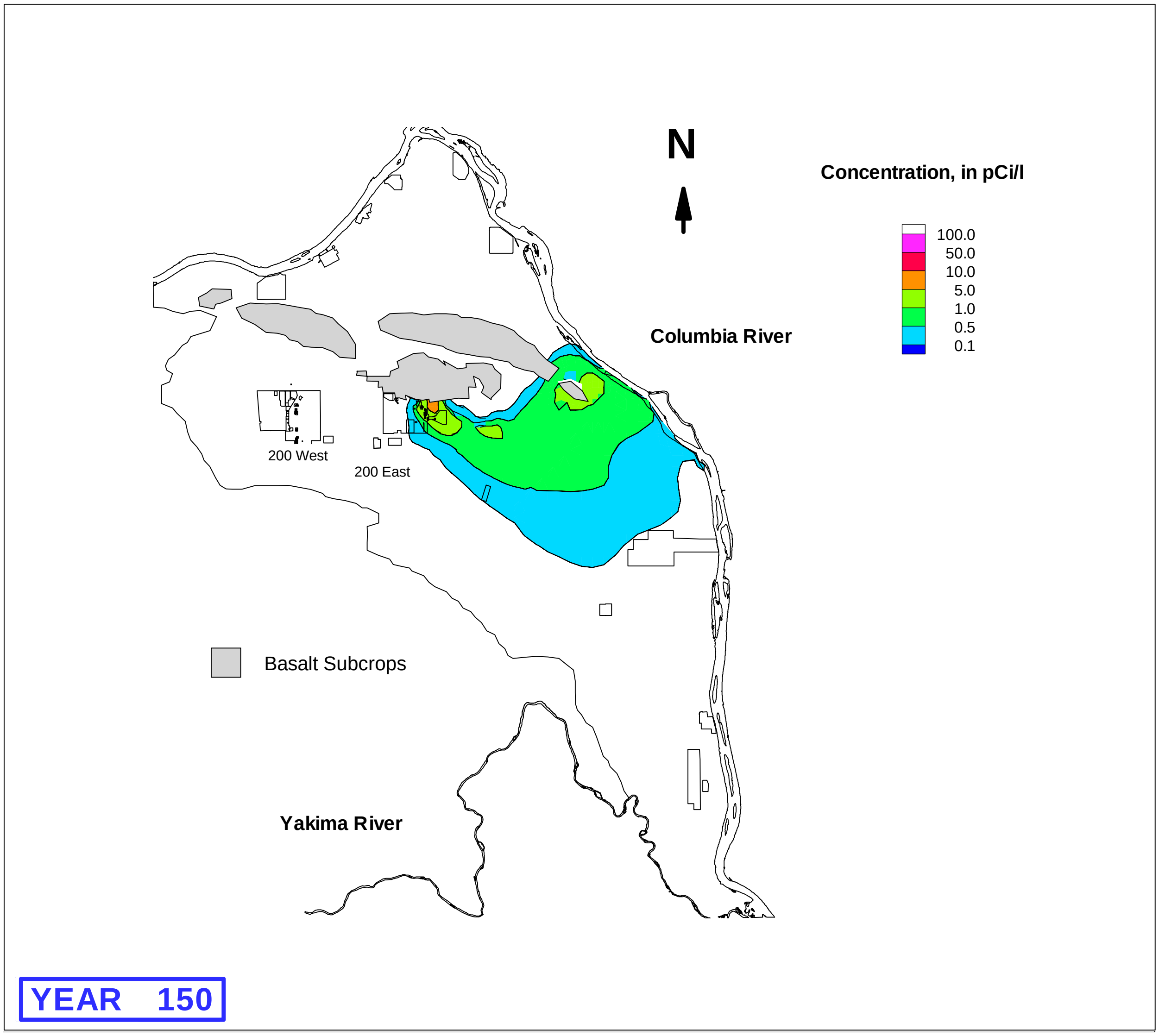


Figure G.15a. Simulated Transport of a 10-Year Unit Release (1 Curie) of a Contaminant Representative of Mobility Class 1[(a)] from MLLW in the 200 East Area at 50 Years After Release Using a Groundwater Model with a Predominant Easterly Flow from the Central Plateau

---

(a) These simulation results relate the effect of an assumed release (1 curie over a period of 10 years) of a hypothetical, long-lived contaminant in Mobility Class 1 to predicted concentrations at various points in the aquifer system. These results provide the basis for the groundwater transport component of the convolution approach described in Section G.1.2.



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HSW EIS 12-10-02

Figure G.15b. Simulated Transport of a 10-Year Unit Release (1 Curie) of a Contaminant Representative of Mobility Class 1[(a)] from MLLW in the 200 East Area at 150 Years After Release Using a Groundwater Model with a Predominant Easterly Flow from the Central Plateau

---

(a) These simulation results relate the effect of an assumed release (1 curie over a period of 10 years) of a hypothetical, long-lived contaminant in Mobility Class 1 to predicted concentrations at various points in the aquifer system. These results provide the basis for the groundwater transport component of the convolution approach described in Section G.1.2.

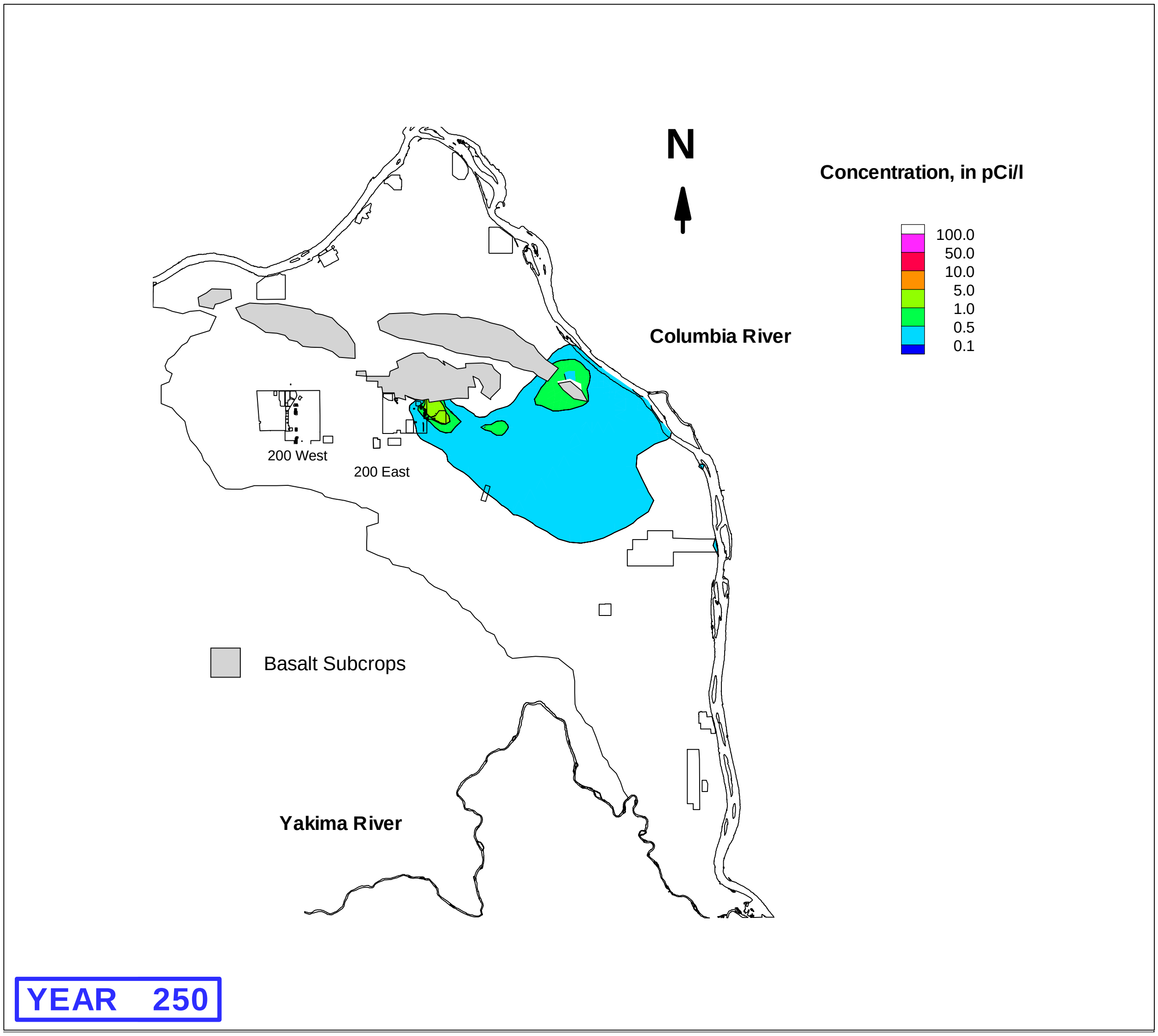

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Figure G.15c. Simulated Transport of a 10-Year Unit Release (1 Curie) of a Contaminant Representative of Mobility Class 1[a] from MLLW in the 200 East Area at 250 Years After Release Using a Groundwater Model with a Predominant Easterly Flow from the Central Plateau

---

(a) These simulation results relate the effect of an assumed release (1 curie over a period of 10 years) of a hypothetical, long-lived contaminant in Mobility Class 1 to predicted concentrations at various points in the aquifer system. These results provide the basis for the groundwater transport component of the convolution approach described in Section G.1.2.

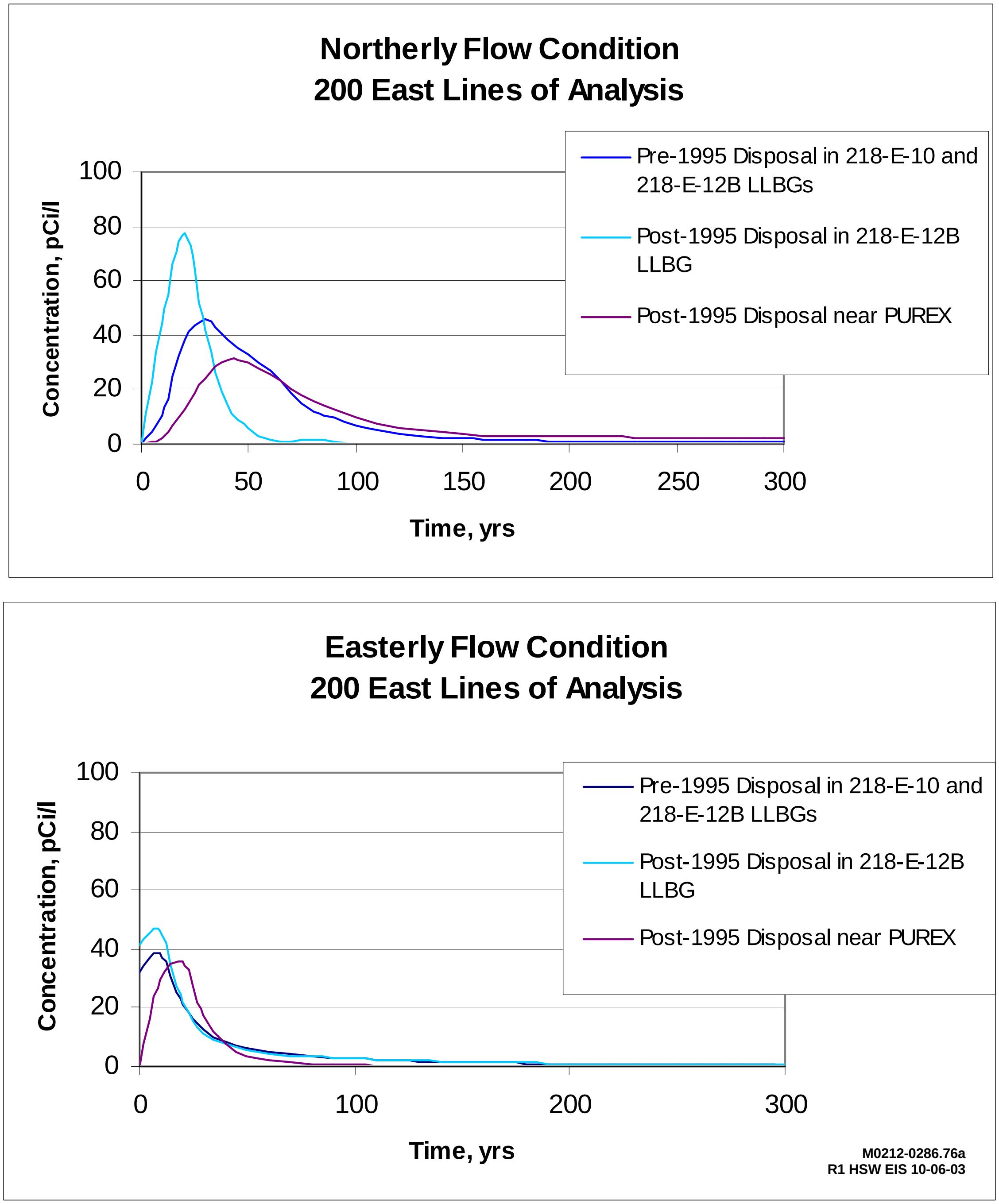


Figure G.16a. Comparison of Predicted Concentrations from Unit Releases from the 200 East Area at 200 East LOAs Using Groundwater Models with a Predominant Northerly and Easterly Flow from the Central Plateau

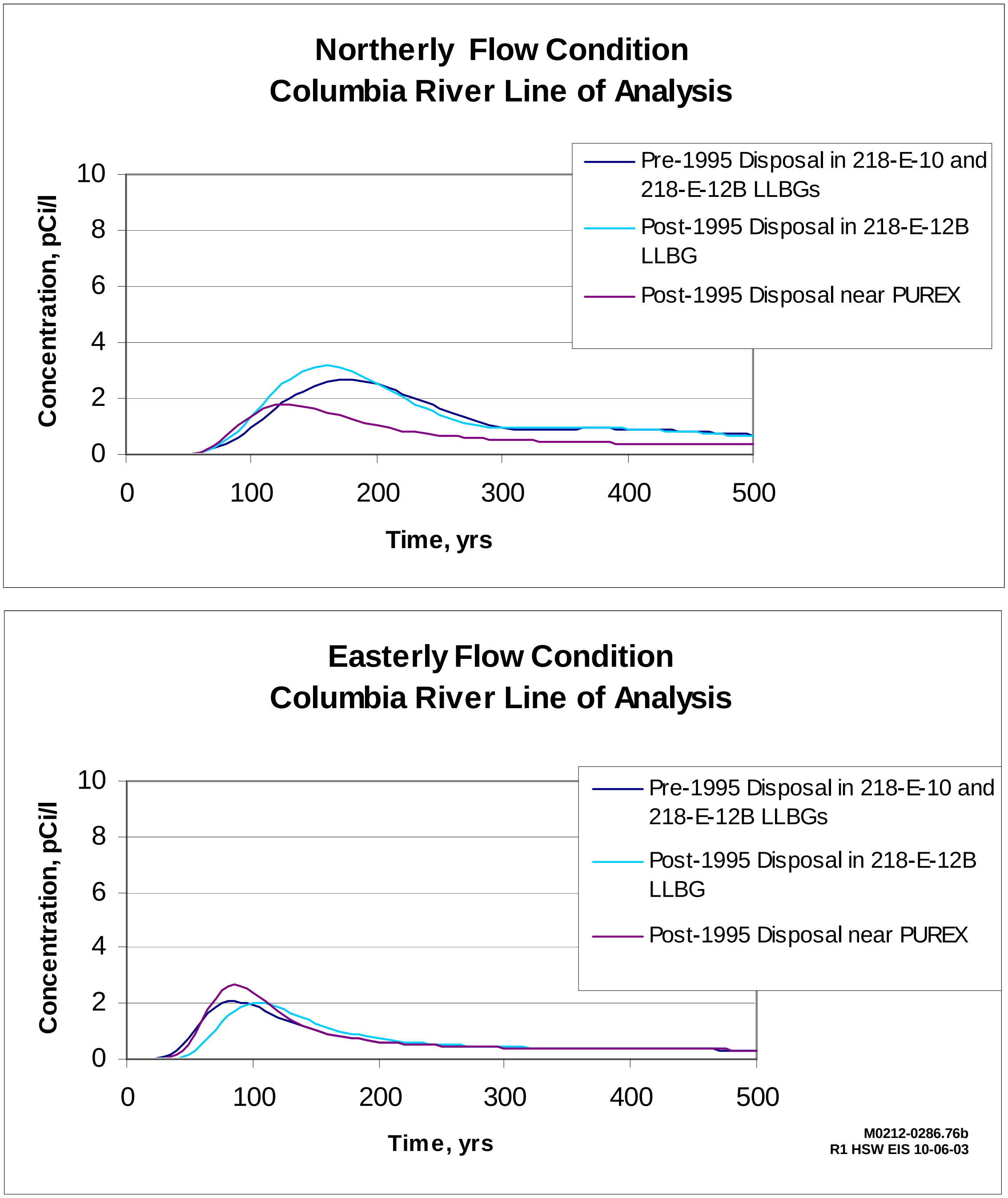


Figure G.16b. Comparison of Predicted Concentrations from Unit Releases from the 200 East Area at Columbia River LOA Using Groundwater Models with a Predominant Northerly and Easterly Flow from the Central Plateau

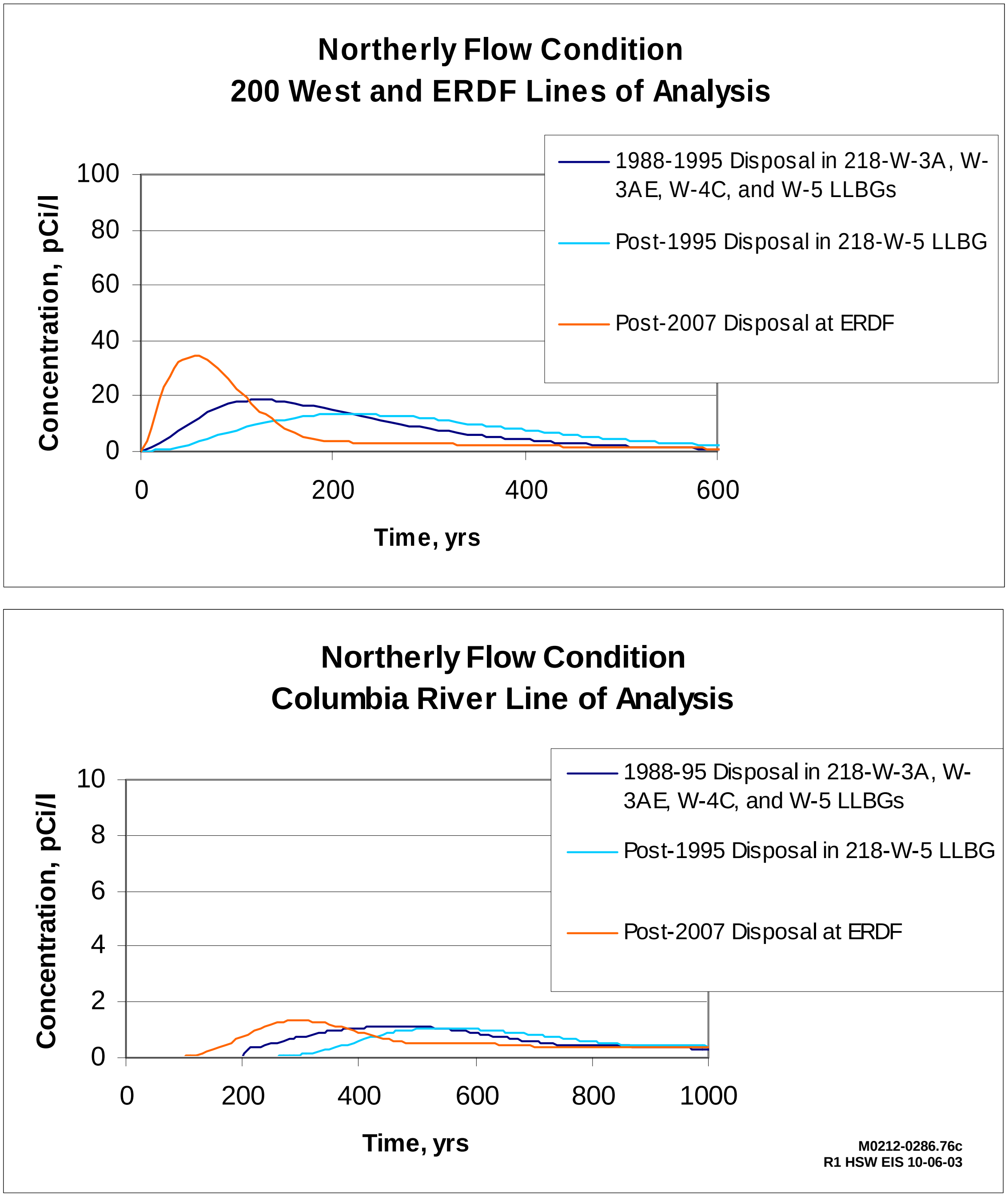


Figure G.17a. Comparison of Predicted Concentrations from Unit Releases from the 200 West Area at the 200 West and ERDF LOAs Using Groundwater Models with a Predominant Northerly and Easterly Flow from the Central Plateau

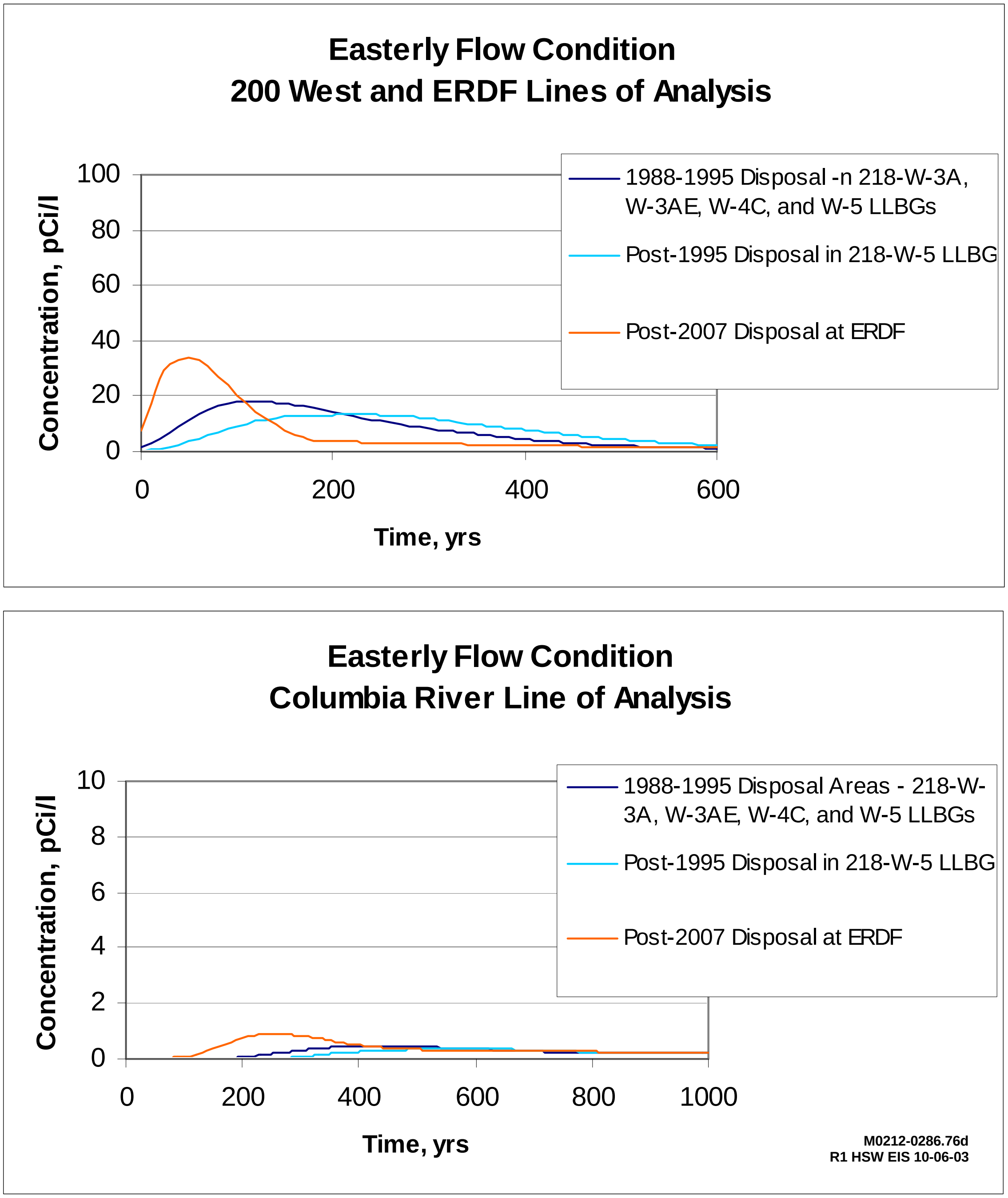


Figure G.17b. Comparison of Predicted Concentrations from Unit Releases from the 200 West Area at the Columbia River LOA Using Groundwater Models with a Predominant Northerly and Easterly Flow from the Central Plateau

This is particularly true for breakthrough curves developed for the LOA near the Columbia River where the location of maximum concentration varies in time as the simulated plumes migrate north to the Columbia River.

G.2 Potential Groundwater Quality Impact Results

Potential impacts on groundwater are provided in the following sections as peak concentrations of contaminants in well water and the time of occurrence. Because of the variation in the location of the different waste types and category releases for a given alternative group, the estimated maximum concentrations calculated from a specific waste category release, provided in Tables G.7 through G.38, may not correspond to the same point on the line of analysis for every waste category and alternative group. Combined concentration levels presented in the following text for each LOA and alternative group reflect the summation of estimated concentration levels regardless of their position on the LOA.

The alternatives, waste types, and disposal conditions are briefly stated to establish the framework for comparing the results. The tables and figures referred to in the following discussion are provided at the end of this section.

G.2.1 Alternative Group A

LLW considered in Alternative Group A includes wastes to be disposed of in several categories:

- Pre-1970 LLW
- 1970–1987 LLW
- 1988–1995 LLW
- 1996–2007 Cat 1 and Cat 3 LLW
- Cat 1 and Cat 3 LLW and MLLW disposed of after 2007 in deeper (18 m) (59 ft) and wider trenches in existing LLBGs 218-E-12B and 218-W-5
- melters disposed of after 2007 in a 21-m (69-ft) deep trench near the PUREX Plant
- ILAW disposed of after 2007 in a disposal facility near the PUREX Plant.

Tabular results of groundwater quality impacts for Alternative Group A are summarized in Tables G.7 through G.9 for wastes disposed of before 2008 and in Tables G.10 through G.12 for wastes disposed of after 2007. Graphical results of groundwater quality impacts are provided in Figures G.18 through G.22 for wastes disposed of before 1996 and in Figures G.23 through G.32 for wastes disposed of after 1996. Results for this alternative group include:

- Predicted peak concentrations of key radionuclides from an LLBG in groundwater at the 1-km (0.6-mi) LOAs downgradient from the waste sites for wastes disposed of before 2008 (Table G.7) and wastes disposed of after 2007 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.10).

- Predicted peak concentrations of key radionuclides from an LLBG in groundwater near the Columbia River for wastes disposed of before 2008 (Table G.8) and wastes disposed of after 2007 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.11).

- Predicted peak river fluxes of key radionuclides from an LLBG to the Columbia River for wastes disposed of before 2008 (Table G.9) and wastes disposed of after 2007 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.12).

G.2.1.1 Wastes Disposed of Before 1996

Constituents released from wastes disposed of before 1996 that have the highest potential impact on groundwater quality are technetium-99 and iodine-129. Estimated combined technetium-99 and potential iodine-129 levels at the 200 East Area NW LOA peaked at about 110 years and at about 220 years at the 200 West Area LOA. Combined concentration levels of technetium-99 were relatively low (less than 20 pCi/L) downgradient from both areas and were a small percentage of the benchmark maximum contaminant level (MCL) for technetium-99 (900 pCi/L). The combined concentration levels of iodine-129 at the 200 East Area NW LOA was about 60 percent (0.6 pCi/L) of the benchmark MCL. This concentration level resulted from releases of the iodine-129 inventory in 1970–1987 LLW. The combined concentration levels of iodine-129 at the 200 West Area LOA was about 50 percent (0.5 pCi/L) of benchmark MCL. This concentration level also resulted from releases of the iodine-129 inventory in 1970–1987 LLW.

Technetium-99 and iodine-129 combined concentrations were well below benchmark MCLs by the time they reached the Columbia River. Overall concentration levels at the Columbia River LOA reached their peaks in about 260 years. Contaminant levels from sources in the 200 West Area reached their peaks near the river LOA between 500 and 600 years.

The combined concentration of carbon-14 and the uranium isotopes were found to peak at about or beyond 10,000 years. Carbon-14 concentrations at all 1-km LOAs were well below the drinking water standard (DWS) of 2000 pCi/L. Combined concentration levels of uranium-238, the dominant uranium isotope, were also well below the benchmark MCL at the 200 East and West Area LOAs at 10,000 years.

Combined contaminant flux for technetium-99 and iodine-129 inventories in previously disposed of LLW reaching the Columbia River within the 10,000-year period of analysis were estimated as follows:

- 95 Ci of technetium-99 (peak loading of 0.1 Ci/yr at around 520–530 years)
- 20 Ci of iodine-129 (peak loading of 0.06 Ci/yr at about 260 years).

This amount of constituent loading does not adversely affect water quality in the Columbia River.

Respective results presented for wastes disposed of before 2008 for Alternative Group A are only presented once in Tables G.7, G.8, and G.9 since these results are the same for all action alternative groups (that is, Alternative Groups A, B, C, D_1, D_2, D_3, E_1, E_2, and E_3). Thus the discussion of results for Alternative Groups B through E will focus on results from LLW and MLLW that would be disposed of after 2007 and not repeat results for wastes disposed of before 2008.

G.2.1.2 Wastes Disposed of After 1995

Potential groundwater quality impacts from wastes disposed of after 1995 also were highest for technetium-99 and iodine-129. Technetium-99 levels at the 200 East Area NW LOA were about 8 percent (75 pCi/L) of the benchmark MCL for the Hanford Only waste volume. The source for these elevated levels is from technetium-99 from MLLW that would be disposed of after 2007. Technetium-99 levels at the 200 West Area LOA were about 33 percent (300 pCi/L) of the benchmark MCL. The source of these impacts is primarily from technetium-99 releases from Cat 3 LLW that would be disposed of after 2007. Predicted technetium-99 levels were very similar for all volumes but were slightly higher for the Upper Bound volume.

Iodine-129 levels at the 200 East Area NW LOA were about 80 percent of the DWS of 1 pCi/L for the Hanford Only volume. The main contributor to these concentration levels is MLLW that would be disposed of after 2007. Iodine-129 levels at the 200 West Area LOA were about 40 percent of the DWS of 1 pCi/L for the Hanford Only volume. The main contributor to these concentration levels is MLLW disposed of between 1996 and 2007 (see Table G.7).

Iodine-129 levels were slightly higher at the 200 East Area NW LOA and slightly lower at the 200 West Area LOA for the Upper Bound volume. This result is reflective of changes in partitioning iodine-129 inventory for the MLLW (1996–2007) waste category between the 200 East and West Areas for the Upper Bound volume (see Table G.7).

Technetium-99 and iodine-129 concentrations were well below benchmark MCLs by the time they reached the Columbia River. Overall concentration levels at the Columbia River LOA from sources in the 200 East Area reached their peaks between 1550 and 1600 years. Contaminant levels from sources in the 200 West Area reached their peaks the Columbia River LOA between 1600 and 2100 years.

Concentration levels of carbon-14 and uranium isotopes at the 1-km (0.6-m) LOAs did not reach their peak values until after the 10,000-year period of analysis and were well below benchmark MCL at 10,000 years.

Combined contaminant flux for technetium-99 and iodine-129 inventories in previously disposed of LLW reaching the Columbia River within the 10,000-year period of analysis were estimated as follows:

- 120 Ci of technetium-99 for the Hanford Only and Upper Bound volumes (peak loading was about 0.04 Ci/yr at about 1750 years)

- 0.2 Ci of iodine-129 for Hanford Only and Upper Bound volumes (peak loading was about 0.0001 Ci/yr at about 1650 years).

This amount of constituent loading does not adversely affect water quality in the Columbia River.

A qualitative analysis of these results using the alternative groundwater conceptual model described in Sections G.1.3.1 and G.1.3.2 would suggest the following:

- Arrival times and estimated concentration levels at the 1-km (0.6-m) well location downgradient for LLW and MLLW disposed of in the 218-E-12B LLBG would be expected to change because these source areas under an easterly flow condition would be closer to an aggregate HSW disposal area boundary and thus be close to the 1-km (0.6-m) well LOA. Changes would be expected to be similar to the earlier rises in concentration levels and slight increases (20 to 30 percent) of concentration levels calculated for unit releases from HSW disposal site areas of the 218-E-12B LLBG. For this alternative group, these types of changes would be expected for nearly all LLW and MLLW categories disposed of in the 218-E-12B LLBG. The most substantial potential impacts would be for key sources that were identified above, including 1) 1970–1987 LLW, 2) MLLW disposed of between 1996 and 2007, and 3) MLLW disposed of after 2007.

- No substantial changes would be expected for estimated concentration levels and impacts estimated from HSW disposal areas in the 218-E-10 LLBG in the 200 East Area and all disposal locations in the 200 West Area and at ERDF.

Respective results presented for wastes disposed of before 2008 for Alternative Group A are only presented once in Tables G.7, G.8, and G.9 since these results are the same for all action alternative groups (that is, Alternative Groups A, B, C, D_1, D_2, D_3, E_1, E_2, and E_3). Thus discussion of results for Alternative Groups B through E will focus on results from LLW and MLLW that would be disposed of after 2007 and not repeat results for LLW and MLLW disposed of between 1996 and 2007 unless the wastes include inventories that are the dominant in a particular HSW disposal area.

G.2.2 Alternative Group B

LLW considered in Alternative Group B includes the same waste considered in Alternative Group A but disposes of Cat 1 and Cat 3 LLW and MLLW in conventional trenches after 2007 in LLBGs 218-E-12B and 218-W-5 and the ILAW disposal facility located just south of the CWC.

Tabular results of groundwater quality impacts for Alternative Group A are summarized in Tables G.7 through G.9 for wastes disposed of before 2008 and in Tables G.13 through G.15 for wastes disposed of after 2007. Graphical results of these impacts are provided in Figures G.18 through G.22 for wastes disposed of before 1996 and in Figures G.33 through G.38 for wastes disposed of after 1996. Results for this alternative group include:

- Predicted peak concentrations of key radionuclides from an LLBG in groundwater at the 1-km (0.6-mi) LOA downgradient from wastes disposed of after 2007 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.13).

- Predicted peak concentrations of key radionuclides from an LLBG in groundwater near the Columbia River for wastes disposed of after 2007 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.14).

- Predicted peak river fluxes of key radionuclides from an LLBG to the Columbia River for wastes disposed of after 2007 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.15).

G.2.2.1 Wastes Disposed of Before 1996

Results for wastes disposed of before 1996 for Alternative Group A are presented in Tables G.7, G8, and G.9 and apply to Alternative Group B.

G.2.2.2 Wastes Disposed of After 1995

Because of assumptions in the source-term release and vadose zone modeling used for LLW and MLLW disposed of between 1996 and 2007 for Alternative Group B, results for this alternative group were the same for those waste categories calculated for Alternative Group A.

For waste disposed of after 1995, results showed slightly higher concentration values of both technetium-99 and iodine-129 from key wastes at all LOAs. Under this alternative group, groundwater quality was most impacted by releases of technetium-99 and iodine-129 from the disposed of LLW and MLLW. Technetium-99 levels at the 200 East Area NW LOA were about 11 and 13 percent (95 and 116 pCi/L) for the Hanford Only and Upper Bound volumes, respectively. The primary source of these elevated levels is from inventories in MLLW that would be disposed of after 2007. These higher concentration levels are generally consistent with the broader surface area of releases associated with the use of conventional trenches under this alternative group.

Technetium-99 levels at the 200 West Area LOA were estimated to be about 33 percent (300 pCi/L) of the benchmark MCL of 900 pCi/L for both the Hanford Only and Upper Bound waste volumes. These values are slightly less than levels estimated for Alternative Group A. However, this would be expected since the source of these impacts is primarily from the technetium-99 inventories in the Cat 3 LLW that would be disposed of after 2007, and the use of conventional trenches under this alternative group would result in some of the inventory associated with Cat 1 and Cat 3 LLW that would be disposed of after 2007 being emplaced in the 200 East Area.

Iodine-129 levels at the 200 East Area NW LOA were 42 and 47 percent (0.42 and 0.47 pCi/L) of the benchmark MCL of 1 pCi/L for the Hanford Only and Upper Bound waste volumes, respectively. The main contributor to these concentration levels is the release of iodine-129 inventories in ungrouted parts of the MLLW that would be disposed of after 2007. Iodine-129 levels at the 200 West Area LOA were less than 8 percent (0.08 pCi/L) of the benchmark MCL for the Hanford Only waste volume. The main contributor to these concentration levels is from iodine-129 inventories in the ungrouted part of the MLLW disposed of between 1996 and 2007 (see Table G.7).

Iodine-129 levels were slightly higher at the 200 East Area NW LOA and slightly lower at the 200 West Area LOA for the Upper Bound volume. This impact is reflective of changes in the partitioning of iodine-129 inventory for the MLLW (1996–2007) waste category between the 200 East and West Areas for the Upper Bound volume (see Table G.7).

Concentration levels of carbon-14 and uranium isotopes at the 1-km (0.6-m) well downgradient from source areas of projected LLW and MLLW did not reach their peak values until after the 10,000-year period of analysis. Concentration levels for both constituents were well below benchmark MCLs at 10,000 years.

Concentrations of all constituents were well below benchmark MCLs by the time they reached the Columbia River LOA. Overall concentration levels at the Columbia River LOA from sources in the 200 East Area reached their peaks at about 1400 years. Contaminant levels from sources in 200 West Area sources reached their peaks near the river at about 1500 years.

Combined contaminant flux for technetium-99 and iodine-129 inventories in wastes disposed of after 1995 reaching the Columbia River within the 10,000-year period of analysis were estimated as follows:

- 120 Ci of technetium-99 for the Hanford Only and Upper Bound volumes (peak loading was about 0.04 Ci/yr at about 1690 years)

- 0.2 Ci of iodine-129 for Hanford Only and Upper Bound volumes (peak loading 0.0001 Ci/yr at about 1630 years).

This amount of constituent loading does not adversely affect water quality in the Columbia River.

G.2.3 Alternative Group C

LLW considered in Alternative Group C includes the same wastes considered in Alternative Group A but disposes of Cat 1 and Cat 3 LLW and MLLW in single, lined, expandable trenches after 2007 in LLBGs 218-E-12B and 218-W-5. The melters would be placed in a lined trench, and ILAW would be placed in a single, expandable, lined trench near the PUREX Plant.

Tabular results of groundwater quality impacts for Alternative Group C are summarized in Tables G.7 through G.9 for wastes disposed of before 2008 and in Tables G.16 through G.18 for wastes disposed of after 2007. Graphical results of these impacts are provided in Figures G.18 through G.22 for wastes disposed of before 1996 and in Figures G.39 through G.44 for wastes disposed of after 1996. Results for this alternative group include:

- Predicted peak concentrations of key radionuclides from an LLBG in groundwater at the 1-km (0.6 mi) LOA downgradient from wastes disposed of after 2007 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.16).

- Predicted peak concentrations of key radionuclides from an LLBG in groundwater near the Columbia River for wastes disposed of after 2007 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.17).

- Predicted peak river fluxes of key radionuclides from an LLBG to the Columbia River for wastes disposed of after 2007 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.18).

G.2.3.1 Wastes Disposed of Before 1996

Results for wastes disposed of before 1996 for Alternative Group A are presented in Tables G.7, G.8, and G.9 and apply to Alternative Group C.

G.2.3.2 Wastes Disposed of After 1995

Because of assumptions in the source-term release and vadose zone modeling used for LLW and MLLW disposed of between 1996 and 2007 for Alternative Group C, results for this alternative group were the same for those waste categories calculated for Alternative Group A (see Tables G.7, G. 8, and G.9). Results for LLW and MLLW that would be disposed of after 2007 for this alternative group were essentially the same as the results presented in Tables G.10 through G.12 for Alternative Group A. These results are consistent since the analysis assumption about waste depth and projected land use for waste that would be disposed of after 2007 are the same for both alternative groups.

G.2.4 Alternative Group D_1

LLW considered in Alternative Group D_1 includes the same wastes considered in Alternative Group A but disposes of Cat 1 and Cat 3 LLW and MLLW in a single, lined, modular combined-use facility after 2007 near the PUREX Plant. The melter trench and the ILAW disposal facility would be placed in the same general area.

Tabular results of groundwater quality impacts for Alternative Group D_1 are summarized in Tables G.7 through G.9 for wastes disposed of before 2008 and in Tables G.19 through G.21 for wastes disposed of after 2007. Graphical results of these impacts are provided in Figures G.18 through G.22 for wastes disposed of before 1996 and in Figures G.45 through G.50 for wastes disposed of after 1996. Results for this alternative group include:

- Predicted peak concentrations of key radionuclides from an LLBG in groundwater at the 1-km (0.6 mi) LOA downgradient from wastes disposed of after 2007 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.19).

- Predicted peak concentrations of key radionuclides from an LLBG in groundwater near the Columbia River for wastes disposed of after 2007 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.20).

- Predicted peak river fluxes of key radionuclides from an LLBG to the Columbia River for wastes disposed of after 2007 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.21).

G.2.4.1 Wastes Disposed of Before 1996

Results for wastes disposed of before 1996 for Alternative Group A are presented in Tables G.7, G.8, and G.9 apply to Alternative Group D_1.

G.2.4.2 Wastes Disposed of After 1995

Because of assumptions in the source-term release and vadose zone modeling used for LLW and MLLW disposed of between 1996 and 2007 for Alternative Group D_1, results for this alternative group were the same for those waste categories calculated for Alternative Group A (see Tables G.7, G. 8, and G.9).

The highest potential impact for this alternative group reflects the emplacement of all wastes that would be disposed of after 2007 in the vicinity of the PUREX Plant. Potential impacts from LLW and MLLW would be dominated by technetium-99 and iodine-129.

Combined concentration levels for technetium-99 were about 18 to 20 percent (170 to 180 pCi/L) of the benchmark MCL at the 200 East Area SE LOA for the Hanford Only and Upper Bound volumes. The primary source for these elevated levels is from inventories in MLLW that would be disposed of after 2007. Two peaks reflect technetium-99 inventories in both Cat 3 LLW and MLLW that would be disposed of after 2007 near the PUREX Plant.

Combined technetium-99 concentration levels at the 200 Area West LOA were about 5 and 3 percent (42 and 31 pCi/L) of the benchmark MCL for the Hanford Only and Upper Bound volumes. These values are slightly less than levels estimated for Alternative Group A. The source of these impacts is primarily from the technetium-99 inventory in MLLW disposed of between 1996 and 2007 (see Table G.7). Decreased concentrations for the Upper Bound volume reflect the emplacement of some of the MLLW inventory in the 200 East Area.

Combined iodine-129 concentration levels at the 200 East SE LOA were about 28 percent (0.28 pCi/L) of the benchmark MCL for the Hanford Only and Upper Bound waste volumes. The main contributor to these concentration levels is iodine-129 inventories in ungrouted parts of the MLLW that would be disposed of after 2007.

Combined iodine-129 levels at the 200 West Area LOA were about 15 and 8 percent (0.15 and 0.08 pCi/L) of the benchmark MCL for the Hanford Only and Upper Bound waste volumes. The main contributor to these concentration levels is from ungrouted iodine-129 inventories in MLLW disposed of between 1996 and 2007 (see Table G.7). Combined iodine-129 levels were slightly higher at the 200 East Area SE LOA and slightly lower at the 200 West Area LOA for the Upper Bound waste volume. These results are reflective of changes in partitioning of iodine-129 inventory for the MLLW (1996–2007) waste category between the 200 East and West Areas for the Upper Bound waste volume (see Table G.7).

Combined concentration levels of carbon-14 and uranium isotopes at all LOAs from source areas of projected LLW and MLLW did not reach their peak values until after the 10,000-year period of analysis. Concentration levels for both constituents were well below the benchmark MCLs at 10,000 years.

Technetium-99 and iodine-129 concentrations were well below benchmark MCLs by the time they reached the Columbia River. Overall concentration levels at the Columbia River LOA from sources in the 200 East Area reached their peaks near the river between 1400 and 1500 years. Contaminant levels at the same LOA from sources in the 200 West Area sources reached their peaks between 2100 and 2200 years.

Combined contaminant flux for technetium-99 and iodine-129 inventories in previously disposed of LLW reaching the Columbia River within the 10,000 period of analysis were estimated as follows:

- 100 Ci of technetium-99 for the Hanford Only and Upper Bound volumes (peak loading was about 0.03 Ci /yr at about 14,700 years)

- 0.1 Ci of iodine-129 for Hanford Only and Upper Bound volumes (peak loading was 0.0001 Ci/yr at about 1540 years).

This amount of constituent loading does not adversely affect water quality in the Columbia River.

G.2.5 Alternative Group D_2

LLW considered in Alternative D_2 includes the same wastes considered in Alternative Group A but disposes of Cat 1 and Cat 3 LLW and MLLW in a single, lined, modular combined-use facility after 2007 in LLBG 218-E-12B. The melter trench and the ILAW disposal facility would be placed in the same general area.

Tabular results of groundwater quality impacts for Alternative D_2 are summarized in Tables G.7 through G.9 for wastes disposed of before 2008 and in Tables G.22 through G.24 for wastes disposed of after 2007. Graphical results of these impacts are provided in Figures G.18 through G.22 for wastes disposed of before 1996 and in Figures G.51 through G.56 for wastes disposed of after 1996. Results for this alternative group include:

- Predicted peak concentrations of key radionuclides from an LLBG in groundwater at the 1-km (0.6-mi) LOA downgradient from wastes disposed of after 2007for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.22).

- Predicted peak concentrations of key radionuclides from an LLBG in groundwater near the Columbia River for wastes disposed of after 2007 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.23).

- Predicted peak river fluxes of key radionuclides from an LLBG to the Columbia River for wastes disposed of after 2007 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.24).

G.2.5.1 Wastes Disposed of Before 1996

Potential impact results presented for wastes disposed of before 1996 for Alternative Group A in Tables G.7, G.8, and G.9 also apply to Alternative Group D_2.

G.2.5.2 Wastes Disposed of After 1995

Because of assumptions in the source-term release and vadose zone modeling used for LLW and MLLW disposed of between 1996 and 2007 for Alternative Group D_2, results for this alternative group were the same for those waste categories calculated for Alternative Group A (see Tables G.7, G. 8, and G.9).

The highest potential impacts for this alternative group reflect emplacement of LLW and MLLW that would be disposed of after 2007 in the 218-E-12B LLBG. These potential impacts would be primarily from technetium-99 and iodine-129.

Combined technetium-99 levels at the 200 East Area NW LOA were about 16 and 19 percent (148 and 169 pCi/L) of the benchmark MCL for the Hanford Only and Upper Bound volumes. The primary source for these elevated levels is from inventories in Cat 3 LLW and MLLW that would be disposed of after 2007.

Combined concentration levels of technetium-99 at the 200 West Area LOA were about 5 and 3 percent (42 and 31 pCi/L) of the benchmark MCL for the Hanford Only and Upper Bound volumes, respectively. These values are slightly less than levels estimated for Alternative Group A. The source of these impacts is primarily from the technetium-99 inventory in MLLW disposed of between 1996 and 2007 (see Table G.7). Decreased concentrations for the Upper Bound volume reflect the emplacement of some of the MLLW inventory in the 200 East Area.

The highest combined iodine-129 levels at the 200 East Area NW LOAs were about 28 percent (0.28 pCi/L) of the benchmark MCL for the Hanford Only and Upper Bound waste volumes. The main contributor to these concentration levels is ungrouted iodine-129 inventories in MLLW that would be disposed of after 2007.

The highest combined iodine-129 levels were about 15 and 8 percent (0.15 and 0.08 pCi/L) of the benchmark MCL at the 200 West Area LOA for the Hanford Only and Upper Bound waste volumes. The main contributor to these concentration levels is ungrouted iodine-129 inventories in MLLW disposed of between 1996 and 2007 (see Table G.7).

The highest iodine-129 levels were slightly higher at the 200 East Area NW LOA and slightly lower at the 200 West Area LOA for the Upper Bound volume. This is reflective of changes in the partitioning of the iodine-129 inventory for the MLLW (1996-2007) waste category between the 200 East and West Areas for the Upper Bound volume (see Table G.7).

Concentration levels of carbon-14 and uranium isotopes at the 1-km (0.6-mi) LOA did not reach their peak values until after the 10,000-year period of analysis. Concentration levels for both constituents were well below the benchmark MCLs at 10,000 years.

Technetium-99 and iodine-129 concentrations were well below the benchmark MCLs by the time they reached the Columbia River. Overall concentration levels at the Columbia River LOA from sources in the 200 East Area reached their peaks between 1500 and 1600 years. Contaminant levels from sources in the 200 West Area reached their peaks near the river at about 2000 years.

Combined contaminant flux for technetium-99 and iodine-129 inventories in previously disposed of LLW reaching the Columbia River within the 10,000-year period of analysis were estimated as follows:

- 100 Ci of technetium-99 for the Hanford Only and Upper Bound volumes (peak loading was about 0.03 Ci/yr at about 1520 years)
- 0.11 Ci of iodine-129 for Hanford Only and Upper Bound volumes (peak loading was 0.0001 Ci/yr at about 1640 years).

This amount of constituent loading does not adversely affect water quality in the Columbia River.

G.2.6 Alternative Group D_3

LLW considered in the Alternative D_3 includes the same wastes considered in Alternative Group A but disposes of Cat 1 and Cat 3 LLW and MLLW in a single, lined, modular combined-use facility after 2007 at ERDF. The melter trench and the ILAW disposal facility would also be placed at ERDF.

Tabular results of groundwater quality impacts for Alternative Group D_3 are summarized in Tables G.7 through G.9 for wastes disposed of before 2008 and in Tables G.23 through G.25 for wastes disposed of after 2007. Graphical results of these impacts are provided in Figures G.18 through G.22 for wastes disposed of before 1996 and in Figures G.57 through G.64 for wastes disposed of after 1996. Results for this alternative group include:

- Predicted peak concentrations of key radionuclides from an LLBG in groundwater at the 1 km (0.6 mi) LOA downgradient from wastes disposed of after 1996 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.23).
- Predicted peak concentrations of key radionuclides from an LLBG in groundwater near the Columbia River for wastes disposed of after 1996 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.24).

- Predicted peak river fluxes of key radionuclides from an LLBG to the Columbia River for wastes disposed of after 1996 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.25).

G.2.6.1 Wastes Disposed of Before 1996

Potential impact results presented for wastes disposed of before 1996 for Alternative Group A in Tables G.7, G.8, and G.9 also apply to Alternative Group D_3.

G.2.6.2 Wastes Disposed of After 1995

Because of assumptions in the source-term release and vadose zone modeling used for LLW and MLLW disposed of between 1996 and 2007 for Alternative Group D_3, results for this alternative group were the same for those waste categories calculated for Alternative Group A (see Table G.7, G. 8, and G.9).

The highest potential impacts for this alternative group reflect emplacement of LLW and MLLW that would be disposed of after 2007 at ERDF. Impacts were primarily from technetium-99 and iodine-129.

No LLW and MLLW were disposed of after 1996 in the 200 East Area for the Hanford Only volume under this alternative group. Combined technetium-99 levels at the 200 East Area NW LOA were about 2 percent (15.7 pCi/L) of the benchmark MCL for the Upper Bound volume. The primary source for these elevated levels is from inventories in MLLW disposed of between 1996 and 2007 (see Table G.7).

Combined technetium-99 levels at the 200 West Area LOA were about 5 and 3 percent (42 and 31 pCi/L) of the benchmark MCL for the Hanford Only and Upper Bound volumes. These values are slightly less than levels estimated for Alternative Group A. The source of these impacts is primarily from the technetium-99 inventory in MLLW disposed of between 1996 and 2007 (see Table G.7). Decreased concentrations for the Upper Bound volume reflect the emplacement of some of the MLLW inventory in the 200 East Area.

Combined technetium-99 levels at the ERDF LOA were about 28 percent (250 pCi/L) of the benchmark MCL for the Hanford Only and Upper Bound volumes. The primary source for these elevated levels is from inventories in Cat 3 LLW that would be disposed of after 2007.

No LLW and MLLW were disposed of after 1996 in the 200 East Area for the Hanford Only waste volume under this alternative group. Combined iodine-129 levels at the 200 East Area NW LOA were about 5 percent (0.05 pCi/L) of the benchmark MCL for the Upper Bound waste volume. The main contributor to these concentration levels is from ungrouted iodine-129 inventories in MLLW disposed of between 1996 and 2007.

Combined iodine-129 levels at the 200 West Area LOA were 15 and 8 percent (0.15 and 0.08 pCi/L) of the benchmark MCL for the Hanford Only and Upper Bound waste volumes. The main contributor to these concentration levels is from ungrouted iodine-129 inventories in MLLW disposed of between 1996 and 2007 (see Table G.7).

Combined iodine-129 levels at the 200 West Area LOA were slightly higher at the 200 East Area NW LOA and slightly lower for the Upper Bound volume. This result reflects assumed changes in the partitioning of the iodine-129 inventory for the MLLW (1996–2007) waste category between the 200 East and West Areas for the Upper Bound volume (see Table G.7).

Combined iodine-129 levels at the ERDF LOA were 92 and 94 percent (0.92 and 0.94 pCi/L) of the benchmark MCL for the Hanford Only volume. The main contributor to these concentration levels is from inventories in MLLW that would be disposed of after 2007.

Concentration levels of carbon-14 and uranium isotopes at all LOAs downgradient from source areas of projected LLW and MLLW did not reach their peak values until after the 10,000-year period of analysis. Concentration levels for both constituents were well below benchmark MCLs at 10,000 years.

Combined technetium-99 and iodine-129 concentrations were well below benchmark MCLs by the time they reached the Columbia River. Overall concentration levels from sources in the 200 East Area reached their peaks near the river at about 1400 years. Contaminant levels from sources in the 200 West Area reached their peaks near the river about 2000 years.

Combined contaminant flux for technetium-99 and iodine-129 inventories in previously disposed of LLW reaching the Columbia River within the 10,000-year period of analysis were estimated as follows:

- 120 and 130 Ci of technetium-99 for the Hanford Only and Upper Bound volumes, respectively (peak loading was about 0.04 Ci /yr between 2000 and 2100 years)

- 0.14 Ci of iodine-129 for Hanford Only and Upper Bound volumes (peak loading was 0.0001 Ci/yr at about 2100 years).

This amount of constituent loading does not adversely affect water quality in the Columbia River.

G.2.7 Alternative Group E_1

LLW considered in Alternative Group E_1 includes the same wastes considered in Alternative Group A but disposes of Cat 1 and Cat 3 LLW and MLLW in a single, lined modular trench after 2007 in LLBG 218-E-12B. The melter trench and the ILAW disposal facility would be placed at ERDF.

Tabular results of groundwater quality impacts for Alternative E_1 are summarized in Tables G.7 through G.9 for wastes disposed of before 2008 and in Tables G.28 through G.30 for wastes disposed of after 2007. Graphical results of these impacts are provided in Figures G.18 through G.22 for wastes disposed of before 1996 and in Figures G.65 through G.72 for wastes disposed of after 1996. Results for this alternative group include:

- Predicted peak concentrations of key radionuclides from an LLBG in groundwater at the 1-km (0.6-mi) LOA downgradient from wastes disposed of after 2007 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.28).

- Predicted peak concentrations of key radionuclides from an LLBG in groundwater near the Columbia River for wastes disposed of after 2007 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.29).

- Predicted peak river fluxes of key radionuclides from an LLBG to the Columbia River for wastes disposed of after 2007 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.30).

G.2.7.1 Wastes Disposed of Before 1996

Potential impact results presented for wastes disposed of before 1996 for Alternative Group A in Tables G.7, G.8, G.9 also apply to Alternative Group E_1.

G.2.7.2 Wastes Disposed of After 1995

Because of assumptions in the source-term release and vadose zone modeling used for LLW and MLLW disposed of between 1996 and 2007 for Alternative Group E_1, results for this alternative group were the same for those waste categories calculated for Alternative Group A (see Tables G.7, G. 8, and G.9).

Potential impacts for this alternative group reflect emplacement of LLW and MLLW that would be disposed of after 2007 in LLBG 218-E-12B and the disposal of melters and ILAW at ERDF. Results for LLW and MLLW that would be disposed of after 2007, excluding the melters, are identical to results for the same wastes in Alternative D_2. The highest potential impacts resulted from releases of technetium-99 and iodine-129.

Combined technetium-99 levels at the 200 East Area NW LOA were about 16 and 19 percent (150 and 170 pCi/L) of the benchmark MCL for the Hanford Only and Upper Bound volumes, respectively. The primary source of these elevated levels is from inventories in Cat 3 LLW and MLLW that would be disposed of after 2007.

Combined technetium-99 levels at the 200 West Area LOA were about 5 and 3 percent (42 and 31 pCi/L) of the benchmark MCL for the Hanford Only and Upper Bound volumes, respectively. These values are slightly less than levels estimated for Alternative Group A. The source of these impacts is primarily from the technetium-99 inventory in MLLW disposed of between 1996 and 2007 (see Table G.7). Decreased concentrations for the Upper Bound volume reflect the emplacement of some of the MLLW inventory in the 200 East Area.

Combined technetium-99 levels at the ERDF LOA were about 0.3 percent (2.7 pCi/L) of the benchmark MCL for both the Hanford Only and Upper Bound volumes. The primary source for these elevated levels is from inventories in the melters that would be disposed of after 2007.

No LLW and MLLW were disposed of after 1996 in the 200 East Area for the Hanford Only waste volume under this alternative group. Combined iodine-129 levels at the 200 East Area NW LOA were about 5 percent (0.04 pCi/L) of the benchmark MCL for the Upper Bound waste volume. The main contributor to these concentration levels is from ungrouted iodine-129 inventories in MLLW disposed of between 1996 and 2007 (see Table G.7).

Combined iodine-129 levels at the 200 West Area LOA were 15 and 8 percent (0.15 and 0.08 pCi/L) of the benchmark MCL for the Hanford Only and Upper Bound waste volumes, respectively. The main contributor to these concentration levels is from ungrouted iodine-129 inventories in MLLW disposed of between 1996 and 2007 (see Table G.7).

Combined iodine-129 levels at the 200 West Area LOA were slightly higher at the 200 East Area NW LOA and slightly lower for the Upper Bound volume, which is reflective of changes in the partitioning of the iodine-129 inventory for the MLLW (1996–2007) waste category between the 200 East and West Areas for the Upper Bound volume (see Table G.7).

Combined iodine-129 levels were 22 percent (0.22 pCi/L) at the ERDF LOA for both the Hanford Only and Upper Bound waste volumes. No iodine-129 inventory was estimated for melters that would be disposed of at ERDF after 2007 for this alternative group.

Concentration levels of carbon-14 and uranium isotopes at the 1-km (0.6-m) well downgradient from source areas of projected LLW and MLLW did not reach their peak values until after the 10,000-year period of analysis. Concentration levels for both constituents were well below the benchmark MCLs.

Technetium-99 and iodine-129 concentrations were well below the benchmark MCLs by the time they reached the Columbia River. Overall concentration levels at the Columbia River LOA from sources in the 200 East Area reached their peaks near the river at about 1400 years. Contaminant levels from sources in the 200 West Area reached their peaks near the river at about 2000 years.

Combined contaminant flux for technetium-99 and iodine-129 inventories in previously disposed of LLW reaching the Columbia River within the 10,000-year period of analysis were estimated as follows:

- 120 and 130 Ci of technetium-99 for the Hanford Only and Upper Bound volumes, respectively (peak loading was about 0.04 Ci/yr between 2000 and 2100 years)

- 0.14 Ci of iodine-129 for Hanford Only and Upper Bound volumes (peak loading was 0.0001 Ci/yr at about 2100 years).

This amount of constituent loading does not adversely affect water quality in the Columbia River.

G.2.8 Alternative Group E_2

LLW considered in Alternative Group E_2 includes the same wastes considered in Alternative Group A but disposes of Cat 1 and Cat 3 LLW and MLLW in a single, lined modular trench after 2007 near the PUREX Plant. The melter trench and the ILAW disposal facility would be placed at ERDF.

Tabular results of groundwater quality impacts for Alternative Group E_2 are summarized in Tables G.7 through G.9 for wastes disposed of before 2008 and in Tables G.31 through G.32 for wastes disposed of after 2007. Graphical results of these impacts are provided in Figures G.18 through G.22 for wastes disposed of before 1996 and in Figures G.73 through G.80 for wastes disposed of after 1996. Results for this alternative group include:

- Predicted peak concentrations of key radionuclides from an LLBG in groundwater at the 1-km (0.6-mi) LOA downgradient from wastes disposed of after 2007 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.31).

- Predicted peak concentrations of key radionuclides from an LLBG in groundwater near the Columbia River for wastes disposed of after 2007 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.32).

- Predicted peak river fluxes of key radionuclides from an LLBG to the Columbia River for wastes disposed of after 2007 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.33).

G.2.8.1 Wastes Disposed of Before 1996

Various results presented for wastes disposed of before 1996 for Alternative Group A in Tables G.7, G.8, G.9 also apply to Alternative Group E_2.

G.2.8.2 Wastes Disposed of After 1995

Because of assumptions in the source-term release and vadose zone modeling used for LLW and MLLW disposed of between 1996 and 2007 for Alternative Group E_2, results for this alternative group were the same for those waste categories calculated for Alternative Group A (see Tables G.7, G. 8, and G.9).

Potential impacts for this alternative group reflect emplacement of LLW and MLLW disposed of after 2007 near the PUREX Plant and the disposal of melters and ILAW at ERDF. Results for LLW and MLLW that would be disposed of after 2007, excluding the melters, are identical to results for the same wastes in Alternative Group D_1 (see Section G.2.4). Results for the melters were the same as those calculated for Alternative Group E_1 (see Section G.2.7).

G.2.9 Alternative Group E_3

LLW considered in Alternative Group E_3 includes the same wastes considered in Alternative A but disposes of Cat 1 and Cat 3 LLW and MLLW in a single, lined modular trench after 2007 at ERDF. The melter trench and the ILAW disposal facility would be placed near the PUREX Plant.

Tabular results of groundwater quality impacts for Alternative Group E_3 are summarized in Tables G.7 through G.9 for wastes disposed of before 2008 in Tables G.34 through G.36 for wastes disposed of after 2007. Graphical results of these impacts are provided in Figures G.18 through G.22 for wastes disposed of before 1996 and in Figures G.81 through G.88 for wastes disposed of after 1996. Results for this alternative group include:

- Predicted peak concentrations of key radionuclides from an LLBG in groundwater at the 1-km (0.6-mi) LOA downgradient from wastes disposed of after 2007 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.34).

- Predicted peak concentrations of key radionuclides from an LLBG in groundwater near the Columbia River for wastes disposed of after 2007 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.35).

- Predicted peak river fluxes of key radionuclides from an LLBG to the Columbia River for wastes disposed of after 2007 for Hanford Only, Lower Bound, and Upper Bound volumes (Table G.36).

G.2.9.1 Wastes Disposed of Before 1996

Various results presented for wastes disposed of before 1996 for Alternative Group A in Tables G.7, G.8, G.9 also apply to Alternative Group E_3.

G.2.9.2 Wastes Disposed of After 1995

Because of assumptions in the source-term release and vadose zone modeling used for LLW and MLLW disposed of between 1996 and 2007 for Alternative Group E_2, results for this alternative group were the same for those waste categories calculated for Alternative Group A (see Tables G.7, G. 8, and G.9).

Potential impacts for this alternative group reflect emplacement of LLW and MLLW disposed of after 2007 near the PUREX Plant and the disposal of melter MLLW and ILAW at ERDF. Results for LLW and MLLW that would be disposed of after 2007, excluding the melters, are identical to results for the same wastes in Alternative Group D_3 (see Section G.2.6).

Results for Alternative Group E_3 for combined technetium-99 and iodine-129 concentration levels for Hanford Only and Upper Bound volumes are summarized in Section 5.3, Figures 5.20 and 5.21. Additional information can be found in several tables and figures referenced in Section G.2.9.

Combined technetium-99 levels were slightly less than 3 percent (22 pCi/L) of the benchmark MCL at the 200 East Area SE LOA for the Hanford Only waste volume. The potential impact for the Hanford Only waste volume reflects the melter and ILAW disposals near the PUREX Plant. The highest combined iodine-129 levels at the 200 East Area SE LOA were about 20 percent (0.2 pCi/L) of the benchmark MCL for both the Hanford Only and Upper Bound waste volumes as a result of the ILAW disposal near PUREX.

G.2.10 No Action Alternative

LLW considered in the No Action Alternative includes wastes to be disposed of in several categories:

- LLW disposed of before 1970
- LLW disposed of after 1970 but before 1988
- LLW disposed of between 1988 and 1995
- Cat 1 LLW disposed of in conventional trenches between 1996 and 2007
- Cat 3 LLW and GTC3 LLW disposed of in conventional trenches between 1996 and 2007
- MLLW disposed of in conventional trenches between 1996 and 2007
- Cat 1 and Cat 3 LLW and MLLW disposed of in conventional trenches in LLBGs 218-E-12B and 218-W-5.

Contaminants considered in the LLW categories include estimated inventories associated with Hanford Only and Lower Bound waste volumes. Contaminants considered in the MLLW category include estimated inventories associated with Hanford Only and Lower Bound waste volumes.

Tabular results of groundwater quality impacts for the No Action Alternative for all waste categories are summarized in Tables G.37 through G.39. Graphical results of these impacts for all waste categories are provided in Figures G.89 through G94. Results for the No Action Alternative include:

- Predicted peak concentrations of key radionuclides from an LLBG in groundwater at the 1-km (0.6-mi) LOA downgradient from the waste sites for LLW disposed of before 1996 for the Hanford Only and Lower Bound volumes and LLW and MLLW disposed of after 1995 for the Hanford Only and Lower Bound volumes (Table G.37).
- Predicted peak concentrations of key radionuclides from an LLBG in groundwater near the Columbia River for wastes disposed of before 1996 for the Hanford Only and Lower Bound volumes and after 1995 for the Hanford Only and Lower Bound volumes (Table G.38).

- Predicted peak river fluxes of key radionuclides from an LLBG to the Columbia River for wastes disposed of before 1996 for the Hanford Only and Lower Bound volumes and after 1995 for the Hanford Only and Lower Bound volumes (Table G.39).

G.2.10.1 Wastes Disposed of Before 1996

The highest potential groundwater quality impacts from wastes disposed of before 1996 are related to technetium-99 and iodine-129 releases. Estimated concentrations of technetium-99 and iodine-129 peak at about 110 years at the 200 East Area NW LOA and about 220 years at the 200 West Area LOA. Combined levels of technetium-99 were less than 2 percent (18 pCi/L) at the 200 East Area NW and West LOAs. Combined levels of iodine-129 at the 200 East Area NW LOA were about 50 percent (0.5 pCi/L) of the benchmark MCL.

Combined levels of iodine-129 at the 200 West Area LOA were about 50 percent (0.5 pCi/L) of the benchmark MCL. This concentration level is from releases of the iodine-129 inventory in LLW disposed of between 1970 and 1987.

Carbon-14 and uranium isotopes concentration levels were found to peak at about or beyond 10,000 years. Carbon-14 concentrations were well below the benchmark MCL of 2000 pCi/L at the 200 East and West Area LOAs. Concentration levels of uranium-238, the dominant uranium isotope, were also well below the benchmark MCL of 30 pCi/L at the 200 East and West Area LOAs at 10,000 years. Uranium-238 concentration levels reached their peak of about 3 pCi/L between 14,000 and 16,000 years at the 200 West Area LOA.

Technetium-99 and iodine-129 concentrations were well below benchmark MCLs by the time they reached the Columbia River. Overall concentration levels from sources in the 200 East Area reached their peaks at the Columbia River LOA at about 260 years. Contaminant levels from sources in the 200 West Area reached their peaks at the Columbia River LOA between 500 and 600 years.

Combined contaminant flux for technetium-99 and iodine-129 inventories in previously disposed of LLW reaching the Columbia River within the 10,000-year period of analysis were estimated as follows:

- 1 Ci of technetium-99 (peak loading at 0.001 Ci/yr between 520–530 years)
- 0.5 Ci of iodine-129 (peak loading at 0.001 Ci/yr at around 260 years).

This amount of constituent loading does not adversely affect water quality in the Columbia River.

G.2.10.2 Wastes Disposed of After 1995

The highest potential groundwater quality impacts from LLW and MLLW disposed of after 1995 resulted from releases of technetium-99 and iodine-129. Combined technetium-99 levels at the 200 East Area NW LOA were about 8 percent (77 pCi/L) of the benchmark MCL for the Hanford Only volume. The primary source for these elevated levels is from inventories in MLLW disposed of after 1995.

Combined technetium-99 levels were about 25 percent (225 pCi/L) of the benchmark MCL at the 200 West Area LOA. The source of these impacts was primarily from the technetium-99 inventory in Cat 3 LLW disposed of after 1995.

The highest combined iodine-129 levels were about 6 percent (0.06 pCi/L) of the benchmark MCL at the 200 West Area LOA for the Hanford Only waste volume. The main contributor to these concentration levels is from inventories in MLLW disposed of after 1995.

Concentration levels of carbon-14 and uranium isotopes at the 1-km (0.6-m) LOAs downgradient from source areas of LLW and MLLW disposed of after 1995 did not reach their peak values until after the 10,000-year period of analysis. Concentration levels for both constituents were well below the benchmark MCLs at 10,000 years.

Technetium-99 and iodine-129 concentration levels were well below the benchmark MCLs by the time they reached the Columbia River. Overall concentration levels at the Columbia River LOA from sources in the 200 East Area reached their peaks at the Columbia River LOA at 260 years for ungrouted forms of technetium-99 and iodine-129 and at about 850 years for grouted forms of the inventories. Contaminant levels from sources in the 200 West Area reached their peaks near the river between 1660 and 1820 years.

Combined contaminant flux for technetium-99 and iodine-129 inventories in previously disposed of LLW reaching the Columbia River within the 10,000-year period of analysis were estimated as follows:

- 100 Ci of technetium-99 for the Hanford Only waste volume (peak loading was about 0.03 Ci/yr at about 1820 years)

- 0.07 Ci of iodine-129 for the Hanford Only waste volume (peak loading was 0.0001 Ci/yr at about 1660 years).

This amount of constituent loading does not adversely affect water quality in the Columbia River.

Table G.7. Predicted Peak Concentrations of Key Constituents from Wastes Disposed of Before 2008 at a 1-km Line of Analysis, All Action Alternatives

		Hanford Only Volume			**Lower Bound Volume**			**Upper Bound Volume**		
Constituent	**Benchmark MCL (pCi/L)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
Pre-1970 LLW										
200 East Area										
C-14	2,000									
Tc-99	900	5.16E-01	1.44E+01	110	5.16E-01	1.44E+01	110	5.16E-01	1.44E+01	110
Grouted Tc-99	900									
I-129	1	1.24E-03	3.47E-02	110	1.24E-03	3.47E-02	110	1.24E-03	3.47E-02	110
Grouted I-129	1									
U-233	(a)	1.03E+01	3.20E-01	10,000	1.03E+01	3.20E-01	10,000	1.03E+01	3.20E-01	10,000
U-234	(a)	3.68E-01	1.14E-02	10,000	3.68E-01	1.14E-02	10,000	3.68E-01	1.14E-02	10,000
U-235	(a)	1.12E-02	3.48E-04	10,000	1.12E-02	3.48E-04	10,000	1.12E-02	3.48E-04	10,000
U-236	(a)	7.53E-03	2.34E-04	10,000	7.53E-03	2.34E-04	10,000	7.53E-03	2.34E-04	10,000
U-238	(a)	2.69E-01	8.35E-03	10,000	2.69E-01	8.35E-03	10,000	2.69E-01	8.35E-03	10,000
200 West Area	(a)									
C-14	2,000									
Tc-99	900	1.30E-01	2.71E+00	190	1.30E-01	2.71E+00	190	1.30E-01	2.71E+00	190
Grouted Tc-99	900		0.00E+00			0.00E+00			0.00E+00	
I-129	1	1.70E-04	3.54E-03	190	1.70E-04	3.54E-03	190	1.70E-04	3.54E-03	190
Grouted I-129	1									
U-233	(a)									
U-234	(a)	1.45E+00	0.00E+00	10,000	1.45E+00	0.00E+00	10,000	1.45E+00	0.00E+00	10,000
U-235	(a)	4.38E-02	0.00E+00	10,000	4.38E-02	0.00E+00	10,000	4.38E-02	0.00E+00	10,000
U-236	(a)	2.95E-02	0.00E+00	10,000	2.95E-02	0.00E+00	10,000	2.95E-02	0.00E+00	10,000
U-238	(a)	1.06E+00	0.00E+00	10,000	1.06E+00	0.00E+00	10,000	1.06E+00	0.00E+00	10,000
1970-1987 LLW										
200 East Area										
C-14	2,000	2.15E+02	5.41E+00	10,000	2.15E+02	5.41E+00	10,000	2.15E+02	5.41E+00	10,000
Tc-99	900									
Grouted Tc-99	900									
I-129	1	1.87E-02	5.23E-01	110	1.87E-02	5.23E-01	110	1.87E-02	5.23E-01	110
Grouted I-129	1									
U-233	(a)									
U-234	(a)	3.08E-02	1.89E-03	10,000	3.08E-02	1.89E-03	10,000	3.08E-02	1.89E-03	10,000
U-235	(a)	2.61E-03	1.60E-04	10,000	2.61E-03	1.60E-04	10,000	2.61E-03	1.60E-04	10,000
U-236	(a)									
U-238	(a)	6.28E-02	3.85E-03	10,000	6.28E-02	3.85E-03	10,000	6.28E-02	3.85E-03	10,000
200 West Area										
C-14	2,000	3.92E+02	0.00E+00	>10,000	3.92E+02	0.00E+00	>10,000	3.92E+02	0.00E+00	>10,000
Tc-99	900									
Grouted Tc-99	900									
I-129	1	1.77E-03	2.99E-02	290	1.77E-03	2.99E-02	290	1.77E-03	2.99E-02	290
Grouted I-129	1									
U-233	(a)									
U-234	(a)	3.94E+01	0.00E+00	>10,000	3.94E+01	0.00E+00	>10,000	3.94E+01	0.00E+00	>10,000
U-235	(a)	3.33E+00	0.00E+00	>10,000	3.33E+00	0.00E+00	>10,000	3.33E+00	0.00E+00	>10,000
U-236	(a)									
U-238	(a)	2.82E+01	0.00E+00	>10,000	2.82E+01	0.00E+00	>10,000	2.82E+01	0.00E+00	>10,000

Table G.7. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
1988-1995 LLW										
200 East Area										
C-14	2,000	5.11E+00	1.94E-02	10,000	5.11E+00	1.94E-02	10,000	5.11E+00	1.94E-02	10,000
Tc-99	900	1.39E-01	3.88E+00	110	1.39E-01	3.88E+00	110	1.39E-01	3.88E+00	110
Grouted Tc-99	900									
I-129	1	9.45E-05	2.64E-03	110	9.45E-05	2.64E-03	110	9.45E-05	2.64E-03	110
Grouted I-129	1									
U-233	(a)	2.09E-05	1.28E-06	10,000	2.09E-05	1.28E-06	10,000	2.09E-05	1.28E-06	10,000
U-234	(a)	1.85E-03	1.13E-04	10,000	1.85E-03	1.13E-04	10,000	1.85E-03	1.13E-04	10,000
U-235	(a)	4.29E-04	2.63E-05	10,000	4.29E-04	2.63E-05	10,000	4.29E-04	2.63E-05	10,000
U-236	(a)	1.85E-06	1.13E-07	10,000	1.85E-06	1.13E-07	10,000	1.85E-06	1.13E-07	10,000
U-238	(a)	1.93E-02	1.18E-03	10,000	1.93E-02	1.18E-03	10,000	1.93E-02	1.18E-03	10,000
200 West Area										
C-14	2,000	9.29E+00	0.00E+00	>10,000	9.29E+00	0.00E+00	>10,000	9.29E+00	0.00E+00	>10,000
Tc-99	900	4.71E-01	8.21E+00	210	4.71E-01	8.21E+00	210	4.71E-01	8.21E+00	210
Grouted Tc-99	900									
I-129	1	3.06E-02	5.34E-01	210	3.06E-02	5.34E-01	210	3.06E-02	5.34E-01	210
Grouted I-129	1									
U-233	(a)	6.54E-02	0.00E+00	>10,000	6.54E-02	0.00E+00	>10,000	6.54E-02	0.00E+00	>10,000
U-234	(a)	5.77E+00	0.00E+00	>10,000	5.77E+00	0.00E+00	>10,000	5.77E+00	0.00E+00	>10,000
U-235	(a)	1.34E+00	0.00E+00	>10,000	1.34E+00	0.00E+00	>10,000	1.34E+00	0.00E+00	>10,000
U-236	(a)	5.77E-03	0.00E+00	>10,000	5.77E-03	0.00E+00	>10,000	5.77E-03	0.00E+00	>10,000
U-238	(a)	6.03E+01	0.00E+00	>10,000	6.03E+01	0.00E+00	>10,000	6.03E+01	0.00E+00	>10,000
1996-2007 Cat 1 LLW (Alternative Groups A, C, D, and E)										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
200 West Area										
C-14	2,000	3.33E+00	0.00E+00	>10,000	4.06E+00	0.00E+00	>10,000	5.21E+00	0.00E+00	>10,000
Tc-99	900	3.00E-01	3.00E+00	1,700	3.66E-01	3.66E+00	1,700	3.99E-01	3.99E+00	1,700
Grouted Tc-99	900									
I-129	1	2.62E-03	2.63E-02	1,700	3.20E-03	3.20E-02	1,700	3.20E-03	3.20E-02	1,700
Grouted I-129	1									
U-233	(a)	1.03E-01	0.00E+00	>10,000	1.25E-01	0.00E+00	>10,000	1.25E-01	0.00E+00	>10,000
U-234	(a)	1.70E-01	0.00E+00	>10,000	2.07E-01	0.00E+00	>10,000	9.01E-01	0.00E+00	>10,000
U-235	(a)	3.56E-02	0.00E+00	>10,000	4.34E-02	0.00E+00	>10,000	8.86E-02	0.00E+00	>10,000
U-236	(a)	4.03E-03	0.00E+00	>10,000	4.92E-03	0.00E+00	>10,000	4.92E-03	0.00E+00	>10,000
U-238	(a)	4.06E-01	0.00E+00	>10,000	4.95E-01	0.00E+00	>10,000	1.66E+00	0.00E+00	>10,000

Table G.7. (contd)

		Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
Constituent	**Benchmark MCL (pCi/L)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
1996-2007 Cat 3 LLW (Alternative Groups A, C, D, and E)										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
200 West Area										
C-14	2,000	1.48E-01	0.00E+00	>10,000	1.54E-01	0.00E+00	>10,000	3.50E-01	0.00E+00	>10,000
Tc-99	900									
Grouted Tc-99	900	7.20E+01	6.64E+00	1,230	7.20E+01	6.64E+00	1,230	7.20E+01	6.64E+00	1,230
I-129	1	3.39E-07	3.39E-06	1,700	3.53E-07	3.53E-06	1,700	3.53E-07	3.53E-06	1,700
Grouted I-129	1									
U-233	(a)	9.79E-02	0.00E+00	>10,000	1.02E-01	0.00E+00	>10,000	2.32E-01	0.00E+00	>10,000
U-234	(a)	1.24E+02	0.00E+00	>10,000	1.29E+02	0.00E+00	>10,000	2.94E+02	0.00E+00	>10,000
U-235	(a)	3.54E+00	0.00E+00	>10,000	3.69E+00	0.00E+00	>10,000	8.39E+00	0.00E+00	>10,000
U-236	(a)	1.60E+01	0.00E+00	>10,000	1.67E+01	0.00E+00	>10,000	3.80E+01	0.00E+00	>10,000
U-238	(a)	1.99E+02	0.00E+00	>10,000	2.07E+02	0.00E+00	>10,000	4.72E+02	0.00E+00	>10,000
1996-2007 Cat 1 LLW (Alternative Group B)										
200 East Area										
C-14	2,000	1.25E-01	9.91E-04	10,000	1.52E-01	1.21E-03	10,000	7.20E-01	5.73E-03	10,000
Tc-99	900	1.13E-02	9.36E-02	1,230	1.38E-02	1.14E-01	1,230	5.52E-02	4.56E-01	1,230
Grouted Tc-99	900									
I-129	1	9.84E-05	8.14E-04	1,230	1.20E-04	9.92E-04	1,230	4.42E-04	3.65E-03	1,230
Grouted I-129	1									
U-233	(a)	3.85E-03	2.08E-04	10,000	4.70E-03	2.43E-04	10,000	1.73E-02	1.20E-05	10,000
U-234	(a)	6.38E-03	3.44E-04	10,000	7.78E-03	4.02E-04	10,000	1.25E-01	8.68E-05	10,000
U-235	(a)	1.34E-03	7.20E-05	10,000	1.63E-03	8.42E-05	10,000	1.22E-02	8.47E-06	10,000
U-236	(a)	1.52E-04	8.17E-06	10,000	1.85E-04	9.55E-06	10,000	6.80E-04	4.72E-07	10,000
U-238	(a)	1.53E-02	8.21E-04	10,000	1.86E-02	9.60E-04	10,000	2.29E-01	1.59E-04	10,000
200 West Area	(a)									
C-14	2,000	3.21E+00	0.00E+00	>10,000	3.91E+00	0.00E+00	>10,000	4.49E+00	0.00E+00	>10,000
Tc-99	900	2.89E-01	2.89E+00	1,700	3.52E-01	3.52E+00	1,700	3.44E-01	3.44E+00	1,700
Grouted Tc-99	900									
I-129	1	2.53E-03	2.53E-02	1,700	3.08E-03	3.08E-02	1,700	2.76E-03	2.76E-02	1,700
Grouted I-129	1									
U-233	(a)	9.84E-02	0.00E+00	>10,000	1.20E-01	0.00E+00	>10,000	1.08E-01	0.00E+00	>10,000
U-234	(a)	1.63E-01	0.00E+00	>10,000	1.99E-01	0.00E+00	>10,000	7.77E-01	0.00E+00	>10,000
U-235	(a)	3.43E-02	0.00E+00	>10,000	4.18E-02	0.00E+00	>10,000	7.64E-02	0.00E+00	>10,000
U-236	(a)	3.88E-03	0.00E+00	>10,000	4.73E-03	0.00E+00	>10,000	4.24E-03	0.00E+00	>10,000
U-238	(a)	3.90E-01	0.00E+00	>10,000	4.76E-01	0.00E+00	>10,000	1.43E+00	0.00E+00	>10,000

Table G.7. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
1996-2007 Cat 3 LLW (Alternative Group B)										
200 East Area										
C-14	2,000		0.00E+00		5.79E-03	4.60E-05	10,000	1.32E-02	1.05E-04	10,000
Tc-99	900									
Grouted Tc-99	900	3.89E+01	1.63E+00	630	2.71E+00	1.14E-01	630	2.71E+00	1.14E-01	630
I-129	1				1.33E-08	1.10E-07	1,230	1.33E-08	1.10E-07	1,230
Grouted I-129	1									
U-233	(a)	8.49E-01	6.70E-07	10,000	3.83E-03	2.90E-09	10,000	8.70E-03	2.32E-08	10,000
U-234	(a)	4.60E-01	3.63E-07	10,000	4.85E+00	3.67E-06	10,000	1.11E+01	2.96E-05	10,000
U-235	(a)	1.90E-02	1.50E-08	10,000	1.39E-01	1.05E-07	10,000	3.15E-01	8.41E-07	10,000
U-236	(a)	1.70E-02	1.34E-08	10,000	6.27E-01	4.75E-07	10,000	1.43E+00	3.82E-06	10,000
U-238	(a)	4.10E-01	3.24E-07		7.78E+00	5.89E-06	10,000	1.77E+01	4.72E-05	10,000
200 West Area										
C-14	2,000	1.42E-01	0.00E+00	>10,000	1.48E-01	0.00E+00	>10,000	3.37E-01	0.00E+00	>10,000
Tc-99	900									
Grouted Tc-99	900	6.93E+01	6.40E+00	1,230	6.93E+01	6.40E+00	1,230	6.93E+01	6.40E+00	1,230
I-129	1	3.26E-07	3.27E-06	1,700	3.40E-07	3.40E-06	1,700	3.40E-07	3.40E-06	1,700
Grouted I-129	1									
U-233	(a)	9.43E-02	0.00E+00	>10,000	9.82E-02	0.00E+00	>10,000	2.23E-01	0.00E+00	>10,000
U-234	(a)	1.19E+02	0.00E+00	>10,000	1.24E+02	0.00E+00	>10,000	2.83E+02	0.00E+00	>10,000
U-235	(a)	3.41E+00	0.00E+00	>10,000	3.55E+00	0.00E+00	>10,000	8.07E+00	0.00E+00	>10,000
U-236	(a)	1.55E+01	0.00E+00	>10,000	1.61E+01	0.00E+00	>10,000	3.66E+01	0.00E+00	>10,000
U-238	(a)	1.91E+02	0.00E+00	>10,000	1.99E+02	0.00E+00	>10,000	4.54E+02	0.00E+00	>10,000
1996-2007 MLLW (Alternative Groups A, C, D, and E)										
200 East Area										
C-14	2,000							2.50E-01	1.99E-03	10,000
Tc-99	900							1.43E+00	1.18E+01	1,230
Grouted Tc-99	900									
I-129	1							6.03E-03	4.99E-02	1,230
Grouted I-129	1									
U-233	(a)							8.23E-04	1.93E-05	10,000
U-234	(a)							9.32E-01	2.19E-02	10,000
U-235	(a)							1.49E-02	3.50E-04	10,000
U-236	(a)							1.74E-02	4.09E-04	10,000
U-238	(a)							2.33E-01	5.47E-03	10,000
200 West Area										
C-14	2,000	6.00E-01	0.00E+00	>10,000	6.01E-01	0.00E+00	>10,000	3.66E-01	0.00E+00	>10,000
Tc-99	900	3.43E+00	3.44E+01	1,700	3.44E+00	3.44E+01	1,700	2.09E+00	2.09E+01	1,700
Grouted Tc-99	900									
I-129	1	1.45E-02	1.45E-01	1,700	1.45E-02	1.45E-01	1,700	8.81E-03	8.82E-02	1,700
Grouted I-129	1									
U-233	(a)	1.96E-03	0.00E+00	>10,000	1.96E-03	0.00E+00	>10,000	1.18E-03	0.00E+00	>10,000
U-234	(a)	2.24E+00	0.00E+00	>10,000	2.24E+00	0.00E+00	>10,000	1.37E+00	0.00E+00	>10,000
U-235	(a)	3.58E-02	0.00E+00	>10,000	3.59E-02	0.00E+00	>10,000	2.18E-02	0.00E+00	>10,000
U-236	(a)	4.19E-02	0.00E+00	>10,000	4.20E-02	0.00E+00	>10,000	2.55E-02	0.00E+00	>10,000
U-238	(a)	5.60E-01	0.00E+00	>10,000	5.61E-01	0.00E+00	>10,000	3.41E-01	0.00E+00	>10,000

Table G.7. (contd)

		Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
Constituent	**Benchmark MCL (pCi/L)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
1996-2007 Grouted MLLW (Alternative Groups A, C, D, and E)										
200 East Area										
C-14	2,000							1.35E+00	1.07E-02	10,000
Tc-99	900									
Grouted Tc-99	900							1.23E+02	8.66E+00	680
I-129	1									
Grouted I-129	1							1.07E-02	2.38E-04	680
U-233	(a)							1.40E-03	4.27E-10	10,000
U-234	(a)							2.24E+02	6.83E-05	10,000
U-235	(a)							9.95E+00	3.03E-06	10,000
U-236	(a)							3.12E-02	9.52E-09	10,000
U-238	(a)							2.33E+02	7.11E-05	10,000
200 West Area										
C-14	2,000	8.58E-01	0.00E+00	>10,000	8.60E-01	0.00E+00	>10,000	7.64E-01	0.00E+00	>10,000
Tc-99	900									
Grouted Tc-99	900	4.91E+00	3.50E-01	1,200	4.92E+00	3.51E-01	1,200	5.96E+01	4.25E+00	1,200
I-129	1									
Grouted I-129	1	2.06E-02	4.64E-04	1,200	2.06E-02	4.65E-04	1,200	8.03E-03	1.81E-04	1,200
U-233	(a)	2.67E-03	0.00E+00	>10,000	2.68E-03	0.00E+00	>10,000	1.04E-03	0.00E+00	>10,000
U-234	(a)	3.19E+00	0.00E+00	>10,000	3.20E+00	0.00E+00	>10,000	1.07E+02	0.00E+00	>10,000
U-235	(a)	5.08E-02	0.00E+00	>10,000	5.09E-02	0.00E+00	>10,000	4.76E+00	0.00E+00	>10,000
U-236	(a)	5.97E-02	0.00E+00	>10,000	5.98E-02	0.00E+00	>10,000	2.33E-02	0.00E+00	>10,000
U-238	(a)	7.93E-01	0.00E+00	>10,000	7.95E-01	0.00E+00	>10,000	1.11E+02	0.00E+00	>10,000
1996-2007 MLLW (Alternative Group B)										
200 East Area										
C-14	2,000							2.16E-02	2.06E-06	10,000
Tc-99	900							1.23E-01	1.71E-01	1,400
Grouted Tc-99	900									
I-129	1							5.16E-04	7.19E-04	1,400
Grouted I-129	1									
U-233	(a)							6.71E-05	2.37E-08	10,000
U-234	(a)							8.03E-02	2.84E-05	10,000
U-235	(a)							1.28E-03	4.53E-07	10,000
U-236	(a)							1.50E-03	5.31E-07	10,000
U-238	(a)							1.99E-02	7.04E-06	10,000
200 West Area										
C-14	2,000	3.50E-01	0.00E+00	>10,000	3.51E-01	0.00E+00	>10,000	1.52E-01	0.00E+00	>10,000
Tc-99	900	2.00E+00	1.76E+00	2,000	2.01E+00	1.76E+00	2,000	8.71E-01	7.64E-01	2,000
Grouted Tc-99	900									
I-129	1	8.43E-03	7.39E-03	2,000	8.46E-03	7.42E-03	2,000	3.65E-03	3.20E-03	2,000
Grouted I-129	1									
U-233	(a)	1.13E-03	0.00E+00	>10,000	1.13E-03	0.00E+00	>10,000	4.74E-04	0.00E+00	>10,000
U-234	(a)	1.30E+00	0.00E+00	>10,000	1.31E+00	0.00E+00	>10,000	5.68E-01	0.00E+00	>10,000
U-235	(a)	2.08E-02	0.00E+00	>10,000	2.09E-02	0.00E+00	>10,000	9.02E-03	0.00E+00	>10,000
U-236	(a)	2.44E-02	0.00E+00	>10,000	2.45E-02	0.00E+00	>10,000	1.06E-02	0.00E+00	>10,000
U-238	(a)	3.26E-01	0.00E+00	>10,000	3.27E-01	0.00E+00	>10,000	1.41E-01	0.00E+00	>10,000

Table G.7. (contd)

		Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
Constituent	**Benchmark MCL (pCi/L)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
1996-2007 Grouted MLLW (Alternative Group B)										
200 East Area										
C-14	2,000							1.12E+00	8.91E-03	10,000
Tc-99	900									
Grouted Tc-99	900							1.28E+02	9.02E+00	680
I-129	1									
Grouted I-129	1							4.18E-03	9.31E-05	680
U-233	(a)							5.43E-04	2.25E-10	10,000
U-234	(a)							2.35E+02	9.73E-05	10,000
U-235	(a)							1.05E+01	4.35E-06	10,000
U-236	(a)							1.21E-02	5.01E-09	10,000
U-238	(a)							2.45E+02	1.01E-04	10,000
200 West Area										
C-14	2,000	7.02E-01	0.00E+00	>10,000	7.05E-01	0.00E+00	>10,000	7.28E-01	0.00E+00	>10,000
Tc-99	900									
Grouted Tc-99	900	4.01E+00	2.86E-01	1,200	4.03E+00	2.88E-01	1,200	7.40E+01	5.28E+00	1,200
I-129	1									
Grouted I-129	1	1.68E-02	3.80E-04	1,200	1.69E-02	3.81E-04	1,200	4.45E-03	1.00E-04	1,200
U-233	(a)	2.19E-03	0.00E+00	>10,000	2.20E-03	0.00E+00	>10,000	5.79E-04	0.00E+00	>10,000
U-234	(a)	2.62E+00	0.00E+00	>10,000	2.63E+00	0.00E+00	>10,000	1.35E+02	0.00E+00	>10,000
U-235	(a)	4.16E-02	0.00E+00	>10,000	4.18E-02	0.00E+00	>10,000	6.00E+00	0.00E+00	>10,000
U-236	(a)	4.89E-02	0.00E+00	>10,000	4.91E-02	0.00E+00	>10,000	1.29E-02	0.00E+00	>10,000
U-238	(a)	6.49E-01	0.00E+00	>10,000	6.52E-01	0.00E+00	>10,000	1.41E+02	0.00E+00	>10,000

(a) The benchmark MCL for uranium is 30 μg/L expressed as total uranium. To convert isotope specific concentrations from pCi/L to μg/L, use following conversion factors:

- Uranium-233 - 1.05E-04
- Uranium-234 - 1.62E-04
- Uranium-235 - 4.66E-01
- Uranium-236 - 1.58E-02
- Uranium-238 - 3.00E+00.

Table G.8. Predicted Peak Concentrations of Key Constituents from Wastes Disposed of Before 2008 at a Line of Analysis Near the Columbia River, All Action Alternatives

		Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
Constituent	Benchmark MCL (pCi/L)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time
Pre-1970 LLW										
200 East Area										
C-14	2,000									
Tc-99	900	5.16E-01	1.29E+00	260	5.16E-01	1.29E+00	260	5.16E-01	1.29E+00	260
Grouted Tc-99	900									
I-129	1	1.24E-03	3.09E-03	260	1.24E-03	3.09E-03	260	1.24E-03	3.09E-03	260
Grouted I-129	1									
U-233	(a)	1.03E+01	1.92E-02	10,000	1.03E+01	1.92E-02	10,000	1.03E+01	1.92E-02	10,000
U-234	(a)	3.68E-01	6.87E-04	10,000	3.68E-01	6.87E-04	10,000	3.68E-01	6.87E-04	10,000
U-235	(a)	1.12E-02	2.09E-05	10,000	1.12E-02	2.09E-05	10,000	1.12E-02	2.09E-05	10,000
U-236	(a)	7.53E-03	1.41E-05	10,000	7.53E-03	1.41E-05	10,000	7.53E-03	1.41E-05	10,000
U-238	(a)	2.69E-01	5.02E-04	10,000	2.69E-01	5.02E-04	10,000	2.69E-01	5.02E-04	10,000
200 West Area	(a)									
C-14	2,000									
Tc-99	900	1.30E-01	1.69E-01	530	1.30E-01	1.69E-01	530	1.30E-01	1.69E-01	530
Grouted Tc-99	900									
I-129	1	1.70E-04	2.21E-04	530	1.70E-04	2.21E-04	530	1.70E-04	2.21E-04	530
Grouted I-129	1									
U-233	(a)									
U-234	(a)	1.45E+00	0.00E+00	10,000	1.45E+00	0.00E+00	10,000	1.45E+00	0.00E+00	10,000
U-235	(a)	4.38E-02	0.00E+00	10,000	4.38E-02	0.00E+00	10,000	4.38E-02	0.00E+00	10,000
U-236	(a)	2.95E-02	0.00E+00	10,000	2.95E-02	0.00E+00	10,000	2.95E-02	0.00E+00	10,000
U-238	(a)	1.06E+00	0.00E+00	10,000	1.06E+00	0.00E+00	10,000	1.06E+00	0.00E+00	10,000
1970-1987 LLW										
200 East Area										
C-14	2,000	2.15E+02	2.65E-01	10,000	2.15E+02	2.65E-01	10,000	2.15E+02	2.65E-01	10,000
Tc-99	900									
Grouted Tc-99	900									
I-129	1	1.87E-02	4.66E-02	260	1.87E-02	4.66E-02	260	1.87E-02	4.66E-02	260
Grouted I-129	1									
U-233	(a)									
U-234	(a)	3.08E-02	1.12E-04	10,000	3.08E-02	1.12E-04	10,000	3.08E-02	1.12E-04	10,000
U-235	(a)	2.61E-03	9.48E-06	10,000	2.61E-03	9.48E-06	10,000	2.61E-03	9.48E-06	10,000
U-236	(a)									
U-238	(a)	6.28E-02	2.28E-04	10,000	6.28E-02	2.28E-04	10,000	6.28E-02	2.28E-04	10,000
200 West Area										
C-14	2,000	3.92E+02	0.00E+00	10,000	3.92E+02	0.00E+00	10,000	3.92E+02	0.00E+00	10,000
Tc-99	900									
Grouted Tc-99	900									
I-129	1	1.77E-03	2.01E-03	610	1.77E-03	2.01E-03	610	1.77E-03	2.01E-03	610
Grouted I-129	1									
U-233	(a)									
U-234	(a)	3.94E+01	0.00E+00	10,000	3.94E+01	0.00E+00	10,000	3.94E+01	0.00E+00	10,000
U-235	(a)	3.33E+00	0.00E+00	10,000	3.33E+00	0.00E+00	10,000	3.33E+00	0.00E+00	10,000
U-236	(a)									
U-238	(a)	2.82E+01	0.00E+00	10,000	2.82E+01	0.00E+00	10,000	2.82E+01	0.00E+00	10,000

Table G.8. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time
1988-1995 LLW										
200 East Area										
C-14	2,000	5.11E+00	9.11E-04	10,000	5.11E+00	9.11E-04	10,000	5.11E+00	9.11E-04	10,000
Tc-99	900	1.39E-01	3.46E-01	260	1.39E-01	3.46E-01	260	1.39E-01	3.46E-01	260
Grouted Tc-99	900									
I-129	1	9.45E-05	2.35E-04	260	9.45E-05	2.35E-04	260	9.45E-05	2.35E-04	260
Grouted I-129	1									
U-233	(a)	2.09E-05	7.59E-08	10,000	2.09E-05	7.59E-08	10,000	2.09E-05	7.59E-08	10,000
U-234	(a)	1.85E-03	6.72E-06	10,000	1.85E-03	6.72E-06	10,000	1.85E-03	6.72E-06	10,000
U-235	(a)	4.29E-04	1.56E-06	10,000	4.29E-04	1.56E-06	10,000	4.29E-04	1.56E-06	10,000
U-236	(a)	1.85E-06	6.72E-09	10,000	1.85E-06	6.72E-09	10,000	1.85E-06	6.72E-09	10,000
U-238	(a)	1.93E-02	7.01E-05	10,000	1.93E-02	7.01E-05	10,000	1.93E-02	7.01E-05	10,000
200 West Area										
C-14	2,000	9.29E+00	0.00E+00	10,000	9.29E+00	0.00E+00	10,000	9.29E+00	0.00E+00	10,000
Tc-99	900	4.71E-01	3.45E-02	600	4.71E-01	3.45E-02	600	4.71E-01	3.45E-02	600
Grouted Tc-99	900									
I-129	1	3.06E-02	3.45E-02	600	3.06E-02	3.45E-02	600	3.06E-02	3.45E-02	600
Grouted I-129	1									
U-233	(a)	6.54E-02	0.00E+00	10,000	6.54E-02	0.00E+00	10,000	6.54E-02	0.00E+00	10,000
U-234	(a)	5.77E+00	0.00E+00	10,000	5.77E+00	0.00E+00	10,000	5.77E+00	0.00E+00	10,000
U-235	(a)	1.34E+00	0.00E+00	10,000	1.34E+00	0.00E+00	10,000	1.34E+00	0.00E+00	10,000
U-236	(a)	5.77E-03	0.00E+00	10,000	5.77E-03	0.00E+00	10,000	5.77E-03	0.00E+00	10,000
U-238	(a)	6.03E+01	0.00E+00	10,000	6.03E+01	0.00E+00	10,000	6.03E+01	0.00E+00	10,000
1996-2007 Cat 1 LLW (Alternative Groups A, C, D, and E)										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
200 West Area										
C-14	2,000	3.33E+00	0.00E+00	>10,000	4.06E+00	0.00E+00	>10,000	5.21E+00	0.00E+00	>10,000
Tc-99	900	3.00E-01	2.63E-01	2,000	3.66E-01	3.21E-01	2,000	3.99E-01	3.50E-01	2,000
Grouted Tc-99	900									
I-129	1	2.62E-03	2.30E-03	2,000	3.20E-03	2.81E-03	2,000	3.20E-03	2.81E-03	2,000
Grouted I-129	1									
U-233	(a)	1.03E-01	0.00E+00	>10,000	1.25E-01	0.00E+00	>10,000	1.25E-01	0.00E+00	>10,000
U-234	(a)	1.70E-01	0.00E+00	>10,000	2.07E-01	0.00E+00	>10,000	9.01E-01	0.00E+00	>10,000
U-235	(a)	3.56E-02	0.00E+00	>10,000	4.34E-02	0.00E+00	>10,000	8.86E-02	0.00E+00	>10,000
U-236	(a)	4.03E-03	0.00E+00	>10,000	4.92E-03	0.00E+00	>10,000	4.92E-03	0.00E+00	>10,000
U-238	(a)	4.06E-01	0.00E+00	>10,000	4.95E-01	0.00E+00	>10,000	1.66E+00	0.00E+00	>10,000

Table G.8. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time
1996-2007 Cat 3 LLW (Alternative Groups A, C, D, and E)										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
200 West Area										
C-14	2,000	1.48E-01	0.00E+00	>10,000	1.54E-01	0.00E+00	>10,000	3.50E-01	0.00E+00	>10,000
Tc-99	900									
Grouted Tc-99	900	7.20E+01	4.62E-01	1,710	7.20E+01	4.62E-01	1,710	7.20E+01	4.62E-01	1,710
I-129	1	3.39E-07	2.97E-07	2,000	3.53E-07	3.09E-07	2,000	3.53E-07	3.09E-07	2,000
Grouted I-129	1									
U-233	(a)	9.79E-02	0.00E+00	>10,000	1.02E-01	0.00E+00	>10,000	2.32E-01	0.00E+00	>10,000
U-234	(a)	1.24E+02	0.00E+00	>10,000	1.29E+02	0.00E+00	>10,000	2.94E+02	0.00E+00	>10,000
U-235	(a)	3.54E+00	0.00E+00	>10,000	3.69E+00	0.00E+00	>10,000	8.39E+00	0.00E+00	>10,000
U-236	(a)	1.60E+01	0.00E+00	>10,000	1.67E+01	0.00E+00	>10,000	3.80E+01	0.00E+00	>10,000
U-238	(a)	1.99E+02	0.00E+00	>10,000	2.07E+02			4.72E+02	0.00E+00	>10,000
1996-2007 Cat 1 LLW (Alternative Group B)										
200 East Area										
C-14	2,000	1.25E-01	1.19E-05	10,000	1.52E-01	1.45E-05	10,000	7.20E-01	6.86E-05	10,000
Tc-99	900	1.13E-02	1.58E-02	1,400	1.38E-02	1.92E-02	1,400	5.52E-02	7.69E-02	1,400
Grouted Tc-99	900									
I-129	1	9.84E-05	1.37E-04	1,400	1.20E-04	1.67E-04	1,400	4.42E-04	6.16E-04	1,400
Grouted I-129	1									
U-233	(a)	3.85E-03	8.28E-06	10,000	4.70E-03	9.06E-06	10,000	1.73E-02	1.29E-07	10,000
U-234	(a)	6.38E-03	1.37E-05	10,000	7.78E-03	1.50E-05	10,000	1.25E-01	8.68E-05	10,000
U-235	(a)	1.34E-03	2.87E-06	10,000	1.63E-03	3.14E-06	10,000	1.22E-02	8.47E-06	10,000
U-236	(a)	1.52E-04	3.26E-07	10,000	1.85E-04	3.56E-07	10,000	6.80E-04	4.72E-07	10,000
U-238	(a)	1.53E-02	3.28E-05	10,000	1.86E-02	3.58E-05	10,000	2.29E-01	1.59E-04	10,000
200 West Area									0.00E+00	
C-14	2,000	3.21E+00	0.00E+00	>10,000	3.91E+00	0.00E+00	>10,000	4.49E+00	0.00E+00	>10,000
Tc-99	900	2.89E-01	2.53E-01	2,000	3.52E-01	3.09E-01	2,000	3.44E-01	3.02E-01	2,000
Grouted Tc-99	900									
I-129	1	2.53E-03	2.21E-03	2,000	3.08E-03	2.70E-03	2,000	2.76E-03	2.42E-03	2,000
Grouted I-129	1									
U-233	(a)	9.84E-02	0.00E+00	>10,000	1.20E-01	0.00E+00	>10,000	1.08E-01	0.00E+00	>10,000
U-234	(a)	1.63E-01	0.00E+00	>10,000	1.99E-01	0.00E+00	>10,000	7.77E-01	0.00E+00	>10,000
U-235	(a)	3.43E-02	0.00E+00	>10,000	4.18E-02	0.00E+00	>10,000	7.64E-02	0.00E+00	>10,000
U-236	(a)	3.88E-03	0.00E+00	>10,000	4.73E-03	0.00E+00	>10,000	4.24E-03	0.00E+00	>10,000
U-238	(a)	3.90E-01	0.00E+00	>10,000	4.76E-01	0.00E+00	>10,000	1.43E+00	0.00E+00	>10,000

Table G.8. (contd)

		Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
Constituent	**Benchmark MCL (pCi/L)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time**
1996-2007 Cat 3 LLW (Alternative Group B)										
200 East Area										
C-14	2,000	5.56E-03		10,000	5.79E-03	5.52E-07	10,000	1.32E-02	1.26E-06	10,000
Tc-99	900									
Grouted Tc-99	900	2.71E+00	5.30E-07	860	2.71E+00	2.67E-02	860	2.71E+00	2.67E-02	860
I-129	1	1.28E-08		1,400	1.33E-08	1.85E-08	1,400	1.33E-08	1.85E-08	1,400
Grouted I-129	1		2.67E-02							
U-233	(a)	3.68E-03		10,000	3.83E-03	8.69E-11	10,000	8.70E-03	2.49E-10	10,000
U-234	(a)	4.66E+00		10,000	4.85E+00	1.10E-07	10,000	1.11E+01	3.17E-07	10,000
U-235	(a)	1.33E-01	8.69E-11	10,000	1.39E-01	3.15E-09	10,000	3.15E-01	9.00E-09	10,000
U-236	(a)	6.02E-01	1.10E-07	10,000	6.27E-01	1.42E-08	10,000	1.43E+00	4.09E-08	10,000
U-238	(a)	7.47E+00	3.15E-09	10,000	7.78E+00	1.77E-07	10,000	1.77E+01	5.06E-07	10,000
200 West Area										
C-14	2,000	1.42E-01	0.00E+00	>10,000	1.48E-01	0.00E+00	>10,000	3.37E-01	0.00E+00	>10,000
Tc-99	900									
Grouted Tc-99	900	6.93E+01	4.45E-01	1,710	6.93E+01	4.45E-01	1,710	6.93E+01	4.45E-01	1,710
I-129	1	3.26E-07	2.86E-07	2,000	3.40E-07	2.98E-07	2,000	3.40E-07	2.98E-07	2,000
Grouted I-129	1									
U-233	(a)	9.43E-02	0.00E+00	>10,000	9.82E-02	0.00E+00	>10,000	2.23E-01	0.00E+00	>10,000
U-234	(a)	1.19E+02	0.00E+00	>10,000	1.24E+02	0.00E+00	>10,000	2.83E+02	0.00E+00	>10,000
U-235	(a)	3.41E+00	0.00E+00	>10,000	3.55E+00	0.00E+00	>10,000	8.07E+00	0.00E+00	>10,000
U-236	(a)	1.55E+01	0.00E+00	>10,000	1.61E+01	0.00E+00	>10,000	3.66E+01	0.00E+00	>10,000
U-238	(a)	1.91E+02	0.00E+00	>10,000	1.99E+02	0.00E+00	>10,000	4.54E+02	0.00E+00	>10,000
1996-2007 MLLW (Alternative Groups A, C, D, and E)										
200 East Area										
C-14	2,000							2.50E-01	1.84E-04	10,000
Tc-99	900							1.43E+00	1.99E+00	800
Grouted Tc-99	900									
I-129	1							6.03E-03	8.41E-03	800
Grouted I-129	1									
U-233	(a)							8.23E-04	4.12E-07	10,000
U-234	(a)							9.32E-01	4.67E-04	10,000
U-235	(a)							1.49E-02	7.46E-06	10,000
U-236	(a)							1.74E-02	8.71E-06	10,000
U-238	(a)							2.33E-01	1.17E-04	10,000
200 West Area										
C-14	2,000	6.00E-01	0.00E+00	>10,000	6.01E-01	0.00E+00	>10,000	3.66E-01	0.00E+00	>10,000
Tc-99	900	3.43E+00	3.01E+00	2,000	3.44E+00	3.02E+00	2,000	2.09E+00	1.83E+00	2,000
Grouted Tc-99	900	0.00E+00	3.36E-02	1,620	0.00E+00	1.27E-02	1,620	0.00E+00	0.00E+00	1,620
I-129	1	1.45E-02	1.27E-02	2,000	1.45E-02	3.08E-02	2,000	8.81E-03	7.72E-03	2,000
Grouted I-129	1	0.00E+00			0.00E+00			0.00E+00		
U-233	(a)	1.96E-03	0.00E+00	>10,000	1.96E-03	0.00E+00	>10,000	1.18E-03	0.00E+00	>10,000
U-234	(a)	2.24E+00	0.00E+00	>10,000	2.24E+00	0.00E+00	>10,000	1.37E+00	0.00E+00	>10,000
U-235	(a)	3.58E-02	0.00E+00	>10,000	3.59E-02	0.00E+00	>10,000	2.18E-02	0.00E+00	>10,000
U-236	(a)	4.19E-02	0.00E+00	>10,000	4.20E-02	0.00E+00	>10,000	2.55E-02	0.00E+00	>10,000
U-238	(a)	5.60E-01	0.00E+00	>10,000	5.61E-01	0.00E+00	>10,000	3.41E-01	0.00E+00	>10,000

Table G.8. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time
1996-2007 Grouted MLLW (Alternative Groups A, C, D, and E)										
200 East Area										
C-14	2,000							1.35E+00	9.95E-04	10,000
Tc-99	900									
Grouted Tc-99	900							1.23E+02	1.06E+00	940
I-129	1									
Grouted I-129	1							1.07E-02	2.93E-05	940
U-233	(a)							1.40E-03	1.88E-12	10,000
U-234	(a)							2.24E+02	3.01E-07	10,000
U-235	(a)							9.95E+00	1.34E-08	10,000
U-236	(a)							3.12E-02	4.20E-11	10,000
U-238	(a)							2.33E+02	3.13E-07	10,000
200 West Area										
C-14	2,000	8.58E-01	0.00E+00	>10,000	8.60E-01	0.00E+00	>10,000	7.64E-01	0.00E+00	>10,000
Tc-99	900									
Grouted Tc-99	900	4.91E+00	3.36E-02	1,620	4.92E+00	3.37E-02	1,620	5.96E+01	4.08E-01	1,620
I-129	1									
Grouted I-129	1	2.06E-02	4.45E-05	1,620	2.06E-02	4.46E-05	1,620	8.03E-03	1.74E-05	1,620
U-233	(a)	2.67E-03	0.00E+00	>10,000	2.68E-03	0.00E+00	>10,000	1.04E-03	0.00E+00	>10,000
U-234	(a)	3.19E+00	0.00E+00	>10,000	3.20E+00	0.00E+00	>10,000	1.07E+02	0.00E+00	>10,000
U-235	(a)	5.08E-02	0.00E+00	>10,000	5.09E-02	0.00E+00	>10,000	4.76E+00	0.00E+00	>10,000
U-236	(a)	5.97E-02	0.00E+00	>10,000	5.98E-02	0.00E+00	>10,000	2.33E-02	0.00E+00	>10,000
U-238	(a)	7.93E-01	0.00E+00	>10,000	7.95E-01	0.00E+00	>10,000	1.11E+02	0.00E+00	>10,000
1996-2007 MLLW (Alternative Group B)										
200 East Area										
C-14	2,000							2.16E-02	2.06E-06	10,000
Tc-99	900							1.23E-01	1.71E-01	1,400
Grouted Tc-99	900									
I-129	1							5.16E-04	7.19E-04	1,400
Grouted I-129	1									
U-233	(a)							6.71E-05	2.37E-08	10,000
U-234	(a)							8.03E-02	2.84E-05	10,000
U-235	(a)							1.28E-03	4.53E-07	10,000
U-236	(a)							1.50E-03	5.31E-07	10,000
U-238	(a)							1.99E-02	7.04E-06	10,000
200 West Area										
C-14	2,000	3.50E-01	0.00E+00	>10,000	3.51E-01	0.00E+00	>10,000	1.52E-01	0.00E+00	>10,000
Tc-99	900	2.00E+00	1.76E+00	2,000	2.01E+00	1.76E+00	2,000	8.71E-01	7.64E-01	2,000
Grouted Tc-99	900									
I-129	1	8.43E-03	7.39E-03	2,000	8.46E-03	7.42E-03	2,000	3.65E-03	3.20E-03	2,000
Grouted I-129	1									
U-233	(a)	1.13E-03	0.00E+00	>10,000	1.13E-03	0.00E+00	>10,000	4.74E-04	0.00E+00	>10,000
U-234	(a)	1.30E+00	0.00E+00	>10,000	1.31E+00	0.00E+00	>10,000	5.68E-01	0.00E+00	>10,000
U-235	(a)	2.08E-02	0.00E+00	>10,000	2.09E-02	0.00E+00	>10,000	9.02E-03	0.00E+00	>10,000
U-236	(a)	2.44E-02	0.00E+00	>10,000	2.45E-02	0.00E+00	>10,000	1.06E-02	0.00E+00	>10,000
U-238	(a)	3.26E-01	0.00E+00	>10,000	3.27E-01	0.00E+00	>10,000	1.41E-01	0.00E+00	>10,000

Table G.8. (contd)

		Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
Constituent	Benchmark MCL (pCi/L)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time
1996-2007 Grouted MLLW (Alternative Group B)										
200 East Area										
C-14	2,000							1.12E+00	1.07E-04	10,000
Tc-99	900									
Grouted Tc-99	900							1.28E+02	1.11E+00	940
I-129	1									
Grouted I-129	1							4.18E-03	1.14E-05	940
U-233	(a)							5.43E-04	1.20E-12	10,000
U-234	(a)							2.35E+02	5.21E-07	10,000
U-235	(a)							1.05E+01	2.33E-08	10,000
U-236	(a)							1.21E-02	2.68E-11	10,000
U-238	(a)							2.45E+02	5.43E-07	10,000
200 West Area										
C-14	2,000	7.02E-01	0.00E+00	>10,000	7.05E-01	0.00E+00	>10,000	7.28E-01	0.00E+00	>10,000
Tc-99	900									
Grouted Tc-99	900	4.01E+00	2.75E-02	1,620	4.03E+00	2.76E-02	1,620	7.40E+01	5.06E-01	1,620
I-129	1									
Grouted I-129	1	1.68E-02	3.64E-05	1,620	1.69E-02	3.66E-05	1,620	4.45E-03	9.63E-06	1,620
U-233	(a)	2.19E-03	0.00E+00	>10,000	2.20E-03	0.00E+00	>10,000	5.79E-04	0.00E+00	>10,000
U-234	(a)	2.62E+00	0.00E+00	>10,000	2.63E+00	0.00E+00	>10,000	1.35E+02	0.00E+00	>10,000
U-235	(a)	4.16E-02	0.00E+00	>10,000	4.18E-02	0.00E+00	>10,000	6.00E+00	0.00E+00	>10,000
U-236	(a)	4.89E-02	0.00E+00	>10,000	4.91E-02	0.00E+00	>10,000	1.29E-02	0.00E+00	>10,000
U-238	(a)	6.49E-01	0.00E+00	>10,000	6.52E-01	0.00E+00	>10,000	1.41E+02	0.00E+00	>10,000

(a) The benchmark MCL for uranium is 30 µg/L expressed as total uranium. To convert isotope specific concentrations from pCi/L to µg/L, use following conversion factors:

- Uranium-233 - 1.05E-04
- Uranium-234 - 1.62E-04
- Uranium-235 - 4.66E-01
- Uranium-236 - 1.58E-02
- Uranium-238 - 3.00E+00.

Table G.9. Predicted Peak River Flux of Key Constituents from Wastes Disposed of Before 2008 at a Line of Analysis Near the Columbia River, All Action Alternatives

	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
Constituent	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci)**	**Approx. Peak Arrival Time (yrs)**
Pre-1970 LLW									
200 East Area									
C-14									
Tc-99	5.16E-01	9.81E-03	290	5.16E-01	9.81E-03	290	5.16E-01	9.81E-03	290
Grouted Tc-99									
I-129	1.24E-03	2.36E-05	290	1.24E-03	2.36E-05	290	1.24E-03	2.36E-05	290
Grouted I-129									
U-233	1.03E+01	1.29E-04	10,000	1.03E+01	1.29E-04	10,000	1.03E+01	1.29E-04	10,000
U-234	3.68E-01	4.61E-06	10,000	3.68E-01	4.61E-06	10,000	3.68E-01	4.61E-06	10,000
U-235	1.12E-02	1.40E-07	10,000	1.12E-02	1.40E-07	10,000	1.12E-02	1.40E-07	10,000
U-236	7.53E-03	9.43E-08	10,000	7.53E-03	9.43E-08	10,000	7.53E-03	9.43E-08	10,000
U-238	2.69E-01	3.37E-06	10,000	2.69E-01	3.37E-06	10,000	2.69E-01	3.37E-06	10,000
200 West Area									
C-14									
Tc-99	1.30E-01	1.68E-03	600	1.30E-01	1.68E-03	600	1.30E-01	1.68E-03	600
Grouted Tc-99									
I-129	1.70E-04	2.20E-06	600	1.70E-04	2.20E-06	600	1.70E-04	2.20E-06	600
Grouted I-129									
U-233									
U-234	1.45E+00	0.00E+00	10,000	1.45E+00	0.00E+00	10,000	1.45E+00	0.00E+00	10,000
U-235	4.38E-02	0.00E+00	10,000	4.38E-02	0.00E+00	10,000	4.38E-02	0.00E+00	10,000
U-236	2.95E-02	0.00E+00	10,000	2.95E-02	0.00E+00	10,000	2.95E-02	0.00E+00	10,000
U-238	1.06E+00	0.00E+00	10,000	1.06E+00	0.00E+00	10,000	1.06E+00	0.00E+00	10,000
1970-1987 LLW									
200 East Area									
C-14	2.15E+02	1.76E-03	10,000	2.15E+02	1.76E-03	10,000	2.15E+02	1.76E-03	10,000
Tc-99									
Grouted Tc-99									
I-129	1.87E-02	3.54E-04	290	1.87E-02	3.54E-04	290	1.87E-02	3.54E-04	290
Grouted I-129									
U-233									
U-234	3.08E-02	7.50E-07	10,000	3.08E-02	7.50E-07	10,000	3.08E-02	7.50E-07	10,000
U-235	2.61E-03	6.35E-08	10,000	2.61E-03	6.35E-08	10,000	2.61E-03	6.35E-08	10,000
U-236									
U-238	6.28E-02	1.53E-06	10,000	6.28E-02	1.53E-06	10,000	6.28E-02	1.53E-06	10,000
200 West Area									
C-14	3.92E+02	0.00E+00	10,000	3.92E+02	0.00E+00	10,000	3.92E+02	0.00E+00	10,000
Tc-99									
Grouted Tc-99									
I-129	1.77E-03	2.07E-05	690	1.77E-03	2.07E-05	690	1.77E-03	2.07E-05	690
Grouted I-129									
U-233									
U-234	3.94E+01	0.00E+00	10,000	3.94E+01	0.00E+00	10,000	3.94E+01	0.00E+00	10,000
U-235	3.33E+00	0.00E+00	10,000	3.33E+00	0.00E+00	10,000	3.33E+00	0.00E+00	10,000
U-236									
U-238	2.82E+01	0.00E+00	10,000	2.82E+01	0.00E+00	10,000	2.82E+01	0.00E+00	10,000

Table G.9. (contd)

	Hanford Only Volume			**Lower Bound Volume**			**Upper Bound Volume**		
Constituent	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci)**	**Approx. Peak Arrival Time (yrs)**
1988-1995 LLW									
200 East Area									
C-14	5.11E+00	6.05E-06	10,000	5.11E+00	6.05E-06	10,000	5.11E+00	6.05E-06	10,000
Tc-99	1.39E-01	2.63E-03	290	1.39E-01	2.63E-03	290	1.39E-01	2.63E-03	290
Grouted Tc-99									
I-129	9.45E-05	1.79E-06	290	9.45E-05	1.79E-06	290	9.45E-05	1.79E-06	290
Grouted I-129									
U-233	2.09E-05	5.09E-10	10,000	2.09E-05	5.09E-10	10,000	2.09E-05	5.09E-10	10,000
U-234	1.85E-03	4.50E-08	10,000	1.85E-03	4.50E-08	10,000	1.85E-03	4.50E-08	10,000
U-235	4.29E-04	1.04E-08	10,000	4.29E-04	1.04E-08	10,000	4.29E-04	1.04E-08	10,000
U-236	1.85E-06	4.50E-11	10,000	1.85E-06	4.50E-11	10,000	1.85E-06	4.50E-11	10,000
U-238	1.93E-02	4.70E-07	10,000	1.93E-02	4.70E-07	10,000	1.93E-02	4.70E-07	10,000
200 West Area									
C-14	9.29E+00	0.00E+00	10,000	9.29E+00	0.00E+00	10,000	9.29E+00	0.00E+00	10,000
Tc-99	4.71E-01	0.00E+00	670	4.71E-01	0.00E+00	670	4.71E-01	0.00E+00	670
Grouted Tc-99									
I-129	3.06E-02	3.58E-04	670	3.06E-02	3.58E-04	670	3.06E-02	3.58E-04	670
Grouted I-129									
U-233	6.54E-02	0.00E+00	10,000	6.54E-02	0.00E+00	10,000	6.54E-02	0.00E+00	10,000
U-234	5.77E+00	0.00E+00	10,000	5.77E+00	0.00E+00	10,000	5.77E+00	0.00E+00	10,000
U-235	1.34E+00	0.00E+00	10,000	1.34E+00	0.00E+00	10,000	1.34E+00	0.00E+00	10,000
U-236	5.77E-03	0.00E+00	10,000	5.77E-03	0.00E+00	10,000	5.77E-03	0.00E+00	10,000
U-238	6.03E+01	0.00E+00	10,000	6.03E+01	0.00E+00	10,000	6.03E+01	0.00E+00	10,000
1996-2007 Cat 1 LLW (Alternative Groups A, C, D, and E)									
200 East Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
200 West Area									
C-14	3.33E+00	0.00E+00	>10,000	4.06E+00	0.00E+00	>10,000	5.21E+00	0.00E+00	>10,000
Tc-99	3.00E-01	2.85E-03	2,180	3.66E-01	3.48E-03	2,180	3.99E-01	3.79E-03	2,180
Grouted Tc-99									
I-129	2.62E-03	2.49E-05	2,180	3.20E-03	3.04E-05	2,180	3.20E-03	3.04E-05	2,180
Grouted I-129									
U-233	1.03E-01	0.00E+00	>10,000	1.25E-01	0.00E+00	>10,000	1.25E-01	0.00E+00	>10,000
U-234	1.70E-01	0.00E+00	>10,000	2.07E-01	0.00E+00	>10,000	9.01E-01	0.00E+00	>10,000
U-235	3.56E-02	0.00E+00	>10,000	4.34E-02	0.00E+00	>10,000	8.86E-02	0.00E+00	>10,000
U-236	4.03E-03	0.00E+00	>10,000	4.92E-03	0.00E+00	>10,000	4.92E-03	0.00E+00	>10,000
U-238	4.06E-01	0.00E+00	>10,000	4.95E-01	0.00E+00	>10,000	1.66E+00	0.00E+00	>10,000

Table G.9. (contd)

	Hanford Only Volume			**Lower Bound Volume**			**Upper Bound Volume**		
Constituent	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci)**	**Approx. Peak Arrival Time (yrs)**
1996-2007 Cat 3 LLW (Alternative Groups A, C, D, and E)									
200 East Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
200 West Area									
C-14	1.48E-01	0.00E+00	>10,000	1.54E-01	0.00E+00	>10,000	3.50E-01	0.00E+00	>10,000
Tc-99									
Grouted Tc-99	7.20E+01	6.01E-03	1,840	7.20E+01	6.01E-03	1,840	7.20E+01	6.01E-03	1,840
I-129	3.39E-07	3.22E-09	2,180	3.53E-07	3.35E-09	2,180	3.53E-07	3.35E-09	2,180
Grouted I-129									
U-233	9.79E-02	0.00E+00	>10,000	1.02E-01	0.00E+00	>10,000	2.32E-01	0.00E+00	>10,000
U-234	1.24E+02	0.00E+00	>10,000	1.29E+02	0.00E+00	>10,000	2.94E+02	0.00E+00	>10,000
U-235	3.54E+00	0.00E+00	>10,000	3.69E+00	0.00E+00	>10,000	8.39E+00	0.00E+00	>10,000
U-236	1.60E+01	0.00E+00	>10,000	1.67E+01	0.00E+00	>10,000	3.80E+01	0.00E+00	>10,000
U-238	1.99E+02	0.00E+00	>10,000	2.07E+02	0.00E+00	>10,000	4.72E+02	0.00E+00	>10,000
1996-2007 Cat 1 LLW (Alternative Group B)									
200 East Area									
C-14	1.25E-01	1.46E-03	690	1.52E-01	1.78E-03	690	7.20E-01	8.44E-03	690
Tc-99	1.13E-02	1.47E-04	1,450	1.38E-02	1.79E-04	1,450	5.52E-02	7.17E-04	1,450
Grouted Tc-99									
I-129	9.84E-05	1.28E-06	1,450	1.20E-04	1.56E-06	1,450	4.42E-04	5.74E-06	1,450
Grouted I-129									
U-233	3.85E-03	4.54E-08	10,000	4.70E-03	4.92E-08	10,000	1.73E-02	5.78E-10	10,000
U-234	6.38E-03	7.52E-08	10,000	7.78E-03	8.15E-08	10,000	1.25E-01	8.68E-05	10,000
U-235	1.34E-03	1.58E-08	10,000	1.63E-03	1.71E-08	10,000	1.22E-02	8.47E-06	10,000
U-236	1.52E-04	1.79E-09	10,000	1.85E-04	1.94E-09	10,000	6.80E-04	4.72E-07	10,000
U-238	1.53E-02	1.80E-07	10,000	1.86E-02	1.95E-07	10,000	2.29E-01	1.59E-04	10,000
200 West Area									
C-14	3.21E+00	0.00E+00	>10,000	3.91E+00	0.00E+00	>10,000	4.49E+00	0.00E+00	>10,000
Tc-99	2.89E-01	2.74E-03	2,180	3.52E-01	3.34E-03	2,180	3.44E-01	3.27E-03	2,180
Grouted Tc-99									
I-129	2.53E-03	2.40E-05	2,180	3.08E-03	2.93E-05	2,180	2.76E-03	2.62E-05	2,180
Grouted I-129									
U-233	9.84E-02	0.00E+00	>10,000	1.20E-01	0.00E+00	>10,000	1.08E-01	0.00E+00	>10,000
U-234	1.63E-01	0.00E+00	>10,000	1.99E-01	0.00E+00	>10,000	7.77E-01	0.00E+00	>10,000
U-235	3.43E-02	0.00E+00	>10,000	4.18E-02	0.00E+00	>10,000	7.64E-02	0.00E+00	>10,000
U-236	3.88E-03	0.00E+00	>10,000	4.73E-03	0.00E+00	>10,000	4.24E-03	0.00E+00	>10,000
U-238	3.90E-01	0.00E+00	>10,000	4.76E-01	0.00E+00	>10,000	1.43E+00	0.00E+00	>10,000

Table G.9. (contd)

Constituent	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci)	Approx. Peak Arrival Time (yrs)
1996-2007 Cat 3 LLW (Alternative Group B)									
200 East Area									
C-14	5.56E-03	6.51E-05	690	5.79E-03	6.78E-05	690	1.32E-02	1.55E-04	690
Tc-99									
Grouted Tc-99	2.71E+00	2.51E-04	970	2.71E+00	2.51E-04	970	2.71E+00	2.51E-04	970
I-129	1.28E-08	1.66E-10	1,450	1.33E-08	1.73E-10	1,450	1.33E-08	1.73E-10	1,450
Grouted I-129									
U-233	3.68E-03	4.57E-13	10,000	3.83E-03	4.57E-13	10,000	8.70E-03	1.12E-12	10,000
U-234	4.66E+00	5.79E-10	10,000	4.85E+00	5.79E-10	10,000	1.11E+01	1.42E-09	10,000
U-235	1.33E-01	1.66E-11	10,000	1.39E-01	1.66E-11	10,000	3.15E-01	4.04E-11	10,000
U-236	6.02E-01	7.48E-11	10,000	6.27E-01	7.48E-11	10,000	1.43E+00	1.83E-10	10,000
U-238	7.47E+00	9.29E-10	10,000	7.78E+00	9.29E-10	10,000	1.77E+01	2.27E-09	10,000
200 West Area									
C-14	1.42E-01	0.00E+00	>10,000	1.48E-01	0.00E+00	>10,000	3.37E-01	0.00E+00	>10,000
Tc-99									
Grouted Tc-99	6.93E+01	5.78E-03	1,840	6.93E+01	5.78E-03	1,840	6.93E+01	5.78E-03	1,840
I-129	3.26E-07	0.00E+00	>10,000	3.40E-07	0.00E+00	>10,000	3.40E-07	0.00E+00	>10,000
Grouted I-129									
U-233	9.43E-02	0.00E+00	>10,000	9.82E-02	0.00E+00	>10,000	2.23E-01	0.00E+00	>10,000
U-234	1.19E+02	0.00E+00	>10,000	1.24E+02	0.00E+00	>10,000	2.83E+02	0.00E+00	>10,000
U-235	3.41E+00	0.00E+00	>10,000	3.55E+00	0.00E+00	>10,000	8.07E+00	0.00E+00	>10,000
U-236	1.55E+01	0.00E+00	>10,000	1.61E+01	0.00E+00	>10,000	3.66E+01	0.00E+00	>10,000
U-238	1.91E+02	0.00E+00	>10,000	1.99E+02	0.00E+00	>10,000	4.54E+02	0.00E+00	>10,000
1996-2007 MLLW (Alternative Groups A, C, D, and E)									
200 East Area									
C-14							2.50E-01	1.06E-07	10,000
Tc-99							1.43E+00	1.86E-02	1,450
Grouted Tc-99									
I-129							6.03E-03	7.83E-05	1,450
Grouted I-129									
U-233							8.23E-04	2.04E-09	10,000
U-234							9.32E-01	2.31E-06	10,000
U-235							1.49E-02	3.70E-08	10,000
U-236							1.74E-02	4.32E-08	10,000
U-238							2.33E-01	5.78E-07	10,000
200 West Area									
C-14	6.00E-01	0.00E+00	>10,000	6.01E-01	0.00E+00	>10,000	3.66E-01	0.00E+00	>10,000
Tc-99	3.43E+00	3.26E-02	2,180	3.44E+00	3.27E-02	2,180	2.09E+00	1.99E-02	2,180
Grouted Tc-99									
I-129	1.45E-02	1.38E-04	2,180	1.45E-02	1.38E-04	2,180	8.81E-03	8.37E-05	2,180
Grouted I-129									
U-233	1.96E-03	0.00E+00	>10,000	1.96E-03	0.00E+00	>10,000	1.18E-03	0.00E+00	>10,000
U-234	2.24E+00	0.00E+00	>10,000	2.24E+00	0.00E+00	>10,000	1.37E+00	0.00E+00	>10,000
U-235	3.58E-02	0.00E+00	>10,000	3.59E-02	0.00E+00	>10,000	2.18E-02	0.00E+00	>10,000
U-236	4.19E-02	0.00E+00	>10,000	4.20E-02	0.00E+00	>10,000	2.55E-02	0.00E+00	>10,000
U-238	5.60E-01	0.00E+00	>10,000	5.61E-01	0.00E+00	>10,000	3.41E-01	0.00E+00	>10,000

Table G.9. (contd)

Constituent	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci)	Approx. Peak Arrival Time (yrs)
1996-2007 Grouted MLLW (Alternative Groups A, C, D, and E)									
200 East Area									
C-14							1.35E+00	5.75E-07	10,000
Tc-99									
Grouted Tc-99							1.23E+02	1.14E-02	970
I-129									
Grouted I-129							1.07E-02	3.13E-07	970
U-233							1.40E-03	1.95E-14	10,000
U-234							2.24E+02	3.12E-09	10,000
U-235							9.95E+00	1.39E-10	10,000
U-236							3.12E-02	4.34E-13	10,000
U-238							2.33E+02	3.24E-09	10,000
200 West Area									
C-14	8.58E-01	0.00E+00	>10,000	8.60E-01	0.00E+00	>10,000	7.64E-01	0.00E+00	>10,000
Tc-99									
Grouted Tc-99	4.91E+00	4.10E-04	1,840	4.92E+00	4.10E-04	1,840	5.96E+01	4.97E-03	1,840
I-129									
Grouted I-129	2.06E-02	5.42E-07	1,840	2.06E-02	5.43E-07	1,840	8.03E-03	2.12E-07	1,840
U-233	2.67E-03	0.00E+00	>10,000	2.68E-03	0.00E+00	>10,000	1.04E-03	0.00E+00	>10,000
U-234	3.19E+00	0.00E+00	>10,000	3.20E+00	0.00E+00	>10,000	1.07E+02	0.00E+00	>10,000
U-235	5.08E-02	0.00E+00	>10,000	5.09E-02	0.00E+00	>10,000	4.76E+00	0.00E+00	>10,000
U-236	5.97E-02	0.00E+00	>10,000	5.98E-02	0.00E+00	>10,000	2.33E-02	0.00E+00	>10,000
U-238	7.93E-01	0.00E+00	>10,000	7.95E-01	0.00E+00	>10,000	1.11E+02	0.00E+00	>10,000
1996-2007 MLLW (Alternative Group B)									
200 East Area									
C-14							2.16E-02	9.20E-09	10,000
Tc-99							1.23E-01	1.60E-03	1,450
Grouted Tc-99									
I-129							5.16E-04	6.70E-06	1,450
Grouted I-129									
U-233							6.71E-05	1.43E-10	10,000
U-234							8.03E-02	1.72E-07	10,000
U-235							1.28E-03	2.74E-09	10,000
U-236							1.50E-03	3.21E-09	10,000
U-238							1.99E-02	4.25E-08	10,000
200 West Area									
C-14	3.50E-01	0.00E+00	>10,000	3.51E-01	0.00E+00	>10,000	1.52E-01	0.00E+00	>10,000
Tc-99	2.00E+00	1.90E-02	2,180	2.01E+00	1.91E-02	2,180	8.71E-01	8.28E-03	2,180
Grouted Tc-99									
I-129	8.43E-03	8.01E-05	2,180	8.46E-03	8.04E-05	2,180	3.65E-03	3.47E-05	2,180
Grouted I-129									
U-233	1.13E-03	0.00E+00	>10,000	1.13E-03	0.00E+00	>10,000	4.74E-04	0.00E+00	>10,000
U-234	1.30E+00	0.00E+00	>10,000	1.31E+00	0.00E+00	>10,000	5.68E-01	0.00E+00	>10,000
U-235	2.08E-02	0.00E+00	>10,000	2.09E-02	0.00E+00	>10,000	9.02E-03	0.00E+00	>10,000
U-236	2.44E-02	0.00E+00	>10,000	2.45E-02	0.00E+00	>10,000	1.06E-02	0.00E+00	>10,000
U-238	3.26E-01	0.00E+00	>10,000	3.27E-01	0.00E+00	>10,000	1.41E-01	0.00E+00	>10,000

Table G.9. (contd)

	Hanford Only Volume			**Lower Bound Volume**			**Upper Bound Volume**		
Constituent	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci)**	**Approx. Peak Arrival Time (yrs)**
Grouted 1996-2007 MLLW (Alternative Group B)									
200 East Area									
C-14							1.12E+00	4.77E-07	10,000
Tc-99									
Grouted Tc-99							1.28E+02	1.18E-02	970
I-129									
Grouted I-129							4.18E-03	1.22E-07	970
U-233							5.43E-04	7.08E-15	10,000
U-234							2.35E+02	3.06E-09	10,000
U-235							1.05E+01	1.37E-10	10,000
U-236							1.21E-02	1.58E-13	10,000
U-238							2.45E+02	3.19E-09	10,000
200 West Area									
C-14	7.02E-01	0.00E+00	>10,000	7.05E-01	0.00E+00	>10,000	7.28E-01	0.00E+00	>10,000
Tc-99									
Grouted Tc-99	4.01E+00	3.35E-04	1,840	4.03E+00	3.36E-04	1,840	7.40E+01	6.17E-03	1,840
I-129									
Grouted I-129	1.68E-02	4.44E-07	1,840	1.69E-02	4.46E-07	1,840	4.45E-03	1.17E-07	1,840
U-233	2.19E-03	0.00E+00	>10,000	2.20E-03	0.00E+00	>10,000	5.79E-04	0.00E+00	>10,000
U-234	2.62E+00	0.00E+00	>10,000	2.63E+00	0.00E+00	>10,000	1.35E+02	0.00E+00	>10,000
U-235	4.16E-02	0.00E+00	>10,000	4.18E-02	0.00E+00	>10,000	6.00E+00	0.00E+00	>10,000
U-236	4.89E-02	0.00E+00	>10,000	4.91E-02	0.00E+00	>10,000	1.29E-02	0.00E+00	>10,000
U-238	6.49E-01	0.00E+00	>10,000	6.52E-01	0.00E+00	>10,000	1.41E+02	0.00E+00	>10,000

Table G.10. Predicted Peak Concentrations of Key Constituents Disposed of After 2007 at a 1-km Line of Analysis, Alternative Group A

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected Cat 1 LLW										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
200 West Area										
C-14	2,000	1.28E+01	0.00E+00	>10,000	1.56E+01	0.00E+00	>10,000	1.59E+01	0.00E+00	>10,000
Tc-99	900	1.08E+00	8.98E+00	1,910	1.32E+00	1.09E+01	1,910	1.33E+00	1.10E+01	1,910
Grouted Tc-99	900									
I-129	1	3.01E-03	2.50E-02	1,910	3.67E-03	3.04E-02	1,910	3.67E-03	3.04E-02	1,910
Grouted I-129	1									
U-233	(a)	3.71E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000
U-234	(a)	6.13E-01	0.00E+00	>10,000	7.47E-01	0.00E+00	>10,000	9.21E-01	0.00E+00	>10,000
U-235	(a)	1.29E-01	0.00E+00	>10,000	1.57E-01	0.00E+00	>10,000	1.68E-01	0.00E+00	>10,000
U-236	(a)	1.46E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000
U-238	(a)	1.47E+00	0.00E+00	>10,000	1.79E+00	0.00E+00	>10,000	2.08E+00	0.00E+00	>10,000
Projected Cat 3 LLW										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
200 West Area										
C-14	2,000	4.44E-01	0.00E+00	>10,000	4.62E-01	0.00E+00	>10,000	1.45E+02	0.00E+00	>10,000
Tc-99	900									
Grouted Tc-99	900	3.23E+03	2.98E+02	1,230	3.23E+03	2.98E+02	1,230	3.23E+03	2.98E+02	1,230
I-129	1	1.96E-06	1.62E-05	1,910	2.04E-06	1.62E-05	1,910	2.04E-06	1.69E-05	1,910
Grouted I-129	1	5.00E+00	1.46E-01	1,230	5.00E+00	1.46E-01	1,230	5.00E+00	1.46E-01	1,230
U-233	(a)	2.98E-01	0.00E+00	>10,000	3.10E-01	0.00E+00	>10,000	1.80E-01	0.00E+00	>10,000
U-234	(a)	3.73E+02	0.00E+00	>10,000	3.89E+02	0.00E+00	>10,000	3.11E+02	0.00E+00	>10,000
U-235	(a)	1.07E+01	0.00E+00	>10,000	1.11E+01	0.00E+00	>10,000	1.20E+01	0.00E+00	>10,000

Table G.10. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
U-236	(a)	**4.82E+01**	**0.00E+00**	**>10,000**	5.02E+01	0.00E+00	>10,000	2.89E+01	0.00E+00	>10,000
U-238	(a)	5.99E+02	0.00E+00	>10,000	6.24E+02	0.00E+00	>10,000	5.04E+02	0.00E+00	>10,000
Projected MLLW										
200 East Area										
C-14	2,000	1.46E+00	1.78E+01	10,000	1.46E+00	3.42E-03	10,000	1.45E+00	3.40E-03	10,000
Tc-99	900	8.34E+00	6.79E+01	1,370	8.36E+00	6.80E+01	1,370	8.27E+00	6.73E+01	1,370
Grouted Tc-99	900									
I-129	1	3.50E-02	2.85E-01	1,370	3.51E-02	2.85E-01	1,370	3.48E-02	2.83E-01	1,370
Grouted I-129	1									
U-233	(a)	4.67E-03	3.56E-05	10,000	4.68E-03	4.09E-05	10,000	4.64E-03	7.14E-05	10,000
U-234	(a)	5.44E+00	4.14E-02	10,000	5.45E+00	4.76E-02	10,000	5.40E+00	8.30E-02	10,000
U-235	(a)	8.67E-02	6.60E-04	10,000	8.69E-02	7.59E-04	10,000	8.61E-02	1.32E-03	10,000
U-236	(a)	1.02E-01	7.75E-04	10,000	1.02E-01	8.90E-04	10,000	1.01E-01	1.55E-03	10,000
U-238	(a)	1.36E+00	1.03E-02	10,000	1.36E+00	1.19E-02	10,000	1.35E+00	2.08E-02	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
Projected Grouted MLLW										
200 East Area										
C-14	2,000	2.86E+00	3.50E+01	10,000	2.87E+00	6.73E-03	10,000	4.25E+00	9.96E-03	10,000
Tc-99	900									
Grouted Tc-99	900	1.57E+02	1.10E+01	680	1.57E+02	1.11E+01	680	3.34E+02	2.35E+01	680
I-129	1									
Grouted I-129	1	6.87E-02	1.53E-03	680	6.88E-02	1.53E-03	680	7.06E-02	1.57E-03	680
U-233	(a)	8.91E-03	2.21E-06	10,000	8.93E-03	2.22E-06	10,000	9.20E-03	2.31E-09	10,000
U-234	(a)	1.07E+01	2.65E-03	10,000	1.07E+01	2.65E-03	10,000	3.35E+02	8.42E-05	10,000
U-235	(a)	1.70E-01	4.21E-05	10,000	1.70E-01	4.22E-05	10,000	1.47E+01	3.69E-06	10,000
U-236	(a)	2.00E-01	4.95E-05	10,000	2.00E-01	4.96E-05	10,000	2.05E-01	5.15E-08	10,000
U-238	(a)	2.64E+00	6.56E-04	10,000	2.65E+00	6.57E-04	10,000	3.42E+02	8.59E-05	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									

Table G.10. (contd)

		Hanford Only Volume			**Lower Bound Volume**			**Upper Bound Volume**		
Constituent	**Benchmark MCL (pCi/L)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
U-235	(a)									
U-236	(a)									
U-238	(a)									
Projected Melter Waste										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900	3.89E+01	2.74E+00	680	3.89E+01	2.74E+00	680	3.89E+01	2.74E+00	680
I-129	1									
Grouted I-129	1									
U-233	(a)	8.49E-01	1.74E-03	10,000	8.49E-01	1.74E-03	10,000	8.49E-01	1.74E-03	10,000
U-234	(a)	4.60E-01	9.43E-04	10,000	4.60E-01	9.43E-04	10,000	4.60E-01	9.43E-04	10,000
U-235	(a)	1.90E-02	3.89E-05	10,000	1.90E-02	3.89E-05	10,000	1.90E-02	3.89E-05	10,000
U-236	(a)	1.70E-02	3.48E-05	10,000	1.70E-02	3.48E-05	10,000	1.70E-02	3.48E-05	10,000
U-238	(a)	4.10E-01	8.40E-04	10,000	4.10E-01	8.40E-04	10,000	4.10E-01	8.40E-04	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									

(a) The benchmark MCL for uranium is 30 μg/L expressed as total uranium. To convert isotope specific concentrations from pCi/L to μg/L, use following conversion factors:

- Uranium-233 - 1.05E-04
- Uranium-234 - 1.62E-04
- Uranium-235 - 4.66E-01
- Uranium-236 - 1.58E-02
- Uranium-238 - 3.00E+00.

Table G.11. Predicted Peak Concentrations of Key Constituents Disposed of After 2007 at a Line of Analysis Near the Columbia River, Alternative Group A

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected Cat 1 LLW										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
200 West Area										
C-14	2,000	1.28E+01	0.00E+00	>10,000	1.56E+01	0.00E+00	>10,000	1.59E+01	0.00E+00	>10,000
Tc-99	900	1.08E+00	8.33E-01	2,260	1.32E+00	1.02E+00	2,260	1.33E+00	1.02E+00	2,260
Grouted Tc-99	900									
I-129	1	3.01E-03	2.32E-03	2,260	3.67E-03	2.83E-03	2,260	3.67E-03	2.83E-03	2,260
Grouted I-129	1									
U-233	(a)	3.71E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000
U-234	(a)	6.13E-01	0.00E+00	>10,000	7.47E-01	0.00E+00	>10,000	9.21E-01	0.00E+00	>10,000
U-235	(a)	1.29E-01	0.00E+00	>10,000	1.57E-01	0.00E+00	>10,000	1.68E-01	0.00E+00	>10,000
U-236	(a)	1.46E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000
U-238	(a)	1.47E+00	0.00E+00	>10,000	1.79E+00	0.00E+00	>10,000	2.08E+00	0.00E+00	>10,000
Projected Cat 3 LLW										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
200 West Area										
C-14	2,000	4.44E-01	0.00E+00	>10,000	4.62E-01	0.00E+00	>10,000	1.45E+02	0.00E+00	>10,000
Tc-99	900									
Grouted Tc-99	900	3.23E+03	2.07E+01	1,710	3.23E+03	2.07E+01	1,710	3.23E+03	2.07E+01	1,710
I-129	1	1.96E-06	1.51E-06	2,260	2.04E-06	1.57E-06	2,260	2.04E-06	1.57E-06	2,260
Grouted I-129	1	5.00E+00	1.01E-02	1,710	5.00E+00	1.01E-02	1,710	5.00E+00	1.01E-02	1,710
U-233	(a)	2.98E-01	0.00E+00	>10,000	3.10E-01	0.00E+00	>10,000	1.80E-01	0.00E+00	>10,000
U-234	(a)	3.73E+02	0.00E+00	>10,000	3.89E+02	0.00E+00	>10,000	3.11E+02	0.00E+00	>10,000
U-235	(a)	1.07E+01	0.00E+00	>10,000	1.11E+01	0.00E+00	>10,000	1.20E+01	0.00E+00	>10,000
U-236	(a)	4.82E+01	0.00E+00	>10,000	5.02E+01	0.00E+00	>10,000	2.89E+01	0.00E+00	>10,000
U-238	(a)	5.99E+02	0.00E+00	>10,000	6.24E+02	0.00E+00	>10,000	5.04E+02	0.00E+00	>10,000

Table G.11. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
Projected MLLW										
200 East Area										
C-14	2,000	1.46E+00	2.15E-05	10,000	1.46E+00	2.15E-05	10,000	1.45E+00	2.14E-05	10,000
Tc-99	900	8.34E+00	9.43E+00	1,590	8.36E+00	9.44E+00	1,590	8.27E+00	9.34E+00	1,590
Grouted Tc-99	900									
I-129	1	3.50E-02	3.96E-02	1,590	3.51E-02	3.97E-02	1,590	3.48E-02	3.93E-02	1,590
Grouted I-129	1									
U-233	(a)	4.67E-03	1.86E-07	10,000	4.68E-03	2.19E-07	10,000	4.64E-03	4.34E-07	10,000
U-234	(a)	5.44E+00	2.17E-04	10,000	5.45E+00	2.55E-04	10,000	5.40E+00	5.05E-04	10,000
U-235	(a)	8.67E-02	3.45E-06	10,000	8.69E-02	4.07E-06	10,000	8.61E-02	8.06E-06	10,000
U-236	(a)	1.02E-01	4.05E-06	10,000	1.02E-01	4.78E-06	10,000	1.01E-01	9.45E-06	10,000
U-238	(a)	1.36E+00	5.41E-05	10,000	1.46E+00	6.37E-05	10,000	1.35E+00	1.26E-04	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
Projected Grouted MLLW										
200 East Area										
C-14	2,000	2.86E+00	4.22E-05	10,000	2.87E+00	4.00E-05	10,000	4.25E+00	6.26E-05	10,000
Tc-99	900									
Grouted Tc-99	900	1.57E+02	1.35E+00	940	1.57E+02	1.00E+00	940	3.34E+02	2.89E+00	940
I-129	1									
Grouted I-129	1	6.87E-02	1.88E-04	940	6.88E-02	2.00E-04	940	7.06E-02	1.93E-04	940
U-233	(a)	8.91E-03	2.15E-08	10,000	8.93E-03	2.00E-08	10,000	9.20E-03	1.24E-11	10,000
U-234	(a)	1.07E+01	2.57E-05	10,000	1.07E+01	3.00E-05	10,000	3.35E+02	4.51E-07	10,000
U-235	(a)	1.70E-01	4.08E-07	10,000	1.70E-01	4.00E-07	10,000	1.47E+01	1.98E-08	10,000
U-236	(a)	2.00E-01	4.80E-07	10,000	2.00E-01	5.00E-07	10,000	2.05E-01	2.76E-10	10,000
U-238	(a)	2.64E+00	6.37E-06	10,000	2.65E+00	6.00E-06	10,000	3.42E+02	4.60E-07	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									

Table G.11. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected Melter Waste										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900	3.89E+01	3.37E-01	940	3.89E+01	3.37E-01	940	3.89E+01	3.37E-01	940
I-129	1									
Grouted I-129	1									
U-233	(a)	8.49E-01	2.16E-05	10,000	8.49E-01	2.16E-05	10,000	8.49E-01	2.16E-05	10,000
U-234	(a)	4.60E-01	1.17E-05	10,000	4.60E-01	1.17E-05	10,000	4.60E-01	1.17E-05	10,000
U-235	(a)	1.90E-02	4.83E-07	10,000	1.90E-02	4.83E-07	10,000	1.90E-02	4.83E-07	10,000
U-236	(a)	1.70E-02	4.32E-07	10,000	1.70E-02	4.32E-07	10,000	1.70E-02	4.32E-07	10,000
U-238	(a)	4.10E-01	1.04E-05	10,000	4.10E-01	1.04E-05	10,000	4.10E-01	1.04E-05	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									

(a) The benchmark MCL for uranium is 30 µg/L expressed as total uranium. To convert isotope specific concentrations from pCi/L to µg/L, use following conversion factors:

- Uranium-233 - 1.05E-04
- Uranium-234 - 1.62E-04
- Uranium-235 - 4.66E-01
- Uranium-236 - 1.58E-02
- Uranium-238 - 3.00E+00.

Table G.12. Predicted Peak River Flux of Key Constituents Disposed of After 2007 at a Line of Analysis to the Columbia River, Alternative Group A

Constituent	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
	Inventory (Ci)	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**
Projected Cat 1 LLW									
200 East Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
200 West Area									
C-14	1.28E+01	0.00E+00	>10,000	1.56E+01	0.00E+00	>10,000	1.59E+01	0.00E+00	>10,000
Tc-99	1.08E+00	1.01E-02	2,340	1.32E+00	1.23E-02	2,340	1.33E+00	1.24E-02	2,340
Grouted Tc-99									
I-129	3.01E-03	2.80E-05	2,340	3.67E-03	3.41E-05	2,340	3.67E-03	3.41E-05	2,340
Grouted I-129									
U-233	3.71E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000
U-234	6.13E-01	0.00E+00	>10,000	7.47E-01	0.00E+00	>10,000	9.21E-01	0.00E+00	>10,000
U-235	1.29E-01	0.00E+00	>10,000	1.57E-01	0.00E+00	>10,000	1.68E-01	0.00E+00	>10,000
U-236	1.46E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000
U-238	1.47E+00	0.00E+00	>10,000	1.79E+00	0.00E+00	>10,000	2.08E+00	0.00E+00	>10,000
Projected Cat 3 LLW									
200 East Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
200 West Area									
C-14	4.44E-01	0.00E+00	>10,000	4.62E-01	0.00E+00	>10,000	1.45E+02	0.00E+00	>10,000
Tc-99									
Grouted Tc-99	3.23E+03	2.69E-01	1,840	3.23E+03	2.69E-01	1,840	3.23E+03	2.69E-01	1,840
I-129	1.96E-06	1.82E-08	2,340	2.04E-06	1.89E-08	2,340	2.04E-06	1.89E-08	2,340
Grouted I-129	5.00E+00	1.32E-04	1,840	5.00E+00	1.32E-04	1,840	5.00E+00	1.32E-04	1,840
U-233	2.98E-01	0.00E+00	>10,000	3.10E-01	0.00E+00	>10,000	1.80E-01	0.00E+00	>10,000
U-234	3.73E+02	0.00E+00	>10,000	3.89E+02	0.00E+00	>10,000	3.11E+02	0.00E+00	>10,000
U-235	1.07E+01	0.00E+00	>10,000	1.11E+01	0.00E+00	>10,000	1.20E+01	0.00E+00	>10,000
U-236	4.82E+01	0.00E+00	>10,000	5.02E+01	0.00E+00	>10,000	2.89E+01	0.00E+00	>10,000
U-238	5.99E+02	0.00E+00	>10,000	6.24E+02	0.00E+00	>10,000	5.04E+02	0.00E+00	>10,000

Table G.12. (contd)

	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
Constituent	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**
Projected MLLW									
200 East Area									
C-14	1.46E+00	1.25E-07	10,000	1.46E+00	1.25E-07	10,000	1.45E+00	1.25E-07	10,000
Tc-99	8.34E+00	9.43E-02	1,630	8.36E+00	9.45E-02	1,630	8.27E+00	9.35E-02	1,630
Grouted Tc-99									
I-129	3.50E-02	3.96E-04	1,630	3.51E-02	3.97E-04	1,630	3.48E-02	3.93E-04	1,630
Grouted I-129									
U-233	4.67E-03	1.10E-09	10,000	4.68E-03	1.29E-09	10,000	4.64E-03	4.45E-13	10,000
U-234	5.44E+00	1.28E-06	10,000	5.45E+00	1.50E-06	10,000	5.40E+00	5.18E-10	10,000
U-235	8.67E-02	2.04E-08	10,000	8.69E-02	2.40E-08	10,000	8.61E-02	8.27E-12	10,000
U-236	1.02E-01	2.40E-08	10,000	1.02E-01	2.81E-08	10,000	1.01E-01	9.70E-12	10,000
U-238	1.36E+00	3.20E-07	10,000	1.36E+00	3.75E-07	10,000	1.35E+00	1.30E-10	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
Projected Grouted MLLW									
200 East Area									
C-14	2.86E+00	2.46E-07	10,000	2.87E+00	2.47E-07	10,000	4.25E+00	3.65E-07	10,000
Tc-99									
Grouted Tc-99	1.57E+02	1.45E-02	970	1.57E+02	1.45E-02	970	3.34E+02	3.09E-02	970
I-129									
Grouted I-129	6.87E-02	2.01E-06	970	6.88E-02	2.01E-06	970	7.06E-02	2.06E-06	970
U-233	8.91E-03	1.27E-10	10,000	8.93E-03	1.27E-10	10,000	9.20E-03	1.31E-10	10,000
U-234	1.07E+01	1.53E-07	10,000	1.07E+01	1.53E-07	10,000	3.35E+02	4.78E-06	10,000
U-235	1.70E-01	2.43E-09	10,000	1.70E-01	2.43E-09	10,000	1.47E+01	2.10E-07	10,000
U-236	2.00E-01	2.85E-09	10,000	2.00E-01	2.85E-09	10,000	2.05E-01	2.93E-09	10,000
U-238	2.64E+00	3.78E-08	10,000	2.65E+00	3.78E-08	10,000	3.42E+02	4.88E-06	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									

Table G.12. (contd)

Constituent	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)
Projected Melter Waste									
200 East Area									
C-14									
Tc-99									
Grouted Tc-99	3.89E+01	3.19E-03	870	3.89E+01	3.19E-03	870	3.89E+01	3.19E-03	870
I-129									
Grouted I-129									
U-233	8.49E-01	2.62E-07	10,000	8.49E-01	2.62E-07	10,000	8.49E-01	2.62E-07	10,000
U-234	4.60E-01	1.42E-07	10,000	4.60E-01	1.42E-07	10,000	4.60E-01	1.42E-07	10,000
U-235	1.90E-02	5.86E-09	10,000	1.90E-02	5.86E-09	10,000	1.90E-02	5.86E-09	10,000
U-236	1.70E-02	5.24E-09	10,000	1.70E-02	5.24E-09	10,000	1.70E-02	5.24E-09	10,000
U-238	4.10E-01	1.26E-07	10,000	4.10E-01	1.26E-07	10,000	4.10E-01	1.26E-07	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									

Table G.13. Predicted Peak Concentrations of Key Constituents Disposed of After 2007 at a 1-km Line of Analysis, Alternative Group B

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected Cat 1 LLW										
200 East Area										
C-14	2,000	4.81E-01	3.84E-03	10,000	5.86E-01	4.68E-03	10,000	2.20E+00	1.76E-02	10,000
Tc-99	900	4.08E-02	2.52E-01	1,210	4.97E-02	3.08E-01	1,210	1.84E-01	1.14E+00	1,210
Grouted Tc-99	900									
I-129	1	1.13E-04	7.01E-04	1,210	1.38E-04	8.55E-04	1,210	5.07E-04	3.14E-03	1,210
Grouted I-129	1									
U-233	(a)	1.39E-02	4.48E-04	10,000	1.70E-02	5.20E-04	10,000	6.24E-02	2.42E-03	10,000
U-234	(a)	2.30E-02	7.41E-04	10,000	2.81E-02	8.60E-04	10,000	1.27E-01	4.93E-03	10,000
U-235	(a)	4.84E-03	1.55E-04	10,000	5.90E-03	1.81E-04	10,000	2.33E-02	9.04E-04	10,000
U-236	(a)	5.49E-04	1.76E-05	10,000	6.69E-04	2.05E-05	10,000	2.46E-03	9.55E-05	10,000
U-238	(a)	5.51E-02	1.77E-03	10,000	6.72E-02	2.06E-03	10,000	2.87E-01	1.11E-02	10,000
200 West Area										
C-14	2,000	1.23E+01	0.00E+00	>10,000	1.50E+01	0.00E+00	>10,000	1.37E+01	0.00E+00	>10,000
Tc-99	900	1.04E+00	9.25E+00	1,770	1.27E+00	1.13E+01	1,770	1.15E+00	1.02E+01	1,770
Grouted Tc-99	900									
I-129	1	2.89E-03	2.57E-02	1,770	3.53E-03	3.13E-02	1,770	3.16E-03	2.81E-02	1,770
Grouted I-129	1									
U-233	(a)	3.57E-01	0.00E+00	>10,000	4.35E-01	0.00E+00	>10,000	3.90E-01	0.00E+00	>10,000
U-234	(a)	5.90E-01	0.00E+00	>10,000	7.19E-01	0.00E+00	>10,000	7.93E-01	0.00E+00	>10,000
U-235	(a)	1.24E-01	0.00E+00	>10,000	1.51E-01	0.00E+00	>10,000	1.45E-01	0.00E+00	>10,000
U-236	(a)	1.40E-02	0.00E+00	>10,000	1.71E-02	0.00E+00	>10,000	1.53E-02	0.00E+00	>10,000
U-238	(a)	1.41E+00	0.00E+00	>10,000	1.72E+00	0.00E+00	>10,000	1.79E+00	0.00E+00	>10,000
Projected Cat 3 LLW										
200 East Area										
C-14	2,000	1.66E-02	1.33E-04	10,000	1.73E-02	1.38E-04	10,000	5.45E+00	4.36E-02	10,000
Tc-99	900									
Grouted Tc-99	900	1.21E+02	5.08E+00	630	1.21E+02	5.08E+00	630	1.21E+02	5.08E+00	630
I-129	1	7.35E-08	4.55E-07	1,210	7.66E-08	4.74E-07	1,210	7.66E-08	4.74E-07	1,210
Grouted I-129	1									
U-233	(a)	1.11E-02	9.13E-09	10,000	1.16E-02	1.06E-08	10,000	6.80E-03	1.29E-08	10,000
U-234	(a)	1.40E+01	1.15E-05	10,000	1.46E+01	1.33E-05	10,000	1.17E+01	2.22E-05	10,000
U-235	(a)	4.00E-01	3.28E-07	10,000	4.17E-01	3.81E-07	10,000	4.51E-01	8.56E-07	10,000
U-236	(a)	1.81E+00	1.49E-06	10,000	1.89E+00	1.73E-06	10,000	1.09E+00	2.07E-06	10,000
U-238	(a)	2.25E+01	1.84E-05	10,000	2.34E+01	2.14E-05	10,000	1.89E+01	3.59E-05	10,000
200 West Area										
C-14	2,000	4.27E-01	0.00E+00	>10,000	4.45E-01	0.00E+00	>10,000	1.39E+02	0.00E+00	>10,000
Tc-99	900									
Grouted Tc-99	900	3.11E+03	2.87E+02	1,230	3.11E+03	2.87E+02	1,230	3.11E+03	2.87E+02	1,710
I-129	1	1.88E-06	1.67E-05	1,770	1.96E-06	1.74E-05	1,770	1.96E-06	1.74E-05	2,110
Grouted I-129	1	5.00E+00	1.46E-01	1,230	5.00E+00	1.46E-01	1,230	5.00E+00	1.46E-01	1,710
U-233	(a)	2.86E-01	0.00E+00	>10,000	2.98E-01	0.00E+00	>10,000	1.73E-01	0.00E+00	>10,000
U-234	(a)	3.59E+02	0.00E+00	>10,000	3.74E+02	0.00E+00	>10,000	2.99E+02	0.00E+00	>10,000
U-235	(a)	1.03E+01	0.00E+00	>10,000	1.07E+01	0.00E+00	>10,000	1.15E+01	0.00E+00	>10,000
U-236	(a)	4.64E+01	0.00E+00	>10,000	4.83E+01	0.00E+00	>10,000	2.78E+01	0.00E+00	>10,000
U-238	(a)	5.77E+02	0.00E+00	>10,000	6.01E+02	0.00E+00	>10,000	4.85E+02	0.00E+00	>10,000

Table G.13. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
Projected MLLW										
200 East Area										
C-14	2,000	1.70E+00	1.27E-02	10,000	1.71E+00	1.27E-02	10,000	1.89E+00	1.41E-02	10,000
Tc-99	900	9.75E+00	1.01E+02	1,250	9.79E+00	1.01E+02	1,250	1.08E+01	1.11E+02	1,250
Grouted Tc-99	900									
I-129	1	4.10E-02	4.23E-01	1,250	4.12E-02	4.25E-01	1,250	4.55E-02	4.69E-01	1,250
Grouted I-129	1									
U-233	(a)	5.49E-03	1.12E-04	10,000	5.51E-03	2.32E-04	10,000	6.10E-03	1.54E-04	10,000
U-234	(a)	6.35E+00	1.30E-01	10,000	6.38E+00	2.69E-01	10,000	7.05E+00	1.78E-01	10,000
U-235	(a)	1.02E-01	2.08E-03	10,000	1.02E-01	4.30E-03	10,000	1.13E-01	2.85E-03	10,000
U-236	(a)	1.19E-01	2.42E-03	10,000	1.19E-01	5.02E-03	10,000	1.32E-01	3.33E-03	10,000
U-238	(a)	1.58E+00	3.24E-02	10,000	1.59E+00	6.71E-02	10,000	1.76E+00	4.43E-02	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
Projected Grouted MLLW										
200 East Area										
C-14	2,000	3.01E+00	2.24E-02	10,000	3.02E+00	2.25E-02	10,000	4.56E+00	3.39E-02	10,000
Tc-99	900									
Grouted Tc-99	900	1.57E+02	1.11E+01	680	1.58E+02	1.11E+01	680	3.20E+02	2.25E+01	680
I-129	1									
Grouted I-129	1	7.22E-02	1.61E-03	680	7.25E-02	1.62E-03	680	8.07E-02	1.80E-03	680
U-233	(a)	9.38E-03	5.47E-07	10,000	9.42E-03	5.48E-07	10,000	1.05E-02	9.88E-09	10,000
U-234	(a)	1.13E+01	6.56E-04	10,000	1.13E+01	6.57E-04	10,000	3.06E+02	2.88E-04	10,000
U-235	(a)	1.78E-01	1.04E-05	10,000	1.79E-01	1.04E-05	10,000	1.33E+01	1.25E-05	10,000
U-236	(a)	2.09E-01	1.22E-05	10,000	2.10E-01	1.22E-05	10,000	2.34E-01	2.20E-07	10,000
U-238	(a)	2.79E+00	1.63E-04	10,000	2.80E+00	1.63E-04	10,000	3.11E+02	2.93E-04	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									

Table G.13. (contd)

		Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
Constituent	**Benchmark MCL (pCi/L)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
Projected Melter Waste										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900	3.89E+01	2.74E+00	680	3.89E+01	2.74E+00	680	3.89E+01	2.74E+00	680
I-129	1									
Grouted I-129	1									
U-233	(a)	8.49E-01	2.51E-06	10,000	8.49E-01	2.51E-06	10,000	8.49E-01	2.51E-06	10,000
U-234	(a)	4.60E-01	1.36E-06	10,000	4.60E-01	1.36E-06	10,000	4.60E-01	1.36E-06	10,000
U-235	(a)	1.90E-02	5.61E-08	10,000	1.90E-02	5.61E-08	10,000	1.90E-02	5.61E-08	10,000
U-236	(a)	1.70E-02	5.02E-08	10,000	1.70E-02	5.02E-08	10,000	1.70E-02	5.02E-08	10,000
U-238	(a)	4.10E-01	1.21E-06	10,000	4.10E-01	1.21E-06	10,000	4.10E-01	1.21E-06	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									

(a) The benchmark MCL for uranium is 30 µg/L expressed as total uranium. To convert isotope specific concentrations from pCi/L to µg/L, use following conversion factors:

- Uranium-233 - 1.05E-04
- Uranium-234 - 1.62E-04
- Uranium-235 - 4.66E-01
- Uranium-236 - 1.58E-02
- Uranium-238 - 3.00E+00.

Table G.14. Predicted Peak Concentrations of Key Constituents Disposed of After 2007 at a Line of Analysis Near the Columbia River, Alternative Group B

		Hanford Only Volume			**Lower Bound Volume**			**Upper Bound Volume**		
Constituent	**Benchmark MCL (pCi/L)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
Cat 1 LLW										
200 East Area										
C-14	2,000	4.81E-01	7.24E-05	10,000	5.86E-01	8.83E-05	10,000	2.20E+00	3.31E-04	10,000
Tc-99	900	4.08E-02	6.10E-02	1,380	4.97E-02	7.44E-02	1,380	1.84E-01	2.75E-01	1,380
Grouted Tc-99	900									
I-129	1	1.13E-04	1.69E-04	1,380	1.38E-04	2.06E-04	1,380	5.07E-04	7.59E-04	1,380
Grouted I-129	1									
U-233	(a)	1.39E-02	4.48E-04	10,000	1.70E-02	5.20E-04	10,000	6.24E-02	2.42E-03	10,000
U-234	(a)	2.30E-02	7.41E-04	10,000	2.81E-02	8.60E-04	10,000	1.27E-01	4.93E-03	10,000
U-235	(a)	4.84E-03	1.55E-04	10,000	5.90E-03	1.81E-04	10,000	2.33E-02	9.04E-04	10,000
U-236	(a)	5.49E-04	1.76E-05	10,000	6.69E-04	2.05E-05	10,000	2.46E-03	9.55E-05	10,000
U-238	(a)	5.51E-02	1.77E-03	10,000	6.72E-02	2.06E-03	10,000	2.87E-01	1.11E-02	10,000
200 West Area										
C-14	2,000	1.23E+01	0.00E+00	>10,000	1.50E+01	0.00E+00	>10,000	1.37E+01	0.00E+00	>10,000
Tc-99	900	1.04E+00	8.44E-01	2,110	1.27E+00	1.03E+00	2,110	1.15E+00	9.32E-01	2,110
Grouted Tc-99	900									
I-129	1	2.89E-03	2.35E-03	2,110	3.53E-03	2.86E-03	2,110	3.16E-03	2.56E-03	2,110
Grouted I-129	1									
U-233	(a)	3.57E-01	0.00E+00	>10,000	4.35E-01	0.00E+00	>10,000	3.90E-01	0.00E+00	>10,000
U-234	(a)	5.90E-01	0.00E+00	>10,000	7.19E-01	0.00E+00	>10,000	7.93E-01	0.00E+00	>10,000
U-235	(a)	1.24E-01	0.00E+00	>10,000	1.51E-01	0.00E+00	>10,000	1.45E-01	0.00E+00	>10,000
U-236	(a)	1.40E-02	0.00E+00	>10,000	1.71E-02	0.00E+00	>10,000	1.53E-02	0.00E+00	>10,000
U-238	(a)	1.41E+00	0.00E+00	>10,000	1.72E+00	0.00E+00	>10,000	1.79E+00	0.00E+00	>10,000
Cat 3 LLW										
200 East Area										
C-14	2,000	1.66E-02	2.50E-06	10,000	1.73E-02	2.61E-06	10,000	5.45E+00	8.21E-04	10,000
Tc-99	900									
Grouted Tc-99	900	1.21E+02	1.19E+00	860	1.21E+02	1.19E+00	860	1.21E+02	1.19E+00	860
I-129	1	7.35E-08	1.10E-07	1,380	7.66E-08	2.06E-04	1,380	7.66E-08	1.15E-07	1,380
Grouted I-129	1									
U-233	(a)	1.11E-02	1.49E-10	10,000	1.16E-02	1.73E-10	10,000	6.80E-03	2.11E-10	10,000
U-234	(a)	1.40E+01	1.88E-07	10,000	1.46E+01	2.18E-07	10,000	1.17E+01	3.63E-07	10,000
U-235	(a)	4.00E-01	5.36E-09	10,000	4.17E-01	6.23E-09	10,000	4.51E-01	1.40E-08	10,000
U-236	(a)	1.81E+00	2.43E-08	10,000	1.89E+00	2.82E-08	10,000	1.09E+00	3.38E-08	10,000
U-238	(a)	2.25E+01	3.01E-07	10,000	2.34E+01	3.50E-07	10,000	1.89E+01	5.87E-07	10,000
200 West Area										
C-14	2,000	4.27E-01	0.00E+00	>10,000	4.45E-01	0.00E+00	>10,000	1.39E+02	0.00E+00	>10,000
Tc-99	900									
Grouted Tc-99	900	3.11E+03	1.99E+01	1,710	3.11E+03	1.99E+01	1,710	3.11E+03	1.99E+01	1,710
I-129	1	1.88E-06	1.52E-06	2,110	1.96E-06	1.59E-06	2,110	1.96E-06	1.59E-06	2,110
Grouted I-129	1	5.00E+00	1.01E-02	1,710	5.00E+00	1.01E-02	1,710	5.00E+00	1.01E-02	1,710
U-233	(a)	2.86E-01	0.00E+00	>10,000	2.98E-01	0.00E+00	>10,000	1.73E-01	0.00E+00	>10,000
U-234	(a)	3.59E+02	0.00E+00	>10,000	3.74E+02	0.00E+00	>10,000	2.99E+02	0.00E+00	>10,000
U-235	(a)	1.03E+01	0.00E+00	>10,000	1.07E+01	0.00E+00	>10,000	1.15E+01	0.00E+00	>10,000
U-236	(a)	4.64E+01	0.00E+00	>10,000	4.83E+01	0.00E+00	>10,000	2.78E+01	0.00E+00	>10,000
U-238	(a)	5.77E+02	0.00E+00	>10,000	6.01E+02	0.00E+00	>10,000	4.85E+02	0.00E+00	>10,000

Table G.14. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected MLLW										
200 East Area										
C-14	2,000	1.70E+00	7.33E-05	10,000	1.71E+00	7.36E-05	10,000	1.89E+00	8.13E-05	10,000
Tc-99	900	9.75E+00	1.27E+01	1,430	9.79E+00	1.27E+01	1,430	1.08E+01	1.40E+01	1,430
Grouted Tc-99	900									
I-129	1	4.10E-02	5.33E-02	1,430	4.12E-02	5.35E-02	1,430	4.55E-02	5.91E-02	1,430
Grouted I-129	1									
U-233	(a)	5.49E-03	7.92E-07	10,000	5.51E-03	2.35E-06	10,000	6.10E-03	1.28E-06	10,000
U-234	(a)	6.35E+00	9.17E-04	10,000	6.38E+00	2.73E-03	10,000	7.05E+00	1.48E-03	10,000
U-235	(a)	1.02E-01	1.47E-05	10,000	1.02E-01	4.36E-05	10,000	1.13E-01	2.37E-05	10,000
U-236	(a)	1.19E-01	1.71E-05	10,000	1.19E-01	5.08E-05	10,000	1.32E-01	2.77E-05	10,000
U-238	(a)	1.58E+00	2.29E-04	10,000	1.59E+00	6.79E-04	10,000	1.76E+00	3.70E-04	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
Projected Grouted MLLW										
200 East Area										
C-14	2,000	3.01E+00	1.29E-04	10,000	3.02E+00	1.30E-04	10,000	4.56E+00	1.96E-04	10,000
Tc-99	900									
Grouted Tc-99	900	1.57E+02	1.36E+00	940	1.58E+02	1.37E+00	940	3.20E+02	2.77E+00	940
I-129	1									
Grouted I-129	1	7.22E-02	1.97E-04	940	7.25E-02	1.98E-04	940	8.07E-02	2.21E-04	940
U-233	(a)	9.38E-03	2.93E-09	10,000	9.42E-03	2.93E-09	10,000	1.05E-02	5.29E-11	10,000
U-234	(a)	1.13E+01	0.00E+00	10,000	1.13E+01	0.00E+00	10,000	3.06E+02	1.54E-06	10,000
U-235	(a)	1.78E-01	0.00E+00	10,000	1.79E-01	0.00E+00	10,000	1.33E+01	6.70E-08	10,000
U-236	(a)	2.09E-01	0.00E+00	10,000	2.10E-01	0.00E+00	10,000	2.34E-01	1.18E-09	10,000
U-238	(a)	2.79E+00	0.00E+00	10,000	2.80E+00	0.00E+00	10,000	3.11E+02	1.57E-06	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									

Table G.14. (contd)

		Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
Constituent	**Benchmark MCL (pCi/L)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
Projected Melter Waste										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900	3.89E+01	3.37E-01	940	3.89E+01	3.37E-01	940	3.89E+01	3.37E-01	940
I-129	1									
Grouted I-129	1									
U-233	30	8.49E-01	1.33E-08	10,000	8.49E-01	1.33E-08	10,000	8.49E-01	1.33E-08	10,000
U-234	30	4.60E-01	7.23E-09	10,000	4.60E-01	7.23E-09	10,000	4.60E-01	7.23E-09	10,000
U-235	30	1.90E-02	2.99E-10	10,000	1.90E-02	2.99E-10	10,000	1.90E-02	2.99E-10	10,000
U-236	30	1.70E-02	2.67E-10	10,000	1.70E-02	2.67E-10	10,000	1.70E-02	2.67E-10	10,000
U-238	30	4.10E-01	6.44E-09	10,000	4.10E-01	6.44E-09	10,000	4.10E-01	6.44E-09	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	30									
U-234	30									
U-235	30									
U-236	30									
U-238	30									

(a) The benchmark MCL for uranium is 30 μg/L expressed as total uranium. To convert isotope specific concentrations from pCi/L to μg/L, use following conversion factors:

- Uranium-233 - 1.05E-04
- Uranium-234 - 1.62E-04
- Uranium-235 - 4.66E-01
- Uranium-236 - 1.58E-02
- Uranium-238 - 3.00E+00.

Table G.15. Predicted Peak River Flux of Key Constituents Disposed of After 2007 at a Line of Analysis to the Columbia River, Alternative Group B

Constituent	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)
Projected Cat 1 LLW									
200 East Area									
C-14	4.81E-01	2.05E-07	10,000	5.86E-01	2.49E-07	10,000	2.20E+00	9.37E-07	10,000
Tc-99	4.08E-02	5.29E-04	1,450	4.97E-02	6.46E-04	1,450	1.84E-01	2.39E-03	1,450
Grouted Tc-99									
I-129	1.13E-04	1.47E-06	1,450	1.38E-04	1.79E-06	1,450	5.07E-04	6.59E-06	1,450
Grouted I-129									
U-233	1.39E-02	4.21E-08	10,000	1.70E-02	4.89E-08	10,000	6.24E-02	2.83E-07	10,000
U-234	2.30E-02	6.96E-08	10,000	2.81E-02	8.09E-08	10,000	1.27E-01	5.75E-07	10,000
U-235	4.84E-03	1.46E-08	10,000	5.90E-03	1.70E-08	10,000	2.33E-02	1.05E-07	10,000
U-236	5.49E-04	1.66E-09	10,000	6.69E-04	1.93E-09	10,000	2.46E-03	1.11E-08	10,000
U-238	5.51E-02	1.66E-07	10,000	6.72E-02	1.93E-07	10,000	2.87E-01	1.30E-06	10,000
200 West Area									
C-14	1.23E+01	0.00E+00	>10,000	1.50E+01	0.00E+00	>10,000	1.37E+01	0.00E+00	>10,000
Tc-99	1.04E+00	9.90E-03	2,180	1.27E+00	1.21E-02	2,180	1.15E+00	1.09E-02	2,180
Grouted Tc-99									
I-129	2.89E-03	2.75E-05	2,180	3.53E-03	3.35E-05	2,180	3.16E-03	3.00E-05	2,180
Grouted I-129									
U-233	3.57E-01	0.00E+00	>10,000	4.35E-01	0.00E+00	>10,000	3.90E-01	0.00E+00	>10,000
U-234	5.90E-01	0.00E+00	>10,000	7.19E-01	0.00E+00	>10,000	7.93E-01	0.00E+00	>10,000
U-235	1.24E-01	0.00E+00	>10,000	1.51E-01	0.00E+00	>10,000	1.45E-01	0.00E+00	>10,000
U-236	1.40E-02	0.00E+00	>10,000	1.71E-02	0.00E+00	>10,000	1.53E-02	0.00E+00	>10,000
U-238	1.41E+00	0.00E+00	>10,000	1.72E+00	0.00E+00	>10,000	1.79E+00	0.00E+00	>10,000
Projected Cat 3 LLW									
200 East Area									
C-14	1.66E-02	1.79E-04	1,490	1.73E-02	1.87E-04	1,490	5.45E+00	5.88E-02	1,490
Tc-99									
Grouted Tc-99	1.21E+02	1.12E-02	970	1.21E+02	1.12E-02	970	1.21E+02	1.12E-02	970
I-129	7.35E-08	3.45E-13	10,000	7.66E-08	3.59E-13	10,000	7.66E-08	3.59E-13	10,000
Grouted I-129									
U-233	1.11E-02	1.43E-13	10,000	1.16E-02	1.66E-13	10,000	6.80E-03	2.02E-13	10,000
U-234	1.40E+01	1.79E-10	10,000	1.46E+01	2.08E-10	10,000	1.17E+01	3.47E-10	10,000
U-235	4.00E-01	5.12E-12	10,000	4.17E-01	5.95E-12	10,000	4.51E-01	1.34E-11	10,000
U-236	1.81E+00	2.32E-11	10,000	1.89E+00	2.70E-11	10,000	1.09E+00	3.23E-11	10,000
U-238	2.25E+01	2.88E-10	10,000	2.34E+01	3.34E-10	10,000	1.89E+01	5.61E-10	10,000
200 West Area									
C-14	4.27E-01	0.00E+00	>10,000	4.45E-01	0.00E+00	>10,000	1.39E+02	0.00E+00	>10,000
Tc-99									
Grouted Tc-99	3.11E+03	2.59E-01	1,840	3.11E+03	2.59E-01	1,840	3.11E+03	2.59E-01	1,840
I-129	1.88E-06	1.79E-08	2,180	1.96E-06	1.86E-08	2,180	1.96E-06	1.86E-08	2,180
Grouted I-129	5.00E+00	1.32E-04	1,840	5.00E+00	1.32E-04	1,840	5.00E+00	1.32E-04	1,840
U-233	2.86E-01	0.00E+00	>10,000	2.98E-01	0.00E+00	>10,000	1.73E-01	0.00E+00	>10,000
U-234	3.59E+02	0.00E+00	>10,000	3.74E+02	0.00E+00	>10,000	2.99E+02	0.00E+00	>10,000
U-235	1.03E+01	0.00E+00	>10,000	1.07E+01	0.00E+00	>10,000	1.15E+01	0.00E+00	>10,000
U-236	4.64E+01	0.00E+00	>10,000	4.83E+01	0.00E+00	>10,000	2.78E+01	0.00E+00	>10,000
U-238	5.77E+02	0.00E+00	>10,000	6.01E+02	0.00E+00	>10,000	4.85E+02	0.00E+00	>10,000

Table G.15. (contd)

Constituent	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)
Projected MLLW									
200 East Area									
C-14	1.70E+00	4.27E-07	10,000	1.71E+00	4.29E-07	10,000	1.89E+00	4.74E-07	10,000
Tc-99	9.75E+00	1.21E-01	1,480	9.79E+00	1.22E-01	1,480	1.08E+01	1.34E-01	1,480
Grouted Tc-99									
I-129	4.10E-02	5.10E-04	1,480	4.12E-02	5.12E-04	1,480	4.55E-02	5.65E-04	1,480
Grouted I-129									
U-233	5.49E-03	4.69E-09	10,000	5.51E-03	1.43E-08	10,000	6.10E-03	7.64E-09	10,000
U-234	6.35E+00	5.43E-06	10,000	6.38E+00	1.66E-05	10,000	7.05E+00	8.83E-06	10,000
U-235	1.02E-01	8.68E-08	10,000	1.02E-01	2.65E-07	10,000	1.13E-01	1.41E-07	10,000
U-236	1.19E-01	1.01E-07	10,000	1.19E-01	3.10E-07	10,000	1.32E-01	1.65E-07	10,000
U-238	1.58E+00	1.35E-06	10,000	1.59E+00	4.14E-06	10,000	1.76E+00	2.20E-06	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
Projected Grouted MLLW									
200 East Area									
C-14	3.01E+00	7.55E-07	10,000	3.02E+00	7.58E-07	10,000	4.56E+00	1.14E-06	10,000
Tc-99									
Grouted Tc-99	1.57E+02	1.46E-02	970	1.58E+02	1.46E-02	970	3.20E+02	2.96E-02	970
I-129									
Grouted I-129	7.22E-02	2.11E-06	970	7.25E-02	2.12E-06	970	8.07E-02	2.36E-06	970
U-233	9.38E-03	1.72E-11	10,000	9.42E-03	1.73E-11	10,000	1.05E-02	3.11E-13	10,000
U-234	1.13E+01	2.07E-08	10,000	1.13E+01	2.07E-08	10,000	3.06E+02	9.07E-09	10,000
U-235	1.78E-01	3.27E-10	10,000	1.79E-01	3.28E-10	10,000	1.33E+01	3.94E-10	10,000
U-236	2.09E-01	3.84E-10	10,000	2.10E-01	3.85E-10	10,000	2.34E-01	6.93E-12	10,000
U-238	2.79E+00	5.12E-09	10,000	2.80E+00	5.13E-09	10,000	3.11E+02	9.22E-09	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									

Table G.15. (contd)

	Hanford Only Volume			**Lower Bound Volume**			**Upper Bound Volume**		
Constituent	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**
Projected Melter Waste									
200 East Area									
C-14									
Tc-99									
Grouted Tc-99	3.89E+01	3.60E-03	970	3.89E+01	3.60E-03	970	3.89E+01	3.60E-03	970
I-129									
Grouted I-129									
U-233	8.49E-01	7.84E-11	>10,000	8.49E-01	7.84E-11	>10,000	8.49E-01	7.84E-11	>10,000
U-234	4.60E-01	4.25E-11	>10,000	4.60E-01	4.25E-11	>10,000	4.60E-01	4.25E-11	>10,000
U-235	1.90E-02	1.75E-12	>10,000	1.90E-02	1.75E-12	>10,000	1.90E-02	1.75E-12	>10,000
U-236	1.70E-02	1.57E-12	>10,000	1.70E-02	1.57E-12	>10,000	1.70E-02	1.57E-12	>10,000
U-238	4.10E-01	3.79E-11	>10,000	4.10E-01	3.79E-11	>10,000	4.10E-01	3.79E-11	>10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									

Table G.16. Predicted Peak Concentrations of Key Constituents Disposed of After 2007 at a 1-km Line of Analysis, Alternative Group C

		Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
Constituent	**Benchmark MCL (pCi/L)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
Projected Cat 1 LLW										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
200 West Area										
C-14	2,000	1.28E+01	0.00E+00	>10,000	1.56E+01	0.00E+00	>10,000	1.59E+01	0.00E+00	>10,000
Tc-99	900	1.08E+00	8.98E+00	1,910	1.32E+00	1.09E+01	1,910	1.33E+00	1.10E+01	1,910
Grouted Tc-99	900	0.00E+00								
I-129	1	3.01E-03	2.50E-02	1,910	3.67E-03	3.04E-02	1,910	3.67E-03	3.04E-02	1,910
Grouted I-129	1	0.00E+00								
U-233	(a)	3.71E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000
U-234	(a)	6.13E-01	0.00E+00	>10,000	7.47E-01	0.00E+00	>10,000	9.21E-01	0.00E+00	>10,000
U-235	(a)	1.29E-01	0.00E+00	>10,000	1.57E-01	0.00E+00	>10,000	1.68E-01	0.00E+00	>10,000
U-236	(a)	1.46E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000
U-238	(a)	1.47E+00	0.00E+00	>10,000	1.79E+00	0.00E+00	>10,000	2.08E+00	0.00E+00	>10,000
Projected Cat 3 LLW										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
200 West Area										
C-14	2,000	4.44E-01	0.00E+00	>10,000	4.62E-01	0.00E+00	>10,000	1.45E+02	0.00E+00	>10,000
Tc-99	900									
Grouted Tc-99	900	3.23E+03	2.98E+02	1,230	3.23E+03	2.98E+02	1,230	3.23E+03	2.98E+02	1,230
I-129	1	1.96E-06	1.62E-05	1,910	2.04E-06	1.69E-05	1,910	2.04E-06	1.69E-05	1,910
Grouted I-129	1	5.00E+00	1.46E-01	1,230	5.00E+00	1.46E-01	1,230	5.00E+00	1.46E-01	1,230
U-233	(a)	2.98E-01	0.00E+00	>10,000	3.10E-01	0.00E+00	>10,000	1.80E-01	0.00E+00	>10,000
U-234	(a)	3.73E+02	0.00E+00	>10,000	3.89E+02	0.00E+00	>10,000	3.11E+02	0.00E+00	>10,000
U-235	(a)	1.07E+01	0.00E+00	>10,000	1.11E+01	0.00E+00	>10,000	1.20E+01	0.00E+00	>10,000

Table G.16. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
U-236	(a)	4.82E+01	0.00E+00	>10,000	5.02E+01	0.00E+00	>10,000	2.89E+01	0.00E+00	>10,000
U-238	(a)	5.99E+02	0.00E+00	>10,000	6.24E+02	0.00E+00	>10,000	5.04E+02	0.00E+00	>10,000
Projected MLLW										
200 East Area										
C-14	2,000	1.46E+00	3.41E-03	10,000	1.46E+00	3.42E-03	10,000	1.45E+00	3.40E-03	10,000
Tc-99	900	8.34E+00	6.79E+01	1,370	8.36E+00	6.80E+01	1,370	8.27E+00	6.73E+01	1,370
Grouted Tc-99	900									
I-129	1	3.50E-02	2.85E-01	1,370	3.51E-02	2.85E-01	1,370	3.48E-02	2.83E-01	1,370
Grouted I-129	1									
U-233	(a)	4.67E-03	3.56E-05	10,000	4.68E-03	4.09E-05	10,000	4.64E-03	7.14E-05	10,000
U-234	(a)	5.44E+00	4.14E-02	10,000	5.45E+00	4.76E-02	10,000	5.40E+00	8.30E-02	10,000
U-235	(a)	8.67E-02	6.60E-04	10,000	8.69E-02	7.59E-04	10,000	8.61E-02	1.32E-03	10,000
U-236	(a)	1.02E-01	7.75E-04	10,000	1.02E-01	8.90E-04	10,000	1.01E-01	1.55E-03	10,000
U-238	(a)	1.36E+00	1.03E-02	10,000	1.36E+00	1.19E-02	10,000	1.35E+00	2.08E-02	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
Projected Grouted MLLW										
200 East Area										
C-14	2,000	2.86E+00	6.71E-03	10,000	2.87E+00	6.73E-03	10,000	4.25E+00	9.96E-03	10,000
Tc-99	900									
Grouted Tc-99	900	1.57E+02	1.10E+01	680	1.57E+02	1.11E+01	680	3.34E+02	2.35E+01	680
I-129	1									
Grouted I-129	1	6.87E-02	1.53E-03	680	6.88E-02	1.53E-03	680	7.06E-02	1.57E-03	680
U-233	(a)	8.91E-03	2.21E-06	10,000	8.93E-03	2.22E-06	10,000	9.20E-03	2.31E-09	10,000
U-234	(a)	1.07E+01	2.65E-03	10,000	1.07E+01	2.65E-03	10,000	3.35E+02	8.42E-05	10,000
U-235	(a)	1.70E-01	4.21E-05	10,000	1.70E-01	4.22E-05	10,000	1.47E+01	3.69E-06	10,000
U-236	(a)	2.00E-01	4.95E-05	10,000	2.00E-01	4.96E-05	10,000	2.05E-01	5.15E-08	10,000
U-238	(a)	2.64E+00	6.56E-04	10,000	2.65E+00	6.57E-04	10,000	3.42E+02	8.59E-05	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									

Table G.16. (contd)

		Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
Constituent	**Benchmark MCL (pCi/L)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
U-238	(a)									
Projected Melter Waste										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900	3.89E+01	1.87E+00	680	3.89E+01	1.87E+00	680	3.89E+01	1.87E+00	680
I-129	1									
Grouted I-129	1									
U-233	(a)	8.49E-01	1.79E-06	10,000	8.49E-01	1.79E-06	10,000	8.49E-01	1.79E-06	10,000
U-234	(a)	4.60E-01	9.68E-07	10,000	4.60E-01	9.68E-07	10,000	4.60E-01	9.68E-07	10,000
U-235	(a)	1.90E-02	4.00E-08	10,000	1.90E-02	4.00E-08	10,000	1.90E-02	4.00E-08	10,000
U-236	(a)	1.70E-02	3.58E-08	10,000	1.70E-02	3.58E-08	10,000	1.70E-02	3.58E-08	10,000
U-238	(a)	4.10E-01	8.62E-07	10,000	4.10E-01	8.62E-07	10,000	4.10E-01	8.62E-07	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									

(a) The benchmark MCL for uranium is 30 µg/L expressed as total uranium. To convert isotope specific concentrations from pCi/L to µg/L, use following conversion factors:

- Uranium-233 - 1.05E-04
- Uranium-234 - 1.62E-04
- Uranium-235 - 4.66E-01
- Uranium-236 - 1.58E-02
- Uranium-238 - 3.00E+00.

Table G.17. Predicted Peak Concentrations of Key Constituents Disposed of After 2007 at a Line of Analysis Near the Columbia River, Alternative Group C

		Hanford Only Volume			**Lower Bound Volume**			**Upper Bound Volume**		
Constituent	**Benchmark MCL (pCi/L)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
Projected Cat 1 LLW										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
200 West Area										
C-14	2,000	1.28E+01	0.00E+00	>10,000	1.56E+01	0.00E+00	>10,000	1.59E+01	0.00E+00	>10,000
Tc-99	900	1.08E+00	8.33E-01	2,260	1.32E+00	1.02E+00	2,260	1.33E+00	1.02E+00	2,260
Grouted Tc-99	900									
I-129	1	3.01E-03	2.32E-03	2,260	3.67E-03	2.83E-03	2,260	3.67E-03	2.83E-03	2,260
Grouted I-129	1									
U-233	(a)	3.71E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000
U-234	(a)	6.13E-01	0.00E+00	>10,000	7.47E-01	0.00E+00	>10,000	9.21E-01	0.00E+00	>10,000
U-235	(a)	1.29E-01	0.00E+00	>10,000	1.57E-01	0.00E+00	>10,000	1.68E-01	0.00E+00	>10,000
U-236	(a)	1.46E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000
U-238	(a)	1.47E+00	0.00E+00	>10,000	1.79E+00	0.00E+00	>10,000	2.08E+00	0.00E+00	>10,000
Projected Cat 3 LLW										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
200 West Area										
C-14	2,000	4.44E-01	0.00E+00	>10,000	4.62E-01	0.00E+00	>10,000	1.45E+02	0.00E+00	>10,000
Tc-99	900									
Grouted Tc-99	900	3.23E+03	2.07E+01	1,710	3.23E+03	2.07E+01	1,710	3.23E+03	2.07E+01	1,710
I-129	1	1.96E-06	1.51E-06	2,260	2.04E-06	1.57E-06	2,260	2.04E-06	1.57E-06	2,260
Grouted I-129	1	5.00E+00	1.01E-02	1,700	5.00E+00	1.01E-02	1,700	5.00E+00	1.01E-02	1,700
U-233	(a)	2.98E-01	0.00E+00	>10,000	3.10E-01	0.00E+00	>10,000	1.80E-01	0.00E+00	>10,000
U-234	(a)	3.73E+02	0.00E+00	>10,000	3.89E+02	0.00E+00	>10,000	3.11E+02	0.00E+00	>10,000
U-235	(a)	1.07E+01	0.00E+00	>10,000	1.11E+01	0.00E+00	>10,000	1.20E+01	0.00E+00	>10,000
U-236	(a)	4.82E+01	0.00E+00	>10,000	5.02E+01	0.00E+00	>10,000	2.89E+01	0.00E+00	>10,000
U-238	(a)	5.99E+02	0.00E+00	>10,000	6.24E+02	0.00E+00	>10,000	5.04E+02	0.00E+00	>10,000

Table G.17. (contd)

		Hanford Only Volume			**Lower Bound Volume**			**Upper Bound Volume**		
Constituent	**Benchmark MCL (pCi/L)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
Projected MLLW										
200 East Area										
C-14	2,000	1.46E+00	2.15E-05	10,000	1.46E+00	2.15E-05	10,000	1.45E+00	2.14E-05	10,000
Tc-99	900	8.34E+00	9.43E+00	1,590	8.36E+00	9.44E+00	1,590	8.27E+00	9.34E+00	1,590
Grouted Tc-99	900									
I-129	1	3.50E-02	3.96E-02	1,590	3.51E-02	3.97E-02	1,590	3.48E-02	3.93E-02	1,590
Grouted I-129	1									
U-233	(a)	4.67E-03	1.86E-07	10,000	4.68E-03	2.19E-07	10,000	4.64E-03	4.34E-07	10,000
U-234	(a)	5.44E+00	2.17E-04	10,000	5.45E+00	2.55E-04	10,000	5.40E+00	5.05E-04	10,000
U-235	(a)	8.67E-02	3.45E-06	10,000	8.69E-02	4.07E-06	10,000	8.61E-02	8.06E-06	10,000
U-236	(a)	1.02E-01	4.05E-06	10,000	1.02E-01	4.78E-06	10,000	1.01E-01	9.45E-06	10,000
U-238	(a)	1.36E+00	5.41E-05	10,000	1.36E+00	6.37E-05	10,000	1.35E+00	1.26E-04	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
Projected Grouted MLLW										
200 East Area										
C-14	2,000	2.86E+00	4.22E-05	10,000	2.87E+00	4.23E-05	10,000	4.25E+00	6.26E-05	10,000
Tc-99	900									
Grouted Tc-99	900	1.57E+02	1.35E+00	940	1.57E+02	1.36E+00	940	3.34E+02	2.89E+00	940
I-129	1									
Grouted I-129	1	6.87E-02	2.14E-04	850	6.88E-02	2.14E-04	850	7.06E-02	2.20E-04	850
U-233	(a)	8.91E-03	2.15E-08	10,000	8.93E-03	2.15E-08	10,000	9.20E-03	1.24E-11	10,000
U-234	(a)	1.07E+01	2.57E-05	10,000	1.07E+01	2.58E-05	10,000	3.35E+02	4.51E-07	10,000
U-235	(a)	1.70E-01	4.08E-07	10,000	1.70E-01	4.09E-07	10,000	1.47E+01	1.98E-08	10,000
U-236	(a)	2.00E-01	4.80E-07	10,000	2.00E-01	4.81E-07	10,000	2.05E-01	2.76E-10	10,000
U-238	(a)	2.64E+00	6.37E-06	10,000	2.65E+00	6.38E-06	10,000	3.42E+02	4.60E-07	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									

Table G.17. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected Melter Waste										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900	3.89E+01	2.03E-01	820	3.89E+01	2.03E-01	820	3.89E+01	2.03E-01	820
I-129	1									
Grouted I-129	1									
U-233	(a)	8.49E-01	2.21E-08	10,000	8.49E-01	2.21E-08	10,000	8.49E-01	2.21E-08	10,000
U-234	(a)	4.60E-01	1.20E-08	10,000	4.60E-01	1.20E-08	10,000	4.60E-01	1.20E-08	10,000
U-235	(a)	1.90E-02	4.96E-10	10,000	1.90E-02	4.96E-10	10,000	1.90E-02	4.96E-10	10,000
U-236	(a)	1.70E-02	4.43E-10	10,000	1.70E-02	4.43E-10	10,000	1.70E-02	4.43E-10	10,000
U-238	(a)	4.10E-01	1.07E-08	10,000	4.10E-01	1.07E-08	10,000	4.10E-01	1.07E-08	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									

(a) The benchmark MCL for uranium is 30 μg/L expressed as total uranium. To convert isotope specific concentrations from pCi/L to μg/L, use following conversion factors:

- Uranium-233 - 1.05E-04
- Uranium-234 - 1.62E-04
- Uranium-235 - 4.66E-01
- Uranium-236 - 1.58E-02
- Uranium-238 - 3.00E+00.

Table G.18. Predicted Peak River Flux of Key Constituents Disposed of After 2007 at a Line of Analysis to the Columbia River, Alternative Group C

Constituent	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
	Inventory (Ci)	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**
Projected Cat 1 LLW									
200 East Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
200 West Area									
C-14	1.28E+01	0.00E+00	>10,000	1.56E+01	0.00E+00	>10,000	1.59E+01	0.00E+00	>10,000
Tc-99	1.08E+00	1.01E-02	2,340	1.32E+00	1.23E-02	2,340	1.33E+00	1.24E-02	2,340
Grouted Tc-99									
I-129	3.01E-03	2.80E-05	2,340	3.67E-03	3.41E-05	2,340	3.67E-03	3.41E-05	2,340
Grouted I-129									
U-233	3.71E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000
U-234	6.13E-01	0.00E+00	>10,000	7.47E-01	0.00E+00	>10,000	9.21E-01	0.00E+00	>10,000
U-235	1.29E-01	0.00E+00	>10,000	1.57E-01	0.00E+00	>10,000	1.68E-01	0.00E+00	>10,000
U-236	1.46E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000
U-238	1.47E+00	0.00E+00	>10,000	1.79E+00	0.00E+00	>10,000	2.08E+00	0.00E+00	>10,000
Projected Cat 3 LLW									
200 East Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
200 West Area									
C-14	4.44E-01	0.00E+00	>10,000	4.62E-01	0.00E+00	>10,000	1.45E+02	0.00E+00	>10,000
Tc-99									
Grouted Tc-99	3.23E+03	2.69E-01	1,840	3.23E+03	2.69E-01	1,840	3.23E+03	2.69E-01	1,840
I-129	1.96E-06	1.82E-08	2,340	2.04E-06	1.89E-08	2,340	2.04E-06	1.89E-08	2,340
Grouted I-129	5.00E+00	1.32E-04	1,840	5.00E+00	1.32E-04	1,840	5.00E+00	1.32E-04	1,840
U-233	2.98E-01	0.00E+00	>10,000	3.10E-01	0.00E+00	>10,000	1.80E-01	0.00E+00	>10,000
U-234	3.73E+02	0.00E+00	>10,000	3.89E+02	0.00E+00	>10,000	3.11E+02	0.00E+00	>10,000
U-235	1.07E+01	0.00E+00	>10,000	1.11E+01	0.00E+00	>10,000	1.20E+01	0.00E+00	>10,000
U-236	4.82E+01	0.00E+00	>10,000	5.02E+01	0.00E+00	>10,000	2.89E+01	0.00E+00	>10,000
U-238	5.99E+02	0.00E+00	>10,000	6.24E+02	0.00E+00	>10,000	5.04E+02	0.00E+00	>10,000

Table G.18. (contd)

	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
Constituent	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**
Projected MLLW									
200 East Area									
C-14	1.46E+00	1.25E-07	10,000	1.46E+00	1.25E-07	10,000	1.45E+00	1.25E-07	10,000
Tc-99	8.34E+00	9.43E-02	1,630	8.36E+00	9.45E-02	1,630	8.27E+00	9.35E-02	1,630
Grouted Tc-99								0.00E+00	
I-129	3.50E-02	3.96E-04	1,630	3.51E-02	3.97E-04	1,630	3.48E-02	3.93E-04	1,630
Grouted I-129									
U-233	4.67E-03	1.10E-09	10,000	4.68E-03	1.29E-09	10,000	4.64E-03	7.49E-13	10,000
U-234	5.44E+00	1.28E-06	10,000	5.45E+00	1.50E-06	10,000	5.40E+00	8.71E-10	10,000
U-235	8.67E-02	2.04E-08	10,000	8.69E-02	2.40E-08	10,000	8.61E-02	1.39E-11	10,000
U-236	1.02E-01	2.40E-08	10,000	1.02E-01	2.81E-08	10,000	1.01E-01	1.63E-11	10,000
U-238	1.36E+00	3.20E-07	10,000	1.36E+00	3.75E-07	10,000	1.35E+00	2.18E-10	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
Projected Grouted MLLW									
200 East Area									
C-14	2.86E+00	2.46E-07	10,000	2.87E+00	2.47E-07	10,000	4.25E+00	3.65E-07	10,000
Tc-99									
Grouted Tc-99	1.57E+02	1.45E-02	970	1.57E+02	1.45E-02	970	3.34E+02	3.09E-02	970
I-129									
Grouted I-129	6.87E-02	2.01E-06	970	6.88E-02	2.01E-06	970	7.06E-02	2.06E-06	970
U-233	8.91E-03	1.27E-10	10,000	8.93E-03	1.27E-10	10,000	9.20E-03	1.31E-10	10,000
U-234	1.07E+01	1.53E-07	10,000	1.07E+01	1.53E-07	10,000	3.35E+02	4.78E-06	10,000
U-235	1.70E-01	2.43E-09	10,000	1.70E-01	2.43E-09	10,000	1.47E+01	2.10E-07	10,000
U-236	2.00E-01	2.85E-09	10,000	2.00E-01	2.85E-09	10,000	2.05E-01	2.93E-09	10,000
U-238	2.64E+00	3.78E-08	10,000	2.65E+00	3.78E-08	10,000	3.42E+02	4.88E-06	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									

Table G.18. (contd)

Constituent	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
	Inventory (Ci)	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**
Projected Melter Waste									
200 East Area									
C-14									
Tc-99									
Grouted Tc-99	3.89E+01	3.19E-03	870	3.89E+01	3.19E-03	870	3.89E+01	3.19E-03	870
I-129									
Grouted I-129									
U-233	8.49E-01	2.69E-10	10,000	8.49E-01	2.69E-10	10,000	8.49E-01	2.69E-10	10,000
U-234	4.60E-01	1.46E-10	10,000	4.60E-01	1.46E-10	10,000	4.60E-01	1.46E-10	10,000
U-235	1.90E-02	6.01E-12	10,000	1.90E-02	6.01E-12	10,000	1.90E-02	6.01E-12	10,000
U-236	1.70E-02	5.38E-12	10,000	1.70E-02	5.38E-12	10,000	1.70E-02	5.38E-12	10,000
U-238	4.10E-01	1.30E-10	10,000	4.10E-01	1.30E-10	10,000	4.10E-01	1.30E-10	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									

Table G.19. Predicted Peak Concentrations of Key Constituents Disposed of After 2007 at a 1-km Line of Analysis, Alternative Group D_1

		Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
Constituent	**Benchmark MCL (pCi/L)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs**	**Approx. Peak Arrival Time (yrs)**
Projected Cat 1 LLW										
200 East Area										
C-14	2,000	1.28E+01	2.01E-02	10,000	1.56E+01	2.45E-02	10,000	1.59E+01	2.50E-02	10,000
Tc-99	900	1.08E+00	6.39E+00	1,380	1.32E+00	7.80E+00	1,380	1.33E+00	7.86E+00	1,380
Grouted Tc-99	900									
I-129	1	3.01E-03	1.78E-02	1,380	3.67E-03	2.17E-02	1,380	3.67E-03	2.17E-02	1,380
Grouted I-129	1									
U-233	(a)	3.71E-01	3.29E-03	10,000	4.52E-01	3.88E-03	10,000	4.52E-01	5.61E-03	10,000
U-234	(a)	6.13E-01	5.44E-03	10,000	7.47E-01	6.41E-03	10,000	9.21E-01	1.14E-02	10,000
U-235	(a)	1.29E-01	1.14E-03	10,000	1.57E-01	1.35E-03	10,000	1.68E-01	2.08E-03	10,000
U-236	(a)	1.46E-02	1.30E-04	10,000	1.78E-02	1.53E-04	10,000	1.78E-02	2.21E-04	10,000
U-238	(a)	1.47E+00	1.30E-02	10,000	1.79E+00	1.54E-02	10,000	2.08E+00	2.58E-02	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
Projected Cat 3 LLW										
200 East Area										
C-14	2,000	4.44E-01	6.97E-04	10,000	4.62E-01	7.26E-04	10,000	1.45E+02	2.28E-01	10,000
Tc-99	900									
Grouted Tc-99	900	3.23E+03	1.55E+02	680	3.23E+03	1.55E+02	680	3.23E+03	1.55E+02	680
I-129	1	1.96E-06	1.16E-05	1,380	2.04E-06	1.21E-05	1,380	2.04E-06	1.21E-05	1,380
Grouted I-129	1	5.00E+00	7.61E-02	680	5.00E+00	7.61E-02	680	5.00E+00	7.61E-02	680
U-233	(a)	2.98E-01	2.56E-08	10,000	3.10E-01	2.97E-08	10,000	1.80E-01	4.43E-08	10,000
U-234	(a)	3.73E+02	3.21E-05	10,000	3.89E+02	3.73E-05	10,000	3.11E+02	7.65E-05	10,000
U-235	(a)	1.07E+01	9.16E-07	10,000	1.11E+01	1.06E-06	10,000	1.20E+01	2.95E-06	10,000
U-236	(a)	4.82E+01	4.14E-06	10,000	5.02E+01	4.81E-06	10,000	2.89E+01	7.11E-06	10,000
U-238	(a)	5.99E+02	5.15E-05	10,000	6.24E+02	5.98E-05	10,000	5.04E+02	1.24E-04	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									

Table G.19. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs	Approx. Peak Arrival Time (yrs)
Projected MLLW										
200 East Area										
C-14	2,000	1.46E+00	2.29E-03	10,000	1.46E+00	2.29E-03	10,000	1.45E+00	2.28E-03	10,000
Tc-99	900	8.34E+00	4.93E+01	1,380	8.36E+00	4.94E+01	1,380	8.27E+00	4.89E+01	1,380
Grouted Tc-99	900		4.81E-02							
I-129	1	3.50E-02	2.07E-01	1,380	3.51E-02	2.07E-01	1,380	3.48E-02	2.06E-01	1,380
Grouted I-129	1									
U-233	(a)	4.67E-03	2.04E-05	10,000	4.68E-03	2.05E-05	10,000	4.64E-03	4.83E-05	10,000
U-234	(a)	5.44E+00	2.38E-02	10,000	5.45E+00	2.38E-02	10,000	5.40E+00	5.62E-02	10,000
U-235	(a)	8.67E-02	3.79E-04	10,000	8.69E-02	3.80E-04	10,000	8.61E-02	8.96E-04	10,000
U-236	(a)	1.02E-01	4.45E-04	10,000	1.02E-01	4.46E-04	10,000	1.01E-01	1.05E-03	10,000
U-238	(a)	1.36E+00	5.94E-03	10,000	1.36E+00	5.95E-03	10,000	1.35E+00	1.41E-02	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
Projected Grouted MLLW										
200 East Area										
C-14	2,000	2.86E+00	4.50E-03	10,000	2.87E+00	4.51E-03	10,000	4.25E+00	6.68E-03	10,000
Tc-99	900									
Grouted Tc-99	900	1.57E+02	7.54E+00	680	1.57E+02	7.55E+00	680	3.34E+02	1.61E+01	680
I-129	1									
Grouted I-129	1	6.87E-02	1.04E-03	680	6.88E-02	1.05E-03	680	7.06E-02	1.07E-03	680
U-233	(a)	8.91E-03	7.19E-08	10,000	8.93E-03	7.20E-08	10,000	9.20E-03	1.94E-08	10,000
U-234	(a)	1.07E+01	8.61E-05	10,000	1.07E+01	8.63E-05	10,000	3.35E+02	7.05E-04	10,000
U-235	(a)	1.70E-01	1.37E-06	10,000	1.70E-01	1.37E-06	10,000	1.47E+01	3.09E-05	10,000
U-236	(a)	2.00E-01	1.61E-06	10,000	2.00E-01	1.61E-06	10,000	2.05E-01	4.31E-07	10,000
U-238	(a)	2.64E+00	2.13E-05	10,000	2.65E+00	2.14E-05	10,000	3.42E+02	7.19E-04	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									

Table G.19. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs	Approx. Peak Arrival Time (yrs)
Projected Melter Waste										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900	3.89E+01	1.87E+00	680	3.89E+01	1.87E+00	680	3.89E+01	1.87E+00	680
I-129	1									
Grouted I-129	1									
U-233	(a)	8.49E-01	1.79E-06	10,000	8.49E-01	1.79E-06	10,000	8.49E-01	1.79E-06	10,000
U-234	(a)	4.60E-01	9.68E-07	10,000	4.60E-01	9.68E-07	10,000	4.60E-01	9.68E-07	10,000
U-235	(a)	1.90E-02	4.00E-08	10,000	1.90E-02	4.00E-08	10,000	1.90E-02	4.00E-08	10,000
U-236	(a)	1.70E-02	3.58E-08	10,000	1.70E-02	3.58E-08	10,000	1.70E-02	3.58E-08	10,000
U-238	(a)	4.10E-01	8.62E-07	10,000	4.10E-01	8.62E-07	10,000	4.10E-01	8.62E-07	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									

(a) The benchmark MCL for uranium is 30 µg/L expressed as total uranium. To convert isotope specific concentrations from pCi/L to µg/L, use following conversion factors:

- Uranium-233 - 1.05E-04
- Uranium-234 - 1.62E-04
- Uranium-235 - 4.66E-01
- Uranium-236 - 1.58E-02
- Uranium-238 - 3.00E+00.

Table G.20. Predicted Peak Concentrations of Key Constituents Disposed of After 2007 at a Line of Analysis Near the Columbia River, Alternative Group D_1

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected Cat 1 LLW										
200 East Area										
C-14	2,000	1.28E+01	2.96E-04	10,000	1.56E+01	3.61E-04	10,000	1.59E+01	3.68E-04	10,000
Tc-99	900	1.08E+00	7.36E-01	1,510	1.32E+00	8.97E-01	1,510	1.33E+00	9.04E-01	1,510
Grouted Tc-99	900									
I-129	1	3.01E-03	2.05E-03	1,510	3.67E-03	2.50E-03	1,510	3.67E-03	2.50E-03	1,510
Grouted I-129	1									
U-233	(a)	3.71E-01	4.40E-05	10,000	4.52E-01	5.12E-05	10,000	4.52E-01	8.41E-05	10,000
U-234	(a)	6.13E-01	7.27E-05	10,000	7.47E-01	8.47E-05	10,000	9.21E-01	1.71E-04	10,000
U-235	(a)	1.29E-01	1.53E-05	10,000	1.57E-01	1.78E-05	10,000	1.68E-01	3.13E-05	10,000
U-236	(a)	1.46E-02	1.73E-06	10,000	1.78E-02	2.02E-06	10,000	1.78E-02	3.31E-06	10,000
U-238	(a)	1.47E+00	1.74E-04	10,000	1.79E+00	2.03E-04	10,000	2.08E+00	3.87E-04	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
Projected Cat 3 LLW										
200 East Area										
C-14	2,000	4.44E-01	1.03E-05	10,000	4.62E-01	1.07E-05	10,000	1.45E+02	3.35E-03	10,000
Tc-99	900									
Grouted Tc-99	900	3.23E+03	1.69E+01	820	3.23E+03	1.69E+01	820	3.23E+03	1.69E+01	820
I-129	1	1.96E-06	1.33E-06	1,510	2.04E-06	1.39E-06	1,510	2.04E-06	1.39E-06	1,510
Grouted I-129	1	5.00E+00	8.26E-03	820	5.00E+00	8.26E-03	820	5.00E+00	8.26E-03	820
U-233	(a)	2.98E-01	3.17E-10	10,000	3.10E-01	3.68E-10	10,000	1.80E-01	5.49E-10	10,000
U-234	(a)	3.73E+02	3.98E-07	10,000	3.89E+02	4.62E-07	10,000	3.11E+02	9.49E-07	10,000
U-235	(a)	1.07E+01	1.14E-08	10,000	1.11E+01	1.32E-08	10,000	1.20E+01	3.66E-08	10,000
U-236	(a)	4.82E+01	5.13E-08	10,000	5.02E+01	5.97E-08	10,000	2.89E+01	8.82E-08	10,000
U-238	(a)	5.99E+02	6.38E-07	10,000	6.24E+02	7.42E-07	10,000	5.04E+02	1.54E-06	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									

Table G.20. (contd)

		Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
Constituent	**Benchmark MCL (pCi/L)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
Projected MLLW										
200 East Area										
C-14	2,000	1.46E+00	3.37E-05	10,000	1.46E+00	3.38E-05	10,000	1.45E+00	3.35E-05	10,000
Tc-99	900	8.34E+00	5.67E+00	1,510	8.36E+00	5.68E+00	1,510	8.27E+00	5.62E+00	1,510
Grouted Tc-99	900									
I-129	1	3.50E-02	2.38E-02	1,510	3.51E-02	2.39E-02	1,510	3.48E-02	2.37E-02	1,510
Grouted I-129	1									
U-233	(a)	4.67E-03	2.53E-07	10,000	4.68E-03	2.54E-07	10,000	4.64E-03	6.77E-07	10,000
U-234	(a)	5.44E+00	2.95E-04	10,000	5.45E+00	2.96E-04	10,000	5.40E+00	7.88E-04	10,000
U-235	(a)	8.67E-02	4.70E-06	10,000	8.69E-02	4.71E-06	10,000	8.61E-02	1.26E-05	10,000
U-236	(a)	1.02E-01	5.52E-06	10,000	1.02E-01	5.53E-06	10,000	1.01E-01	1.47E-05	10,000
U-238	(a)	1.36E+00	7.36E-05	10,000	1.36E+00	7.37E-05	10,000	1.35E+00	1.97E-04	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
Projected Grouted MLLW										
200 East Area										
C-14	2,000	2.86E+00	6.62E-05	10,000	2.87E+00	6.64E-05	10,000	4.25E+00	9.83E-05	10,000
Tc-99	900									
Grouted Tc-99	900	1.57E+02	8.19E-01	820	1.57E+02		820	3.34E+02	1.75E+00	820
I-129	1									
Grouted I-129	1	6.87E-02	1.13E-04	820	6.88E-02	1.14E-04	820	7.06E-02	1.17E-04	820
U-233	(a)	8.91E-03	8.91E-10	10,000	8.93E-03	8.93E-10	10,000	9.20E-03	2.40E-10	10,000
U-234	(a)	1.07E+01	1.07E-06	10,000	1.07E+01	1.07E-06	10,000	3.35E+02	8.74E-06	10,000
U-235	(a)	1.70E-01	1.70E-08	10,000	1.70E-01	1.70E-08	10,000	1.47E+01	3.83E-07	10,000
U-236	(a)	2.00E-01	2.00E-08	10,000	2.00E-01	2.00E-08	10,000	2.05E-01	5.35E-09	10,000
U-238	(a)	2.64E+00	2.64E-07	10,000	2.65E+00	2.65E-07	10,000	3.42E+02	8.92E-06	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									

Table G.20. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected Melter Waste										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900	3.89E+01	2.03E-01	820	3.89E+01	2.03E-01	820	3.89E+01	2.03E-01	820
I-129	1									
Grouted I-129	1									
U-233	(a)	8.49E-01	2.21E-08	10,000	8.49E-01	2.21E-08	10,000	8.49E-01	2.21E-08	10,000
U-234	(a)	4.60E-01	1.20E-08	10,000	4.60E-01	1.20E-08	10,000	4.60E-01	1.20E-08	10,000
U-235	(a)	1.90E-02	4.96E-10	10,000	1.90E-02	4.96E-10	10,000	1.90E-02	4.96E-10	10,000
U-236	(a)	1.70E-02	4.43E-10	10,000	1.70E-02	4.43E-10	10,000	1.70E-02	4.43E-10	10,000
U-238	(a)	4.10E-01	1.07E-08	10,000	4.10E-01	1.07E-08	10,000	4.10E-01	1.07E-08	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									

(a) The benchmark MCL for uranium is 30 µg/L expressed as total uranium. To convert isotope specific concentrations from pCi/L to µg/L, use following conversion factors:

- Uranium-233 - 1.05E-04
- Uranium-234 - 1.62E-04
- Uranium-235 - 4.66E-01
- Uranium-236 - 1.58E-02
- Uranium-238 - 3.00E+00.

Table G.21. Predicted Peak River Flux of Key Constituents Disposed of After 2007 at a Line of Analysis to the Columbia River, Alternative Group D_1

Constituent	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
	Inventory (Ci)	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**
Projected Cat 1 LLW									
200 East Area									
C-14	1.28E+01	3.60E-06	10,000	1.56E+01	4.39E-06	10,000	1.59E+01	4.48E-06	10,000
Tc-99	1.08E+00	1.15E-02	1,530	1.32E+00	1.40E-02	1,530	1.33E+00	1.41E-02	1,530
Grouted Tc-99									
I-129	3.01E-03	3.19E-05	1,530	3.67E-03	3.89E-05	1,530	3.67E-03	3.89E-05	1,530
Grouted I-129									
U-233	3.71E-01	5.34E-07	10,000	4.52E-01	6.22E-07	10,000	4.52E-01	1.03E-06	10,000
U-234	6.13E-01	8.83E-07	10,000	7.47E-01	1.03E-06	10,000	9.21E-01	2.10E-06	10,000
U-235	1.29E-01	1.86E-07	10,000	1.57E-01	2.16E-07	10,000	1.68E-01	3.84E-07	10,000
U-236	1.46E-02	2.10E-08	10,000	1.78E-02	2.45E-08	10,000	1.78E-02	4.06E-08	10,000
U-238	1.47E+00	2.12E-06	10,000	1.79E+00	2.46E-06	10,000	2.08E+00	4.75E-06	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
Projected Cat 3 LLW									
200 East Area									
C-14	4.44E-01	1.25E-07	10,000	4.62E-01	1.30E-07	10,000	1.45E+02	4.08E-05	10,000
Tc-99									
Grouted Tc-99	3.23E+03	2.65E-01	870	3.23E+03	2.69E-01	1,840	3.23E+03	2.65E-01	870
I-129	1.96E-06	2.07E-08	1,530	2.04E-06	2.16E-08	1,530	2.04E-06	2.16E-08	1,530
Grouted I-129	5.00E+00	1.30E-04	870	5.00E+00	1.32E-04	1,840	5.00E+00	1.30E-04	870
U-233	2.98E-01	3.85E-12	10,000	3.10E-01	4.47E-12	10,000	1.80E-01	6.66E-12	10,000
U-234	3.73E+02	4.83E-09	10,000	3.89E+02	5.61E-09	10,000	3.11E+02	1.15E-08	10,000
U-235	1.07E+01	1.38E-10	10,000	1.11E+01	1.60E-10	10,000	1.20E+01	4.44E-10	10,000
U-236	4.82E+01	6.23E-10	10,000	5.02E+01	7.24E-10	10,000	2.89E+01	1.07E-09	10,000
U-238	5.99E+02	7.74E-09	10,000	6.24E+02	9.00E-09	10,000	5.04E+02	1.86E-08	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									

Table G.21. (contd)

Constituent	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
	Inventory (Ci)	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**
Projected MLLW									
200 East Area									
C-14	1.46E+00	4.10E-07	10,000	1.46E+00	4.11E-07	10,000	1.45E+00	4.08E-07	10,000
Tc-99	8.34E+00	8.84E-02	1,530	8.36E+00	8.85E-02	1,530	8.27E+00	8.76E-02	1,530
Grouted Tc-99									
I-129	3.50E-02	3.71E-04	1,530	3.51E-02	3.72E-04	1,530	3.48E-02	3.69E-04	1,530
Grouted I-129									
U-233	4.67E-03	3.07E-09	10,000	4.68E-03	3.08E-09	10,000	4.64E-03	8.26E-09	10,000
U-234	5.44E+00	3.58E-06	10,000	5.45E+00	3.59E-06	10,000	5.40E+00	9.61E-06	10,000
U-235	8.67E-02	5.71E-08	10,000	8.69E-02	5.72E-08	10,000	8.61E-02	1.53E-07	10,000
U-236	1.02E-01	6.70E-08	10,000	1.02E-01	6.71E-08	10,000	1.01E-01	1.80E-07	10,000
U-238	1.36E+00	8.93E-07	10,000	1.36E+00	8.95E-07	10,000	1.35E+00	2.40E-06	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
Projected Grouted MLLW									
200 East Area									
C-14	2.86E+00	8.07E-07	10,000	2.87E+00	8.08E-07	10,000	4.25E+00	1.20E-06	10,000
Tc-99									
Grouted Tc-99	1.57E+02	1.28E-02	870	1.57E+02	1.29E-02	870	3.34E+02	2.74E-02	870
I-129									
Grouted I-129	6.87E-02	1.78E-06	870	6.88E-02	1.78E-06	870	7.06E-02	1.83E-06	870
U-233	8.91E-03	1.08E-11	10,000	8.93E-03	1.08E-11	10,000	9.20E-03	2.91E-12	10,000
U-234	1.07E+01	1.30E-08	10,000	1.07E+01	1.30E-08	10,000	3.35E+02	1.06E-07	10,000
U-235	1.70E-01	2.06E-10	10,000	1.70E-01	2.06E-10	10,000	1.47E+01	4.65E-09	10,000
U-236	2.00E-01	2.42E-10	10,000	2.00E-01	2.43E-10	10,000	2.05E-01	6.49E-11	10,000
U-238	2.64E+00	3.21E-09	10,000	2.65E+00	3.21E-09	10,000	3.42E+02	1.08E-07	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									

Table G.21. (contd)

Constituent	Hanford Only Volume Inventory (Ci)	Hanford Only Volume Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Hanford Only Volume Approx. Peak Arrival Time (yrs)	Lower Bound Volume Inventory (Ci)	Lower Bound Volume Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Lower Bound Volume Approx. Peak Arrival Time (yrs)	Upper Bound Volume Inventory (Ci)	Upper Bound Volume Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Upper Bound Volume Approx. Peak Arrival Time (yrs)
Projected Melter Waste									
200 East Area									
C-14									
Tc-99									
Grouted Tc-99	3.89E+01	3.19E-03	870	3.89E+01	3.19E-03	870	3.89E+01	3.19E-03	870
I-129									
Grouted I-129									
U-233	8.49E-01	2.69E-10	10,000	8.49E-01	2.69E-10	10,000	8.49E-01	2.69E-10	10,000
U-234	4.60E-01	1.46E-10	10,000	4.60E-01	1.46E-10	10,000	4.60E-01	1.46E-10	10,000
U-235	1.90E-02	6.01E-12	10,000	1.90E-02	6.01E-12	10,000	1.90E-02	6.01E-12	10,000
U-236	1.70E-02	5.38E-12	10,000	1.70E-02	5.38E-12	10,000	1.70E-02	5.38E-12	10,000
U-238	4.10E-01	1.30E-10	10,000	4.10E-01	1.30E-10	10,000	4.10E-01	1.30E-10	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									

Table G.22. Predicted Peak Concentrations of Key Constituents Disposed of After 2007 at a 1-km Line of Analysis, Alternative Group D_2

		Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
Constituent	**Benchmark MCL (pCi/L)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
Projected Cat 1 LLW										
200 East Area										
C-14	2,000	1.28E+01	3.09E-02	10,000	1.56E+01	3.76E-02	10,000	1.59E+01	3.84E-02	10,000
Tc-99	900	1.08E+00	5.17E+00	1,320	1.32E+00	6.31E+00	1,320	1.33E+00	6.36E+00	1,320
Grouted Tc-99	900									
I-129	1	3.01E-03	1.44E-02	1,320	3.67E-03	1.75E-02	1,320	3.67E-03	1.75E-02	1,320
Grouted I-129	1									
U-233	(a)	3.71E-01	5.20E-03	10,000	4.52E-01	6.13E-03	10,000	4.52E-01	8.62E-03	10,000
U-234	(a)	6.13E-01	8.59E-03	10,000	7.47E-01	1.01E-02	10,000	9.21E-01	1.76E-02	10,000
U-235	(a)	1.29E-01	1.81E-03	10,000	1.57E-01	2.13E-03	10,000	1.68E-01	3.20E-03	10,000
U-236	(a)	1.46E-02	2.05E-04	10,000	1.78E-02	2.42E-04	10,000	1.78E-02	3.39E-04	10,000
U-238	(a)	1.47E+00	2.06E-02	10,000	1.79E+00	2.43E-02	10,000	2.08E+00	3.97E-02	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
Projected Cat 3 LLW										
200 East Area										
C-14	2,000	4.44E-01	1.07E-03	10,000	4.62E-01	1.11E-03	10,000	1.45E+02	3.50E-01	10,000
Tc-99	900									
Grouted Tc-99	900	3.23E+03	1.35E+02	630	3.23E+03	1.35E+02	630	3.23E+03	1.35E+02	630
I-129	1	1.96E-06	9.36E-06	1,320	2.04E-06	9.75E-06	1,320	2.04E-06	9.75E-06	1,320
Grouted I-129	1	5.00E+00	6.63E-02	630	5.00E+00	6.63E-02	630	5.00E+00	6.63E-02	630
U-233	(a)	2.98E-01	4.08E-08	10,000	3.10E-01	4.74E-08	10,000	1.80E-01	7.07E-08	10,000
U-234	(a)	3.73E+02	5.12E-05	10,000	3.89E+02	5.95E-05	10,000	3.11E+02	1.22E-04	10,000
U-235	(a)	1.07E+01	1.46E-06	10,000	1.11E+01	1.70E-06	10,000	1.20E+01	4.71E-06	10,000
U-236	(a)	4.82E+01	6.61E-06	10,000	5.02E+01	7.68E-06	10,000	2.89E+01	1.13E-05	10,000
U-238	(a)	5.99E+02	8.21E-05	10,000	6.24E+02	9.54E-05	10,000	5.04E+02	1.98E-04	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									

Table G.22. (contd)

		Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
Constituent	**Benchmark MCL (pCi/L)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
Projected MLLW										
200 East Area										
C-14	2,000	1.46E+00	3.41E-03	10,000	1.28E+01	2.01E-02	10,000	1.45E+00	3.40E-03	10,000
Tc-99	900	8.34E+00	6.79E+01	1,,370	1.08E+00	6.39E+00	1,,370	8.27E+00	6.73E+01	1,,370
Grouted Tc-99	900				0.00E+00					
I-129	1	3.50E-02	2.85E-01	1,,370	3.01E-03	1.78E-02	1,,370	3.48E-02	2.83E-01	1,,370
Grouted I-129	1									
U-233	(a)	4.67E-03	2.96E-05	10,000	3.71E-01	3.29E-03	>10,000	4.64E-03	7.14E-05	10,000
U-234	(a)	5.44E+00	3.45E-02	10,000	6.13E-01	5.44E-03	>10,000	5.40E+00	8.30E-02	10,000
U-235	(a)	8.67E-02	5.50E-04	10,000	1.29E-01	1.14E-03	>10,000	8.61E-02	1.32E-03	10,000
U-236	(a)	1.02E-01	6.45E-04	10,000	1.46E-02	1.30E-04	>10,000	1.01E-01	1.55E-03	10,000
U-238	(a)	1.36E+00	8.60E-03	10,000	1.47E+00	1.30E-02	>10,000	1.35E+00	2.08E-02	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
Projected Grouted MLLW										
200 East Area										
C-14	2,000	2.86E+00	6.71E-03	10,000	2.87E+00	6.73E-03	10,000	4.25E+00	9.96E-03	10,000
Tc-99	900									
Grouted Tc-99	900	1.57E+02	1.10E+01	680	1.57E+02	1.11E+01	680	3.34E+02	2.35E+01	680
I-129	1									
Grouted I-129	1	6.87E-02	1.53E-03	680	6.88E-02	1.53E-03	680	7.06E-02	1.57E-03	680
U-233	(a)	8.91E-03	1.04E-07	10,000	8.93E-03	1.04E-07	10,000	9.20E-03	2.80E-08	10,000
U-234	(a)	1.07E+01	1.25E-04	10,000	1.07E+01	1.25E-04	10,000	3.35E+02	1.02E-03	10,000
U-235	(a)	1.70E-01	1.98E-06	10,000	1.70E-01	1.99E-06	10,000	1.47E+01	4.48E-05	10,000
U-236	(a)	2.00E-01	2.33E-06	10,000	2.00E-01	2.34E-06	10,000	2.05E-01	6.25E-07	10,000
U-238	(a)	2.64E+00	3.09E-05	10,000	2.65E+00	3.10E-05	10,000	3.42E+02	1.04E-03	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									

Table G.22. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected Melter Waste										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900	3.89E+01	2.74E+00	680	3.89E+01	2.74E+00	680	3.89E+01	2.74E+00	680
I-129	1									
Grouted I-129	1									
U-233	(a)	8.49E-01	2.51E-06	10,000	8.49E-01	2.51E-06	10,000	8.49E-01	2.51E-06	10,000
U-234	(a)	4.60E-01	1.36E-06	10,000	4.60E-01	1.36E-06	10,000	4.60E-01	1.36E-06	10,000
U-235	(a)	1.90E-02	5.61E-08	10,000	1.90E-02	5.61E-08	10,000	1.90E-02	5.61E-08	10,000
U-236	(a)	1.70E-02	5.02E-08	10,000	1.70E-02	5.02E-08	10,000	1.70E-02	5.02E-08	10,000
U-238	(a)	4.10E-01	1.21E-06	10,000	4.10E-01	1.21E-06	10,000	4.10E-01	1.21E-06	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									

(a) The benchmark MCL for uranium is 30 µg/L expressed as total uranium. To convert isotope specific concentrations from pCi/L to µg/L, use following conversion factors:

- Uranium-233 - 1.05E-04
- Uranium-234 - 1.62E-04
- Uranium-235 - 4.66E-01
- Uranium-236 - 1.58E-02
- Uranium-238 - 3.00E+00.

Table G.23. Predicted Peak Concentrations of Key Constituents Disposed of After 2007 at a Line of Analysis Near the Columbia River, Alternative Group D_2

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected Cat 1 LLW										
200 East Area										
C-14	2,000	1.28E+01	6.49E-04	10,000	1.56E+01	7.92E-04	10,000	1.59E+01	8.07E-04	10,000
Tc-99	900	1.08E+00	1.39E+00	1,530	1.32E+00	1.70E+00	1,530	1.33E+00	1.71E+00	1,530
Grouted Tc-99	900									
I-129	1	3.01E-03	3.87E-03	1,530	3.67E-03	4.71E-03	1,530	3.67E-03	4.71E-03	1,530
Grouted I-129	1									
U-233	(a)	3.71E-01	6.08E-05	10,000	4.52E-01	7.08E-05	10,000	4.52E-01	3.30E-07	10,000
U-234	(a)	6.13E-01	1.00E-04	10,000	7.47E-01	1.17E-04	10,000	9.21E-01	6.73E-07	10,000
U-235	(a)	1.29E-01	2.11E-05	10,000	1.57E-01	2.46E-05	10,000	1.68E-01	1.23E-07	10,000
U-236	(a)	1.46E-02	2.39E-06	10,000	1.78E-02	2.79E-06	10,000	1.78E-02	1.30E-08	10,000
U-238	(a)	1.47E+00	2.41E-04	10,000	1.79E+00	2.80E-04	10,000	2.08E+00	1.52E-06	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
Projected Cat 3 LLW										
200 East Area										
C-14	2,000	4.44E-01	2.25E-05	10,000	4.62E-01	2.34E-05	10,000	1.45E+02	7.36E-03	10,000
Tc-99	900									
Grouted Tc-99	900	3.23E+03	3.18E+01	860	3.23E+03	3.18E+01	860	3.23E+03	3.18E+01	860
I-129	1	1.96E-06	2.52E-06	1,530	2.04E-06	2.62E-06	1,530	2.04E-06	2.62E-06	1,530
Grouted I-129	1	5.00E+00	1.56E-02	860	5.00E+00	1.56E-02	860	5.00E+00	1.56E-02	860
U-233	(a)	2.98E-01	4.37E-10	10,000	3.10E-01	5.08E-10	10,000	1.80E-01	7.57E-10	10,000
U-234	(a)	3.73E+02	5.48E-07	10,000	3.89E+02	6.37E-07	10,000	3.11E+02	1.31E-06	10,000
U-235	(a)	1.07E+01	1.56E-08	10,000	1.11E+01	1.82E-08	10,000	1.20E+01	5.04E-08	10,000
U-236	(a)	4.82E+01	7.08E-08	10,000	5.02E+01	8.22E-08	10,000	2.89E+01	1.21E-07	10,000
U-238	(a)	5.99E+02	8.80E-07	10,000	6.24E+02	1.02E-06	10,000	5.04E+02	2.12E-06	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									

Table G.23. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected MLLW										
200 East Area										
C-14	2,000	1.46E+00	2.15E-05	10,000	1.46E+00	2.15E-05	10,000	1.45E+00	2.14E-05	10,000
Tc-99	900	8.34E+00	9.43E+00	1,590	8.36E+00	9.44E+00	1,590	8.27E+00	9.34E+00	1,590
Grouted Tc-99	900									
I-129	1	3.50E-02	3.96E-02	1,590	3.51E-02	3.97E-02	1,590	3.48E-02	3.93E-02	1,590
Grouted I-129	1									
U-233	(a)	4.67E-03	1.58E-07	10,000	4.68E-03	1.59E-07	10,000	4.64E-03	4.34E-07	10,000
U-234	(a)	5.44E+00	1.84E-04	10,000	5.45E+00	1.85E-04	10,000	5.40E+00	5.05E-04	10,000
U-235	(a)	8.67E-02	2.94E-06	10,000	8.69E-02	2.95E-06	10,000	8.61E-02	8.06E-06	10,000
U-236	(a)	1.02E-01	3.45E-06	10,000	1.02E-01	3.46E-06	10,000	1.01E-01	9.45E-06	10,000
U-238	(a)	1.36E+00	4.60E-05	10,000	1.36E+00	4.61E-05	10,000	1.35E+00	1.26E-04	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
Projected Grouted MLLW										
200 East Area										
C-14	2,000	2.86E+00	4.22E-05	10,000	2.87E+00	4.23E-05	10,000	4.25E+00	6.26E-05	10,000
Tc-99	900									
Grouted Tc-99	900	1.57E+02	1.35E+00	940	1.57E+02	1.36E+00	940	3.34E+02	2.89E+00	940
I-129	1									
Grouted I-129	1	6.87E-02	1.88E-04	940	6.88E-02	1.88E-04	940	7.06E-02	1.93E-04	940
U-233	(a)	8.91E-03	5.58E-10	10,000	8.93E-03	5.58E-10	10,000	9.20E-03	1.50E-10	10,000
U-234	(a)	1.07E+01	6.68E-07	10,000	1.07E+01	6.69E-07	10,000	3.35E+02	5.47E-06	10,000
U-235	(a)	1.70E-01	1.06E-08	10,000	1.70E-01	1.06E-08	10,000	1.47E+01	2.40E-07	10,000
U-236	(a)	2.00E-01	1.25E-08	10,000	2.00E-01	1.25E-08	10,000	2.05E-01	3.34E-09	10,000
U-238	(a)	2.64E+00	1.65E-07	10,000	2.65E+00	1.66E-07	10,000	3.42E+02	5.58E-06	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									

Table G.23. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected Melter Waste										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900	3.89E+01	3.37E-01	940	3.89E+01	3.37E-01	940	3.89E+01	3.37E-01	940
I-129	1									
Grouted I-129	1									
U-233	(a)	8.49E-01	1.33E-08	10,000	8.49E-01	1.33E-08	10,000	8.49E-01	1.33E-08	10,000
U-234	(a)	4.60E-01	7.23E-09	10,000	4.60E-01	7.23E-09	10,000	4.60E-01	7.23E-09	10,000
U-235	(a)	1.90E-02	2.99E-10	10,000	1.90E-02	2.99E-10	10,000	1.90E-02	2.99E-10	10,000
U-236	(a)	1.70E-02	2.67E-10	10,000	1.70E-02	2.67E-10	10,000	1.70E-02	2.67E-10	10,000
U-238	(a)	4.10E-01	6.44E-09	10,000	4.10E-01	6.44E-09	10,000	4.10E-01	6.44E-09	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									

(a) The benchmark MCL for uranium is 30 µg/L expressed as total uranium. To convert isotope specific concentrations from pCi/L to µg/L, use following conversion factors:

- Uranium-233 - 1.05E-04
- Uranium-234 - 1.62E-04
- Uranium-235 - 4.66E-01
- Uranium-236 - 1.58E-02
- Uranium-238 - 3.00E+00.

Table G.24. Predicted Peak River Flux of Key Constituents Disposed of After 2007 at a Line of Analysis to the Columbia River, Alternative Group D_2

Constituent	**Hanford Only Volume**			**Lower Bound Volume**			**Upper Bound Volume**		
	Inventory (Ci)	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**
Projected Cat 1 LLW									
200 East Area									
C-14	1.28E+01	1.86E-06	10,000	1.56E+01	2.27E-06	10,000	1.59E+01	2.31E-06	10,000
Tc-99	1.08E+00	1.27E-02	1,600	1.32E+00	1.55E-02	1,600	1.33E+00	1.56E-02	1,600
Grouted Tc-99									
I-129	3.01E-03	3.53E-05	1,600	3.67E-03	4.30E-05	1,600	3.67E-03	4.30E-05	1,600
Grouted I-129									
U-233	3.71E-01	2.74E-07	10,000	4.52E-01	3.18E-07	10,000	4.52E-01	5.46E-07	10,000
U-234	6.13E-01	4.53E-07	10,000	7.47E-01	5.26E-07	10,000	9.21E-01	1.11E-06	10,000
U-235	1.29E-01	9.51E-08	10,000	1.57E-01	1.11E-07	10,000	1.68E-01	2.03E-07	10,000
U-236	1.46E-02	1.08E-08	10,000	1.78E-02	1.25E-08	10,000	1.78E-02	2.15E-08	10,000
U-238	1.47E+00	1.08E-06	10,000	1.79E+00	1.26E-06	10,000	2.08E+00	2.51E-06	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
Projected Cat 3 LLW									
200 East Area									
C-14	4.44E-01	6.44E-08	10,000	4.62E-01	6.71E-08	10,000	1.45E+02	2.11E-05	10,000
Tc-99									
Grouted Tc-99	3.23E+03	2.99E-01	970	3.23E+03	2.99E-01	970	3.23E+03	2.99E-01	970
I-129	1.96E-06	2.29E-08	1,600	2.04E-06	2.39E-08	1,600	2.04E-06	2.39E-08	1,600
Grouted I-129	5.00E+00	1.46E-04	970	5.00E+00	1.46E-04	970	5.00E+00	1.46E-04	970
U-233	2.98E-01	1.96E-12	10,000	3.10E-01	2.28E-12	10,000	1.80E-01	3.40E-12	10,000
U-234	3.73E+02	2.46E-09	10,000	3.89E+02	2.86E-09	10,000	3.11E+02	5.87E-09	10,000
U-235	1.07E+01	7.02E-11	10,000	1.11E+01	8.16E-11	10,000	1.20E+01	2.26E-10	10,000
U-236	4.82E+01	3.18E-10	10,000	5.02E+01	3.69E-10	10,000	2.89E+01	5.45E-10	10,000
U-238	5.99E+02	3.95E-09	10,000	6.24E+02	4.59E-09	10,000	5.04E+02	9.51E-09	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									

Table G.24. (contd)

Constituent	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
	Inventory (Ci)	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**
Projected MLLW									
200 East Area									
C-14	1.46E+00	1.25E-07	10,000	1.46E+00	1.25E-07	10,000	1.45E+00	1.25E-07	10,000
Tc-99	8.34E+00	9.43E-02	1,630	8.36E+00	9.45E-02	1,630	8.27E+00	9.35E-02	1,630
Grouted Tc-99									
I-129	3.50E-02	3.96E-04	1,630	3.51E-02	3.97E-04	1,630	3.48E-02	3.93E-04	1,630
Grouted I-129									
U-233	4.67E-03	9.32E-10	10,000	4.68E-03	9.34E-10	10,000	4.64E-03	7.49E-13	10,000
U-234	5.44E+00	1.09E-06	10,000	5.45E+00	1.09E-06	10,000	5.40E+00	8.71E-10	10,000
U-235	8.67E-02	1.73E-08	10,000	8.69E-02	1.73E-08	10,000	8.61E-02	1.39E-11	10,000
U-236	1.02E-01	2.03E-08	10,000	1.02E-01	2.04E-08	10,000	1.01E-01	1.63E-11	10,000
U-238	1.36E+00	2.71E-07	10,000	1.36E+00	2.71E-07	10,000	1.35E+00	2.18E-10	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
Projected Grouted MLLW									
200 East Area									
C-14	2.86E+00	2.46E-07	10,000	2.87E+00	2.47E-07	10,000	4.25E+00	3.65E-07	10,000
Tc-99									
Grouted Tc-99	1.57E+02	1.45E-02	970	1.57E+02	1.45E-02	970	3.34E+02	3.09E-02	970
I-129									
Grouted I-129	6.87E-02	2.01E-06	970	6.88E-02	2.01E-06	970	7.06E-02	2.06E-06	970
U-233	8.91E-03	3.28E-12	10,000	8.93E-03	3.29E-12	10,000	9.20E-03	1.28E-13	10,000
U-234	1.07E+01	3.93E-09	10,000	1.07E+01	3.94E-09	10,000	3.35E+02	4.66E-09	10,000
U-235	1.70E-01	6.25E-11	10,000	1.70E-01	6.26E-11	10,000	1.47E+01	2.05E-10	10,000
U-236	2.00E-01	7.35E-11	10,000	2.00E-01	7.36E-11	10,000	2.05E-01	2.85E-12	10,000
U-238	2.64E+00	9.74E-10	10,000	2.65E+00	9.75E-10	10,000	3.42E+02	4.76E-09	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									

Table G.24. (contd)

Constituent	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)
Projected Melter Waste									
200 East Area									
C-14									
Tc-99									
Grouted Tc-99	3.89E+01	3.60E-03	970	3.89E+01	3.60E-03	970	3.89E+01	3.60E-03	970
I-129									
Grouted I-129									
U-233	8.49E-01	7.84E-11	10,000	8.49E-01	7.84E-11	10,000	8.49E-01	7.84E-11	10,000
U-234	4.60E-01	4.25E-11	10,000	4.60E-01	4.25E-11	10,000	4.60E-01	4.25E-11	10,000
U-235	1.90E-02	1.75E-12	10,000	1.90E-02	1.75E-12	10,000	1.90E-02	1.75E-12	10,000
U-236	1.70E-02	1.57E-12	10,000	1.70E-02	1.57E-12	10,000	1.70E-02	1.57E-12	10,000
U-238	4.10E-01	3.79E-11	10,000	4.10E-01	3.79E-11	10,000	4.10E-01	3.79E-11	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									

Table G.25. Predicted Peak Concentrations of Key Constituents Disposed of After 2007 at a 1-km Line of Analysis, Alternative Group D_3

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected Cat 1 LLW										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
ERDF Area										
C-14	2,000	1.28E+01	0.00E+00	>10,000	1.56E+01	0.00E+00	>10,000	1.59E+01	0.00E+00	>10,000
Tc-99	900	1.08E+00	9.31E+00	1,740	1.32E+00	1.14E+01	1,740	1.33E+00	1.14E+01	1,740
Grouted Tc-99	900									
I-129	1	3.01E-03	2.59E-02	1,740	3.67E-03	3.16E-02	1,740	3.67E-03	3.16E-02	1,740
Grouted I-129	1									
U-233	(a)	3.71E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000
U-234	(a)	6.13E-01	0.00E+00	>10,000	7.47E-01	0.00E+00	>10,000	9.21E-01	0.00E+00	>10,000
U-235	(a)	1.29E-01	0.00E+00	>10,000	1.57E-01	0.00E+00	>10,000	1.68E-01	0.00E+00	>10,000
U-236	(a)	1.46E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000
U-238	(a)	1.47E+00	0.00E+00	>10,000	1.79E+00	0.00E+00	>10,000	2.08E+00	0.00E+00	>10,000
Projected Cat 3 LLW										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
ERDF Area										
C-14	2,000	4.44E-01	0.00E+00	>10,000	4.62E-01	0.00E+00	>10,000	1.45E+02	0.00E+00	>10,000
Tc-99	900									
Grouted Tc-99	900	3.23E+03	2.25E+02	1,070	3.23E+03	2.25E+02	1,070	3.23E+03	2.25E+02	1,070
I-129	1	1.96E-06	1.69E-05	1,740	2.04E-06	1.76E-05	1,740	2.04E-06	1.76E-05	1,740
Grouted I-129	1	5.00E+00	1.10E-01	1,070	5.00E+00	1.10E-01	1,070	5.00E+00	1.10E-01	1,070
U-233	(a)	2.98E-01	0.00E+00	>10,000	3.10E-01	0.00E+00	>10,000	1.80E-01	0.00E+00	>10,000
U-234	(a)	3.73E+02	0.00E+00	>10,000	3.89E+02	0.00E+00	>10,000	3.11E+02	0.00E+00	>10,000
U-235	(a)	1.07E+01	0.00E+00	>10,000	1.11E+01	0.00E+00	>10,000	1.20E+01	0.00E+00	>10,000
U-236	(a)	4.82E+01	0.00E+00	>10,000	5.02E+01	0.00E+00	>10,000	2.89E+01	0.00E+00	>10,000
U-238	(a)	5.99E+02	0.00E+00	>10,000	6.24E+02	0.00E+00	>10,000	5.04E+02	0.00E+00	>10,000

Table G.25. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected MLLW										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
ERDF Area										
C-14	2,000	1.46E+00	0.00E+00	>10,000	1.46E+00	0.00E+00	>10,000	1.45E+00	0.00E+00	>10,000
Tc-99	900	8.34E+00	7.18E+01	1,740	8.36E+00	7.19E+01	1,740	8.27E+00	7.12E+01	1,740
Grouted Tc-99	900									
I-129	1	3.50E-02	3.01E-01	1,740	3.51E-02	3.02E-01	1,740	3.48E-02	2.99E-01	1,740
Grouted I-129	1									
U-233	(a)	4.67E-03	0.00E+00	>10,000	4.68E-03	0.00E+00	>10,000	4.64E-03	0.00E+00	>10,000
U-234	(a)	5.44E+00	0.00E+00	>10,000	5.45E+00	0.00E+00	>10,000	5.40E+00	0.00E+00	>10,000
U-235	(a)	8.67E-02	0.00E+00	>10,000	8.69E-02	0.00E+00	>10,000	8.61E-02	0.00E+00	>10,000
U-236	(a)	1.02E-01	0.00E+00	>10,000	1.02E-01	0.00E+00	>10,000	1.01E-01	0.00E+00	>10,000
U-238	(a)	1.36E+00	0.00E+00	>10,000	1.36E+00	0.00E+00	>10,000	1.35E+00	0.00E+00	>10,000
Projected Grouted MLLW										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
ERDF Area										
C-14	2,000	2.86E+00	0.00E+00	>10,000	2.87E+00	0.00E+00	>10,000	4.25E+00	0.00E+00	>10,000
Tc-99	900									
Grouted Tc-99	900	1.57E+02	1.09E+01	1,070	1.57E+02	1.00E+01	1,070	3.34E+02	2.33E+01	1,070
I-129	1									
Grouted I-129	1	6.87E-02	1.51E-03	1,070	6.88E-02	2.00E-03	1,070	7.06E-02	1.56E-03	1,070
U-233	(a)	8.91E-03	0.00E+00	>10,000	8.93E-03	0.00E+00	>10,000	9.20E-03	0.00E+00	>10,000
U-234	(a)	1.07E+01	0.00E+00	>10,000	1.07E+01	000.E+00	>10,000	3.35E+02	0.00E+00	>10,000
U-235	(a)	1.70E-01	0.00E+00	>10,000	1.70E-01	0.00E+00	>10,000	1.47E+01	0.00E+00	>10,000
U-236	(a)	2.00E-01	0.00E+00	>10,000	2.00E-01	0.00E+00	>10,000	2.05E-01	0.00E+00	>10,000
U-238	(a)	2.64E+00	0.00E+00	>10,000	2.65E+00	000.E+00	>10,000	3.42E+02	0.00E+00	>10,000

Table G.25. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected Melter Waste										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
ERDF Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900	3.89E+01	2.71E+00	1,070	3.89E+01	2.71E+00	1,070	3.89E+01	2.71E+00	1,070
I-129	1									
Grouted I-129	1									
U-233	(a)	8.49E-01	0.00E+00	>10,000	8.49E-01	0.00E+00	>10,000	8.49E-01	0.00E+00	>10,000
U-234	(a)	4.60E-01	0.00E+00	>10,000	4.60E-01	0.00E+00	>10,000	4.60E-01	0.00E+00	>10,000
U-235	(a)	1.90E-02	0.00E+00	>10,000	1.90E-02	0.00E+00	>10,000	1.90E-02	0.00E+00	>10,000
U-236	(a)	1.70E-02	0.00E+00	>10,000	1.70E-02	0.00E+00	>10,000	1.70E-02	0.00E+00	>10,000
U-238	(a)	4.10E-01	0.00E+00	>10,000	4.10E-01	0.00E+00	>10,000	4.10E-01	0.00E+00	>10,000

(a) The benchmark MCL for uranium is 30 μg/L expressed as total uranium. To convert isotope specific concentrations from pCi/L to μg/L, use following conversion factors:

- Uranium-233 - 1.05E-04
- Uranium-234 - 1.62E-04
- Uranium-235 - 4.66E-01
- Uranium-236 - 1.58E-02
- Uranium-238 - 3.00E+00.

Table G.26. Predicted Peak Concentrations of Key Constituents Disposed of After 2007 at a Line of Analysis Near the Columbia River, Alternative Group D_3

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected Cat 1 LLW										
200 East Area										
C-14	2,000	1.28E+01	0.00E+00	>10,000	1.56E+01	0.00E+00	>10,000	1.59E+01	0.00E+00	>10,000
Tc-99	900	1.08E+00	8.26E-01	2,010	1.32E+00	1.01E+00	2,010	1.33E+00	1.01E+00	2,010
Grouted Tc-99	900									
I-129	1	3.01E-03	2.30E-03	2,010	3.67E-03	2.80E-03	2,010	3.67E-03	2.80E-03	2,010
Grouted I-129	1									
U-233	(a)	3.71E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000
U-234	(a)	6.13E-01	0.00E+00	>10,000	7.47E-01	0.00E+00	>10,000	9.21E-01	0.00E+00	>10,000
U-235	(a)	1.29E-01	0.00E+00	>10,000	1.57E-01	0.00E+00	>10,000	1.68E-01	0.00E+00	>10,000
U-236	(a)	1.46E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000
U-238	(a)	1.47E+00	0.00E+00	>10,000	1.79E+00	0.00E+00	>10,000	2.08E+00	0.00E+00	>10,000
ERDF Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
Projected Cat 3 LLW										
200 East Area										
C-14	2,000	4.44E-01	0.00E+00	>10,000	4.62E-01	0.00E+00	>10,000	1.45E+02	0.00E+00	>10,000
Tc-99	900									
Grouted Tc-99	900	3.23E+03	1.97E+01	1,420	3.23E+03	1.97E+01	1,420	3.23E+03	1.97E+01	1,420
I-129	1	1.96E-06	1.49E-06	2,010	2.04E-06	1.56E-06	2,010	2.04E-06	1.56E-06	2,010
Grouted I-129	1	5.00E+00	9.65E-03	1,420	5.00E+00	9.65E-03	1,420	5.00E+00	9.65E-03	1,420
U-233	(a)	2.98E-01	0.00E+00	>10,000	3.10E-01	0.00E+00	>10,000	1.80E-01	0.00E+00	>10,000
U-234	(a)	3.73E+02	0.00E+00	>10,000	3.89E+02	0.00E+00	>10,000	3.11E+02	0.00E+00	>10,000
U-235	(a)	1.07E+01	0.00E+00	>10,000	1.11E+01	0.00E+00	>10,000	1.20E+01	0.00E+00	>10,000
U-236	(a)	4.82E+01	0.00E+00	>10,000	5.02E+01	0.00E+00	>10,000	2.89E+01	0.00E+00	>10,000
U-238	(a)	5.99E+02	0.00E+00	>10,000	6.24E+02	0.00E+00	>10,000	5.04E+02	0.00E+00	>10,000
ERDF Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									

Table G.26. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
U-238	(a)									
Projected MLLW										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
ERDF Area										
C-14	2,000	1.46E+00	0.00E+00	>10,000	1.46E+00	0.00E+00	>10,000	1.45E+00	0.00E+00	>10,000
Tc-99	900	8.34E+00	6.36E+00	2,010	8.36E+00	6.38E+00	2,010	8.27E+00	6.31E+00	2,010
Grouted Tc-99	900									
I-129	1	3.50E-02	2.67E-02	2,010	3.51E-02	2.68E-02	2,010	3.48E-02	2.65E-02	2,010
Grouted I-129	1									
U-233	(a)	4.67E-03	0.00E+00	>10,000	4.68E-03	0.00E+00	>10,000	4.64E-03	0.00E+00	>10,000
U-234	(a)	5.44E+00	0.00E+00	>10,000	5.45E+00	0.00E+00	>10,000	5.40E+00	0.00E+00	>10,000
U-235	(a)	8.67E-02	0.00E+00	>10,000	8.69E-02	0.00E+00	>10,000	8.61E-02	0.00E+00	>10,000
U-236	(a)	1.02E-01	0.00E+00	>10,000	1.02E-01	0.00E+00	>10,000	1.01E-01	0.00E+00	>10,000
U-238	(a)	1.36E+00	0.00E+00	>10,000	1.36E+00	0.00E+00	>10,000	1.35E+00	0.00E+00	>10,000
Projected Grouted MLLW										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
ERDF Area										
C-14	2,000	2.86E+00	0.00E+00	>10,000	2.87E+00	0.00E+00	>10,000	4.25E+00	0.00E+00	>10,000
Tc-99	900									
Grouted Tc-99	900	1.57E+02	9.56E-01	1,420	1.57E+02	9.58E-01	1,420	3.34E+02	2.04E+00	1,420
I-129	1									
Grouted I-129	1	6.87E-02	1.33E-04	1,420	6.88E-02	1.33E-04	1,420	7.06E-02	1.36E-04	1,420
U-233	(a)	8.91E-03	0.00E+00	>10,000	8.93E-03	0.00E+00	>10,000	9.20E-03	0.00E+00	>10,000
U-234	(a)	1.07E+01	0.00E+00	>10,000	1.07E+01	0.00E+00	>10,000	3.35E+02	0.00E+00	>10,000
U-235	(a)	1.70E-01	0.00E+00	>10,000	1.70E-01	0.00E+00	>10,000	1.47E+01	0.00E+00	>10,000
U-236	(a)	2.00E-01	0.00E+00	>10,000	2.00E-01	0.00E+00	>10,000	2.05E-01	0.00E+00	>10,000
U-238	(a)	2.64E+00	0.00E+00	>10,000	2.65E+00	0.00E+00	>10,000	3.42E+02	0.00E+00	>10,000

Table G.26. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected Melter Waste										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
ERDF Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900	3.89E+01	2.38E-01	1,420	3.89E+01	2.38E-01	1,420	3.89E+01	3.23E-03	1,510
I-129	1									
Grouted I-129	1									
U-233	(a)	8.49E-01	0.00E+00	>10,000	8.49E-01	0.00E+00	>10,000	8.49E-01	0.00E+00	>10,000
U-234	(a)	4.60E-01	0.00E+00	>10,000	4.60E-01	0.00E+00	>10,000	4.60E-01	0.00E+00	>10,000
U-235	(a)	1.90E-02	0.00E+00	>10,000	1.90E-02	0.00E+00	>10,000	1.90E-02	0.00E+00	>10,000
U-236	(a)	1.70E-02	0.00E+00	>10,000	1.70E-02	0.00E+00	>10,000	1.70E-02	0.00E+00	>10,000
U-238	(a)	4.10E-01	0.00E+00	>10,000	4.10E-01	0.00E+00	>10,000	4.10E-01	0.00E+00	>10,000

(a) The benchmark MCL for uranium is 30 µg/L expressed as total uranium. To convert isotope specific concentrations from pCi/L to µg/L, use following conversion factors:

- Uranium-233 - 1.05E-04
- Uranium-234 - 1.62E-04
- Uranium-235 - 4.66E-01
- Uranium-236 - 1.58E-02
- Uranium-238 - 3.00E+00.

Table G.27. Predicted Peak River Flux of Key Constituents Disposed of After 2007 at a Line of Analysis to the Columbia River, Alternative Group D_3

Constituent	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)
Projected Cat 1 LLW									
200 East Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
ERDF Area									
C-14	1.28E+01	0.00E+00	>10,000	1.56E+01	0.00E+00	>10,000	1.59E+01	0.00E+00	>10,000
Tc-99	1.08E+00	1.08E-02	2,070	1.32E+00	1.31E-02	2,070	1.33E+00	1.32E-02	2,070
Grouted Tc-99									
I-129	3.01E-03	2.99E-05	2,070	3.67E-03	3.65E-05	2,070	3.67E-03	3.65E-05	2,070
Grouted I-129									
U-233	3.71E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000
U-234	6.13E-01	0.00E+00	>10,000	7.47E-01	0.00E+00	>10,000	9.21E-01	0.00E+00	>10,000
U-235	1.29E-01	0.00E+00	>10,000	1.57E-01	0.00E+00	>10,000	1.68E-01	0.00E+00	>10,000
U-236	1.46E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000
U-238	1.47E+00	0.00E+00	>10,000	1.79E+00	0.00E+00	>10,000	2.08E+00	0.00E+00	>10,000
Projected Cat 3 LLW									
200 East Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
ERDF Area									
C-14	4.44E-01	0.00E+00	>10,000	4.62E-01	0.00E+00	>10,000	1.45E+02	0.00E+00	>10,000
Tc-99									
Grouted Tc-99	3.23E+03	2.67E-01	1,510	3.23E+03	2.67E-01	1,510	3.23E+03	2.67E-01	1,510
I-129	1.96E-06	1.95E-08	2,070	2.04E-06	2.03E-08	2,070	2.04E-06	2.03E-08	2,070
Grouted I-129	5.00E+00	1.31E-04	1,510	5.00E+00	1.31E-04	1,510	5.00E+00	1.31E-04	1,510
U-233	2.98E-01	0.00E+00	>10,000	3.10E-01	0.00E+00	>10,000	1.80E-01	0.00E+00	>10,000
U-234	3.73E+02	0.00E+00	>10,000	3.89E+02	0.00E+00	>10,000	3.11E+02	0.00E+00	>10,000
U-235	1.07E+01	0.00E+00	>10,000	1.11E+01	0.00E+00	>10,000	1.20E+01	0.00E+00	>10,000

Table G.27. (contd)

	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
Constituent	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)
U-236	4.82E+01	0.00E+00	>10,000	5.02E+01	0.00E+00	>10,000	2.89E+01	0.00E+00	>10,000
U-238	5.99E+02	0.00E+00	>10,000	6.24E+02	0.00E+00	>10,000	5.04E+02	0.00E+00	>10,000
Projected MLLW									
200 East Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
ERDF Area									
C-14	1.46E+00	0.00E+00	>10,000	1.46E+00	0.00E+00	>10,000	1.45E+00	0.00E+00	>10,000
Tc-99	8.34E+00	8.29E-02	2,070	8.36E+00	8.30E-02	2,070	8.27E+00	8.21E-02	2,070
Grouted Tc-99									
I-129	3.50E-02	3.48E-04	2,070	3.51E-02	3.49E-04	2,070	3.48E-02	3.46E-04	2,070
Grouted I-129									
U-233	4.67E-03	0.00E+00	>10,000	4.68E-03	0.00E+00	>10,000	4.64E-03	0.00E+00	>10,000
U-234	5.44E+00	0.00E+00	>10,000	5.45E+00	0.00E+00	>10,000	5.40E+00	0.00E+00	>10,000
U-235	8.67E-02	0.00E+00	>10,000	8.69E-02	0.00E+00	>10,000	8.61E-02	0.00E+00	>10,000
U-236	1.02E-01	0.00E+00	>10,000	1.02E-01	0.00E+00	>10,000	1.01E-01	0.00E+00	>10,000
U-238	1.36E+00	0.00E+00	>10,000	1.36E+00	0.00E+00	>10,000	1.35E+00	0.00E+00	>10,000
Projected Grouted MLLW									
200 East Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
ERDF Area									
C-14	2.86E+00	0.00E+00	>10,000	2.87E+00	0.00E+00	>10,000	4.25E+00	0.00E+00	>10,000
Tc-99									
Grouted Tc-99	1.57E+02	1.30E-02	1,510	1.57E+02	1.30E-02	1,510	3.34E+02	2.77E-02	1,510
I-129									
Grouted I-129	6.87E-02	1.80E-06	1,510	6.88E-02	1.80E-06	1,510	7.06E-02	1.85E-06	1,510
U-233	8.91E-03	0.00E+00	>10,000	8.93E-03	0.00E+00	>10,000	9.20E-03	0.00E+00	>10,000
U-234	1.07E+01	0.00E+00	>10,000	1.07E+01	0.00E+00	>10,000	3.35E+02	0.00E+00	>10,000
U-235	1.70E-01	0.00E+00	>10,000	1.70E-01	0.00E+00	>10,000	1.47E+01	0.00E+00	>10,000
U-236	2.00E-01	0.00E+00	>10,000	2.00E-01	0.00E+00	>10,000	2.05E-01	0.00E+00	>10,000

Table G.27. (contd)

Constituent	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
	Inventory (Ci)	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**
U-238	2.64E+00	0.00E+00	>10,000	2.65E+00	0.00E+00	>10,000	3.42E+02	0.00E+00	>10,000
Projected Melter Waste									
200 East Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
ERDF Area									
C-14									
Tc-99									
Grouted Tc-99	3.89E+01	3.23E-03	1,510	3.89E+01	3.23E-03	1,510	3.89E+01	3.23E-03	1,510
I-129									
Grouted I-129									
U-233	8.49E-01	0.00E+00	>10,000	8.49E-01	0.00E+00	>10,000	8.49E-01	0.00E+00	>10,000
U-234	4.60E-01	0.00E+00	>10,000	4.60E-01	0.00E+00	>10,000	4.60E-01	0.00E+00	>10,000
U-235	1.90E-02	0.00E+00	>10,000	1.90E-02	0.00E+00	>10,000	1.90E-02	0.00E+00	>10,000
U-236	1.70E-02	0.00E+00	>10,000	1.70E-02	0.00E+00	>10,000	1.70E-02	0.00E+00	>10,000
U-238	4.10E-01	0.00E+00	>10,000	4.10E-01	0.00E+00	>10,000	4.10E-01	0.00E+00	>10,000

Table G.28. Predicted Peak Concentrations of Key Constituents Disposed of After 2007 at a 1-km Line of Analysis, Alternative Group E_1

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected Cat 1 LLW										
200 East Area										
C-14	2,000	1.28E+01	3.09E-02	10,000	1.56E+01	3.76E-02	10,000	1.59E+01	3.84E-02	10,000
Tc-99	900	1.08E+00	5.17E+00	1,320	1.32E+00	6.31E+00	1,320	1.33E+00	6.36E+00	1,320
Grouted Tc-99	900									
I-129	1	3.01E-03	1.44E-02	1,320	3.67E-03	1.75E-02	1,320	3.67E-03	1.75E-02	1,320
Grouted I-129	1									
U-233	30	3.71E-01	5.26E-03	10,000	4.52E-01	6.22E-03	10,000	4.52E-01	8.62E-03	10,000
U-234	30	6.13E-01	8.69E-03	10,000	7.47E-01	1.03E-02	10,000	9.21E-01	1.76E-02	10,000
U-235	30	1.29E-01	1.83E-03	10,000	1.57E-01	2.16E-03	10,000	1.68E-01	3.20E-03	10,000
U-236	30	1.46E-02	2.07E-04	10,000	1.78E-02	2.45E-04	10,000	1.78E-02	3.39E-04	10,000
U-238	30	1.47E+00	2.08E-02	10,000	1.79E+00	2.46E-02	10,000	2.08E+00	3.97E-02	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	30									
U-234	30									
U-235	30									
U-236	30									
U-238	30									
Projected Cat 3 LLW										
200 East Area										
C-14	2,000	4.44E-01	1.07E-03	10,000	4.62E-01	1.11E-03	10,000	1.45E+02	3.50E-01	10,000
Tc-99	900									
Grouted Tc-99	900	3.23E+03	1.35E+02	630	3.23E+03	1.35E+02	630	3.23E+03	1.35E+02	630
I-129	1	1.96E-06	9.36E-06	1,320	2.04E-06	9.75E-06	1,320	2.04E-06	9.75E-06	1,320
Grouted I-129	1	5.00E+00	6.63E-02	630	5.00E+00	6.63E-02	630	5.00E+00	6.63E-02	630
U-233	30	2.98E-01	4.23E-08	10,000	3.10E-01	4.91E-08	10,000	1.80E-01	7.32E-08	10,000
U-234	30	3.73E+02	5.31E-05	10,000	3.89E+02	6.17E-05	10,000	3.11E+02	1.27E-04	10,000
U-235	30	1.07E+01	1.51E-06	10,000	1.11E+01	1.76E-06	10,000	1.20E+01	4.88E-06	10,000
U-236	30	4.82E+01	6.85E-06	10,000	5.02E+01	7.96E-06	10,000	2.89E+01	1.18E-05	10,000
U-238	30	5.99E+02	8.51E-05	10,000	6.24E+02	9.89E-05	10,000	5.04E+02	2.05E-04	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	30									
U-234	30									
U-235	30									
U-236	30									
U-238	30									

Table G.28. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected MLLW										
200 East Area										
C-14	2,000	1.46E+00	3.41E-03	10,000	1.46E+00	3.42E-03	10,000	1.45E+00	3.40E-03	10,000
Tc-99	900	8.34E+00	6.79E+01	1,370	8.36E+00	6.80E+01	1,370	8.27E+00	6.73E+01	1,370
Grouted Tc-99	900									
I-129	1	3.50E-02	2.85E-01	1,370	3.51E-02	2.85E-01	1,370	3.48E-02	2.83E-01	1,370
Grouted I-129	1									
U-233	30	4.67E-03	2.96E-05	10,000	4.68E-03	2.97E-05	10,000	4.64E-03	7.14E-05	10,000
U-234	30	5.44E+00	3.45E-02	10,000	5.45E+00	3.45E-02	10,000	5.40E+00	8.30E-02	10,000
U-235	30	8.67E-02	5.50E-04	10,000	8.69E-02	5.51E-04	10,000	8.61E-02	1.32E-03	10,000
U-236	30	1.02E-01	6.45E-04	10,000	1.02E-01	6.46E-04	10,000	1.01E-01	1.55E-03	10,000
U-238	30	1.36E+00	8.60E-03	10,000	1.36E+00	8.62E-03	10,000	1.35E+00	2.08E-02	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	30									
U-234	30									
U-235	30									
U-236	30									
U-238	30									
Projected Grouted MLLW										
200 East Area										
C-14	2,000	2.86E+00	6.71E-03	10,000	2.87E+00	6.73E-03	10,000	4.25E+00	9.96E-03	10,000
Tc-99	900									
Grouted Tc-99	900	1.57E+02	1.10E+01	680	1.57E+02	1.11E+01	680	3.34E+02	2.35E+01	680
I-129	1									
Grouted I-129	1	6.87E-02	9.11E-04	620	6.88E-02	9.13E-04	620	7.06E-02	9.36E-04	620
U-233	30	8.91E-03	1.04E-07	10,000	8.93E-03	1.04E-07	10,000	9.20E-03	2.80E-08	10,000
U-234	30	1.07E+01	1.25E-04	10,000	1.07E+01	1.25E-04	10,000	3.35E+02	1.02E-03	10,000
U-235	30	1.70E-01	1.98E-06	10,000	1.70E-01	1.99E-06	10,000	1.47E+01	4.48E-05	10,000
U-236	30	2.00E-01	2.33E-06	10,000	2.00E-01	2.34E-06	10,000	2.05E-01	6.25E-07	10,000
U-238	30	2.64E+00	3.09E-05	10,000	2.65E+00	3.10E-05	10,000	3.42E+02	1.04E-03	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	30									
U-234	30									
U-235	30									
U-236	30									
U-238	30									

Table G.28. (contd)

		Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
Constituent	**Benchmark MCL (pCi/L)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
Projected Melter Waste										
ERDF Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900	3.89E+01	2.71E+00	1,070	3.89E+01	2.71E+00	1,070	3.89E+01	2.71E+00	1,070
I-129	1									
Grouted I-129	1									
U-233	30	8.49E-01	9.62E-04	10,000	8.49E-01	9.62E-04	10,000	8.49E-01	9.62E-04	10,000
U-234	30	4.60E-01	5.21E-04	10,000	4.60E-01	5.21E-04	10,000	4.60E-01	5.21E-04	10,000
U-235	30	1.90E-02	2.15E-05	10,000	1.90E-02	2.15E-05	10,000	1.90E-02	2.15E-05	10,000
U-236	30	1.70E-02	1.93E-05	10,000	1.70E-02	1.93E-05	10,000	1.70E-02	1.93E-05	10,000
U-238	30	4.10E-01	4.65E-04	10,000	4.10E-01	4.65E-04	10,000	4.10E-01	4.65E-04	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	30									
U-234	30									
U-235	30									
U-236	30									
U-238	30									

Table G.29. Predicted Peak Concentrations of Key Constituents Disposed of After 2007 at a Line of Analysis Near the Columbia River, Alternative Group E_1

		Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
Constituent	Benchmark MCL (pCi/L)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected Cat 1 LLW										
200 East Area										
C-14	2,000	1.28E+01	6.49E-04	10,000	1.56E+01	7.92E-04	10,000	1.59E+01	8.07E-04	10,000
Tc-99	900	1.08E+00	1.39E+00	1,530	1.32E+00	1.70E+00	1,530	1.33E+00	1.71E+00	1,530
Grouted Tc-99	900									
I-129	1	3.01E-03	3.87E-03	1,530	3.67E-03	4.71E-03	1,530	3.67E-03	4.71E-03	1,530
Grouted I-129	1									
U-233	30	3.71E-01	9.60E-05	10,000	4.52E-01	1.12E-04	10,000	4.52E-01	1.85E-04	10,000
U-234	30	6.13E-01	1.59E-04	10,000	7.47E-01	1.85E-04	10,000	9.21E-01	3.77E-04	10,000
U-235	30	1.29E-01	3.33E-05	10,000	1.57E-01	3.88E-05	10,000	1.68E-01	6.88E-05	10,000
U-236	30	1.46E-02	3.78E-06	10,000	1.78E-02	4.40E-06	10,000	1.78E-02	7.29E-06	10,000
U-238	30	1.47E+00	3.80E-04	10,000	1.79E+00	4.43E-04	10,000	2.08E+00	8.51E-04	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	30									
U-234	30									
U-235	30									
U-236	30									
U-238	30									
Projected Cat 3 LLW										
200 East Area										
C-14	2,000	4.44E-01	2.25E-05	10,000	4.62E-01	2.34E-05	10,000	1.45E+02	7.36E-03	10,000
Tc-99	900									
Grouted Tc-99	900	3.23E+03	3.18E+01	860	3.23E+03	3.18E+01	860	3.23E+03	3.18E+01	860
I-129	1	1.96E-06	2.52E-06	1,530	2.04E-06	2.62E-06	1,530	2.04E-06	2.62E-06	1,530
Grouted I-129	1	5.00E+00	1.56E-02	850	5.00E+00	1.56E-02	850	5.00E+00	1.56E-02	850
U-233	30	2.98E-01	6.92E-10	10,000	3.10E-01	8.04E-10	10,000	1.80E-01	1.20E-09	10,000
U-234	30	3.73E+02	8.68E-07	10,000	3.89E+02	1.01E-06	10,000	3.11E+02	2.07E-06	10,000
U-235	30	1.07E+01	2.48E-08	10,000	1.11E+01	2.88E-08	10,000	1.20E+01	7.98E-08	10,000
U-236	30	4.82E+01	1.12E-07	10,000	5.02E+01	1.30E-07	10,000	2.89E+01	1.92E-07	10,000
U-238	30	5.99E+02	1.39E-06	10,000	6.24E+02	1.62E-06	10,000	5.04E+02	3.35E-06	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	30									
U-234	30									
U-235	30									
U-236	30									
U-238	30									

Table G.29. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
Projected MLLW										
200 East Area										
C-14	2,000	1.46E+00	2.15E-05	10,000	1.46E+00	2.15E-05	10,000	1.45E+00	2.14E-05	10,000
Tc-99	900	8.34E+00	9.43E+00	1,590	8.36E+00	9.44E+00	1,590	8.27E+00	9.34E+00	1,590
Grouted Tc-99	900									
I-129	1	3.50E-02	3.96E-02	1,590	3.51E-02	3.97E-02	1,590	3.48E-02	3.93E-02	1,590
Grouted I-129	1									
U-233	30	4.67E-03	1.58E-07	10,000	4.68E-03	1.59E-07	10,000	4.64E-03	4.34E-07	10,000
U-234	30	5.44E+00	1.84E-04	10,000	5.45E+00	1.85E-04	10,000	5.40E+00	5.05E-04	10,000
U-235	30	8.67E-02	2.94E-06	10,000	8.69E-02	2.95E-06	10,000	8.61E-02	8.06E-06	10,000
U-236	30	1.02E-01	3.45E-06	10,000	1.02E-01	3.46E-06	10,000	1.01E-01	9.45E-06	10,000
U-238	30	1.36E+00	4.60E-05	10,000	1.36E+00	4.61E-05	10,000	1.35E+00	1.26E-04	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	30									
U-234	30									
U-235	30									
U-236	30									
U-238	30									
Projected Grouted MLLW										
200 East Area										
C-14	2,000	2.86E+00	4.22E-05	10,000	2.87E+00	4.23E-05	10,000	4.25E+00	6.26E-05	10,000
Tc-99	900									
Grouted Tc-99	900	1.57E+02	1.35E+00	940	1.57E+02	1.36E+00	940	3.34E+02	2.89E+00	940
I-129	1									
Grouted I-129	1	6.87E-02	2.14E-04	850	6.88E-02	2.14E-04	850	7.06E-02	2.20E-04	850
U-233	30	8.91E-03	5.58E-10	10,000	8.93E-03	5.58E-10	10,000	9.20E-03	1.50E-10	10,000
U-234	30	1.07E+01	6.68E-07	10,000	1.07E+01	6.69E-07	10,000	3.35E+02	5.47E-06	10,000
U-235	30	1.70E-01	1.06E-08	10,000	1.70E-01	1.06E-08	10,000	1.47E+01	2.40E-07	10,000
U-236	30	2.00E-01	1.25E-08	10,000	2.00E-01	1.25E-08	10,000	2.05E-01	3.34E-09	10,000
U-238	30	2.64E+00	1.65E-07	10,000	2.65E+00	1.66E-07	10,000	3.42E+02	5.58E-06	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	30									
U-234	30									
U-235	30									
U-236	30									
U-238	30									

Table G.29. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected Melter Waste										
ERDF Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900	3.89E+01	2.38E-01	1,420	3.89E+01	2.38E-01	1,420	3.89E+01	2.38E-01	1,420
I-129	1									
Grouted I-129	1									
U-233	30	8.49E-01	7.61E-07	10,000	8.49E-01	7.61E-07	10,000	8.49E-01	7.61E-07	10,000
U-234	30	4.60E-01	4.12E-07	10,000	4.60E-01	4.12E-07	10,000	4.60E-01	4.12E-07	10,000
U-235	30	1.90E-02	1.70E-08	10,000	1.90E-02	1.70E-08	10,000	1.90E-02	1.70E-08	10,000
U-236	30	1.70E-02	1.52E-08	10,000	1.70E-02	1.52E-08	10,000	1.70E-02	1.52E-08	10,000
U-238	30	4.10E-01	3.67E-07	10,000	4.10E-01	3.67E-07	10,000	4.10E-01	3.67E-07	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	30									
U-234	30									
U-235	30									
U-236	30									
U-238	30									

Table G.30. Predicted Peak River Flux of Key Constituents Disposed of After 2007 at a Line of Analysis to the Columbia River, Alternative Group E_1

	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
Constituent	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**
Projected Cat 1 LLW									
200 East Area									
C-14	1.28E+01	1.86E-06	10,000	1.56E+01	2.27E-06	10,000	1.59E+01	2.31E-06	10,000
Tc-99	1.08E+00	1.27E-02	1,600	1.32E+00	1.55E-02	1,600	1.33E+00	1.56E-02	1,600
Grouted Tc-99									
I-129	3.01E-03	3.53E-05	1,600	3.67E-03	4.30E-05	1,600	3.67E-03	4.30E-05	1,600
Grouted I-129									
U-233	3.71E-01	2.74E-07	10,000	4.52E-01	3.18E-07	10,000	4.52E-01	5.46E-07	10,000
U-234	6.13E-01	4.53E-07	10,000	7.47E-01	5.26E-07	10,000	9.21E-01	1.11E-06	10,000
U-235	1.29E-01	9.51E-08	10,000	1.57E-01	1.11E-07	10,000	1.68E-01	2.03E-07	10,000
U-236	1.46E-02	1.08E-08	10,000	1.78E-02	1.25E-08	10,000	1.78E-02	2.15E-08	10,000
U-238	1.47E+00	1.08E-06	10,000	1.79E+00	1.26E-06	10,000	2.08E+00	2.51E-06	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
Projected Cat 3 LLW									
200 East Area									
C-14	4.44E-01	6.44E-08	10,000	4.62E-01	6.71E-08	10,000	1.45E+02	2.11E-05	10,000
Tc-99									
Grouted Tc-99	3.23E+03	2.99E-01	970	3.23E+03	2.99E-01	970	3.23E+03	2.99E-01	970
I-129	1.96E-06	2.29E-08	1,600	2.04E-06	2.39E-08	1,600	2.04E-06	2.39E-08	1,600
Grouted I-129	5.00E+00	1.46E-04	970	5.00E+00	1.46E-04	970	5.00E+00	1.46E-04	970
U-233	2.98E-01	1.96E-12	10,000	3.10E-01	2.28E-12	10,000	1.80E-01	3.40E-12	10,000
U-234	3.73E+02	2.46E-09	10,000	3.89E+02	2.86E-09	10,000	3.11E+02	5.87E-09	10,000
U-235	1.07E+01	7.02E-11	10,000	1.11E+01	8.16E-11	10,000	1.20E+01	2.26E-10	10,000
U-236	4.82E+01	3.18E-10	10,000	5.02E+01	3.69E-10	10,000	2.89E+01	5.45E-10	10,000
U-238	5.99E+02	3.95E-09	10,000	6.24E+02	4.59E-09	10,000	5.04E+02	9.51E-09	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									

Table G.30. (contd)

Constituent	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
	Inventory (Ci)	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**
Projected MLLW									
200 East Area									
C-14	1.46E+00	1.25E-07	10,000	1.46E+00	1.25E-07	10,000	1.45E+00	1.25E-07	10,000
Tc-99	8.34E+00	9.43E-02	1,630	8.36E+00	9.45E-02	1,630	8.27E+00	9.35E-02	1,630
Grouted Tc-99									
I-129	3.50E-02	3.96E-04	1,630	3.51E-02	3.97E-04	1,630	3.48E-02	3.93E-04	1,630
Grouted I-129									
U-233	4.67E-03	9.32E-10	10,000	4.68E-03	9.34E-10	10,000	4.64E-03	2.56E-09	10,000
U-234	5.44E+00	1.09E-06	10,000	5.45E+00	1.09E-06	10,000	5.40E+00	2.98E-06	10,000
U-235	8.67E-02	1.73E-08	10,000	8.69E-02	1.73E-08	10,000	8.61E-02	4.75E-08	10,000
U-236	1.02E-01	2.03E-08	10,000	1.02E-01	2.04E-08	10,000	1.01E-01	5.57E-08	10,000
U-238	1.36E+00	2.71E-07	10,000	1.36E+00	2.71E-07	10,000	1.35E+00	7.44E-07	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
Projected Grouted MLLW									
200 East Area									
C-14	2.86E+00	2.46E-07	10,000	2.87E+00	2.47E-07	10,000	4.25E+00	3.65E-07	10,000
Tc-99									
Grouted Tc-99	1.57E+02	1.28E-02	970	1.57E+02	1.45E-02	970	3.34E+02	3.09E-02	970
I-129									
Grouted I-129	6.87E-02	2.01E-06	970	6.88E-02	2.01E-06	970	7.06E-02	2.06E-06	970
U-233	8.91E-03	3.28E-12	10,000	8.93E-03	3.29E-12	10,000	9.20E-03	8.83E-13	10,000
U-234	1.07E+01	3.93E-09	10,000	1.07E+01	3.94E-09	10,000	3.35E+02	3.22E-08	10,000
U-235	1.70E-01	6.25E-11	10,000	1.70E-01	6.26E-11	10,000	1.47E+01	1.41E-09	10,000
U-236	2.00E-01	7.35E-11	10,000	2.00E-01	7.36E-11	10,000	2.05E-01	1.97E-11	10,000
U-238	2.64E+00	9.74E-10	10,000	2.65E+00	9.75E-10	10,000	3.42E+02	3.28E-08	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									

Table G.30. (contd)

Constituent	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)
Projected Melter Waste									
ERDF Area									
C-14									
Tc-99									
Grouted Tc-99	3.89E+01	3.23E-03	1,510	3.89E+01	3.23E-03	1,510	3.89E+01	3.23E-03	1,510
I-129									
Grouted I-129									
U-233	8.49E-01	4.92E-09	10,000	8.49E-01	4.92E-09	10,000	8.49E-01	4.92E-09	10,000
U-234	4.60E-01	2.67E-09	10,000	4.60E-01	2.67E-09	10,000	4.60E-01	2.67E-09	10,000
U-235	1.90E-02	1.10E-10	10,000	1.90E-02	1.10E-10	10,000	1.90E-02	1.10E-10	10,000
U-236	1.70E-02	9.86E-11	10,000	1.70E-02	9.86E-11	10,000	1.70E-02	9.86E-11	10,000
U-238	4.10E-01	2.38E-09	10,000	4.10E-01	2.38E-09	10,000	4.10E-01	2.38E-09	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									

Table G.31. Predicted Peak Concentrations of Key Constituents Disposed of After 2007 at a 1-km Line of Analysis, Alternative Group E_2

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concencration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected Cat 1 LLW										
200 East Area										
C-14	2,000	1.28E+01	2.01E-02	10,000	1.56E+01	2.45E-02	10,000	1.59E+01	2.50E-02	10,000
Tc-99	900	1.08E+00	6.39E+00	1,380	1.32E+00	7.80E+00	1,380	1.33E+00	7.86E+00	1,380
Grouted Tc-99	900									
I-129	1	3.01E-03	1.78E-02	1,380	3.67E-03	2.17E-02	1,380	3.67E-03	2.17E-02	1,380
Grouted I-129	1									
U-233	30	3.71E-01	3.29E-03	10,000	4.52E-01	3.88E-03	10,000	4.52E-01	5.61E-03	10,000
U-234	30	6.13E-01	5.44E-03	10,000	7.47E-01	6.41E-03	10,000	9.21E-01	1.14E-02	10,000
U-235	30	1.29E-01	1.14E-03	10,000	1.57E-01	1.35E-03	10,000	1.68E-01	2.08E-03	10,000
U-236	30	1.46E-02	1.30E-04	10,000	1.78E-02	1.53E-04	10,000	1.78E-02	2.21E-04	10,000
U-238	30	1.47E+00	1.30E-02	10,000	1.79E+00	1.54E-02	10,000	2.08E+00	2.58E-02	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	30									
U-234	30									
U-235	30									
U-236	30									
U-238	30									
Projected Cat 3 LLW										
200 East Area										
C-14	2,000	4.44E-01	6.97E-04	10,000	4.62E-01	7.26E-04	10,000	1.45E+02	2.28E-01	10,000
Tc-99	900									
Grouted Tc-99	900	3.23E+03	1.55E+02	680	3.23E+03	1.55E+02	680	3.23E+03	1.55E+02	680
I-129	1	1.96E-06	1.16E-05	1,380	2.04E-06	1.21E-05	1,380	2.04E-06	1.21E-05	1,380
Grouted I-129	1	5.00E+00	7.61E-02	680	5.00E+00	7.61E-02	680	5.00E+00	7.61E-02	680
U-233	30	2.98E-01	2.56E-08	10,000	3.10E-01	2.97E-08	10,000	1.80E-01	4.43E-08	10,000
U-234	30	3.73E+02	3.21E-05	10,000	3.89E+02	3.73E-05	10,000	3.11E+02	7.65E-05	10,000
U-235	30	1.07E+01	9.16E-07	10,000	1.11E+01	1.06E-06	10,000	1.20E+01	2.95E-06	10,000
U-236	30	4.82E+01	4.14E-06	10,000	5.02E+01	4.81E-06	10,000	2.89E+01	7.11E-06	10,000
U-238	30	5.99E+02	5.15E-05	10,000	6.24E+02	5.98E-05	10,000	5.04E+02	1.24E-04	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	30									
U-234	30									
U-235	30									
U-236	30									
U-238	30									

Table G.31. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concencration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected MLLW										
200 East Area										
C-14	2,000	1.46E+00	2.29E-03	10,000	1.46E+00	2.29E-03	10,000	1.45E+00	2.28E-03	10,000
Tc-99	900	8.34E+00	4.93E+01	1,380	8.36E+00	4.94E+01	1,380	8.27E+00	4.89E+01	1,380
Grouted Tc-99	900									
I-129	1	3.50E-02	2.07E-01	1,380	3.51E-02	2.07E-01	1,380	3.48E-02	2.06E-01	1,380
Grouted I-129	1									
U-233	30	4.67E-03	2.04E-05	10,000	4.68E-03	2.05E-05	10,000	4.64E-03	4.83E-05	10,000
U-234	30	5.44E+00	2.38E-02	10,000	5.45E+00	2.38E-02	10,000	5.40E+00	5.62E-02	10,000
U-235	30	8.67E-02	3.79E-04	10,000	8.69E-02	3.80E-04	10,000	8.61E-02	8.96E-04	10,000
U-236	30	1.02E-01	4.45E-04	10,000	1.02E-01	4.46E-04	10,000	1.01E-01	1.05E-03	10,000
U-238	30	1.36E+00	5.94E-03	10,000	1.36E+00	5.95E-03	10,000	1.35E+00	1.41E-02	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	30									
U-234	30									
U-235	30									
U-236	30									
U-238	30									
Projected Grouted MLLW										
200 East Area										
C-14	2,000	2.86E+00	4.50E-03	10,000	2.87E+00	4.51E-03	10,000	4.25E+00	6.68E-03	10,000
Tc-99	900									
Grouted Tc-99	900	1.57E+02	7.54E+00	680	1.57E+02	7.55E+00	680	3.34E+02	1.61E+01	680
I-129	1									
Grouted I-129	1	6.87E-02	9.11E-04	620	6.88E-02	9.13E-04	620	7.06E-02	9.36E-04	620
U-233	30	8.91E-03	7.19E-08	10,000	8.93E-03	7.20E-08	10,000	9.20E-03	1.94E-08	10,000
U-234	30	1.07E+01	8.61E-05	10,000	1.07E+01	8.63E-05	10,000	3.35E+02	7.05E-04	10,000
U-235	30	1.70E-01	1.37E-06	10,000	1.70E-01	1.37E-06	10,000	1.47E+01	3.09E-05	10,000
U-236	30	2.00E-01	1.61E-06	10,000	2.00E-01	1.61E-06	10,000	2.05E-01	4.31E-07	10,000
U-238	30	2.64E+00	2.13E-05	10,000	2.65E+00	2.14E-05	10,000	3.42E+02	7.19E-04	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	30									
U-234	30									
U-235	30									
U-236	30									
U-238	30									

Table G.31. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concencration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected Melter Waste										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	30									
U-234	30									
U-235	30									
U-236	30									
U-238	30									
ERDF Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900	3.89E+01	2.71E+00	1,070	3.89E+01	2.71E+00	1,070	3.89E+01	2.71E+00	1,070
I-129	1									
Grouted I-129	1									
U-233	30	8.49E-01	9.62E-04	10,000	8.49E-01	9.62E-04	10,000	8.49E-01	9.62E-04	10,000
U-234	30	4.60E-01	5.21E-04	10,000	4.60E-01	5.21E-04	10,000	4.60E-01	5.21E-04	10,000
U-235	30	1.90E-02	2.15E-05	10,000	1.90E-02	2.15E-05	10,000	1.90E-02	2.15E-05	10,000
U-236	30	1.70E-02	1.93E-05	10,000	1.70E-02	1.93E-05	10,000	1.70E-02	1.93E-05	10,000
U-238	30	4.10E-01	4.65E-04	10,000	4.10E-01	4.65E-04	10,000	4.10E-01	4.65E-04	10,000

Table G.32. Predicted Peak Concentrations of Key Constituents Disposed of After 2007 at a Line of Analysis Near the Columbia River, Alternative Group E_2

		Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
Constituent	**Benchmark MCL (pCi/L)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
Projected Cat 1 LLW										
200 East Area										
C-14	2,000	1.28E+01	2.96E-04	10,000	1.56E+01	3.61E-04	10,000	1.59E+01	3.68E-04	10,000
Tc-99	900	1.08E+00	7.36E-01	1,510	1.32E+00	8.97E-01	1,510	1.33E+00	9.04E-01	1,510
Grouted Tc-99	900									
I-129	1	3.01E-03	2.05E-03	1,510	3.67E-03	2.50E-03	1,510	3.67E-03	2.50E-03	1,510
Grouted I-129	1									
U-233	30	3.71E-01	4.40E-05	10,000	4.52E-01	5.12E-05	10,000	4.52E-01	8.41E-05	10,000
U-234	30	6.13E-01	7.27E-05	10,000	7.47E-01	8.47E-05	10,000	9.21E-01	1.71E-04	10,000
U-235	30	1.29E-01	1.53E-05	10,000	1.57E-01	1.78E-05	10,000	1.68E-01	3.13E-05	10,000
U-236	30	1.46E-02	1.73E-06	10,000	1.78E-02	2.02E-06	10,000	1.78E-02	3.31E-06	10,000
U-238	30	1.47E+00	1.74E-04	10,000	1.79E+00	2.03E-04	10,000	2.08E+00	3.87E-04	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	30									
U-234	30									
U-235	30									
U-236	30									
U-238	30									
Projected Cat 3 LLW										
200 East Area										
C-14	2,000	4.44E-01	1.03E-05	10,000	4.62E-01	1.07E-05	10,000	1.45E+02	3.35E-03	10,000
Tc-99	900									
Grouted Tc-99	900	3.23E+03	1.69E+01	820	3.23E+03	1.69E+01	820	3.23E+03	1.69E+01	820
I-129	1	1.96E-06	1.33E-06	1,510	2.04E-06	1.39E-06	1,510	2.04E-06	1.39E-06	1,510
Grouted I-129	1	5.00E+00	0.00E+00	820	5.00E+00	8.26E-03	820	5.00E+00	0.00E+00	820
U-233	30	2.98E-01	2.56E-08	10,000	3.10E-01	2.97E-08	10,000	1.80E-01	4.43E-08	10,000
U-234	30	3.73E+02	3.21E-05	10,000	3.89E+02	3.73E-05	10,000	3.11E+02	7.65E-05	10,000
U-235	30	1.07E+01	9.16E-07	10,000	1.11E+01	1.06E-06	10,000	1.20E+01	2.95E-06	10,000
U-236	30	4.82E+01	4.14E-06	10,000	5.02E+01	4.81E-06	10,000	2.89E+01	7.11E-06	10,000
U-238	30	5.99E+02	5.15E-05	10,000	6.24E+02	5.98E-05	10,000	5.04E+02	1.24E-04	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	30									
U-234	30									
U-235	30									
U-236	30									
U-238	30									

Table G.32. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected MLLW										
200 East Area										
C-14	2,000	1.46E+00	3.37E-05	10,000	1.46E+00	3.38E-05	10,000	1.45E+00	3.35E-05	10,000
Tc-99	900	8.34E+00	5.67E+00	1,510	8.36E+00	5.68E+00	1,510	8.27E+00	5.62E+00	1,510
Grouted Tc-99	900									
I-129	1	3.50E-02	2.38E-02	1,510	3.51E-02	2.39E-02	1,510	3.48E-02	2.37E-02	1,510
Grouted I-129	1									
U-233	30	4.67E-03	2.53E-07	10,000	4.68E-03	2.54E-07	10,000	4.64E-03	6.77E-07	10,000
U-234	30	5.44E+00	2.95E-04	10,000	5.45E+00	2.96E-04	10,000	5.40E+00	7.88E-04	10,000
U-235	30	8.67E-02	4.70E-06	10,000	8.69E-02	4.71E-06	10,000	8.61E-02	1.26E-05	10,000
U-236	30	1.02E-01	5.52E-06	10,000	1.02E-01	5.53E-06	10,000	1.01E-01	1.47E-05	10,000
U-238	30	1.36E+00	7.36E-05	10,000	1.36E+00	7.37E-05	10,000	1.35E+00	1.97E-04	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	30									
U-234	30									
U-235	30									
U-236	30									
U-238	30									
Projected Grouted MLLW										
200 East Area										
C-14	2,000	2.86E+00	6.62E-05	10,000	2.87E+00	6.64E-05	10,000	4.25E+00	9.83E-05	10,000
Tc-99	900									
Grouted Tc-99	900	1.57E+02	8.19E-01	820	1.57E+02	8.21E-01	820	3.34E+02	1.75E+00	820
I-129	1									
Grouted I-129	1	6.87E-02	1.13E-04	820	6.88E-02	1.14E-04	820	7.06E-02	1.17E-04	820
U-233	30	8.91E-03	8.91E-10	10,000	8.93E-03	8.93E-10	10,000	9.20E-03	2.40E-10	10,000
U-234	30	1.07E+01	1.07E-06	10,000	1.07E+01	1.07E-06	10,000	3.35E+02	8.74E-06	10,000
U-235	30	1.70E-01	1.70E-08	10,000	1.70E-01	1.70E-08	10,000	1.47E+01	3.83E-07	10,000
U-236	30	2.00E-01	2.00E-08	10,000	2.00E-01	2.00E-08	10,000	2.05E-01	5.35E-09	10,000
U-238	30	2.64E+00	2.64E-07	10,000	2.65E+00	2.65E-07	10,000	3.42E+02	8.92E-06	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	30									
U-234	30									
U-235	30									
U-236	30									
U-238	30									

Table G.32. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected Melter Waste										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	30									
U-234	30									
U-235	30									
U-236	30									
U-238	30									
ERDF Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900	3.89E+01	2.38E-01	1,420	3.89E+01	2.38E-01	1,420	3.89E+01	2.38E-01	1,420
I-129	1									
Grouted I-129	1									
U-233	30	8.49E-01	0.00E+00	>10,000	8.49E-01	0.00E+00	>10,000	8.49E-01	0.00E+00	>10,000
U-234	30	4.60E-01	0.00E+00	>10,000	4.60E-01	0.00E+00	>10,000	4.60E-01	0.00E+00	>10,000
U-235	30	1.90E-02	0.00E+00	>10,000	1.90E-02	0.00E+00	>10,000	1.90E-02	0.00E+00	>10,000
U-236	30	1.70E-02	0.00E+00	>10,000	1.70E-02	0.00E+00	>10,000	1.70E-02	0.00E+00	>10,000
U-238	30	4.10E-01	0.00E+00	>10,000	4.10E-01	0.00E+00	>10,000	4.10E-01	0.00E+00	>10,000

Table G.33. Predicted Peak River Flux of Key Constituents Disposed of After 2007 at a Line of Analysis to the Columbia River, Alternative Group E_2

	Hanford Only Volume			**Lower Bound Volume**			**Upper Bound Volume**		
Constituent	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**
Projected Cat 1 LLW									
200 East Area									
C-14	1.28E+01	3.60E-06	10,000	1.56E+01	4.39E-06	10,000	1.59E+01	4.48E-06	10,000
Tc-99	1.08E+00	1.15E-02	1,530	1.32E+00	1.40E-02	1,530	1.33E+00	1.41E-02	1,530
Grouted Tc-99									
I-129	3.01E-03	3.19E-05	1,530	3.67E-03	3.89E-05	1,530	3.67E-03	3.89E-05	1,530
Grouted I-129									
U-233	3.71E-01	5.34E-07	10,000	4.52E-01	6.22E-07	10,000	4.52E-01	1.03E-06	10,000
U-234	6.13E-01	8.83E-07	10,000	7.47E-01	1.03E-06	10,000	9.21E-01	2.10E-06	10,000
U-235	1.29E-01	1.86E-07	10,000	1.57E-01	2.16E-07	10,000	1.68E-01	3.84E-07	10,000
U-236	1.46E-02	2.10E-08	10,000	1.78E-02	2.45E-08	10,000	1.78E-02	4.06E-08	10,000
U-238	1.47E+00	2.12E-06	10,000	1.79E+00	2.46E-06	10,000	2.08E+00	4.75E-06	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
Projected Cat 3 LLW									
200 East Area									
C-14	4.44E-01	1.25E-07	10,000	4.62E-01	1.30E-07	10,000	1.45E+02	4.08E-05	10,000
Tc-99									
Grouted Tc-99	3.23E+03	2.65E-01	870	3.23E+03	2.65E-01	870	3.23E+03	2.65E-01	870
I-129	1.96E-06	2.07E-08	1,530	2.04E-06	2.16E-08	1,530	2.04E-06	2.16E-08	1,530
Grouted I-129	5.00E+00	0.00E+00	870	5.00E+00	1.30E-04	870	5.00E+00	0.00E+00	870
U-233	2.98E-01	3.85E-12	10,000	3.10E-01	4.47E-12	10,000	1.80E-01	6.66E-12	10,000
U-234	3.73E+02	4.83E-09	10,000	3.89E+02	5.61E-09	10,000	3.11E+02	1.15E-08	10,000
U-235	1.07E+01	1.38E-10	10,000	1.11E+01	1.60E-10	10,000	1.20E+01	4.44E-10	10,000
U-236	4.82E+01	6.23E-10	10,000	5.02E+01	7.24E-10	10,000	2.89E+01	1.07E-09	10,000
U-238	5.99E+02	7.74E-09	10,000	6.24E+02	9.00E-09	10,000	5.04E+02	1.86E-08	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									

Table G.33. (contd)

	Hanford Only Volume			**Lower Bound Volume**			**Upper Bound Volume**		
Constituent	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**
Projected MLLW									
200 East Area									
C-14	1.46E+00	4.10E-07	10,000	1.46E+00	4.11E-07	10,000	1.45E+00	4.08E-07	10,000
Tc-99	8.34E+00	8.84E-02	1,530	8.36E+00	8.85E-02	1,530	8.27E+00	8.76E-02	1,530
Grouted Tc-99									
I-129	3.50E-02	3.71E-04	1,530	3.51E-02	3.72E-04	1,530	3.48E-02	3.69E-04	1,530
Grouted I-129									
U-233	4.67E-03	3.07E-09	10,000	4.68E-03	3.08E-09	10,000	4.64E-03	8.26E-09	10,000
U-234	5.44E+00	3.58E-06	10,000	5.45E+00	3.59E-06	10,000	5.40E+00	9.61E-06	10,000
U-235	8.67E-02	5.71E-08	10,000	8.69E-02	5.72E-08	10,000	8.61E-02	1.53E-07	10,000
U-236	1.02E-01	6.70E-08	10,000	1.02E-01	6.71E-08	10,000	1.01E-01	1.80E-07	10,000
U-238	1.36E+00	8.93E-07	10,000	1.36E+00	8.95E-07	10,000	1.35E+00	2.40E-06	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
Projected Grouted MLLW									
200 East Area									
C-14	2.86E+00	8.07E-07	10,000	2.87E+00	8.08E-07	10,000	4.25E+00	1.20E-06	10,000
Tc-99									
Grouted Tc-99	1.57E+02	1.28E-02	870	1.57E+02	1.29E-02	870	3.34E+02	2.74E-02	870
I-129									
Grouted I-129	6.87E-02	1.78E-06	870	6.88E-02	1.78E-06	870	7.06E-02	1.83E-06	870
U-233	8.91E-03	1.08E-11	10,000	8.93E-03	1.08E-11	10,000	9.20E-03	2.91E-12	10,000
U-234	1.07E+01	1.30E-08	10,000	1.07E+01	1.30E-08	10,000	3.35E+02	1.06E-07	10,000
U-235	1.70E-01	2.06E-10	10,000	1.70E-01	2.06E-10	10,000	1.47E+01	4.65E-09	10,000
U-236	2.00E-01	2.42E-10	10,000	2.00E-01	2.43E-10	10,000	2.05E-01	6.49E-11	10,000
U-238	2.64E+00	3.21E-09	10,000	2.65E+00	3.21E-09	10,000	3.42E+02	1.08E-07	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									

Table G.33. (contd)

Constituent	**Hanford Only Volume**			**Lower Bound Volume**			**Upper Bound Volume**		
	Inventory (Ci)	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**
Projected Melter Waste									
200 East Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
ERDF Area									
C-14									
Tc-99									
Grouted Tc-99	3.89E+01	3.23E-03	1,510	3.89E+01	3.23E-03	1,510	3.89E+01	3.23E-03	1,510
I-129									
Grouted I-129									
U-233	8.49E-01	0.00E+00	>10,000	8.49E-01	0.00E+00	>10,000	8.49E-01	0.00E+00	>10,000
U-234	4.60E-01	0.00E+00	>10,000	4.60E-01	0.00E+00	>10,000	4.60E-01	0.00E+00	>10,000
U-235	1.90E-02	0.00E+00	>10,000	1.90E-02	0.00E+00	>10,000	1.90E-02	0.00E+00	>10,000
U-236	1.70E-02	0.00E+00	>10,000	1.70E-02	0.00E+00	>10,000	1.70E-02	0.00E+00	>10,000
U-238	4.10E-01	0.00E+00	>10,000	4.10E-01	0.00E+00	>10,000	4.10E-01	0.00E+00	>10,000

Table G.34. Predicted Peak Concentrations of Key Constituents Disposed of After 2007 at a 1-km Line of Analysis, Alternative Group E_3

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected Cat 1 LLW										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
ERDF Area										
C-14	2,000	1.28E+01	1.58E-02	>10,000	1.56E+01	1.92E-02	>10,000	1.59E+01	1.96E-02	>10,000
Tc-99	900	1.08E+00	9.31E+00	1,740	1.32E+00	1.14E+01	1,740	1.33E+00	1.14E+01	1,740
Grouted Tc-99	900									
I-129	1	3.01E-03	2.59E-02	1,740	3.67E-03	3.16E-02	1,740	3.67E-03	3.16E-02	1,740
Grouted I-129	1									
U-233	(a)	3.71E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000
U-234	(a)	6.13E-01	0.00E+00	>10,000	7.47E-01	0.00E+00	>10,000	9.21E-01	0.00E+00	>10,000
U-235	(a)	1.29E-01	0.00E+00	>10,000	1.57E-01	0.00E+00	>10,000	1.68E-01	0.00E+00	>10,000
U-236	(a)	1.46E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000
U-238	(a)	1.47E+00	0.00E+00	>10,000	1.79E+00	0.00E+00	>10,000	2.08E+00	0.00E+00	>10,000
Projected Cat 3 LLW										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
ERDF Area										
C-14	2,000	4.44E-01	5.47E-04	10,000	4.62E-01	5.69E-04	10,000	1.45E+02	1.79E-01	10,000
Tc-99	900									
Grouted Tc-99	900	3.23E+03	2.25E+02	1,070	3.23E+03	2.25E+02	1,070	3.23E+03	2.25E+02	1,070
I-129	1	1.96E-06	1.69E-05	1,740	2.04E-06	1.76E-05	1,740	2.04E-06	1.76E-05	1,740
Grouted I-129	1	5.00E+00	1.10E-01	1,070	5.00E+00	1.10E-01	1,070	5.00E+00	1.10E-01	1,070
U-233	(a)	2.98E-01	0.00E+00	>10,000	3.10E-01	0.00E+00	>10,000	1.80E-01	0.00E+00	>10,000
U-234	(a)	3.73E+02	0.00E+00	>10,000	3.89E+02	0.00E+00	>10,000	3.11E+02	0.00E+00	>10,000
U-235	(a)	1.07E+01	0.00E+00	>10,000	1.11E+01	0.00E+00	>10,000	1.20E+01	0.00E+00	>10,000

Table G.34. (contd)

		Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
Constituent	**Benchmark MCL (pCi/L)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
U-236	(a)	4.82E+01	0.00E+00	>10,000	5.02E+01	0.00E+00	>10,000	2.89E+01	0.00E+00	>10,000
U-238	(a)	5.99E+02	0.00E+00	>10,000	6.24E+02	0.00E+00	>10,000	5.04E+02	0.00E+00	>10,000
Projected MLLW										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
ERDF Area										
C-14	2,000	1.46E+00	1.80E-03	10,000	1.46E+00	1.80E-03	10,000	1.45E+00	1.79E-03	10,000
Tc-99	900	8.34E+00	7.18E+01	1,740	8.36E+00	7.19E+01	1,740	8.27E+00	7.12E+01	1,740
Grouted Tc-99	900									
I-129	1	3.50E-02	3.01E-01	1,740	3.51E-02	3.02E-01	1,740	3.48E-02	2.99E-01	1,740
Grouted I-129	1									
U-233	(a)	4.67E-03	0.00E+00	>10,000	4.68E-03	0.00E+00	>10,000	4.64E-03	0.00E+00	>10,000
U-234	(a)	5.44E+00	0.00E+00	>10,000	5.45E+00	0.00E+00	>10,000	5.40E+00	0.00E+00	>10,000
U-235	(a)	8.67E-02	0.00E+00	>10,000	8.69E-02	0.00E+00	>10,000	8.61E-02	0.00E+00	>10,000
U-236	(a)	1.02E-01	0.00E+00	>10,000	1.02E-01	0.00E+00	>10,000	1.01E-01	0.00E+00	>10,000
U-238	(a)	1.36E+00	0.00E+00	>10,000	1.36E+00	0.00E+00	>10,000	1.35E+00	0.00E+00	>10,000
Projected Grouted MLLW										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
ERDF Area										
C-14	2,000	2.86E+00	3.53E-03	10,000	2.87E+00	3.54E-03	10,000	4.25E+00	5.24E-03	10,000
Tc-99	900									
Grouted Tc-99	900	1.57E+02	1.09E+01	1,070	1.57E+02	1.09E+01	1,070	3.34E+02	2.33E+01	1,070
I-129	1									
Grouted I-129	1	6.87E-02	1.51E-03	1,070	6.88E-02	1.52E-03	1,070	7.06E-02	1.56E-03	1,070
U-233	(a)	8.91E-03	0.00E+00	>10,000	8.93E-03	0.00E+00	>10,000	9.20E-03	0.00E+00	>10,000
U-234	(a)	1.07E+01	0.00E+00	>10,000	1.07E+01	0.00E+00	>10,000	3.35E+02	0.00E+00	>10,000
U-235	(a)	1.70E-01	0.00E+00	>10,000	1.70E-01	0.00E+00	>10,000	1.47E+01	0.00E+00	>10,000

Table G.34. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
U-236	(a)	2.00E-01	0.00E+00	>10,000	2.00E-01	0.00E+00	>10,000	2.05E-01	0.00E+00	>10,000
U-238	(a)	2.64E+00	0.00E+00	>10,000	2.65E+00	0.00E+00	>10,000	3.42E+02	0.00E+00	>10,000
Projected Melter Waste										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900	3.89E+01	1.87E+00	680	3.89E+01	1.87E+00	680	3.89E+01	1.87E+00	680
I-129	1									
Grouted I-129	1									
U-233	(a)	8.49E-01	1.26E-03	10,000	8.49E-01	1.26E-03	10,000	8.49E-01	1.26E-03	10,000
U-234	(a)	4.60E-01	6.82E-04	10,000	4.60E-01	6.82E-04	10,000	4.60E-01	6.82E-04	10,000
U-235	(a)	1.90E-02	2.82E-05	10,000	1.90E-02	2.82E-05	10,000	1.90E-02	2.82E-05	10,000
U-236	(a)	1.70E-02	2.52E-05	10,000	1.70E-02	2.52E-05	10,000	1.70E-02	2.52E-05	10,000
U-238	(a)	4.10E-01	6.08E-04	10,000	4.10E-01	6.08E-04	10,000	4.10E-01	6.08E-04	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									

(a) The benchmark MCL for uranium is 30 µg/L expressed as total uranium. To convert isotope specific concentrations from pCi/L to µg/L, use following conversion factors:

- Uranium-233 - 1.05E-04
- Uranium-234 - 1.62E-04
- Uranium-235 - 4.66E-01
- Uranium-236 - 1.58E-02
- Uranium-238 - 3.00E+00.

Table G.35. Predicted Peak Concentrations of Key Constituents Disposed of After 2007 at a Line of Analysis Near the Columbia River, Alternative Group E_3

		Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
Constituent	**Benchmark MCL (pCi/L)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
Projected Cat 1 LLW										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
ERDF Area										
C-14	2,000	1.28E+01	1.38E-05	10,000	1.56E+01	1.69E-05	10,000	1.59E+01	1.72E-05	10,000
Tc-99	900	1.08E+00	8.62E-01	1,660	1.32E+00	1.05E+00	1,660	1.33E+00	1.06E+00	1,660
Grouted Tc-99	900									
I-129	1	3.01E-03	2.40E-03	1,660	3.67E-03	2.92E-03	1,660	3.67E-03	2.92E-03	1,660
Grouted I-129	1									
U-233	(a)	3.71E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000
U-234	(a)	6.13E-01	0.00E+00	>10,000	7.47E-01	0.00E+00	>10,000	9.21E-01	0.00E+00	>10,000
U-235	(a)	1.29E-01	0.00E+00	>10,000	1.57E-01	0.00E+00	>10,000	1.68E-01	0.00E+00	>10,000
U-236	(a)	1.46E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000
U-238	(a)	1.47E+00	0.00E+00	>10,000	1.79E+00	0.00E+00	>10,000	2.08E+00	0.00E+00	>10,000
Projected Cat 3 LLW										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
ERDF Area										
C-14	2,000	4.44E-01	4.80E-07	10,000	4.62E-01	5.00E-07	10,000	1.45E+02	1.57E-04	10,000
Tc-99	900									
Grouted Tc-99	900	3.23E+03	1.97E+01	1,420	3.23E+03	1.97E+01	1,420	3.23E+03	1.97E+01	1,420
I-129	1	1.96E-06	1.56E-06	1,660	2.04E-06	1.62E-06	1,660	2.04E-06	1.62E-06	1,660
Grouted I-129	1	5.00E+00	1.01E-02	1,700	5.00E+00	1.01E-02	1,700	5.00E+00	1.01E-02	1,700
U-233	(a)	2.98E-01	0.00E+00	>10,000	3.10E-01	0.00E+00	>10,000	1.80E-01	0.00E+00	>10,000
U-234	(a)	3.73E+02	0.00E+00	>10,000	3.89E+02	0.00E+00	>10,000	3.11E+02	0.00E+00	>10,000
U-235	(a)	1.07E+01	0.00E+00	>10,000	1.11E+01	0.00E+00	>10,000	1.20E+01	0.00E+00	>10,000
U-236	(a)	4.82E+01	0.00E+00	>10,000	5.02E+01	0.00E+00	>10,000	2.89E+01	0.00E+00	>10,000
U-238	(a)	5.99E+02	0.00E+00	>10,000	6.24E+02	0.00E+00	>10,000	5.04E+02	0.00E+00	>10,000

Table G.35. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected MLLW										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
ERDF Area										
C-14	2,000	1.46E+00	1.58E-06	10,000	1.46E+00	1.58E-06	10,000	1.45E+00	1.57E-06	10,000
Tc-99	900	8.34E+00	6.64E+00	1,660	8.36E+00	6.65E+00	1,660	8.27E+00	6.58E+00	1,660
Grouted Tc-99	900									
I-129	1	3.50E-02	2.79E-02	1,660	3.51E-02	2.79E-02	1,660	3.48E-02	2.77E-02	1,660
Grouted I-129	1									
U-233	(a)	4.67E-03	0.00E+00	>10,000	4.68E-03	0.00E+00	>10,000	4.64E-03	0.00E+00	>10,000
U-234	(a)	5.44E+00	0.00E+00	>10,000	5.45E+00	0.00E+00	>10,000	5.40E+00	0.00E+00	>10,000
U-235	(a)	8.67E-02	0.00E+00	>10,000	8.69E-02	0.00E+00	>10,000	8.61E-02	0.00E+00	>10,000
U-236	(a)	1.02E-01	0.00E+00	>10,000	1.02E-01	0.00E+00	>10,000	1.01E-01	0.00E+00	>10,000
U-238	(a)	1.36E+00	0.00E+00	>10,000	1.36E+00	0.00E+00	>10,000	1.35E+00	0.00E+00	>10,000
Projected Grouted MLLW										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									
ERDF Area										
C-14	2,000	2.86E+00	3.10E-06	10,000	2.87E+00	3.10E-06	10,000	4.25E+00	4.60E-06	10,000
Tc-99	900									
Grouted Tc-99	900	1.57E+02	9.56E-01	1,420	1.57E+02	9.58E-01	1,420	3.34E+02	2.04E+00	1,420
I-129	1									
Grouted I-129	1	6.87E-02	1.33E-04	1,420	6.88E-02	1.33E-04	1,420	7.06E-02	1.36E-04	1,420
U-233	(a)	8.91E-03	0.00E+00	>10,000	8.93E-03	0.00E+00	>10,000	9.20E-03	0.00E+00	>10,000
U-234	(a)	1.07E+01	0.00E+00	>10,000	1.07E+01	0.00E+00	>10,000	3.35E+02	0.00E+00	>10,000
U-235	(a)	1.70E-01	0.00E+00	>10,000	1.70E-01	0.00E+00	>10,000	1.47E+01	0.00E+00	>10,000
U-236	(a)	2.00E-01	0.00E+00	>10,000	2.00E-01	0.00E+00	>10,000	2.05E-01	0.00E+00	>10,000
U-238	(a)	2.64E+00	0.00E+00	>10,000	2.65E+00	0.00E+00	>10,000	3.42E+02	0.00E+00	>10,000

Table G.35. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected Melter Waste										
200 East Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900	3.89E+01	2.03E-01	820	3.89E+01	2.03E-01	820	3.89E+01	2.03E-01	820
I-129	1									
Grouted I-129	1									
U-233	(a)	8.49E-01	7.61E-07	10,000	8.49E-01	7.61E-07	10,000	8.49E-01	7.61E-07	10,000
U-234	(a)	4.60E-01	4.12E-07	10,000	4.60E-01	4.12E-07	10,000	4.60E-01	4.12E-07	10,000
U-235	(a)	1.90E-02	1.70E-08	10,000	1.90E-02	1.70E-08	10,000	1.90E-02	1.70E-08	10,000
U-236	(a)	1.70E-02	1.52E-08	10,000	1.70E-02	1.52E-08	10,000	1.70E-02	1.52E-08	10,000
U-238	(a)	4.10E-01	3.67E-07	10,000	4.10E-01	3.67E-07	10,000	4.10E-01	3.67E-07	10,000
200 West Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900									
I-129	1									
Grouted I-129	1									
U-233	(a)									
U-234	(a)									
U-235	(a)									
U-236	(a)									
U-238	(a)									

(a) The benchmark MCL for uranium is 30 µg/L expressed as total uranium. To convert isotope specific concentrations from pCi/L to µg/L, use following conversion factors:

- Uranium-233 - 1.05E-04
- Uranium-234 - 1.62E-04
- Uranium-235 - 4.66E-01
- Uranium-236 - 1.58E-02
- Uranium-238 - 3.00E+00.

Table G.36. Predicted Peak River Flux of Key Constituents Disposed of After 2007 at a Line of Analysis to the Columbia River, Alternative E_3

Constituent	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)
Projected Cat 1 LLW									
200 East Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
ERDF Area									
C-14	1.28E+01	8.79E-08	10,000	1.56E+01	1.07E-07	10,000	1.59E+01	1.09E-07	10,000
Tc-99	1.08E+00	1.12E-02	1,720	1.32E+00	1.36E-02	1,720	1.33E+00	1.37E-02	1,720
Grouted Tc-99									
I-129	3.01E-03	3.10E-05	1,720	3.67E-03	3.79E-05	1,720	3.67E-03	3.79E-05	1,20
Grouted I-129									
U-233	3.71E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000
U-234	6.13E-01	0.00E+00	>10,000	7.47E-01	0.00E+00	>10,000	9.21E-01	0.00E+00	>10,000
U-235	1.29E-01	0.00E+00	>10,000	1.57E-01	0.00E+00	>10,000	1.68E-01	0.00E+00	>10,000
U-236	1.46E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000
U-238	1.47E+00	0.00E+00	>10,000	1.79E+00	0.00E+00	>10,000	2.08E+00	0.00E+00	>10,000
Projected Cat 3 LLW									
200 East Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
ERDF Area									
C-14	4.44E-01	3.05E-09	10,000	4.62E-01	3.17E-09	10,000	1.45E+02	9.96E-07	10,000
Tc-99									
Grouted Tc-99	3.23E+03	2.67E-01	1,510	3.23E+03	2.67E-01	1,510	3.23E+03	2.67E-01	1,510
I-129	1.96E-06	2.02E-08	1,720	2.04E-06	2.10E-08	1,720	2.04E-06	2.10E-08	1,720
Grouted I-129	5.00E+00	1.31E-04	1,510	5.00E+00	1.31E-04	1,510	5.00E+00	1.31E-04	1,510
U-233	2.98E-01	0.00E+00	>10,000	3.10E-01	0.00E+00	>10,000	1.80E-01	0.00E+00	>10,000
U-234	3.73E+02	0.00E+00	>10,000	3.89E+02	0.00E+00	>10,000	3.11E+02	0.00E+00	>10,000
U-235	1.07E+01	0.00E+00	>10,000	1.11E+01	0.00E+00	>10,000	1.20E+01	0.00E+00	>10,000

Table G.36. (contd)

	Hanford Only Volume			**Lower Bound Volume**			**Upper Bound Volume**		
Constituent	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**
U-236	4.82E+01	0.00E+00	>10,000	5.02E+01	0.00E+00	>10,000	2.89E+01	0.00E+00	>10,000
U-238	5.99E+02	0.00E+00	>10,000	6.24E+02	0.00E+00	>10,000	5.04E+02	0.00E+00	>10,000
Projected MLLW									
200 East Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
ERDF Area									
C-14	1.46E+00	1.00E-08	10,000	1.46E+00	1.00E-08	10,000	1.45E+00	9.96E-09	10,000
Tc-99	8.34E+00	8.61E-02	1,720	8.36E+00	8.62E-02	1,720	8.27E+00	8.53E-02	1,720
Grouted Tc-99									
I-129	3.50E-02	3.61E-04	1,720	3.51E-02	3.62E-04	1,720	3.48E-02	3.59E-04	1,720
Grouted I-129									
U-233	4.67E-03	0.00E+00	>10,000	4.68E-03	0.00E+00	>10,000	4.64E-03	0.00E+00	>10,000
U-234	5.44E+00	0.00E+00	>10,000	5.45E+00	0.00E+00	>10,000	5.40E+00	0.00E+00	>10,000
U-235	8.67E-02	0.00E+00	>10,000	8.69E-02	0.00E+00	>10,000	8.61E-02	0.00E+00	>10,000
U-236	1.02E-01	0.00E+00	>10,000	1.02E-01	0.00E+00	>10,000	1.01E-01	0.00E+00	>10,000
U-238	1.36E+00	0.00E+00	>10,000	1.36E+00	0.00E+00	>10,000	1.35E+00	0.00E+00	>10,000
Projected Grouted MLLW									
200 East Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									
ERDF Area									
C-14	2.86E+00	1.97E-08	10,000	2.87E+00	1.97E-08	10,000	4.25E+00	2.92E-08	10,000
Tc-99									
Grouted Tc-99	1.57E+02	1.30E-02	1,510	1.57E+02	1.30E-02	1,510	3.34E+02	2.77E-02	1,510
I-129									
Grouted I-129	6.87E-02	1.80E-06	1,510	6.88E-02	1.80E-06	1,510	7.06E-02	1.85E-06	1,510
U-233	8.91E-03	0.00E+00	>10,000	8.93E-03	0.00E+00	>10,000	9.20E-03	0.00E+00	>10,000
U-234	1.07E+01	0.00E+00	>10,000	1.07E+01	0.00E+00	>10,000	3.35E+02	0.00E+00	>10,000
U-235	1.70E-01	0.00E+00	>10,000	1.70E-01	0.00E+00	>10,000	1.47E+01	0.00E+00	>10,000

Table G.36. (contd)

Constituent	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)
U-236	2.00E-01	0.00E+00	>10,000	2.00E-01	0.00E+00	>10,000	2.05E-01	0.00E+00	>10,000
U-238	2.64E+00	0.00E+00	>10,000	2.65E+00	0.00E+00	>10,000	3.42E+02	0.00E+00	>10,000
Projected Melter Waste									
200 East Area									
C-14									
Tc-99									
Grouted Tc-99	3.89E+01	3.19E-03	870	3.89E+01	3.19E-03	870	3.89E+01	3.19E-03	870
I-129									
Grouted I-129									
U-233	8.49E-01	1.89E-07	10,000	8.49E-01	1.89E-07	10,000	8.49E-01	1.89E-07	10,000
U-234	4.60E-01	1.03E-07	10,000	4.60E-01	1.03E-07	10,000	4.60E-01	1.03E-07	10,000
U-235	1.90E-02	4.24E-09	10,000	1.90E-02	4.24E-09	10,000	1.90E-02	4.24E-09	10,000
U-236	1.70E-02	3.79E-09	10,000	1.70E-02	3.79E-09	10,000	1.70E-02	3.79E-09	10,000
U-238	4.10E-01	9.14E-08	10,000	4.10E-01	9.14E-08	10,000	4.10E-01	9.14E-08	10,000
200 West Area									
C-14									
Tc-99									
Grouted Tc-99									
I-129									
Grouted I-129									
U-233									
U-234									
U-235									
U-236									
U-238									

Table G.37. Predicted Peak Concentrations of Key Constituents at a 1-km Line of Analysis, No Action Alternative

		Hanford Only Volume			Lower Bound Volume		
Constituent	**Benchmark MCL (pCi/L)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
Pre-1970 LLW							
200 East Area							
C-14	2,000						
Tc-99	900	5.16E-01	1.37E+01	110	5.16E-01	1.37E+01	110
Grouted Tc-99	900						
I-129	1	1.24E-03	3.30E-02	110	1.24E-03	3.30E-02	110
Grouted I-129	1						
U-233	(a)	1.03E+01	3.20E-01	10,000	1.03E+01	3.20E-01	10,000
U-234	(a)	3.68E-01	1.14E-02	10,000	3.68E-01	1.14E-02	10,000
U-235	(a)	1.12E-02	3.48E-04	10,000	1.12E-02	3.48E-04	10,000
U-236	(a)	7.53E-03	2.34E-04	10,000	7.53E-03	2.34E-04	10,000
U-238	(a)	2.69E-01	8.35E-03	10,000	2.69E-01	8.35E-03	10,000
200 West Area	(a)						
C-14	2,000						
Tc-99	900	1.30E-01	2.70E+00	190	1.30E-01	2.70E+00	190
Grouted Tc-99	900						
I-129	1	1.70E-04	3.54E-03	190	1.70E-04	3.54E-03	190
Grouted I-129	1						
U-233	(a)						
U-234	(a)	1.45E+00	0.00E+00	>10,000	1.45E+00	0.00E+00	>10,000
U-235	(a)	4.38E-02	0.00E+00	>10,000	4.38E-02	0.00E+00	>10,000
U-236	(a)	2.95E-02	0.00E+00	>10,000	2.95E-02	0.00E+00	>10,000
U-238	(a)	1.06E+00	0.00E+00	>10,000	1.06E+00	0.00E+00	>10,000
1970-1987 LLW							
200 East Area							
C-14	2,000	2.15E+02	4.84E+00	10,000	2.15E+02	4.84E+00	10,000
Tc-99	900						
Grouted Tc-99	900						
I-129	1	1.87E-02	5.23E-01	110	1.87E-02	5.23E-01	110
Grouted I-129	1						
U-233	(a)						
U-234	(a)	3.08E-02	1.89E-03	10,000	3.08E-02	1.89E-03	10,000
U-235	(a)	2.61E-03	1.60E-04	10,000	2.61E-03	1.60E-04	10,000
U-236	(a)						
U-238	(a)	6.28E-02	3.85E-03	10,000	6.28E-02	3.85E-03	10,000
200 West Area							
C-14	2,000	3.92E+02	0.00E+00	>10,000	3.92E+02	0.00E+00	>10,000
Tc-99	900						
Grouted Tc-99	900						
I-129	1	1.77E-03	3.94E-02	250	1.77E-03	3.94E-02	250
Grouted I-129	1						
U-233	(a)						
U-234	(a)	3.94E+01	0.00E+00	>10,000	3.94E+01	0.00E+00	>10,000
U-235	(a)	3.33E+00	0.00E+00	>10,000	3.33E+00	0.00E+00	>10,000
U-236	(a)						
U-238	(a)	2.82E+01	0.00E+00	>10,000	2.82E+01	0.00E+00	>10,000

Table G.37. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume		
		Inventory (Ci)	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
1988-1995 LLW							
200 East Area							
C-14	2,000	5.11E+00	1.15E-01	10,000	5.11E+00	1.15E-01	10,000
Tc-99	900	1.39E-01	3.89E+00	110	1.39E-01	3.89E+00	110
Grouted Tc-99	900						
I-129	1	9.45E-05	2.64E-03	110	9.45E-05	2.64E-03	110
Grouted I-129	1						
U-233	(a)	2.09E-05	1.28E-06	10,000	2.09E-05	1.28E-06	10,000
U-234	(a)	1.85E-03	1.13E-04	10,000	1.85E-03	1.13E-04	10,000
U-235	(a)	4.29E-04	2.63E-05	10,000	4.29E-04	2.63E-05	10,000
U-236	(a)	1.85E-06	1.13E-07	10,000	1.85E-06	1.13E-07	10,000
U-238	(a)	1.93E-02	1.18E-03	10,000	1.93E-02	1.18E-03	10,000
200 West Area							
C-14	2,000	9.29E+00	0.00E+00	>10,000	9.29E+00	0.00E+00	>10,000
Tc-99	900	4.71E-01	1.18E+01	210	471E-01	1.18E+01	210
Grouted Tc-99	900						
I-129	1	3.06E-02	7.70E-01	210	3.06E-02	7.70E-01	210
Grouted I-129	1						
U-233	(a)	6.54E-02	0.00E+00	>10,000	6.54E-02	0.00E+00	>10,000
U-234	(a)	5.77E+00	0.00E+00	>10,000	5.77E+00	0.00E+00	>10,000
U-235	(a)	1.34E+00	0.00E+00	>10,000	134E+00	0.00E+00	>10,000
U-236	(a)	5.77E-03	0.00E+00	>10,000	5.77E-03	0.00E+00	>10,000
U-238	(a)	6.03-1	0.00E+00	>10,000	6.03E+01	0.00E+00	>10,000
Cat 1 LLW Disposed of After 1995							
200 East Area							
C-14	2,000	5.90E-01	1.33E-02	10,000	7.20E-01	1.62E-02	10,000
Tc-99	900	5.03E-02	5.32E-01	630	6.14E-02	6.49E-01	630
Grouted Tc-99	900						
I-129	1	2.03E-04	2.15E-03	630	2.48E-04	2.62E-03	630
Grouted I-129	1						
U-233	(a)	1.78E-02	1.09E-03	10,000	2.17E-02	1.33E-03	10,000
U-234	(a)	2.94E-02	1.80E-03	10,000	3.58E-02	2.19E-03	10,000
U-235	(a)	6.16E-03	3.77E-04	10,000	7.51E-03	4.60E-04	10,000
U-236	(a)	6.99E-04	4.29E-05	10,000	8.53E-04	5.23E-05	10,000
U-238	(a)	7.03E-02	4.31E-03	10,000	8.57E-02	5.25E-03	10,000
200 West Area	(a)						
C-14	2,000	1.53E+01	0.00E+00	>10,000	1.86E+01	0.00E+00	>10,000
Tc-99	900	1.29E+00	2.02E+01	1,070	1.57E+00	2.46E+01	1,070
Grouted Tc-99	900						
I-129	1	5.22E-03	8.18E-02	1,070	6.36E-03	9.98E-02	1,070
Grouted I-129	1						
U-233	(a)	4.55E-01	0.00E+00	>10,000	5.55E-01	0.00E+00	>10,000
U-234	(a)	7.53E-01	0.00E+00	>10,000	9.18E-01	0.00E+00	>10,000
U-235	(a)	1.57E-01	0.00E+00	>10,000	1.92E-01	0.00E+00	>10,000
U-236	(a)	1.79E-02	0.00E+00	>10,000	2.18E-02	0.00E+00	>10,000
U-238	(a)	1.80E+00	0.00E+00	>10,000	2.19E+00	0.00E+00	>10,000

Table G.37. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume		
		Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Cat 3 LLW Disposed of After 1995							
200 East Area							
C-14	2,000	2.21E-02	4.97E-04	10,000	2.30E-02	5.18E-04	10,000
Tc-99	900						
Grouted Tc-99	900	1.25E+02	5.24E+00	630	1.25E+02	5.24E+00	630
I-129	1	8.62E-08	9.11E-07	630	8.98E-08	9.49E-07	630
Grouted I-129	1						
U-233	(a)	1.48E-02	8.04E-04	10,000	1.54E-02	8.37E-04	10,000
U-234	(a)	1.86E+01	1.01E+00	10,000	1.94E+01	1.05E+00	10,000
U-235	(a)	5.34E-01	2.90E-02	10,000	5.56E-01	3.02E-02	10,000
U-236	(a)	2.41E+00	1.31E-01	10,000	2.51E+00	1.36E-01	10,000
U-238	(a)	3.00E+01	1.63E+00	10,000	3.12E+01	1.70E+00	10,000
200 West Area							
C-14	2,000	5.67E-01	0.00E+00	>10,000	5.91E-01	0.00E+00	>10,000
Tc-99	900						
Grouted Tc-99	900	3.18E+03	2.93E+02	1,230	3.18E+03	2.93E+02	1,230
I-129	1	221E-06	3.46E-05	1,070	2.30E-06	3.61E-05	1,070
Grouted I-129	1	5.00E+00	1.46E-01	1,230	5.00E+00	1.46E-01	1,230
U-233	(a)	3.79E-01	0.00E+00	>10,000	3.95E-01	0.00E+00	>10,000
U-234	(a)	4.78E+02	0.00E+00	>10,000	4.98E+02	0.00E+00	>10,000
U-235	(a)	1.36E+01	0.00E+00	>10,000	1.42E+01	0.00E+00	>10,000
U-236	(a)	6.17E+01	0.00E+00	>10,000	6.43E+01	0.00E+00	>10,000
U-238	(a)	7.67E+02	0.00E+00	>10,000	7.99E+02	0.00E+00	>10,000
MLLW Disposed of After 1995							
200 East Area							
C-14	2,000						
Tc-99	900						
Grouted Tc-99	900						
I-129	1						
Grouted I-129	1						
U-233	(a)						
U-234	(a)						
U-235	(a)						
U-236	(a)						
U-238	(a)						
200 West Area							
C-14	2,000	1.69E-01	0.00E+00	>10,000	1.69E-01	0.00E+00	>10,000
Tc-99	900	9.65E-01	1.51E+01	1,070	9.63E-01	1.51E+01	1,070
Grouted Tc-99	900					0.00E+00	
I-129	1	4.04E-03	6.34E-02	1,070	4.03E-03	6.33E-02	1,070
Grouted I-129	1						
U-233	(a)	5.25E-04	0.00E+00	>10,000	5.24E-04	0.00E+00	>10,000
U-234	(a)	6.29E-01	0.00E+00	>10,000	6.28E-01	0.00E+00	>10,000
U-235	(a)	9.99E-03	0.00E+00	>10,000	9.97E-03	0.00E+00	>10,000
U-236	(a)	1.17E-02	0.00E+00	>10,000	1.17E-02	0.00E+00	>10,000
U-238	(a)	1.56E-01	0.00E+00	>10,000	1.56E-01	0.00E+00	>10,000

Table G.37. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume		
		Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Grouted MLLW Disposed of After 1995							
200 East Area							
C-14	2,000						
Tc-99	900						
Grouted Tc-99	900						
I-129	1						
Grouted I-129	1						
U-233	(a)						
U-234	(a)						
U-235	(a)						
U-236	(a)						
U-238	(a)						
200 West Area							
C-14	2,000	5.85E-01	0.00E+00	>10,000	5.84E-01	0.00E+00	>10,000
Tc-99	900						
Grouted Tc-99	900	3.35E+00	2.39E-01	1,200	3.34E+00	2.39E-01	1,200
I-129	1						
Grouted I-129	1	1.40E-02	3.16E-04	1,200	1.40E-02	3.15E-04	1,200
U-233	(a)	1.82E-03	0.00E+00	>10,000	1.82E-03	0.00E+00	>10,000
U-234	(a)	2.18E+00	0.00E+00	>10,000	2.18E+00	0.00E+00	>10,000
U-235	(a)	3.46E-02	0.00E+00	>10,000	3.45E-02	0.00E+00	>10,000
U-236	(a)	4.07E-02	0.00E+00	>10,000	4.06E-02	0.00E+00	>10,000
U-238	(a)	5.41E-01	0.00E+00	>10,000	5.40E-01	0.00E+00	>10,000

(a) The benchmark MCL for uranium is 30 µg/L expressed as total uranium. To convert isotope specific concentrations from pCi/L to µg/L, use following conversion factors:

- Uranium-233 - 1.05E-04
- Uranium-234 - 1.62E-04
- Uranium-235 - 4.66E-01
- Uranium-236 - 1.58E-02
- Uranium-238 - 3.00E+00.

Table G.38. Predicted Peak Concentrations of Key Constituents at a Line of Analysis Near the Columbia River, No Action Alternative

		Hanford Only Volume			Lower Bound Volume		
Constituent	**Benchmark MCL (pCi/L)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
Pre-1970 LLW							
200 East Area							
C-14	2,000						
Tc-99	900	5.16E-01	1.29E+00	260	5.16E-01	1.29E+00	260
Grouted Tc-99	900						
I-129	1	1.24E-03	3.10E-03	260	1.24E-03	3.10E-03	260
Grouted I-129	1						
U-233	(a)	1.03E+01	1.92E-02	10,000	1.03E+01	1.92E-02	10,000
U-234	(a)	3.68E-01	6.87E-04	10,000	3.68E-01	6.87E-04	10,000
U-235	(a)	1.12E-02	2.09E-05	10,000	1.12E-02	2.09E-05	10,000
U-236	(a)	7.53E-03	1.41E-05	10,000	7.53E-03	1.41E-05	10,000
U-238	(a)	2.69E-01	5.02E-04	10,000	2.69E-01	5.02E-04	10,000
200 West Area	(a)						
C-14	2,000						
Tc-99	900	1.30E-01	1.69E-01	530	1.30E-01	1.69E-01	530
Grouted Tc-99	900						
I-129	1	1.70E-04	2.21E-04	530	1.70E-04	2.21E-04	530
Grouted I-129	1						
U-233	(a)						
U-234	(a)	1.45E+00	0.00E+00	>10,000	1.45E+00	0.00E+00	>10,000
U-235	(a)	4.38E-02	0.00E+00	>10,000	4.38E-02	0.00E+00	>10,000
U-236	(a)	2.95E-02	0.00E+00	>10,000	2.95E-02	0.00E+00	>10,000
U-238	(a)	1.06E+00	0.00E+00	>10,000	1.06E+00	0.00E+00	>10,000
1970-1987 LLW							
200 East Area							
C-14	2,000	2.15E+02	3.89E-01	10,000	2.15E+02	3.89E-01	10,000
Tc-99	900						
Grouted Tc-99	900						
I-129	1	1.87E-02	4.66E-02	260	1.87E-02	4.66E-02	260
Grouted I-129	1						
U-233	(a)						
U-234	(a)	3.08E-02	1.12E-04	10,000	3.08E-02	1.12E-04	10,000
U-235	(a)	2.61E-03	9.48E-06	10,000	2.61E-03	9.48E-06	10,000
U-236	(a)						
U-238	(a)	6.28E-02	2.28E-04	10,000	6.28E-02	2.28E-04	10,000
200 West Area							
C-14	2,000	3.92E+02	0.00E+00	>10,000	3.92E+02	0.00E+00	>10,000
Tc-99	900						
Grouted Tc-99	900						
I-129	1	1.77E-03	2.01E-03	610	1.77E-03	2.01E-03	610
Grouted I-129	1						
U-233	(a)						
U-234	(a)	3.94E+01	0.00E+00	>10,000	3.94E+01	0.00E+00	>10,000
U-235	(a)	3.33E+00	0.00E+00	>10,000	3.33E+00	0.00E+00	>10,000
U-236	(a)						
U-238	(a)	2.82E+01	0.00E+00	>10,000	2.82E+01	0.00E+00	>10,000

Table G.38. (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume		
		Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
1988-1995 LLW							
200 East Area							
C-14	2,000	5.11E+00	7.76E-03	10,000	5.11E+00	7.76E-03	10,000
Tc-99	900	1.39E-01	3.47E-01	260	1.39E-01	3.47E-01	260
Grouted Tc-99	900						
I-129	1	9.45E-05	2.36E-04	260	9.45E-05	2.36E-04	260
Grouted I-129	1						
U-233	(a)	2.09E-05	7.59E-08	10,000	2.09E-05	7.59E-08	10,000
U-234	(a)	1.85E-03	6.72E-06	10,000	1.85E-03	6.72E-06	10,000
U-235	(a)	4.29E-04	1.56E-06	10,000	4.29E-04	1.56E-06	10,000
U-236	(a)	1.85E-06	6.72E-09	10,000	1.85E-06	6.72E-09	10,000
U-238	(a)	1.93E-02	7.01E-05	10,000	1.93E-02	7.01E-05	10,000
200 West Area							
C-14	2,000	9.29E+00	0.00E+00	>10,000	9.29E+00	0.00E+00	>10,000
Tc-99	900	4.71E-01	5.32E-01	600	4.71E-01	5.32E-01	600
Grouted Tc-99	900						
I-129	1	3.06E-02	3.46E-02	600	3.06E-02	3.46E-02	600
Grouted I-129	1						
U-233	(a)	6.54E-02	0.00E+00	>10,000	6.54E-02	0.00E+00	>10,000
U-234	(a)	5.77E+00	0.00E+00	>10,000	5.77E+00	0.00E+00	>10,000
U-235	(a)	1.34E+00	0.00E+00	>10,000	1.34E+00	0.00E+00	>10,000
U-236	(a)	5.77E-03	0.00E+00	>10,000	5.77E-03	0.00E+00	>10,000
U-238	(a)	6.03E+01	0.00E+00	>10,000	6.03E+01	0.00E+00	>10,000
1996-2007 Cat 1 LLW							
200 East Area							
C-14	2,000	5.90E-01	4.35E-04	10,000	7.20E-01	5.31E-04	10,000
Tc-99	900	5.03E-02	7.89E-02	800	6.14E-02	9.62E-02	800
Grouted Tc-99	900						
I-129	1	2.03E-04	3.19E-04	800	2.48E-04	3.89E-04	800
Grouted I-129	1						
U-233	(a)	1.78E-02	6.46E-05	10,000	2.17E-02	7.88E-05	10,000
U-234	(a)	2.94E-02	1.07E-04	10,000	3.58E-02	1.30E-04	10,000
U-235	(a)	6.16E-03	2.24E-05	10,000	7.51E-03	2.73E-05	10,000
U-236	(a)	6.99E-04	2.54E-06	10,000	8.53E-04	3.10E-06	10,000
U-238	(a)	7.03E-02	2.55E-04	10,000	8.57E-02	3.11E-04	10,000
200 West Area	(a)						
C-14	2,000	1.53E+01	0.00E+00	>10,000	1.86E+01	0.00E+00	>10,000
Tc-99	900	1.29E+00	1.24E+00	1,420	1.57E+00	1.51E+00	1,420
Grouted Tc-99	900						
I-129	1	5.22E-03	5.03E-03	1,420	6.36E-03	6.13E-03	1,420
Grouted I-129	1						
U-233	(a)	4.55E-01	0.00E+00	>10,000	5.55E-01	0.00E+00	>10,000
U-234	(a)	7.53E-01	0.00E+00	>10,000	9.18E-01	0.00E+00	>10,000
U-235	(a)	1.57E-01	0.00E+00	>10,000	1.92E-01	0.00E+00	>10,000
U-236	(a)	1.79E-02	0.00E+00	>10,000	2.18E-02	0.00E+00	>10,000
U-238	(a)	1.80E+00	0.00E+00	>10,000	2.19E+00	0.00E+00	>10,000

Table G.38. (contd)

		Hanford Only Volume			Lower Bound Volume		
Constituent	**Benchmark MCL (pCi/L)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
1996-2007 Cat 3 LLW							
200 East Area							
C-14	2,000	2.21E-02	1.63E-05	10,000	2.30E-02	1.70E-05	10,000
Tc-99	900						
Grouted Tc-99	900	1.25E+02	1.23E+00	800	1.25E+02	1.23E+00	860
I-129	1	8.62E-08	1.35E-07	800	8.98E-08	1.41E-07	800
Grouted I-129	1						
U-233	(a)	1.48E-02	3.26E-05	10,000	1.54E-02	3.40E-05	10,000
U-234	(a)	1.86E+01	4.11E-02	10,000	1.94E+01	4.28E-02	10,000
U-235	(a)	5.34E-01	1.18E-03	10,000	5.56E-01	1.23E-03	10,000
U-236	(a)	2.41E+00	5.31E-03	10,000	2.51E+00	5.53E-03	10,000
U-238	(a)	3.00E+01	6.60E-02	10,000	3.12E+01	6.88E-02	10,000
200 West Area							
C-14	2,000	5.67E-01	0.00E+00	>10,000	5.91E-01	0.00E+00	>10,000
Tc-99	900						
Grouted Tc-99	900	3.18E+03	2.04E+01	1,710	3.18E+03	2.04E+01	1,710
I-129	1	2.21E-06	2.13E-06	1,420	2.30E-06	2.22E-06	1,420
1996-2007 Cat 3 LLW (contd)							
Grouted I-129	1	5.00E+00	1.01E-02	1,710	5.00E+00	1.01E-02	1,710
U-233	(a)	3.79E-01	0.00E+00	>10,000	3.95E-01	0.00E+00	>10,000
U-234	(a)	4.78E+02	0.00E+00	>10,000	4.98E+02	0.00E+00	>10,000
U-235	(a)	1.36E+01	0.00E+00	>10,000	1.42E+01	0.00E+00	>10,000
U-236	(a)	6.17E+01	0.00E+00	>10,000	6.43E+01	0.00E+00	>10,000
U-238	(a)				7.99E+02	0.00E+00	>10,000
1996-2007 MLLW							
200 East Area							
C-14	2,000						
Tc-99	900						
Grouted Tc-99	900						
I-129	1						
Grouted I-129	1						
U-233	(a)						
U-234	(a)						
U-235	(a)						
U-236	(a)						
U-238	(a)						
200 West Area							
C-14	2,000	1.69E-01	0.00E+00	>10,000	1.69E-01	0.00E+00	>10,000
Tc-99	900	9.65E-01	9.30E-01	1,420	9.63E-01	9.28E-01	1,420
Grouted Tc-99	900						
I-129	1	4.04E-03	3.89E-03	1,420	4.03E-03	3.89E-03	1,420
Grouted I-129	1						
U-233	(a)	5.25E-04	0.00E+00	>10,000	5.24E-04	0.00E+00	>10,000
U-234	(a)	6.29E-01	0.00E+00	>10,000	6.28E-01	0.00E+00	>10,000
U-235	(a)	9.99E-03	0.00E+00	>10,000	9.97E-03	0.00E+00	>10,000
U-236	(a)	1.17E-02	0.00E+00	>10,000	1.17E-02	0.00E+00	>10,000
U-238	(a)	1.56E-01	0.00E+00	>10,000	1.56E-01	0.00E+00	>10,000

Table G.38. (contd)

		Hanford Only Volume			Lower Bound Volume		
Constituent	**Benchmark MCL (pCi/L)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
Grouted 1996-2007 MLLW							
200 East Area							
C-14	2,000						
Tc-99	900						
Grouted Tc-99	900						
I-129	1						
Grouted I-129	1						
U-233	(a)						
U-234	(a)						
U-235	(a)						
U-236	(a)						
U-238	(a)						
200 West Area							
C-14	2,000	5.85E-01	0.00E+00	>10,000	5.84E-01	0.00E+00	>10,000
Tc-99	900						
Grouted 1996-2007 MLLW (contd)							
Grouted Tc-99	900	3.35E+00	2.29E-02	1,620	3.34E+00	2.29E-02	1,620
I-129	1						
Grouted I-129	1	1.40E-02	3.03E-05	1,620	1.40E-02	3.02E-05	1,620
U-233	(a)	1.82E-03	0.00E+00	>10,000	1.82E-03	0.00E+00	>10,000
U-234	(a)	2.18E+00	0.00E+00	>10,000	2.18E+00	0.00E+00	>10,000
U-235	(a)	3.46E-02	0.00E+00	>10,000	3.45E-02	0.00E+00	>10,000
U-236	(a)	4.07E-02	0.00E+00	>10,000	4.06E-02	0.00E+00	>10,000
U-238	(a)	5.41E-01	0.00E+00	>10,000	5.40E-01	0.00E+00	>10,000

(a) The benchmark MCL for uranium is 30 µg/L expressed as total uranium. To convert isotope specific concentrations from pCi/L to µg/L, use following conversion factors:

- Uranium-233 - 1.05E-04
- Uranium-234 - 1.62E-04
- Uranium-235 - 4.66E-01
- Uranium-236 - 1.58E-02
- Uranium-238 - 3.00E+00.

Table G.39. Predicted Peak River Flux of Key Constituents at a Line of Analysis Near the Columbia River, No Action Alternative

	Hanford Only Volume			Lower Bound Volume		
Constituent	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Approx. Peak Arrival Time (yrs)
Pre-1970 LLW						
200 East Area						
C-14						
Tc-99	5.16E-01	9.81E-03	290	5.16E-01	9.81E-03	290
Grouted Tc-99						
I-129	1.24E-03	2.36E-05	290	1.24E-03	2.36E-05	290
Grouted I-129						
U-233	1.03E+01	1.54E-04	10,000	1.03E+01	1.54E-04	10,000
U-234	3.68E-01	5.50E-06	10,000	3.68E-01	5.50E-06	10,000
U-235	1.12E-02	1.67E-07	10,000	1.12E-02	1.67E-07	10,000
U-236	7.53E-03	1.13E-07	10,000	7.53E-03	1.13E-07	10,000
U-238	2.69E-01	4.02E-06	10,000	2.69E-01	4.02E-06	10,000
200 West Area						
C-14						
Tc-99	1.30E-01	1.68E-03	600	1.30E-01	1.68E-03	600
Grouted Tc-99						
I-129	1.70E-04	2.20E-06	600	1.70E-04	2.20E-06	600
Grouted I-129						
U-233						
U-234	1.45E+00	0.00E+00	>10,000	1.45E+00	0.00E+00	>10,000
U-235	4.38E-02	0.00E+00	>10,000	4.38E-02	0.00E+00	>10,000
U-236	2.95E-02	0.00E+00	>10,000	2.95E-02	0.00E+00	>10,000
U-238	1.06E+00	0.00E+00	>10,000	1.06E+00	0.00E+00	>10,000
1970-1987 LLW						
200 East Area						
C-14	2.15E+02	2.55E-03	10,000	2.15E+02	2.55E-03	10,000
Tc-99						
Grouted Tc-99						
I-129	1.87E-02	3.54E-04	290	1.87E-02	3.54E-04	290
Grouted I-129						
U-233						
U-234	3.08E-02	4.71E-07	10,000	3.08E-02	4.71E-07	10,000
U-235	2.61E-03	3.99E-08	10,000	2.61E-03	3.99E-08	10,000
U-236						
U-238	6.28E-02	9.60E-07	10,000	6.28E-02	9.60E-07	10,000
200 West Area						
C-14	3.92E+02	0.00E+00	>10,000	3.92E+02	0.00E+00	>10,000
Tc-99						
Grouted Tc-99						
I-129	1.77E-03	2.07E-05	690	1.77E-03	2.07E-05	690
Grouted I-129						
U-233						
U-234	3.94E+01	0.00E+00	>10,000	3.94E+01	0.00E+00	>10,000
U-235	3.33E+00	0.00E+00	>10,000	3.33E+00	0.00E+00	>10,000
U-236						
U-238	2.82E+01	0.00E+00	>10,000	2.82E+01	0.00E+00	>10,000

Table G.39. (contd)

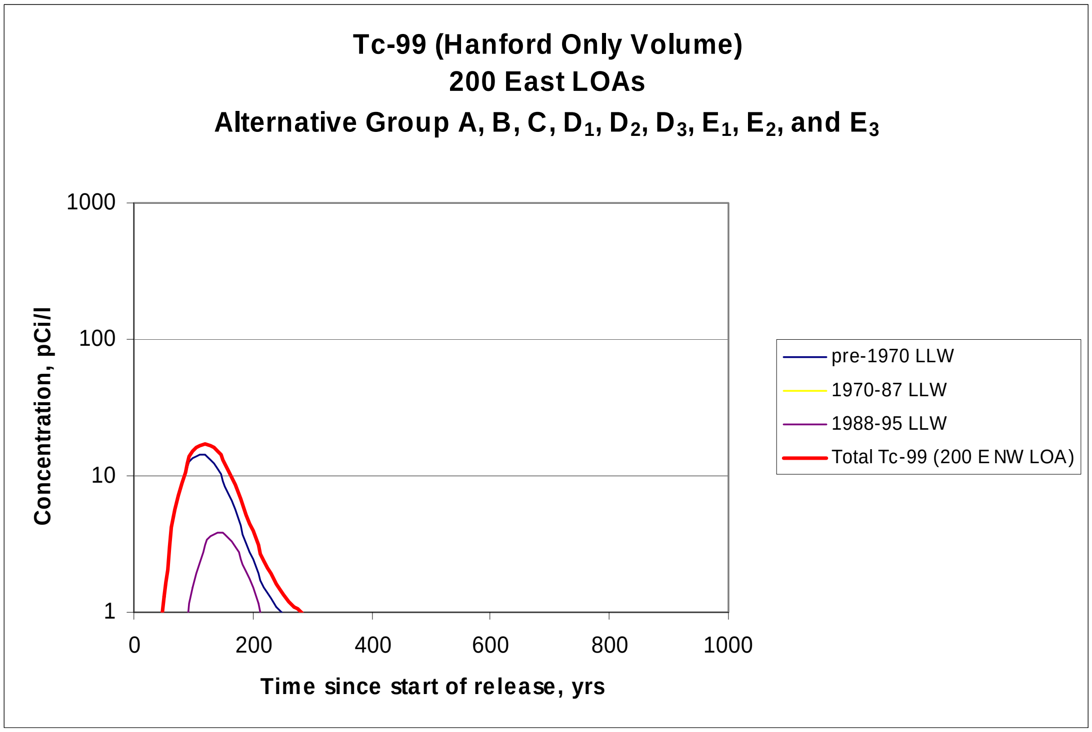
	Hanford Only Volume			Lower Bound Volume		
Constituent	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**
1988-1995 LLW						
200 East Area						
C-14	5.11E+00	5.08E-05	10,000	5.11E+00	5.08E-05	10,000
Tc-99	1.39E-01	2.63E-03	290	1.39E-01	2.63E-03	290
Grouted Tc-99						
I-129	9.45E-05	1.79E-06	290	9.45E-05	1.79E-06	290
Grouted I-129						
U-233	2.09E-05	4.71E-11	10,000	2.09E-05	4.71E-11	10,000
U-234	1.85E-03	4.17E-09	10,000	1.85E-03	4.17E-09	10,000
U-235	4.29E-04	9.67E-10	10,000	4.29E-04	9.67E-10	10,000
U-236	1.85E-06	4.17E-12	10,000	1.85E-06	4.17E-12	10,000
U-238	1.93E-02	4.35E-08	10,000	1.93E-02	4.35E-08	10,000
200 West Area						
C-14	9.29E+00	0.00E+00	>10,000	9.29E+00	0.00E+00	>10,000
Tc-99	4.71E-01	5.51E-03	670	4.71E-01	5.51E-03	670
Grouted Tc-99						
I-129	3.06E-02	3.58E-04	670	3.06E-02	3.58E-04	670
Grouted I-129						
U-233	6.54E-02	0.00E+00	>10,000	6.54E-02	0.00E+00	>10,000
U-234	5.77E+00	0.00E+00	>10,000	5.77E+00	0.00E+00	>10,000
U-235	1.34E+00	0.00E+00	>10,000	1.34E+00	0.00E+00	>10,000
U-236	5.77E-03	0.00E+00	>10,000	5.77E-03	0.00E+00	>10,000
U-238	6.03E+01	0.00E+00	>10,000	6.03E+01	0.00E+00	>10,000
1996-2007 Cat 1 LLW						
200 East Area						
C-14	5.90E-01	2.34E-06	10,000	7.20E-01	2.86E-06	10,000
Tc-99	5.03E-02	7.31E-04	850	6.14E-02	8.92E-04	850
Grouted Tc-99						
I-129	2.03E-04	2.95E-06	850	2.48E-04	3.60E-06	850
Grouted I-129						
U-233	1.78E-02	4.01E-08	10,000	2.17E-02	4.89E-08	10,000
U-234	2.94E-02	6.62E-08	10,000	3.58E-02	8.07E-08	10,000
U-235	6.16E-03	1.39E-08	10,000	7.51E-03	1.69E-08	10,000
U-236	6.99E-04	1.58E-09	10,000	8.53E-04	1.92E-09	10,000
U-238	7.03E-02	1.58E-07	10,000	8.57E-02	1.93E-07	10,000
200 West Area						
C-14	1.53E+01	0.00E+00	>10,000	1.86E+01	0.00E+00	>10,000
Tc-99	1.29E+00	1.31E-02	1,610	1.57E+00	1.60E-02	1,610
Grouted Tc-99						
I-129	5.22E-03	5.32E-05	1,610	6.36E-03	6.49E-05	1,610
Grouted I-129						
U-233	4.55E-01	0.00E+00	>10,000	5.55E-01	0.00E+00	>10,000
U-234	7.53E-01	0.00E+00	>10,000	9.18E-01	0.00E+00	>10,000
U-235	1.57E-01	0.00E+00	>10,000	1.92E-01	0.00E+00	>10,000
U-236	1.79E-02	0.00E+00	>10,000	2.18E-02	0.00E+00	>10,000
U-238	1.80E+00	0.00E+00	>10,000	2.19E+00	0.00E+00	>10,000

Table G.39. (contd)

Constituent	Hanford Only Volume Inventory (Ci)	Hanford Only Volume Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Hanford Only Volume Approx. Peak Arrival Time (yrs)	Lower Bound Volume Inventory (Ci)	Lower Bound Volume Maximum River Flux Within 10,000 yrs (Ci/10 yrs)	Lower Bound Volume Approx. Peak Arrival Time (yrs)
1996-2007 Cat 3 LLW						
200 East Area						
C-14	2.21E-02	8.77E-08	10,000	2.30E-02	9.13E-08	10,000
Tc-99						
Grouted Tc-99	1.25E+02	1.16E-02	970	1.25E+02	1.16E-02	970
I-129	8.62E-08	1.25E-09	850	8.98E-08	1.30E-09	850
Grouted I-129						
U-233	1.48E-02	1.60E-08	10,000	1.54E-02	6.65E-11	10,000
U-234	1.86E+01	2.01E-05	10,000	1.94E+01	8.37E-08	10,000
U-235	5.34E-01	5.77E-07	10,000	5.56E-01	2.40E-09	10,000
U-236	2.41E+00	2.60E-06	10,000	2.51E+00	1.08E-08	10,000
U-238	3.00E+01	3.24E-05	10,000	3.12E+01	1.35E-07	10,000
200 West Area						
C-14	5.67E-01	0.00E+00	>10,000	5.91E-01	0.00E+00	>10,000
Tc-99						
Grouted Tc-99	3.18E+03	2.65E-01	1,840	3.18E+03	2.65E-01	1,840
I-129	2.21E-06	2.25E-08	1,610	2.30E-06	2.35E-08	1,610
Grouted I-129	5.00E+00	1.32E-04	1,840	5.00E+00	1.32E-04	1,840
U-233	3.79E-01	0.00E+00	>10,000	3.95E-01	0.00E+00	>10,000
U-234	4.78E+02	0.00E+00	>10,000	4.98E+02	0.00E+00	>10,000
U-235	1.36E+01	0.00E+00	>10,000	1.42E+01	0.00E+00	>10,000
U-236	6.17E+01	0.00E+00	>10,000	6.43E+01	0.00E+00	>10,000
U-238	7.67E+02	0.00E+00	>10,000	7.99E+02	0.00E+00	>10,000
1996-2007 MLLW						
200 East Area						
C-14						
Tc-99						
Grouted Tc-99						
I-129						
Grouted I-129						
U-233						
U-234						
U-235						
U-236						
U-238						
200 West Area						
C-14	1.69E-01	0.00E+00	>10,000	1.69E-01	0.00E+00	>10,000
Tc-99	9.65E-01	9.85E-03	1,610	9.63E-01	9.83E-03	1,610
Grouted Tc-99						
I-129	4.04E-03	4.12E-05	1,610	4.03E-03	4.11E-05	1,610
Grouted I-129						
U-233	5.25E-04	0.00E+00	>10,000	5.24E-04	0.00E+00	>10,000
U-234	6.29E-01	0.00E+00	>10,000	6.28E-01	0.00E+00	>10,000
U-235	9.99E-03	0.00E+00	>10,000	9.97E-03	0.00E+00	>10,000
U-236	1.17E-02	0.00E+00	>10,000	1.17E-02	0.00E+00	>10,000
U-238	1.56E-01	0.00E+00	>10,000	1.56E-01	0.00E+00	>10,000

Table G.39. (contd)

Constituent	**Hanford Only Volume**			**Lower Bound Volume**		
	Inventory (Ci)	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum River Flux Within 10,000 yrs (Ci/10 yrs)**	**Approx. Peak Arrival Time (yrs)**
Grouted 1996-2007 MLLW						
200 East Area						
C-14						
Tc-99						
Grouted Tc-99						
I-129						
Grouted I-129						
U-233						
U-234						
U-235						
U-236						
U-238						
200 West Area						
C-14	5.85E-01	0.00E+00	>10,000	5.84E-01	0.00E+00	>10,000
Tc-99						
Grouted Tc-99	3.35E+00	2.79E-04	1,840	3.34E+00	2.79E-04	1,840
I-129						
Grouted I-129	1.40E-02	3.03E-05	1,620	1.40E-02	3.02E-05	1,620
U-233	1.82E-03	0.00E+00	>10,000	1.82E-03	0.00E+00	>10,000
U-234	2.18E+00	0.00E+00	>10,000	2.18E+00	0.00E+00	>10,000
U-235	3.46E-02	0.00E+00	>10,000	3.45E-02	0.00E+00	>10,000
U-236	4.07E-02	0.00E+00	>10,000	4.06E-02	0.00E+00	>10,000
U-238	5.41E-01	0.00E+00	>10,000	5.40E-01	0.00E+00	>10,000



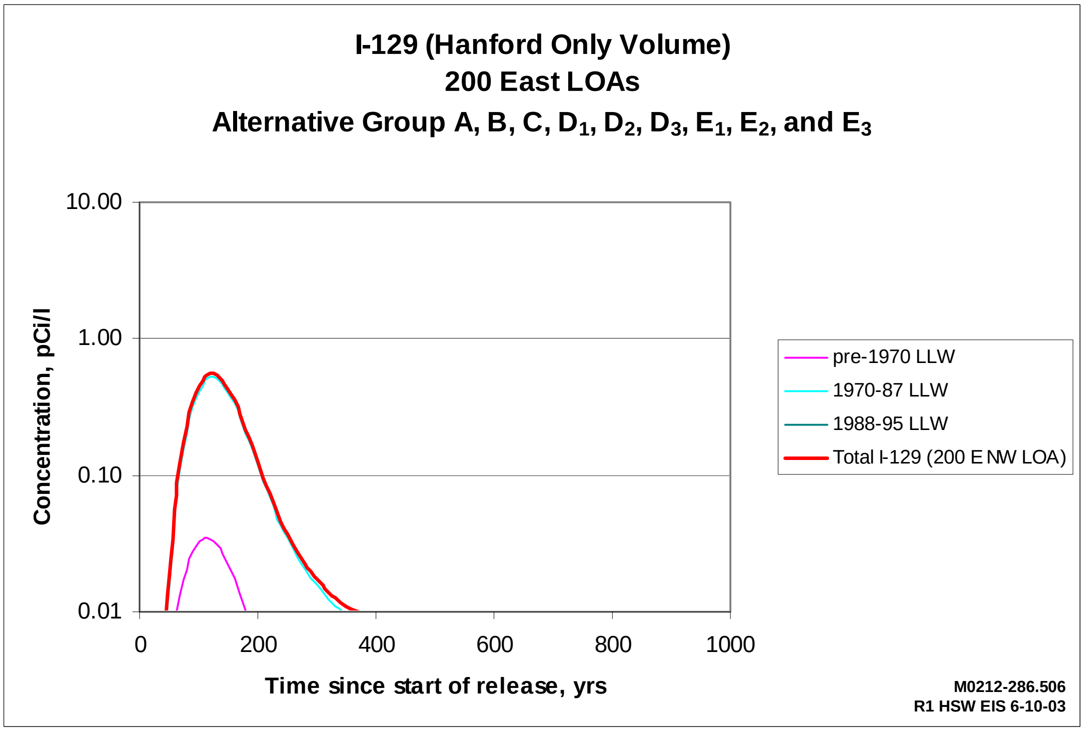


Figure G.18. Tc-99 and I-129 Concentration Profiles at the 1-km Lines of Analysis (200 East) (All Action Alternatives – Wastes Disposed of Before 1996)

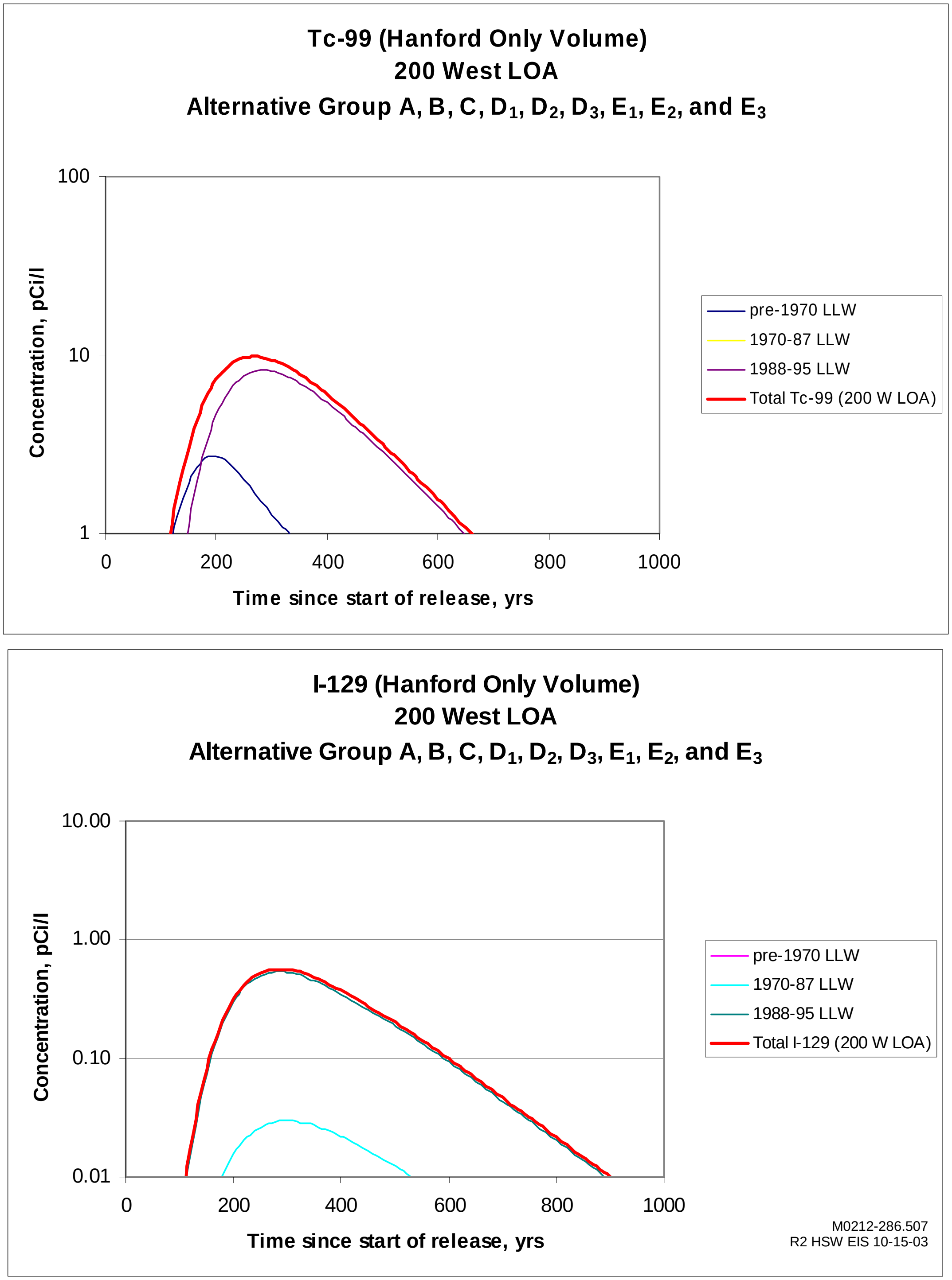
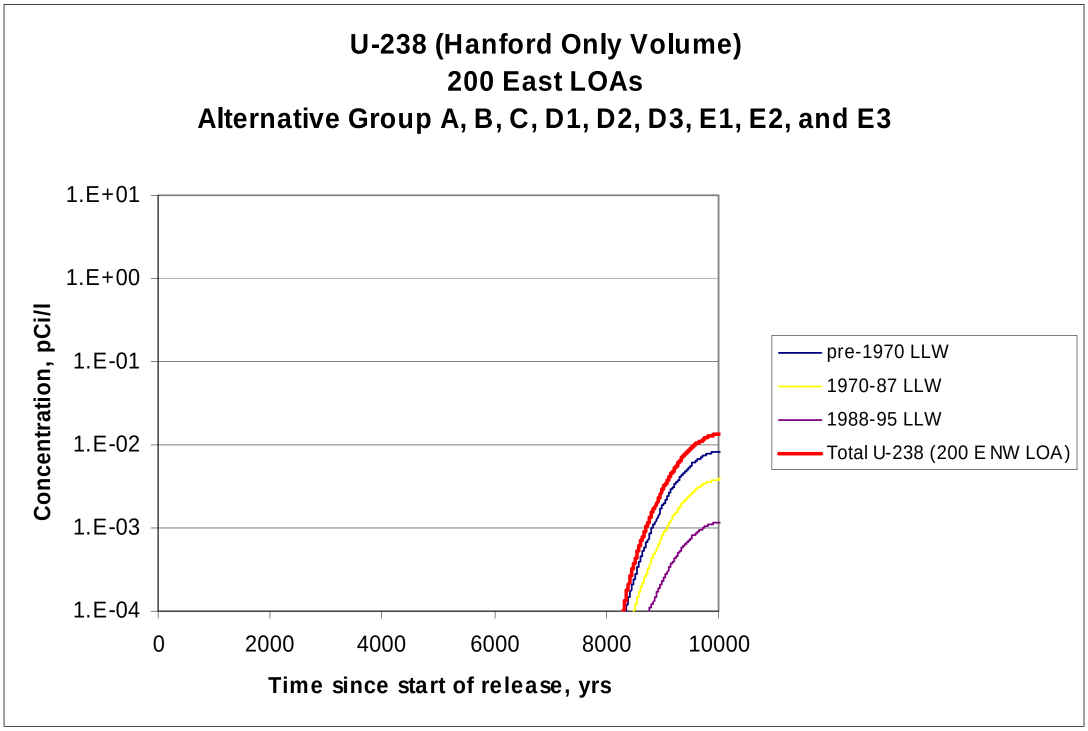


Figure G.19. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (200 West) (All Action Alternatives – Wastes Disposed of Before 1996)



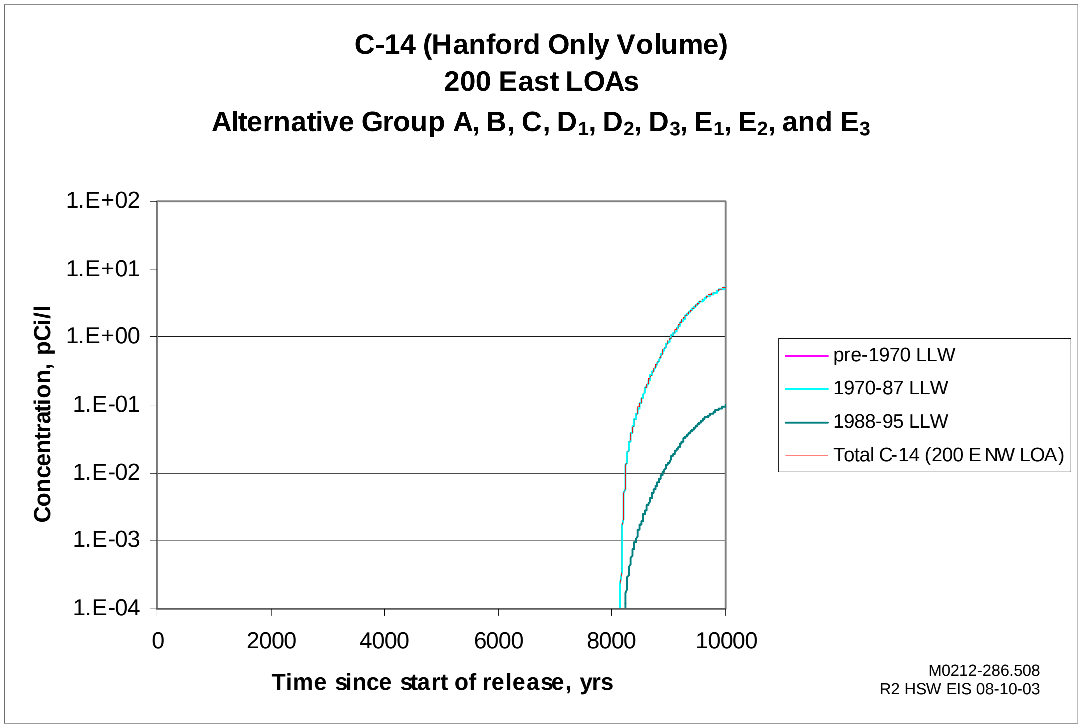


Figure G.20. U-238 and C-14 Concentration Profiles at the 1-km Line of Analysis (200 East) (All Action Alternatives – Wastes Disposed of Before 1996)

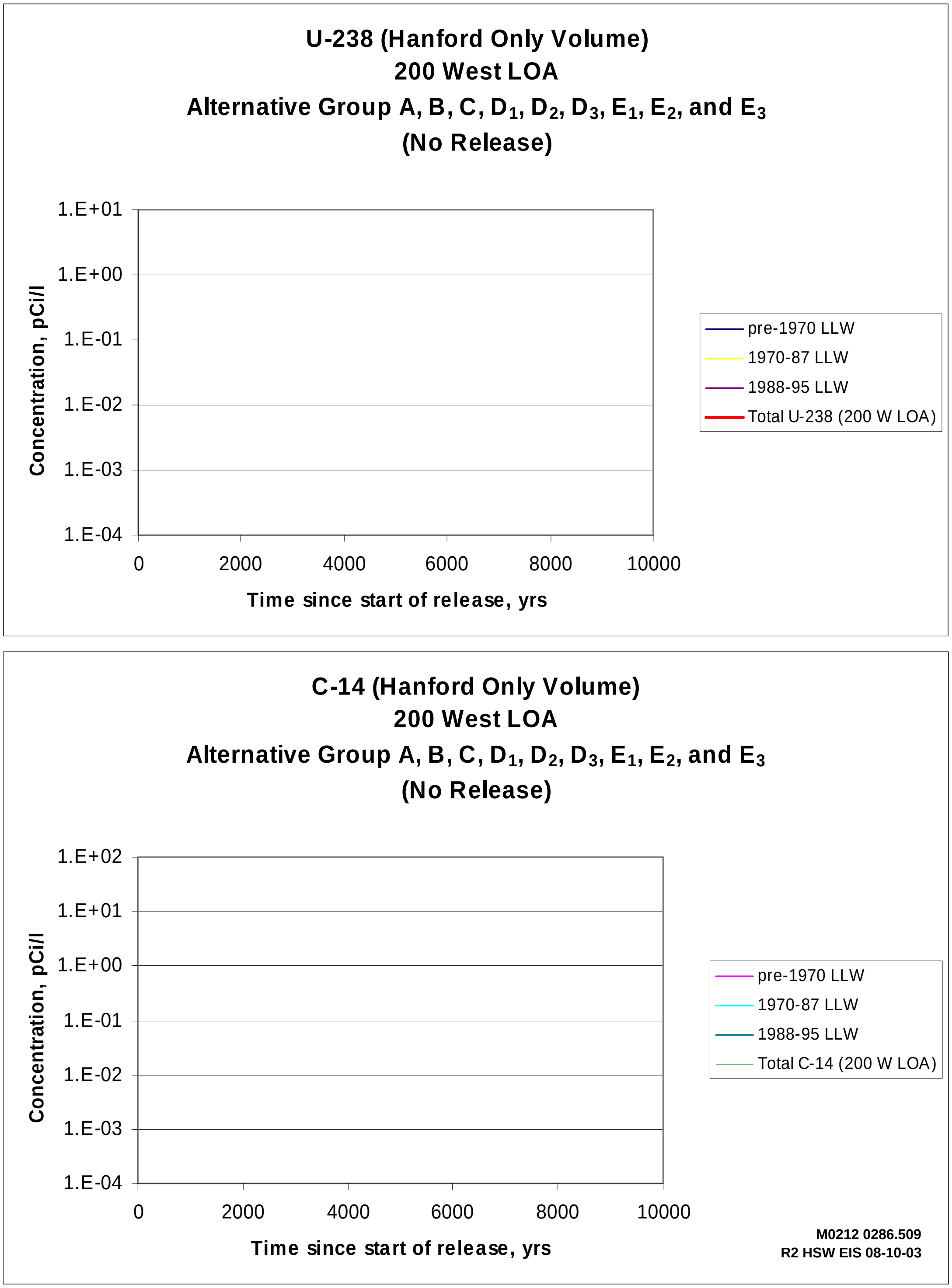


Figure G.21. U-238 and C-14 Concentration Profiles at the 1-km Line of Analysis (200 West) (All Action Alternatives – Wastes Disposed of Before 1996)

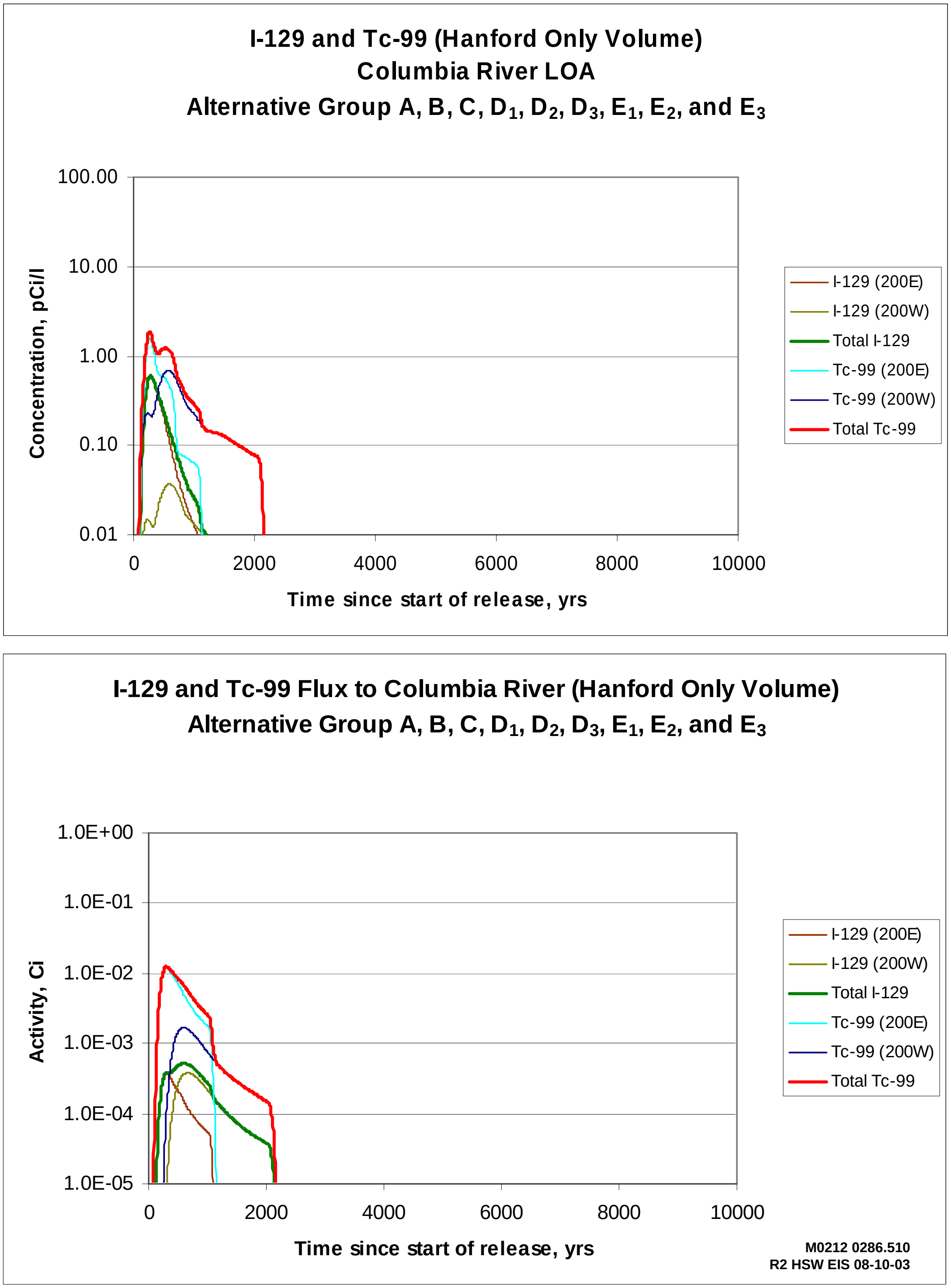


Figure G.22. I-129 and Tc-99 Concentration and River Flux Profiles Near the Columbia River (All Action Alternatives – Wastes Disposed of Before 1996)

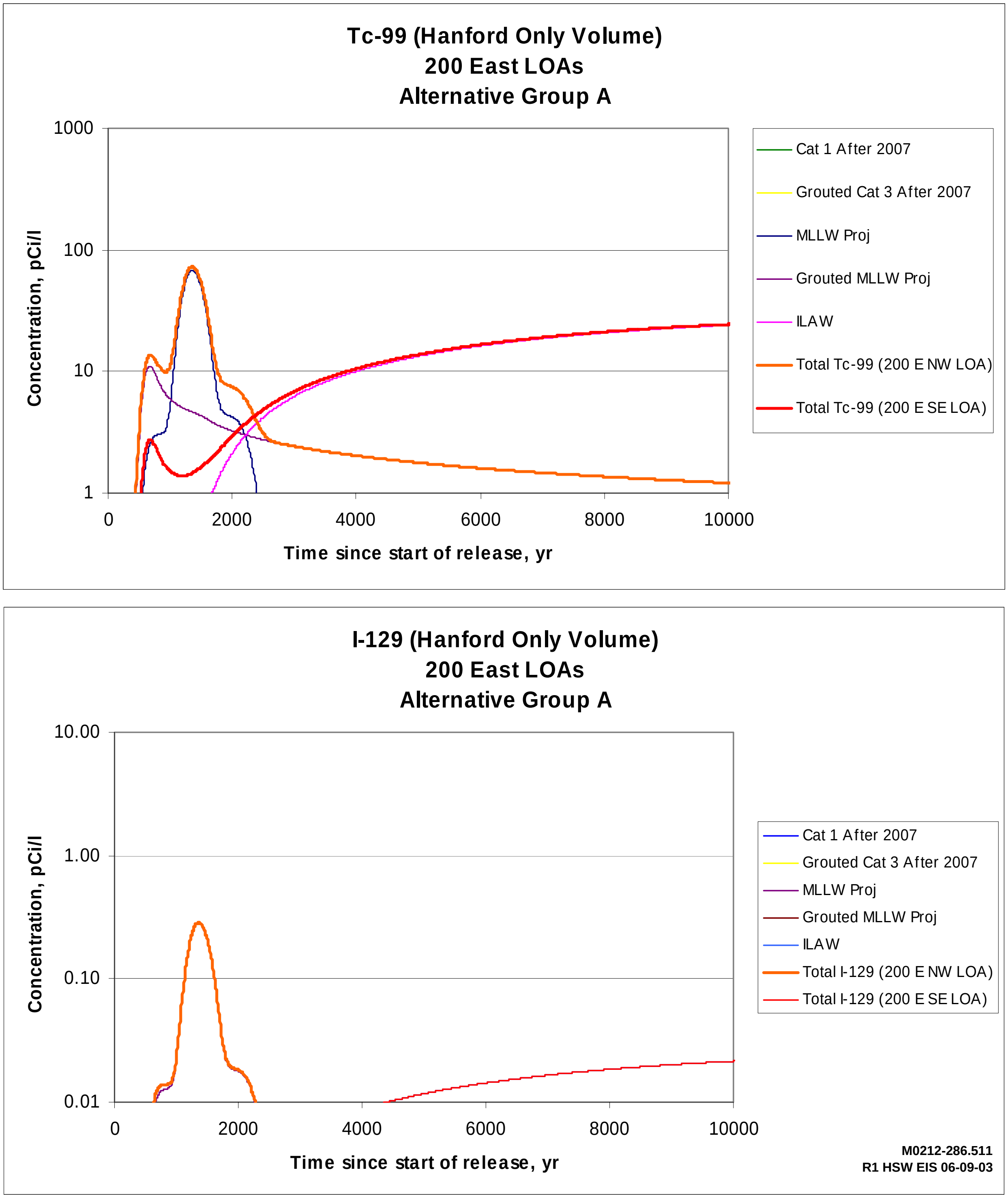


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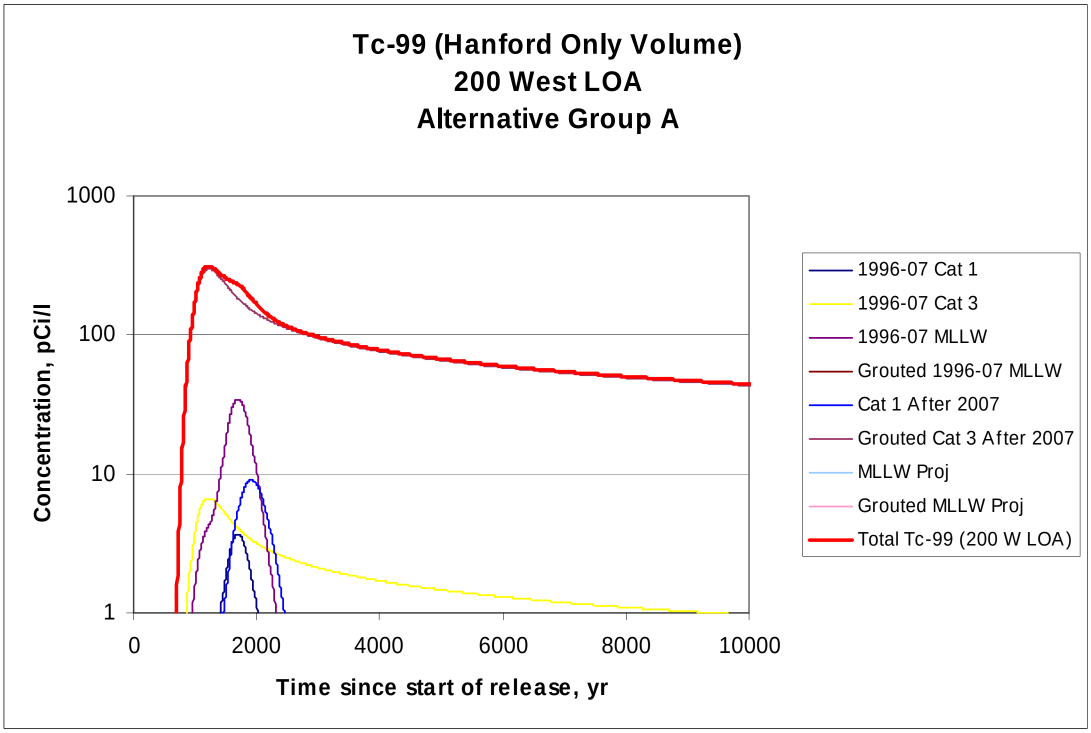
Figure G.23. Tc-99 and I-129 Concentration Profiles at the 1-km Lines of Analysis (200 East) (Alternative Group A – Hanford Only Wastes Disposed of After 1995)



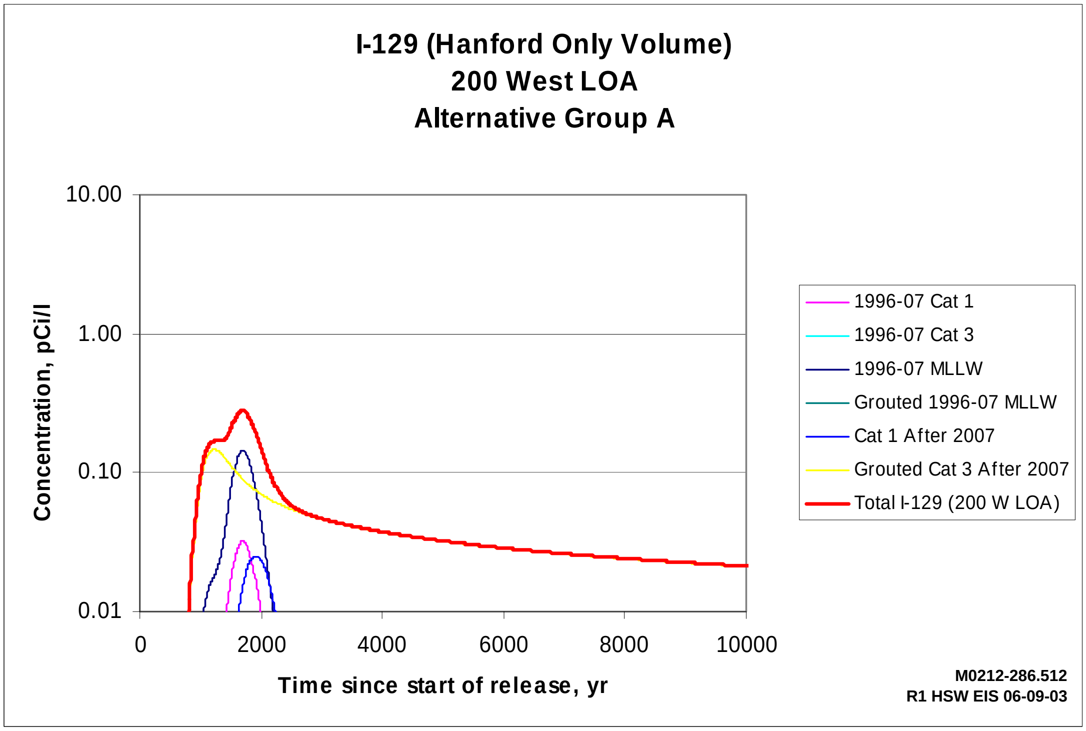


Figure G.24. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (200 West) (Alternative Group A – Hanford Only Wastes Disposed of After 1995)

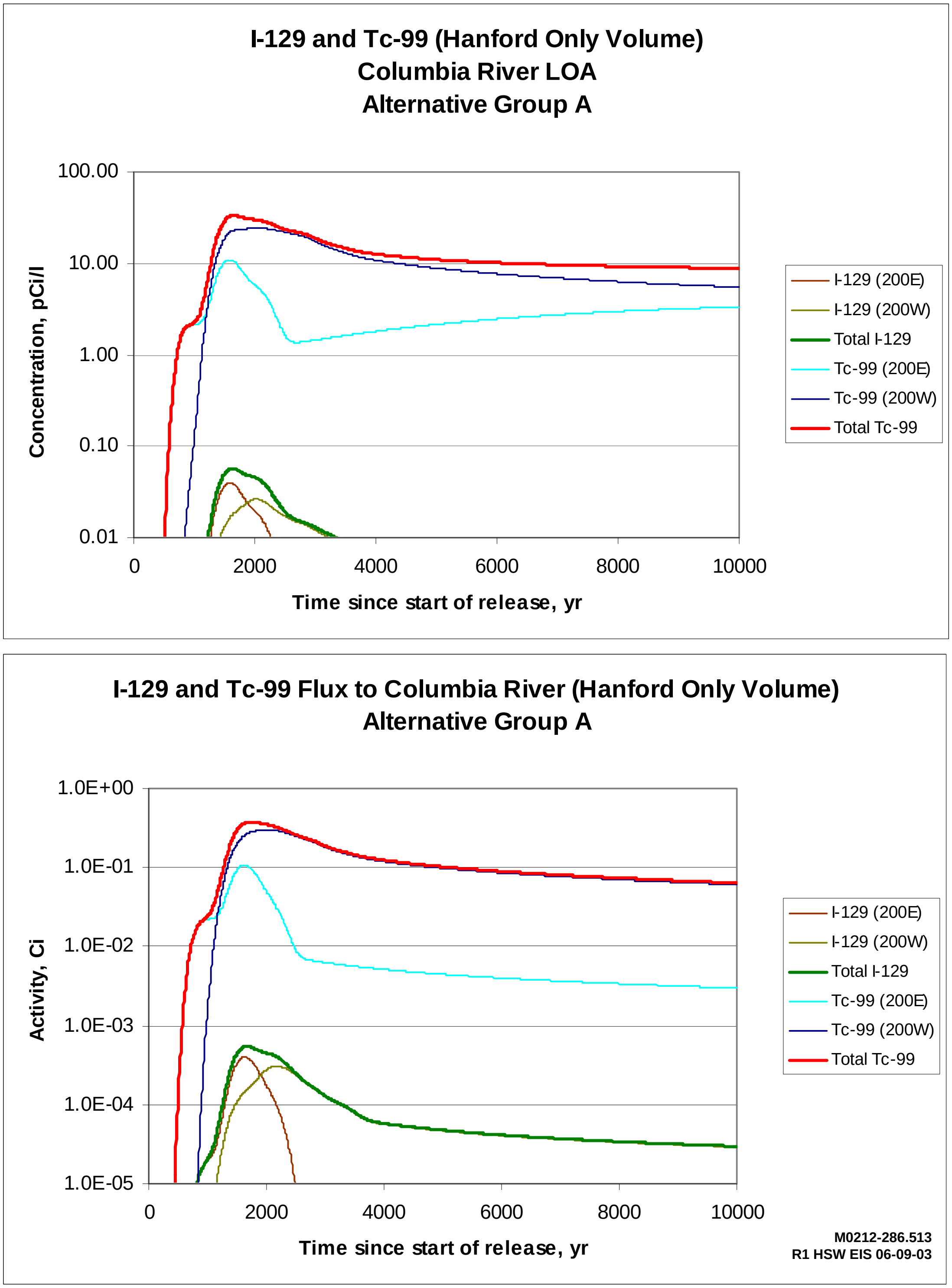


Figure G.25. I-129 and Tc-99 Concentration and River Flux Profiles Near the Columbia River (Alternative Group A – Hanford Only Wastes Disposed of After 1995)

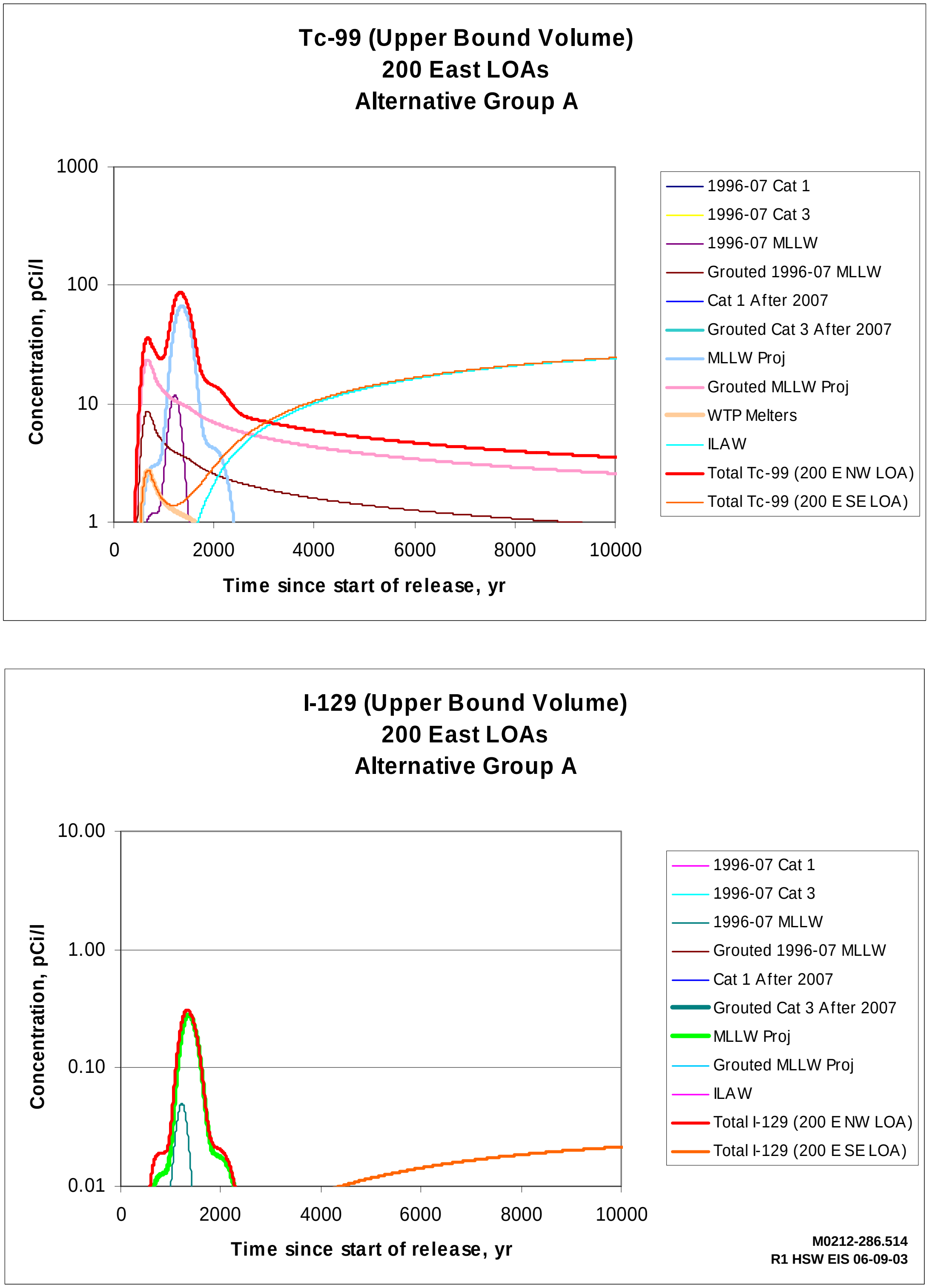


Figure G.26. Tc-99 and I-129 Concentration Profiles at the 1-km Lines of Analysis (200 East) (Alternative Group A – Upper Bound Volume Wastes Disposed of After 1995)

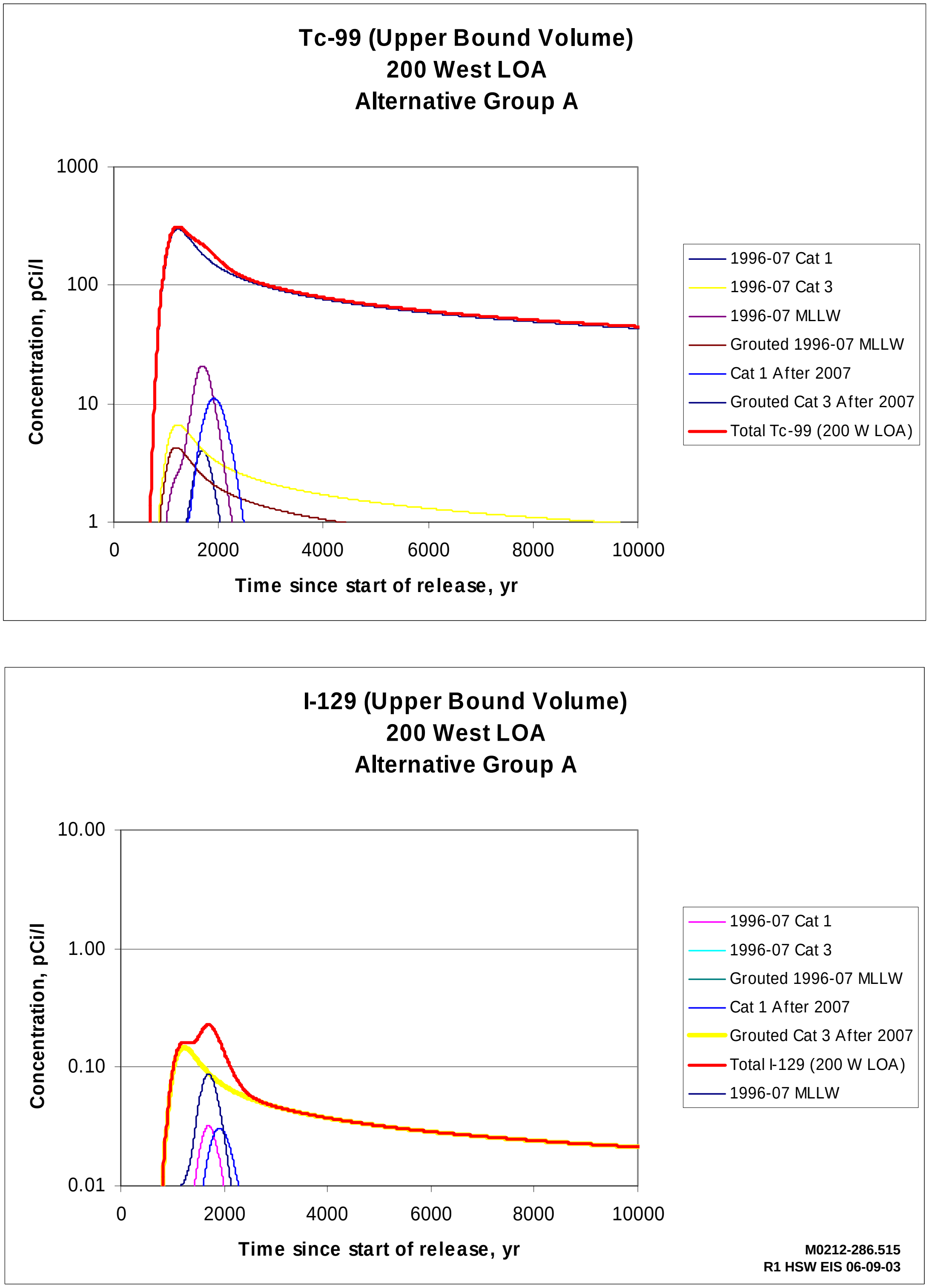


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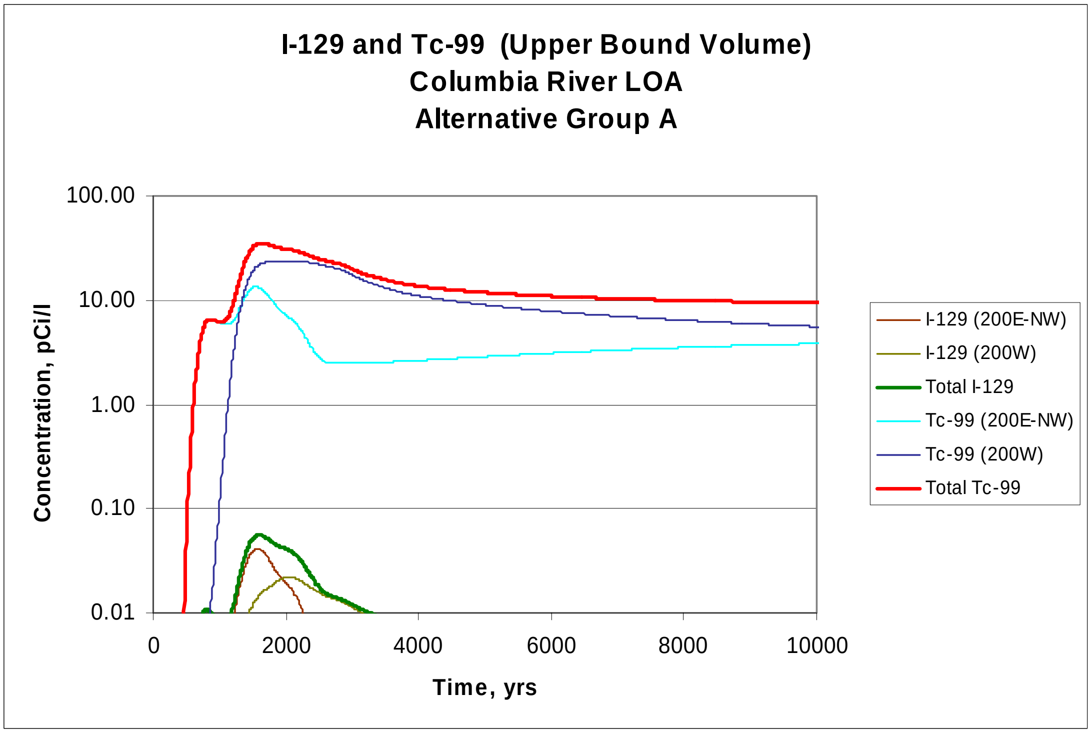
Figure G.27. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (200 West) (Alternative Group A – Upper Bound Volume Wastes Disposed of After 1995)



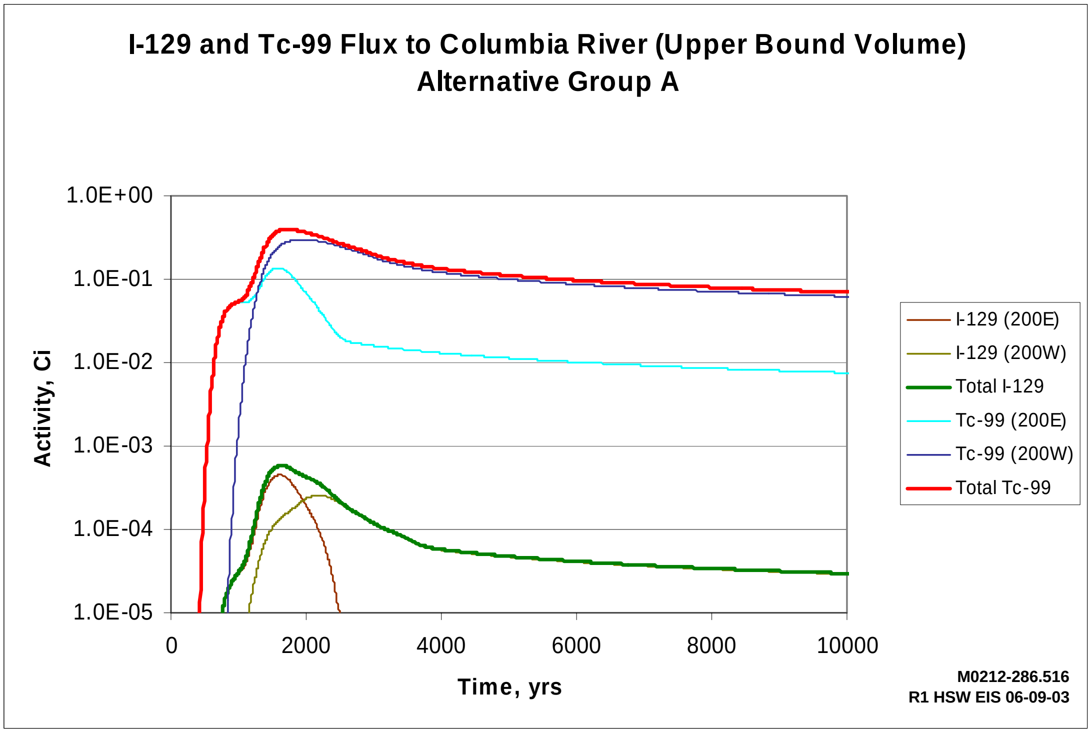
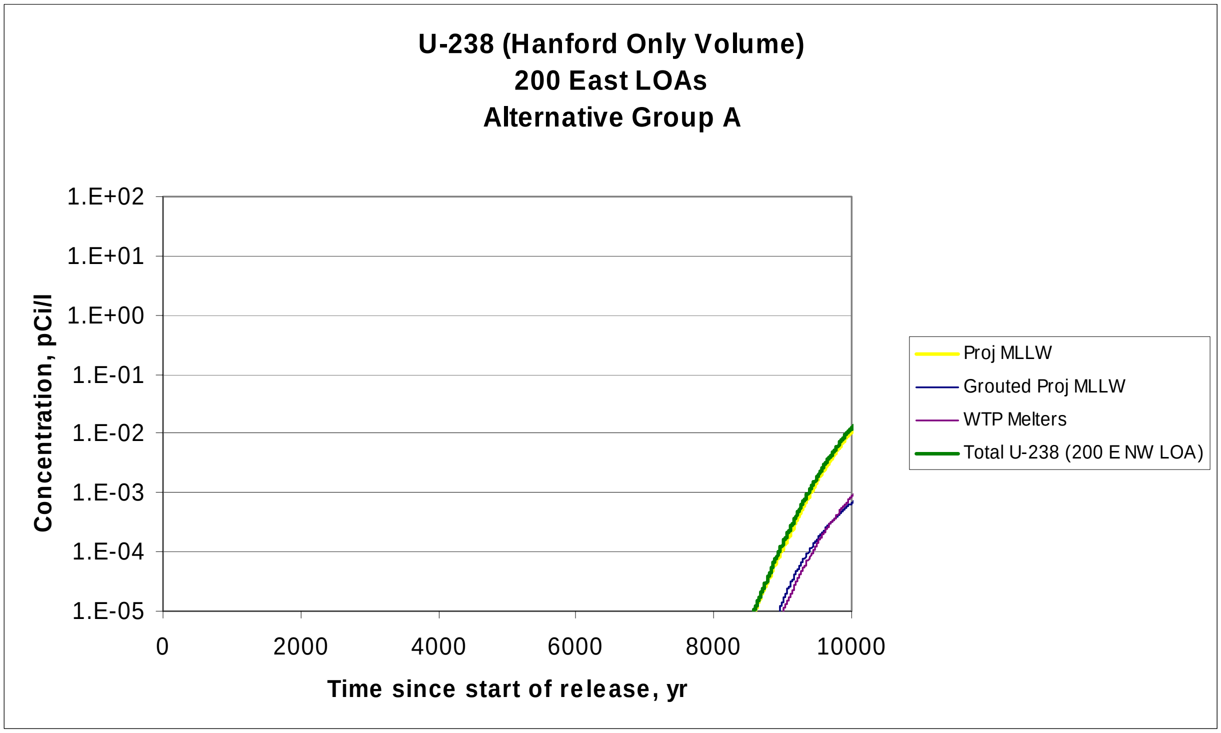


Figure G.28. I-129 and Tc-99 Concentration and River Flux Profiles Near the Columbia River (Alternative Group A – Upper Bound Volume Wastes Disposed of After 1995)



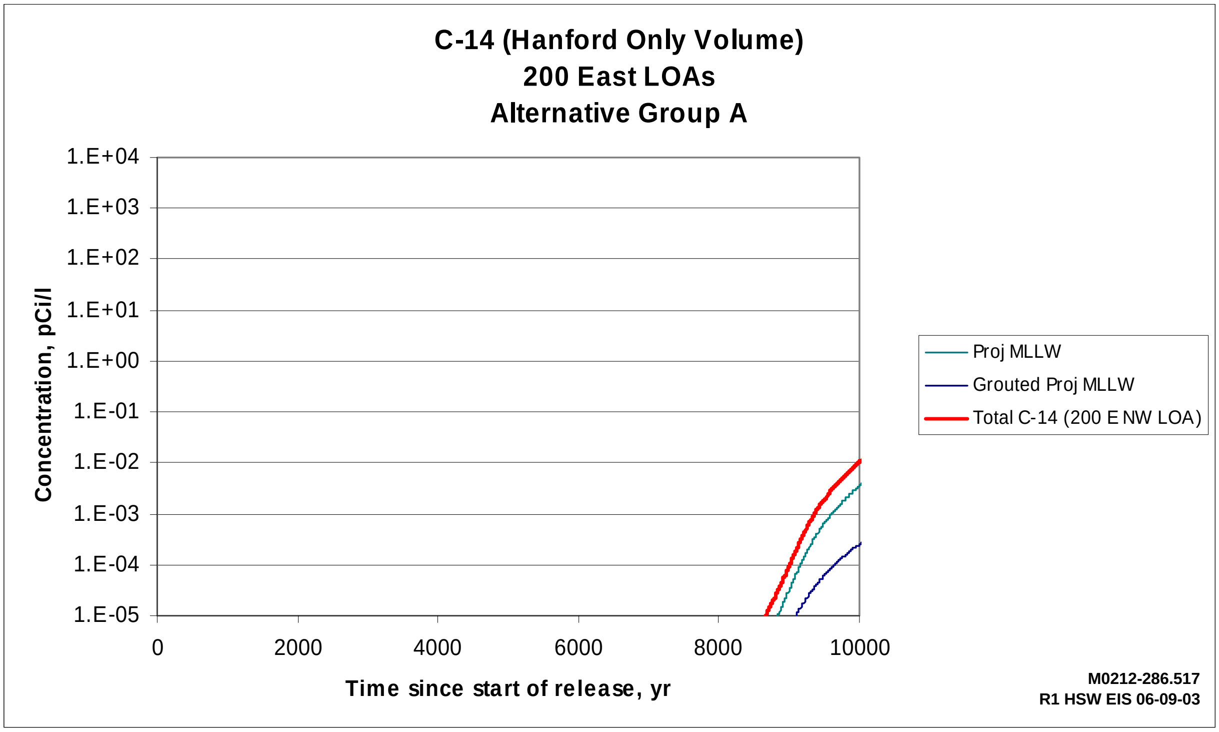
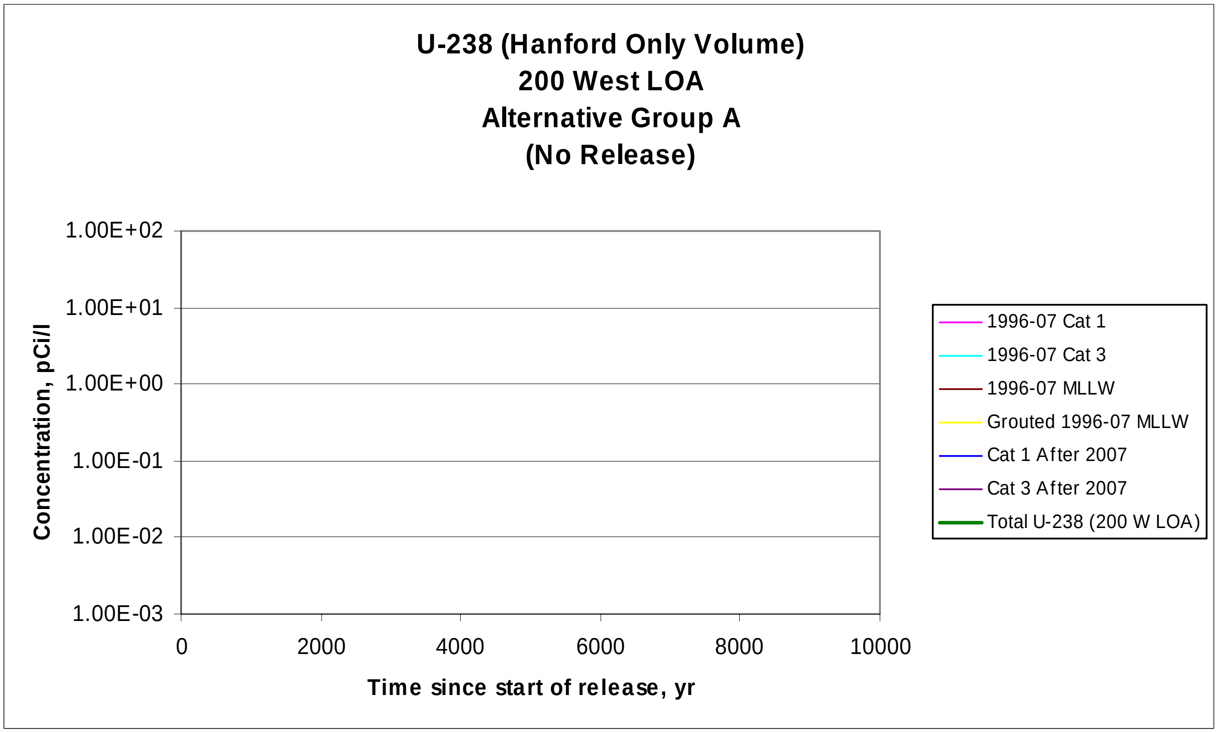


Figure G.29. U-238 and C-14 Concentration Profiles at the 1-km Lines of Analysis (200 East) (Alternative Group A – Hanford Only Wastes Disposed of After 1995)



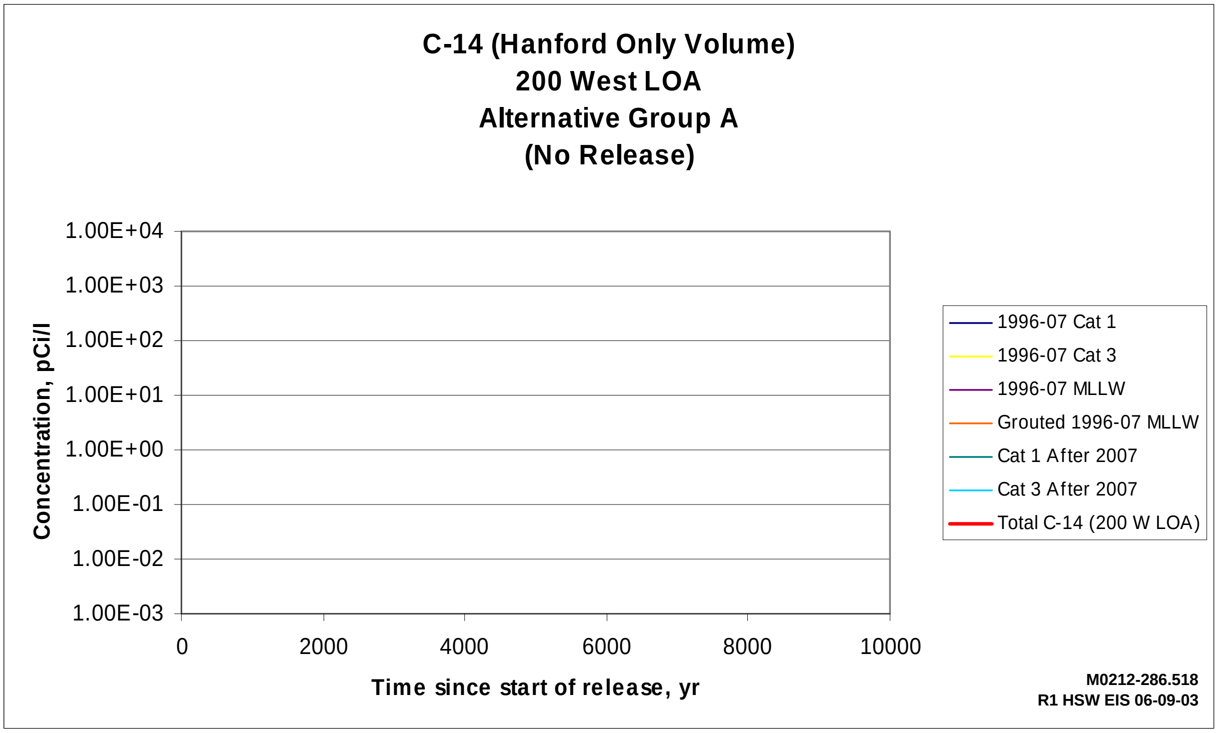


Figure G.30. U-238 and C-14 Concentration Profiles at the 1-km Line of Analysis (200 West) (Alternative Group A – Hanford Only Wastes Disposed of After 1995)

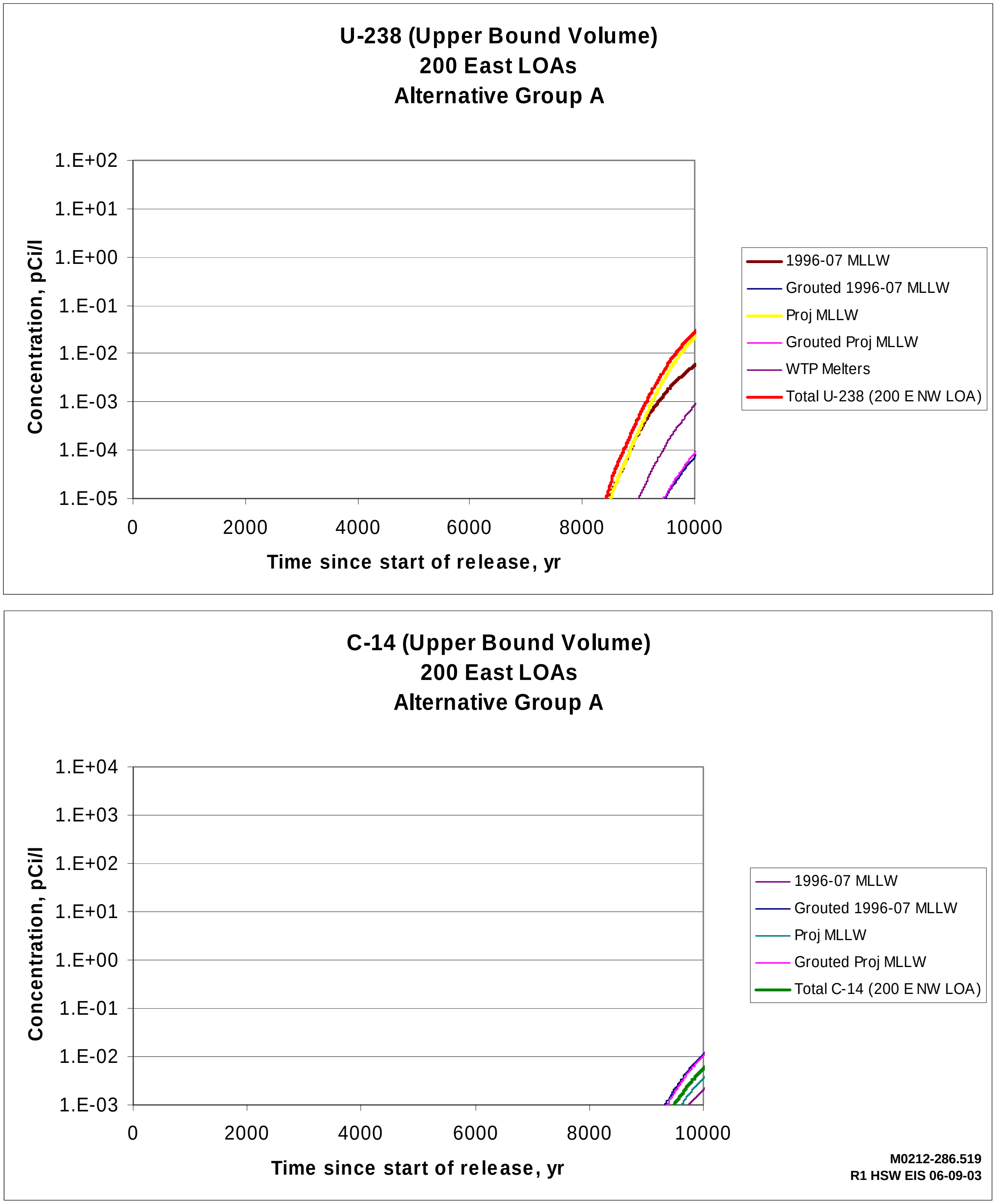
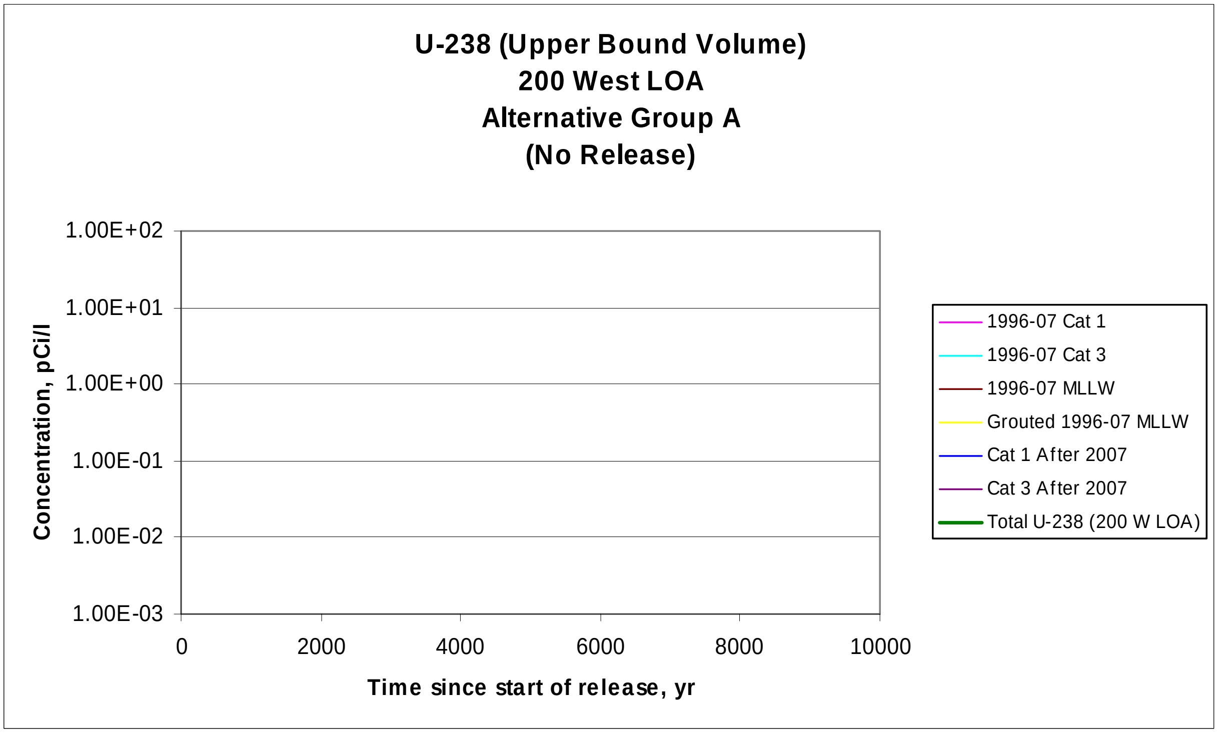


Figure G.31. U-238 and C-14 Concentration Profiles at the 1-km Lines of Analysis (200 East) (Alternative Group A – Upper Bound Volume Wastes Disposed of After 1995)



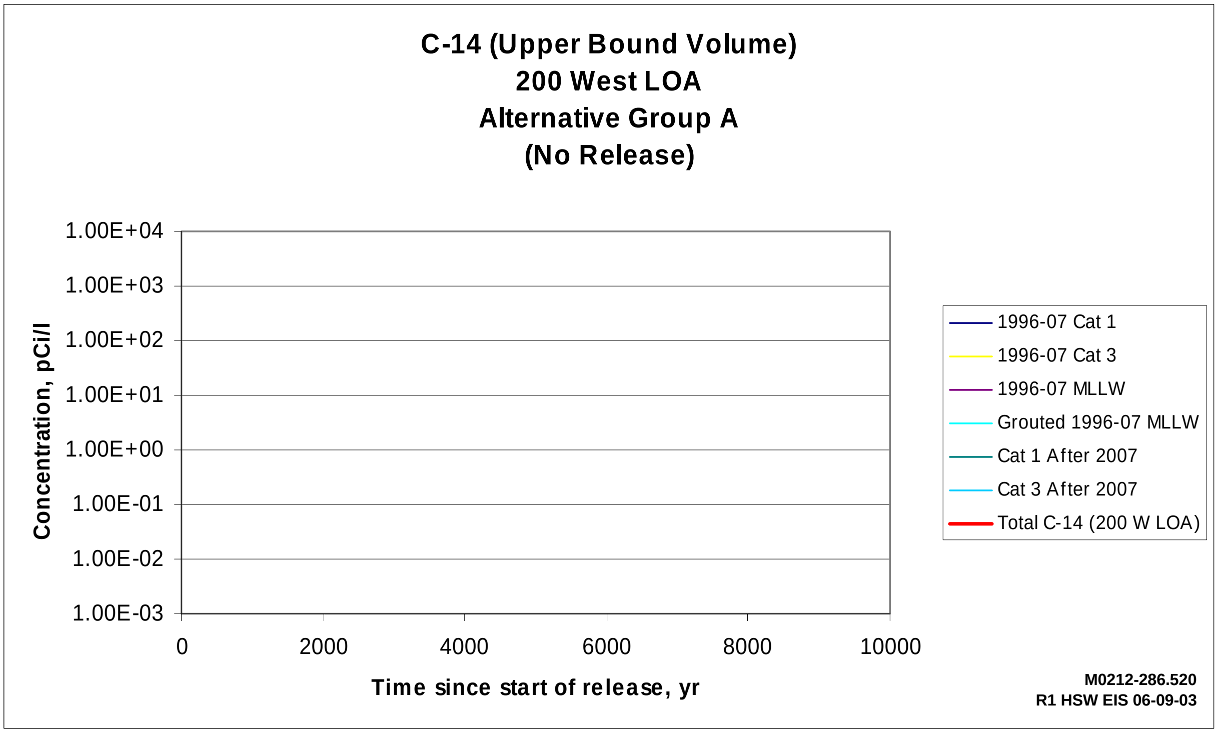


Figure G.32. U-238 and C-14 Concentration Profiles at the 1-km Line of Analysis (200 West) (Alternative Group A – Upper Bound Volume Wastes Disposed of After 1995)

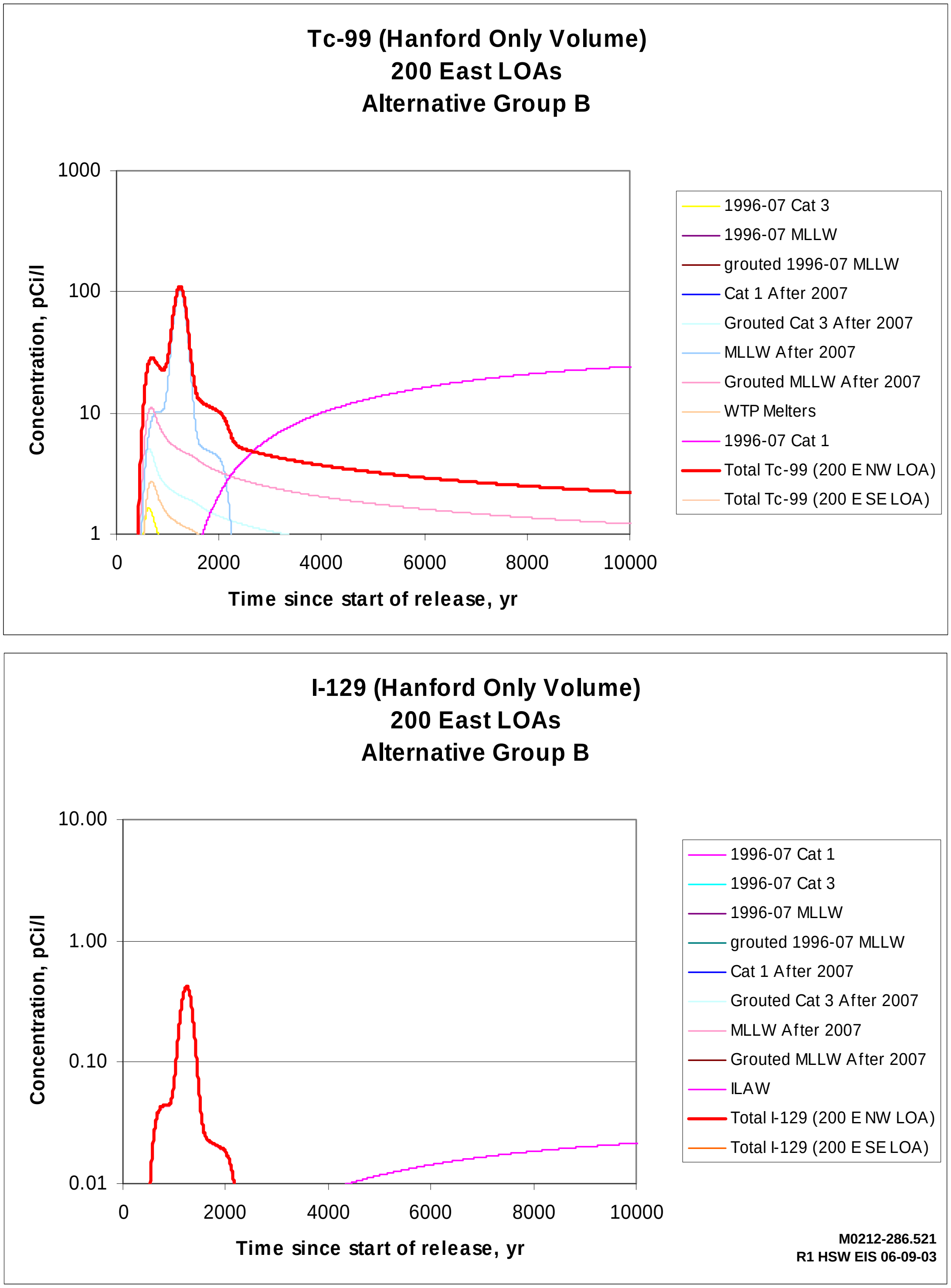


Figure G.33. Tc-99 and I-129 Concentration Profiles at the 1-km Lines of Analysis (200 East) (Alternative Group B – Hanford Only Wastes Disposed of After 1995)

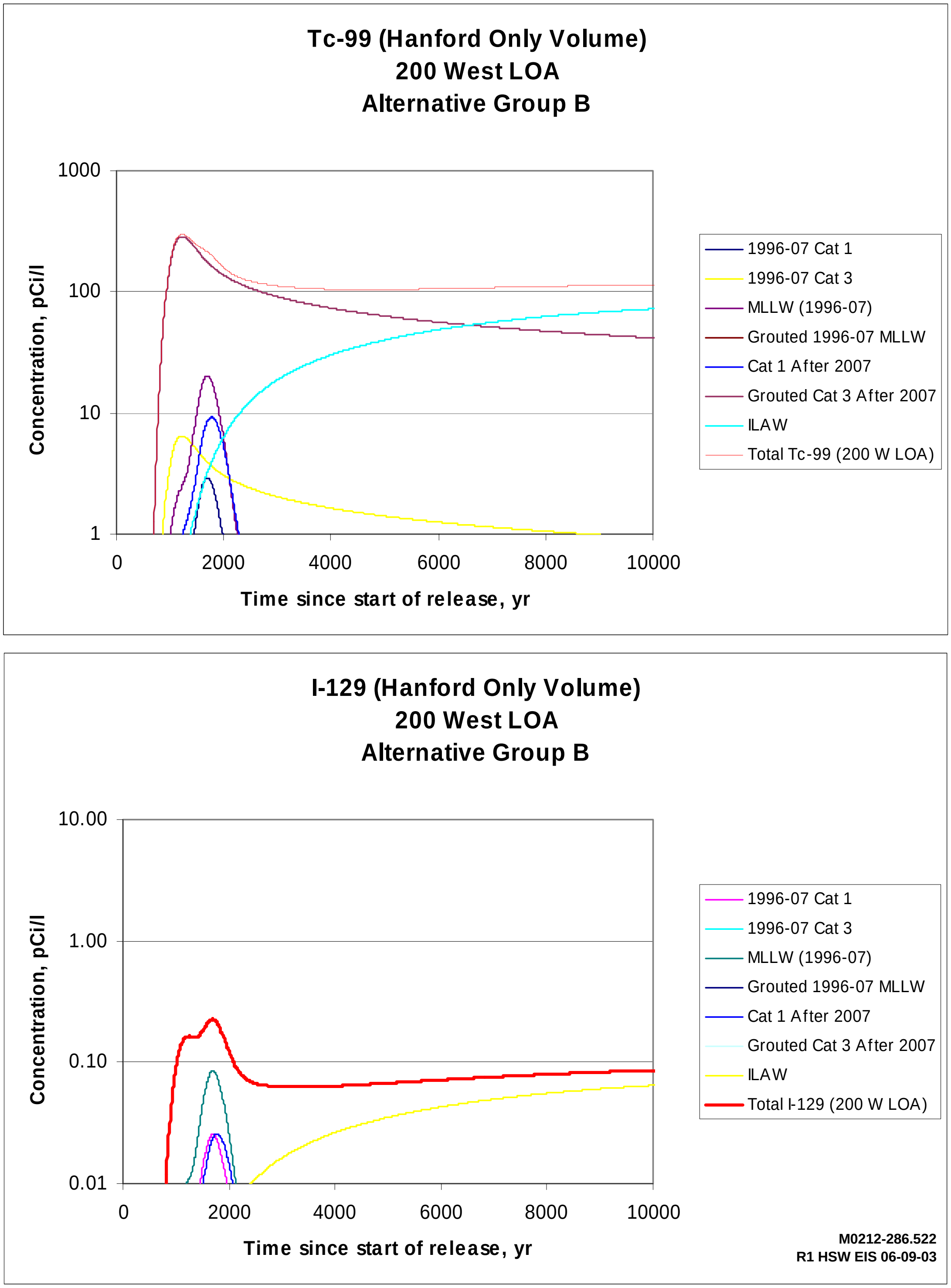


Figure G.34. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (200 West) (Alternative Group B – Hanford Only Wastes Disposed of After 1995)

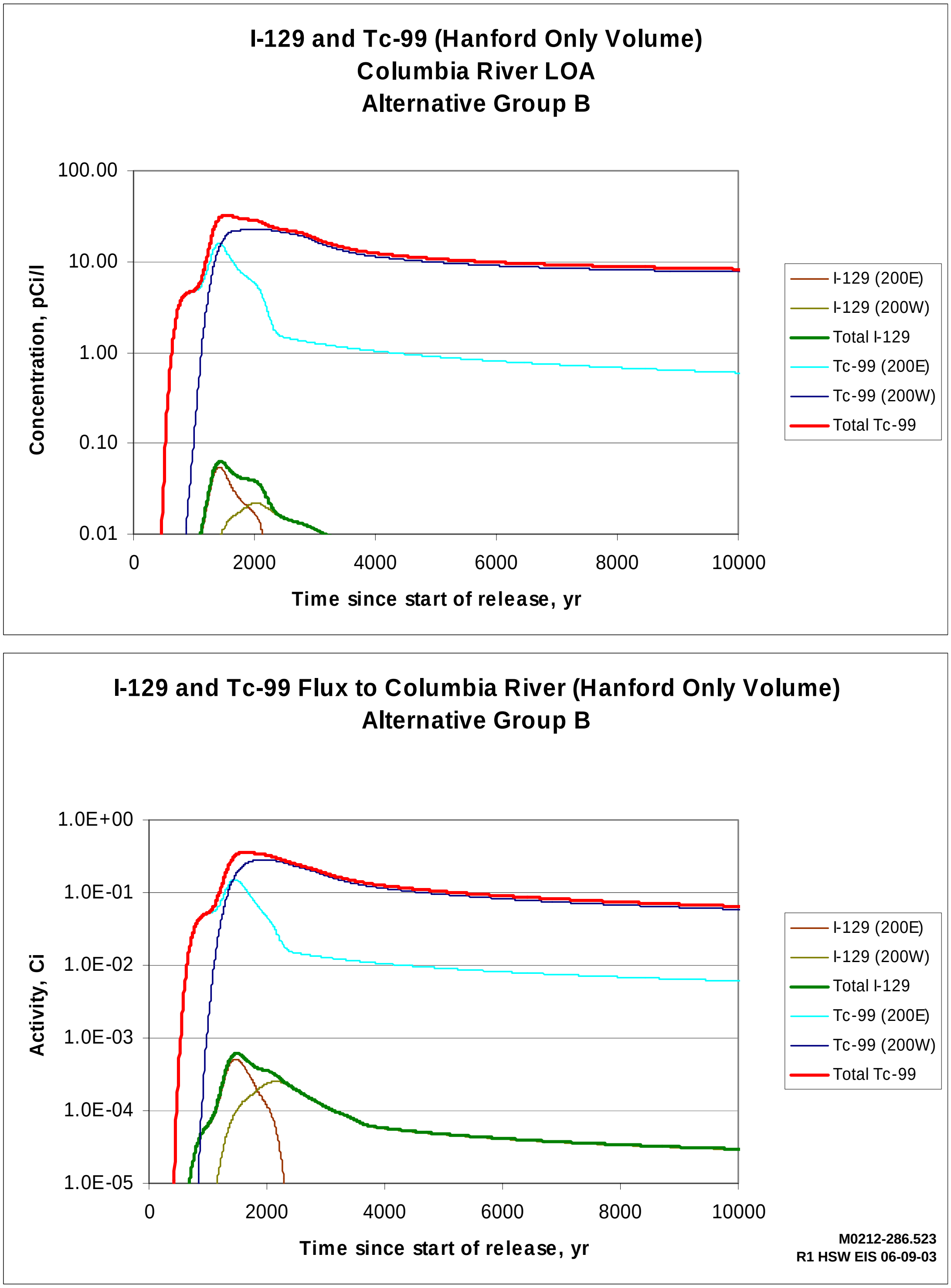


Figure G.35. I-129 and Tc-99 Concentration and River Flux Profiles Near the Columbia River (Alternative Group B – Hanford Only Wastes Disposed of After 1995)

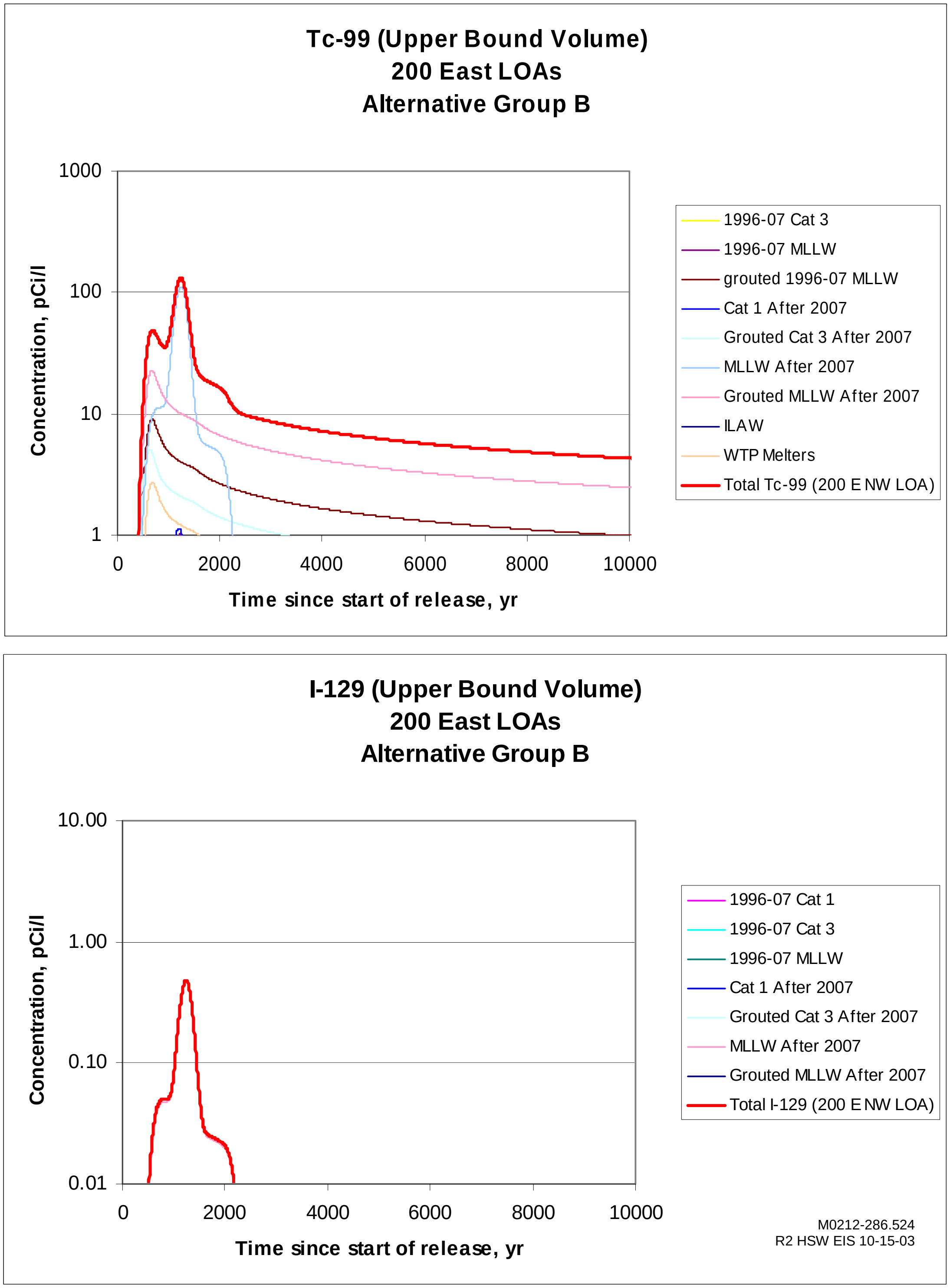


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Figure G.36. Tc-99 and I-129 Concentration Profiles at the 1-km Lines of Analysis (200 East) (Alternative Group B – Upper Bound Volume Wastes Disposed of After 1995)

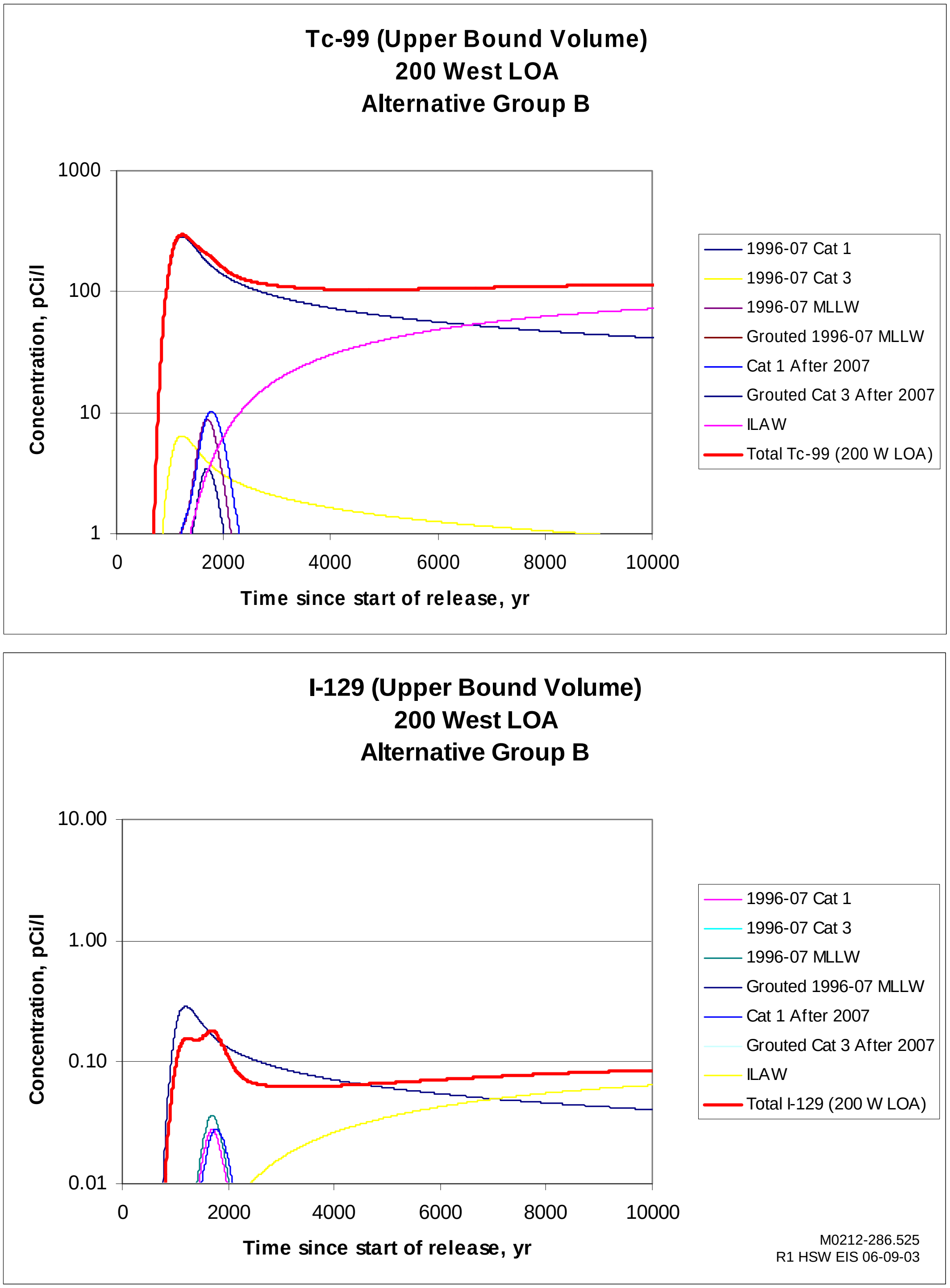


Figure G.37. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (200 West) (Alternative Group B – Upper Bound Volume Wastes Disposed of After 1995)

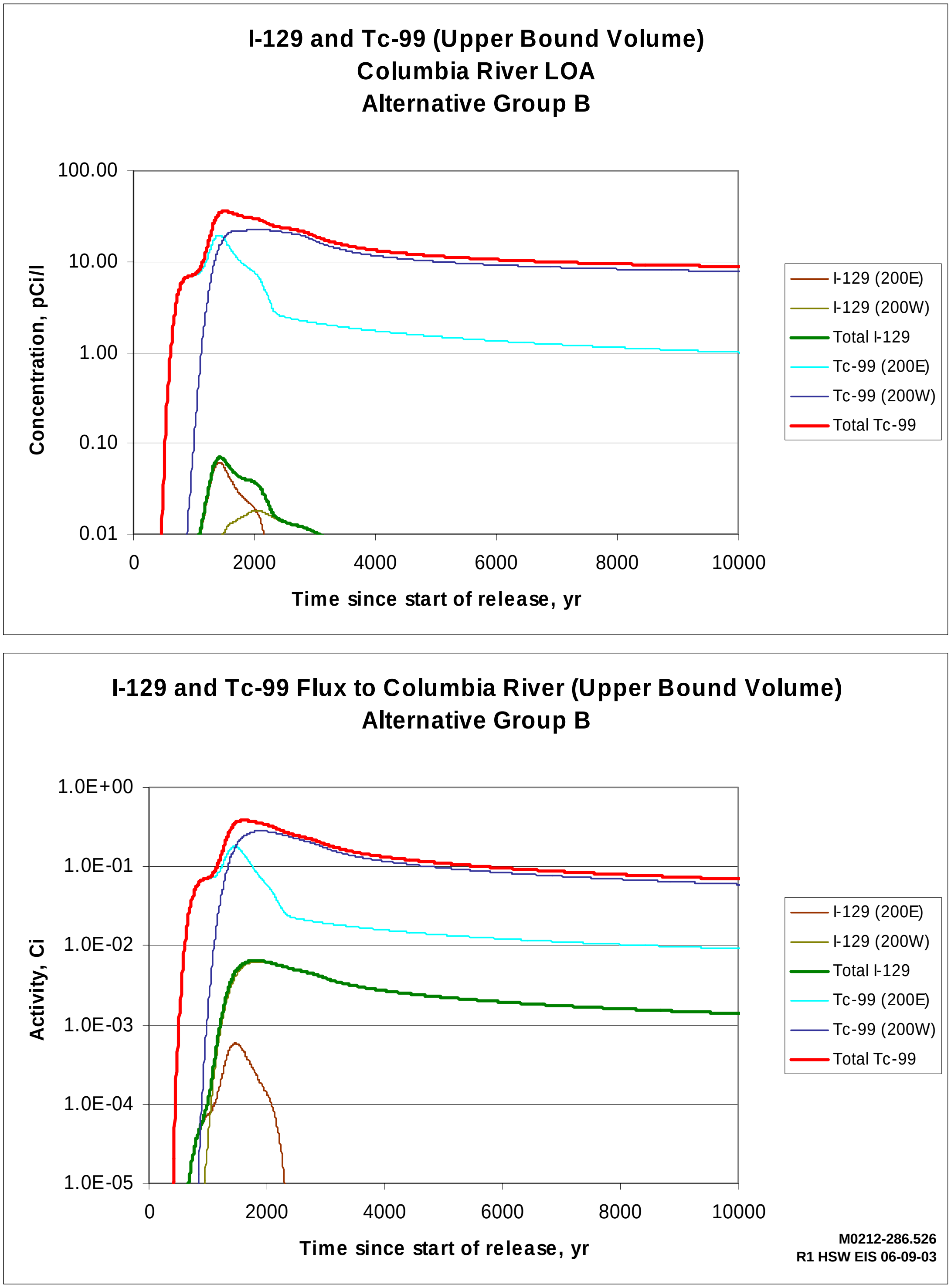
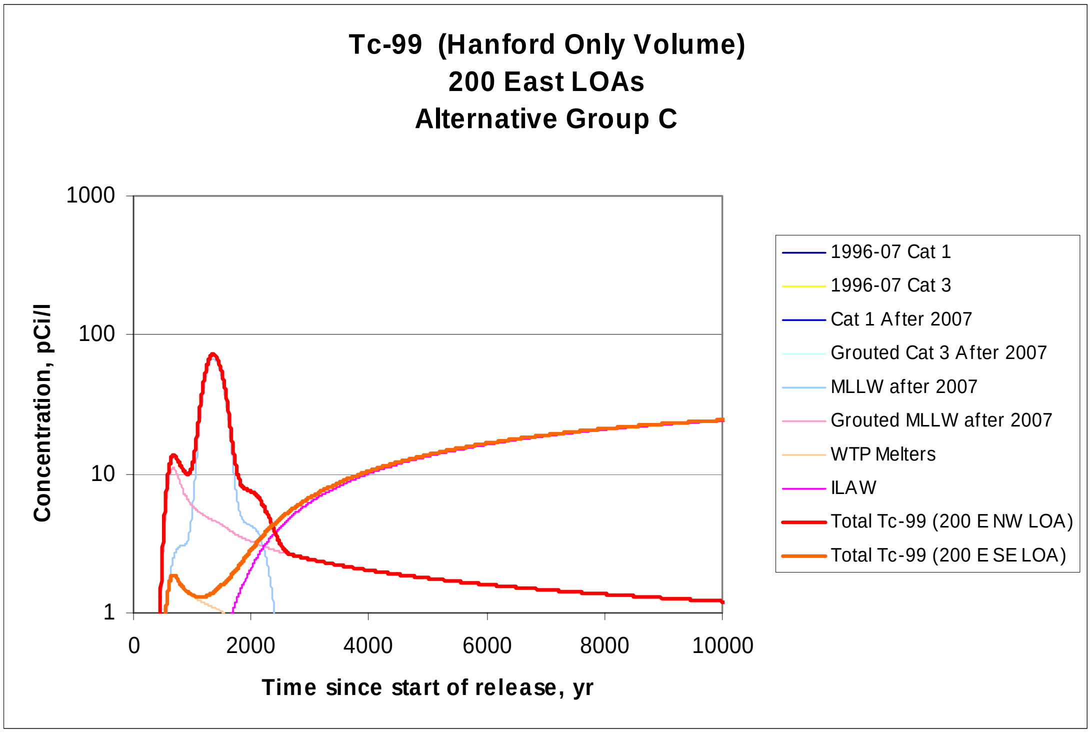


Figure G.38. I-129 and Tc-99 Concentration and River Flux Profiles Near the Columbia River (Alternative Group B – Upper Bound Volume Wastes Disposed of After 1995)



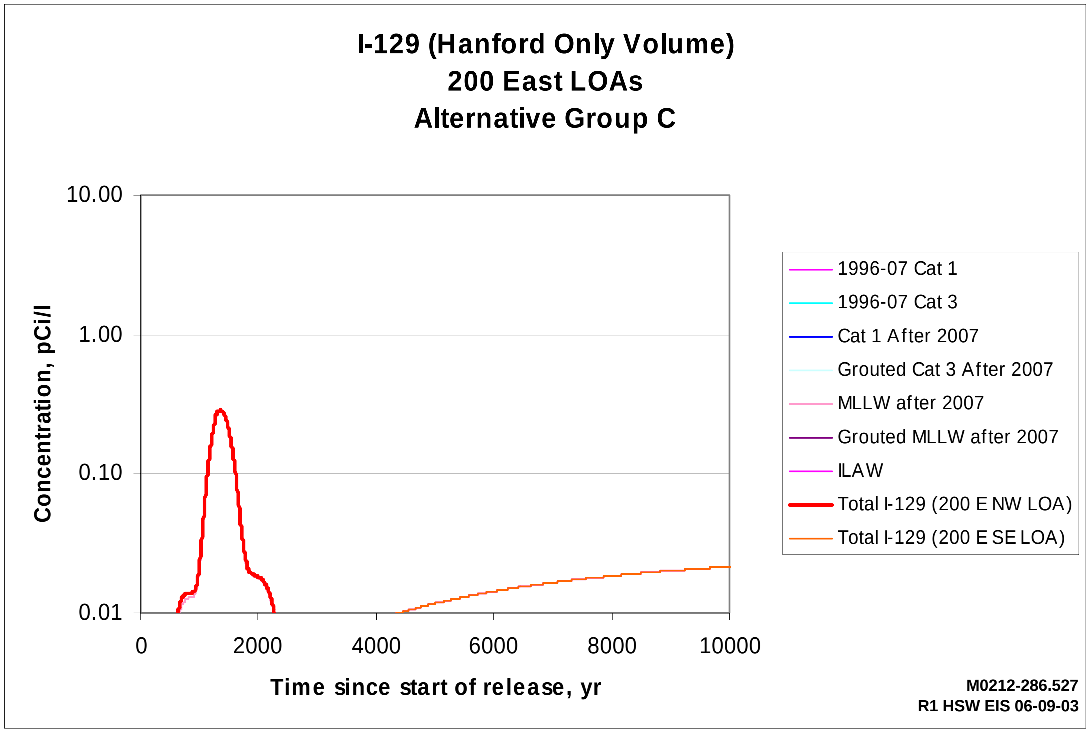


Figure G.39. Tc-99 and I-129 Concentration Profiles at the 1-km Lines of Analysis (200 East) (Alternative Group C – Hanford Only Wastes Disposed of After 1995)

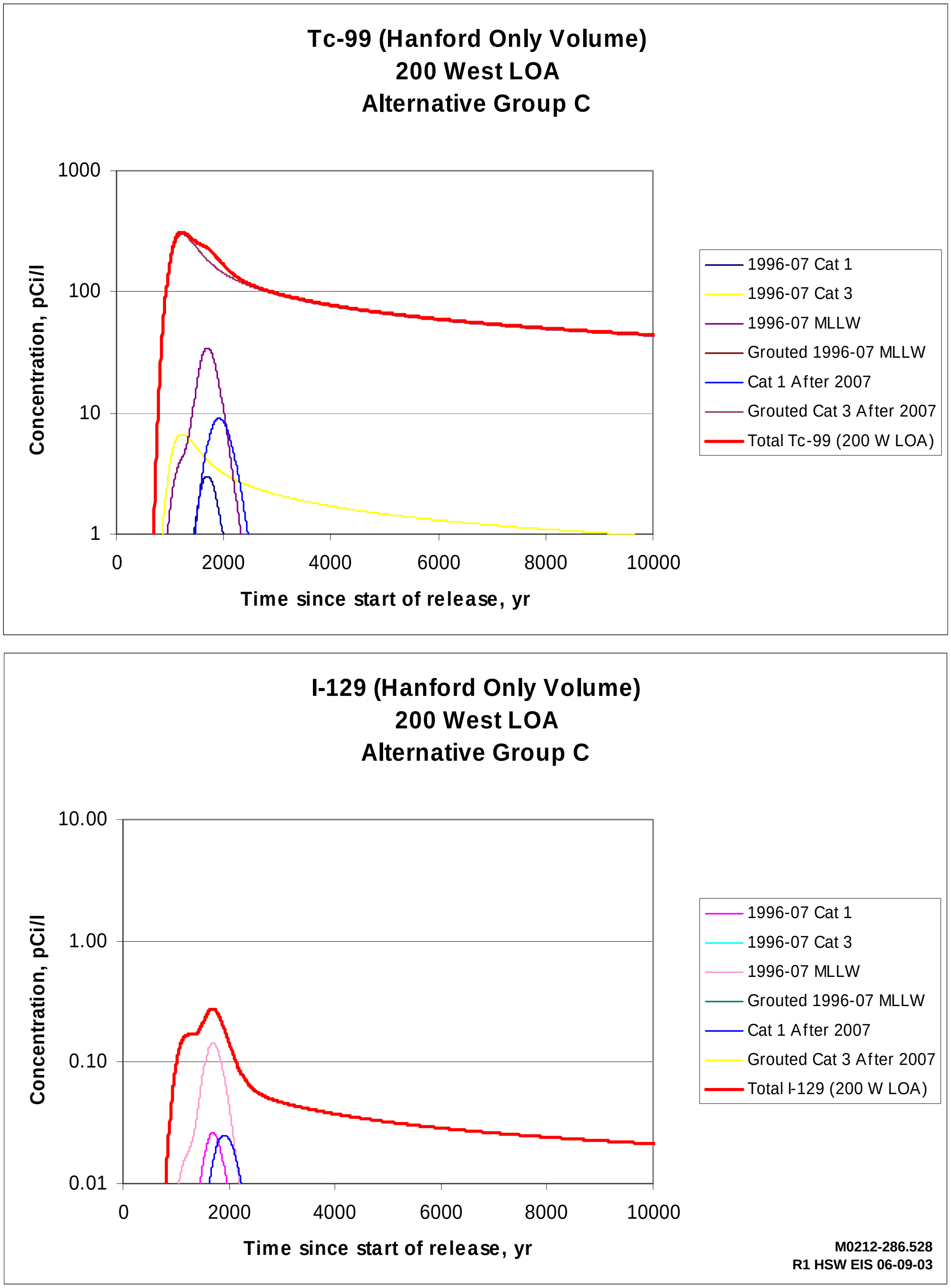


Figure G.40. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (200 West) (Alternative Group C – Hanford Only Wastes Disposed of After 1995)

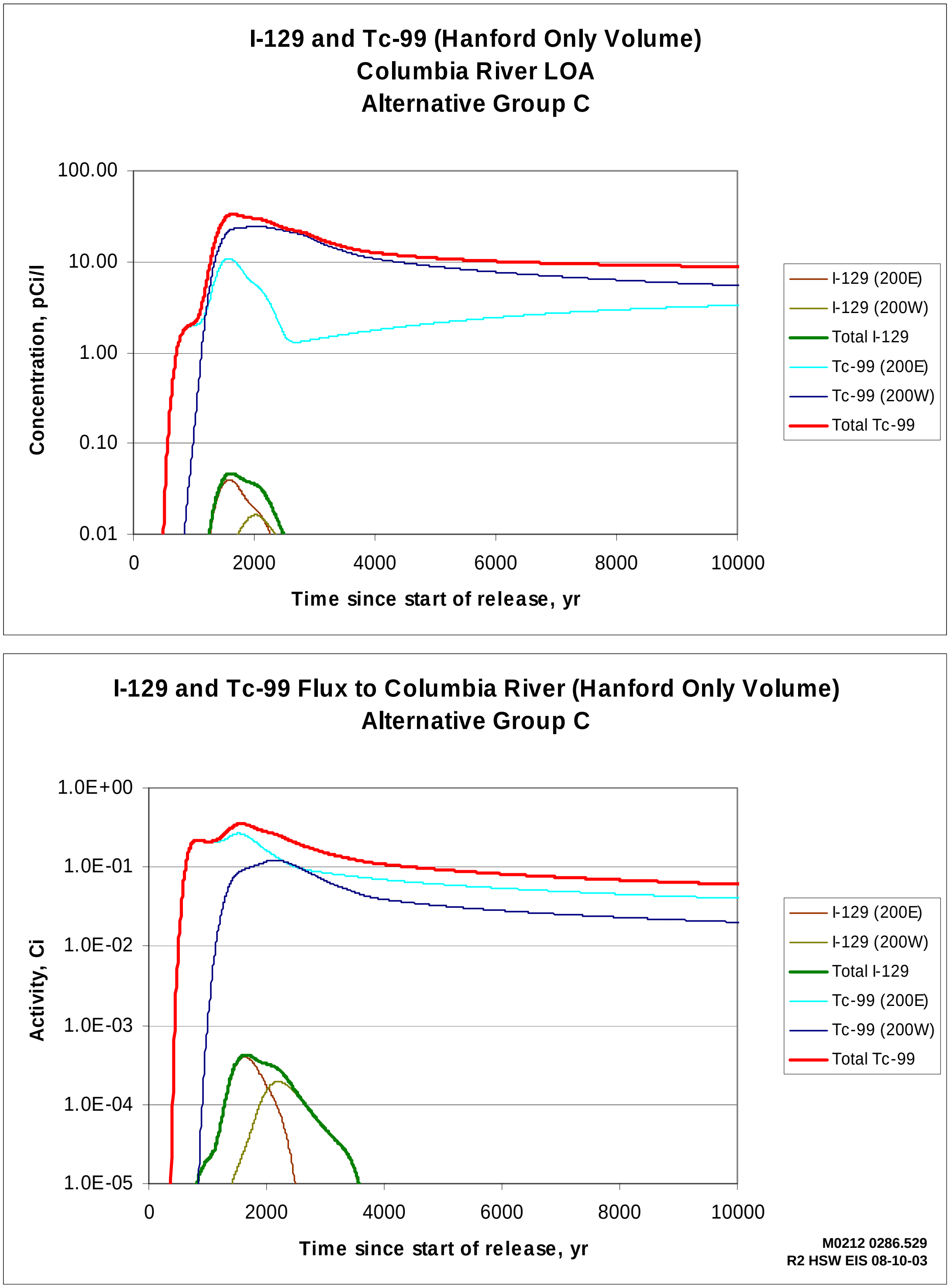


Figure G.41. I-129 and Tc-99 Concentration and River Flux Profiles Near the Columbia River (Alternative Group C – Hanford Only Wastes Disposed of After 1995)

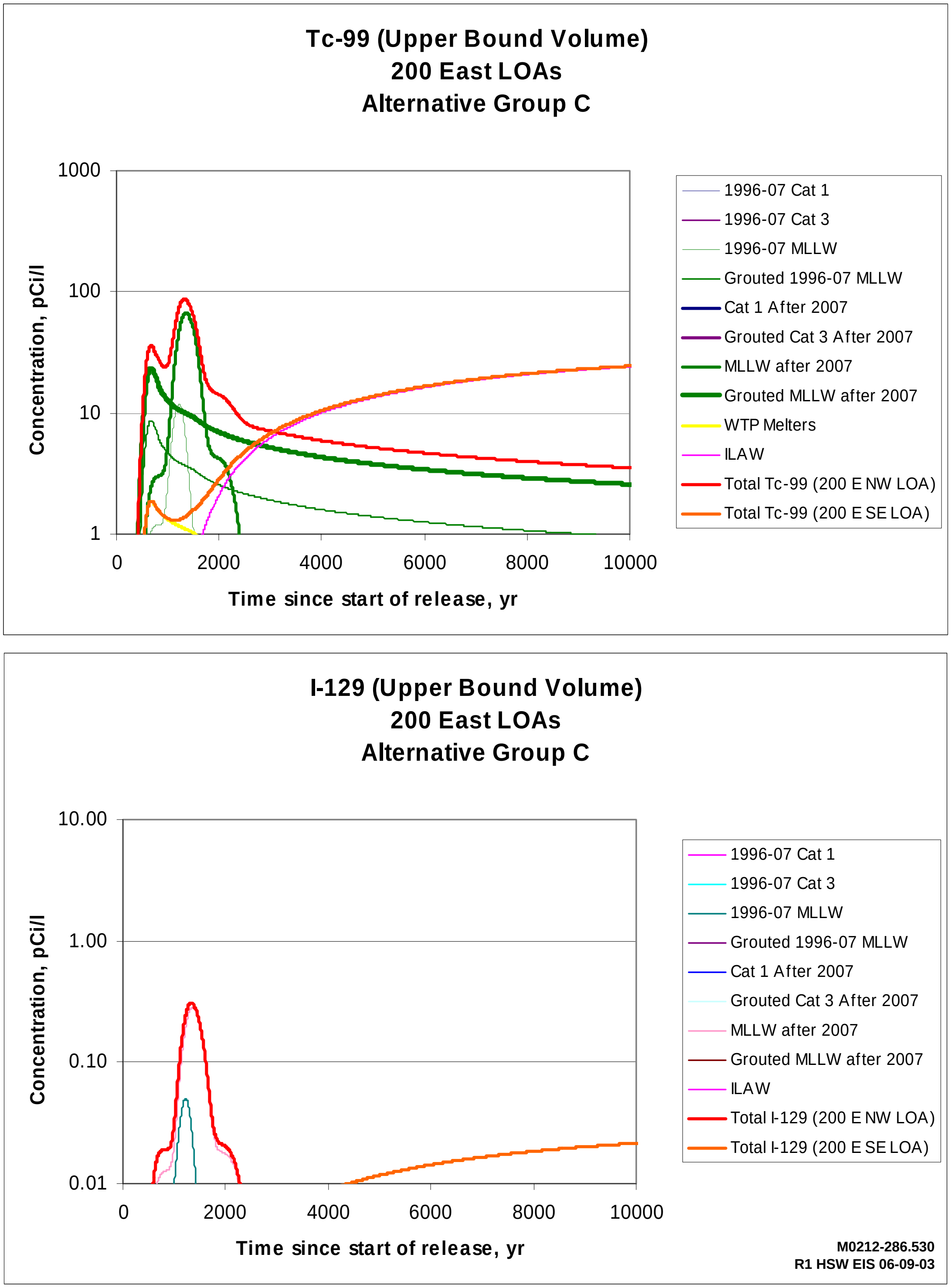
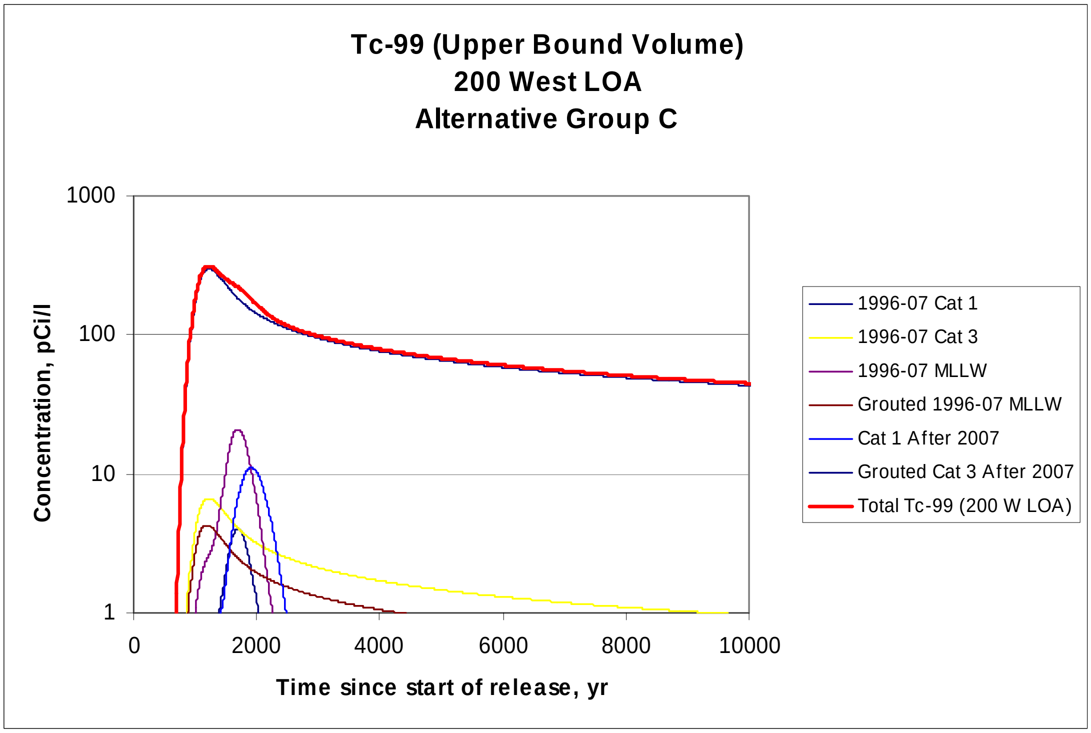


Figure G.42. Tc-99 and I-129 Concentration Profiles at the 1-km Lines of Analysis (200 East) (Alternative Group C – Upper Bound Volume Wastes Disposed of After 1995)



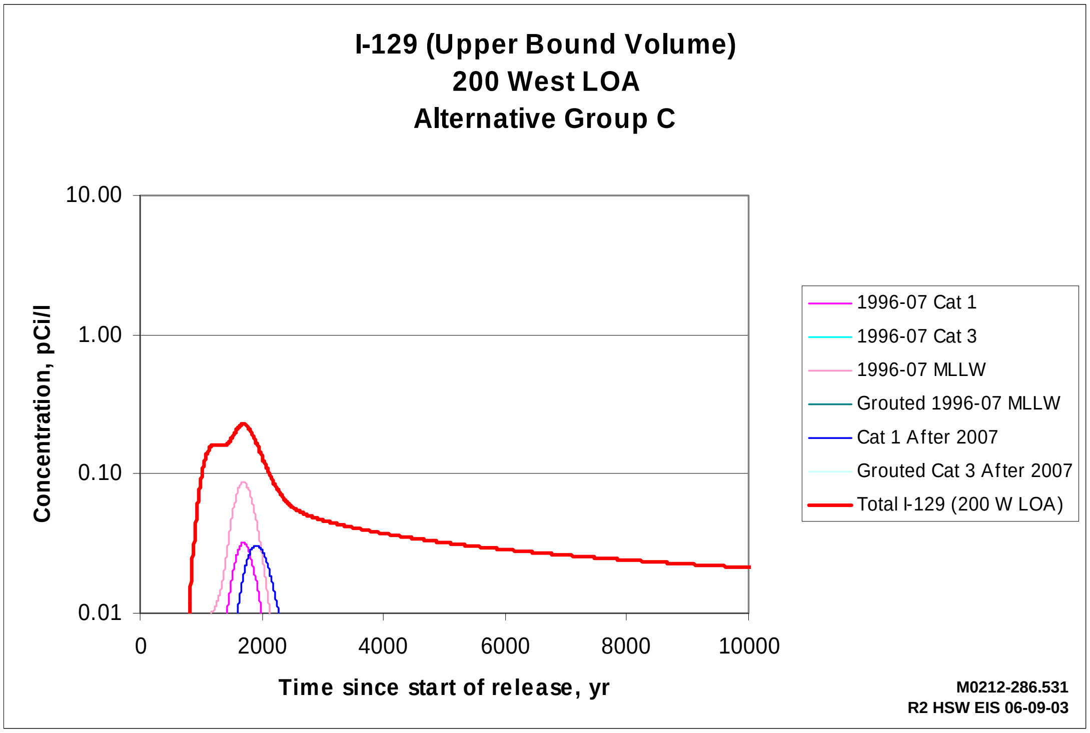
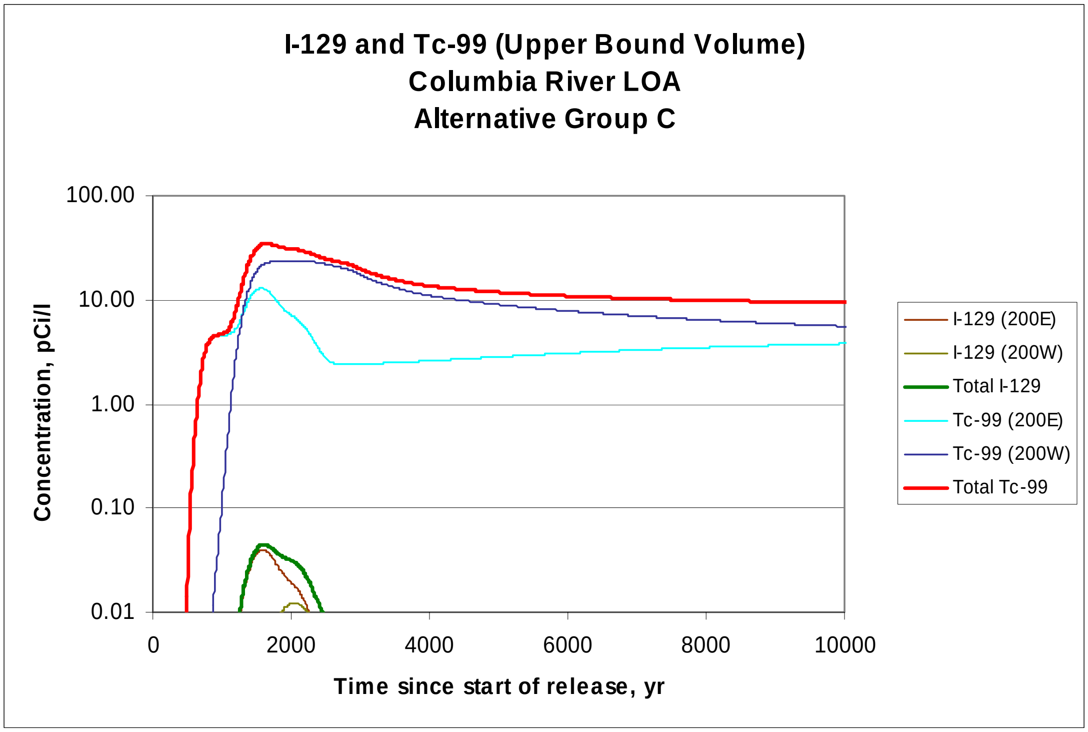


Figure G.43. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (200 West) (Alternative Group C – Upper Bound Volume Wastes Disposed of After 1995)



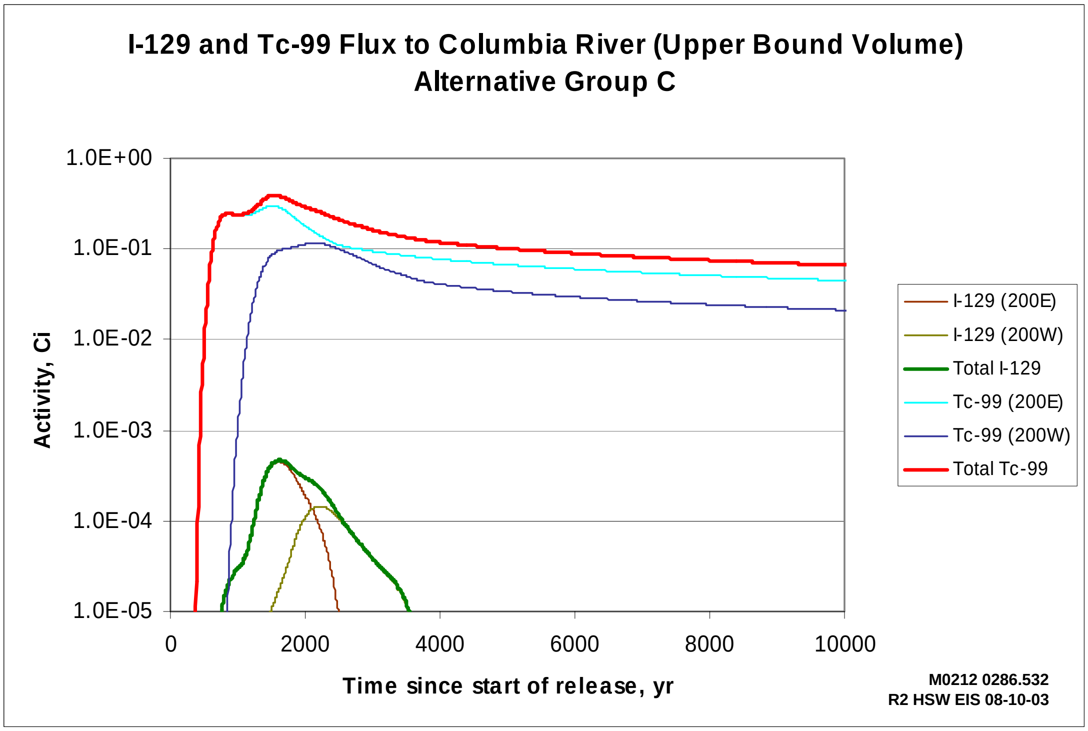
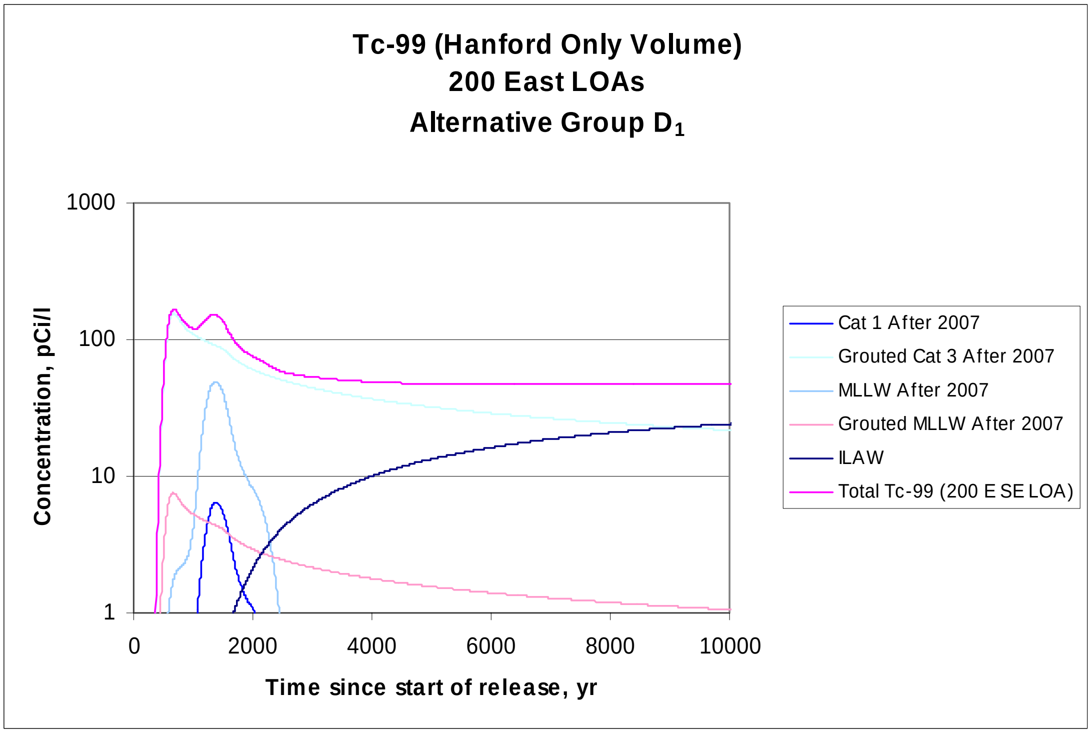


Figure G.44. I-129 and Tc-99 Concentration and River Flux Profiles Near the Columbia River (Alternative Group C – Upper Bound Volume Wastes Disposed of After 1995)



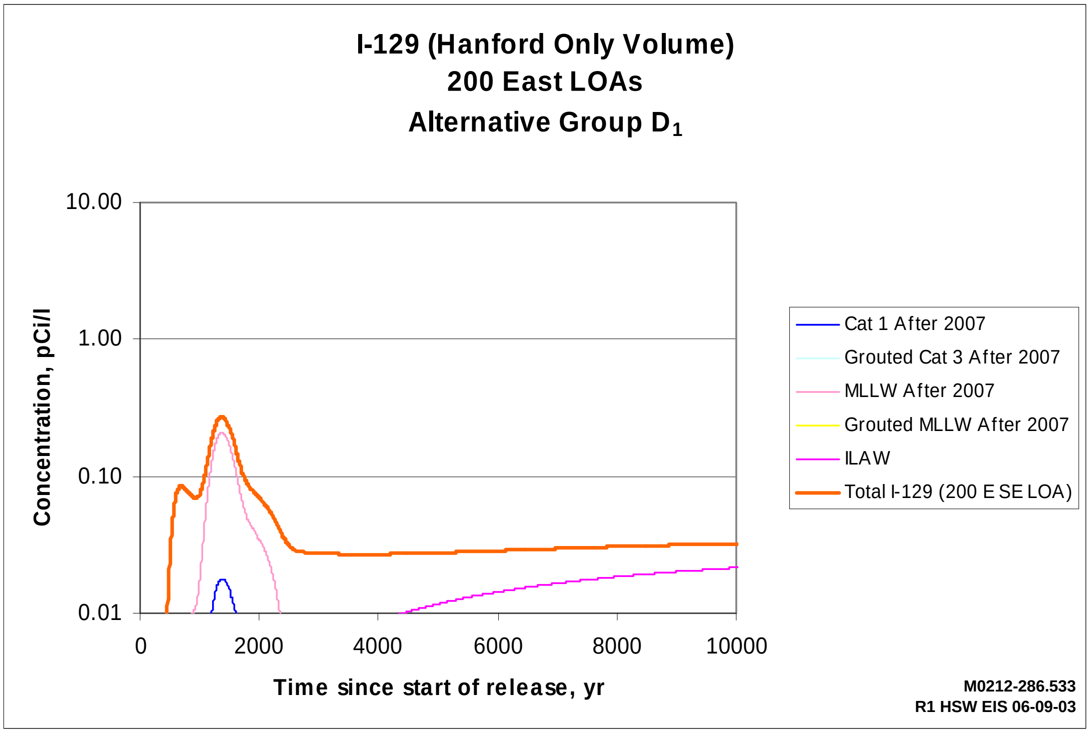


Figure G.45. Tc-99 and I-129 Concentration Profiles at the 1-km Lines of Analysis (200 East) (Alternative Group D_1 – Hanford Only Wastes Disposed of After 1995)

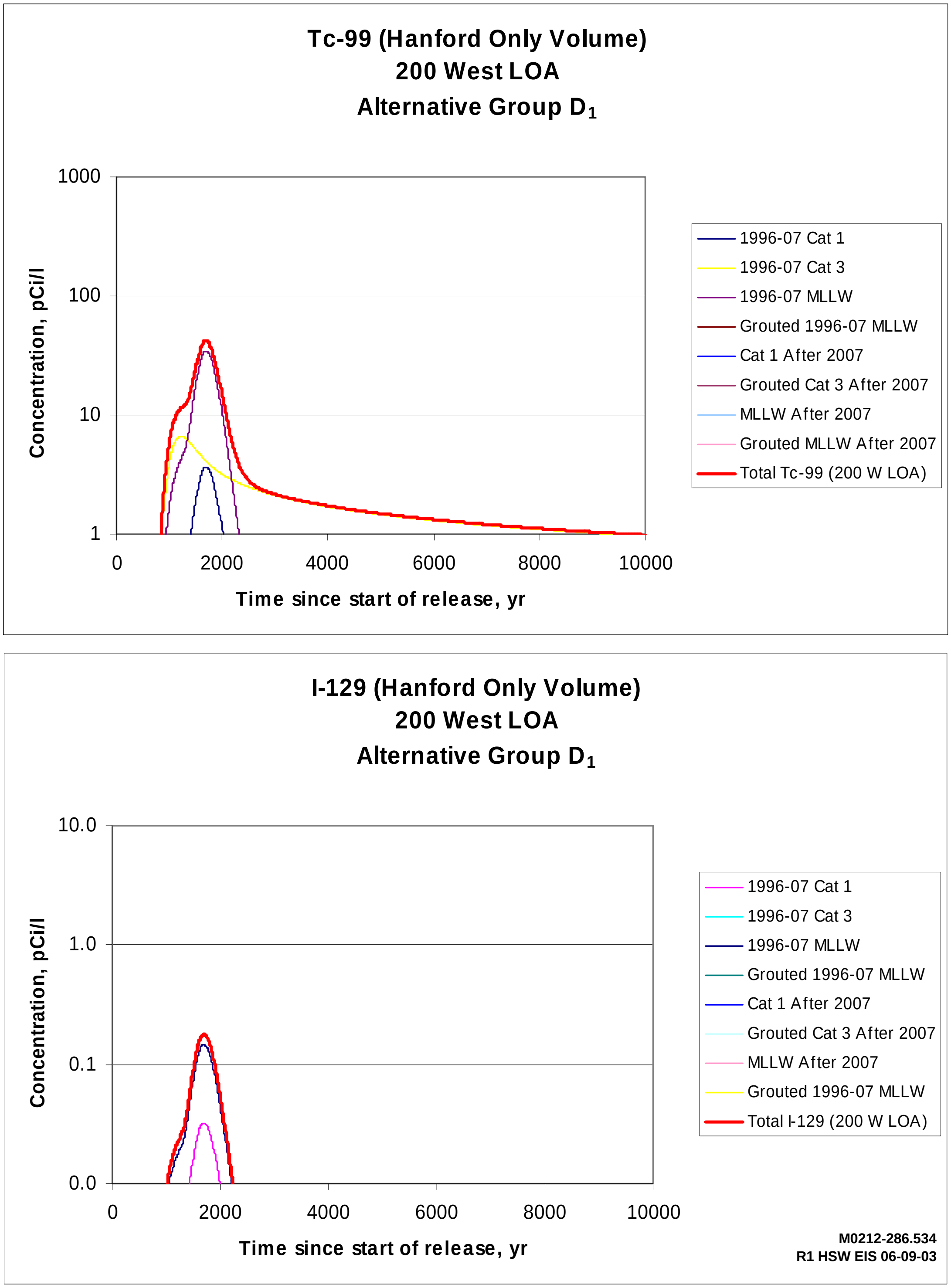


Figure G.46. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (200 West) (Alternative Group D_1 – Hanford Only Wastes Disposed of After 1995)

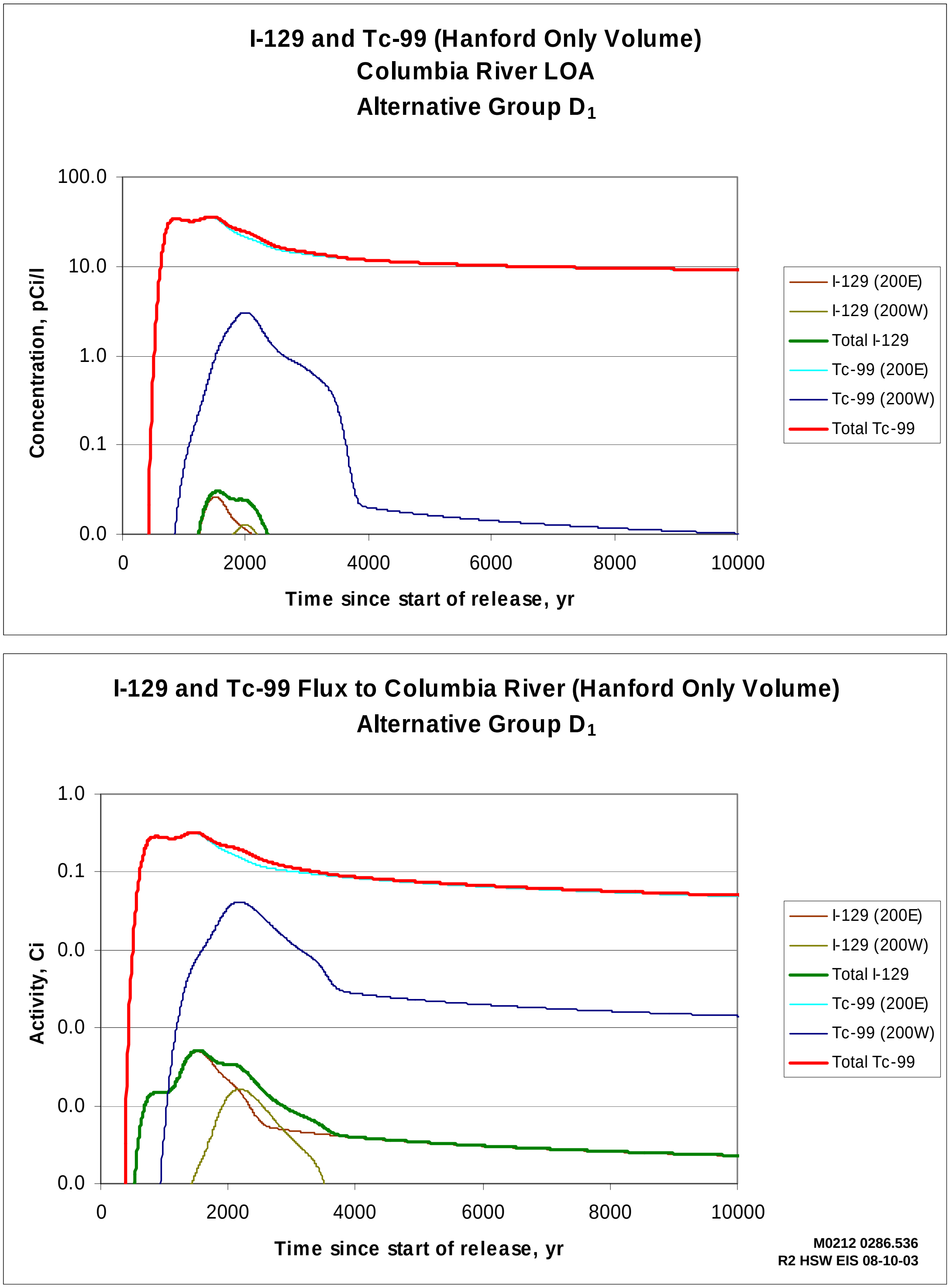


Figure G.47. I-129 and Tc-99 Concentration and River Flux Profiles Near the Columbia River (Alternative Group D_1 – Hanford Only Wastes Disposed of After 1995)

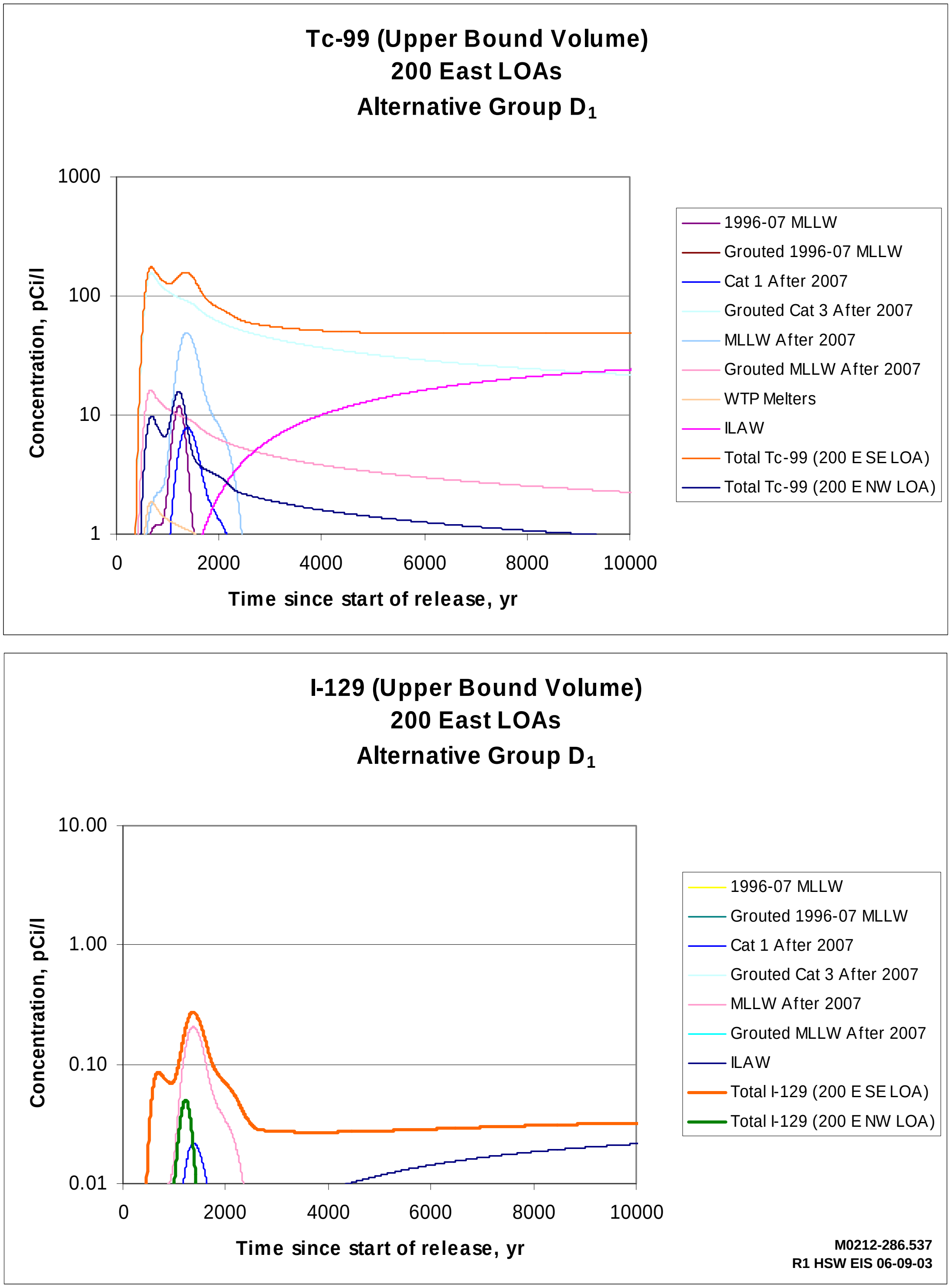


Figure G.48. Tc-99 and I-129 Concentration Profiles at the 1-km Lines of Analysis (200 East) (Alternative Group D_1 – Upper Bound Volume Wastes Disposed of After 1995)

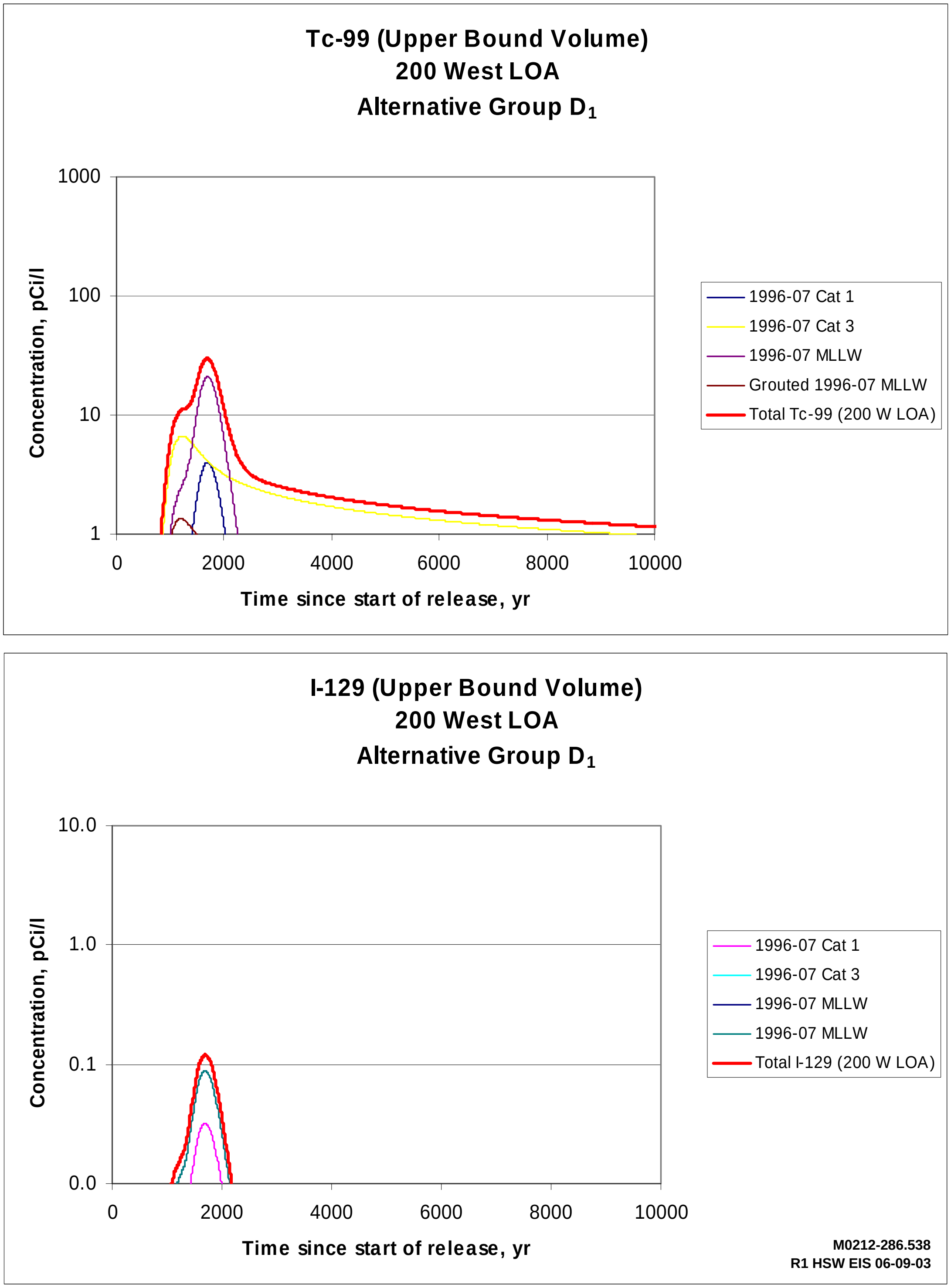


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Figure G.49. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (200 West) (Alternative Group D_1 – Upper Bound Volume Wastes Disposed of After 1995)

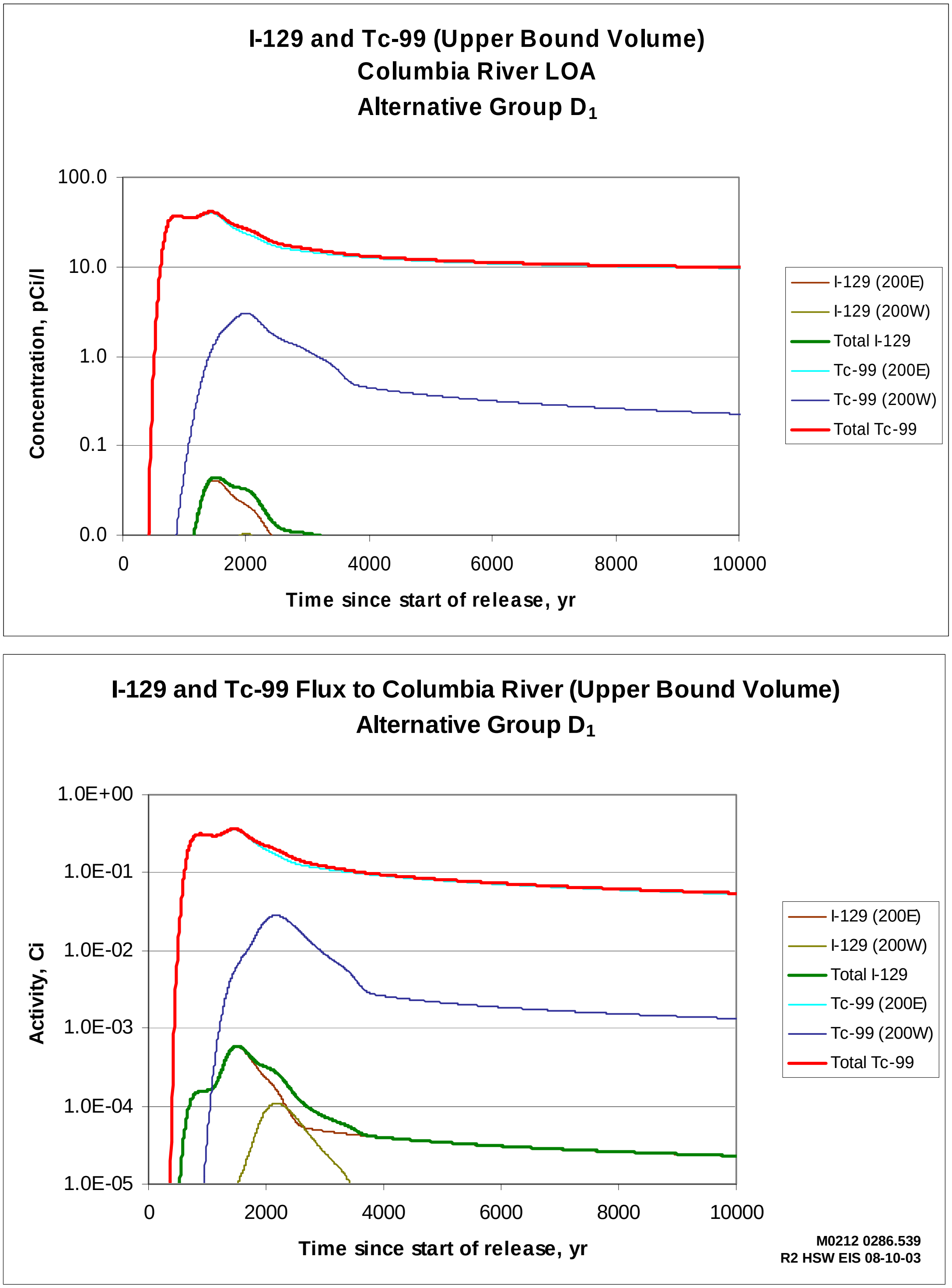


Figure G.50. I-129 and Tc-99 Concentration and River Flux Profiles Near the Columbia River (Alternative Group D_1 – Upper Bound Volume Wastes Disposed of After 1995)

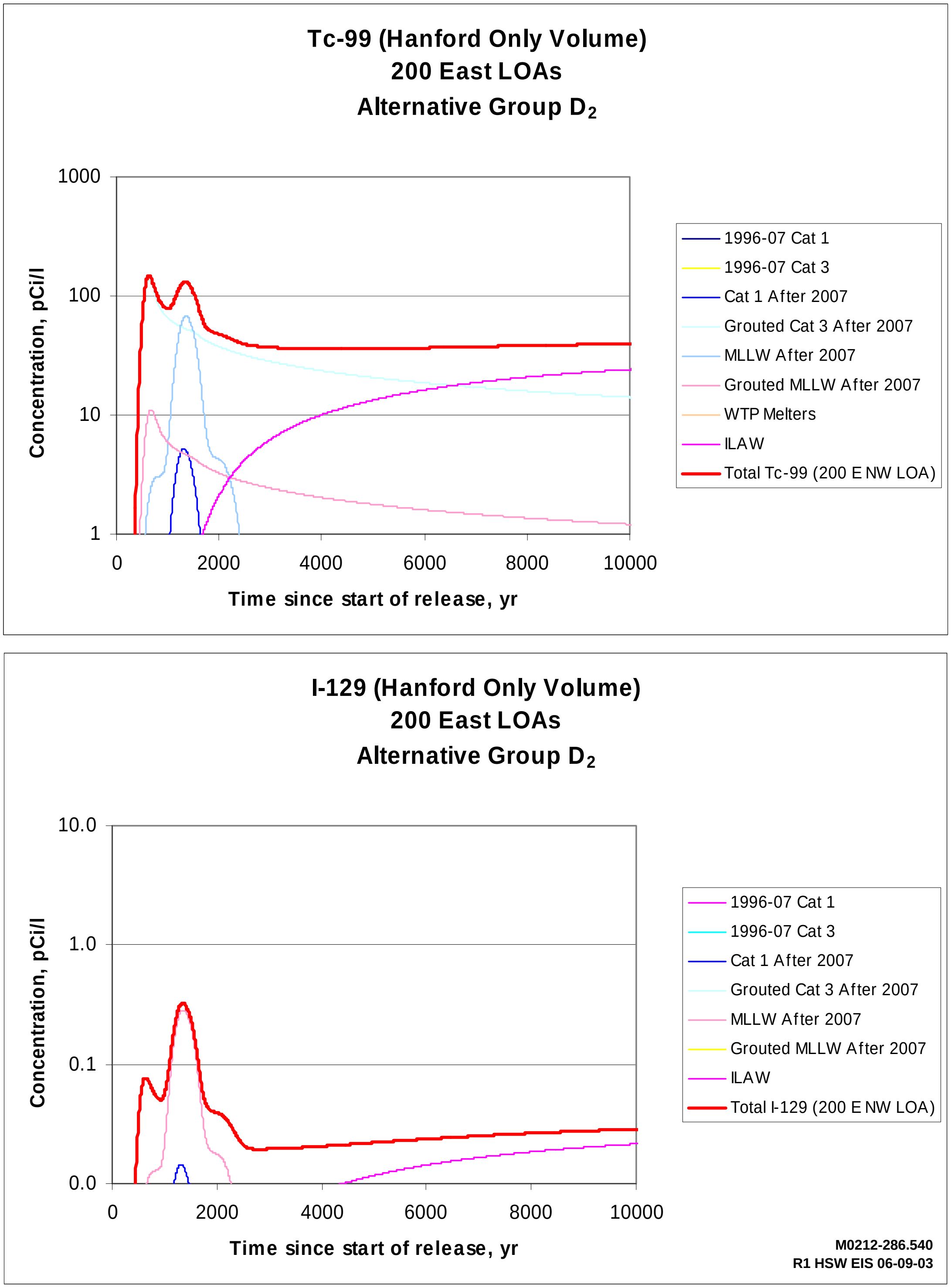


Figure G.51. Tc-99 and I-129 Concentration Profiles at the 1-km Lines of Analysis (200 East) (Alternative Group D_2 – Hanford Only Wastes Disposed of After 1995)

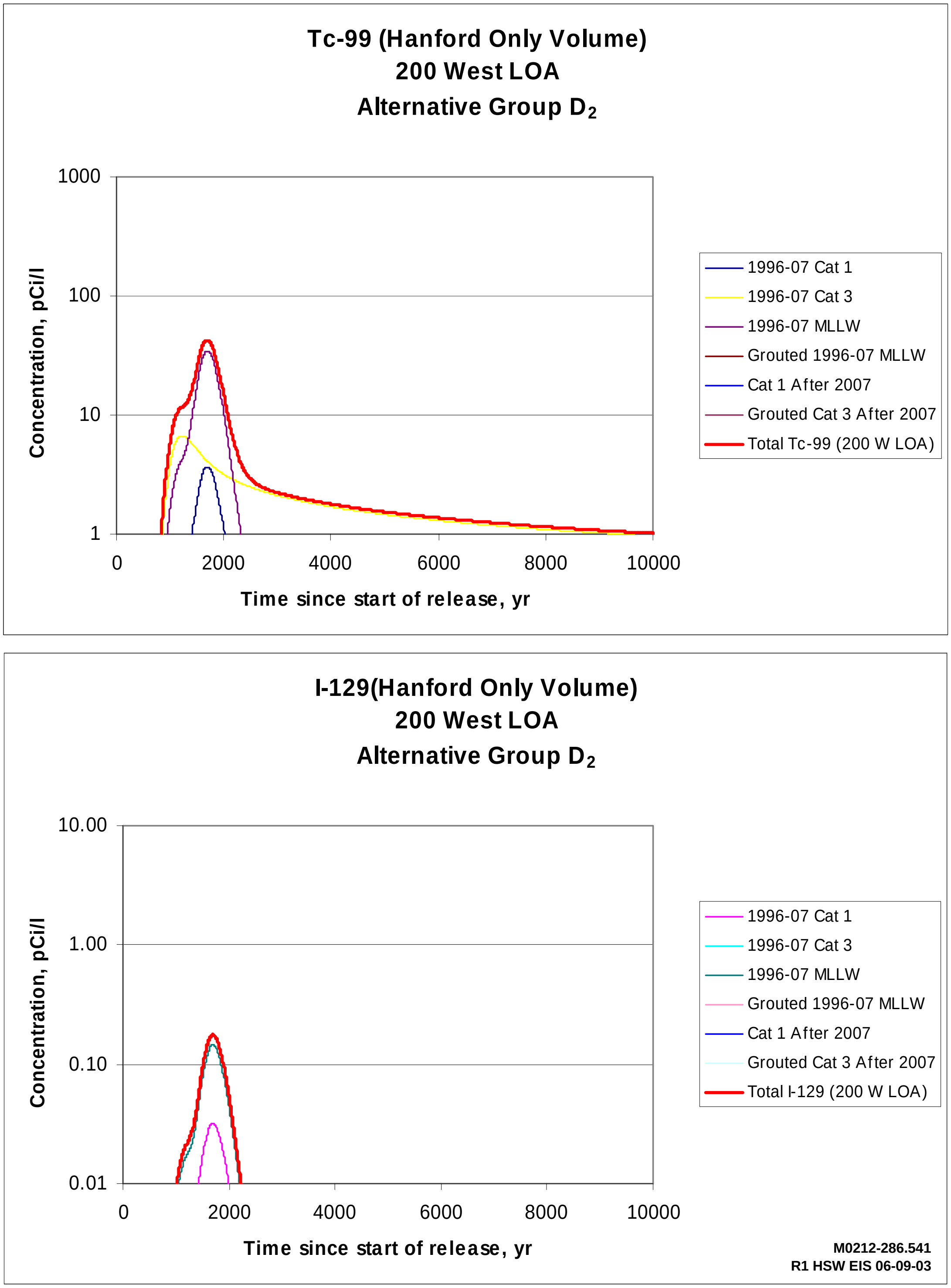


Figure G.52. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (200 West) (Alternative Group D_2 – Hanford Only Wastes Disposed of After 1995)

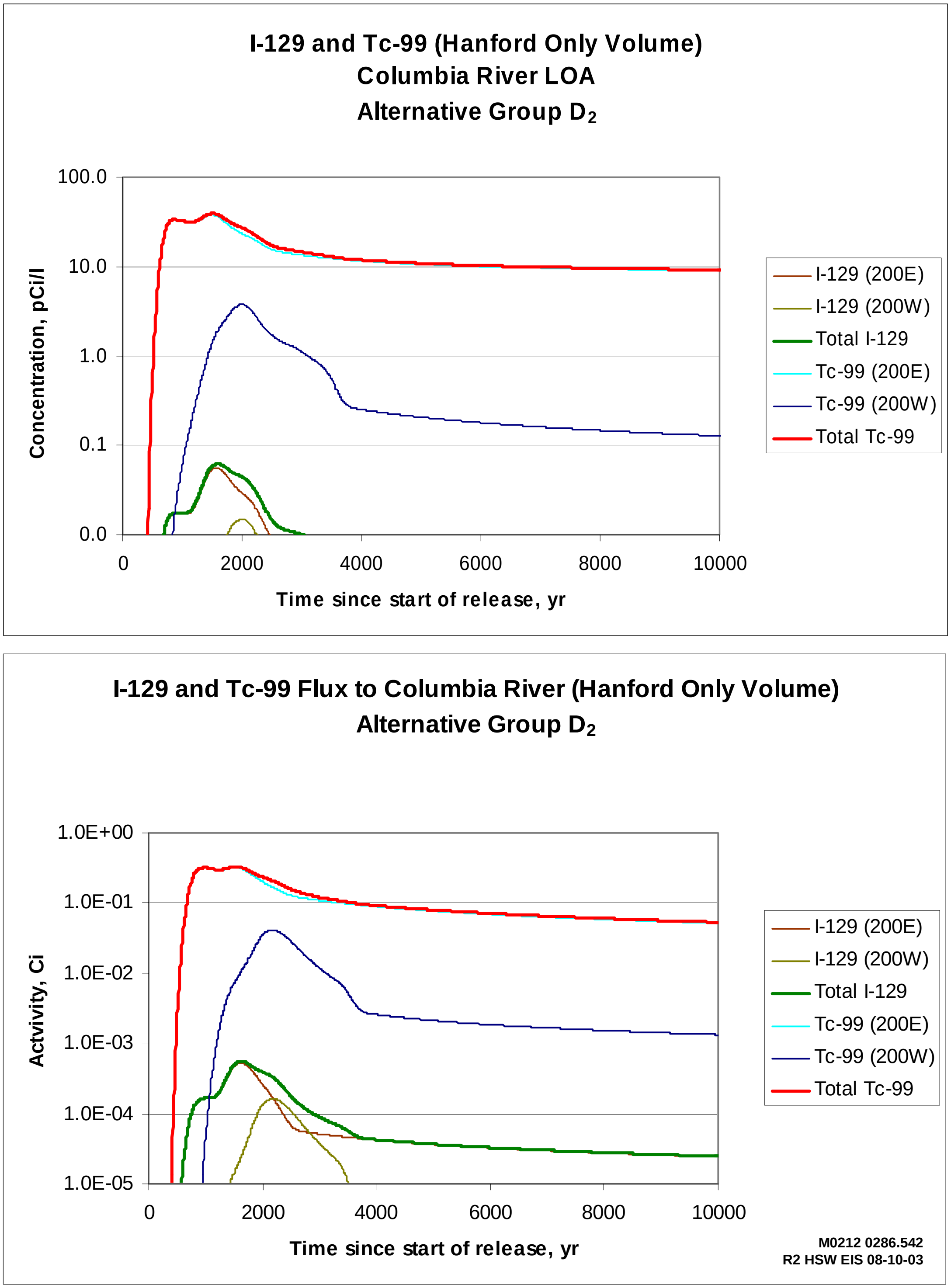
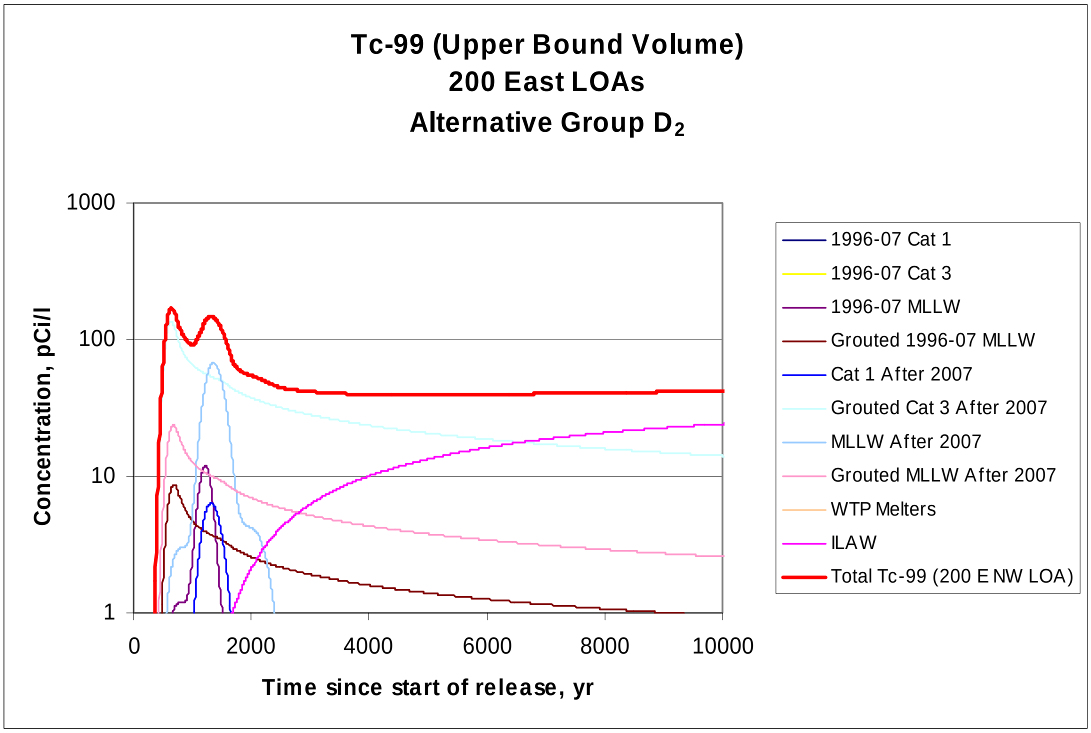


Figure G.53. I-129 and Tc-99 Concentration and River Flux Profiles Near the Columbia River (Alternative Group D_2 – Hanford Only Wastes Disposed of After 1995)



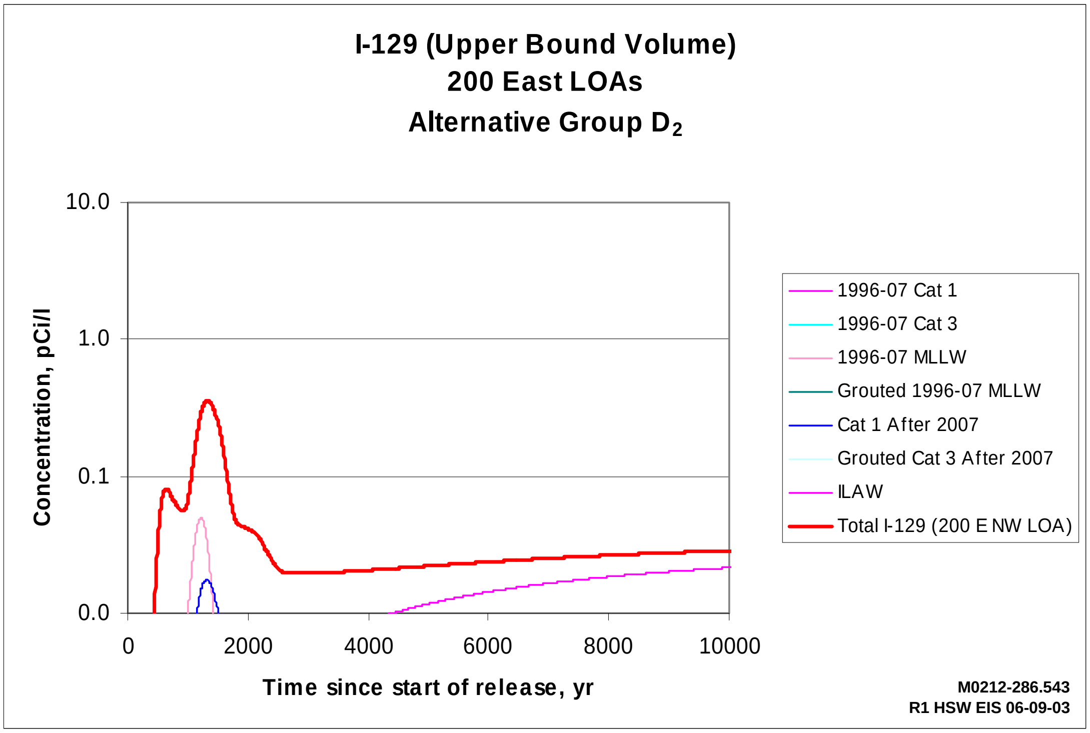
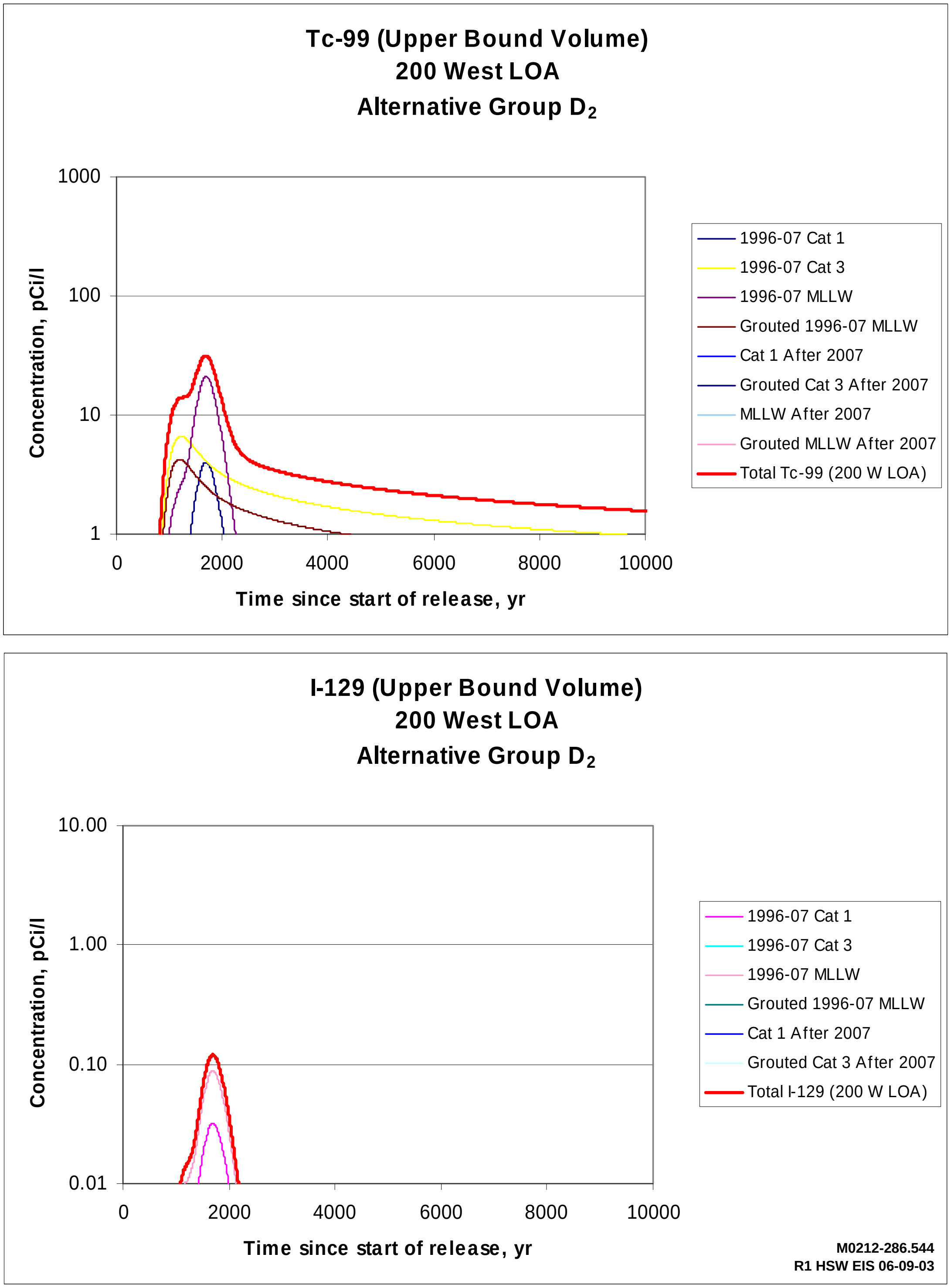


Figure G.54. Tc-99 and I-129 Concentration Profiles at the 1-km Lines of Analysis (200 East) (Alternative Group D_2 – Upper Bound Volume Wastes Disposed of After 1995)



Tc-99 (Upper Bound Volume)
200 West LOA
Alternative Group D_2

I-129 (Upper Bound Volume)
200 West LOA
Alternative Group D_2

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Figure G.55. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (200 West) (Alternative Group D_2 – Upper Bound Volume Wastes Disposed of After 1995)

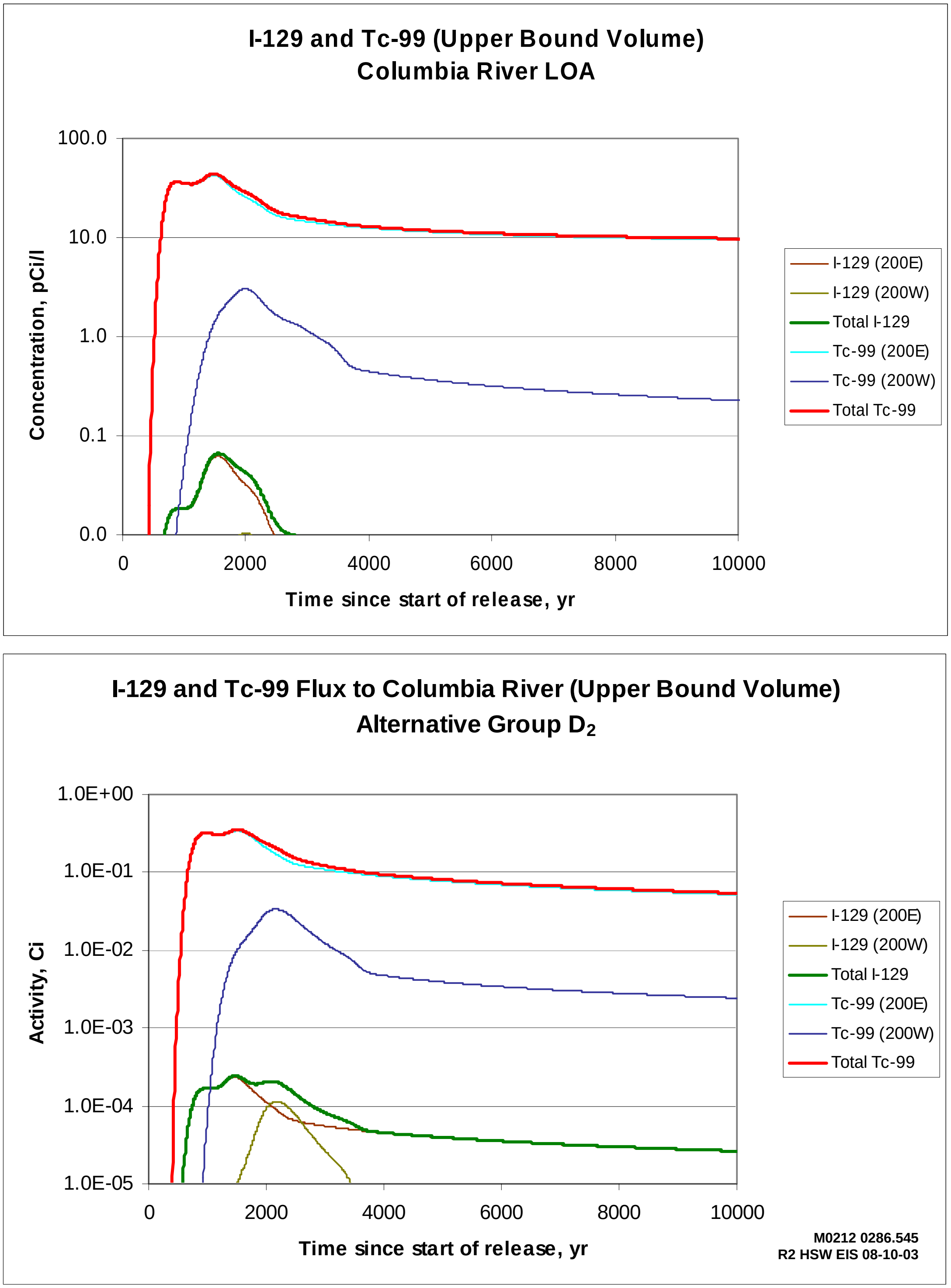
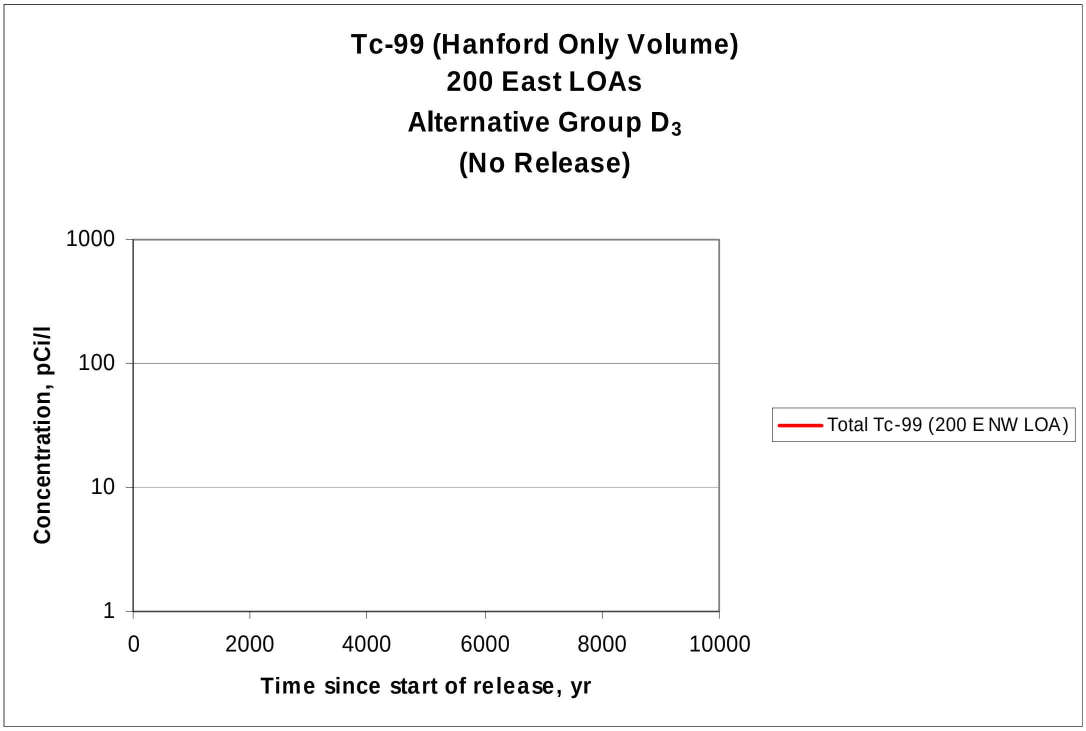


Figure G.56. I-129 and Tc-99 Concentration and River Flux Profiles Near the Columbia River (Alternative Group D_2 – Upper Bound Volume Wastes Disposed of After 1995)



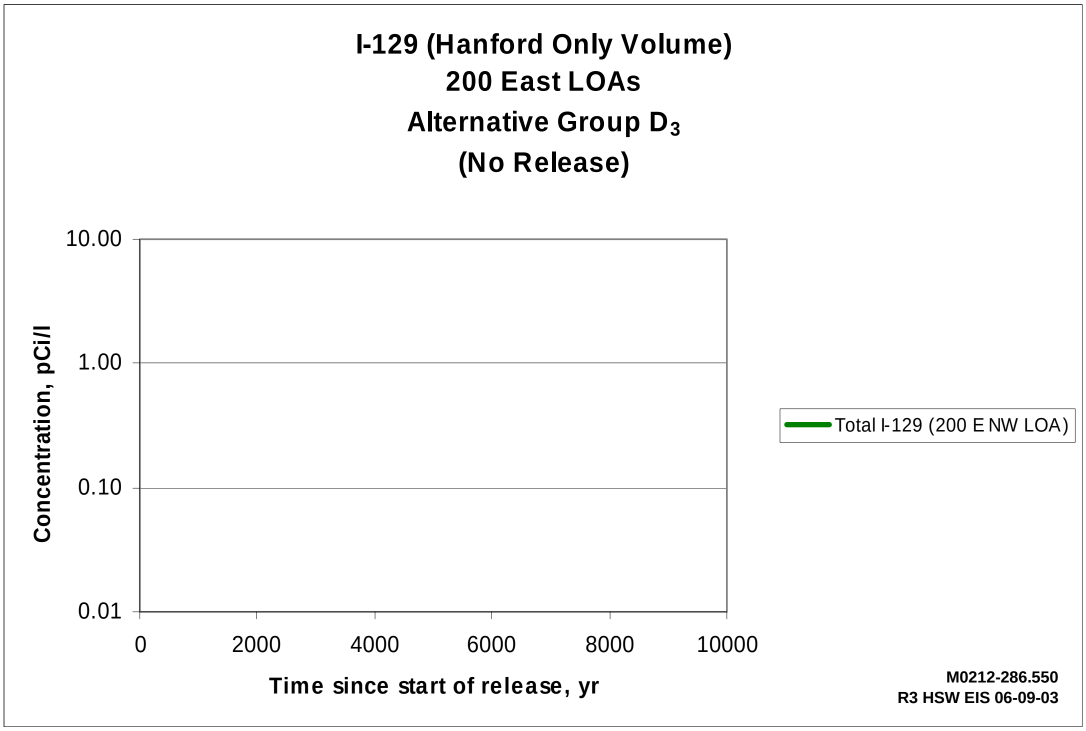
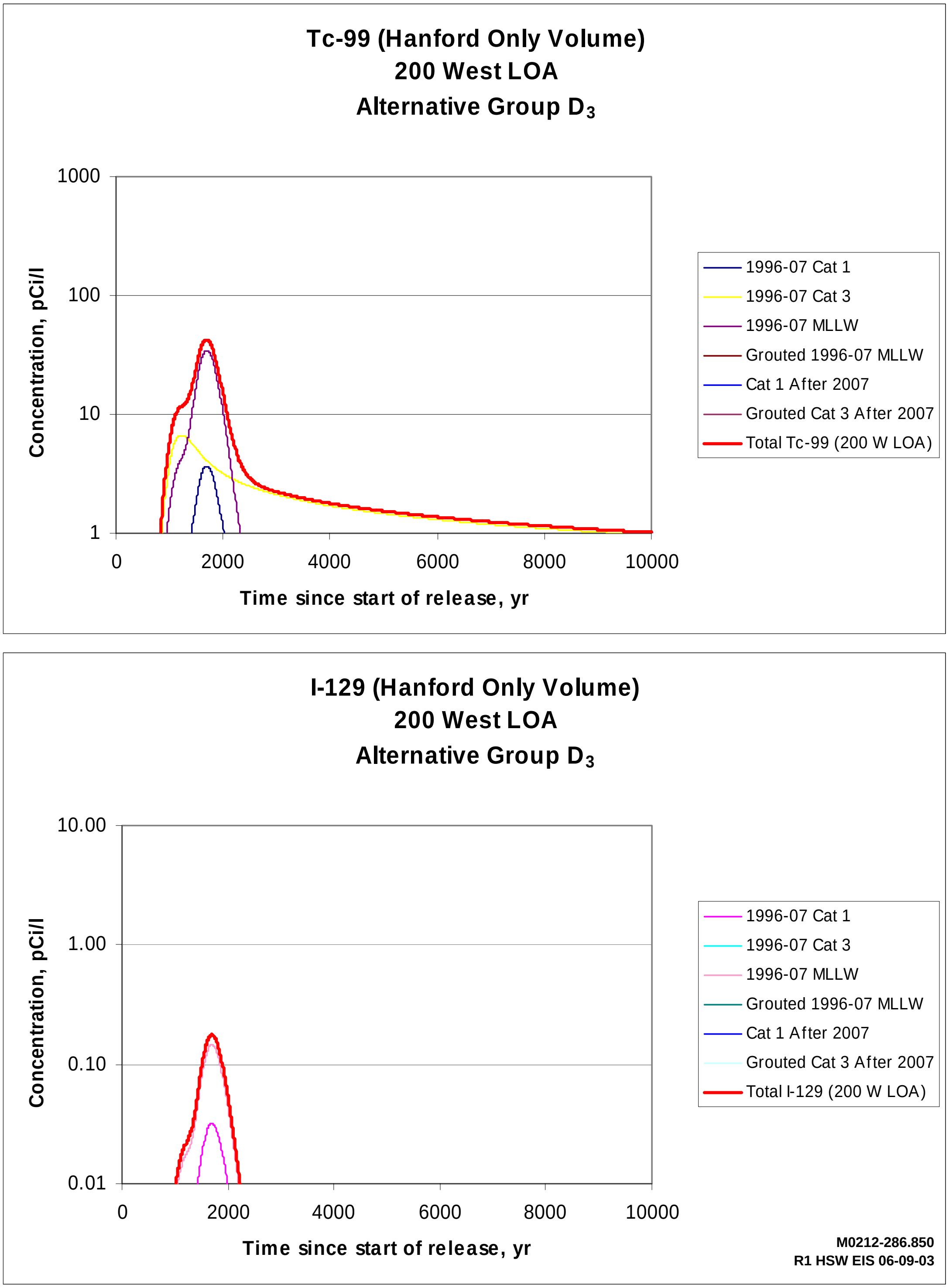


Figure G.57. Tc-99 and I-129 Concentration Profiles at the 1-km Lines of Analysis (200 East) (Alternative Group D_3 – Hanford Only Wastes Disposed of After 1995)


Tc-99 (Hanford Only Volume)
200 West LOA
Alternative Group D_3

I-129 (Hanford Only Volume)
200 West LOA
Alternative Group D_3

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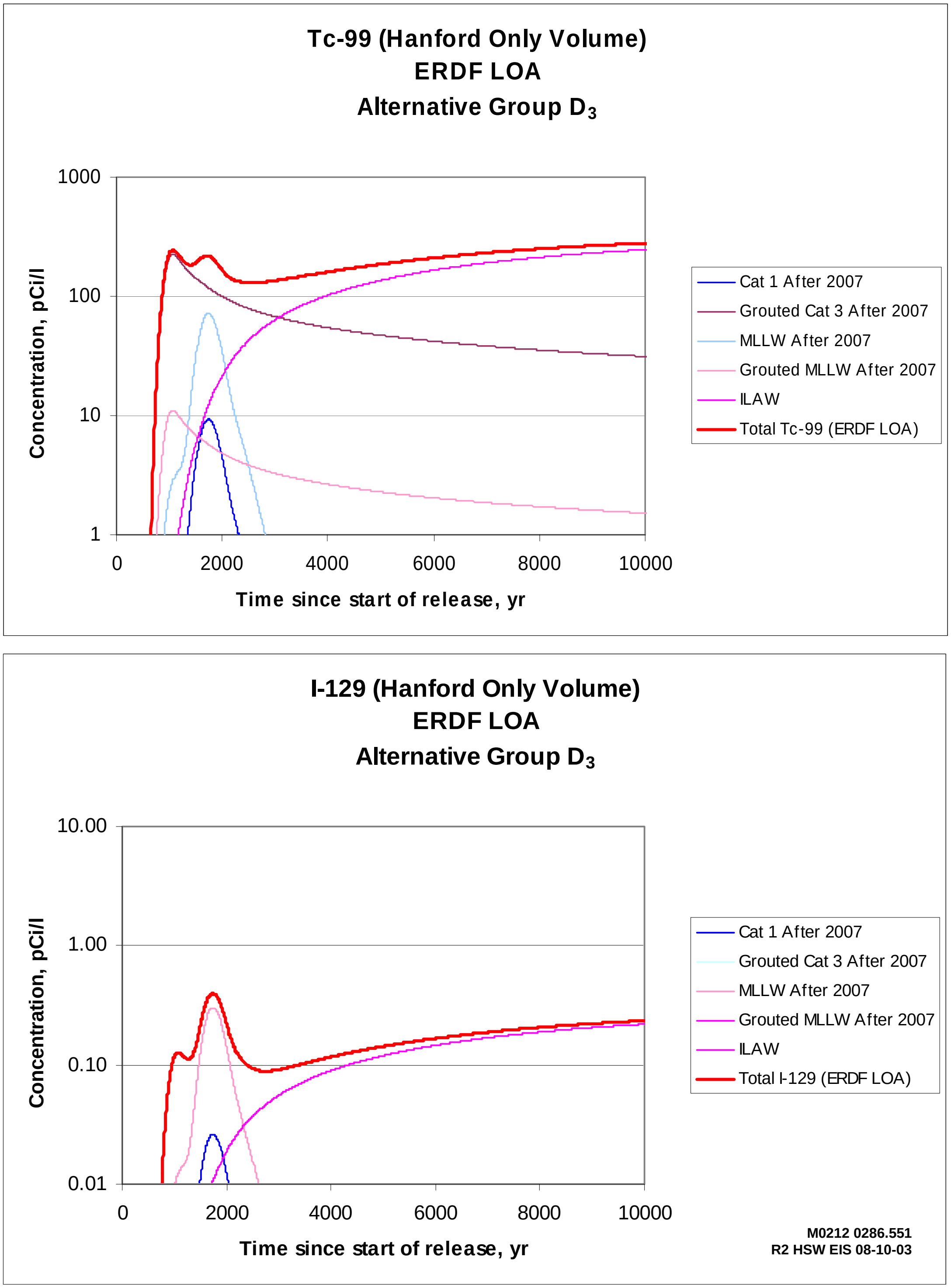
R1 HSW EIS 06-09-03

Figure G.58. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (200 West) (Alternative Group D_3 – Hanford Only Wastes Disposed of After 1995)



M0212 0286.551
R2 HSW EIS 08-10-03

Figure G.59. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (ERDF) (Alternative Group D_3 – Hanford Only Wastes Disposed of After 1995)

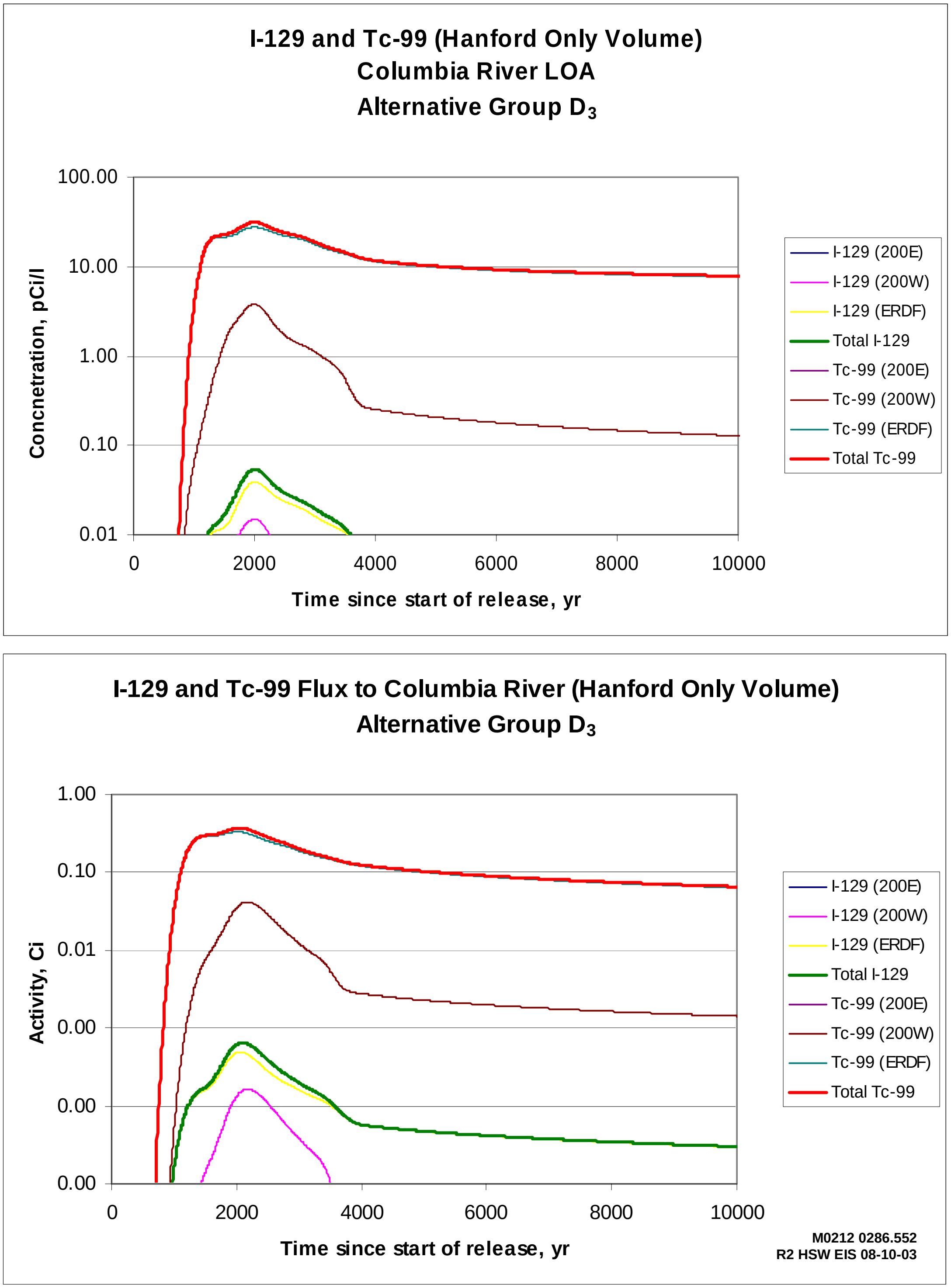
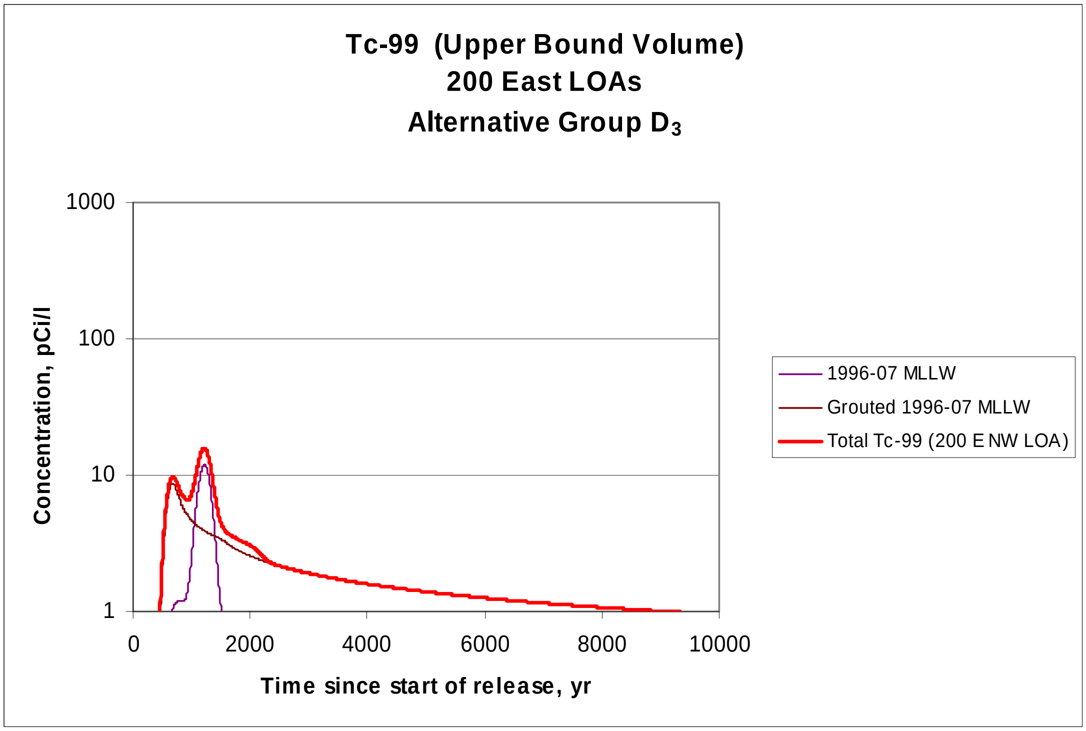


Figure G.60. I-129 and Tc-99 Concentration and River Flux Profiles Near the Columbia River (Alternative Group D_3 – Hanford Only Wastes Disposed of After 1995)



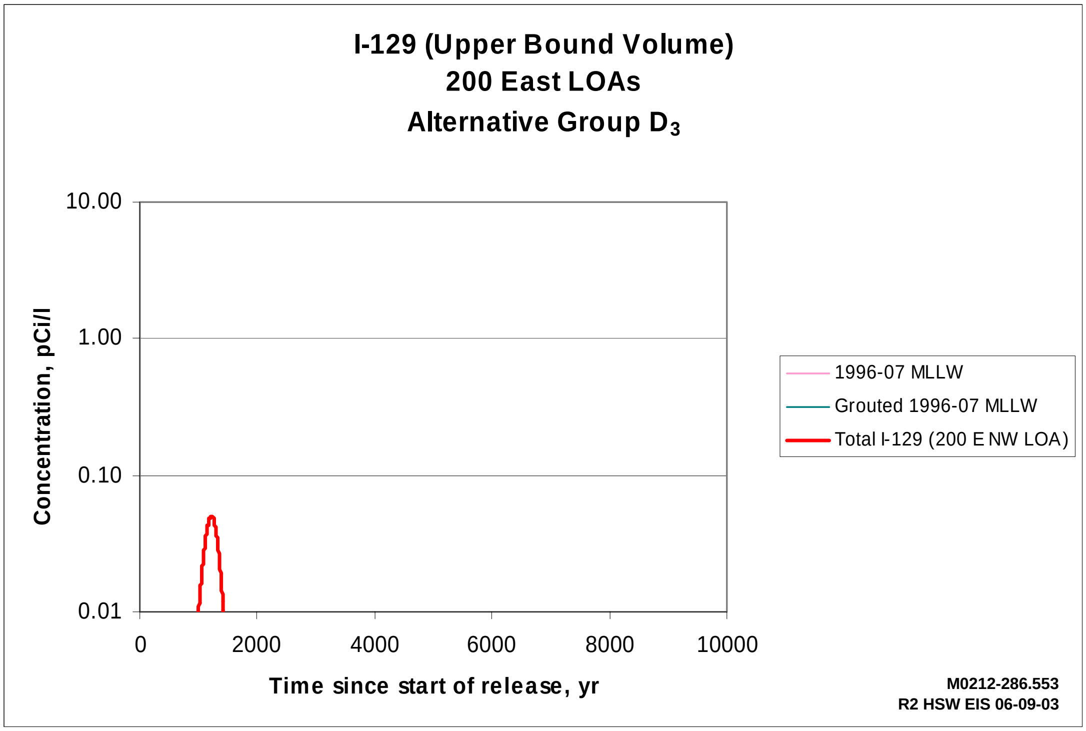


Figure G.61. Tc-99 and I-129 Concentration Profiles at the 1-km Lines of Analysis (200 East) (Alternative Group D_3 – Upper Bound Volume Wastes Disposed of After 1995)

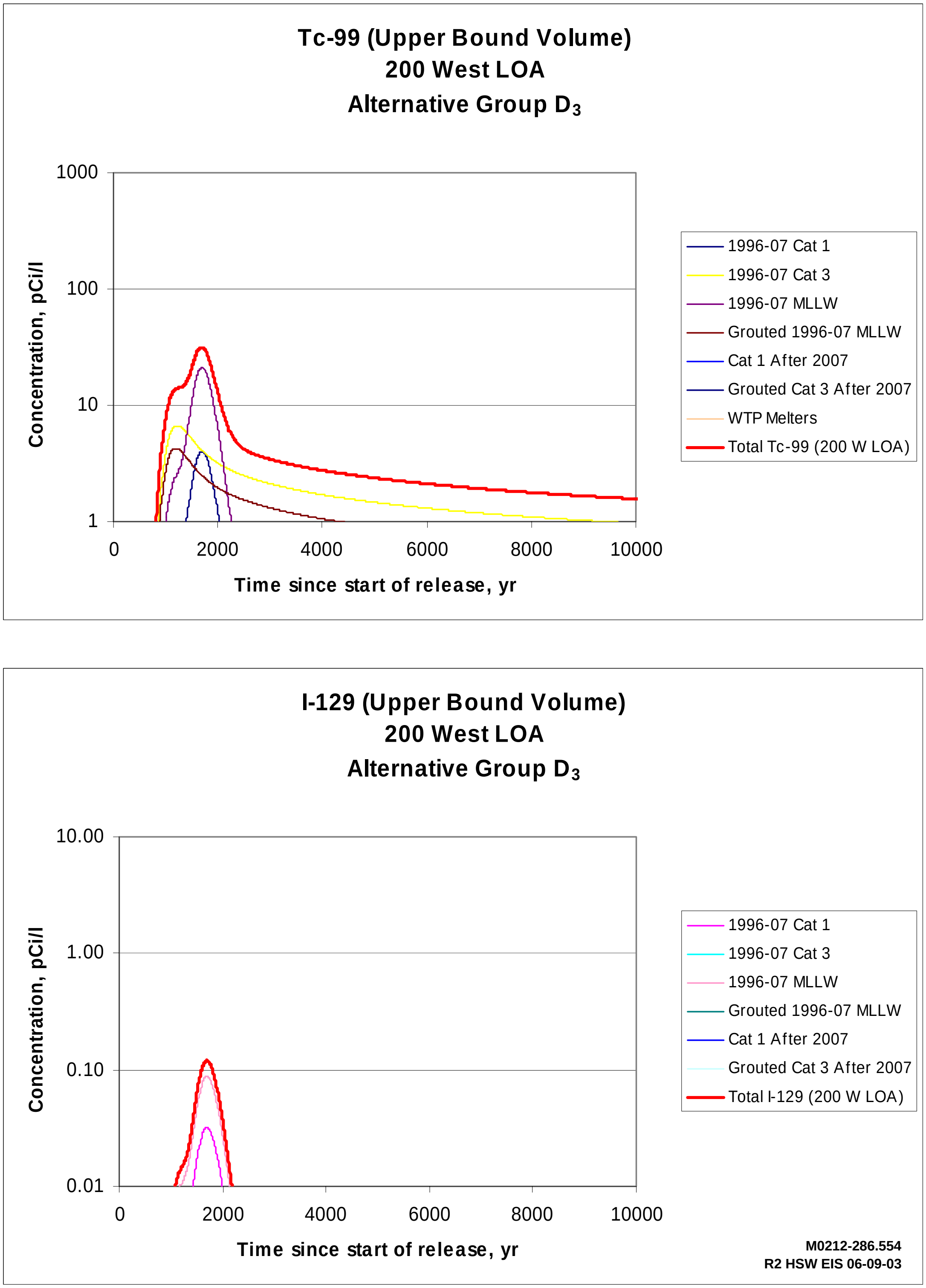
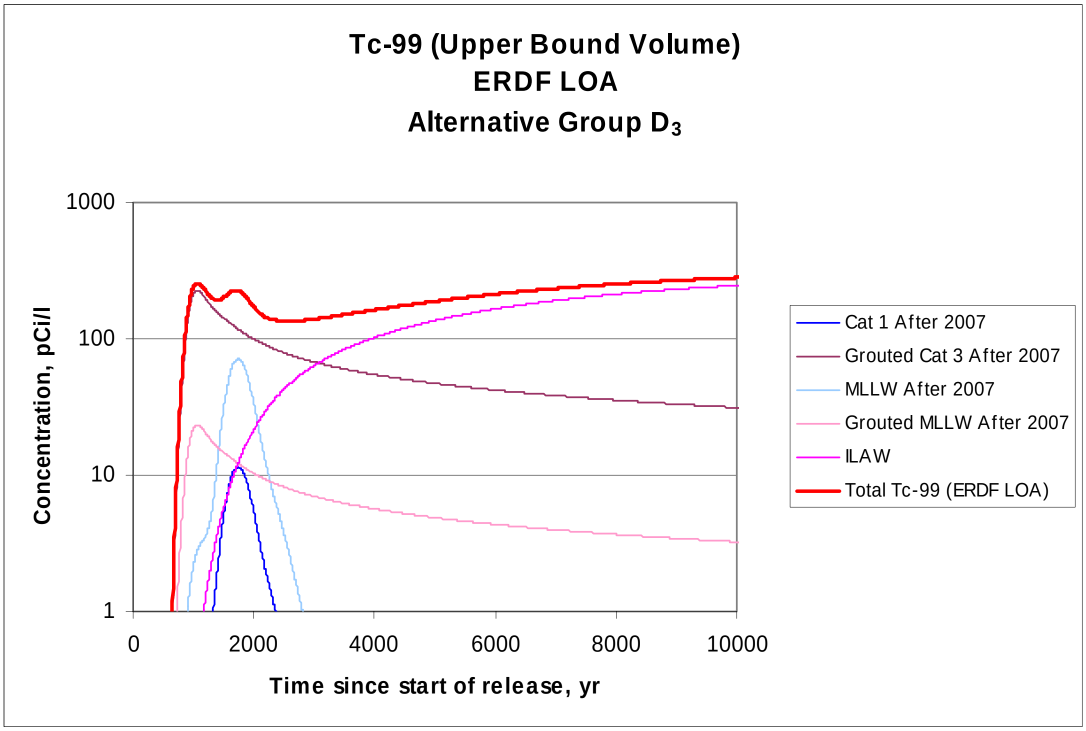


Figure G.62. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (200 West) (Alternative Group D_3 – Upper Bound Volume Wastes Disposed of After 1995)



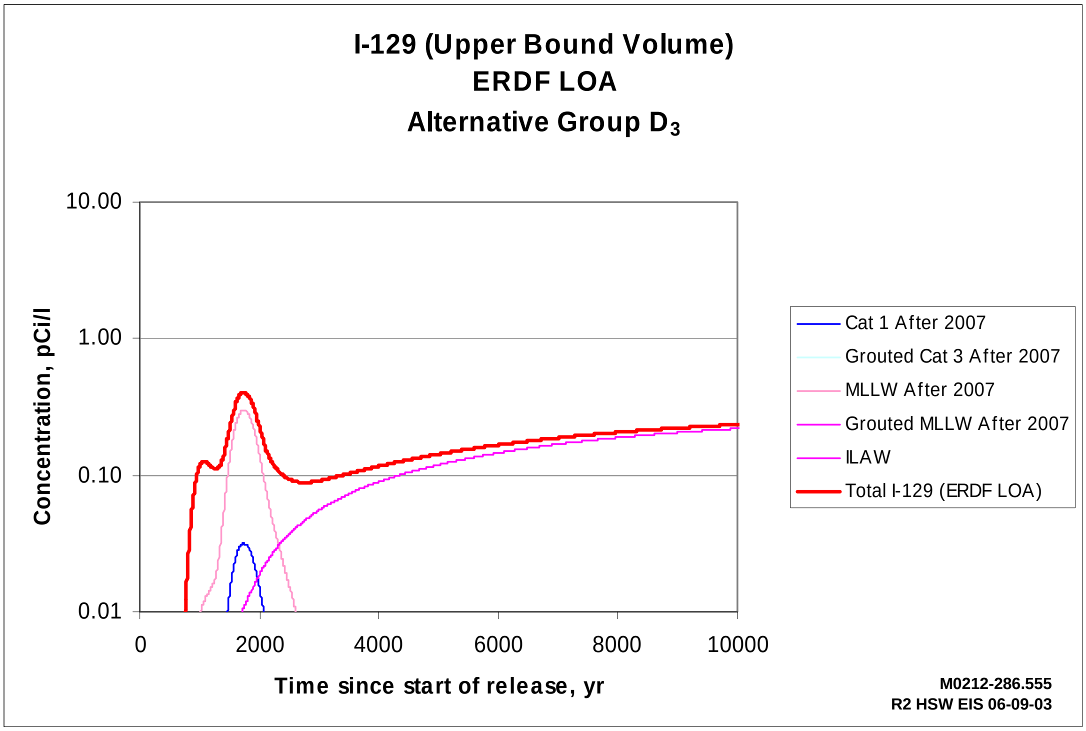


Figure G.63. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (ERDF) (Alternative Group D_3 – Upper Bound Volume Wastes Disposed of After 1995)

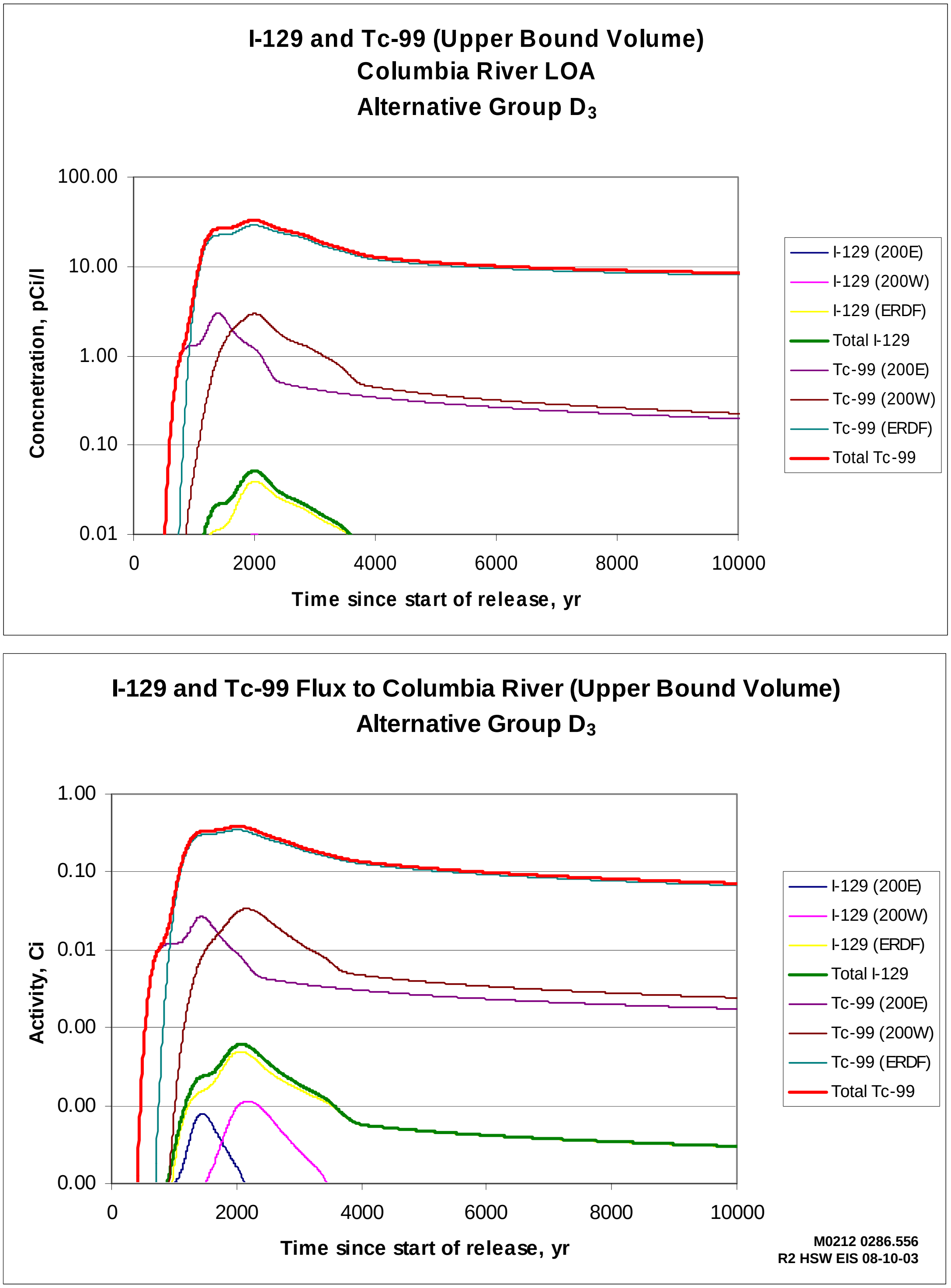
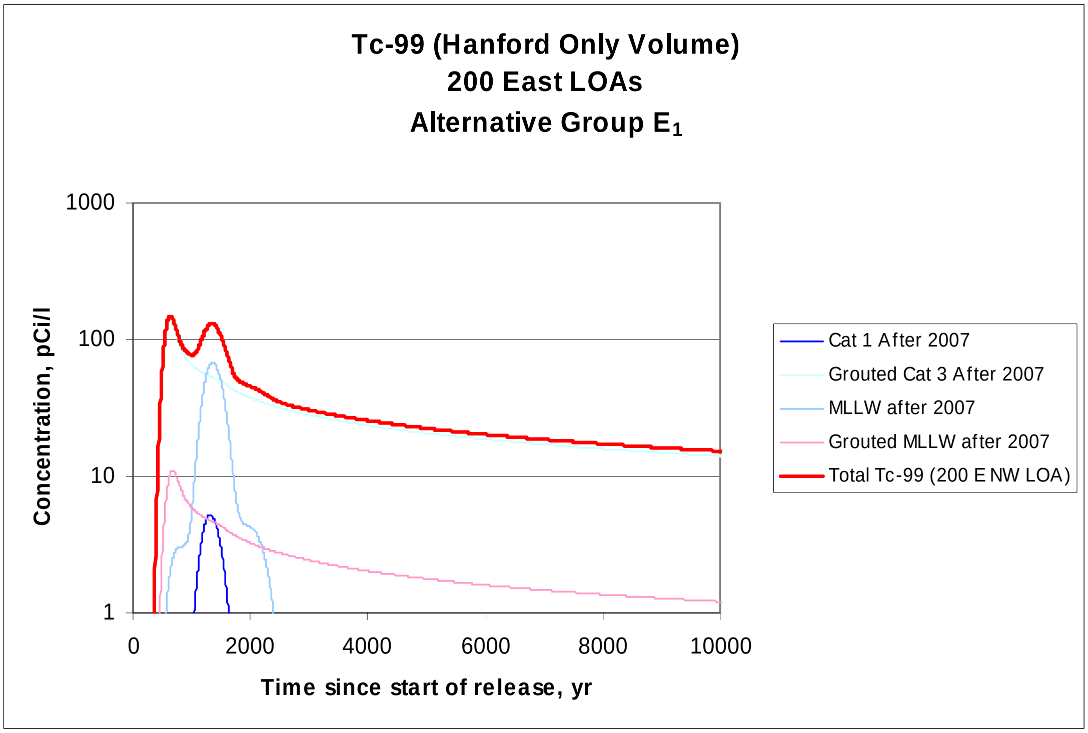


Figure G.64. I-129 and Tc-99 Concentration and River Flux Profiles Near the Columbia River (Alternative Group D_3 – Upper Bound Volume Wastes Disposed of After 1995)



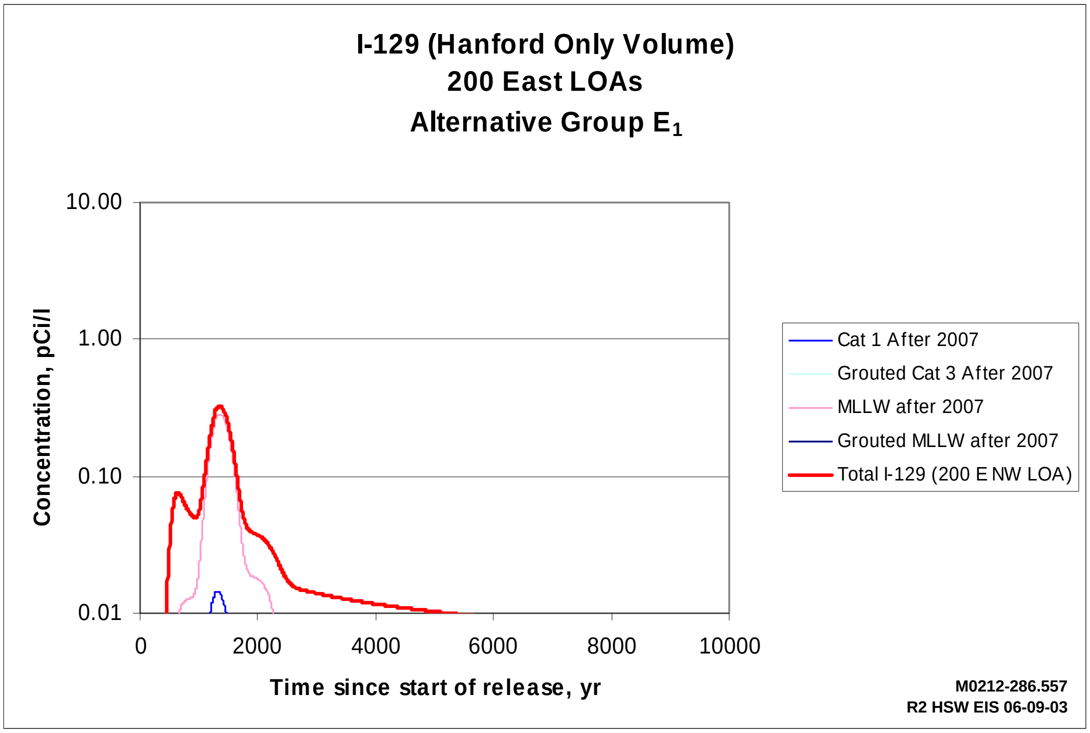


Figure G.65. Tc-99 and I-129 Concentration Profiles at the 1-km Lines of Analysis (200 East) (Alternative Group E_1 – Hanford Only Wastes Disposed of After 1995)

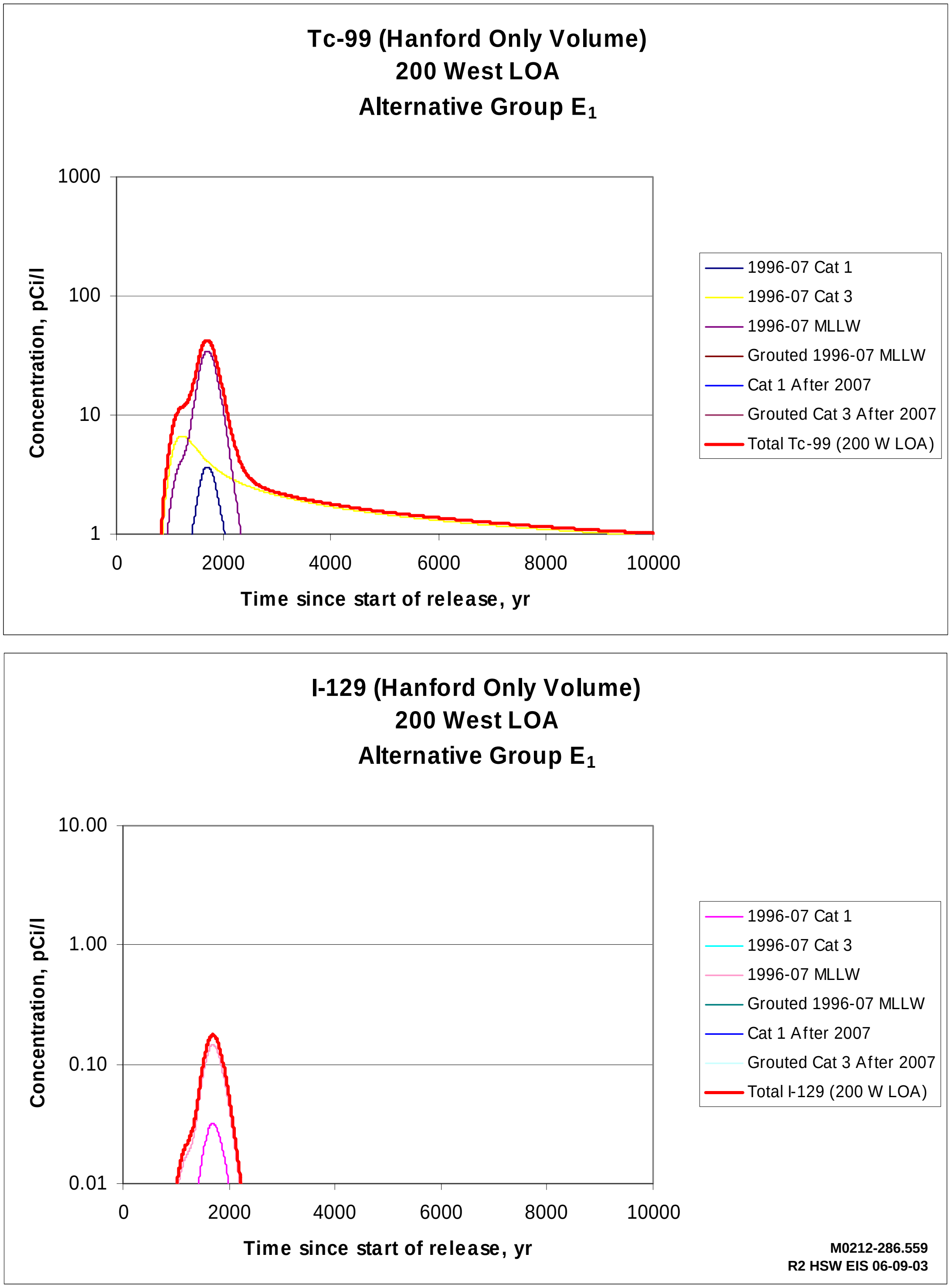


Figure G.66. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (200 West) (Alternative Group E_1 – Hanford Only Wastes Disposed of After 1995)

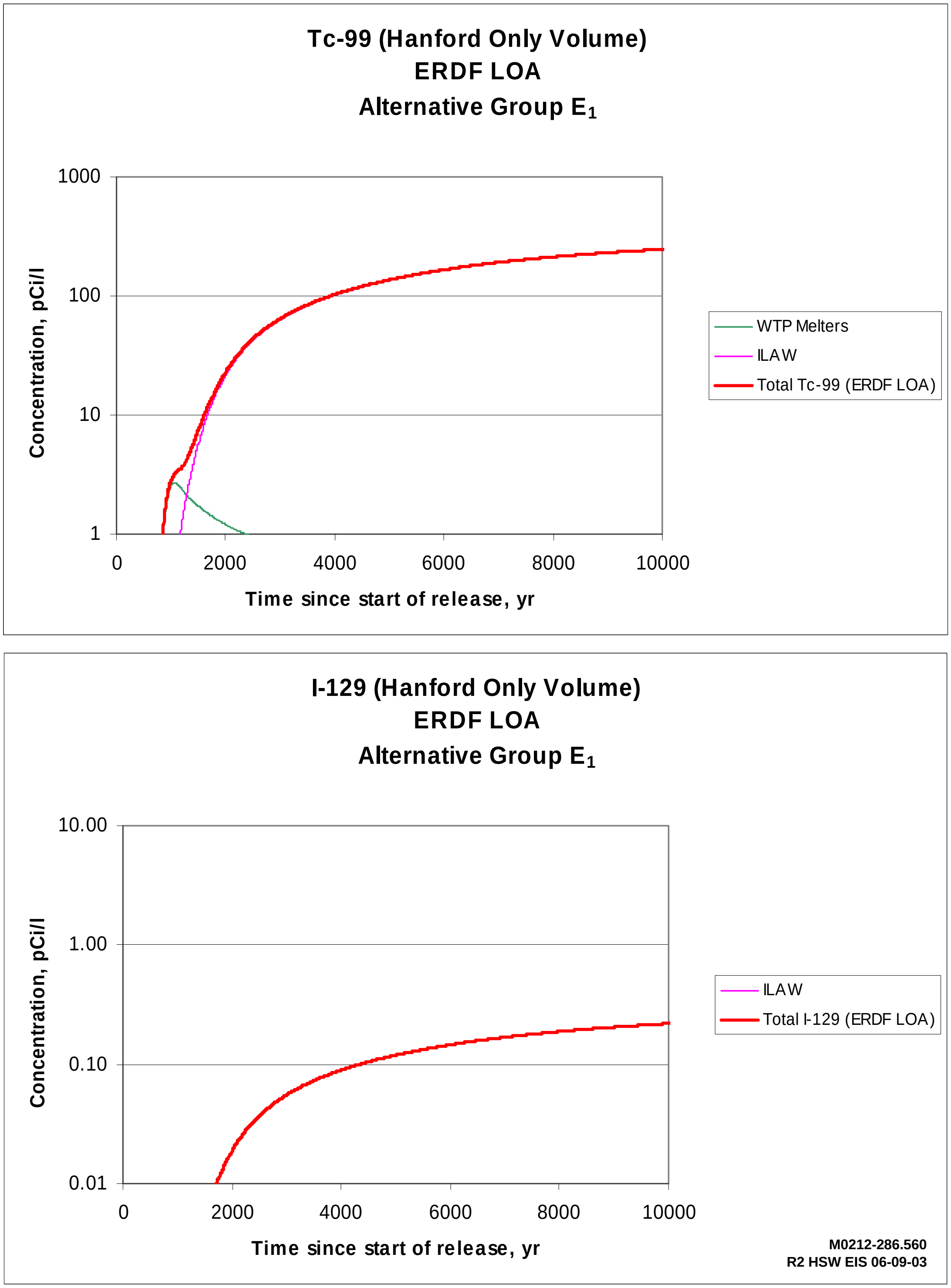


Figure G.67. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (ERDF) (Alternative Group E_1 – Hanford Only Wastes Disposed of After 1995)

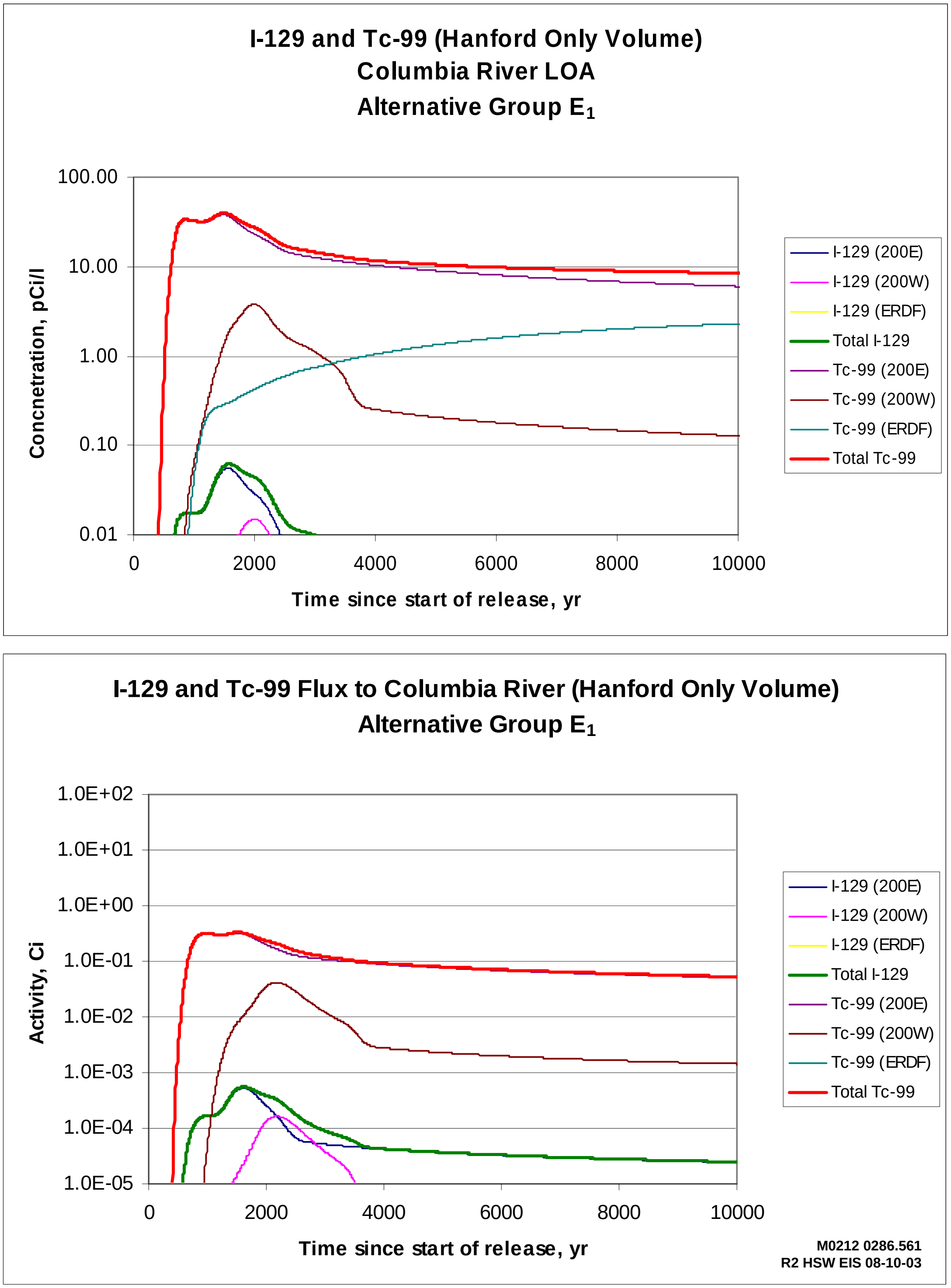


Figure G.68. I-129 and Tc-99 Concentration and River Flux Profiles Near the Columbia River (Alternative Group E_1 – Hanford Only Wastes Disposed of After 1995)

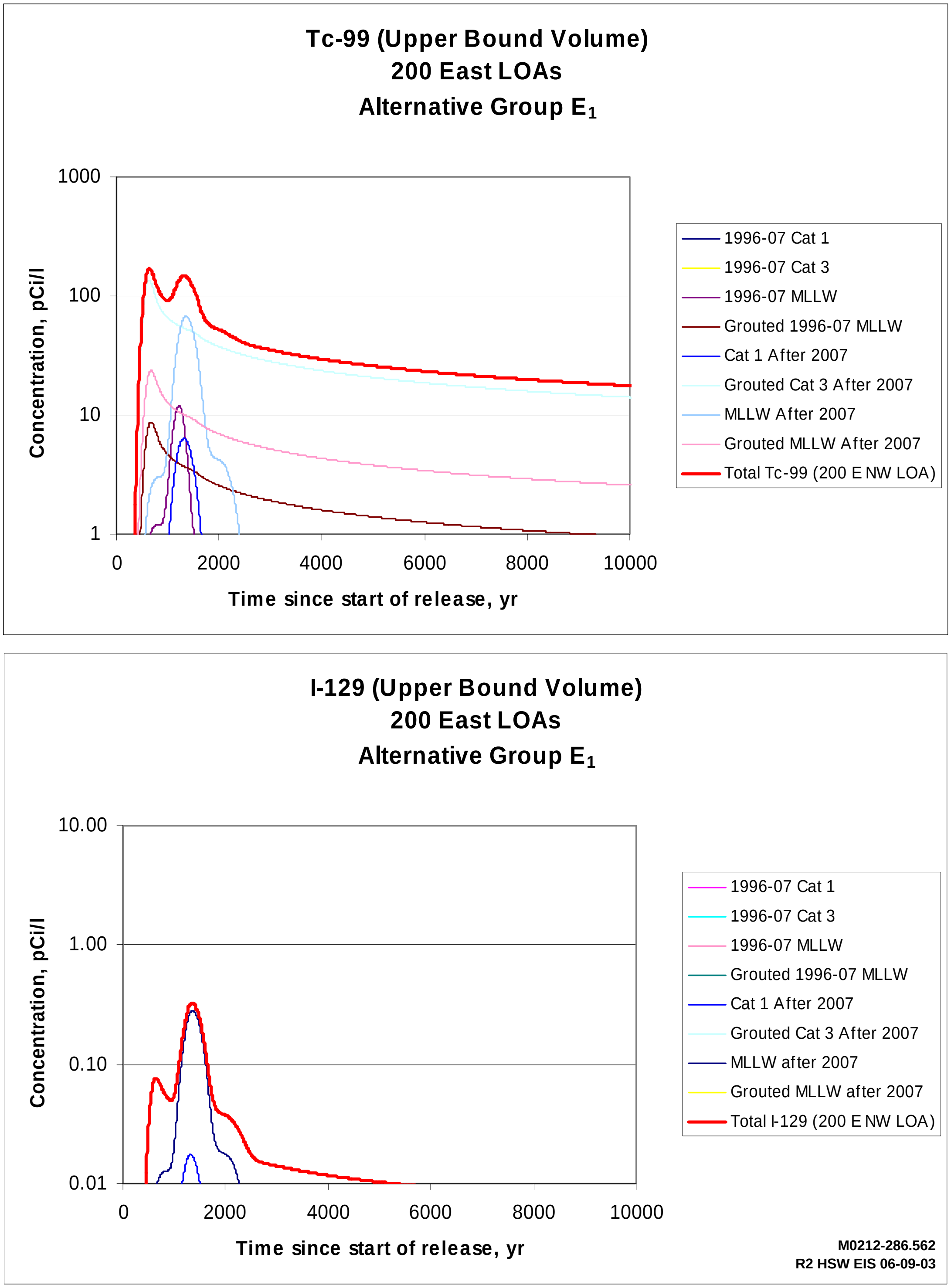


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Figure G.69. Tc-99 and I-129 Concentration Profiles at 1-km Lines of Analysis (200 East) (Alternative Group E_1 – Upper Bound Volume Wastes Disposed of After 1995)

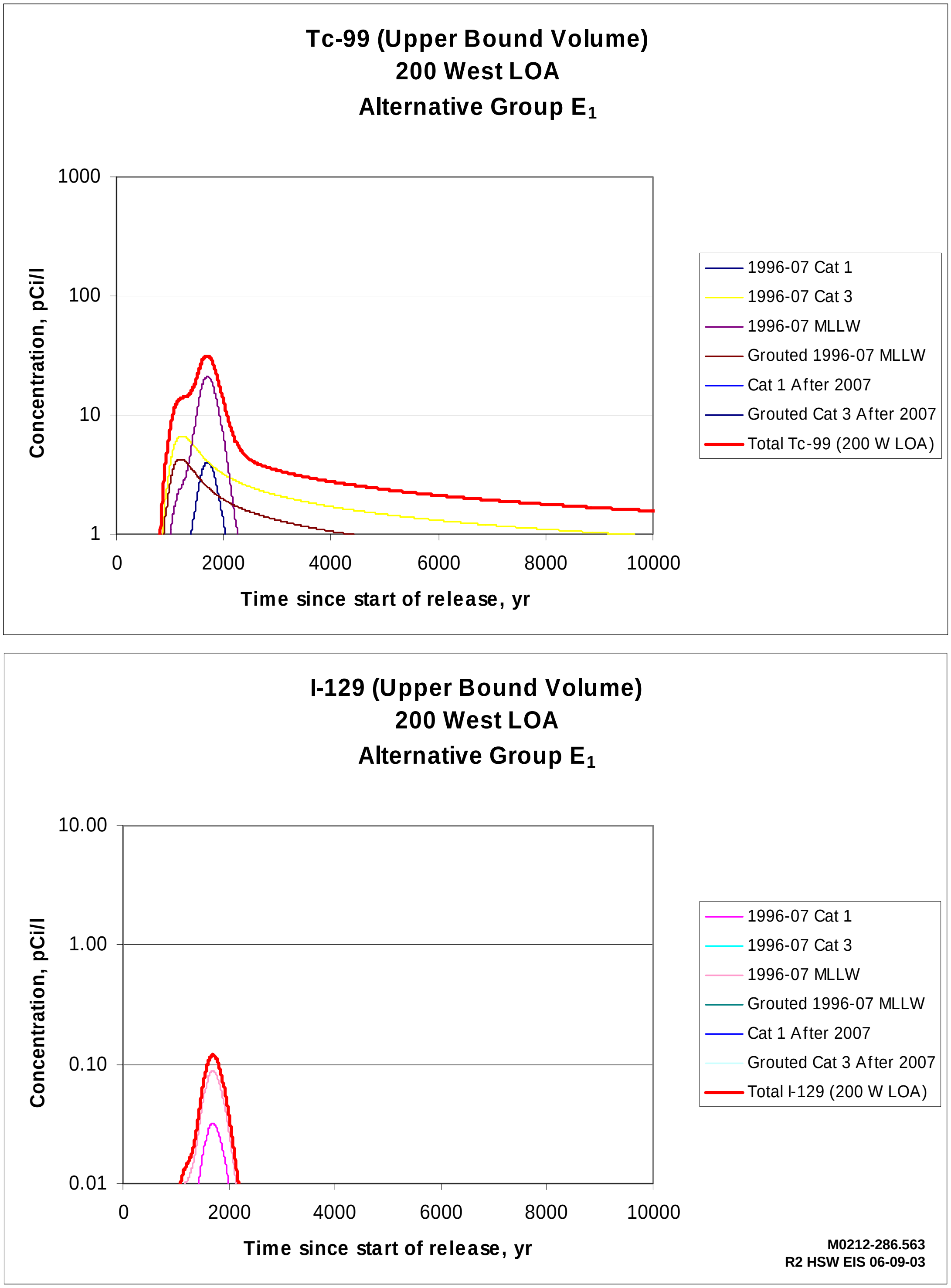


Figure G.70. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (200 West) (Alternative Group E_1 – Upper Bound Volume Wastes Disposed of After 1995)

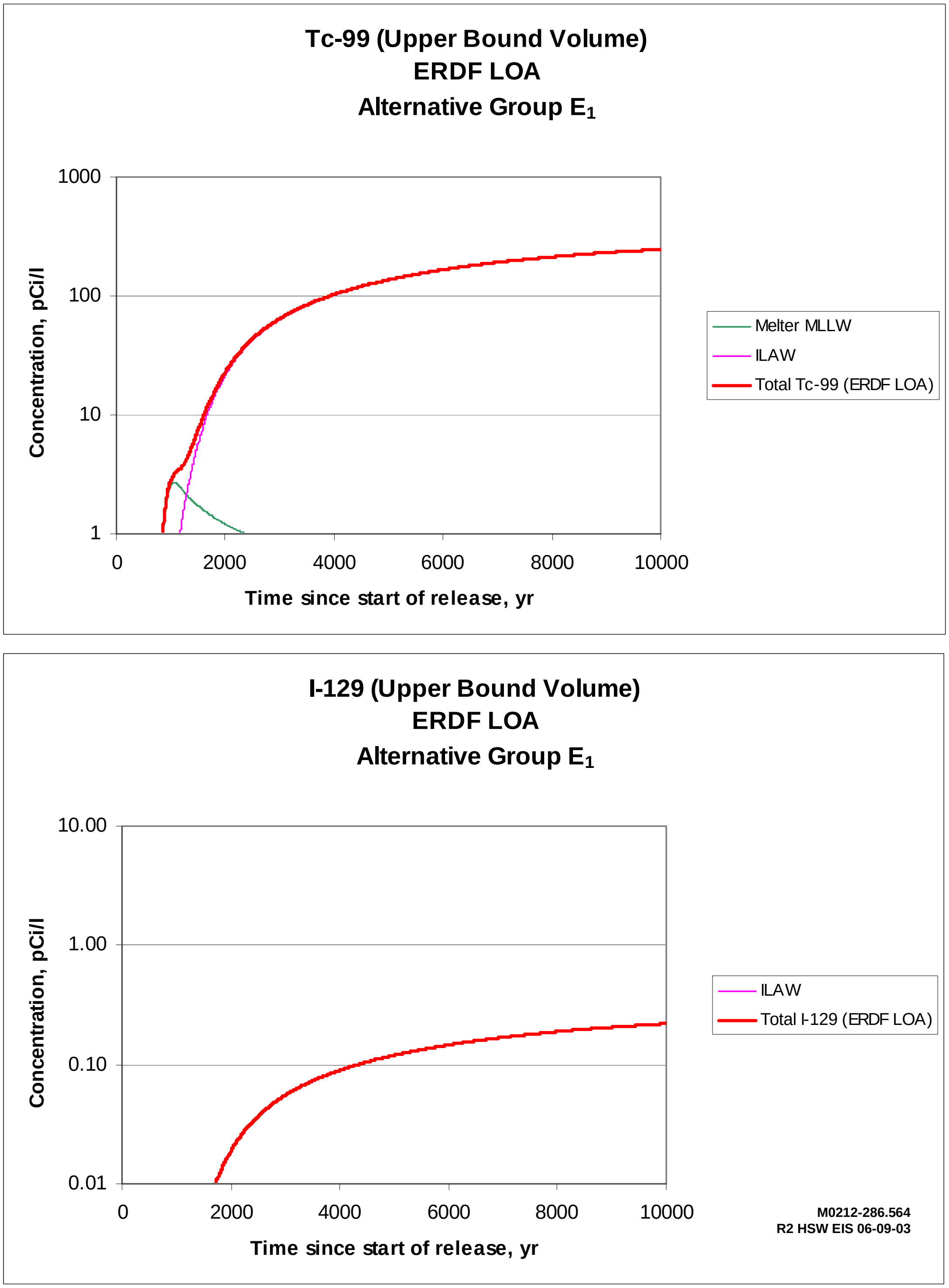


Figure G.71. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (ERDF) (Alternative Group E_1 – Upper Bound Volume Wastes Disposed of After 1995)

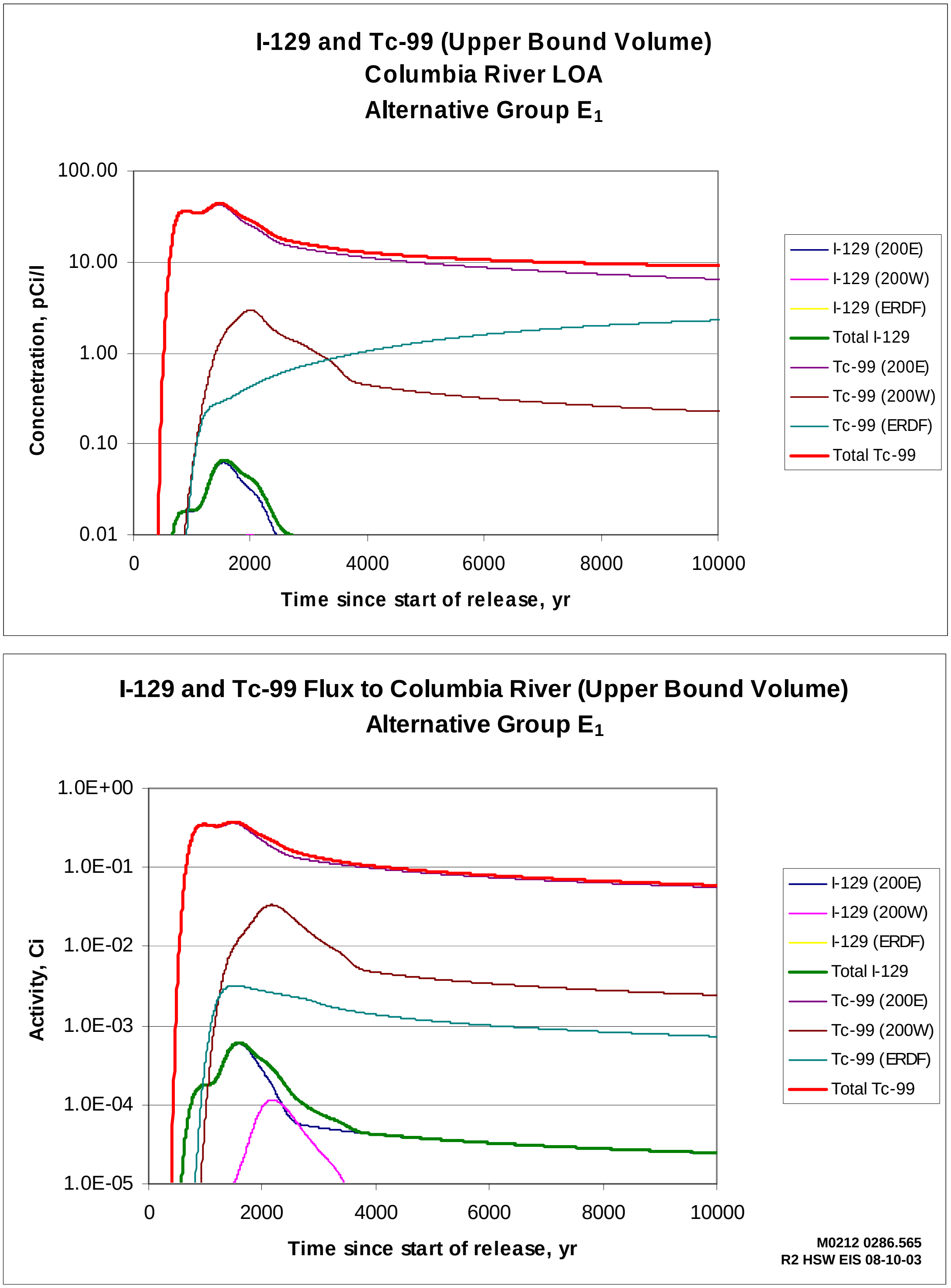


Figure G.72. I-129 and Tc-99 Concentration and River Flux Profiles Near the Columbia River (Alternative Group E_1 – Upper Bound Volume Wastes Disposed of After 1995)

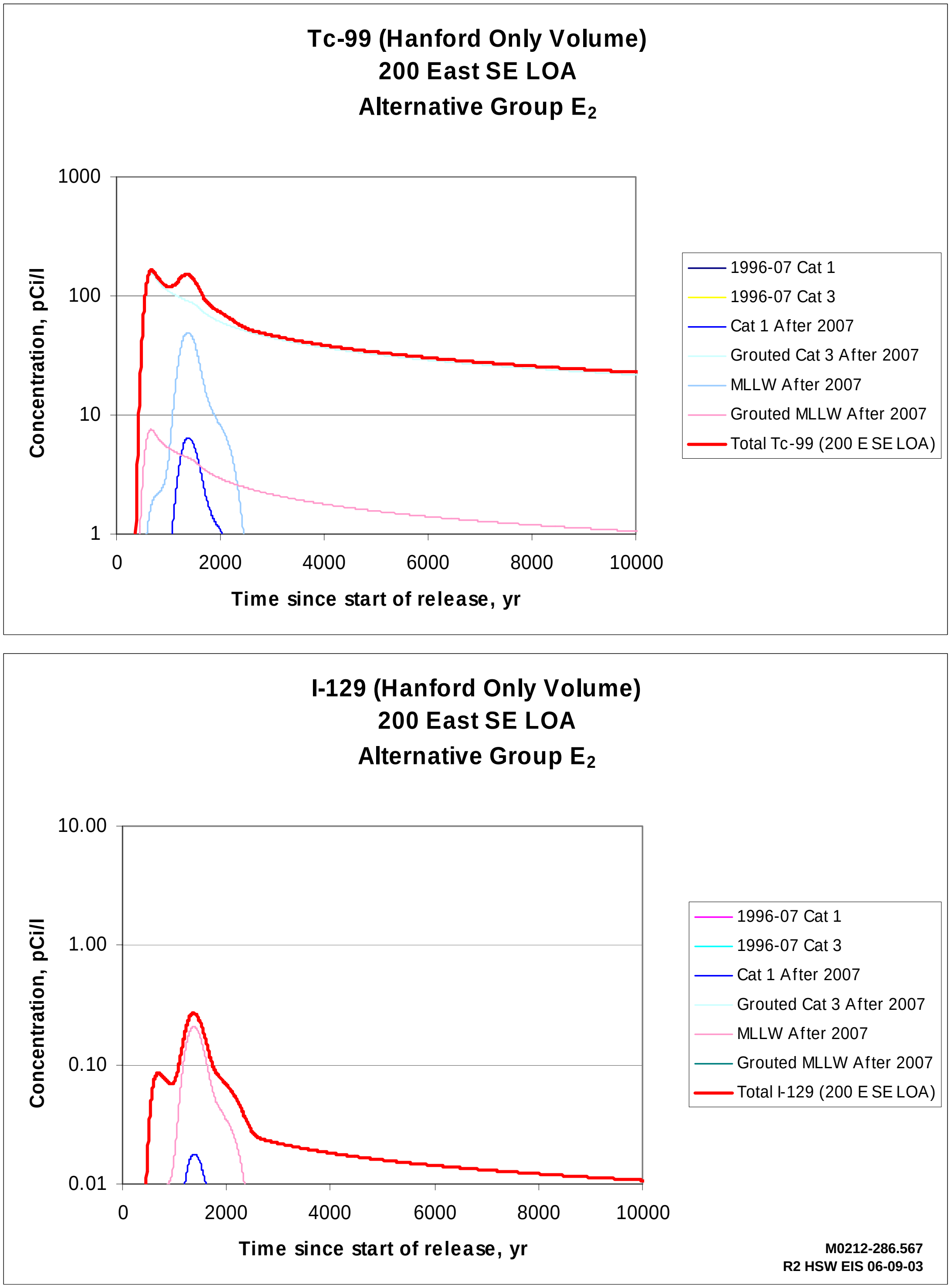


Figure G.73. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (200 East SE) (Alternative Group E_2 – Hanford Only Wastes Disposed of After 1995)

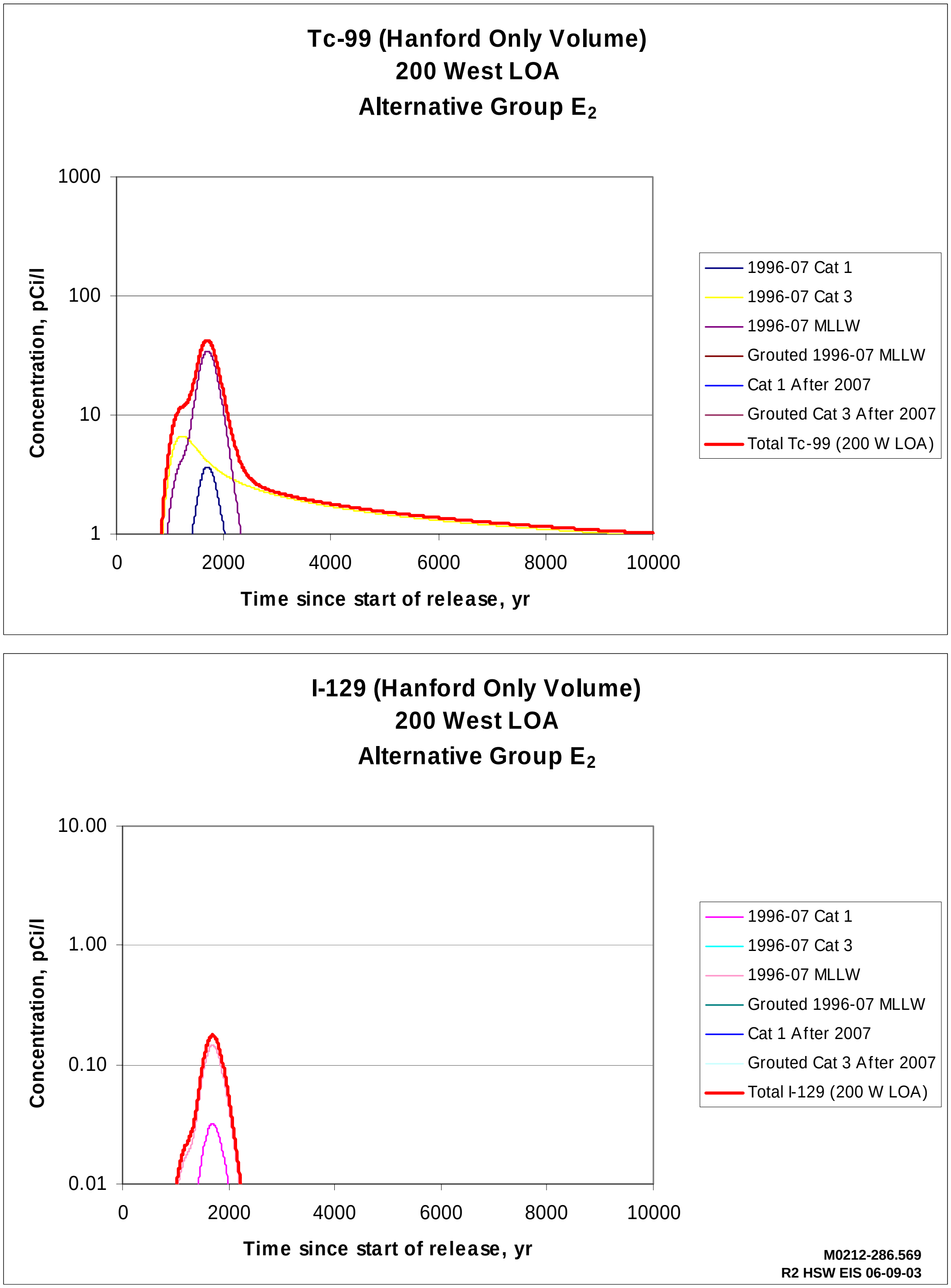


Figure G.74. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (200 West) (Alternative Group E_2 – Hanford Only Wastes Disposed of After 1995)

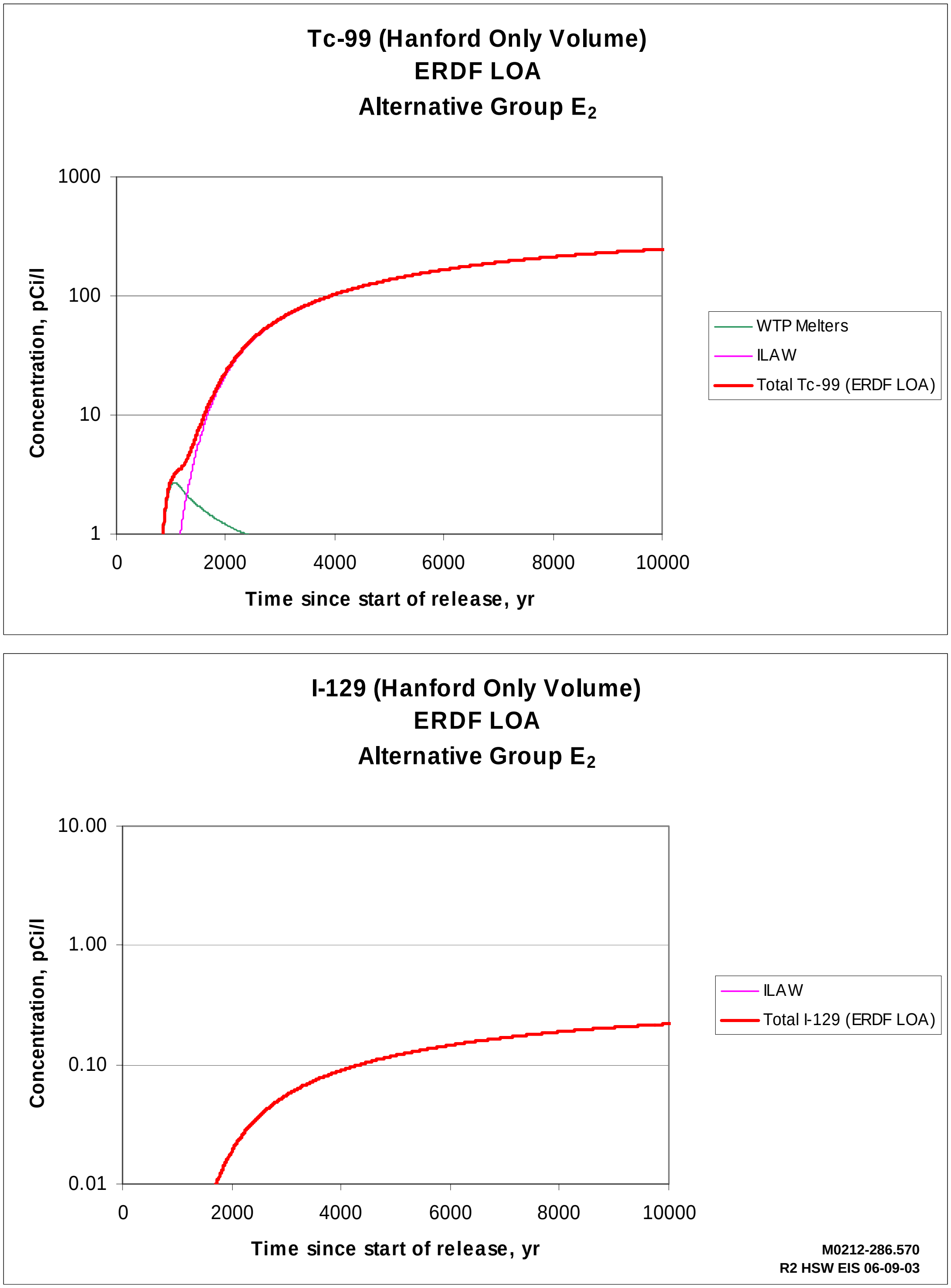


Figure G.75. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (ERDF) (Alternative Group E_2 – Hanford Only Wastes Disposed of After 1995)

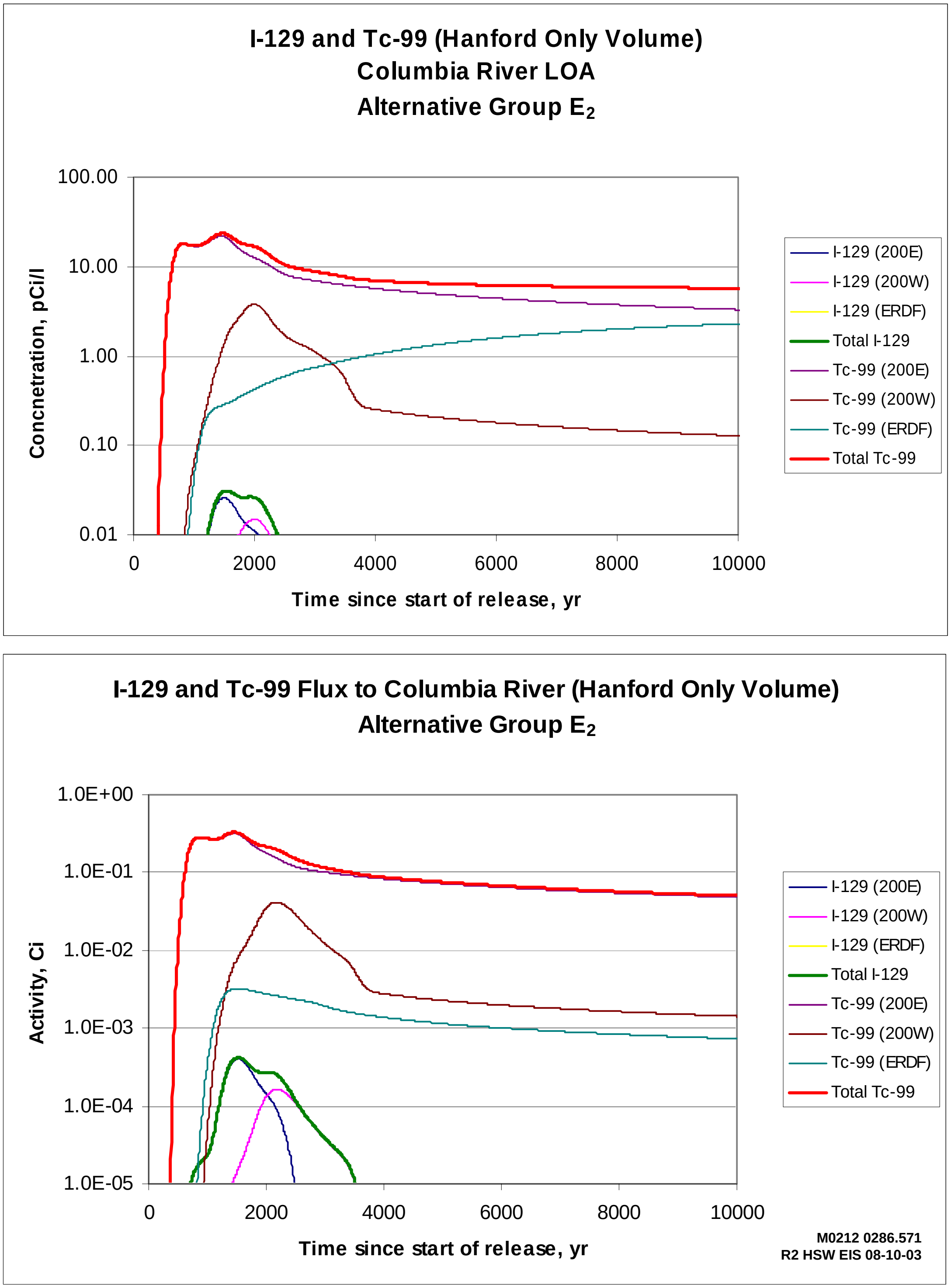


Figure G.76. I-129 and Tc-99 Concentration and River Flux Profiles Near the Columbia River (Alternative Group E_2 – Hanford Only Wastes Disposed of After 1995)

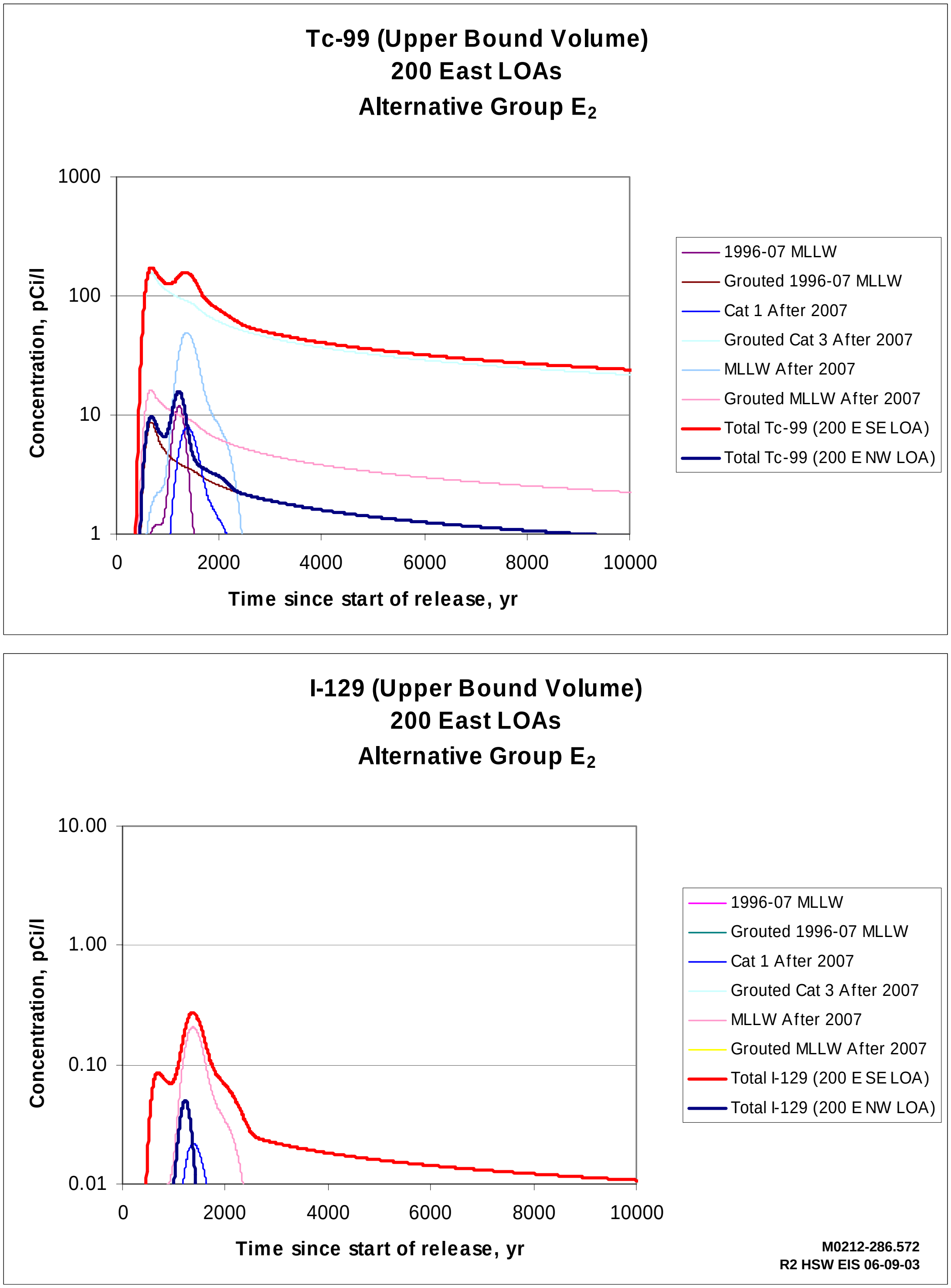


Figure G.77. Tc-99 and I-129 Concentration Profiles at the 1-km Lines of Analysis (200 East) (Alternative Group E_2 – Upper Bound Volume Wastes Disposed of After 1995)

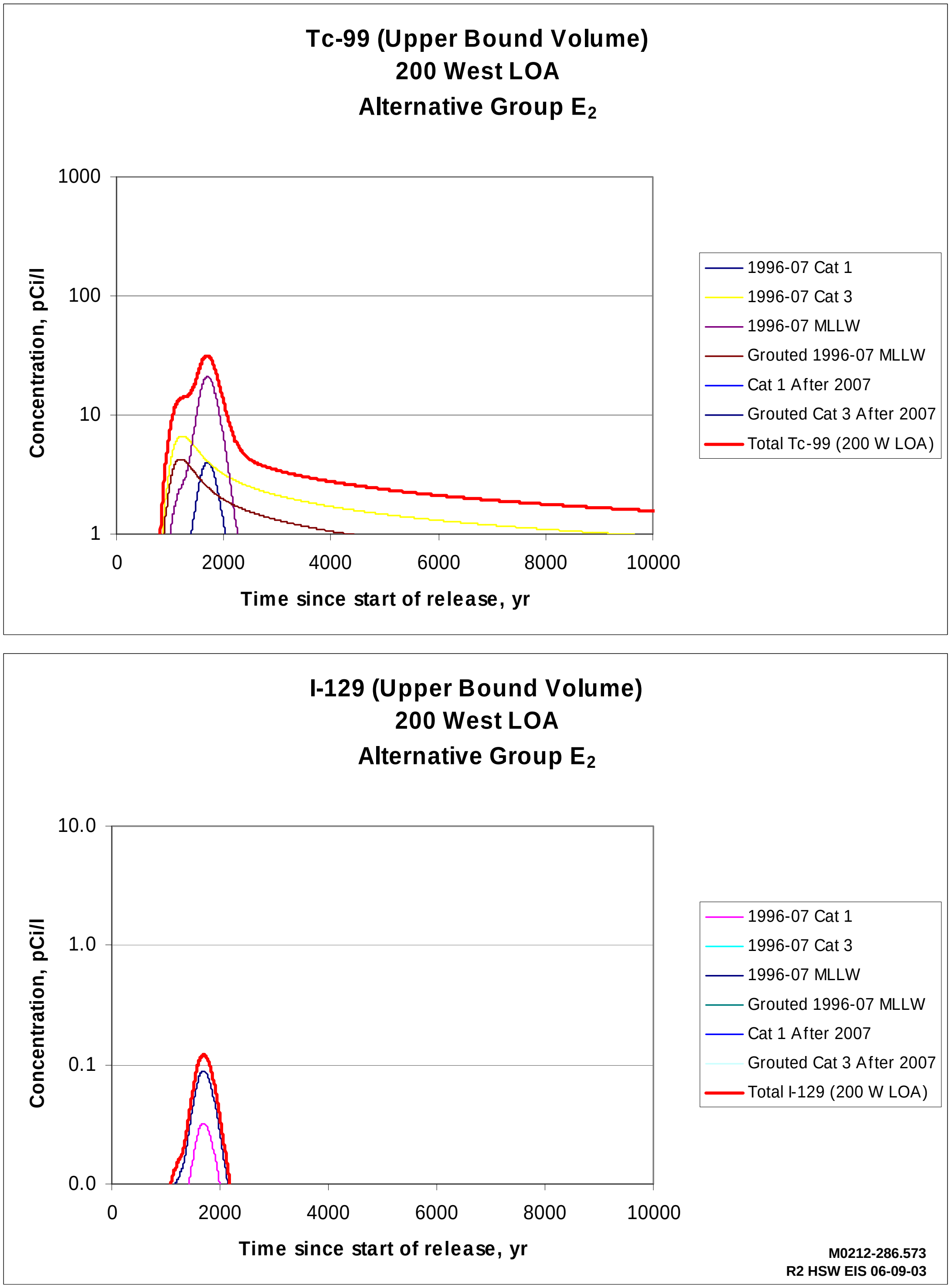
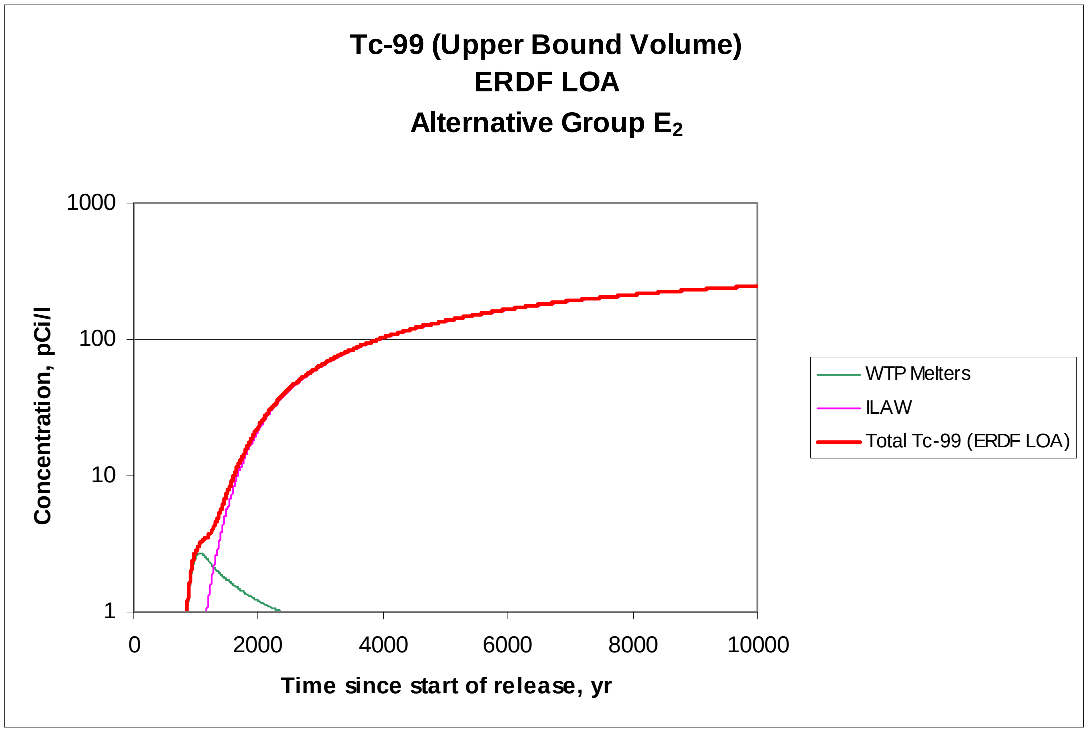


Figure G.78. Tc-99 and I-129 Concentration Profiles at 1-km Line of Analysis (200 West) (Alternative Group E_2 – Upper Bound Volume Wastes Disposed of After 1995)



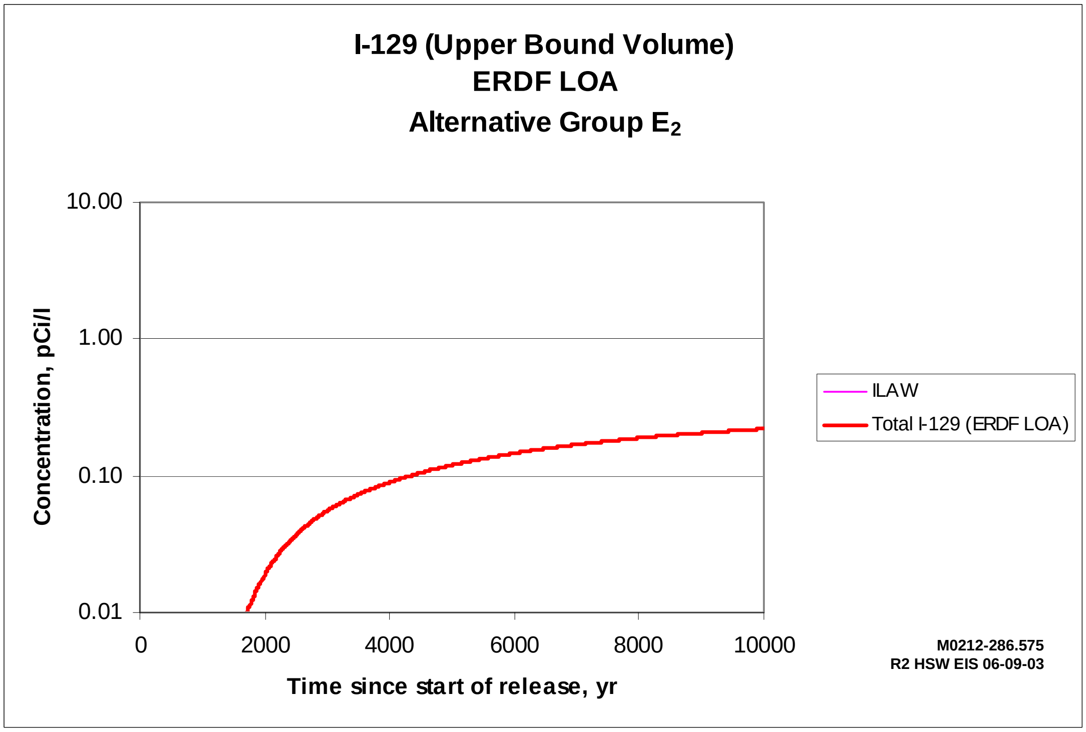


Figure G.79. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (ERDF) (Alternative Group E_2 – Upper Bound Volume Wastes Disposed of After 1995)

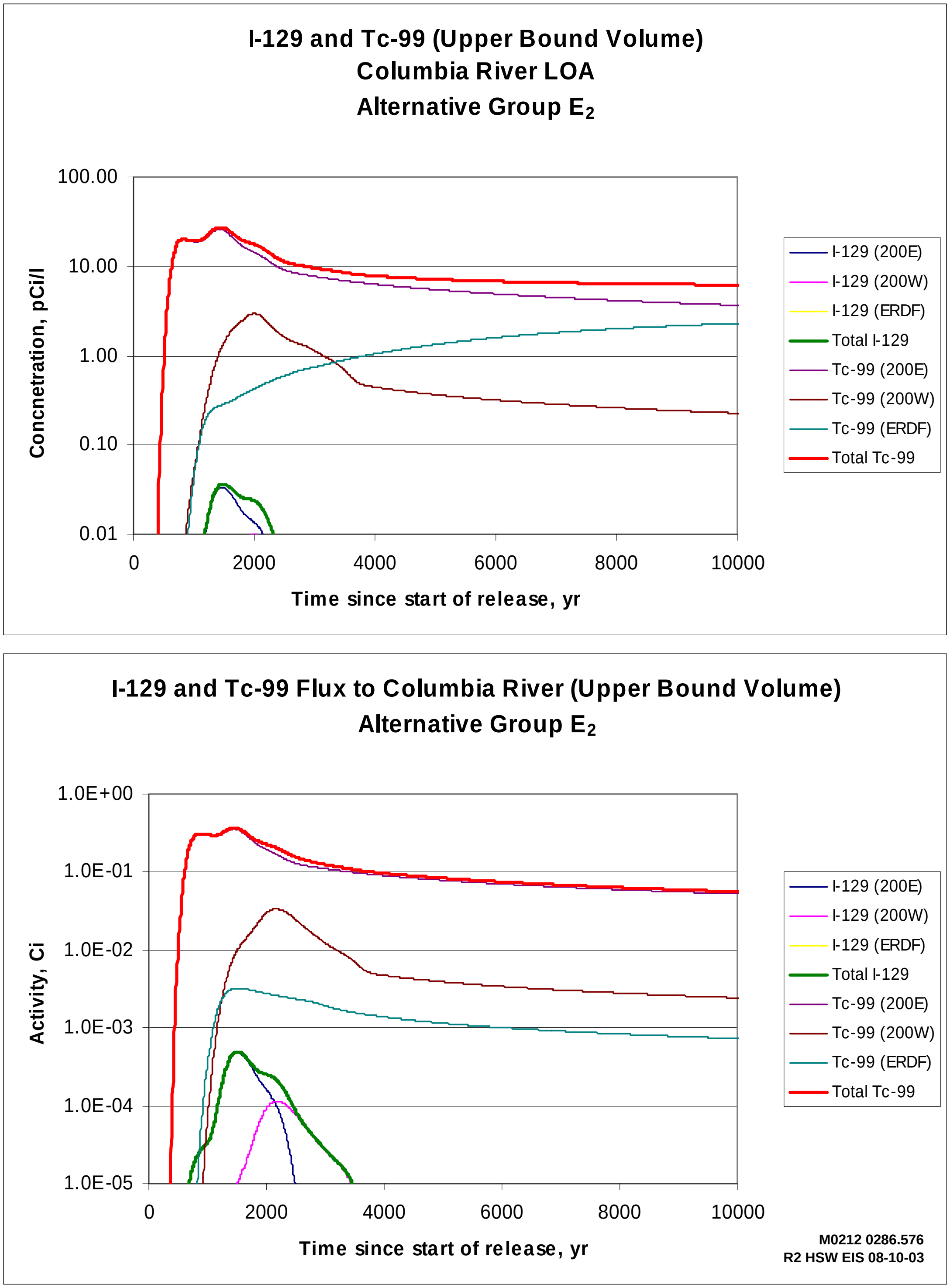


Figure G.80. I-129 and Tc-99 Concentration and River Flux Profiles Near the Columbia River (Alternative Group E_2 – Upper Bound Volume Wastes Disposed of After 1995)

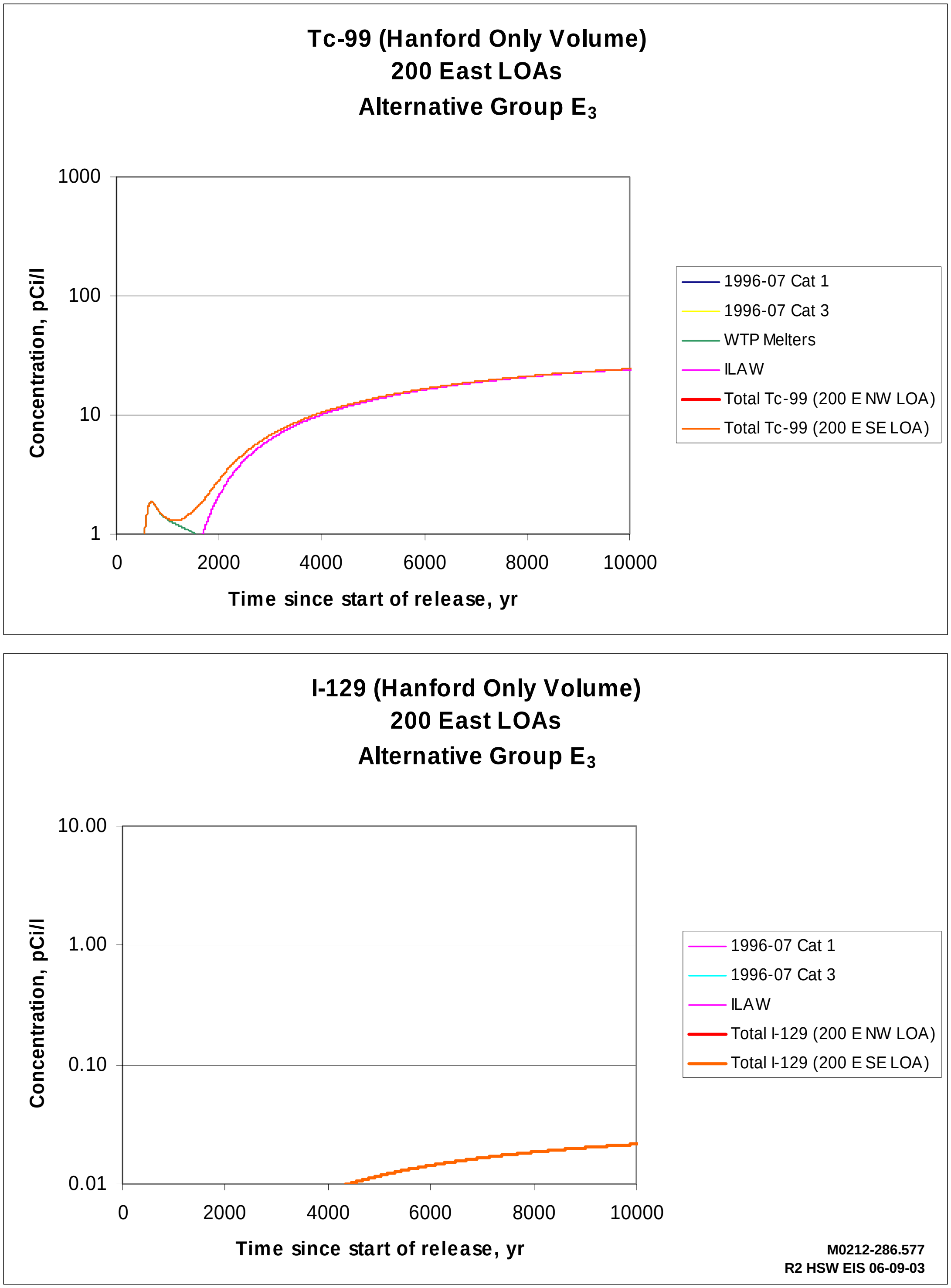


Figure G.81. Tc-99 and I-129 Concentration Profiles at the 1-km Lines of Analysis (200 East) (Alternative Group E_3 – Hanford Only Wastes Disposed of After 1995)

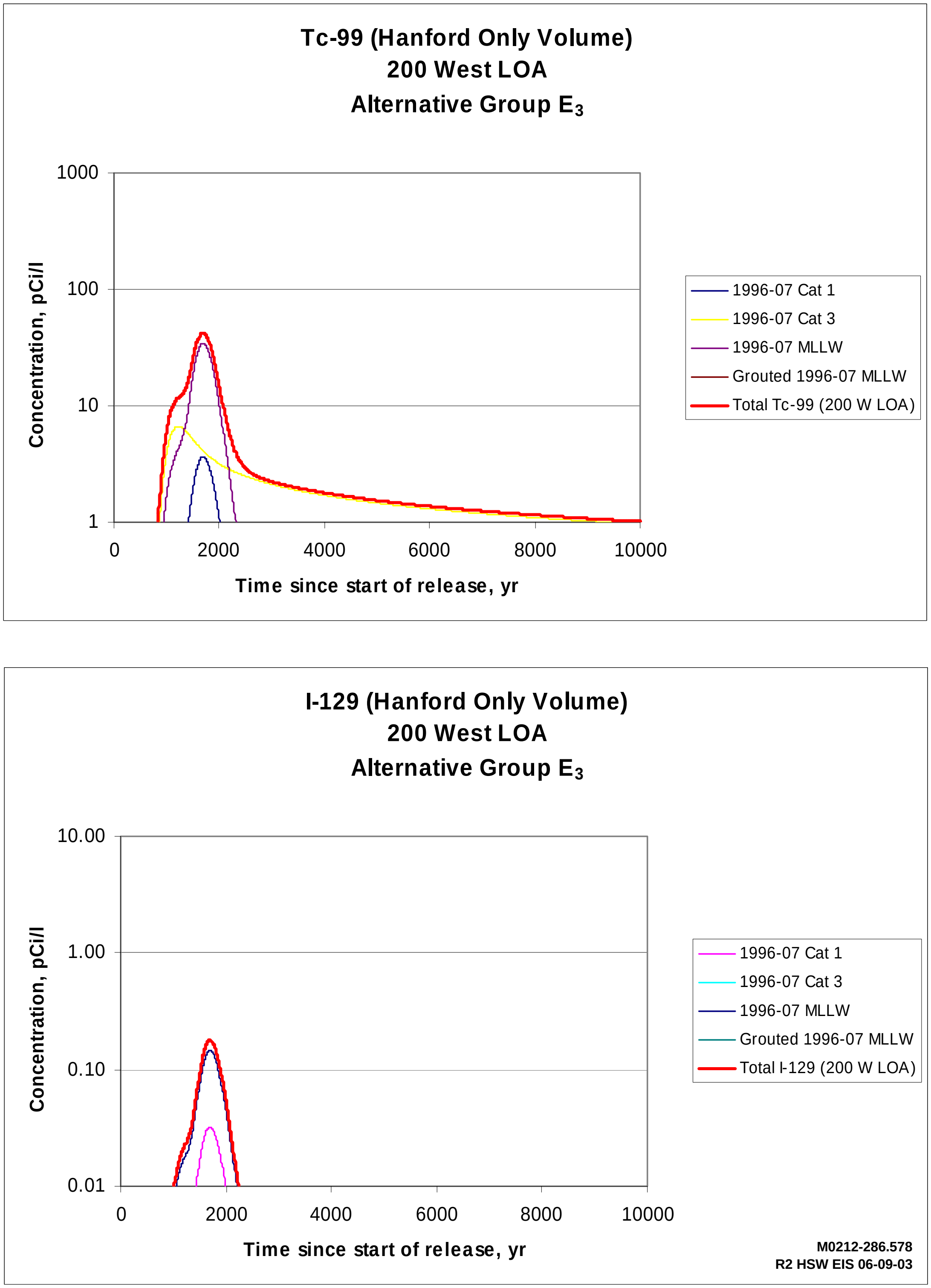


Figure G.82. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (200 West) (Alternative Group E_3 – Hanford Only Wastes Disposed of After 1995)

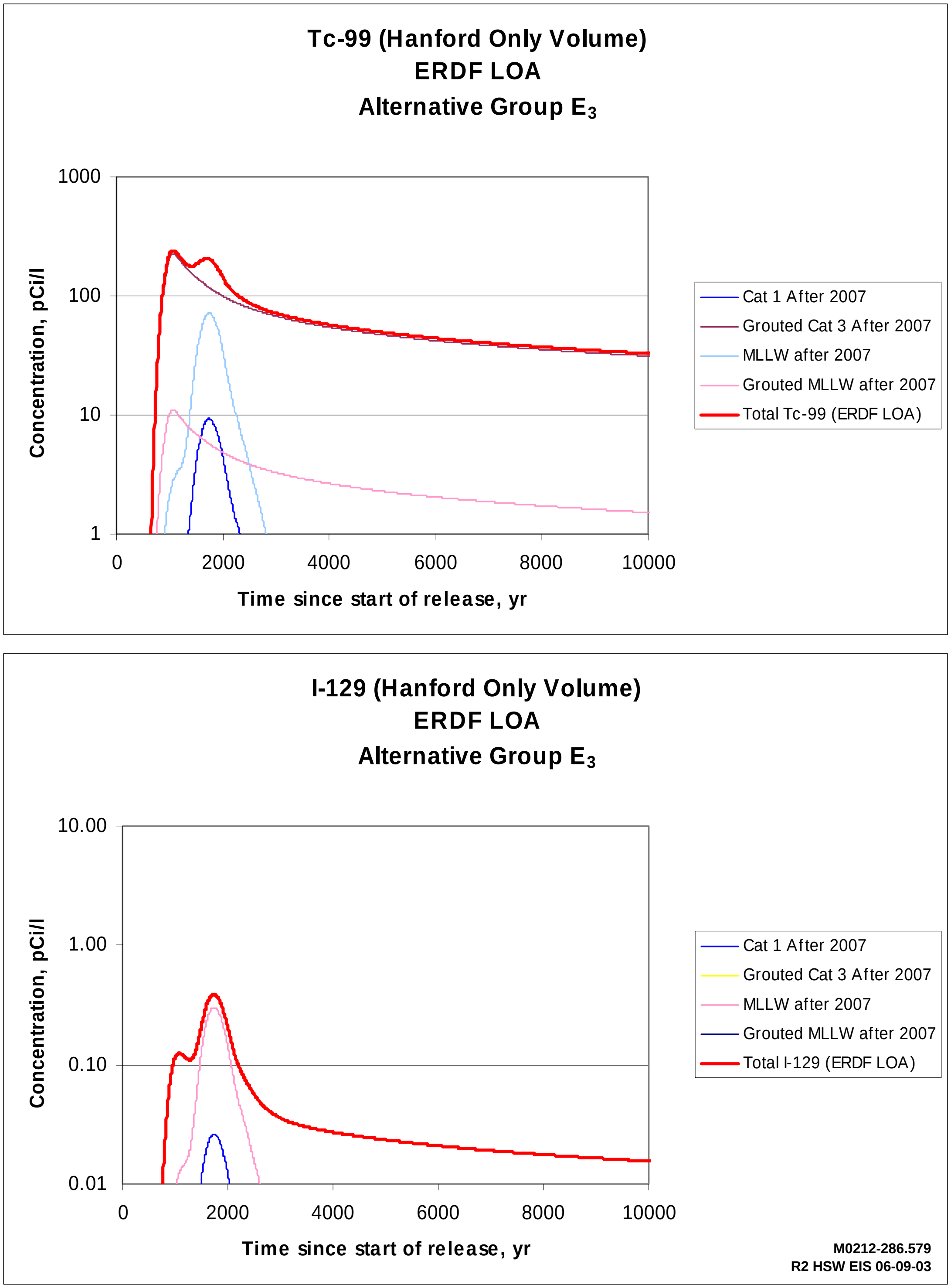


Figure G.83. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (ERDF) (Alternative Group E_3 – Hanford Only Wastes Disposed of After 1995)

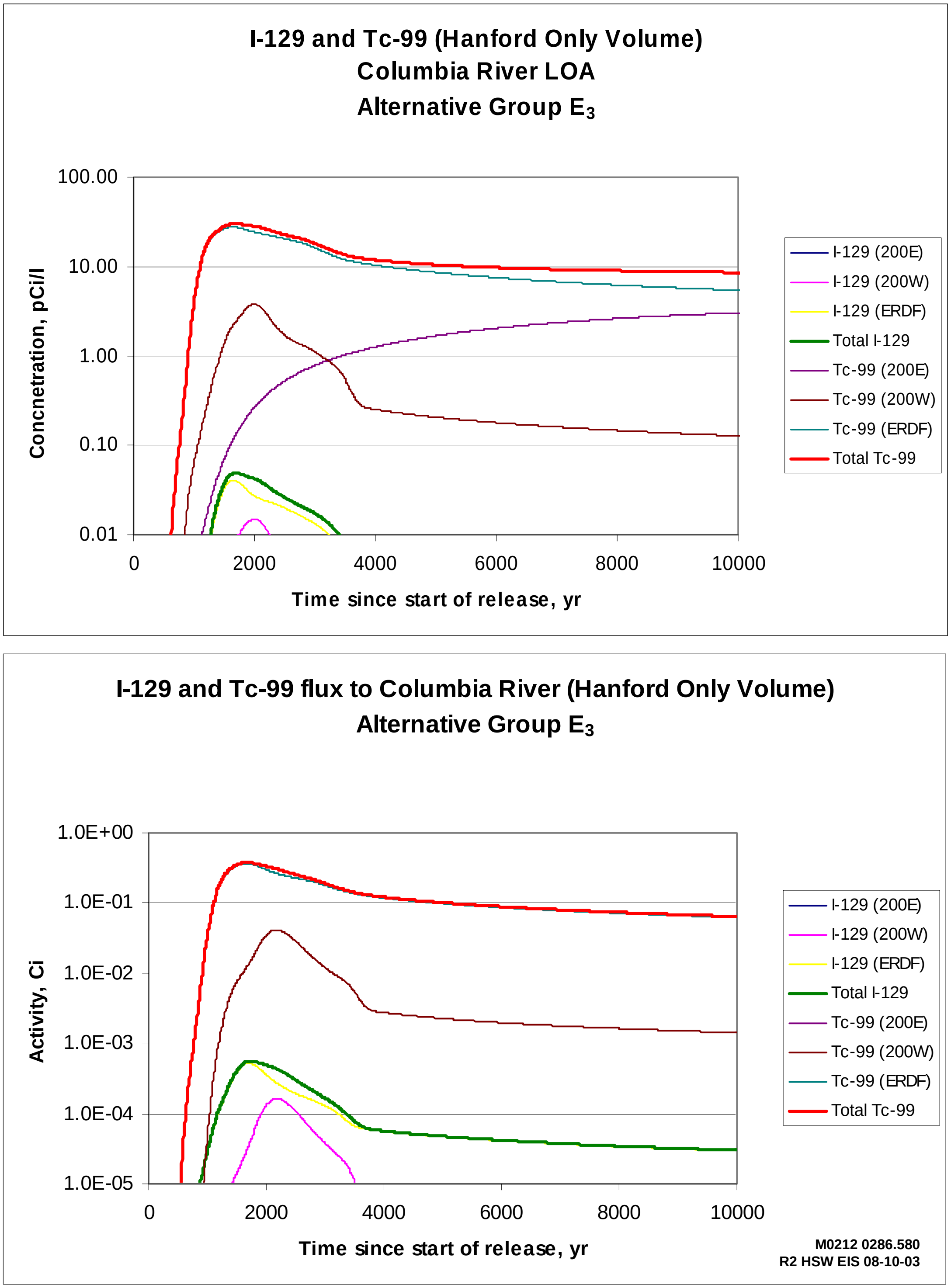


Figure G.84. I-129 and Tc-99 Concentration and River Flux Profiles Near the Columbia River (Alternative Group E_3 – Hanford Only Wastes Disposed of After 1995)

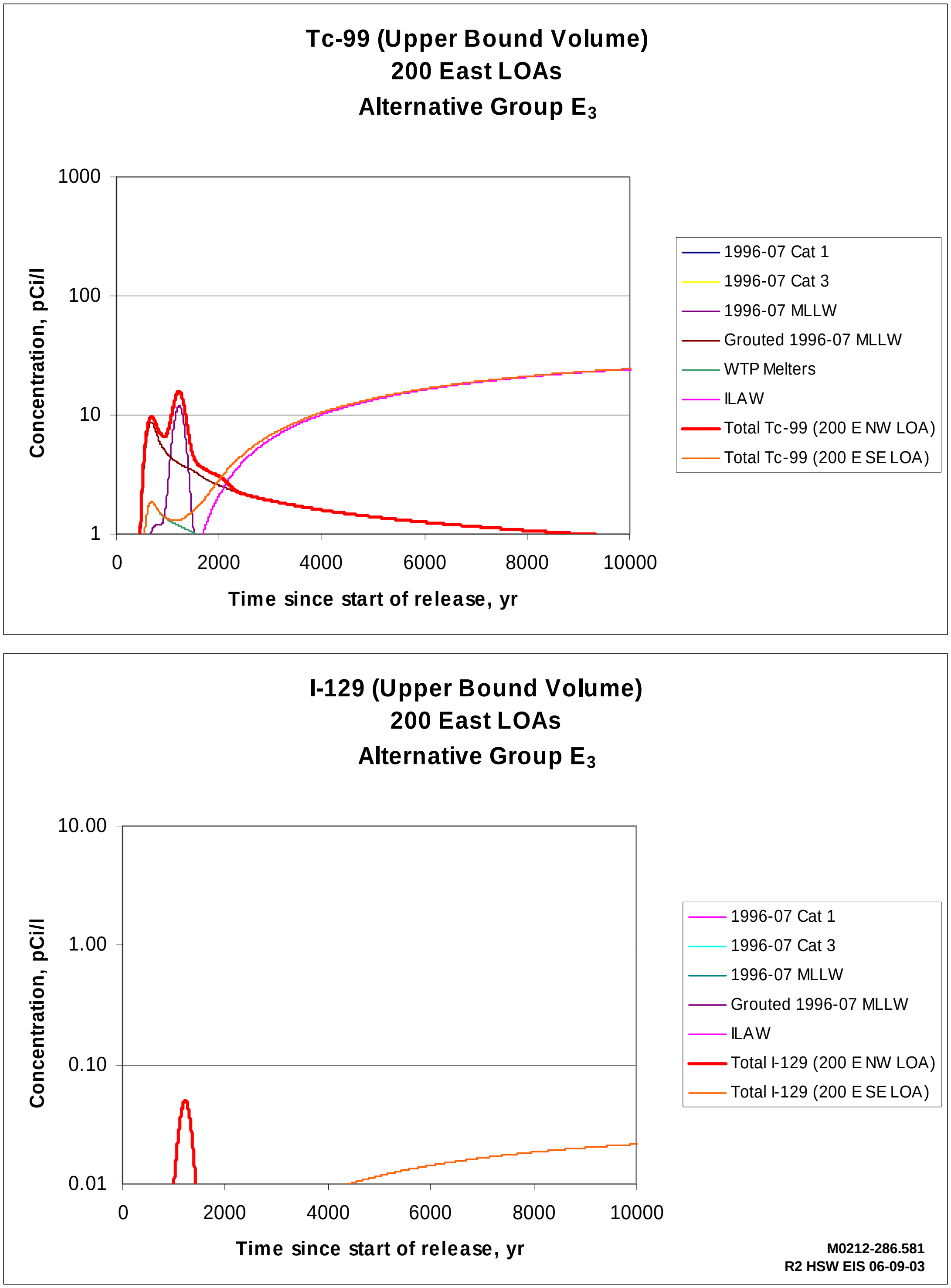


Figure G.85. Tc-99 and I-129 Concentration Profiles at the 1-km Lines of Analysis (200 East) (Alternative Group E_3 – Upper Bound Volume Wastes Disposed of After 1995)

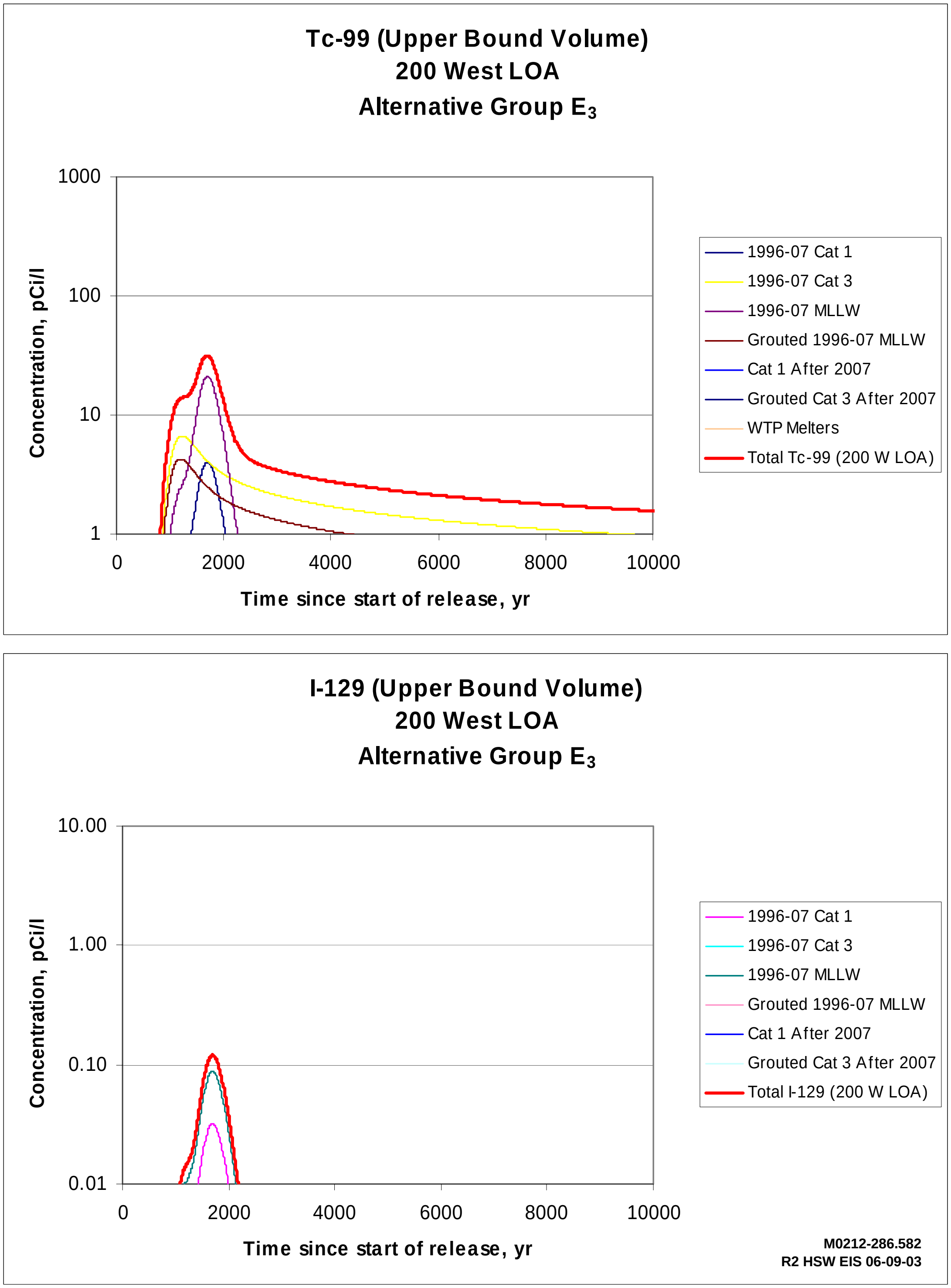
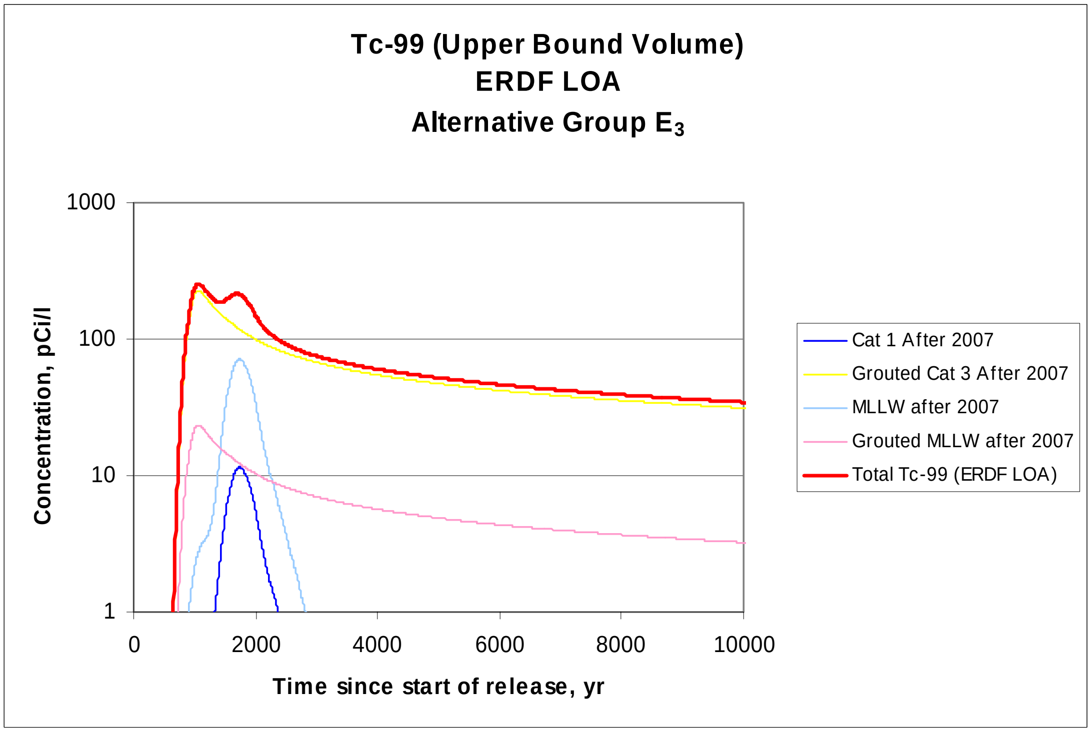


Figure G.86. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (200 West) (Alternative Group E_3 – Upper Bound Volume Wastes Disposed of After 1995)



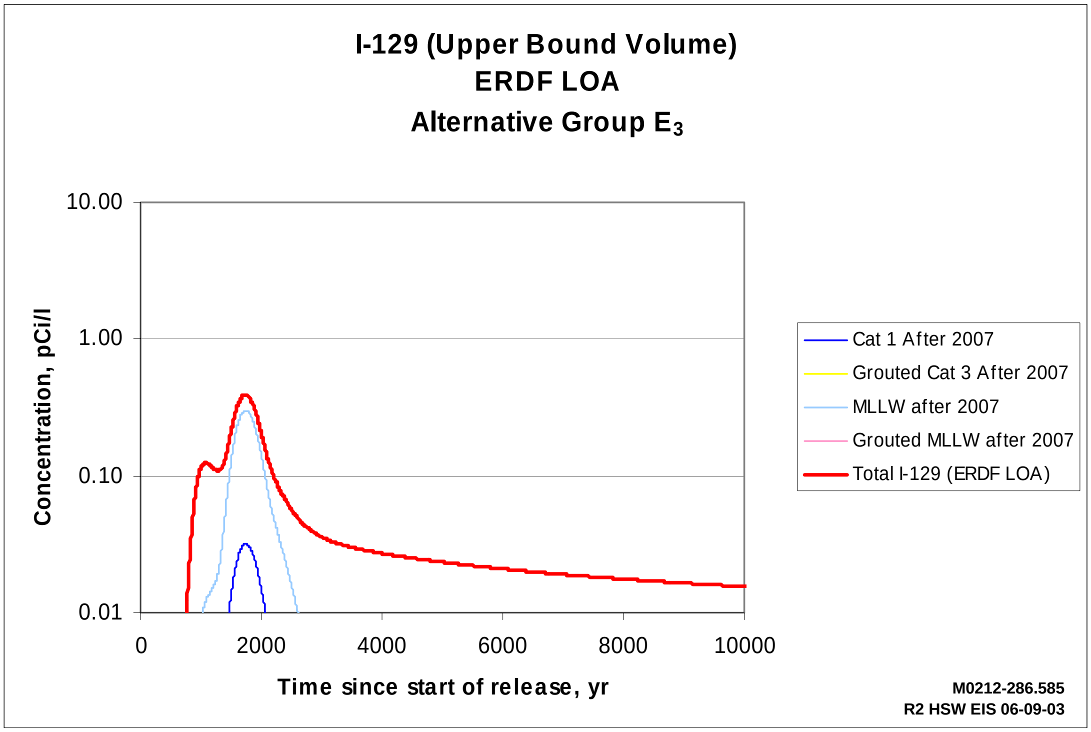


Figure G.87. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (ERDF) (Alternative Group E_3 – Upper Bound Volume Wastes Disposed of After 1995)

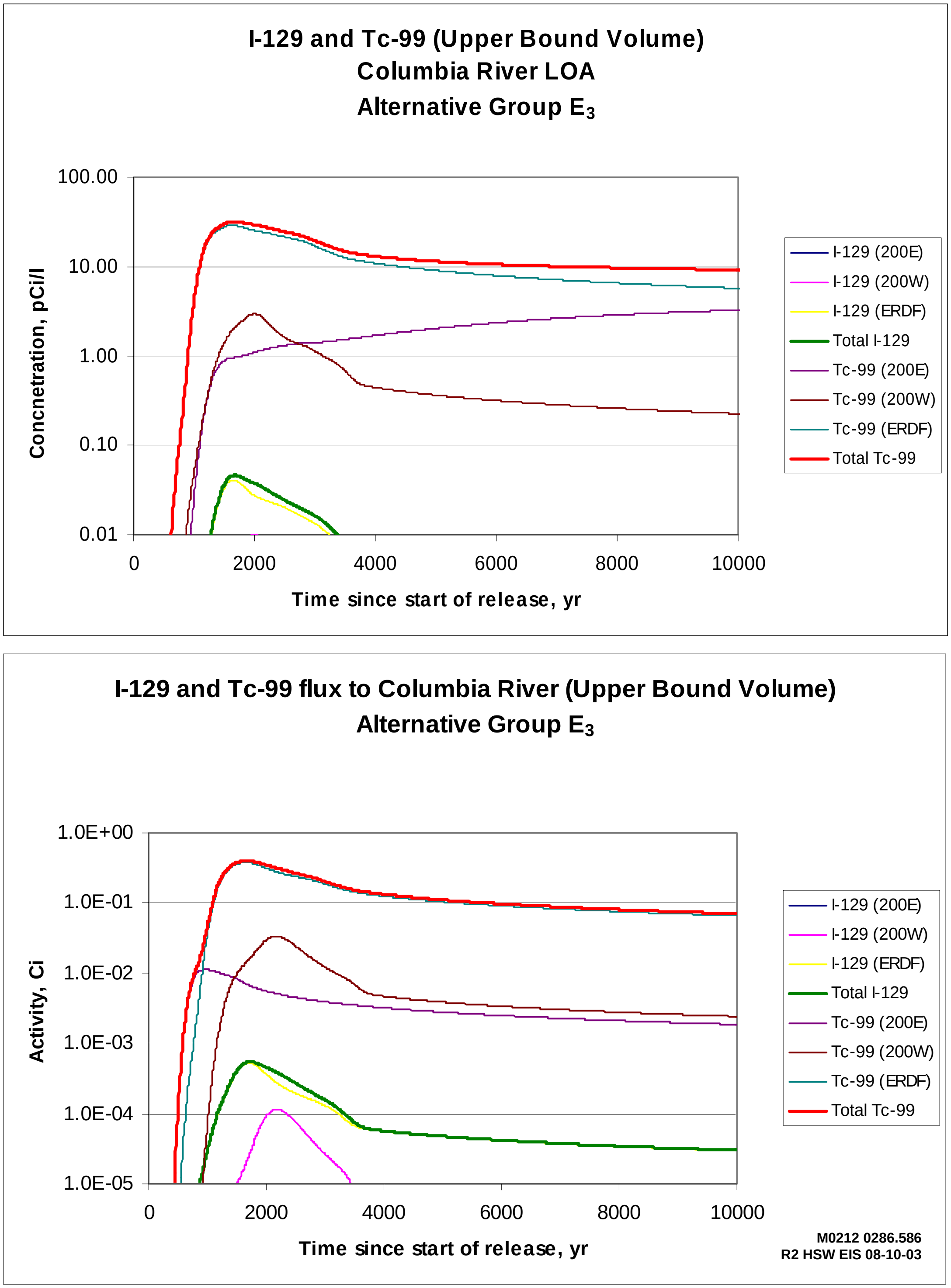


Figure G.88. I-129 and Tc-99 Concentration and River Flux Profiles Near the Columbia River (Alternative Group E_3 – Upper Bound Volume Wastes Disposed of After 1995)

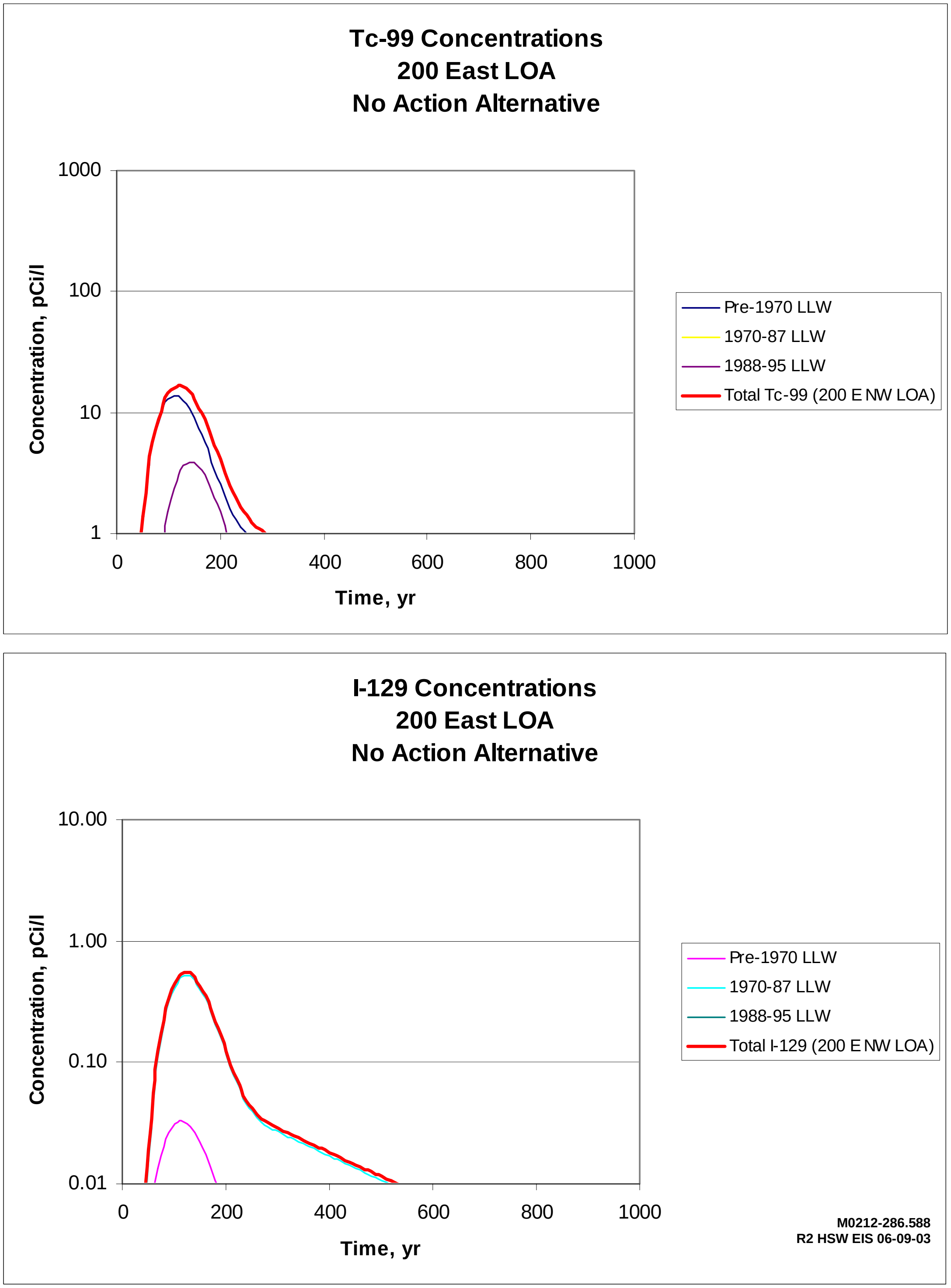
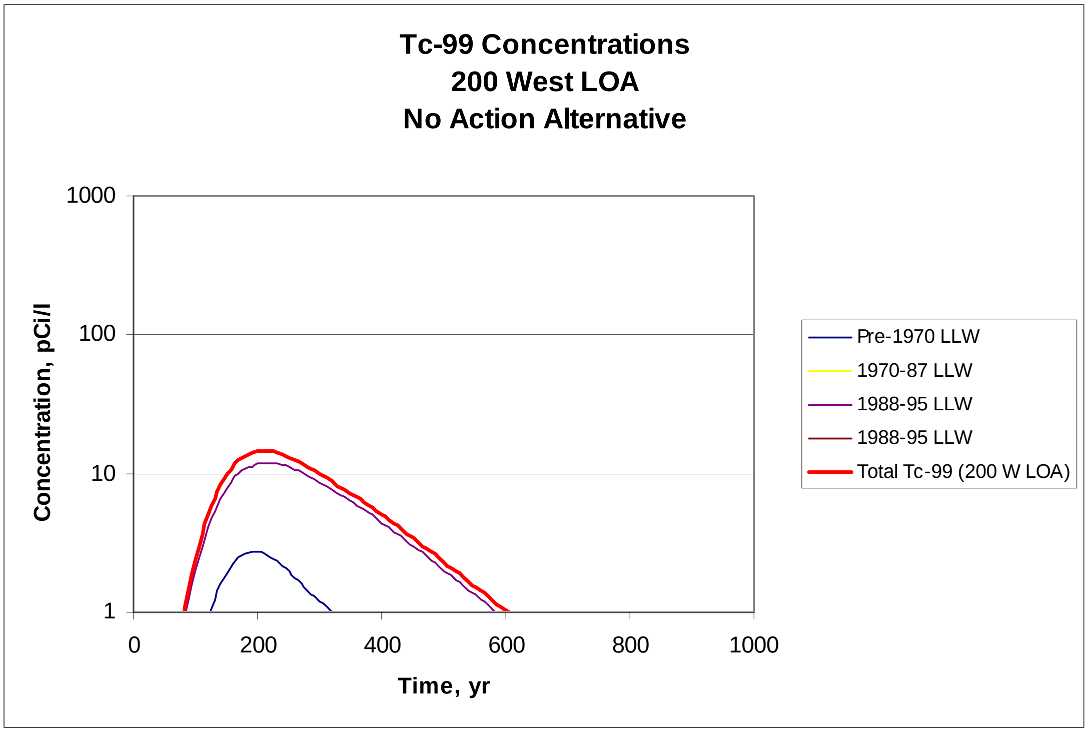


Figure G.89. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (200 East) (No Action Alternative – Wastes Disposed of Before 1996)



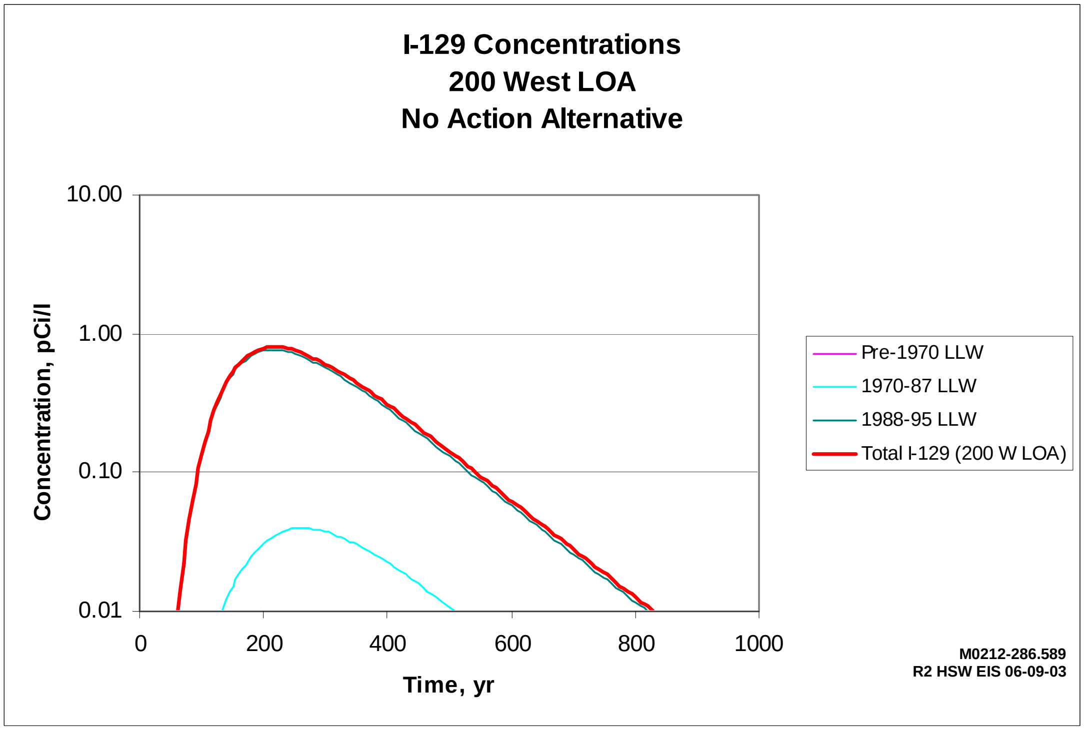


Figure G.90. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (200 West) (No Action Alternative – Wastes Disposed of Before 1996)

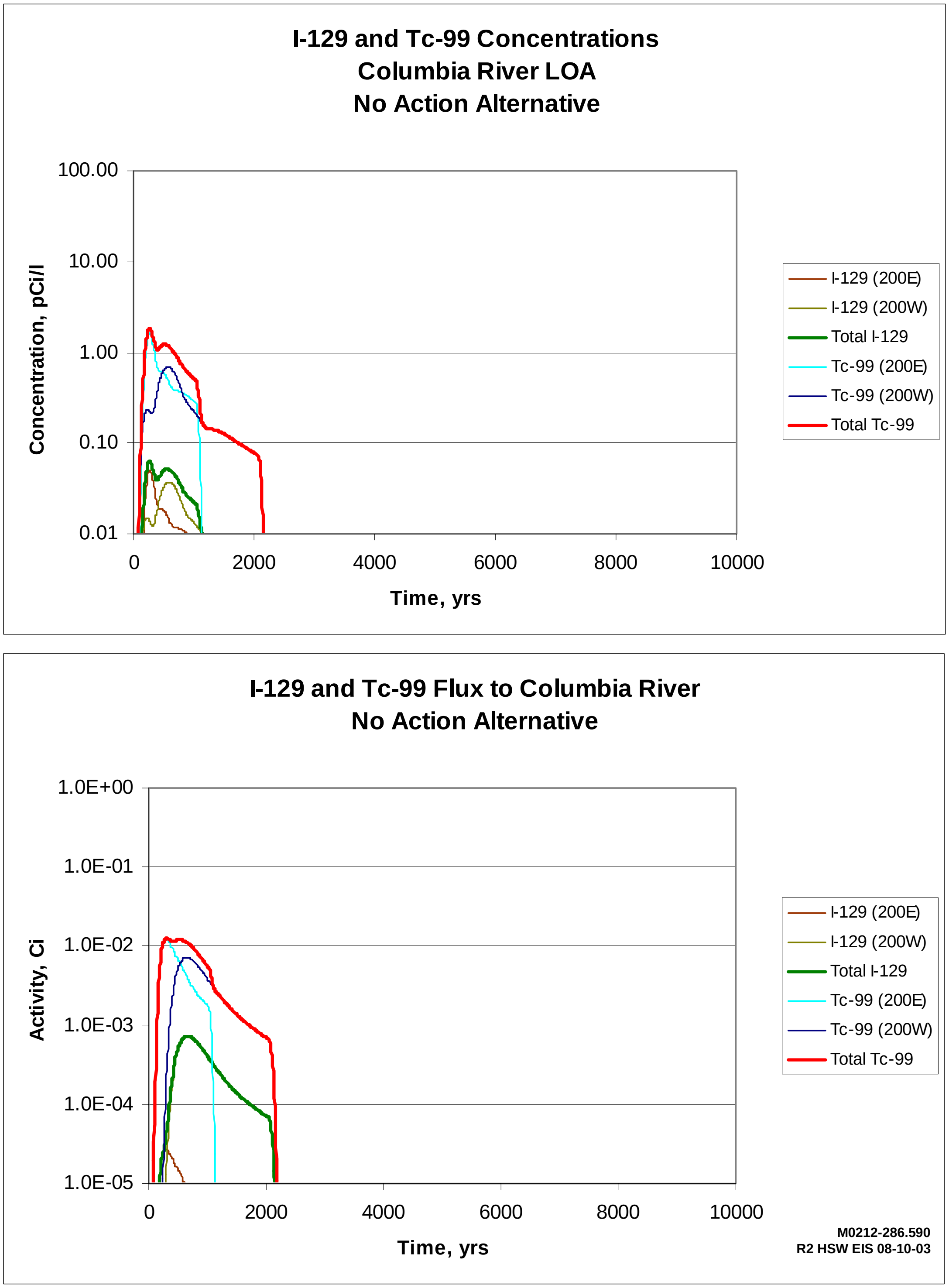


Figure G.91. I-129 and Tc-99 Concentration and River Flux Profiles Near the Columbia River (No Action Alternative – Wastes Disposed of Before 1996)

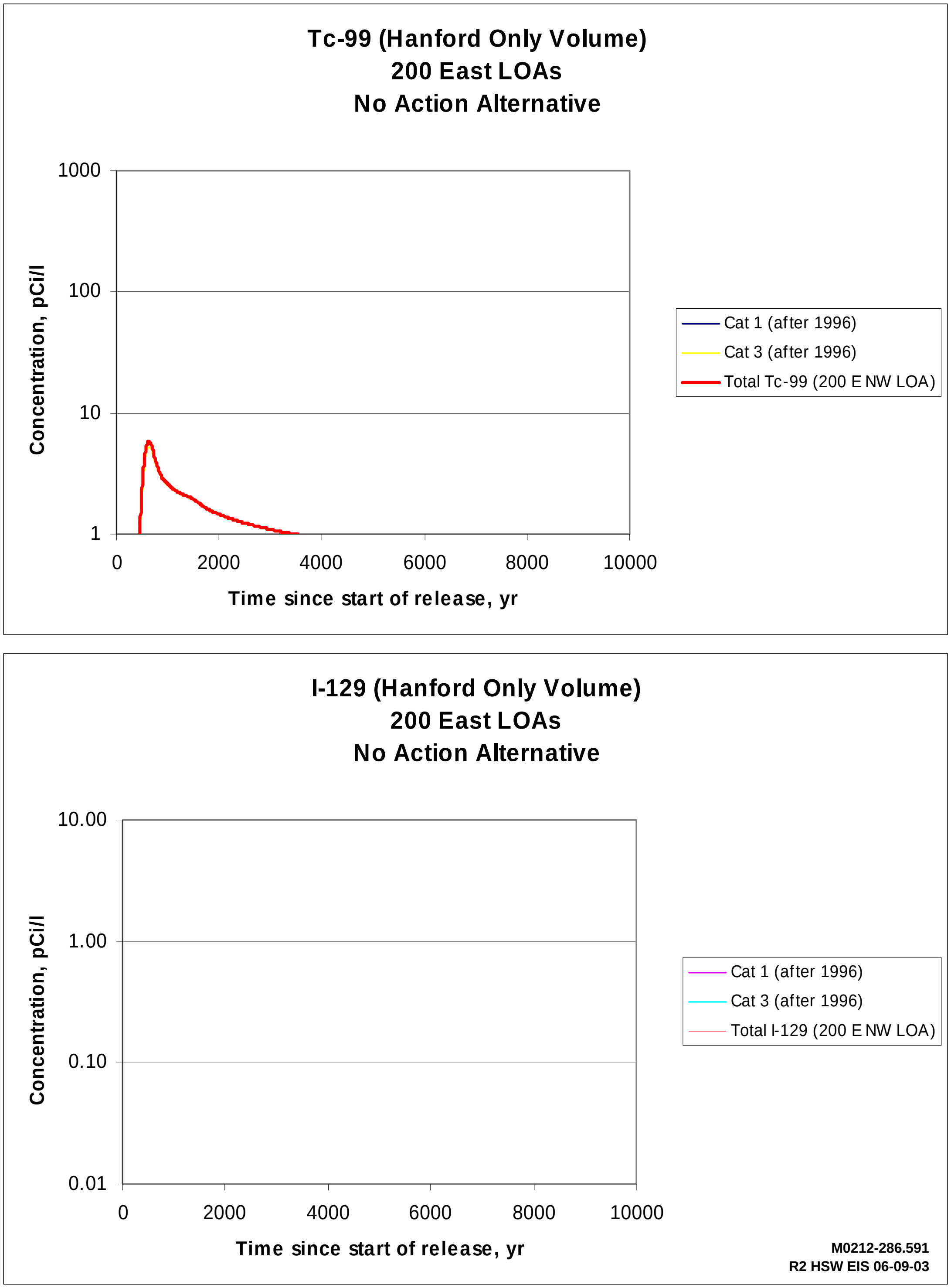


Figure G.92. Tc-99 and I-129 Concentration Profiles at the 1-km Lines of Analysis (200 East) (No Action Alternative – Hanford Only Wastes Disposed of After 1995)

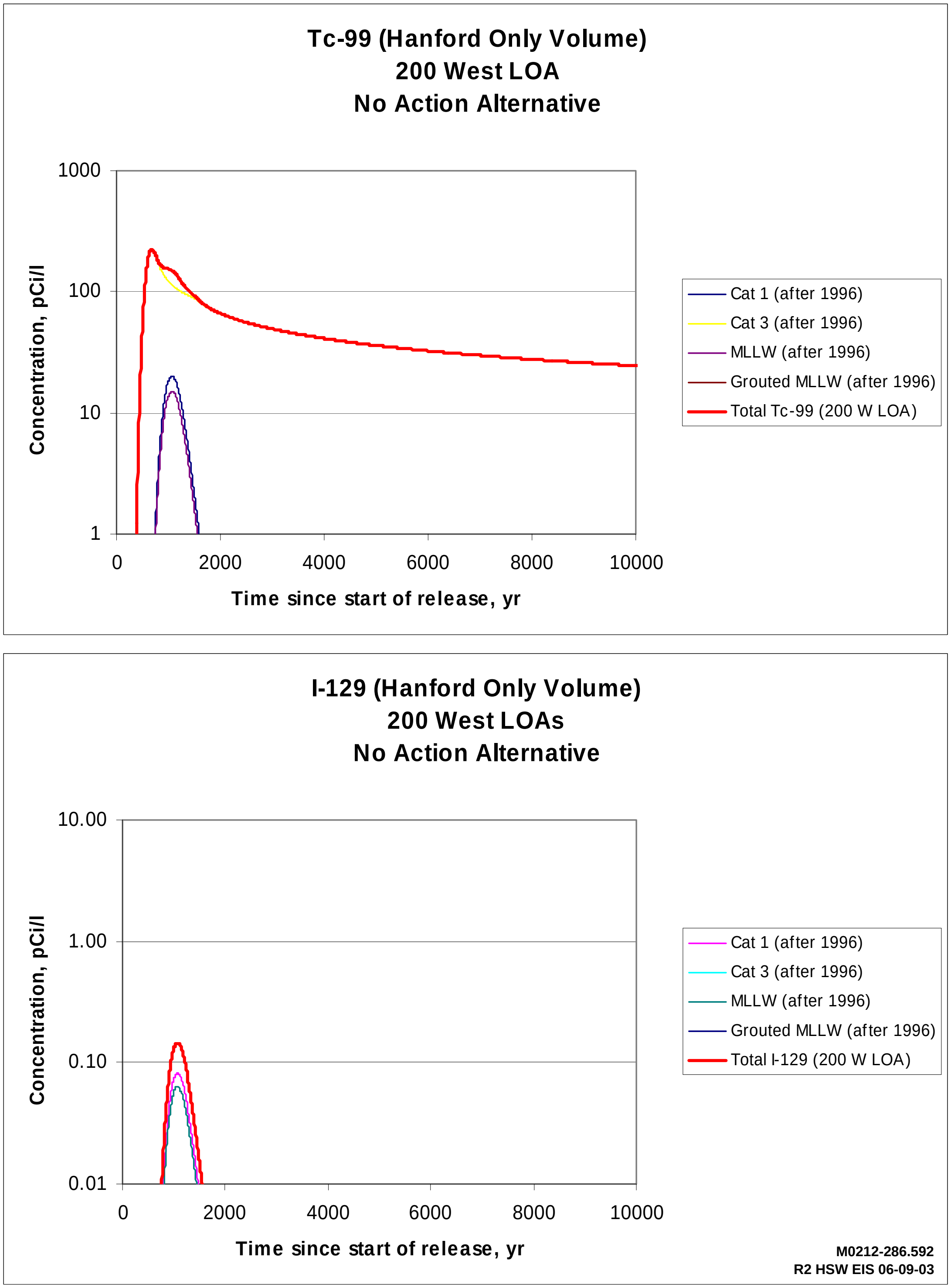


Figure G.93. Tc-99 and I-129 Concentration Profiles at the 1-km Line of Analysis (200 West) (No Action Alternative – Hanford Only Wastes Disposed of After 1995)

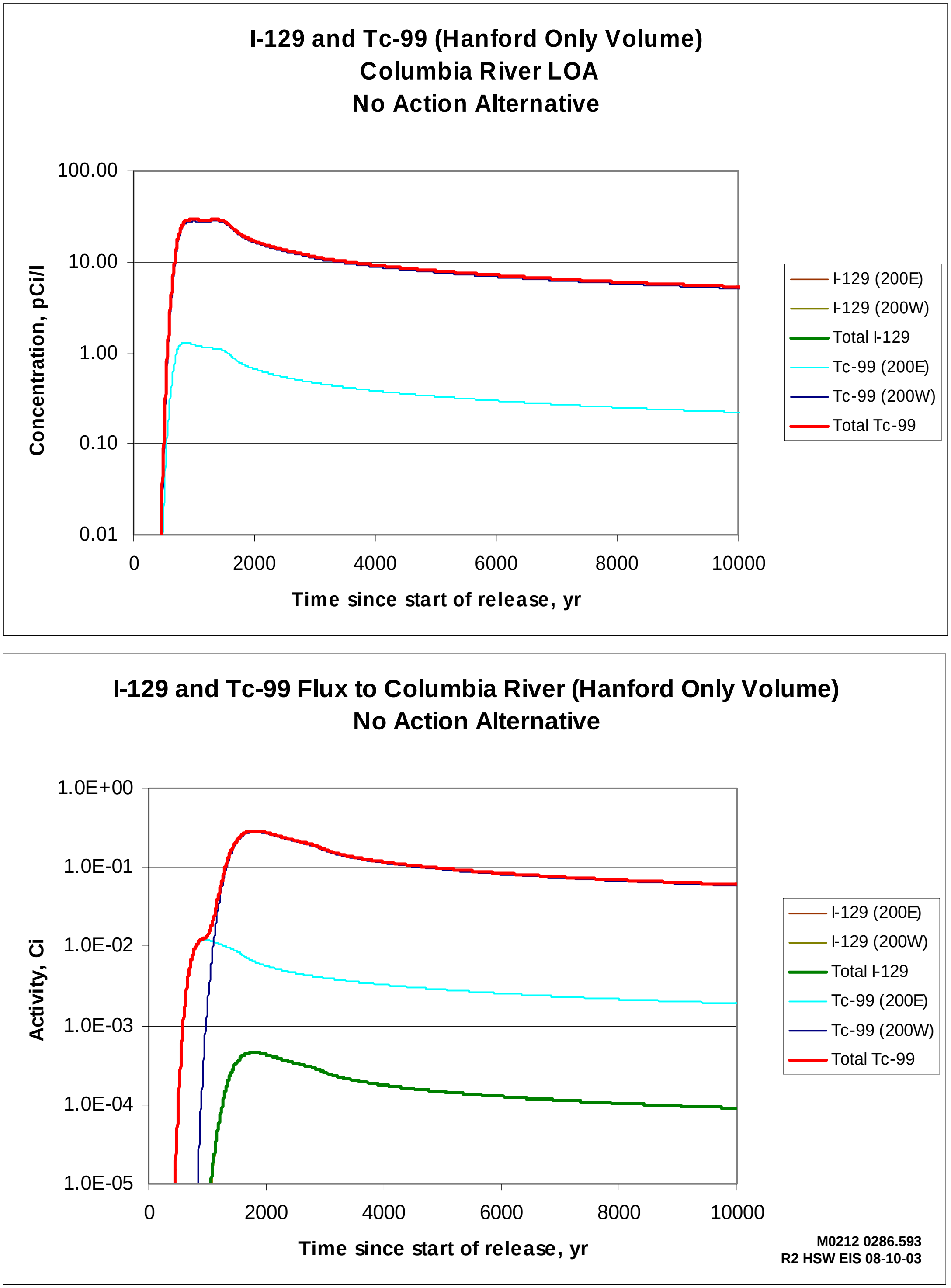


Figure G.94. I-129 and Tc-99 Concentration and River Flux Profiles Near the Columbia River (No Action Alternative – Hanford Only Wastes Disposed of After 1995)

G.3 Use of ILAW Performance Assessment Calculations in Potential HSW EIS Long-Term Groundwater Quality and Human Health Impacts

Potential impact results presented for the ILAW disposal facility were based on performance assessment (PA) calculations made for siting the facility in the vicinity of the PUREX Plant, as summarized in Mann et al. (2001). The following section discusses:

- range of waste form and engineering performance examined to date, as discussed in Mann et al. (2001) including the specific discussion of the case selected for this analysis
- additional planned analyses of waste disposal system performance
- scaling of ILAW PA results for use in this analysis.

G.3.1 Range of Waste Form and Engineering Performance Evaluated in the 2001 ILAW Performance Assessment

The potential long-term impacts from disposing ILAW was analyzed in the *Hanford Immobilized Low-Activity Waste Performance Assessment: 2001* (Mann et al. 2001), known as 2001 ILAW PA. A wide variety of cases were analyzed. Performance objectives covering air, groundwater, surface water, all-pathways, and inadvertent intrusion were established based on analyzing applicable and relevant regulations. The document concluded that there was a reasonable expectation that long-term public health and safety as well as the environment would be protected from the disposal in dirt trenches of a vitrified product from the Waste Treatment Plant (WTP). This document was reviewed by the Washington State Department of Ecology and approved by DOE headquarters, in accordance with DOE (2001).

The 2001 ILAW PA was built around a base analysis case. This case was designed to include the major features of disposal facility design and performance without going into details that have minimal impact in long-term performance. Important features are the waste composition and facility design.

At the time of writing the 2001 ILAW PA, the reference glasses to be produced by the WTP were not specified. Therefore, the ILAW PA activity used a glass composition (LAWABP1) developed by the Pacific Northwest National Laboratory in the composition envelope within which the WTP was working because of extensive laboratory testing data base for LAWABP1. Subsequent testing of the WTP reference glasses shows that the performance of LAWABP1 is very comparable to the WTP reference glasses. The results of the base analysis case, along with other cases analyzed, are illustrated in Figure G.95 as the curve labeled LAWABP1. Results of this case are also presented in tabular form in Table G.40.

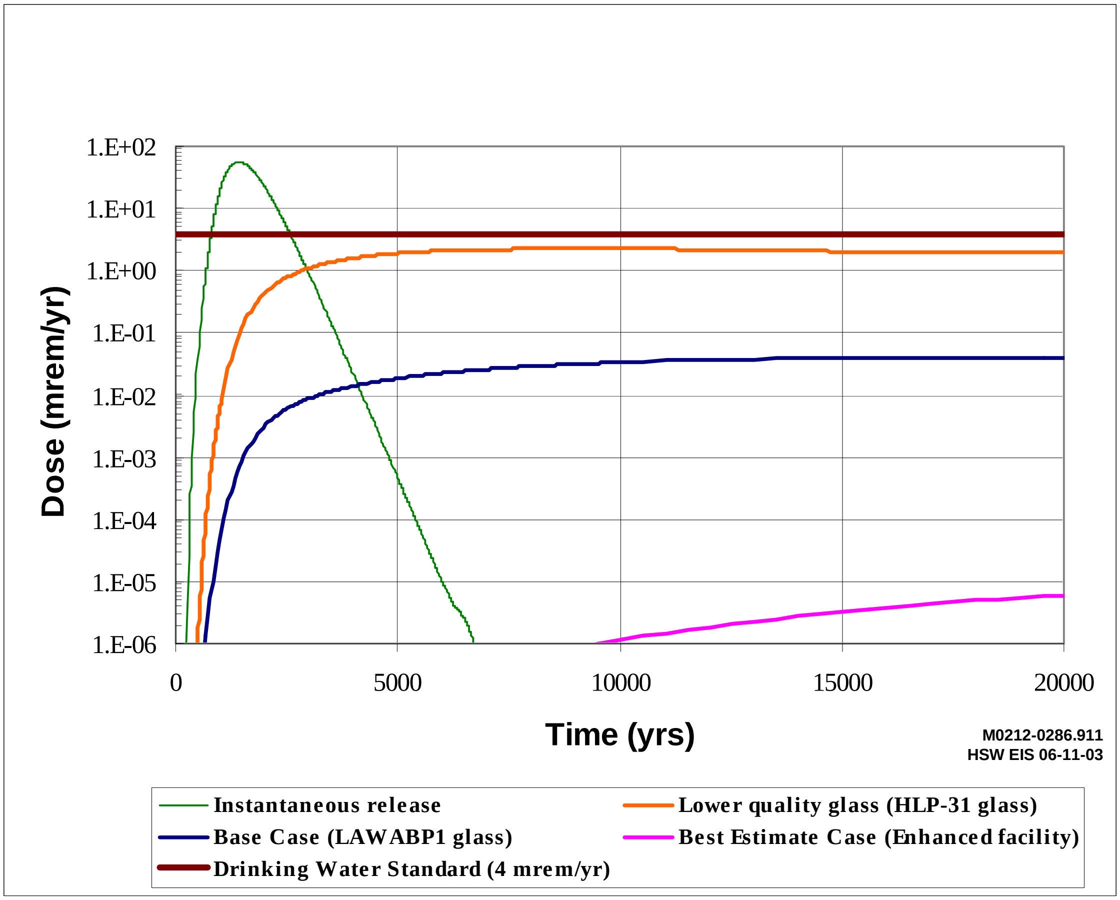


Figure G.95. Drinking Water Dose at a Well 100 Meters Downgradient from the ILAW Disposal Facility as a Function of Time for Various ILAW Waste Form Performance and Disposal Facility Parameters (after Mann et al. [2001])

Table G.40. Drinking Water Doses (mrem/yr) (after Mann et al. [2001])[(a)]

Case	@ 1,000 Years	@ 10,000 Years	Peak (@)
Base Case (LAWABP1 glass)[(b)]	0.00007	0.034	0.040 (98,000 yrs)
Best Estimate Case (Enhanced Facility Design)[(c)]	--	0.000001	Not calculated
Lower Quality Glass Case (HLP-31 glass)	0.006	2.2	2.3 (9,000 yrs)
Extreme Release Case (pulse)	19.7	--	56 (1,400 yrs)

(a) Renormalized for increased Tc-99, due to removal from Tc-99 separations process from WTP.
(b) “Base analysis case” of the 2001 ILAW PA.
(c) “Best estimate case” of 2001 ILAW PA.

The conceptual designs for the ILAW disposal facility have been evolving with time. The basic design is a set of large, deep trenches in the ground, underlain by RCRA-compliant liners. The presence of a surface barrier has remained constant while the width, depth, thickness, and placement of the trenches on the disposal site have changed. An important feature of the current conceptual design is a capillary break that acts as a moisture diverter underneath the surface barrier. As the name implies, this feature, using natural materials, diverts most of the water around and away from the waste forms. This case is labeled the "best estimate" case in the 2001 ILAW PA and was shown in Figure G.95 and summarized in Table G.40 as the "Best Estimate Case (Enhanced Facility)."

Although a wide variety of sensitivity cases were run in the 2001 ILAW PA, the ones of most interest here are those addressing various waste form performance. The release of contaminants from a waste form can be quite complex, particularly for those waste forms containing large amounts of sodium waste (such as those containing tank waste). Cases were run to test the sensitivity of the results to models and data used. Cases were also run to determine the effect of various waste forms.

To determine the performance of a lower-quality glass, the 2001 ILAW PA investigated the behavior of HLP-31 glass. This glass releases contaminants at a rate of about 10 times faster than LAWABP1 and, moreover, does not exhibit the common trait of decreased release as the concentration of silic acid (a by-product of glass dissolution) increases. For the conditions expected in the ILAW disposal facility, these two effects combine to cause the estimated potential impacts from HLP-31 waste forms to be about a factor of 100 greater than the potential impacts from the LAWABP1 waste forms. However, as seen from Figure G.95 and in Table G.40, even this higher release is estimated to be below 4 mrem/year.

To investigate the performance of an extremely poor waste form, the 2001 ILAW PA investigated an extreme release case that assumed that all waste was released instantaneously. Because of the thickness of soil underlying the proposed ILAW disposal facility, the pulse broadens to the shape seen in Figure G.95 and summarized in Table G.40, which is actually quite broad (full width at one-tenth maximum of approximately 2,000 years). For such cases, where the time over which release occurs is shorter than the time to travel through the soil to reach groundwater, the plateau-shaped curves of glass are replaced by peaked curves. The estimated drinking water dose for this instantaneous case is greater than 4 mrem/yr.

G.3.2 Additional Planned Analyses of Waste Disposal System Performance

The DOE has announced its plans for an environmental impact statement on the retrieval, treatment, and disposal of the waste being managed in the high-level waste tank farms at the Hanford Site and closure of the 149 single-shell tanks and associated facilities in the HLW tank farms (68 FR 1052). The tanks contain both radioactive and chemically hazardous waste. That document will provide additional analyses of low-activity waste treatment alternatives and resulting impacts upon disposal system performance.

G.3.3 Specific Scaling of ILAW PA Results for Use in the Analysis

G.3.3.1 Scaling for Estimated Inventory

Under a number of alternatives (Alternative Groups A, C, D_1, and E_3) where ILAW disposal is sited near the PUREX facility, results of a sensitivity case in Mann et al. (2001) that analyzed the effect of 25,550 Ci of technetium was used. This case reflected no technetium removal in the separation processes from the Waste Treatment Plant. This technetium-99 inventory (25,550 Ci) is a factor of 4.4 higher than the estimated inventory of technetium-99 (about 5790 Ci) if technetium-99 removal were considered in the separation process. The resulting scaled technetium-99 concentrations and other constituents from the ILAW PA that were used for those alternative groups where ILAW disposal is sited near the PUREX Plant is provided in Figure G.96.

G.3.3.2 Scaling for Alternative HSW-EIS Disposal Site Locations

Potential impact results presented for the ILAW disposal facility were based on performance assessment calculations made for siting the facility in the vicinity of the PUREX Plant, as summarized by Mann et al. (2001). However, for a few of the alternative groups, the ILAW disposal facility is sited in areas south of the CWC and at ERDF, and the calculated potential impacts at these alternative sites would be expected to be different because of the change in hydrogeologic conditions and hydraulic properties at these three locations.

For purposes of this analysis, the potential human health impacts results presented in Appendix F and Section 5.11 for Alternative Group B (where the ILAW disposal facility is sited in an area south of the CWC) and Alternative Groups D_3, E_1, and E_2 (where the ILAW disposal facility is sited in the ERDF area) are based on simple scaling of comparative simulation results of source releases in these areas using the sitewide groundwater flow and transport model. Groundwater concentrations and results of potential human health impacts summarized in the original performance assessment calculations described in Mann et al. (2001) were based on well intercept factors (WIFs) or dilution factors from a given areal flux of a hypothetical contaminant released to the unconfined aquifer from the ILAW disposal facility (Bergeron and Wurstner 2000). The WIF is defined as the ratio of the concentration at a well location in the aquifer to the concentration of infiltrating water entering the aquifer. These WIFs are being used in conjunction with calculations of released contaminant fluxes through the vadose zone to estimate potential impacts from radiological and hazardous chemical contaminants within the ILAW disposal facility at LOAs.

For the purposes of implementing the unit-release calculation, the concentration of a source entering the aquifer of 1 Ci/m^3 was used. The rate of mass flux associated with this concentration is a function of the infiltration rate assumed for the disposal facility covered by the Modified RCRA Subtitle C Barrier system. With a rate of 0.42 cm/yr assumed for the ILAW disposal facility, the resulting solute flux entering the aquifer from each of the disposal concepts is 4.2×10^{-3} $Ci/yr/m^2$. This is the product of the contaminant concentration in the infiltrating water and the infiltration rate.

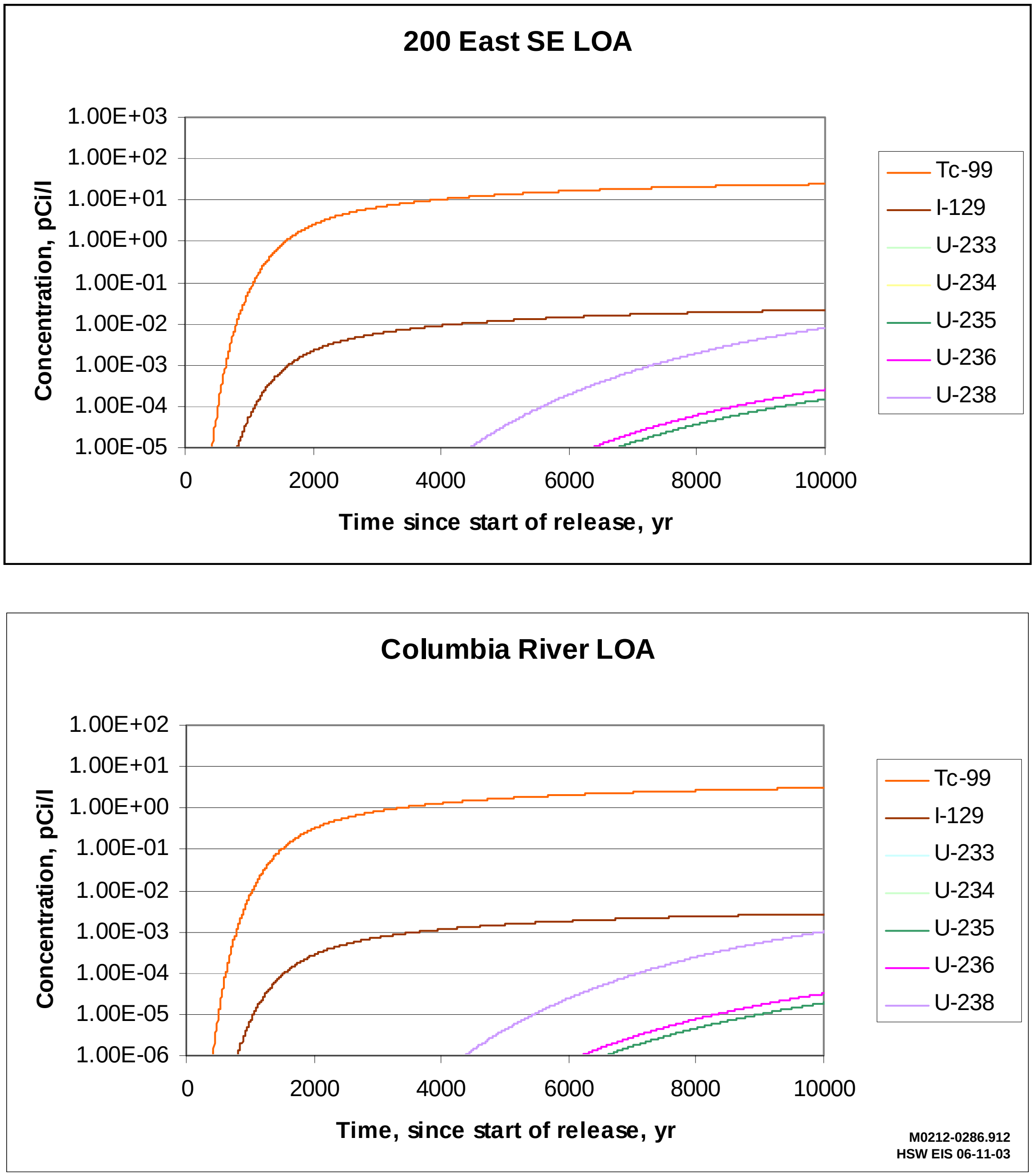


Figure G.96. Scaled Concentrations of Key Constituents that were Used from the ILAW PA at the 200 East Area SE and Columbia River LOAs for Those Alternative Groups where ILAW Disposal was Sited near the PUREX Plant, Alternative Groups A, C, D_1, and E_3

In the simulations used to support this assessment, the same calculation performed for the base case described in Bergeron and Wurstner (2000) (see Section 6.1.1 in Volume I of this EIS) using the regional scale model was performed again at the approximate PUREX location and the two alternative areas described in Alternative Group B (south of the CWC) and Alternative Groups D_3, E_1, and E_2 (near ERDF) using the groundwater models in this assessment. The ratio of predicted WIFs at the 1-km (0.6-mi) LOA and along the Columbia River about 1 km downgradient from the CWC and ERDF locations to the comparable predicted WIFs from the PUREX locations provided the basis for the scaling of results used in this analysis.

The groundwater model using the extended basalt subcrop conditions north of the 200 East Area and the resultant predominant easterly flow out of the 200 East and West Areas was considered to be most representative of original conditions simulated with the model used by Bergeron and Wurstner (2000) of the two groundwater evaluations in this analysis. This model was the one used in this comparative analysis.

Results of applying WIFs using an assumed infiltration rate in the source area of 0.42 cm/yr for the three postulated ILAW disposal locations, as presented in Figure G.95, suggest that predicted groundwater concentrations and calculated human health impacts would be a factor of about 3 higher and about 3.4 higher at the 1-km (0.6-mi) LOA downgradient of the HSW disposal site locations (south of CWC and near ERDF, respectively) relative to a comparable location about 1 km downgradient from the PUREX location. These higher-predicted concentrations would be consistent with differences in hydrogeology at these two locations relative to conditions found near the PUREX Plant. Near the PUREX Plant, the upper part of the unconfined aquifer is largely composed of very permeable sediments associated with the Hanford formation. Whereas, at the ERDF and CWC locations, the upper part of the unconfined aquifer is made up of less permeable sand and gravel sediments associated with the Ringold sediments.

Results of applying WIF ratios at LOAs along the Columbia River resulting from releases at these two alternative locations are also presented in Table G.41. The resulting WIF ratio suggests that peak concentrations estimated along the Columbia River from these alternative locations of disposal would have about a factor of 0.8 and 0.9 lower, respectively, than was calculated from releases near the PUREX Plant. The reduction in concentration levels would be consistent with the longer flow path to the Columbia River location.

Table G.41. Well Intercept Factors at LOAs Downgradient from the ILAW Disposal Facility Sited Near the PUREX Plant and Alternative Locations

	Near PUREX	**South of CWC**	**Near ERDF**
1-km LOA			
PUREX WIF	5.1E-04	1.5E-03	1.8E-03
WIF Ratio (near PUREX)	1.0	3.0	3.4
Columbia River LOA			
PUREX Ratio	1.8E-04	1.4E-04	1.6E-04
WIF Ratio (near PUREX)	1.0	0.8	0.9

G.4 Effect of Changing Assumptions on Long-Term Cover System Performance

The section presents results from a selected set of sensitivity cases that were evaluated to examine and illustrate the effect of changing assumptions related to cover system performance on predicted groundwater quality impacts. The cases evaluated were related to groundwater impacts from selected wastes categories and configurations proposed under Alternative Group D_1. Two specific assumptions evaluated were as follows:

- No cover is assumed to exist and waste release is controlled by infiltration through natural vegetated surface conditions likely would persist following site closure. The assumed infiltration rate for these conditions is 0.5 cm/yr.

- The RCRA Subtitle C Barrier system is assumed to persist for the entire period of analysis and waste release is assumed to be controlled by the cover design infiltration rate of 0.01 cm/yr.

The specific contaminants and waste categories evaluated in these sensitivity cases included ungrouted Upper Bound inventories of technetium-99 and iodine-129 contained in MLLW and ungrouted and grouted Upper Bound inventories of uranium-238 contained in MLLW (see Figures G.97 and G.98). These specific examples illustrate the effect of the cover assumptions for contaminants from Mobility Class 1 (K_d = 0.0 mL/g) and Mobility Class 2 (K_d=0.6 mL/g).

A comparison of results based on the current conservative cover system assumption of failure after 500 years and a return to natural infiltration within 500 years after failure produces very similar potential impacts to those predicted with the assumption that no-cover system is used. For all cases examined, differences in the results show predicted peak concentrations at the 1-km LOA, based on the 500-year cover system assumption, to be slightly lower and to arrive about 600 to 700 years later than the calculated peak concentrations at the 1-km LOA for the no-cover assumption. The delay in arrival time is reflective of the effect of the lower infiltration and release rate that would be expected to occur when the cover system is assumed to operate at or near its design infiltration of 0.01 cm/yr for the first 600 to 700 years after closure.

Figures G.97 and G.98 also compare resulting potential impacts using a calculational assumption where the cover system remains intact and does not fail during the period of interest. For all cases examined, predicted peak concentrations at the 1 km LOA consistent with the intact cover system assumption are calculated to be about 7 percent of the peak and to arrive over a much longer period of time than the peak concentration arrival time at the 1-km LOA for the 500-year cover scenario (see Table 5.13 in Section 5.3 of Volume I of this EIS). Results based on this assumption reflect the effect of the expected reduced infiltration and waste release from the waste disposal zone while the cover system is assumed to be intact and operating at its design infiltration rate of 0.01 cm/yr.

G.5 Potential Groundwater Quality Impacts at Low-Level Waste Management Area Boundaries for Selected Alternatives

This primary comparative assessment used lines of analysis located on the Hanford Site along lines approximately 1 km (0.6 mi) downgradient of aggregate Hanford solid waste (HSW) disposal areas within the 200 East and 200 West Areas, at ERDF, and near the Columbia River located about 100 meters downgradient from all disposal site areas (see Figure G.1). The HSW disposal facilities are not contiguous units and therefore a facility boundary compliance analysis that may be appropriate on a trench-by-trench basis would not lend itself to a comparison of the alternative groups presented in this EIS. However, additional analyses of potential groundwater quality impacts for the new Combined-Use Facility in this HSW EIS (Alternative Groups D_1, D_2, and D_3), are presented in this section and provide a perspective on the relative potential impact at waste management boundaries immediately 100 meters downgradient of the aggregate waste disposal area versus potential impacts at the 1-km LOAs. A similar impact analysis also is provided for all LLW and MLLW disposed of before 2008 considered in this analysis for another perspective.

Because of assumptions used in waste release, vadose zone transport, and introduction of constituent release to underlying groundwater, these analyses represent a very conservative evaluation, that is, an overestimate of potential water quality impacts in the vicinity of aggregate low-level waste management area (LLWMA) boundaries and should not be considered a compliance analysis as required by DOE Order 435.1 (DOE 2001), RCRA closure, or CERCLA. The conservatism used in this analysis is particularly evident in the analysis of waste contained in LLBG 218-E-12B, where the aquifer system is predicted to become dry over the period of interest (see Section G.5.2). Specific unit releases used to approximate potential impacts from waste categories and associated disposal areas were represented as a linear source just inside the aquifer system down-slope relative to the top of the basalt bedrock underlying this LLBG. This representation is a simplistic representation of the complex future migration of contaminants from this burial ground and resulting concentration levels estimated downgradient of LLWMA 2 likely would be substantially less than those reported here.

With respect to conservatism in the broader comparative analysis (1-km LOAs) presented in the previous section, the maximum concentrations presented for each 1-km LOA and alternative group reflected a summation of predicted maximum concentrations for several waste categories regardless of their position on the LOA. These resulting concentrations also were used to provide a determination of the sum-of-fractions of benchmark MCLs for key constituents (that is, technetium-99 and iodine-129) for each alternative group and are presented in Section 3.4 and the Summary of this HSW EIS. That approach, that is, combining groundwater concentrations from separate waste sources, would not be appropriate for results of analyses presented in this section because of differences in locations of the wastes in question within each LLWMA, the associated locations of estimated potential maximum concentration, and the timing of arrival for maximum potential concentrations from each waste category.

A discussion and summary of ratios to benchmark MCLs for technetium-99 and iodine-129 for each waste category in the three alternatives groups (D_1, D_2, and D_3) are presented in Section G.5.4.4.

G.5.1 Local-Scale Lines of Analysis

Lines of analysis used in these local-scale calculations were positioned to be within about 100 meters of the aggregate waste management areas, as shown in Figures G.99 and G.100. In the 200 East Area, the LOAs were about 100 meters downgradient from LLWMAs 1 and 2 and a designated integrated disposal area near the PUREX Plant. In the 200 West Area, the LOAs were about 100 meters downgradient from aggregate LLWMAs 3 and 4. At ERDF, the LOAs were about 100 meters downgradient from the designated integrated disposal area hypothetically located within the third cell of ERDF.

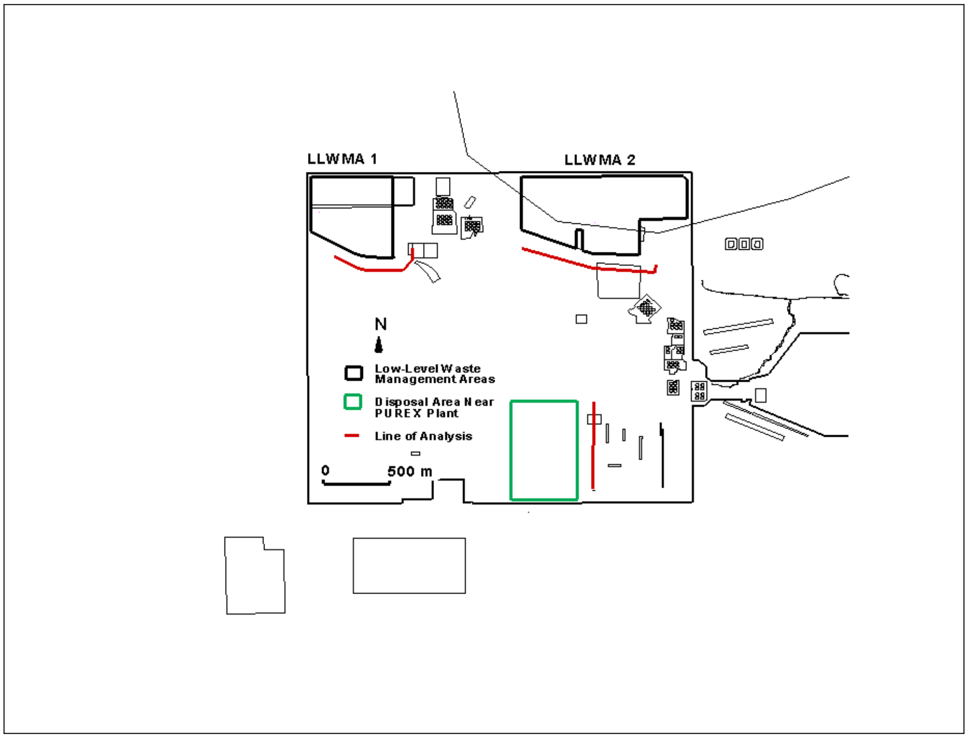


Figure G.99. Local-Scale Lines of Analysis 100 Meters Downgradient from the LLW Management Areas in the 200 East Area

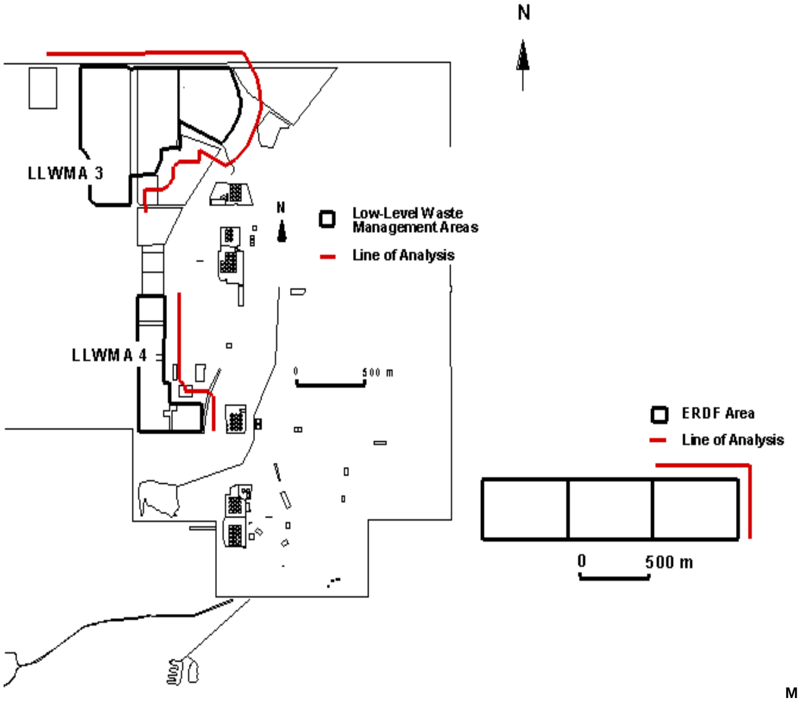


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Figure G.100. Local-Scale Lines of Analysis 100 Meters Downgradient from the LLW Management Areas in the 200 West Area and at ERDF

G.5.2 Source-Term Release and Vadose Zone Transport

The potential groundwater quality impacts associated with the following local-scale analysis for Alternative Groups D_1, D_2, and D_3 were based on the same source-term release and vadose transport calculations for these alternative groups in the main comparative analysis described in Sections G.1.3 and G.1.4.

G.5.3 Unit-Release Calculations and Transport in Groundwater

This analysis made use of the unit-release concept described previously in Section G.1.5. Three separate local-scale models of the Hanford sitewide groundwater model developed for the 200 East Area, 200 West Area, and at ERDF (Figures G.101, G.102, and G.103, respectively) were used in the analysis. The distributions of hydraulic characteristics and geometry of major hydrogeologic units used in the

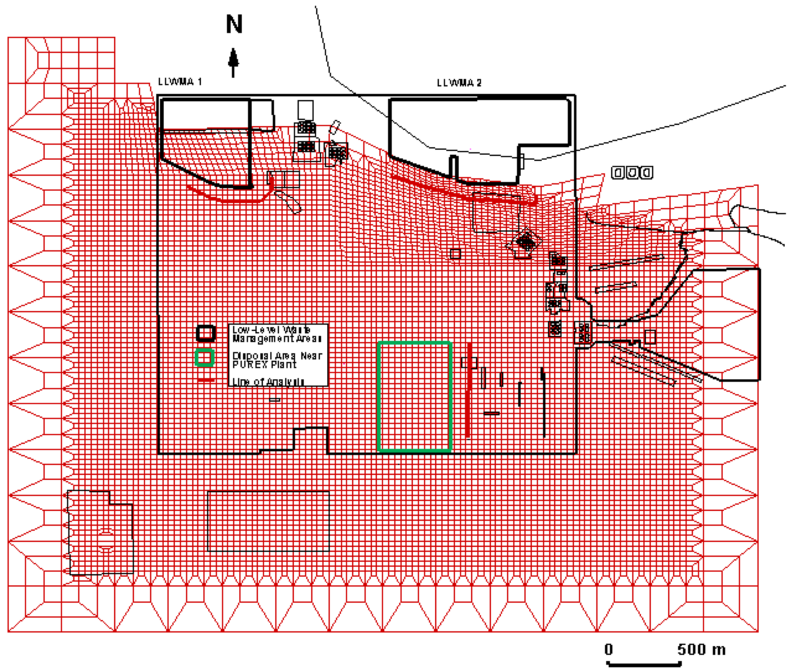

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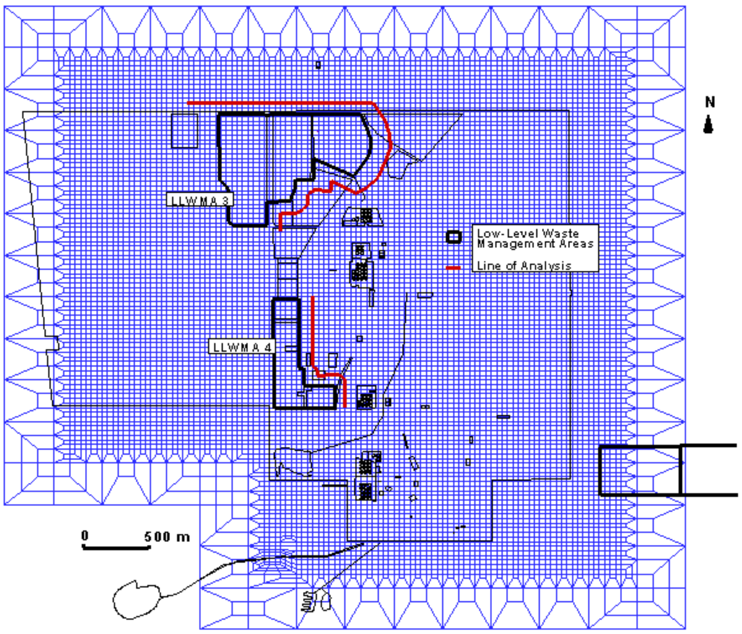
Figure G.101. Local-Scale Finite Element Grid Used in the Unit-Release Calculations in Groundwater Beneath the 200 East Area

local-scale models were based on the interpolation of regional-scale model characteristics and interpretation of major units onto the local-scale model grids. As was done for the regional-scale transport simulations, calculations were performed for post-Hanford conditions, as described in Section G.1.5.

For this analysis, a longitudinal dispersivity, D_L, of 10 m (33 ft) was selected using this typical approach for estimating longitudinal dispersivity based on the scale of interest. The key scale of interest is the minimum distance between some of the source areas within the aggregate waste management areas to within about 100 meters downgradient from the waste management boundaries. Thus, a dispersivity value used in the analysis was selected to be approximately equal to 10 percent of the minimum travel distance of interest of about 100 meters. A transverse dispersivity of about 20 percent of the longitudinal dispersivity, or 2 m, also was used in the analysis.



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R1 HSW EIS 08-28-03

Figure G.102. Local-Scale Finite Element Grid Used in Unit-Release Calculations in Groundwater Beneath the 200 West Area

Because the aquifer system is predicted to be dry beneath parts of the LLBGs in the 200 East Area, the specific unit-release calculations used to represent waste categories and associated disposal areas located within LLBG 218-E-12B was represented as a line source just inside the aquifer system down-dip (relative to the top of the underlying basalt bedrock) of this LLBG. This representation is a simplified representation of the complex future migration of contaminants from this burial ground and resulting concentration levels estimated about 100 meters downgradient from LLWMA 2 are deemed to be very conservative.

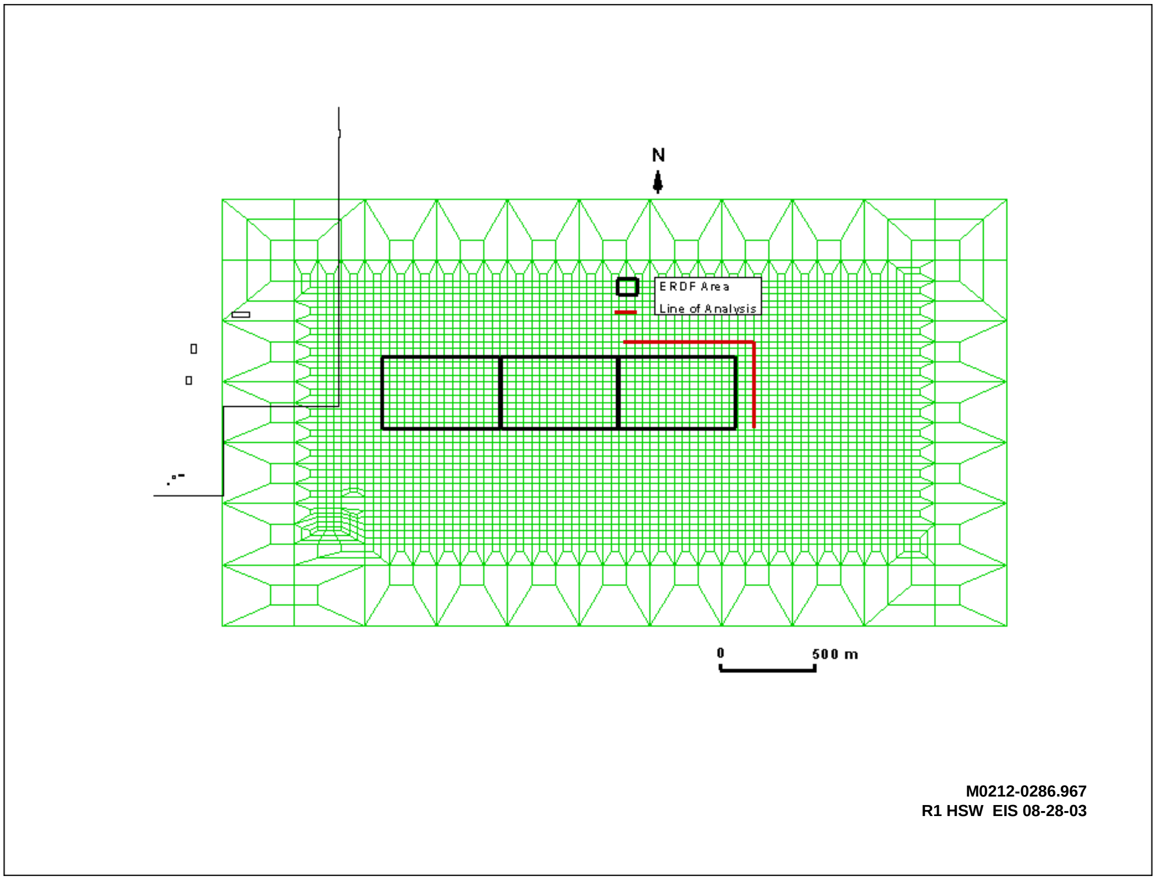


Figure G.103. Local-Scale Finite Element Grid Used in Unit-Release Calculations in Groundwater Beneath ERDF

This evaluation was done by first calculating transport of 10-year releases of a unit of dry mass into the unconfined aquifer at the approximate locations of the LLBGs at the water table. These transport calculations were made with local-scale versions of the steady-state groundwater flow field developed with the regional-scale model. These calculated concentrations, based on a unit release, were then used in the convolution integral calculational method to translate transport of mass releases from the LLW through the vadose zone and the aquifer to LOAs downgradient from designated aggregate LLWMAs.

The approximate disposal area configurations used in the unit-release calculations for each waste category for waste disposed of before 2008 for the 200 East and 200 West Areas for all three alternative groups (D_1, D_2, and D_3) combined are shown in Figures G.104 (200 East Area) and G.105 (200 West Area). The approximate disposal area configurations used in the unit-release calculations for each waste category for waste disposed of after 2007 for all three alternative groups (D_1, D_2, and D_3) are shown in Figures G.106, G.107, and G.108, respectively.

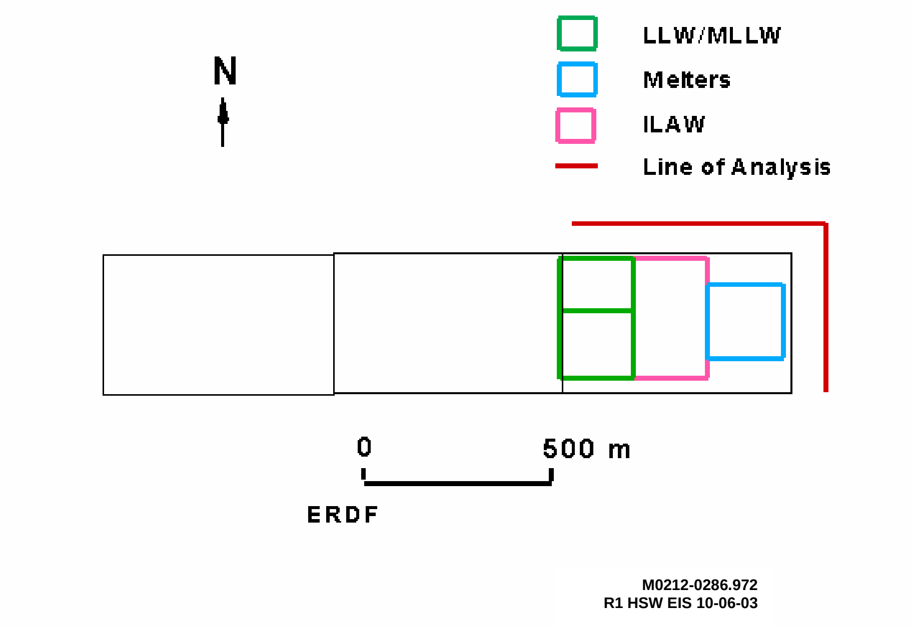


Figure G.108. Approximate Disposal Area Footprint used in Alternative Group D_3 (at ERDF) to Represent Waste Disposed of After 2007 in the Unit-Release Calculation in Groundwater

Similar to what was done in the 1-km LOA calculations, potential results calculated for the ILAW disposal facility at various LLWMA boundaries for eash alternative were based on performance assessment calculations made for siting the facility in the vicinity of the PUREX Plant, as summarized by Mann et al. (2001). The predicted concentrations for the constituents of interest at the near PUREX location boundary are approximately 40 percent higher than concentrations estimated at 1 km (see Figure G.96) as estimated by Mann et al. (2001). For purposes of this analysis, estimated concentrations of key constituents and associated potential human health impacts results at the ERDF and 218-E-12B LLBG were scaled off of the ratio of the estimated concentrations for technetium-99 in LLW at the PUREX location using the local-scale models to comparative concentrations at the ERDF and 218-E-12B using the other local-scale models. Based on these specific concentration ratios, estimated concentrations of all constituents released from the ILAW at the ERDF and the 218-E-12B LLBG were estimated to be about 4 times those estimated by Mann et al. (2001) at the near PURX Plant location.

G.5.4 Summary of Results

Potential impacts on groundwater for Alternative Group D_1, D_2, and D_3 within about 100 meters of the aggregate waste management areas are provided in the following sections. The alternatives, waste types, and disposal conditions are briefly stated to establish the framework for comparing the results. Results for this alternative group for waste disposed of before 2008 are summarized in Table G.42. Results for waste disposed of after 2007 for Alternative Groups D_1, D_2, and D_3 are summarized in Tables G.43, G.44, and G.45, respectively.

Table G.45. Predicted Peak Concentrations of Key Constituents for Wastes Disposed of After 2007 at Aggregate LLW Management Area Boundaries, Alternative Group D_3

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concentration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)	Inventory (Ci)	Maximum Concen-tration Within 10,000 yrs (pCi/L)	Approx. Peak Arrival Time (yrs)
Projected Cat 1 LLW After 2007										
ERDF Area										
C-14	2,000	1.28E+01	0.00E+00	>10,000	1.56E+01	0.00E+00	>10,000	1.59E+01	0.00E+00	>10,000
Tc-99	900	1.08E+00	2.91E+01	1660	1.32E+00	3.55E+01	1660	1.33E+00	2.83E+01	1660
Grouted Tc-99	900									
I-129	1	3.01E-03	8.10E-02	1660	3.67E-03	9.88E-02	1660	3.67E-03	7.81E-02	1660
Grouted I-129	1									
U-233	(a)	3.71E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000	4.52E-01	0.00E+00	>10,000
U-234	(a)	6.13E-01	0.00E+00	>10,000	7.47E-01	0.00E+00	>10,000	9.21E-01	0.00E+00	>10,000
U-235	(a)	1.29E-01	0.00E+00	>10,000	1.57E-01	0.00E+00	>10,000	1.68E-01	0.00E+00	>10,000
U-236	(a)	1.46E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000	1.78E-02	0.00E+00	>10,000
U-238	(a)	1.47E+00	0.00E+00	>10,000	1.79E+00	0.00E+00	>10,000	2.08E+00	0.00E+00	>10,000
Projected Cat 3 LLW After 2007										
ERDF Area										
C-14	2,000	4.44E-01	0.00E+00	>10,000	4.62E-01	0.00E+00	>10,000	1.45E+02	0.00E+00	>10,000
Tc-99	900									
Grouted Tc-99	900	3.23E+03	7.32E+02	990	3.23E+03	7.32E+02	990	3.23E+03	5.78E+02	990
I-129	1	1.96E-06	5.27E-05	1670	2.04E-06	5.49E-05	1670	2.04E-06	4.34E-05	1670
Grouted I-129	1	5.00E+00	3.59E-01	990	5.00E+00	3.59E-01	990	5.00E+00	2.83E-01	990
U-233	(a)	2.98E-01	0.00E+00	>10,000	3.10E-01	0.00E+00	>10,000	1.80E-01	0.00E+00	>10,000
U-234	(a)	3.73E+02	0.00E+00	>10,000	3.89E+02	0.00E+00	>10,000	3.11E+02	0.00E+00	>10,000
U-235	(a)	1.07E+01	0.00E+00	>10,000	1.11E+01	0.00E+00	>10,000	1.20E+01	0.00E+00	>10,000
U-236	(a)	4.82E+01	0.00E+00	>10,000	5.02E+01	0.00E+00	>10,000	2.89E+01	0.00E+00	>10,000
U-238	(a)	5.99E+02	0.00E+00	>10,000	6.24E+02	0.00E+00	>10,000	5.04E+02	0.00E+00	>10,000
Projected MLLW After 2007										
ERDF Area										
C-14	2,000	1.46E+00	0.00E+00	>10,000	1.46E+00	0.00E+00	>10,000	1.45E+00	0.00E+00	>10,000
Tc-99	900	8.34E+00	2.25E+02	1660	8.36E+00	2.25E+02	1660	8.27E+00	1.76E+02	1660
Grouted Tc-99	900									
I-129	1	3.50E-02	9.43E-01	1660	3.51E-02	9.45E-01	1660	3.48E-02	7.41E-01	1660
Grouted I-129	1									
U-233	(a)	4.67E-03	0.00E+00	>10,000	4.68E-03	0.00E+00	>10,000	4.64E-03	0.00E+00	>10,000
U-234	(a)	5.44E+00	0.00E+00	>10,000	5.45E+00	0.00E+00	>10,000	5.40E+00	0.00E+00	>10,000
U-235	(a)	8.67E-02	0.00E+00	>10,000	8.69E-02	0.00E+00	>10,000	8.61E-02	0.00E+00	>10,000
U-236	(a)	1.02E-01	0.00E+00	>10,000	1.02E-01	0.00E+00	>10,000	1.01E-01	0.00E+00	>10,000
U-238	(a)	1.36E+00	0.00E+00	>10,000	1.36E+00	0.00E+00	>10,000	1.35E+00	0.00E+00	>10,000
Projected Grouted MLLW After 2007										
200 East Area										
C-14	2,000	2.86E+00	0.00E+00	>10,000	2.87E+00	0.00E+00	>10,000	4.25E+00	0.00E+00	>10,000
Tc-99	900									
Grouted Tc-99	900	1.57E+02	3.55E+01	990	1.57E+02	3.61E+01	990	3.34E+02	5.98E+01	990
I-129	1									
Grouted I-129	1	6.87E-02	4.93E-03	990	6.88E-02	4.91E-03	990	7.06E-02	4.00E-03	990
U-233	(a)	8.91E-03	0.0.E+00	>10,000	8.93E-03	0.00E+00	>10,000	9.20E-03	0.00E+00	>10,000
U-234	(a)	1.07E+01	0.0.E+00	>10,000	1.07E+01	0.00E+00	>10,000	3.35E+02	0.00E+00	>10,000
U-235	(a)	1.70E-01	0.0.E+00	>10,000	1.70E-01	0.00E+00	>10,000	1.47E+01	0.00E+00	>10,000

Table G.45 (contd)

Constituent	Benchmark MCL (pCi/L)	Hanford Only Volume			Lower Bound Volume			Upper Bound Volume		
		Inventory (Ci)	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concentration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**	**Inventory (Ci)**	**Maximum Concen-tration Within 10,000 yrs (pCi/L)**	**Approx. Peak Arrival Time (yrs)**
U-236	(a)	2.00E-01	0.00E+00	>10,000	2.00E-01	0.00E+00	>10,000	2.05E-01	0.00E+00	>10,000
U-238	(a)	2.64E+00	0.00E+00	>10,000	2.65E+00	0.00E+00	>10,000	3.42E+02	0.00E+00	>10,000
Projected Melter Waste										
ERDF Area										
C-14	2,000									
Tc-99	900									
Grouted Tc-99	900	3.89E+01	9.06E+00	990	3.89E+01	9.06E+00	990	3.89E+01	9.06E+00	990
I-129	1									
Grouted I-129	1									
U-233	(a)	8.49E-01	0.00E+00	>10,000	8.49E-01	0.00E+00	>10,000	8.49E-01	0.00E+00	>10,000
U-234	(a)	4.60E-01	0.00E+00	>10,000	4.60E-01	0.00E+00	>10,000	4.60E-01	0.00E+00	>10,000
U-235	(a)	1.90E-02	0.00E+00	>10,000	1.90E-02	0.00E+00	>10,000	1.90E-02	0.00E+00	>10,000
U-236	(a)	1.70E-02	0.00E+00	>10,000	1.70E-02	0.00E+00	>10,000	1.70E-02	0.00E+00	>10,000
U-238	(a)	4.10E-01	0.00E+00	>10,000	4.10E-01	0.00E+00	>10,000	4.10E-01	0.00E+00	>10,000

(a) The benchmark MCL for uranium is 30 µg/L expressed as total uranium. To convert isotope specific concentrations from pCi/L to µg/L, use following conversion factors:

- Uranium-233 - 1.05E-04
- Uranium-234 - 1.62E-04
- Uranium-235 - 4.66E-01
- Uranium-236 - 1.58E-02
- Uranium-238 - 3.00E+00.

G.5.4.1 Alternative Group D_1

LLW considered in Alternative Group D_1 includes the same wastes considered in Alternative Group A but disposes of Cat 1 and Cat 3 LLW and MLLW in a single, lined, modular combined-use facility near the PUREX Plant after 2007. The melter trench and ILAW disposal facility would be placed in the same general area.

G.5.4.1.1 Wastes Disposed of Before 2008

Waste disposed of before 2008 consists of four categories: 1) pre-1970 LLW, 2) 1970–87 LLW, 3) 1988–95 LLW, and 4) 1996–2007 LLW and MLLW. Following are brief summaries of potential groundwater quality impacts at about 100 meters downgradient from aggregate LLWMAs for each of these waste categories. Results for waste disposed of before 2008 for Alternative Group D_1 were presented in Table G.42.

Pre-1970 Low-Level Waste

Pre-1970 waste is primarily disposed of in LLBGs 218-E-10 (LLWMA 1) and 218-E-12B (LLWMA 2) in the 200 East Area and in LLBG 218-W-4C (LLWMA 4) in the 200 West Area. For these wastes, technetium-99 and iodine-129 released from LLBGs have the highest potential impact on groundwater quality.

Iodine-129 is estimated to be about 80 percent of the benchmark MCL and technetium-99 about 30 percent of the benchmark MCL about 100 meters downgradient of LLWMA 2 in the 200 East Area. These resulting concentration levels estimated about 100 meters downgradient of LLWMA 2 are deemed to be very conservative because of the approximation of release to groundwater in this area used in the current approach (see Section G.5.3)

1970–1987 Low-Level Waste

1970–1987 waste is primarily disposed of in LLBGs 218-E-10 (LLWMA 1) and 218-E-12B (LLWMA 2) in the 200 East Area and in LLBG 218-W-4A (LLWMA 4), 218-W-3A, and 218-W-3AE (LLWMA 3) in the 200 West Area. Iodine-129 released from 1970–1987 waste from LLBGs has the highest potential impact on groundwater quality.

Iodine-129 is estimated to be about 7 times higher than the benchmark MCL of 1 pCi/L about 100 meters downgradient of LLWMA 2 in the 200 East Area. As in the case of pre-1970 LLW, these resulting concentration levels estimated about about 100 meters downgradient of LLWMA 2 are deemed to be very conservative because of the approximation of release to groundwater in this area used in the current approach (see Section G.5.3).

1988–1995 Low-Level Waste

1988–1995 waste is primarily disposed of in LLBGs 218-E-10 (LLWMA 1) and 218-E-12B (LLWMA 2) in the 200 East Area and in LLBG 218-W-3A and 218-W-5 (LLWMA 4) in the 200 West Area. Technetium-99 and iodine-129 released from 1988–1995 waste from LLBGs have the highest potential impact on groundwater quality.

Iodine-129 is estimated to be about 5 percent of the benchmark MCL about 100 meters downgradient of LLWMA 2 in the 200 East Area. Technetium-99 is estimated to be about 7 percent of the benchmark MCL about 100 meters downgradient of LLWMA 2 in the 200 East Area and about 9 percent of the benchmark MCL about 100 meters downgradient of LLWMA 3 in the 200 West Area.

As in the case of pre-1970 LLW, concentration levels estimated about 100 meters downgradient of LLWMA 2 are deemed to be very conservative because of the approximation of release to groundwater in this area used in the current approach (see Section G.5.3).

1996–2007 LLW and MLLW

1996–2007 waste is disposed of in LLBGs 218-E-10 (LLWMA 1) and 218-E-12B (LLWMA 2) in the 200 East Area and in LLBG 218-W-3A and 218-W-5 (LLWMA 3) in the 200 West Area. Following is a brief summary of potential groundwater quality impacts from the three main components of these wastes, including 1) Category 1 LLW, 2) Category 3 LLW, and 3) MLLW.

> **Category 1 LLW.** Iodine-129 and technetium-99 released from 1996–2007 Cat 1 LLW primarily located in LLBG 218-W-5 have the highest potential impact on groundwater quality. Iodine-129 levels are estimated to be about 15 to 18 percent of the benchmark MCL about 100 meters downgradient of LLWMA 3 in the 200 West Area for the Hanford Only and Upper Bound waste volumes. Technetium-99 levels are estimated to be about 1 and 2 percent of the benchmark MCL about 100 meters downgradient of LLWMA 3 in the 200 West Area.
>
> **Category 3 LLW.** Technetium-99 released from 1996–2007 Cat 3 LLW primarily located in LLBG 218-W-5 has the highest potential impact on groundwater quality. Technetium-99 levels are estimated to be about 2 percent of the benchmark MCL about 100 meters downgradient of LLWMA 3 in the 200 West Area.
>
> **MLLW.** Technetium-99 and iodine-129 released from ungrouted 1996–2007 MLLW have the highest potential impact on groundwater quality. Concentration levels of all constituents are below benchmark MCLs for grouted 1996-2007 MLLW.

Estimated technetium-99 concentration levels are about 21 percent of the benchmark MCL about 100 meters downgradient of LLWMA 3 for all volumes. Estimated iodine-129 concentration levels are about 48 and 80 percent of the benchmark MCL about 100 meters downgradient of LLWMA 3 for the Hanford Only and Upper Bound waste volumes and about equal to the benchmark standard about 100 meters downgradient of WMA 2 for the Upper Bound waste volume.

As in the case of pre-1970 LLW, concentration levels estimated about 100 meters downgradient of LLWMA 2 are deemed to be very conservative because of the approximation of release to groundwater in this area used in the current approach (see Section G.5.3).

G.5.4.1.2 Waste Disposed of After 2007 Near the PUREX Plant

The highest potential impact for this alternative group reflects the emplacement of all wastes disposed of after 2007 in the vicinity of the PUREX Plant. Potential impacts from LLW and MLLW are dominated by technetium-99 and iodine-129 (see Table G.43).

The maximum potential impact from technetium-99 is from Cat 3 LLW, where estimated concentration levels are about 21 percent of the benchmark MCL for both the Hanford Only and Upper Bound waste volumes. The maximum potential impact from iodine-129 is from ungrouted MLLW, where estimated concentration levels are about 29 and 26 percent of the benchmark MCL for the Hanford Only and Upper Bound waste volumes, respectively.

Estimated concentration levels of all other constituents in these waste categories and all constituents in other waste categories are well below benchmark MCLs.

G.5.4.2 Alternative Group D_2

LLW considered in Alternative Group D_2 includes the same wastes considered in Alternative Group D_1 but disposes of Cat 1 and Cat 3 LLW and MLLW in a single, lined, modular combined-use facility after 2007 in LLBG 218-E-12B. The melter trench and the ILAW disposal facility would be placed in the same general area.

G.5.4.2.1 Wastes Disposed of Before 2008

Because of assumptions in the source-term release and vadose zone modeling used for LLW previously disposed of before 2008 for Alternative D_2, results for this alternative group were the same for those waste categories calculated for Alternative Group D_1. Results for waste disposed of before 2008 for Alternative Group D_1 were presented in Table G.42.

G.5.4.2.2 Waste Disposed of After 2007 in the LLBG 218-E-12B

The highest potential impact for this alternative group reflects the emplacement of all wastes disposed of after 2007 in the LLBG 218-E012B. Potential impacts from LLW and MLLW are dominated by technetium-99 and iodine-129 (see Table G.44).

The maximum potential impact from technetium-99 is from Cat 3 LLW, where estimated concentration levels are about 86 percent of the benchmark MCL for all waste volumes. The maximum potential impact from iodine-129 is from ungrouted MLLW, where estimated concentration levels are about 94 and 95 percent of the benchmark MCL for both the Hanford Only and Upper Bound waste volumes. The potential impact from iodine-129 is from Cat 3 LLW, where estimated concentration levels are about 38 percent of the benchmark MCL for both the Hanford Only and Upper Bound waste volumes. These higher levels of potential groundwater quality impacts relative to those calculated for similar waste inventories in Alternative Group D_1 reflect differences in aquifer conditions found beneath the near-PUREX location (that is, high permeability and moderate saturated thickness of the Hanford formation at the water table) and the 218-E-12B LLBG (that is, slightly lower hydraulic conductivities and thinner saturated thicknesses of the Hanford formation at the water table).

Estimate concentrations of all other constituents in these waste categories and all constituents in other waste categories are below benchmark MCLs.

As in the case of other wastes disposed of in LLBG 218-E-12B, these resulting concentration levels estimated about 100 meters downgradient of LLWMA 2 are deemed to be very conservative because of the approximation of release to groundwater in this area used in the current approach (see Section G.5.3)

G.5.4.3 Alternative Group D_3

LLW considered in Alternative Group D_3 includes the same wastes considered in Alternative Group D_1 but disposes of Cat 1 and Cat 3 LLW and MLLW in a single, lined, modular combined-use facility at ERDF after 2007. The melter trench and the ILAW disposal facility would also be placed at ERDF.

G.5.4.3.1 Wastes Disposed of Before 2008

Because of assumptions in the source-term release and vadose zone modeling used for LLW previously disposed of before 2008 for Alternative D_3, results for this alternative group were the same for those waste categories calculated for Alternative Group D_1. Results for waste disposed of before 2008 for Alternative Group D_1 were presented in Table G.42.

G.5.4.3.2 Waste Disposed of After 2007

The highest potential impact for this alternative group reflects the emplacement of all wastes disposed of after 2007 in LLBG 218-E-12B. Potential impacts from LLW and MLLW are dominated by technetium-99 and iodine-129 (see Table G.45).

The maximum potential impact from technetium-99 is from Cat 3 LLW, where estimated concentration levels are about 86 percent of the benchmark MCL for all waste volumes. The maximum potential impact from iodine-129 is from ungrouted MLLW, where estimated concentration levels are about 94 and 95 percent of the benchmark MCL for both the Hanford Only and Upper Bound waste volumes. The potential impact from iodine-129 is from Cat 3 LLW, where estimated concentration levels are about 38 percent of the benchmark MCL for both the Hanford Only and Upper Bound waste volumes. These higher levels of potential groundwater quality impacts relative to those calculated for similar waste inventories in Alternative Group D_1 reflect differences in aquifer conditions found beneath the near PUREX location (that is, high permeability and moderate saturated thickness of the Hanford formation at the water table) and the 218-E-12B LLBG (that is, slightly lower hydraulic conductivities and thinner saturated thicknesses of the Hanford formation at the water table).

Estimate concentrations of all other constituents in these waste categories and all constituents in other waste categories are below benchmark MCLs.

As in the case of other wastes disposed of in LLBG 218-E-12B, the resulting concentration levels estimated about 100 meters downgradient of LLWMA 2 are deemed to be very conservative because of the approximation of release to groundwater in this area used in the current approach (see Section G.5.3).

G.5.4.4 Summary of Ratios to Benchmark MCLs for Technetium-99 and Iodine-129

This section presents a discussion of the combined ratios of maximum potential concentrations to benchmark MCLs for technetium-99 and iodine-129 using the sum-of-fractions rule for all wastes considered in the three alternative groups. The breakdown is provided in two broad categories—1) waste disposed of before 2008 and 2) waste disposed of after 2007—and includes results for the Hanford Only and Upper Bound waste volumes.

In general, the ratio of concentrations at the LLWMA boundary locations to concentrations a the 1-km locations ranged from 1.3:1 for wastes disposed of after 2007 at the combined-use facility located near the PUREX Plant to 22:1 for previously disposed of wastes (before 2008) located in the 200 West Area.

G.5.4.4.1 Waste Disposed of Before 2008

The sum-of-fractions of maximum potential concentrations as compared with benchmark MCLs for technetium-99 and iodine-129 for waste disposed of before 2008, as presented in Table G.46, are the same for all three alternative groups. Each waste category was evaluated as a separate entity because of differences in locations of the wastes in question within each LLWMA, the associated locations of estimated potential maximum concentration, and the timing of arrival for maximum potential concentrations from each waste category. Because of the higher waste containment integrity used for waste disposed of after 1995, waste releases of mobile constituents (that is, technetium-99 and iodine-129) to groundwater after 1995 would be delayed from release to groundwater from waste disposed of before or during 1995 by several hundred years.

Table G.46. Sum of MCL Fractions and Drinking Water Dose from Maximum Potential Concentrations for Technetium-99 and Iodine-129 for Waste Buried Before 2008 at Facility Boundaries

Primary Contributing Waste Category	**200 East Area**				**200 West Area**			
	Ratios of Maximum Potential Concentrations to Benchmark MCL			**Estimated Dose (mrem/yr)**	**Ratios of Maximum Potential Concentrations to Benchmark MCL**			**Estimated Dose (mrem/yr)**
	Tc-99	**I-129**	**Sum-of-Fractions**		**Tc-99**	**I-129**	**Sum-of-Fractions**	
Pre-1970 LLW	0.36	0.8	1.2	0.51	0.3	0.03	0.33	0.040
1970–1987 LLW	-	7.2	7.2	1.5	-	0.05	0.05	0.010
1988–1995 LLW	0.09	0.06	0.15	0.10	0.07	4.2	4.3	0.96
1996–2007 Cat 3 LLW								
Hanford Only	-	-	-	-	0.03	-	0.03	0.026
Upper Bound	-	-	-	-	0.03	-	0.03	0.026
1996–2007 MLLW								
Hanford Only	-	-	-	-	0.21	0.8	1.0	0.36
Upper Bound	0.27	1	1.3	0.47	0.12	0.5	0.67	0.21

The largest sum-of-fractions were calculated from maximum potential concentrations estimated for iodine-129 contained in 1970–1987 wastes disposed of in LLBGs in the 200 East Area and in 1988–1995 LLW disposed of in LLBGs (mainly 218-W-5 and 218-W-3A) in the 200 West Area. The arrival of maximum concentrations at the given LLWMA boundary were estimated to occur at about 90 years from the start of release, that is, about the year 1966, in the 200 East Area and at about 150 years from the start of release for wastes in the 200 West Area. These relatively short arrival times of maximum concentrations reflect the assumptions used in the release of waste disposed of before 1995, that is, using a relatively high infiltration rate of 5.0 cm/yr in waste release and vadose zone transport. The maximum concentration would be expected to persist at the LLWMA boundary for a relatively short period of time (a few decades) after initial arrival and would dissipate within the period of active institutional control (that is, 100 years after site closure), during which time ground water use within the Central Plateau would be restricted.

As may be seen from Table G.46, there are exceedances of benchmark MCLs using the sum-of-fractions rule; however, it may also be noted that drinking water doses are below the DOE benchmark drinking water standard of 4 mrem/yr at the the LLWMA boundary points of analysis.

G.5.4.4.2 Waste Disposed of After 2007

Combined ratios of maximum potential concentrations to benchmark MCLs for technetium-99 and iodine-129 for waste disposed of after 2007 are presented in Table G.47 for all three alternative groups. In this case, the wastes would be disposed of within the combined-use facility. They are evaluated separately from the wastes disposed of before 2008 because of differences in locations of the wastes in question within each LLWMA, the associated locations of estimated potential maximum concentration, and the timing of arrival for maximum potential concentrations from each waste category. Because of the improved waste isolation and containment used in disposal of waste between 1996 and 2007, releases of mobile constituents (that is, technetium-99 and iodine-129) from these wastes to groundwater would be separated from releases to groundwater from waste disposed of before 1996 by several hundred years. In addition, the use of a glass waste form for waste in ILAW would cause releases of mobile constituents from these wastes to groundwater to be separated from releases to groundwater from waste disposed of before 1996 by several thousand years.

For the three alternative groups considered, the calculated sum-of fractions would be lowest if the combined-use facility were sited near the PUREX Plant location. The higher levels of potential groundwater quality impacts at the 218-E-12B (Alternative Group D_2) and the ERDF (Alternative Group D_3) locations relative to the near-PUREX location (Alternative Group D_1) reflect differences in aquifer conditions found beneath the 218-E-12B LLBG (slightly lower hydraulic conductivities and thinner saturated thicknesses of the Hanford formation at the water table) and the ERDF (lower hydraulic conductivities associated with the Ringold Formation at the water table) locations.

Similar to the results shown in Table G.46, there are exceedances of benchmark MCLs using the sum-of-fractions rule; however, again, it should be noted that drinking water doses are below the DOE benchmark drinking water standard of 4 mrem/yr at the the LLWMA boundary points of analysis.

G.6 Potential Groundwater Quality Impacts From Hazardous Chemicals in Pre-1988 Wastes

In response to comments received during the public comment periods on the drafts of the HSW EIS, efforts were made to develop an estimate of quantities of potentially hazardous chemicals in previously buried LLW so that potential impacts of such chemicals on groundwater quality could be evaluated.

G.6.1 Inventory Estimates

LLW disposed of prior to September 1987 does contain hazardous chemical constituents, but no specific requirements existed to account for or report the content of hazardous chemical constituents in this category of LLW. As a consequence, analysis of these constituents and estimated impacts based on the limited amount of information on estimated inventories and waste disposal locations would be subject to uncertainty at this time. These facilities are part of the LLW and MLLW facilities in LLW Management Areas 1 through 4 that currently are being monitored under RCRA interim status programs. Final closure or remedial investigation of these facilities under RCRA and/or CERCLA guidelines could involve further analysis of the potential impacts of the chemical components of these inventories.

Efforts were made to develop estimates of hazardous chemicals and their inventory quantities based hazardous chemical generation documented during the late 1980s. The estimation of these inventories, which used a waste stream analysis estimation method, is summarized in FH (2003).

The most substantial quantities of hazardous chemicals (in terms of inventory quantities) identified from this effort are summarized in Table G.48. These specific selected hazardous chemical inventories provided the basis for the following analysis of potential groundwater quality impacts from hazardous chemical inventories in wastes disposed of before 1988.

Table G.48. Estimated Inventories of Selected Hazardous Chemicals Potentially Disposed of in HSW LLBGs Between 1962 and 1987

Constituent	Inventory (kg)
Chromium	100
Fluoride	5,000[a]
Nitrate	5,000[b]
Lead	>600,000
Mercury	1000
1,1,1-trichloroethane	900
Xylene	3,000
Toluene	3,000
Methylene chloride	800
Oil	3,000
Diesel fuel	20,000
Hydraulic fluid	40,000
PCBs	8,000

(a) Fluoride mass equivalent for 10,000 kg of sodium fluoride.
(b) Nitrate mass equivalent to 6,000 kg of sodium nitrate.

G.6.2 Contaminant Group and Screening Analysis

As was done in the impact analysis for radiological constituents, the potential for each of the hazardous chemical constituents to impact groundwater was evaluated. Screening of these constituents evaluated their relative mobility in the subsurface system within a 10,000-year period of analysis. In addition, because of the presence of several organic chemicals in the table, the screening also considered the potential for chemical degradation within the period of analysis.

As in the radiological constituent analysis, the constituents were grouped based on their mobility in the vadose zone and underlying unconfined aquifer using estimated or assumed K_d for each constituent as a measure of mobility. A summary of all hazardous constituents using the same mobility groupings (based on K_d values) described in Section G.1.3.1 is provided in Table G.49.

The mobility of constituents in Table G.46 were further evaluated using estimates of constituent transport times through the thick vadose zone to the unconfined aquifer during the 10,000-year period of analysis described in Section G.1.3.1. Based on a natural infiltration rate of 0.5 cm/yr through the underlying vadose zone (see the screening analysis method described in Section G.1.3.1) and the estimated levels of sorption and associated retardation for each of the classes above, travel times of all constituents were estimated. Results of this analysis show that without a substantial driving force, arrival times of constituents within Mobility Classes 3, 4, and 5 through the thick vadose zone to the unconfined aquifer beneath the LLBGs were calculated to be well beyond the 10,000-year period of analysis. Thus all constituents in these classes were eliminated from further consideration. These constituents eliminated from further consideration included diesel fuel, hydraulic fluid, oil, lead, mercury, and PCBs.

Because the constituent list evaluated includes a few volatile organic chemicals, the effect of potential biotic and abiotic degradation and volatization also were examined in the constituent screening process. Table G.50, which provides generic estimates of the biotic and abiotic degradation for selected chemicals, suggests that degradation, particularly biotic degradation, may be an important factor in reducing inventories of the organic constituents in question. Table G.51, which provides some laboratory estimates of volatilization rates, suggests that this process also would be important. Consideration of relatively high degradation and volatilization rates for the compounds in question provided the basis for eliminating the volatile organic chemicals within Mobility Class 1 including: 1,1,1-trichloroethane, xylene, toluene, and methylene chloride. No contaminants were identified in Mobility Class 2.

While these organic compounds would be expected to be reduced in source areas by the processes of degradation and volatilization, there is potential for an impact from breakdown products generated from degradation of the constituents in question. While these impacts were not evaluated in detail, the general types of byproduct compounds that could be formed were examined qualitatively to identify other potential constituents of concern.

Breakdown products from the above constituents may be produced from combinations of three subsurface processes. Two of these processes include biotic degradation by microorganisms under aerobic or anaerobic conditions. In the absence of viable microbial populations, abiotic degradation, which usually occurs as a result of chemical hydrolysis of the constituent, may also occur. Breakdown of these constituents has generally established degradation pathways resulting in the formation of a number of intermediate breakdown products. Intermediate breakdown products that are regulated would be of most interest from an impact perspective.

A review of established degradation pathways for the four constituents (Jordan and Payne 1980; Truex et al. 2001; Vogel et al. 1987) identified two regulated byproducts of greatest potential concern: 1,1-dichloroethene and vinyl chloride, which would be associated with degradation of 1,1,1-trichloroethane. Methylene chloride produces chloromethane as a breakdown product (EPA 2000), but chloromethane is not regulated compound. Toluene and xylene produce breakdown products that are common constituents found in lignin (woody materials) and that break down in natural biological cycles. Such breakdown products are not regulated (EPA 2000).

The final list of constituents considered for further analysis included the remaining inorganic chemicals in Mobility Class 1: chromium, fluoride, and nitrate.

G.6.3 Analysis Methods and Other Key Assumptions

The following hypothetical groundwater quality impacts associated with hazardous chemicals contained in wastes disposed of before 1988 were based on the same source-term release and vadose transport calculations for in the main comparative analysis described in Sections G.1.3 and G.1.4 for this waste category. Little is known about the actual quantities and distribution of hazardous chemicals so the analysis of the estimated inventory for the selected constituents can only be considered a gross approximation of the potential impacts from these hazardous chemical in disposed of wastes. For purposes of these calculations, the entire hazardous chemical inventory was conservatively assumed to be uniformly disposed of in wastes contained within the 218-W-4B LLBG in the 200 West Area. The wastes currently disposed of in this LLBG are mostly wastes disposed of prior to 1970.

This analysis made use of the unit-release calculations for pre-1970 wastes in the local-scale groundwater model developed for the 200 West Area described in Section G.5.1. The underlying assumptions and analysis characteristics associated specifically with the analysis for pre-1970 LLW described in Section G.5.1 provided the basis for the results described here.

G.6.4 Summary of Results

Based on the constituent list and associated inventories developed for waste disposed of prior to 1988, summarized in Table G.48, potential groundwater quality impacts from hazardous chemicals are not expected to be substantial. A screening analysis that considered a combination of contamination mobility (due to sorption) and the potential contaminant degradation (due to biotic degradation and volatilization) reduced the starting lists of inorganic and organic constituents with the most substantial inventories to a list of three chemicals—chromium, fluoride, and nitrate.

For conditions where all of the estimated hazardous chemical inventories for these constituents are hypothetically emplaced in the 218-W-4B LLBG in the 200 West Area, estimated concentration levels at about 100 meters downgradient of the associated low-level waste management area (for example, LLWMA 3) were found to be below benchmark MCLs for all three chemicals (see Table G.52).

In actuality, waste disposed of before 1988 can be found within multiple burial grounds in the 200 East Area within the 218-E-10 and 218-E-12B LLBGs and in the 200 West Area primarily within the 218-W-4B, 218-W-4C, 218-W-3A, and 218-W-3AE LLBGs. Use of alternative assumptions that would distribute the estimated inventory to multiple LLBGs (rather than only in 218-W-4B) would result in further reductions in estimated concentration levels at aggregate LLWMA boundaries.

Final closure or remedial investigation of these facilities under RCRA and/or CERCLA guidelines eventually could involve further evaluation of historical waste records, more detailed waste characterization, and a more comprehensive analysis of the potential impacts of the chemical components of these inventories.

Table G.52. Predicted Peak Concentrations of Selected Hazardous Chemical Within Waste Disposed of Before 1988

Constituent	Benchmark MCL (mg/L)	Inventory (Kg)	Maximum Concentration[a] (mg/L)	Approximate Peak Arrival Time (yrs)
chromium	0.10	100	0.02	140
fluoride	4.0	5,000[b]	1.0	140
nitrate	10.0[c]	5,000[d]	0.25[e]	140

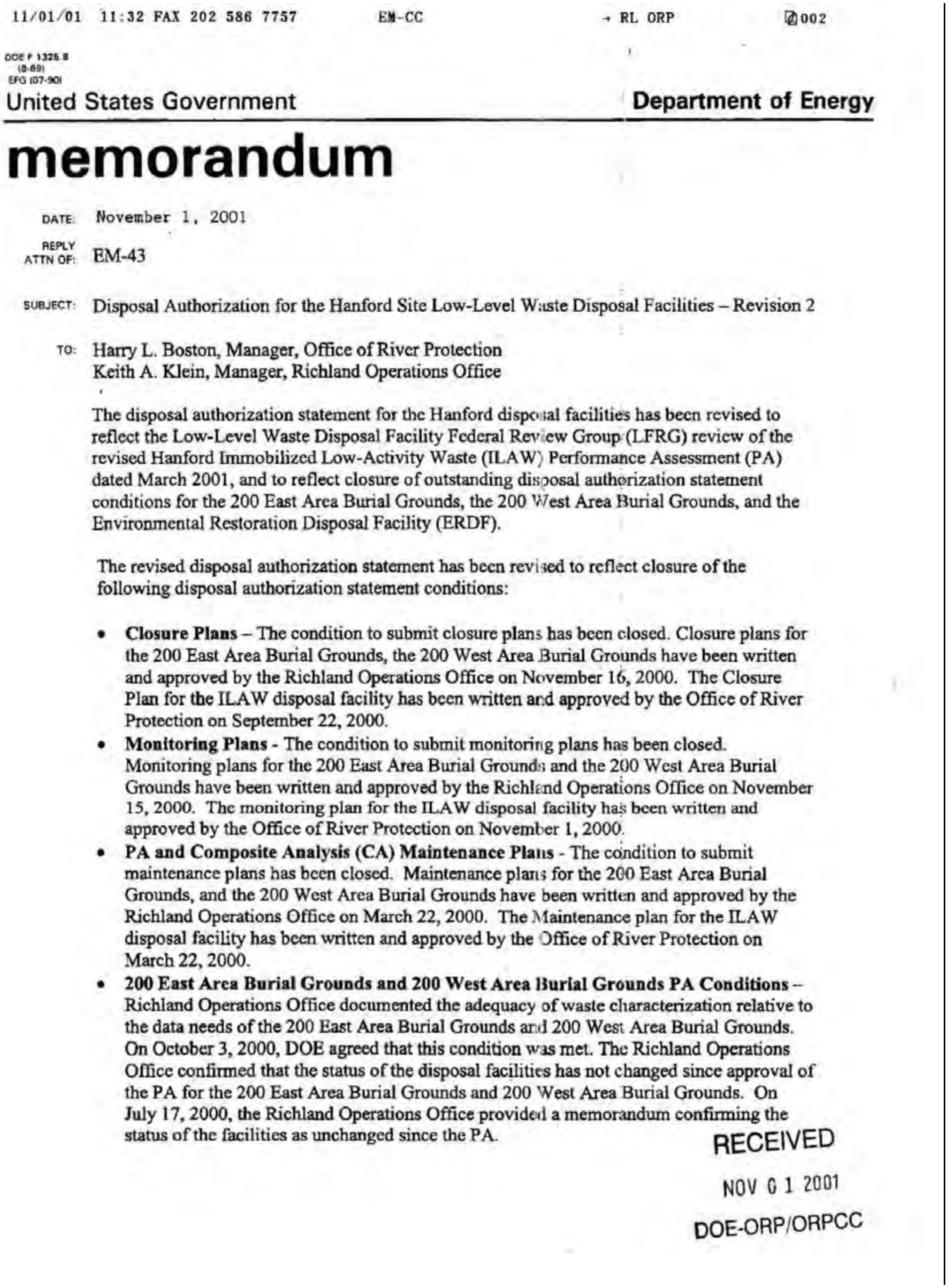
(a) Results are based on hypothetical disposal of these wastes in LLBG 218-W-4B in the 200 West Area, and concentration levels reflect levels estimated at about 100 m downgradient of the LLW Management Area 4 boundary.

(b) Fluoride mass equivalent in 10,000 kg of sodium fluoride.

(c) Benchmark MCL for nitrate is expressed as nitrogen.

(d) Nitrate mass equivalent for 6,000 kg of sodium nitrate.

(e) Concentration for nitrate is expressed as nitrogen.



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United States Government — **Department of Energy**

memorandum

DATE: November 1, 2001

REPLY ATTN OF: EM-43

SUBJECT: Disposal Authorization for the Hanford Site Low-Level Waste Disposal Facilities – Revision 2

TO: Harry L. Boston, Manager, Office of River Protection
Keith A. Klein, Manager, Richland Operations Office

The disposal authorization statement for the Hanford disposal facilities has been revised to reflect the Low-Level Waste Disposal Facility Federal Review Group (LFRG) review of the revised Hanford Immobilized Low-Activity Waste (ILAW) Performance Assessment (PA) dated March 2001, and to reflect closure of outstanding disposal authorization statement conditions for the 200 East Area Burial Grounds, the 200 West Area Burial Grounds, and the Environmental Restoration Disposal Facility (ERDF).

The revised disposal authorization statement has been revised to reflect closure of the following disposal authorization statement conditions:

- **Closure Plans** – The condition to submit closure plans has been closed. Closure plans for the 200 East Area Burial Grounds, the 200 West Area Burial Grounds have been written and approved by the Richland Operations Office on November 16, 2000. The Closure Plan for the ILAW disposal facility has been written and approved by the Office of River Protection on September 22, 2000.
- **Monitoring Plans** - The condition to submit monitoring plans has been closed. Monitoring plans for the 200 East Area Burial Grounds and the 200 West Area Burial Grounds have been written and approved by the Richland Operations Office on November 15, 2000. The monitoring plan for the ILAW disposal facility has been written and approved by the Office of River Protection on November 1, 2000.
- **PA and Composite Analysis (CA) Maintenance Plans** - The condition to submit maintenance plans has been closed. Maintenance plans for the 200 East Area Burial Grounds, and the 200 West Area Burial Grounds have been written and approved by the Richland Operations Office on March 22, 2000. The Maintenance plan for the ILAW disposal facility has been written and approved by the Office of River Protection on March 22, 2000.
- **200 East Area Burial Grounds and 200 West Area Burial Grounds PA Conditions** – Richland Operations Office documented the adequacy of waste characterization relative to the data needs of the 200 East Area Burial Grounds and 200 West Area Burial Grounds. On October 3, 2000, DOE agreed that this condition was met. The Richland Operations Office confirmed that the status of the disposal facilities has not changed since approval of the PA for the 200 East Area Burial Grounds and 200 West Area Burial Grounds. On July 17, 2000, the Richland Operations Office provided a memorandum confirming the status of the facilities as unchanged since the PA.

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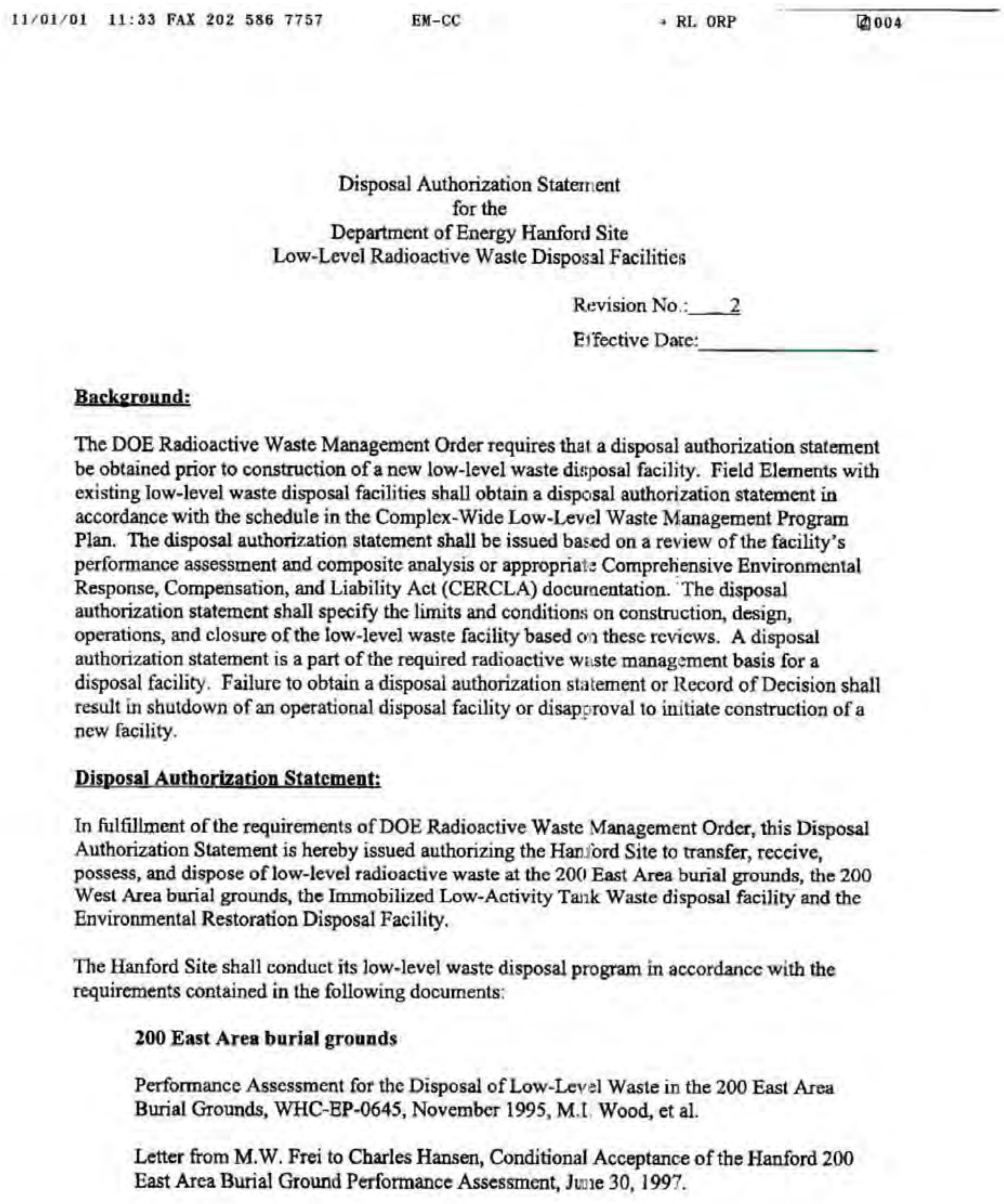
- **ILAW Condition -** The review of the revised Hanford ILAW PA dated March 2001 closed the ILAW PA conditions contained in the November 4, 1999, disposal authorization statement. However, the LFRG review emphasized the importance of the glass waste form consistency in meeting your performance criteria established in the performance assessment. As a result of the need for short and long term waste form integrity it is imperative that appropriate and sufficient glass testing, including product consistency tests, be carried out prior to disposal to confirm that the assumptions used in the performance assessment are representative of the final waste form.
- **ERDF Condition** – On June 18, 2001, DOE approved the crosswalk for ERDF that demonstrates the Record of Decision for the ERDF is consistent with the DOE Order 435.1 requirements and granted disposal authorization to the ERDF, closing the condition.

Richland Operations Office is authorized to continue operations of the DOE Hanford Site 200 East Area Burial Grounds, the 200 West Area Burial Grounds and ERDF for low-level waste disposal subject to the CA conditions in the revised disposal authorization statement. Office of River Protection is authorized to continue development of the ILAW disposal facility subject to the CA conditions in the revised disposal authorization statement. Failure by the Hanford site to comply with these conditions should be reported by the Richland Operations Office and the Office of River Protection to Jay Rhoderick or William E. Murphie, LFRG Co-Chairs and based upon their recommendation to me, could result in the revoking of the authorization and the immediate shutdown of the disposal facilities. If your staff have any questions regarding the process for working with the LFRG on meeting the remaining conditions, they should contact Jay Rhoderick (301) 903-7211 or William Murphie at (301) 903-2328.

Randal Scott

Randal S. Scott
Acting Deputy Assistant Secretary
for Project Completion
Office of Environmental Management

Attachment



Disposal Authorization Statement
for the
Department of Energy Hanford Site
Low-Level Radioactive Waste Disposal Facilities

Revision No.: 2

Effective Date:________________

Background:

The DOE Radioactive Waste Management Order requires that a disposal authorization statement be obtained prior to construction of a new low-level waste disposal facility. Field Elements with existing low-level waste disposal facilities shall obtain a disposal authorization statement in accordance with the schedule in the Complex-Wide Low-Level Waste Management Program Plan. The disposal authorization statement shall be issued based on a review of the facility's performance assessment and composite analysis or appropriate Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) documentation. The disposal authorization statement shall specify the limits and conditions on construction, design, operations, and closure of the low-level waste facility based on these reviews. A disposal authorization statement is a part of the required radioactive waste management basis for a disposal facility. Failure to obtain a disposal authorization statement or Record of Decision shall result in shutdown of an operational disposal facility or disapproval to initiate construction of a new facility.

Disposal Authorization Statement:

In fulfillment of the requirements of DOE Radioactive Waste Management Order, this Disposal Authorization Statement is hereby issued authorizing the Hanford Site to transfer, receive, possess, and dispose of low-level radioactive waste at the 200 East Area burial grounds, the 200 West Area burial grounds, the Immobilized Low-Activity Tank Waste disposal facility and the Environmental Restoration Disposal Facility.

The Hanford Site shall conduct its low-level waste disposal program in accordance with the requirements contained in the following documents:

200 East Area burial grounds

Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds, WHC-EP-0645, November 1995, M.I. Wood, et al.

Letter from M.W. Frei to Charles Hansen, Conditional Acceptance of the Hanford 200 East Area Burial Ground Performance Assessment, June 30, 1997.

Addendum to the Performance Assessment Analysis for Low-Level Waste Disposal in the 200 East Area Active Burial Grounds, HNF-2005, Rev. 0, M.I. Wood, December 21, 1998.

200 West Area burial grounds

Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds, WHC-EP-0645, November 1995, M.I. Wood, et al.

Letter from S.P. Cowan to Charles Hansen, Conditional Acceptance of the Hanford 200 West Area Burial Ground Performance Assessment, June 30, 1996.

Addendum to the Performance Assessment Analysis for Low-Level Waste Disposal in the 200 West Area Active Burial Grounds, HNF-SD-WM-TI-798, Rev. 0, M.I. Wood, December 20, 1996.

Immobilized Low-Activity Tank Waste Disposal Facility

Hanford Immobilized Low-Activity Waste Performance Assessment: 2001 Version, DOE/ORP-2000-24 Rev.b., F.M. Mann, et al., March 2001.

Hanford Site

Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site, PNNL-11800, March 1998, C.T. Kincaid, et al.

Letter from J. Fiore and M. Frei to Manager for Hanford Office of River Protection and Manager for Richland Operations Office dated September 1999, Subject: Conditional Acceptance of the Immobilized Low-Activity Tank Waste Disposal Facility Performance Assessment and Hanford Site 200 Plateau Composite Analysis.

This Disposal Authorization Statement is subject to all applicable rules and Orders now or hereafter in effect and to all conditions specified below. Also, this authorization is applicable to any subsequent revisions and additions to the performance assessments and the composite analysis provided such revisions and additions are in accordance with the performance assessment and composite analysis maintenance program. Applicable permits and reports that comprise the Radioactive Waste Management Basis shall be approved and continue to be maintained current according to the applicable DOE Orders and regulations.

Facility Construction and Design

The 200 East Area burial grounds consist of three types of earthen trenches described in the performance assessment: Category 1 trenches, Category 3 trenches, and trenches for Naval reactor components. The design features of each disposal unit constructed in the field shall conform to the conceptual model used in the performance assessment or special analysis. Any changes in disposal technology, disposal unit, or waste form must be analyzed and authorized according to the performance assessment and composite analysis maintenance program and approved by DOE.

The 200 West Area burial grounds consists of two types of earthen trenches described in the performance assessment: Category 1 trenches and Category 3 trenches. The design features of each disposal unit constructed in the field shall conform to the conceptual model used in the performance assessment or special analysis. Any changes in disposal technology, disposal unit, or waste form must be analyzed and authorized according to the performance assessment and composite analysis maintenance program and approved by DOE.

A detailed design for the Immobilized Low-Activity Tank Waste disposal facility is not yet available. Since the 1998 Immobilized Low-Activity Tank Waste Performance Assessment, the design of the facility has been changed from underground concrete vaults to trenches. The current designs have the disposal facility as a series of large, covered trenches containing glass waste forms from the vitrification of low-activity waste from treatment of Hanford tank waste. This combination of disposal unit and waste form has been analyzed in the 2001 Hanford Immobilized Low-Activity Tank Waste performance assessment. The design features of each disposal unit constructed in the field shall conform to the design limits derived from the conceptual models used in the performance assessment or special analysis. Any changes in disposal technology, disposal unit or waste form must be analyzed according to the performance assessment and composite analysis maintenance program and approved by DOE.

Radionuclide Limits, Waste Form, and Packaging

Each disposal unit within the 200 East Area burial grounds, the 200 West Area burial grounds, and the Immobilized Low-Activity Tank Waste disposal facility shall have waste acceptance criteria which provide specific radionuclide disposal limits, waste form restrictions, and descriptions of acceptable waste packages. The waste acceptance criteria shall be based on facility performance assessments, special analyses, and composite analyses as well as safety documentation and criticality considerations. Waste acceptance procedures shall be in place that describe requirements for waste characterization, waste certification and record keeping, as well as the process for authorizing deviations from the requirements. All waste received for disposal at these facilities must conform to the waste acceptance procedures. The waste acceptance criteria shall be reviewed and approved through the facility Radioactive Waste Management Basis.

The Immobilized Low-Activity Tank Waste disposal facility glass waste form characteristics were important assumptions used in the performance assessment to demonstrate compliance with performance criteria. As a result of the need for short and long term waste form integrity it is imperative that appropriate and sufficient glass testing, including product consistency tests, be carried out prior to disposal to confirm that the assumptions used in the performance assessment are representative of the final waste form.

Closure

Closure plans for the 200 East Area burial grounds, the 200 West Area burial grounds have been written and approved by the Richland Operations Office on November 16, 2000. The Closure

Plan for the Immobilized Low-Activity Tank Waste disposal facility has been written and approved by the Office of River Protection on September 22, 2000. These closure plans addressed any outstanding closure commitments from the review of the 200 East Area Burial Grounds, the 200 West Area Burial Grounds, and the Immobilized Low-Activity Tank Waste Disposal Facility performance assessments and the composite analysis. Any deviations in the closure plan from the closure concept analyzed in the performance assessments must be analyzed and approved per the performance assessment and composite analysis maintenance program.

Monitoring

Monitoring plans for the 200 East Area burial grounds and the 200 West Area burial grounds have been written and approved by the Richland Operations Office on November 15, 2000. The monitoring plan for the Immobilized Low-Activity Tank Waste disposal facility has been written and approved by the Office of River Protection on November 1, 2000. These plans shall be updated at least every five years to reflect changing facility conditions. The plans shall include monitoring frequencies and protocols for all the data collection required to assess the continued performance of the disposal facilities. These plans shall also include a requirement for comparison with the performance assessment results and development of any corrective action necessary.

Performance Assessment and Composite Analysis Maintenance

Maintenance plans for the 200 East Area burial grounds, and the 200 West Area burial grounds have been written and approved by the Richland Operations Office on March 22, 2000. The Maintenance plan for the Immobilized Low-Activity Tank Waste disposal facility has been written and approved by the Office of River Protection on March 22, 2000. Changes in the disposal facility operation (e.g., waste form, disposal unit design, radionuclide quantity) or in site policy (e.g., land use plan) or strategy (e.g., closure plans, remedial actions) and consequent changes in disposal facility controls shall be managed per the performance assessment and composite analysis maintenance program.

Copies of the annual review of the adequacy of the performance assessments and the composite analysis shall be provided to the Low-Level Waste Disposal Facility Federal Review Group (LFRG).

200 East Area Burial Grounds and 200 West Area Burial Grounds Performance Assessment Conditions

There are no outstanding conditions.

Environmental Restoration Disposal Facility Condition

There are no outstanding conditions.

Immobilized Low-Activity Tank Waste Disposal Facility Performance Assessment Conditions

There are no outstanding conditions.

The secondary issues identified in the Hanford review team report shall be addressed in future updates to the performance assessment as part of normal performance assessment maintenance.

Hanford Site Composite Analysis Conditions

Continue the strategy to include the Gable Mountain Pond within the 200 Area buffer zone and integrate with Hanford's land use planning documentation.

As agreed provide to the LFRG, by September 30, 2001, an addendum to the composite analysis that addresses the following:

> Bounding sensitivity analyses of the impact on the composite analysis results of the PUREX tunnels, the chemical separations plants, and the CERCLA sites in the 200 Area.

The secondary issues identified in the Hanford review team report shall be addressed as the composite analysis is maintained. Also, the following secondary issue, identified during the August 16-17, 1999, LFRG meeting shall be addressed as the composite analysis is maintained:

> Provide justification for the assumption that the basalt aquifers and interbeds do not contain significant contaminants.

Violations of Operational Requirements

Performance assessment and composite analysis commitments that are not met will result in the review of the applicability of continued disposal authorization.

Randal S. Scott

Randal S. Scott
Acting Deputy Assistant Secretary
for Project Completion
Office of Environmental Management

Compliance Evaluation of the Performance Assessments and the Composite Analysis for the Disposal of Low-Level Waste in the Hanford Low-Level Waste Disposal Facilities

The Low Level Waste Disposal Facility Federal Review Group (LFRG) concludes that the performance assessment and the composite analysis were found generally acceptable and it was determined that continued waste management operations be approved with specific conditions as delineated in the disposal authorization statement. The LFRG reviewed the following documents to make this determination:

- Hanford Immobilized Low-Activity Waste Performance Assessment: 2001 Version, DOE/ORP-2000-24 Rev.b., F.M. Mann, et al., March 2001.
- Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds, WHC-EP-0645, November 1995, M.I. Wood, et al., and the Addendum to the Performance Assessment Analysis for Low-Level Waste Disposal in the 200 West Area Active Burial Grounds, HNF-SD-WM-TI-798, Rev. 0, M.I. Wood, December 20, 1996.
- Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds, WHC-EP-0645, November 1995, M.I. Wood, et al. and the Addendum to the Performance Assessment Analysis for Low-Level Waste Disposal in the 200 East Area Active Burial Grounds, HNF-2005, Rev. 0, M.I. Wood, December 21, 1998.
- Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site, PNNL-11800, March 1998, C.T. Kincaid, et al.
- Review Team Reports.

On August 16, 1999, the performance assessment for the Immobilized Low-Activity Tank Waste disposal facility was conditionally approved and the 200 area plateau composite analysis was accepted with conditions. On September 28, 2001, a revised performance assessment for the Immobilized Low-Activity Tank Waste disposal facility was conditionally approved. There are no outstanding conditions.

The performance assessments for the 200 East and West area burial grounds were conditionally accepted on June 30, 1997 and June 27, 1996, respectively. The performance assessments were judged to provide a reasonable expectation that the DOE Order 5820.2A and DOE Order 435.1 performance objectives would not be exceeded. The LFRG concluded that the composite analysis provided sufficient information to determine that the Hanford low-level waste disposal facilities' operations would not contribute significantly to any composite effects. Therefore, if any adverse exposure concerns resulted, management alternatives should be directed at other sites or sources of radioactive contamination. There are no outstanding conditions for the 200 East Area burial grounds and 200 West Area burial grounds performance assessment. The Richland Operations Office completed and documented a review of the adequacy of waste characterization relative to the data needs of the 200 East Area burial grounds and 200 West Area burial grounds performance assessments. DOE agreed that this condition was met on October 3, 2000.

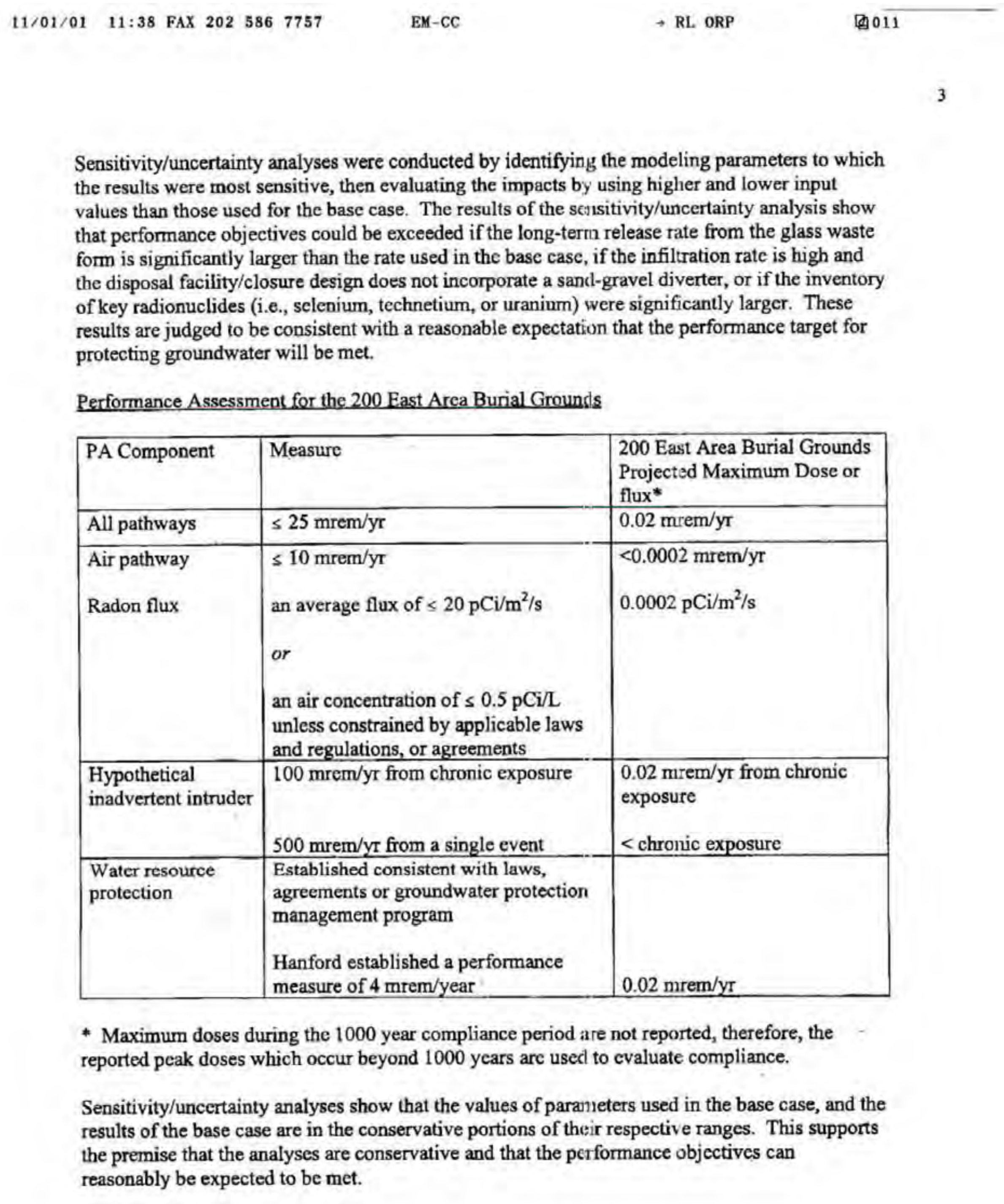
On July 17, 2000, Richland Operations Office provided a memorandum confirming that the status of the 200 East Area burial grounds and 200 West Area burial grounds have not changed since approval of the performance assessment. DOE agreed that this condition was met on October 3, 2000.

The review by LFRG completes the approval of the composite analysis for Environmental Restoration Disposal Facility. To ensure consistency between the Record of Decision and the DOE Order 435.1 requirements, the Richland Operations Office provided to the Office of Project Completion, a crosswalk demonstrating that the substantive requirements of DOE Order 435.1 have been fulfilled. DOE approved the crosswalk on June 18, 2001, finding that the crosswalk does demonstrate compliance with DOE Order 435.1 and granted disposal authorization to the Environmental Restoration Disposal Facility.

The base case analysis results in the following calculated doses relative to the performance measures:

Performance Assessment for the Immobilized Low-Activity Tank Waste Disposal Facility

PA Component	Measure	Immobilized Low-Activity Tank Waste Disposal Facility Projected Maximum Dose or flux
All pathways	≤ 25 mrem/yr	0.070 mrem/yr
Air pathway	≤ 10 mrem/yr	$<10^{-5}$ mrem/yr
Radon flux	an average flux of ≤20 pCi/m^2/s *or* an air concentration of ≤ 0.5 pCi/L unless constrained by applicable laws and regulations, or agreements	<0.001 pCi/m^2/s
Hypothetical inadvertent intruder	100 mrem/yr from chronic exposure 500 mrem/yr from a single event	10.2 mrem/yr from chronic exposure 0.76 mrem/yr from a single event
Water resource protection	Established consistent with laws, agreements or groundwater protection management program Hanford adopted the following performance measures for groundwater protection: Beta/photon emitters: 4 mrem/yr Alpha emitters: 15 pCi/L Radon: 3 pCi/L	0.0102 mrem/yr 0.034 pCi/L < 0.001 pCi/L



Sensitivity/uncertainty analyses were conducted by identifying the modeling parameters to which the results were most sensitive, then evaluating the impacts by using higher and lower input values than those used for the base case. The results of the sensitivity/uncertainty analysis show that performance objectives could be exceeded if the long-term release rate from the glass waste form is significantly larger than the rate used in the base case, if the infiltration rate is high and the disposal facility/closure design does not incorporate a sand-gravel diverter, or if the inventory of key radionuclides (i.e., selenium, technetium, or uranium) were significantly larger. These results are judged to be consistent with a reasonable expectation that the performance target for protecting groundwater will be met.

Performance Assessment for the 200 East Area Burial Grounds

PA Component	Measure	200 East Area Burial Grounds Projected Maximum Dose or flux*
All pathways	≤ 25 mrem/yr	0.02 mrem/yr
Air pathway Radon flux	≤ 10 mrem/yr an average flux of ≤ 20 pCi/m^2/s *or* an air concentration of ≤ 0.5 pCi/L unless constrained by applicable laws and regulations, or agreements	<0.0002 mrem/yr 0.0002 pCi/m^2/s
Hypothetical inadvertent intruder	100 mrem/yr from chronic exposure 500 mrem/yr from a single event	0.02 mrem/yr from chronic exposure < chronic exposure
Water resource protection	Established consistent with laws, agreements or groundwater protection management program Hanford established a performance measure of 4 mrem/year	0.02 mrem/yr

* Maximum doses during the 1000 year compliance period are not reported, therefore, the reported peak doses which occur beyond 1000 years are used to evaluate compliance.

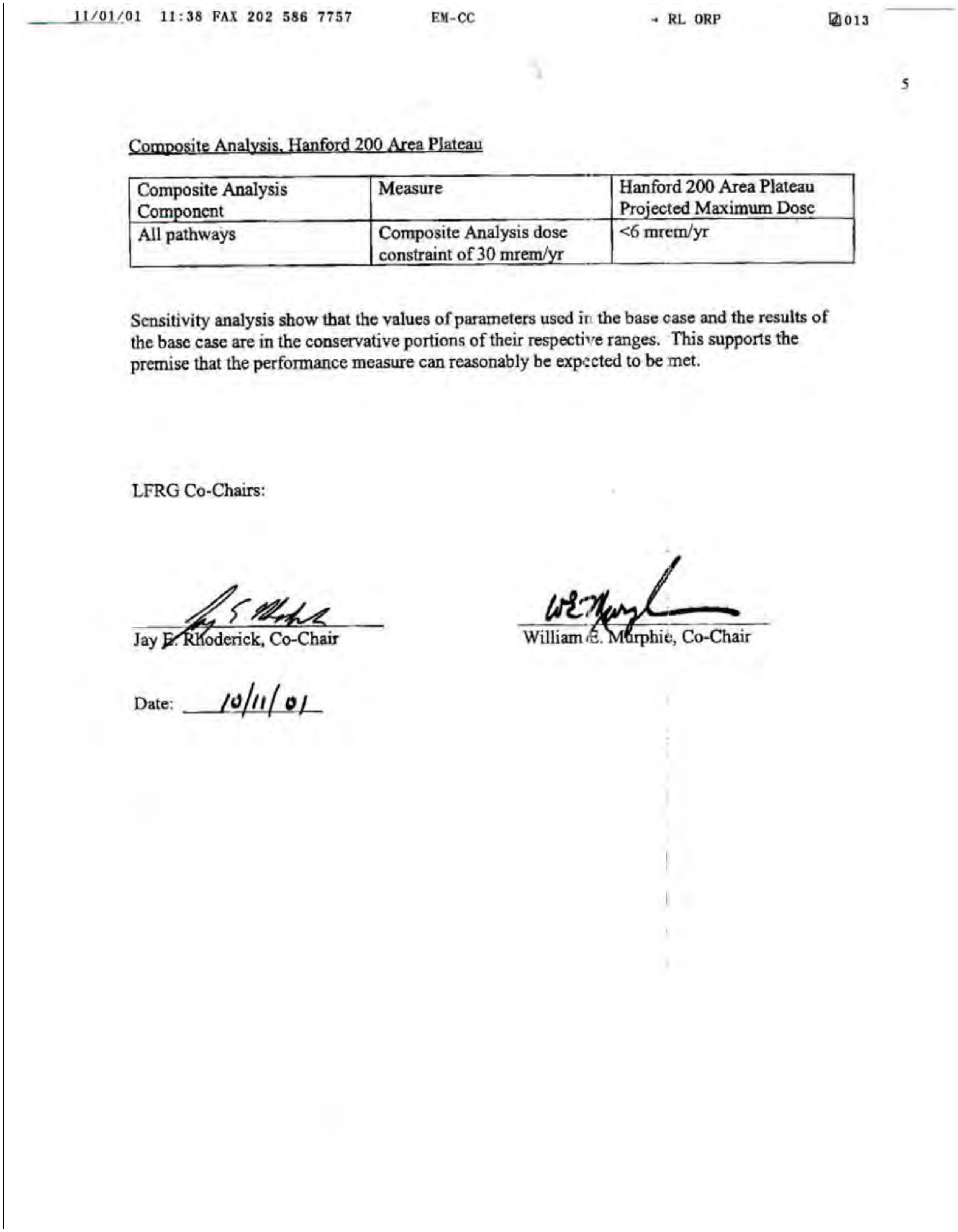
Sensitivity/uncertainty analyses show that the values of parameters used in the base case, and the results of the base case are in the conservative portions of their respective ranges. This supports the premise that the analyses are conservative and that the performance objectives can reasonably be expected to be met.

Performance Assessment for the 200 West Area Burial Grounds

PA Component	Measure	200 West Area Burial Grounds Projected Maximum Dose or flux*
All pathways	≤ 25 mrem/yr	0.47 mrem/yr
Air pathway	≤ 10 mrem/yr	0.012 mrem/yr
Radon flux	an average flux of ≤ 20 $pCi/m^2/s$ *or* an air concentration of ≤ 0.5 pCi/L unless constrained by applicable laws and regulations, or agreements	0.15 $pCi/m^2/s$
Hypothetical inadvertent intruder	100 mrem/yr from chronic exposure 500 mrem/yr from a single event	44 mrem/yr from chronic exposure < chronic exposure
Water resource protection	Established consistent with laws, agreements or groundwater protection management program Hanford established a performance measure of 4 mrem/year	0.35 mrem/yr

* Maximum doses during the 1000 year compliance period are not reported, therefore, the reported peak doses which occur beyond 1000 years are used to evaluate compliance.

Sensitivity/uncertainty analyses show that the values of parameters used in the base case, and the results of the base case are in the conservative portions of their respective ranges. This supports the premise that the analyses are conservative and that the performance objectives can reasonably be expected to be met.



Composite Analysis, Hanford 200 Area Plateau

Composite Analysis Component	Measure	Hanford 200 Area Plateau Projected Maximum Dose
All pathways	Composite Analysis dose constraint of 30 mrem/yr	<6 mrem/yr

Sensitivity analysis show that the values of parameters used in the base case and the results of the base case are in the conservative portions of their respective ranges. This supports the premise that the performance measure can reasonably be expected to be met.

LFRG Co-Chairs:

Jay E. Rhoderick, Co-Chair

William E. Murphie, Co-Chair

Date: 10/11/01

G.7 References

68 FR 1052. “Notice of Intent to Prepare an Environmental Impact Statement for Retrieval, Treatment, and Disposal of Tank Waste and Closure of Single-Shell Tanks at the Hanford Site, Richland, WA.” *Federal Register* (January 8, 2003).

Bergeron M. P. and S. K. Wurstner. 2000. *Groundwater Flow and Transport Calculations Supporting the Immobilized Low-Activity Waste Disposal Facility Performance Assessment*. PNNL-13400, Pacific Northwest National Laboratory, Richland, Washington.

Bryce, R., C. T. Kincaid, P. W. Eslinger, and L. F. Morasch. 2002. *An Initial Assessment of Hanford Impacts Performed with the System Assessment Capability*. PNNL-14027, Pacific Northwest National Laboratory, Richland, Washington. Online at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-14027/PNNL-14027.pdf

Buck, J. W., L. M. Bagaasen, M. P. Bergeron, G. P. Streile, L. H. Staven, K. J. Castleton, G. M. Gelston, D. L. Strenge, K. M. Kupka, R. J. Serne , and T. A. Ikenberry. 1997. *Analysis of the Long-Term Consequence Analysis of No Action Alternative 2: Support Information for the Waste Isolation Pilot Plant Disposal Phase Supplemental Environmental Impact Statement*. PNNL-11251, Pacific Northwest National Laboratory, Richland, Washington.

Cantrell, K. J., R. J. Serne, and G. V. Last. 2002. *Hanford Contaminant Distribution Coefficient Database and Users Guide*. PNNL-13895, Pacific Northwest National Laboratory, Richland, Washington. Online at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13895.pdf

CFEST, Co. 1997. *Draft User’s Manual, CFEST96 Flow and Solute Transport, Constant/Variable Density, Computationally Efficient, and Low Disk PC/Unix Version*. Consultant for Environmental System Technologies, Irvine, California.

Cole, C. R., S. K. Wurstner, M. P. Bergeron, M. D. Williams, and P. D. Thorne. 1997. *Three-Dimensional Analysis of Future Groundwater Flow Conditions and Contaminant Plume Transport in the Hanford Site Unconfined Aquifer System: FY 1996 and 1997 Status Report*. PNNL-11801, Pacific Northwest National Laboratory, Richland, Washington.

Cole, C. R., M. P. Bergeron, S. K. Wurstner, P. D. Thorne, S. Orr, and M. McKinley. 2001a. *Transient Inverse Calibration of the Site-Wide Groundwater Flow Model to the Hydraulic Impacts of the Unconfined Aquifer System from Hanford Operations, Southeastern Washington—1943-1996*. PNNL-13447, Pacific Northwest National Laboratory, Richland, Washington.

Cole C. R., M. P. Bergeron, C. J. Murray, P. D. Thorne, S. K. Wurstner, and P. M. Rogers. 2001b. *Uncertainty Analysis Framework – Hanford Site-Wide Groundwater Flow and Transport Model*. PNNL-13641, Pacific Northwest National Laboratory, Richland, Washington. Online at: http://www.pnl.gov/main/publications/external/technical_reports/pnnl-13641.pdf

DOE. 1994. *Remedial Investigation and Feasibility Study Report for the Environmental Restoration Disposal Facility*. DOE/RL-93-99, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE. 2001. *Radioactive Waste Management*. DOE Order 435.1, Change 1, U.S. Department of Energy, Washington, D.C. Online at: http://www.directives.doe.gov

DOE and Ecology. 1996. *Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement*. DOE/EIS-0189, U.S. Department of Energy, Richland Operations Office, Richland, Washington and Washington State Department of Ecology, Olympia, Washington.

EPA. 2000. *Drinking Water Standards and Health Advisories*. EPA 822-B-00-001, Office of Water, Environmental Protection Agency, Washington, D.C.

Fayer, M. J. and T. B. Walters. 1995. *Estimated Recharge Rates at the Hanford Site*. PNL-10285, Pacific Northwest Laboratory, Richland, Washington.

Fayer M. J., E. M. Murphy, J. L. Downs, F. O. Khan, C. W. Lindenmeier, and B. N. Bjornstad. 1999. *Recharge Data Package for the Immobilized Low-Activity Waste 2001 Performance Assessment*. PNNL-13033, Pacific Northwest National Laboratory, Richland, Washington.

FH. 2004. *Hanford Site Solid Waste Management Environmental Impact Statement Technical Information Document*. HNF-4755, Rev. 2, Fluor Hanford, Inc., Richland, Washington.

Freeze, R. A. and J. A. Cherry. 1979. *Groundwater*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Gupta S. K., C. R. Cole, C. T. Kincaid, and A. M. Monti. 1987. *Coupled Fluid, Energy, and Solute Transport (CFEST) Model: Formulation and User's Manual*. BMI/ONWI-660, Battelle Memorial Institute, Office of Nuclear Waste Isolation, Columbus, Ohio.

Howard, P. H. 1990. *Handbook of Environmental Fate and Exposure Data for Organic Chemicals, Volume II, Solvents*. Lewis Publishers Inc., Chelsea, Michigan.

Howard, P. H., R. S. Boethling, W. F. Jarvis, W. M. Meylan, and E. M. Michalenko. 1991. *Handbook of Environmental Degradation Rates*. Lewis Publishers, Inc., Chelsea, Michigan.

Jordan, R. E. and J. R. Payne. 1980. *Fate and Weathering of Petroleum Spills in the Marine Environment: A Literature Review and Synopsis*. Ann Arbor Science Publishers, Inc., Ann Arbor, Michigan.

Kaplan, D. I., R. J. Serne, A. T. Owen, J. Conca, T. W. Wietsma, and T. L. Gervais. 1996. *Radionuclide Adsorption Distribution Coefficients Measured in Hanford Sediments for the Low-Level Waste Performance Assessment Project*. PNNL-11485, Pacific Northwest National Laboratory, Richland, Washington. Online at: www.osti.gov/dublincore/gpo/servlets/purl/567525-gKURXK/webviewable

Khaleel, R. and E. J. Freeman. 1995. *Variability and Scaling of Hydraulic Properties for 200 Area Soils, Hanford Site*. WHC-EP-0883, Westinghouse Hanford Company, Richland, Washington.

Kincaid, C. T., M. P. Bergeron, C. R. Cole, M. D. Freshley, N. L. Hassig, V. G. Johnson, D. I. Kaplan, R. J. Serne, G. P. Streile, D. L. Strenge, P. D. Thorne, L. W. Vail, G. A. Whyatt, and S. K. Wurstner. 1998. *Composite Analysis for Low Level Waste Disposal in the 200 Areas Plateau of the Hanford Site*. PNNL-11800, Pacific Northwest National Laboratory, Richland, Washington.

Lee, T. 1999. *Applied Mathematics in Hydrogeology*. Lewis Publishers, Boca Raton, Florida.

Lindsey, K. A. 1995. *Miocene- to Pliocene-Aged Suprabasalt Sediments of the Hanford Site, South-Central Washington*. BHI-00184 Rev 00, Bechtel Hanford, Inc., Richland, Washington.

Mabey, W. R., J. H. Smith, R. T. Podoll, H. Johnson, T. Mill, T. Chou, J. Gates, I. Patridge, H. Jaber, D. Vandenberg. 1982. *Aquatic Fate Process Data for Organic Priority Pollutants*. EPA 440/4-81-014, Monitoring and Data Support Division, U.S. Environmental Protection Agency, Washington, D.C.

Mackay, D., W. Y. Shiu, and K. C. Ma. 1992. *Illustrated Handbook of Physical-Chemical Properties and Environmental Fate of Organic Chemicals, Volume 1: Monoaromatic Hydrocarbons, Chlorobenzenes, and PCBs*, Lewis Publishers, Chelsea, Michigan.

Mann F. M. 2002. *Annual Summary of ILAW Performance Assessment for 2002*. DOE/ORP-2000-19, Rev. 2, CH2M Hill Hanford Group, Richland, Washington.

Mann, F. M., C. R. Eiholzer, Y. Chen, N. W. Kline, A. H. Lu, B. P. McGrail, P. D. Rittmann, G. F. Williamson, J. A. Voogd, N. R. Brown, and P. E. LaMont. 1997. *Hanford Low-level Tank Waste Interim Performance Assessment*. HNF-EP-0884, Rev. 1, Lockheed Martin Hanford Corporation, Richland, Washington.

Mann, F. M., K. C. Burgard, W. R. Root, R. J. Puigh, S. H. Finfrock, R. Khaleel, D. H. Bacon, E. J. Freeman, B. P. McGrail, S. K. Wurstner, and P. E. LaMont. 2001. *Hanford Immobilized Low-Activity Waste Performance Assessment: 2001 Version*. DOE/ORP-2,000-24, Rev. 0, U.S. Department of Energy, Office of River Protection, Richland, Washington.

Martell, A. E. 1971. "Principles of Complex Formation." In *Organic Compounds in Aquatic Environments,* edited by S. D. Faust and J. V. Hunter. Marcel Dekker, Inc., New York, New York.

Martell, A. E. and R. M. Smith. 1977. *Critical Stability Constants Vol. 3: Other Organic Ligands*. Plenum Press, New York, New York.

Mills, D. B., D. B. Porcella, M. J. Ungs, S. A. Gherini, K. V. Summers, Lingfung Mok, G. L. Rupp, G. L. Bowie, and D. A. Haith. 1985. *Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants in Surface and Ground Water - Part II (Revised 1985)*. EPA/600/6-85/002b, Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Athens, Georgia. Online at: http://www.epa.gov/waterscience/library/modeling/wqascreenpart2.pdf

Mualem, Y. 1976. "A New Model for Predicting the Hydraulic Conductivity of Unsaturated Porous Media." *Water Resources Research.* 12, 513.

Nichols, W. E., N. J. Aimo, M. Oostrom, and M. D. White. 1997. *STOMP Subsurface Transport Over Multiple Phases: Application Guide*. PNNL-11216, Pacific Northwest National Laboratory, Richland, Washington.

Radding, S. B., T. Mill, C. W. Gould, D. H. Liu, H. L. Johnson, D. C. Bomberger, and C. V. Fojo. 1976. *The Environmental Fate of Selected Polynuclear Aromatic Hydrocarbons*. EPA 560/5-75-009, Office of Toxic Substances, U.S. Environmental Protection Agency, Washington, D.C.

Richards, L. A. 1931. "Capillary Conduction of Liquids through Porous Media." *Physics*, 1, pp 318-333.

Serne, R. J., W. J. Martin, R. O. Lokken, V. L. LeGore, C. W. Lindenmeier, and P. F. C. Martin. 1989. *Leach and EP Toxicity Test on Grouted 106-AN Tank Waste*. PNL-6960, Pacific Northwest Laboratory, Richland, Washington.

Serne, R. J. and M. I. Wood. 1990. *Hanford Waste-Form Release and Sediment Interaction: A Status Report with Rationale and Recommendations for Additional Studies.* PNL-7297, Pacific Northwest Laboratory, Richland, Washington.

Serne, R. J., R. C. Arthur, and K. M. Krupka. 1990. *Review of Geochemical Processes and Codes for Assessment of Radionuclide Migration Potential at Commercial LLW Sites*. NUREG/CR-5548, U.S. Nuclear Regulatory Commission, Washington, D.C.

Serne, R. J., A. R. Felmy, K. J. Cantrell, K. M. Krupka, J. A. Campbell, H. Bolton, and J. K. Fredrickson. 1995. *Characterization of Radionuclide-Chelating Agent Complexes Found in Low-level Radioactive Decontamination Waste: Literature Review.* NUREG/CR-6124, U.S. Nuclear Regulatory Commission, Washington, D.C.

Smith, R. M. and A. E. Martell. 1982. *Critical Stability Constants: Vol. 5: First Supplement*. Plenum Press, New York, New York.

Strenge, D. L. and S. R. Peterson. 1989. *Chemical Data Bases for the Multimedia Environmental Pollutant Assessment System (MEPAS): Version 1*. PNL-7145, Pacific Northwest Laboratory, Richland, Washington.

Thorne, P. D. and M. A. Chamness. 1992. *Status Report on the Development of a Three-Dimensional Conceptual Model for the Hanford Site Unconfined Aquifer System*. PNL-8332, Pacific Northwest Laboratory, Richland, Washington.

Thorne, P. D., M. A. Chamness, F. A. Spane Jr., V. R. Vermeul, and W. D. Webber. 1993. *Three-Dimensional Conceptual Model for the Hanford Site Unconfined Aquifer System, FY 1993 Status Report*. PNL-8971, Pacific Northwest Laboratory, Richland, Washington.

Thorne, P. D., M. A. Chamness, V. R. Vermeul, Q. C. MacDonald, and S. E. Schubert. 1994. *Three-Dimensional Conceptual Model for the Hanford Site Unconfined Aquifer System, FY 1994 Status Report*. PNL-10195, Pacific Northwest Laboratory, Richland, Washington.

Truex, M. J., C. J. Murray, C. R. Cole, R. J. Cameron, M. D. Johnson, R. S. Skeen, and C. D. Johnson. 2001. *Assessment of Carbon Tetrachloride Groundwater Transport in Support of the Hanford Carbon Tetrachloride Innovative Technology Demonstration Program*. PNNL-13560, Pacific Northwest National Laboratory, Richland, Washington. Online at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13560.pdf

van Genuchten, M. 1980. "A Closed-Form Equation for Predicting the Hydraulic Conductivity of Unsaturated Soils." *Soil Sci. Am. J*. 44, 892-898.

Vogel, T. M., C. S. Criddle, and P. L. McCarty. 1987. "Transformations of Halogenated Aliphatic Compounds." *Environmental Science and Technology*, 21: 722-736.

Walters W. H., M. C. Richmond, and B. G. Gilmore. 1994. *Reconstruction of Radionuclide Concentrations in the Columbia River from Hanford, Washington to Portland Oregon, January 1950–January 1971*. PNWD-2225 HEDR, Battelle Pacific Northwest Laboratories, Richland, Washington.

Walton, W. C. 1985. *Practical Aspects of Groundwater Modeling: Flow, Mass and Heat Transport, and Subsidence, Analytical and Computer Models.* Second Edition, National Water Well Association, Worthington, Ohio.

Ward, A. L., G. W. Gee, and M. D. White. 1997. *A Comprehensive Analysis of Contaminant Transport in the Vadose Zone Beneath Tank SX-109*. PNNL-11463, Pacific Northwest National Laboratory, Richland, Washington.

Warren, B. R. and D. L. Strenge. 1994. *Multimedia-Modeling Environmental Database*and *Editor (MMEDE) User Manual*. PNNL-11652, Pacific Northwest National Laboratory, Richland, Washington.

White, M. D. and M. Oostrom. 1996. *STOMP Subsurface Transport Over Multiple Phases: Theory Guide*. PNNL-11217, Pacific Northwest National Laboratory, Richland, Washington.

White, M. D. and M. Oostrom. 1997. *STOMP Subsurface Transport Over Multiple Phases: User's Guide*. PNNL-11218, Pacific Northwest National Laboratory, Richland, Washington.

Wood, M. I., R. Khaleel, P. D. Rittmann, A. H. Lu, S. H. Finfrock, R. J. Serne, K. J. Cantrell, and T. H. DeLorenzo. 1995. *Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds*. WHC-ED-0645, Westinghouse Hanford Company, Richland, Washington.

Wood, M. I., R. Khaleel, P. D. Rittmann, S. H. Finfrock, T. H. DeLorenzo, and D. Y. Garbrick. 1996. *Performance Assessment for the Disposal of Low-Level Waste in the 200-East Area Burial Grounds*. WHC-SD-WM-TI-730, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Wood, M. I. and J. A. Van Vliet. 2002. *Performance Assessment Review Report, 2001-2002 Annual Review of the 200 West and 200 East Area Performance Assessments*, (letter to Mr. Michael H. Schlender, Deputy Manager, Richland Operations Office, U.S. Department of Energy, correspondence # FH-0204558, dated September 30), Fluor Hanford, Richland, Washington.

Wurstner, S. K., P. D. Thorne, M. A. Chamness, M. D. Freshley, and M. D. Williams. 1995. *Development of a Three-Dimensional Groundwater Model of the Hanford Site Unconfined Aquifer System: FY 1995 Status Report*. PNL-10886, Pacific Northwest Laboratory, Richland, Washington.

Appendix H

Traffic and Transportation

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This appendix evaluates the potential impacts of onsite and offsite shipments of low-level waste (LLW), mixed low-level waste (MLLW) (including melters), transuranic (TRU) waste (including mixed TRU waste), and immobilized low-activity waste (ILAW); shipments of MLLW from Hanford to offsite treatment facilities and back; and the shipment of construction and capping materials to Hanford. This appendix presents the potential impacts of shipments of LLW, MLLW, and TRU wastes from offsite to Hanford facilities and shipments of TRU wastes from Hanford to the Waste Isolation Pilot Plant (WIPP) for disposal. The potential impacts of shipments of LLW, MLLW, and TRU wastes from offsite to Hanford and TRU wastes from Hanford to WIPP are presented for entire routes across the United States and for the portions of these routes that traverse Washington and Oregon. The methods and data used to conduct these calculations have been updated with respect to the methods and data used in the *Final Waste Management Programmatic Environmental Impact Statement* (WM PEIS) (DOE 1997a). Where possible, data used in the WM PEIS are used in this analysis for consistency. Changes to the data relied on between the WM PEIS and the HSW EIS include the population data (2000 versus 1990 Census), route characteristics (shipping distances and population characteristics along the routes were calculated using a geographic information system [GIS] based software), and waste volume projections. The estimated impacts of transporting TRU wastes to WIPP were reanalyzed using updated methods and data but are consistent with the transportation analysis in the *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (WIPP SEIS-II) (DOE 1997b).

Estimates of potential radiological and non-radiological impacts of transporting various types of waste are presented in the following sections. This analysis resulted in estimates of radiological hazards from waste transported under incident-free and accident conditions and chemical hazards from waste transportation accidents, as well as physical hazards (that is, fatalities from trauma) from traffic accidents involving waste shipments. Health effects from incident-free vehicular emissions are also estimated. The physical (non-radiological) hazards and the impacts of incident-free vehicular emissions are independent of the cargo being transported. Total integrated radiological and non-radiological impacts are calculated in addition to maximum individual incident-free radiological exposures and the impacts to populations and individuals of the maximum credible accidents. Note that all of the methods used in this appendix to calculate potential transportation impacts are commonly used in U.S. Department of Energy (DOE) environmental documents. In addition, potential impacts of sabotage or acts of terrorism are addressed in this analysis (see Section H.8). Finally, the transportation impacts from the WM PEIS (DOE 1997a) and WIPP SEIS-II (DOE 1997b) are compared to the updated transportation impacts in this HSW EIS.

H.1 Description of Methods

The methods used in this HSW EIS to estimate the impacts of transporting waste, construction materials, and capping materials are described in the following section. Section H.1.1 describes the RADTRAN 5 computer code (Neuhauser et al. 2003) that was used to predict the radiological incident-free doses and accident risks to the public and transport crews associated with the alternative groups examined in this EIS. The method used to calculate physical (non-radiological) incident-free risks is described in Section H.1.2. The method used to calculate non-radiological accident risks is described in Section H.1.3. The method used to calculate the impacts of accidental releases of hazardous chemicals is described in Section H.1.4.

H.1.1 Radiological Impact Analysis Methodology

RADTRAN 5 was used to estimate collective impacts to populations from incident-free transportation of radioactive material and collective population risks from accidents during transport. RADTRAN 5 is organized into nine models:

- package
- transportation (infrastructure)
- population distribution
- accident severity and package behavior
- accident probability
- meteorological dispersion
- exposure pathway
- accident dose risk
- health effects.

RADTRAN 5 uses these models to calculate the potential population dose from incident-free transportation and the risk to the population from potential accident scenarios.

Collective Population Doses from Incident-Free Transport. RADTRAN 5 estimates doses to people on or near the transportation routes from external radiation emitted from the loaded shipping containers. RADTRAN 5 calculates incident-free doses to the following population groups:

- **Persons along the route (referred to as *off-link population*)**. RADTRAN 5 estimates population doses to all persons living or working within 0.8 km (0.5 mi) of each side of a transportation route.

- **Persons sharing the route (*on-link population*)**. Collective doses are estimated for persons in vehicles sharing the transportation route, traveling in the same or opposite direction.

- **Persons at stops**. RADTRAN 5 estimates collective doses to persons who may be exposed to a shipment while it is at a stop. For truck shipments to or from offsite locations, stops may be made for fuel, food, or rest. For onsite truck shipments, stop times are set to zero because of the short transport distances.

- **Crew members**. Incident-free doses to truck crew members are estimated.

The total collective population doses are the sum of the doses to the off-link population, on-link population, and persons at stops. Worker doses include the doses to truck crew members. Note that the population doses resulting from onsite shipments would be to Hanford Site workers that may be adjacent to or near a shipment of radioactive waste. Onsite shipments of radioactive waste would not expose a member of the public to any substantial radioactive dose rate because Hanford Site access restrictions prevent the shipments from approaching locations where a member of the public could be. One exception would be shipments from the 300 Area or 400 Area to the 200 Areas treatment and disposal facilities. The highway from the 300 Area and 400 Area to the Wye Barricade is publicly accessible, and a member of the public could conceivably be on the highway at the time a waste shipment is being transported. However, some shipments of radioactive materials from the 300 Area and 400 Area to the 200 East and 200 West Areas are currently conducted during off-shift hours (for example, nights and weekends) and often require closure of the road between the 300 Area or 400 Area and the Wye Barricade. This is done in some cases to minimize public exposure to the shipments. Consequently, except for this small potential dose to a non-Hanford worker member of the public, the doses to the public referred to in this appendix from onsite shipments are actually doses to Hanford workers who may be driving to or from their work locations as a waste shipment passes by. Doses to the public are associated with shipments of MLLW to offsite treatment facilities and back; shipments of TRU wastes to WIPP; and LLW, MLLW, and TRU shipments from offsite to Hanford.

Incident-free doses estimated by RADTRAN 5 generally are based on extrapolating the dose rate emitted from the package as a function of distance from a point source. The public and worker doses are dependent upon parameters, such as population density, shipping distance, exposure distance, exposure duration, stop times, traffic density, and the Transportation Index (TI), of the package or packages. The TI is defined as the highest package dose rate (mrem per hour) that would be received by an individual located at a distance of 1 m (3.3 ft) from the external surface of the package.

Radiological accident risks. RADTRAN 5 assesses accident risk by combining the probabilities and consequences of accidents to produce a risk value. RADTRAN 5 considers a spectrum of potential transportation accidents, ranging from those with high frequencies and low consequences (for example, fender benders) to those with low frequencies and high consequences (accidents in which the shipping container is exposed to severe mechanical and thermal conditions).

An accident analysis in RADTRAN 5 is performed using an accident severity and package release model. The user can define up to 30 severity categories, with each category increasing in magnitude. Severity categories are related to fire, puncture, crush, and immersion environments created in vehicular accidents. For this analysis, the eight severity categories defined in NUREG-0170 (NRC 1977) were adopted for onsite shipments. Severity Category I represents minor accidents in which the packaging system retains confinement of the cargo (that is, no release). Higher severity categories represent more severe accident conditions with correspondingly higher releases and lower probabilities. The eight accident severity category scheme is consistent with those used in the WM PEIS and WIPP SEIS-II as well as with recommendations given in DOE (2002c).

Each severity category has an assigned conditional probability (or the probability, given an accident occurs, that it will be of the specified severity). The accident scenarios are further defined by allowing the user to input release fractions and aerosol and respirable fractions for each severity category. These fractions are also a function of the physical-chemical properties of the materials being transported. RADTRAN 5 values for materials similar to the various types of waste were used in this analysis. For example, Category 1 solid wastes were modeled as a generic small-powder-material form. Using these values, the Category 1 LLW solids are assigned an aerosol fraction value of 0.10 (that is, 10 percent aerosol-size particles) and a respirable fraction value of 0.05 (5 percent of the aerosol-size particles are also respirable-size particles). These parameters were used for all onsite shipments of solid materials, including Category 1 LLW, Category 3 LLW, MLLW, and TRU wastes.

For accidents that result in a release of radioactive material, RADTRAN 5 assumes the material is dispersed into the environment according to standard Gaussian diffusion models. The code allows the user to choose two different methods for modeling the atmospheric transport of radionuclides after a potential accident. The user can either input Pasquill atmospheric-stability category data or averaged time-integrated concentrations. In this analysis, the default standard cloud option (using time-integrated concentrations) was used.

RADTRAN 5 calculates the population dose from the released radioactive material for five possible exposure pathways. These pathways are

- external dose from exposure to the passing cloud of radioactive material

- external dose from radionuclides deposited on the ground by the passing plume (the analysis included the radiation exposures from this pathway even though the area surrounding a potential accidental release would be evacuated and decontaminated, thus preventing long-term exposures from this pathway)

- internal dose from inhalation of airborne radioactive contaminants

- internal dose from resuspension of radioactive materials that were deposited on the ground (the analysis included the radiation exposures from this pathway even though evacuation and decontamination of the area surrounding a potential accidental release would prevent long-term exposures)

- internal dose from ingestion of contaminated food (the analysis assumed interdiction of foodstuffs and evacuation after an accident so no internal dose due to ingestion of contaminated foods was calculated).

Standard radionuclide uptake and dosimetry models are incorporated into RADTRAN 5. The computer code combines the accident consequences and frequencies of each severity category, sums up the severity categories, and then integrates across all the shipments. Accident-risk impacts that are provided in the form of a collective population dose (person-rem over the entire shipping campaign) are then converted to population risk using health-effects conversion factors. The dose to risk factors, which were taken from Federal Guidance Report 13 (Eckerman et al. 1999), assume 6.0E-04 latent cancer fatalities (LCFs) per person-rem for workers and the general public.

Analysis of maximally exposed individuals. A scenario-based analysis was conducted to develop estimates of incident-free radiation doses to maximally exposed individuals (MEIs). The analysis is based on information in DOE (2002a) and incorporates information about exposure times, dose rates, and the number of times an individual may be exposed to an offsite shipment. Adjustments were made where necessary to reflect the waste shipments addressed in this HSW EIS. In all cases, it was assumed that the dose rate emitted from the shipping containers is 10 mrem/hr at 2 m (6.6 ft) from the side of the transport vehicle, the maximum dose rate allowed by U.S. Department of Transportation (DOT) regulations. The actual dose rates emitted from typical waste shipments are likely to be much lower. For example, the average dose rate from historical LLW shipments is about 1 mrem/hr at 1 m (3.3 ft) (DOE 2002a) and would be even lower at 2 m (6.6 ft) from the surface of the shipment. Contact-handled (CH) TRU waste shipment dose rates were estimated in the WIPP SEIS-II (DOE 1997b) for Hanford TRU waste at between 2.2 and 3.3 mrem/hr at 1 m (3.3 ft), and would be even lower at 2 m (6.6 ft) from the shipment. Using the point-source approximation (that is, dose rate is proportional to $1/r^2$ where r is the distance between the radiation source and receptor), the dose rates at 2 m (6.6 ft) from LLW and CH TRU waste shipments would be about one-fourth of the dose rate at 1 m (3.3 ft). Thus as a first-order approximation, the dose rates from actual LLW shipments would be, on average, about 0.25 mrem/hr at 2 m (6.6 ft) and the dose rates from actual CH TRU waste shipments would be about 0.5 to 0.8 mrem/hr at 2 m (6.6 ft) from the shipments. These dose rates are well below the regulatory maximum dose rate assumed in the analysis. For perspective, the radiation dose rates measured at 1 m (3.3 ft) from the recent TRU waste shipments to Hanford were all below 1 mrem/hr and would be even lower at 2 m (6.6 ft) from the shipment. The highest measured dose rates were 30 mrem/hr at the point of contact with the shipment and 0.8 mrem/hr at 1 m (3.3 ft) from the shipment.

An MEI is a person who may receive the highest radiation dose from a shipment to and/or from the Hanford Site. The analysis evaluated the following exposure scenarios:

Truck crew member. Truck crew members would receive the highest radiation doses during incident-free transport because of their proximity to the loaded shipping container for an extended period of time. The analysis assumed that crew member doses are limited to 2 rem per year (DOE 2002b).

Inspectors. Radioactive waste shipments are inspected by federal or state vehicle inspectors, for example, at state ports of entry. DOE (2002b) assumed that inspectors would be exposed for 1 hour at a distance of 1 m (3.3 ft) from the shipping containers.

Resident. The analysis assumed that a resident lives 30 m (100 ft) from the point where a shipment would pass and would be exposed to all shipments along a particular route. Exposures to residents on a per-shipment basis were extracted from the WIPP SEIS-II (DOE 1997b) and used in the HSW EIS to estimate potential radiation doses to maximally exposed residents.

Individual stuck in traffic. This scenario addresses potential traffic interruptions that could lead to a person being exposed to a loaded shipment for one hour at a distance of 1.2 m (4 ft). The analysis assumed this exposure scenario would occur only one time to any individual.

Person at a truck service station. This scenario estimates doses to an employee at a service station where all truck shipments along a particular route would stop. DOE (2002b) assumed this person is exposed for 49 minutes at a distance of 16 m (52 ft) from the loaded shipping container.

Information was extracted from DOE (2002b) and DOE (1997b) to develop unit dose factors (rem per shipment) that were applied to the shipping data in this HSW EIS to develop the MEI dose impacts (see Section H.3.2.3.1). This is valid because the calculated impacts are functions of dose rate and exposure duration. The calculations do not differentiate between cargo types so the results would be same even though DOE (2002b) addresses commercial spent nuclear fuel, whereas this HSW EIS addresses various forms of solid radioactive wastes. The analyses of maximally exposed individuals in DOE (2002b) and this HSW EIS assumed the dose rate emitted from the shipment was to be at the regulatory limit.

Analysis of maximum credible accidents. The results of an analysis of the impacts to populations and individuals of maximum credible accidents were extracted from DOE (1997b) and summarized in this HSW EIS. The analysis assumed a severe accident involving remote-handled (RH) TRU waste occurred in an urban area. The pure consequences (that is, the consequences are not weighted against the probability of occurrence, as is done in the RADTRAN 5 assessment of radiological accident risks) of this potential accident were then estimated using standard atmospheric dispersion and radiological dose calculation methods.

H.1.2 Physical (Non-Radiological) Incident-Free Risks

Non-radiological incident-free impacts consist of fatalities from pollutants, such as diesel exhaust emitted from vehicles. This category of impacts is not related to the radiological characteristics of the cargo. Spreadsheet calculations were performed using unit-risk factors (fatalities per kilometer of travel) to derive estimates of the non-radiological impacts. The non-radiological impacts were calculated by multiplying the unit risk factors by the total round-trip shipping distances for all of the shipments in each shipping option. Non-radiological unit risk factors for incident-free transport were taken from Biwer and Butler (1999).

H.1.3 Non-Radiological Accident Risks in Transit

The non-radiological accident impacts of traffic accidents associated with the transportation of radioactive waste are assumed to be comparable to the impacts associated with general transportation activities in the United States. A unit factor (fatalities per kilometer or fatalities per mile) is multiplied by the round-trip shipping distance to calculate non-radiological impacts from vehicular accidents. The fatalities are due to vehicular impacts with solid objects, rollovers, or collisions and are not related to the radioactive nature of the cargo being transported. For onsite shipments, the fatality data developed by Saricks and Tompkins (1999) for primary highways in the state of Washington was used in the calculations. Separate unit factors were used to develop estimates of the number of accidents involving the shipments and the number of fatalities resulting from the accidents.

A similar, yet more detailed, approach was used to develop non-radiological accidents and fatality estimates for offsite shipments. The TRAGIS computer code (Johnson and Michelhaugh 2000) was used to develop estimates of the distance traveled in each state along a route and the type of highway (interstate, state highway, or other). Actual routes were used in these analyses. Saricks and Tompkins (1999) provided accident rates and fatality rates that are a function of the highway type. The approach taken to estimate non-radiological impacts of offsite shipments was to multiply the state-level accident or fatality rates by the distances traveled in each state on the corresponding highway type and then sum up all the states on each route. These non-radiological impact analyses assumed round-trip shipments in order to account for shipment of loaded containers and return shipments of empty containers. This is different from the radiological impact analyses, which estimate impacts only when the shipping containers are loaded with radioactive waste. For interstate highways, the actual interstate distances and interstate accident rates were used. For non-interstate highway travel, either the “Primary” or “Other” rates given by Saricks and Tompkins (1999) were used, whichever was greater. For the states of Georgia, New York, Oregon, and South Carolina, Saricks and Tompkins (1999) gives only one accident rate and one fatality rate. These rates were applied to both interstate and non-interstate travel in those specific states.

H.1.4 Hazardous Chemical Impact Analysis

The impact of accidental releases of hazardous chemicals from the various waste shipments was addressed differently from accidental releases of LLW, MLLW, and TRU wastes. A maximum credible accident involving each shipment was postulated. This is similar to the analysis of the impacts of the maximum credible radiological accidents discussed in Section H.1.1. Hazardous chemical release and atmospheric dispersion calculations were then performed to determine the maximum downwind concentration to which an individual would be exposed. The downwind concentrations were compared to safe exposure levels for each chemical (Emergency Response Planning Guidelines [ERPGs] or Temporary Emergency Exposure Limits [TEELs]; see Section H.6) to determine the potential public and worker impacts. Hazardous chemical impacts were calculated for maximally exposed individuals and not for populations. Exposures to other individuals would be to lower concentrations of the hazardous chemicals and thus, if the impacts to the maximally exposed individual do not result in adverse health impacts, the surrounding population would also not be expected to suffer adverse health impacts. This analytical approach is consistent with guidance outlined in the DOE NEPA Compliance Guide (DOE 1998b) and the DOE Transportation Risk Assessment Handbook (DOE 2002a) as well as with the analytical approaches reflected in recent DOE EISs addressing nationwide transportation of radioactive wastes; the WIPP SEIS-II (DOE 1997b) and Yucca Mountain EIS (DOE 2002b).

The formula used to estimate the downwind concentrations of hazardous chemicals is

$$Concentration = \frac{Source\ Inventory \times Respirable\ Release\ Fraction \times \frac{E}{Q}}{Release\ Duration}$$

where E/Q is the atmospheric dispersion coefficient.

Hazardous chemical concentrations for the highest-volume waste streams are presented in Section H.2.3.

The maximum credible accident postulated in this analysis is assumed to involve a severe impact followed by a fire. The impact condition is assumed to break up the waste form and cause the waste container to fail so the contained material has an open pathway to the environment. A fire is then assumed to occur, resulting in additional damage and aerosolization of the waste material. The aerosol and respirable fractions used in the radiological impact analysis also were used to characterize the released hazardous chemicals for the solid waste constituents. For solid chemicals, the aerosol and respirable fractions were set equal to 0.1 and 0.05, respectively. Therefore, a combined respirable release fraction of 0.005 was used in the calculations to characterize releases of solid (that is, powder form) materials. For waste constituents that could volatilize under these conditions, the aerosol and respirable fractions were both set equal to 1.0 (that is, 100 percent of the material is dispersible and 100 percent is respirable).

Because an accident could occur anywhere and at any time during a shipment, predicting the population distributions and weather conditions at the time of the accident is not possible. For this analysis, the concentrations of the hazardous materials at the location of the MEI were calculated using data taken from DOE (1997b). The MEI for onsite and offsite shipments was assumed to be located 100 m (109 yd) downwind from the accident location for the entire duration of the release. The dose to the MEI for offsite shipments would be similar. Downwind air concentrations are also a function of wind speed and atmospheric stability class. The wind speed was assumed to be 1 m/s, and Pasquill Stability Class F (stable conditions) was assumed. These are low-probability wind conditions that tend to overestimate typical concentrations of released materials. Plume rise (that is, loft of the plume resulting from the thermal conditions caused by the fire) was considered. It was assumed that the effective height of the plume would be approximately 21 m (69 ft). The resulting E/Q value was calculated to be 1.13E-04 sec/m^3 (DOE 1997b).

The impacts to the MEI were determined by comparing the downwind concentrations of each hazardous chemical to safe exposure levels. The primary source of the exposure levels is *ERPGs and TEELs for Chemicals of Concern, Rev. 19* (Craig 2002). The safe exposure level assumed here is TEEL-2, as defined by Craig (2002). The TEEL-2 concentration is defined as the maximum concentration in air below which 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.

H.2 Solid Waste Shipping Data

This section presents information about waste volumes, number of shipments, packaging characteristics, and route characteristics that were used in the transportation impact analysis. Section H.2.1 presents these data for onsite shipments and Section H.2.2 presents the offsite shipment data.

H.2.1 Onsite Shipping Data

RADTRAN 5 calculations are performed for each origin/destination pair. Onsite population densities and shipping distances are based on Hanford map distances and occupancies in buildings along the routes.

The shipment origins, destinations, distances, and number of shipments to be transported onsite in the alternative groups are presented later in this appendix. The capacities of the various onsite shipment types and other shipment characteristics are shown in Table H.1.

Table H.1. General Shipping Parameters for HSW EIS Solid Waste Shipments

Parameter	Value
Waste volume (m^3 per shipment)[(a)]	
LLW Cat 1	7.5
LLW Cat 3	0.89
MLLW	3.4
CH TRU waste drums	7.5
CH TRU waste boxes	5.7
RH TRU waste	0.89[(b)]
ILAW	2.6 (one canister)
Spent melters (one melter per shipment)	175
Elemental lead and mercury	0.5
Transport Index (dose rate at 1 m from shipping container, mrem/hr)[(c)]	
LLW Cat 1 and MLLW	
LLW Cat 3 and RH MLLW	1[(d)]
CH TRU waste (drums and boxes)	10[(d)]
RH TRU waste	4
ILAW	10
Spent melters	14[(e)]
	14[(e)]
Number of truck crew[(f)]	2
Average vehicular speed (km/hr)[(f)]	
Rural	88
Suburban	40
Urban	24
Stop time (hr/km), number of people exposed while stopped and average exposure distance while stopped	NA (No stops for onsite shipments)
Number of people per vehicle sharing route[(g)]	2
Population densities (persons/km^2)	Route-specific
One-way traffic count (vehicles/hr)[(f)]	
Rural	470
Suburban	780
Urban	2800

(a) Shipment capacities are based on current Hanford shipping practices except where otherwise indicated.
(b) Source: WIPP SEIS-II (DOE 1997b).
(c) Source: WM PEIS (DOE 1997a) except where otherwise indicated.
(d) Source: *A Resource Handbook for DOE Transportation Risk Assessment* (DOE 2002a).
(e) Based on regulatory maximum external dose rate of 10 mrem/hr at 2 m from the shipping container. See 49 CFR 173.441.
(f) Source: RADTRAN default parameter (Neuhauser and Kanipe 1992).
(g) Source: NUREG-0170 (NRC 1977).

Radioactive Waste Shipping Regulations and Packaging

The two key federal government agencies responsible for ensuring the safety of transporting radioactive materials are the U.S. Department of Transportation (DOT) and U.S. Nuclear Regulatory Commission (NRC). DOT regulations for the safe transportation of radioactive materials are found in Title 49 of the Code of Federal Regulations (49 CFR 106-180). NRC transportation regulations are found in 10 CFR 71. These regulations establish a comprehensive set of requirements that ensure appropriate packaging (or shipping container) commensurate with the hazard presented by the shipment is used, vehicle (tractor-trailer, railcar) safety and reliability, route selection, driver training and accreditation, and shipment labeling and placarding in accordance with the level of hazard.

The most important element of safety is the packaging or shipping containers used to transport waste materials. Federal regulations, with which DOE must comply for offsite shipments, establish two types of packaging that will be used for offsite transport of waste materials: Type A and Type B. The levels of radioactivity and the specific radionuclides contained in the wastes determine whether a shipment is transported in a Type A or Type B package. In general, lower-hazard (that is, low-radioactive content) shipments are transported in Type A packages and higher-hazard (high-radioactive content) shipments are transported in Type B packages. Type A packages would be used for most LLW and MLLW shipments. These waste types are characterized by relatively low radiation levels and radionuclide concentrations. Type A packages are required to withstand a series of tests, referred to as normal conditions of transport, without functional failure. Type A packaging tests include a water spray test, drop test, stacking test, and penetration test. Examples of Type A containers used for transporting LLW and MLLW include 208-L (55-gal) steel drums, steel boxes, and various sizes of concrete and steel shielded cylindrical containers. Type B packages, on the other hand, are used for radioactive materials that have relatively high radionuclide concentrations and/or relatively high concentrations of transuranic radionuclides, such as plutonium and americium. TRU waste, some high-curie content LLW and MLLW shipments, and possibly ILAW canisters would be shipped in Type B packages. Type B packages must withstand a series of tests that are designed to simulate severe accidents (including impact, puncture, thermal, and water immersion environments) in addition to the normal conditions of transport. Examples of Type B packages include the massive spent nuclear fuel shipping casks and the TRUPACT container used to transport TRU waste to WIPP. Properly designed, manufactured, tested, and maintained packaging systems are the backbone of DOE's transportation safety program.

Population density information for onsite shipments was obtained from the Spent Nuclear Fuel Programmatic EIS (DOE 1995). It should be noted that these values adequately bound the present and future conditions at Hanford based on the following considerations. First, the populations are assumed to be uniformly distributed on both sides of the roadway for the entire trip. In reality, most Hanford workers would be located within buildings and large fractions of the road pass through uninhabited areas between buildings. Second, many of the Hanford buildings are set back from the most frequently used roadways and there would be few or no people between the road and the building. Third, the largest potential change in Hanford's population since 1995 is due to construction of the Waste Treatment Plant (WTP). The WTP is located on the extreme east end of the 200 East Area, away from most roads that would be used for solid waste transportation. Most of the current WTP construction work force is temporary and will relocate elsewhere after WTP construction is complete in about 2010 and would not be present when most of the shipments addressed under the HSW EIS proposed action and alternatives would take place.

For shipments from unspecified locations to the 200 West Area, it was assumed that the origin of the shipment was the 300 Area, the onsite waste generators farthest from the 200 West Area. These shipments were assumed to travel a one-way distance of 48 km (30 mi) through a region defined by three population densities: 1.6 km (1 mi) through a region with the 300 Area population density (660 persons/km^2 or 1700 persons/mi^2); 6.4 km (4 mi) through a region with the 200 West Area population density (120 persons/km^2 or 300 persons/mi^2); and 40 km (25 mi) through a region with the 600 Area population density (0.14 persons/km^2 or 0.35 persons/mi^2). These route characteristics were also used for shipments of waste to an offsite commercial treatment facility adjacent to the Hanford Site. For intra-200 West Area shipments (for example, from the CWC to WRAP or the T Plant Complex to the LLBGs), a distance of 1.6 km (1 mi) was assumed. Ten percent of route was assumed to travel through an area defined by a population density of 660 persons/km^2 (1700 persons/mi^2) and 90 percent in an area defined by a population density of 0.14 persons/km^2 (0.35 persons/mi^2). Shipments between the 200 East and 200 West Areas (for example, ILAW shipments to a 200 East Area disposal facility in Alternative Group B) were modeled as a 16-km (10-mi) shipment, 10 percent of which would be through an area defined by a population density of 660 persons/km^2 (1700 persons/mi^2) and 90 percent in an area defined by a population density of 0.14 persons/km^2 (0.35 persons/mi^2). This analysis is conservative because most of the onsite personnel will be in buildings located on one side of the road or the other and in buildings that are set back away from the roads, although the code assumes a uniform population density on both sides of the road. Also, many of the shipments will come from the 200 East and 200 West Areas, a much shorter shipping distance than from the 300 Area.

Table H.2 presents the shipping data for Alternative Group A Hanford Only waste volume. The table provides the origin and destination for each onsite shipment, the projected waste volume, and the number of shipments. Alternative Group A also involves shipments of MLLW to offsite treatment facilities, including shipments of contact-handled inorganic solids and debris (waste stream 13B) to the Oak Ridge [Tennessee] Reservation (ORR) and back for thermal treatment and shipments of contact-handled inorganic solids and debris to a commercial treatment facility adjacent to the Hanford Site and back for non-thermal treatment (waste stream 13A).

Shipping data for Alternative Group B (see Table H.3) is similar to Group A except for ILAW and MLLW shipments. In Group B, the ILAW disposal facility is assumed to be located in the 200 West Area (it was assumed to be located near the PUREX Plant in Alternative Group A); consequently, the shipping distance for ILAW canisters is longer in Alternative Group B than in Alternative Group A. For MLLW, wastes that were assumed to be shipped offsite for thermal treatment are, instead, shipped to a new treatment facility assumed to be located in the 200 West Area. A small fraction of MLLW that was assumed to be shipped to the ORR for thermal treatment in Alternative Group A will continue to be shipped to ORR in Alternative Group B, but the majority is treated and disposed of onsite. This significantly reduces the shipping distances for these wastes in Alternative Group B.

Shipping data for Alternative Group C is similar to Alternative Group A, as the disposition of the wastes for both alternative groups are assumed to be located in the 200 West Area. Therefore, there would be only minimal differences in shipping data between the two alternative groups.

Similarly, MLLW is assumed to be disposed of in facilities located in the 200 East Area for Alternative Group C and Alternative Group A. Hence, there would be no differences in shipping data or impacts.

Table H.2. Shipping Data for Alternative Group A, Hanford Only Waste Volume

Onsite Shipments	Origin	Destination	Waste Volume, m^3	Number of Shipments[(a)]
LLW				
WRAP				
1B–LLW Cat 1	300 Area	WRAP	3,326	443
2C–LLW Cat 3	300 Area	WRAP	1,462	1,643
T Plant Complex				
1B2–LLW Cat 1	WRAP	T Plant	274	37
2C2–LLW Cat 3	WRAP	T Plant	143	161
Offsite Commercial Facilities				
6–LLW (non-conforming)	CWC	Comm Treat	299	40
Repackage in HICs, In-Trench Grouting				
2A–LLW Cat 3 direct disposal	300 Area	200 W LLBG	35,372	39,744
2C1–LLW Cat 3 from WRAP	WRAP	200 W LLBG	1,318	1,481
2C2–LLW Cat 3 from T Plant	T Plant	200 W LLBG	214	240
200 W LLBG				
1A–LLW Cat 1 direct disposal	300 Area	200 W LLBG	66,522	8,870
1A–LLW Cat 1 from Stream 11	300 Area	200 W LLBG	158	21
1B1–LLW Cat 1 from WRAP	WRAP	200 W LLBG	3,034	405
1B2–LLW Cat 1 from T Plant	T Plant	200 W LLBG	411	55
6–LLW (non-conforming)	Comm Treat	200 W LLBG	598	80
MLLW				
WRAP				
11–Wastes ready for disposal	300 Area	WRAP	187	55
13–Waste verification	CWC	WRAP	2,684	789
13–Post-verification	WRAP	CWC	2,684	789
MLLW determined to be LLW	WRAP	LLBG	18	5
13A–CH standard (non-thermal) verification	Comm Treat	WRAP	4,022	1,183
13B–CH standard (thermal) verification	ORR	WRAP	673	47
Modified T Plant Complex				
12–RH MLLW	300 Area	T Plant	2,904	3,263
Commercial Treatment Facilities				
13A–CH standard (non-thermal)	CWC	Comm Treat	20,108	5,914
13B–CH standard (thermal)	CWC	ORR	6,727	470
14–Elemental lead	CWC	Comm Treat	600	176
15–Elemental mercury	CWC	Comm Treat	21	6

Table H.2. (contd)

Onsite Shipments	Origin	Destination	Waste Volume, m^3	Number of Shipments[(a)]
MLLW Enhanced Trench Design				
11–Wastes ready for disposal	300 Area	200 E LLBG	26,682	7,848
11–From WRAP verification	WRAP	200 E LLBG	187	55
12–RH MLLW from Modified T Plant	T Plant	200 E LLBG	4,066	1,196
13A–CH standard (non-thermal)	Comm Treat	200 E LLBG	36,195	10,646
13B–CH standard (thermal)	ORR	200 E LLBG	6,054	423
13A–CH standard (non-thermal) - post-verification	WRAP	200 E LLBG	4,022	1,183
13B–CH standard – post-verification	WRAP	200 E LLBG	673	198
14–Elemental lead	Comm Treat	200 E LLBG	1,200	353
15–Elemental mercury	Comm Treat	200 E LLBG	312	92
22–WTP melters	200E Area	200 E Trench	6,825	39
TRU Wastes				
WRAP				
4–Retrievably stored drums in trenches	LLBG	WRAP	3,714	495
9–Newly generated and existing CH standard containers	300 Area	WRAP	27,597	3,680
T Plant Complex				
17–K Basin sludge	K Basin	T Plant	139	156
Modified T Plant Complex				
4–Retrievably stored drums in trenches	LLBG	Modified T Plant	7,125	950
5–RH TRU waste in caissons	Caissons (200W)	Modified T Plant	23	26
8–TRU commingled PCB waste	CWC	Modified T Plant	80	11
10A–Newly generated CH non-standard	300 Area	Modified T Plant	1,077	144
10B–Newly generated RH TRU waste	300 Area	Modified T Plant	2,153	2,419
LLBGs				
4–TRU drums assayed in trench as LLW	Not transported; remains in burial ground			
4–TRU assayed as LLW in T Plant/WRAP	T Plant/ WRAP	200 W LLBG	3,000	400
4–TRU assayed in T Plant as LLW	T Plant	200 E LLBG	169	23
9–Drums assayed in WRAP as LLW	WRAP	200 W LLBG	305	41
10A–TRU assayed in T Plant as CH LLW	Modified T Plant	200 W LLBG	215	29
10B–TRU assayed in T Plant as RH LLW	Modified T Plant	200 W LLBG	431	484
ILAW	WTP	200 E Disposal	211,000	97,235

(a) Due to rounding, the number of shipments may not match exactly the result of dividing the volume shipped by the shipment capacity. See Table H.1 for the shipping capacities for the various waste types.

CH = contact-handled.

RH = remote-handled.

Table H.3. Shipping Data for Alternative Group B, Hanford Only Waste Volume

Onsite Shipments	Origin	Destination	Waste Volume, m^3	Number of Shipments[(a)]
LLW				
WRAP				
1B–LLW Cat 1	300 Area	WRAP	3,326	443
2C–LLW Cat 3	300 Area	WRAP	1,462	1,643
T Plant Complex				
1B2–LLW Cat 1	WRAP	T Plant	274	37
2C2–LW Cat 3	WRAP	T Plant	143	161
Offsite Commercial Facilities				
6–LLW (non-conforming)	CWC	Comm Treat	299	40
Repackage in HICs, In-Trench Grouting				
2A–LLW Cat 3 direct disposal	300 Area	LLBG	35,372	39,744
2C1–LLW Cat 3 from WRAP	WRAP	LLBG	1,318	1,481
2C2–LLW Cat 3 from T Plant	T Plant	LLBG	214	240
LLBGs				
1A–LLW Cat 1 direct disposal	300 Area	LLBG	66,522	8,870
1A–LLW Cat 1 from Stream 11	300 Area	LLBG	158	21
1B1–LLW Cat 1 from WRAP	WRAP	LLBG	3,034	405
1B2–LLW Cat 1 from T Plant	T Plant	LLBG	411	55
6–LLW (non-conforming)	Comm Treat	LLBG	598	80
MLLW				
WRAP				
11–Wastes ready for disposal	300 Area	WRAP	187	55
13–Waste verification	CWC	WRAP	2,684	789
13–Post-verification	WRAP	CWC	2,684	789
MLLW determined to be LLW	WRAP	LLBG	176	52
13B–CH standard (thermal) verification	ORR	WRAP	36	3
New Waste Processing Facility				
12–RH MLLW	CWC	NWPF	2,904	3,263
13A, B–CH standard	CWC	NWPF	26,475	7,787
14–Elemental lead	CWC	NWPF	600	176
15–Elemental mercury	CWC	NWPF	21	6
Offsite Treatment Facility				
13B–CH standard (thermal)	CWC	ORR	360	25
MLLW Enhanced Trench Design				
11–Wastes ready for disposal	300 Area	200 E LLBG	26,682	7,848
11–From WRAP verification	WRAP	200 E LLBG	187	55
12–RH MLLW from NWPF	NWPF	200 E LLBG	4,066	1,196
13A,B–CH standard	NWPF	200 E LLBG	46,584	13,701

Table H.3. (contd)

Onsite Shipments	Origin	Destination	Waste Volume, m^3	Number of Shipments[(a)]
13B–CH standard (thermal)	ORR	200 E LLBG	324	23
14–Elemental lead	NWPF	200 E LLBG	1,200	353
15–Elemental mercury	NWPF	200 E LLBG	312	92
22–WTP melters	200E Area	200 E Trench	6,825	39
TRU Wastes				
WRAP				
4–Retrievably stored drums in trenches	LLBG	WRAP	3,714	495
9–Newly generated and existing CH standard containers	300 Area	WRAP	27,597	3,680
T Plant Complex				
17–K Basin sludge	K Basin	T Plant	139	156
New Waste Processing Facility				
4–Retrievably stored drums in trenches	LLBG	NWPF	7,125	950
5–RH TRU waste in caissons	Caissons (200W)	NWPF	23	26
8–TRU commingled PCB waste	CWC	NWPF	80	11
10A–Newly generated CH non-standard	300 Area	NWPF	1,077	144
10B–Newly generated RH TRU waste	300 Area	NWPF	2,153	2,419
LLBGs				
4–TRU drums assayed in trench as LLW	Not transported; remains in burial ground			
4–TRU assayed as LLW in NWPF/WRAP	NWPF/WRAP	200 W LLBG	3,000	400
4–TRU assayed in NWPF as LLW	NWPF	200 E LLBG	169	23
9–Drums assayed in WRAP as LLW	WRAP	200 W LLBG	305	41
10A–TRU assayed in NWPF as CH LLW	NWPF	200 W LLBG	215	29
10B–TRU assayed in NWPF as RH LLW	NWPF	200 W LLBG	431	484
ILAW	WTP	200 E Disposal	211,000	97,235

(a) Due to rounding, the number of shipments may not match exactly the result of dividing the volume shipped by the shipment capacity. See Table H.1 for the shipping capacities for the various waste types.

CH = contact-handled.
RH = remote-handled.
NWPF = new waste processing facility.
ORR = Oak Ridge Reservation.
WTP = Waste Treatment Plant.

Alternative Group A also forms the base for Alternative Groups D and E. The difference among the three alternative groups is the location of disposal facilities for LLW; Alternative Groups D and E assume the wastes will be located in or near the 200 East Area, Alternative Group A assumes the wastes will be located in the 200 West Area. Because most of these wastes were assumed to be transported from the 300 Area to the 200 Area disposal facilities to bound the impacts, the exact locations of the disposal facilities have little effect on the potential transportation impacts.

Shipping data for the No Action Alternative are presented in Table H.4. Key differences between the No Action Alternative and the action alternative groups are that many waste streams are stored rather than being treated and disposed of. The MLLW that was assumed to be shipped to ORR for treatment and back is assumed, instead, to be shipped to a commercial treatment facility adjacent to the Hanford Site. The No Action Alternative substantially reduces the amount of transportation required to manage solid wastes.

Table H.4. Onsite Shipping Data for the No Action Alternative

Onsite Shipments	Origin	Destination	Volume Shipped, m^3	Number of Shipments[(a)]
LLW				
WRAP				
1B–LLW Cat 1	300 Area	WRAP	3,326	443
2C–LW Cat 3	300 Area	WRAP	1,462	1,643
T Plant Complex				
1B2–LLW Cat 1	WRAP	T Plant	274	37
2C2–LLW Cat 3	WRAP	T Plant	143	161
Repackage in HICs or Trench Grouting				
2A–LLW Cat 3 direct disposal	300 Area	200 W LLBG	35,372	39,744
2C1–LLW Cat 3 from WRAP	WRAP	200 W LLBG	1,318	1,481
2C2–LLW Cat 3 from the T Plant Complex	T Plant	200 W LLBG	214	240
LLBGs				
1A–LLW Cat 1 direct disposal	300 Area	200 W LLBG	66,522	8,870
1A–LLW Cat 1 from Stream 11	300 Area	200 W LLBG	18	2
1B1–LLW Cat 1 from WRAP	WRAP	200 W LLBG	3,034	405
1B2–LLW Cat 1 from the T Plant Complex	T Plant	200 W LLBG	411	55
MLLW				
WRAP				
11–Wastes ready for disposal	300 Area	WRAP	205	60
13–Waste verification	CWC	WRAP	2,684	789
13–Offsite treatment verification	Comm Treat	WRAP	36	3
Commercial Treatment Facilities				
13B–CH standard (thermal)	CWC	Comm Treat	360	25
Central Waste Complex				
11–Wastes ready for indefinite storage	300 Area	CWC	18,123	5,330
12–RH and non-standard packages	300 Area	CWC	2,904	3,263
13A,B–CH solids and debris	300 Area	CWC	26,475	7,787
13–Post-WRAP verification	WRAP	CWC	2,684	789

Table H.4. (contd)

Onsite Shipments	Origin	Destination	Volume Shipped, m^3	Number of Shipments[(a)]
14–Elemental lead	300 Area	CWC	600	176
15–Elemental mercury	300 Area	CWC	21	6
22–WTP melters	WTP (200E)	CWC	6,825	39
200 E LLBG Existing Design Trenches				
11–Wastes ready for disposal	300 Area	200 E LLBG	26,682	7,848
11–Post-verification wastes from WRAP	WRAP	200 E LLBG	113	33
3B–CH standard (thermal) from WRAP verification	WRAP	200 E LLBG	36	11
13B–CH standard (thermal) from Comm Treat	Comm Treat	200 E LLBG	324	23
TRU Wastes				
WRAP				
4–Retrievably stored drums in trenches	200 E LLBG	WRAP	3,714	495
9–H - standard containers				
- 208-L (55-gal) drums	300 Area	WRAP	6,092	812
- Standard waste boxes	300 Area	WRAP	21,505	3,773
Storage at CWC or T Plant Complex				
4–TRU to indefinite storage	200 E LLBG	CWC	7,125	950
5–RH TRU waste in caissons	200 W LLBG	CWC	23	26
8–TRU commingled PCB waste	300 Area	CWC	80	11
10A–Newly generated CH non-standard	300 Area	CWC	1,077	144
10B–Newly generated RH waste	300 Area	CWC	2,157	2,424
17–K Basin sludge	K Basin	T Plant	139	156
LLBGs				
4–Drums assayed in WRAP as LLW	WRAP	200W LLBG	371	49
9–Drums assayed in WRAP as LLW	WRAP	200 W LLBG	305	41
ILAW	WTP	Vault	Intrafacility Transfer	

(a) Due to rounding, the number of shipments may not match exactly the result of dividing the volume shipped by the shipment capacity. See Table H.1 for the shipping capacities for the various waste types.

CH = contact-handled.
RH = remote-handled.
ORR = Oak Ridge Reservation.
WTP = Waste Treatment Plant.

To provide a conservative analysis, waste sent from Hanford for thermal treatment was assumed to go to the ORR. This is conservative because of the long shipping distance between Hanford and ORR. The analysis of the ORR shipments is discussed in the sections that address offsite shipments. The results are presented here for onsite shipments because the waste is Hanford-generated. Shipments to non-thermal treatment facilities were assumed to be transported to a commercial treatment facility adjacent to the Hanford Site.

H.2.2 Offsite Shipping Data

The volumes of the different waste types that might be shipped to Hanford from offsite and from Hanford to WIPP are presented in Appendix B. These data are summarized in Table H.5. The table includes Upper Bound and Lower Bound waste volume estimates. The Upper Bound waste volume includes all the TRU wastes that might be transported from small quantity sites to Hanford under a "western hub" scenario (DOE 2002d).

Table H.5. Offsite Shipment Volumes and Shipment Projections

Waste Type/Generator	Waste Volume, m^3		Number of Shipments	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
LLW				
Ames Laboratory (Ames, Iowa)	75	75	6	6
Argonne National Laboratory-East	11,366	11,366	795	795
Battelle Columbus Laboratory	774	774	55	55
Bettis Atomic Power Laboratory	549	549	39	39
Bettis Atomic Power Shipyards	1	1	1	1
Brookhaven National Laboratory	1,574	14,894	111	1,042
Energy Technology Engineering Center	1,428	1,521	100	107
Fermi National Accelerator Laboratory	1,627	1,627	114	114
General Electric Vallecitos	0	20	0	2
Grand Junction Projects Office	0	55	0	4
Idaho National Engineering and Environmental Laboratory	0	6,419	0	449
Inhalation Toxicology Research Institute	0	670	0	47
Knolls Atomic Power Shipyards	356	356	25	25
Lawrence Berkeley National Laboratory	174	174	13	13
Lawrence Livermore National Laboratory	0	10,975	0	768
MIT/Bates Linear Accelerator Center	11	11	1	1
Oak Ridge Reservation	0	78,883	0	5,517
Paducah Gaseous Diffusion Plant	46	46	4	4
Pantex Facility	0	1,205	0	85
Princeton Plasma Physics Laboratory	2,081	2,081	146	146
Rocky Flats Plant	0	65,033	0	4,548
Sandia National Laboratories	0	2,748	0	193
Separations Process Research Unit	0	8,220	0	575
Stanford Linear Accelerator	756	756	53	53
West Valley Nuclear Services	0	11,297	0	790
Total LLW	20,818	219,756	1,463	15,379
MLLW				
Battelle Columbus Laboratory	0.3	0.3	1	1
Energy Technology Engineering Center	0	1,365	0	96

Table H.5. (contd)

Waste Type/Generator	Waste Volume, m^3		Number of Shipments	
	Lower Bound	**Upper Bound**	**Lower Bound**	**Upper Bound**
Idaho National Engineering and Environmental Laboratory	0	196	0	14
Knolls Atomic Power Laboratory	6	6	1	1
Los Alamos National Laboratory	0	3,373	0	236
Oak Ridge Reservation	0	55,323	0	3,869
Paducah Gaseous Diffusion Plant	0	2,681	0	188
Portsmouth Gaseous Diffusion Plant	0	2,933	0	206
Princeton Plasma Physics Laboratory	91	91	7	7
Puget Sound Naval Shipyards	3	3	1	1
Rocky Flats Plant	0	68,146	0	4,766
Sandia National Laboratory	0	160	0	12
Savannah River Site	0	6,134	0	429
West Valley Nuclear Services	0	26	0	2
Total MLLW	101	140,438	10	9,828
CH TRU Waste[(a)]				
Battelle Columbus Laboratories[(c)]	2	2	1	1
Energy Technology Engineering Center[(c)]	4	4	1	1
General Electric-Vallecitos Nuclear Center.	0	28	0	4
Lawrence Berkeley National Laboratory	0	3	0	1
Lawrence Livermore National Laboratory	0	1,237	0	165
Nevada Test Site	0	182	0	25
Total CH TRU Waste	6	1,456	2	197
RH TRU Waste[(a)]				
Battelle Columbus Laboratories[(c)]	25	25	29	29
Energy Technology Engineering Center[(c)]	15	15	17	17
Framatome ANP	0	9	0	10
General Electric Vallecitos Nuclear Center	0	50	0	57
Total RH TRU Waste	40	99	46	113
Shipments from Hanford to WIPP[(b)]				
CH TRU waste to WIPP	39,157	40,607	5,221	5,415
RH TRU waste to WIPP	2,657	2,716	2,986	3,052
Total TRU Wastes to WIPP	41,814	43,323	8,207	8,467

(a) These projections do not include additional TRU waste volumes at the West Valley Demonstration Project that could be shipped to Hanford under a non-preferred alternative (DOE 2003). The potential impacts of these shipments are provided in Section H.3.3.2.2. See Section C.1 for additional information about waste volumes.

(b) Under the No Action Alternative for the Hanford Only waste volume, 31,207 m^3 of CH TRU waste (4,161 shipments) are projected to be shipped from Hanford to WIPP. Under the action alternatives for the Hanford Only waste volume, 39,151 m^3 of CH TRU waste and 2,617 m^3 of RH TRU waste (5,221 and 2,941 shipments, respectively) are projected to be shipped from Hanford to WIPP. The Upper and Lower Bound waste volumes include these wastes plus the TRU wastes from offsite, as listed above.

(c) At the present time, Hanford has received all of the TRU waste from ETEC and about one-sixth of the TRU waste from the Battelle Columbus Laboratories.

A third and fourth case also were analyzed. The third case involves shipment of the Hanford Only waste volume of TRU waste to WIPP under the No Action Alternative. There are no other offsite shipments in the No Action Alternative. In the No Action Alternative, a total of 31,200 m^3 of CH TRU waste is assumed to be shipped to WIPP. This would require about 4,200 shipments. In the No Action Alternative, no RH TRU waste would be transported from Hanford to WIPP (that is, RH TRU waste is assumed to be stored onsite for an indefinite period of time). The fourth case involves shipment of the Hanford Only waste volume of TRU waste to WIPP under the action alternative groups. In this case, a total of about 39,000 m^3 of CH TRU waste and 2,600 m^3 of RH TRU waste are assumed to be shipped from Hanford to WIPP. This represents about 5,200 shipments of CH TRU waste and 2,900 shipments of RH TRU waste. Table H.6 presents the shipment capacities that were used to calculate the numbers of shipments presented in Table H.5.

Table H.6. Shipping Capacities Used to Estimate Offsite Shipments

Waste Type	Shipping Capacity, m^3	Basis
LLW	14.3	WM PEIS;[(a)] equivalent to 80 drums per shipment.
MLLW	14.3	WM PEIS;[(a)] same as LLW.
CH TRU waste	7.5	Equivalent to 42 drums/shipment at 85% packing efficiency.
RH TRU waste	0.89	WIPP SEIS-II.[(b)]

(a) Source: DOE (1997a).
(b) Source: DOE (1997b).

The TRAGIS computer code was used to develop the route characteristics information used in the impact analyses. The data developed by TRAGIS includes the distances traveled in rural, suburban, and urban population density regions. These analyses used actual highway routes to and from Hanford. Population data are based on the 2000 Census. These data are used in various calculations performed by RADTRAN 5. The route characteristics for shipments from offsite to Hanford and from Hanford to WIPP that are used in this impact analysis are presented in Table H.7. Figure H.1 illustrates the routes used in this analysis.

Table H.7. Route Characteristics Data for Offsite Shipments

Offsite Generator	One-Way Distance (km)	Distance by Zone			Population Densities, per km^2		
		Rural	Suburban	Urban	Rural	Suburban	Urban
Ames Laboratory (Ames, Iowa)	2769	2393.8	340.6	34.8	9.1	289.5	2280.9
Argonne National Laboratory-East	3240.1	2770.5	432.8	37.1	9.8	289	2263.3
Battelle Columbus Laboratory	3751.8	3087.3	611.4	53.5	10.6	296.8	2217.4
Bettis Atomic Power Laboratory	3996.6	3162.2	759.6	75	11	300.3	2268.6
Bettis Atomic Power Shipyards	3996.6	3162.2	759.6	75	11	300.3	2268.6
Brookhaven National Laboratory	4659.7	3534.9	982.7	142.5	11.5	320	2531.7
Energy Technology Engineering Center	1959.4	1437.1	424.6	97.7	11.2	355	2455.7
Fermi National Accelerator Laboratory	3225.2	2766.6	425.1	33.7	9.7	285.2	2200.9
General Electric Vallecitos	1455.4	979.9	385	90.3	11.8	372.5	2402.9
Grand Junction Project Office	1525.5	1216.3	257.8	51.6	8.4	349.4	2402.6
Idaho National Engineering and Environmental Laboratory	875.1	762.3	99.2	13.7	7.5	325.4	2180.3
Inhalation Toxicology Research Institute	2036.7	1665.3	311.6	60.1	7.7	347.4	2410.5
Knolls Atomic Power Shipyards	4556.3	3472.5	989.5	94.6	11.6	304.2	2266.6
Los Alamos National Laboratory	2548.7	2132.8	361	54.8	8	337.6	2304.3
Lawrence Berkeley National Laboratory	1422.9	969.2	362.6	90.9	11.7	369	2529.6
Lawrence Livermore National Laboratory	1463.2	986.3	385.1	91.7	11.7	374.3	2406.7
MIT/Bates Linear Accelerator Center	4818.7	3613.7	1092.3	112.9	11.8	308.8	2409.8
Nevada Test Site	1842.1	1496.7	286.2	59.6	8.8	339.0	2407.9
Oak Ridge Reservation	4038.9	3264.5	710.7	63.8	10.9	298.1	2201
Paducah Gaseous Diffusion Plant	3583.6	2960.9	567.2	55.6	10.0	306.9	2174.0
Portsmouth Gaseous Diffusion Plant	3817.5	3072.5	663.5	81.9	10.3	325	2242.5
Pantex Facility	2573.7	2171.1	349.3	53.4	7.4	350.7	2285.8
Princeton Plasma Physics Laboratory	4597.8	3545.3	955.3	97.4	11.6	310	2284.6
Puget Sound Naval Shipyard	485.9	290.3	159.2	36.5	10.4	369.7	2308.5
Rocky Flats Plant	2046.7	1671.3	312.2	63.5	7.7	349	2402.4
Sandia National Laboratories	2046.7	1671.3	312.2	63.5	7.7	349	2402.9
Savannah River Site	4460.4	3429	928	103.5	11.2	320.7	2240.4
Separations Process Research Unit	4556.3	3472.5	989.5	94.6	11.6	304.2	2266.6
Stanford Linear Accelerator	1522.1	987.3	405.9	128.5	11.9	382.6	2637
West Valley Nuclear Services	4133.2	3253.7	804.6	75.2	11.3	291.9	2268.1
Hanford to WIPP	3137.8	2671.7	399.3	66.8	7.2	340	2301.1

AMES - Ames Laboratory
ANL - Argonne National Laboratory
BETTIS - Bettis Laboratory
BMI - Battelle Memorial Institute
BNL - Brookhaven National Laboratory
ETEC - Energy Technology and Engineering Center
FERMI - Fermi National Accelerator Laboratory
GE-VAL - General Electric Vallecitos Nuclear Center
GRAND-JN - Grand Junction Office
INEEL - Idaho National Engineering and Environmental Laboratory
ITRI - Inhalation Toxicology Research Institute
KNPL - Knolls Atomic Power Laboratory
LANL - Los Alamos National Laboratory
LBNL - Lawrence Berkeley National Laboratory
LLNL - Lawrence Livermore National Laboratory

MIT BATES - Bates Linear Accelerator Center
NTS - Nevada Test Site
ORNL - Oak Ridge National Laboratory
PADUCAH - Paducah Gaseous Diffusion Plant
PANTEX - Pantex Plant
PORTSMOUTH - Portsmouth Gaseous Diffusion Plant
PPPL - Princeton Plasma Physics Laboratory
PSNS - Puget Sound Naval Shipyard
ROCKY FLATS - Rocky Flats Field Office
SNL - Sandia National Laboratories
SLAC - Stanford Linear Accelerator Center
SPRU - Separations Process Research Unit
SRS - Savannah River Site
WEST VALLEY - West Valley Demonstration Project
WIPP - Waste Isolation Pilot Plant

Highways shown in gray are major transportation routes; those highlighted in green are specific routes evaluated for waste shipments in this HSW EIS.

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Figure H.1. Routes from Offsite to Hanford and from Hanford to WIPP

H.2.3 Accident Risk Input Data

This section provides the key input parameters used in the RADTRAN 5 analysis of transportation accident risks. These parameters include the severity category fractions, release fractions, and radionuclide concentrations in shipments of solid waste.

Table H.8 shows the accident parameters used in this analysis of onsite shipments in Type A 208-L (55-gal) drums and boxes as well as ILAW canisters. Note that the release fractions used are very conservative for the vitrified waste form, which would be transported in shipping containers that are much less likely to fail in accident conditions than a drum or box shipment. For offsite shipments of CH TRU waste, the analysis assumes the TRUPACT-II container would be used. The accident scenarios assume a truck shipment would contain three TRUPACT-II containers but that only one TRUPACT-II would fail in a severe accident and the remaining two TRUPACT-II containers would not. This is consistent with the assumption made in WIPP SEIS-II (DOE 1997b), and is based on an evaluation conducted by Fischer et al. (1987) in which it was concluded that the release fraction from an engulfing fire that fails three TRUPACT-IIs is lower than the impact release fraction from a single failed TRUPACT-II. For offsite shipments of RH TRU waste, the analysis assumes that the RH 72B package would be used. Offsite shipments of LLW and MLLW were assumed to be shipped in Type A packages, even though the radionuclide inventories used in this analysis may exceed Type A packaging limits. This was done to ensure that the radiological accident risk analysis would bound the range of potential impacts. Based on historical experience, offsite LLW and MLLW shipments are predominantly shipped in Type A packages.

Accident rates for offsite shipments were calculated using state-specific data from Saricks and Tompkins (1999) and the outputs from the TRAGIS calculations. Weighted average traffic accident and fatality rates were calculated for each route by combining the distances traveled along each route on interstates and primary highways with the rates given by Saricks and Tompkins (1999) for these types of highways. The overall rate was calculated by summing across all the states along a specific route between offsite and Hanford and between Hanford and WIPP.

Concentrations of radioactive materials that were used to calculate the per-shipment inventories of each radionuclide, taken from the Technical Information Document (FH 2004), are shown in Table H.9. Table H.10 presents similar information for offsite shipments. Hazardous chemical source inventories for each material shipped were taken from the Technical Information Document (FH 2004) and are shown in Table H.11. A “maximum drum” approach was used to develop the inventories by taking the highest concentrations of each radionuclide for each waste type. Consequently, the inventories may exceed Type A packaging limitations. The actual shipments would be conducted in compliance with the packaging requirements. Where necessary, adjustments were made to the 208-L (55-gal) drum inventories to account for different waste container sizes and shipment capacities. Note that only a few streams are presented in Tables H.9 through H.11. Readers are referred to FH (2004) for information on other waste streams.

Table H.8. RADTRAN 5 Accident Parameters for Onsite Truck Shipments

<table>
<tr><th colspan="4">Accident Rate
Onsite(a) – Hanford Sitewide Average – 1.14E-07 Accidents per Mile</th></tr>
<tr><th colspan="4">Fractional Occurrence by Severity Category
(Conditional Probability Given an Accident Occurs)(b)</th></tr>
<tr><th>Severity Category</th><th colspan="3"></th></tr>
<tr><td>I</td><td colspan="3">5.5E-01</td></tr>
<tr><td>II</td><td colspan="3">3.6E-01</td></tr>
<tr><td>III</td><td colspan="3">7E-02</td></tr>
<tr><td>IV</td><td colspan="3">1.6E-02</td></tr>
<tr><td>V</td><td colspan="3">2.8E-03</td></tr>
<tr><td>VI</td><td colspan="3">1.1E-03</td></tr>
<tr><td>VII</td><td colspan="3">8.5E-05</td></tr>
<tr><td>VIII</td><td colspan="3">1.5E-05</td></tr>
<tr><th colspan="4">Fractional Occurrence by Population Zone
(Conditional Probability Given an Accident Occurs of the Specified Severity)(b)</th></tr>
<tr><th>Severity Category</th><th>Rural</th><th>Suburban</th><th>Urban</th></tr>
<tr><td>I</td><td>0.1</td><td>0.1</td><td>0.8</td></tr>
<tr><td>II</td><td>0.1</td><td>0.1</td><td>0.8</td></tr>
<tr><td>III</td><td>0.3</td><td>0.4</td><td>0.3</td></tr>
<tr><td>IV</td><td>0.3</td><td>0.4</td><td>0.3</td></tr>
<tr><td>V</td><td>0.5</td><td>0.3</td><td>0.3</td></tr>
<tr><td>VI</td><td>0.7</td><td>0.2</td><td>0.1</td></tr>
<tr><td>VII</td><td>0.8</td><td>0.1</td><td>0.1</td></tr>
<tr><td>VIII</td><td>0.9</td><td>0.05</td><td>0.05</td></tr>
<tr><th colspan="4">Release Fraction
(Fraction of Container Contents Released from Shipment by Severity Category)(b)</th></tr>
<tr><th>Severity Category</th><th colspan="2">Type A Package
(e.g., Cat 1 LLW)</th><th>Type B Package
(e.g., CH TRU waste)</th></tr>
<tr><td>I</td><td colspan="2">0</td><td>0</td></tr>
<tr><td>II</td><td colspan="2">0.01</td><td>0</td></tr>
<tr><td>III</td><td colspan="2">0.1</td><td>0.01</td></tr>
<tr><td>IV</td><td colspan="2">1</td><td>0.1</td></tr>
<tr><td>V</td><td colspan="2">1</td><td>1</td></tr>
<tr><td>VI</td><td colspan="2">1</td><td>1</td></tr>
<tr><td>VII</td><td colspan="2">1</td><td>1</td></tr>
<tr><td>VIII</td><td colspan="2">1</td><td>1</td></tr>
</table>

Table H.8. (contd)

Accident Rate Onsite[a] **– Hanford Sitewide Average – 1.14E-07 Accidents per Mile**	
Aerosol and Respirable Fractions	
LLW and MLLW	Volatiles–Aerosol and Respirable Fractions = 1 and 1, respectively Solids (Powders) –Aerosol Fraction = 0.1; Respirable Fraction = 0.05
CH TRU waste (DOE 1997a)	Categories I and II–Total Respirable Release Fraction: 0.0 Category III–8E-09; Category IV–2E-07; Category V–8E-05 Category VI–2E-04; Category VII–2E-04; Category VIII–2E-04
RH TRU waste (DOE 1997a)	Categories I and II–Total Respirable Release Fraction: 0.0 Category III–6E-09; Category IV–2E-07; Category V–1E-04 Category VI–1E-04; Category VII–2E-04; Category VIII–2E-04
ILAW	Categories I and II–Total Respirable Release Fraction: 0.0 Category III–8E-09; Category IV–2E-07; Category V–8E-05 Category VI–2E-04; Category VII–2E-04; Category VIII–2E-04
Miscellaneous Parameters	
Deposition velocity (DOE 2002a)	0.01 m/sec
Resuspension half-life (DOE 1997b)	365 days

(a) Source: Green et al. (1996).

(b) Data taken from NUREG-0170 (NRC 1977) except where otherwise indicated. See text box in Section H.2 for definitions of Type A and Type B packages.

Table H.9. Radionuclide Concentrations (Ci/m^3) Used to Calculate Per-Shipment Inventories[(a)] for Onsite Shipments

Radionuclide	Cat 1 LLW (CH)	Cat 3 LLW (RH)	CH MLLW	RH MLLW	ILAW	CH TRU Waste[(b)]	RH TRU Waste[(b)]
Am-241	2.6E-03	3.1E-05	0	0	1.1E-01	3.6	12
C-14	4.3E-06	7.7E-05	0	0	< 0.1%	0	0
Cm-244	3.3E-04	5.6E-04	0	0	1.1E-03	0	0
Co-60	1.8E-02	6.3E-01	3.1E-01	2.8E-01	< 0.1%	6.4E-04	2.5
Cs-137–Ba-137m	3.3	3.5E-03	7.4	6.6	< 0.1%	0.01	49
Fe-55	1.7E-02	1.1E-01	2.8	2.5	< 0.1%	0	0
H-3	5.4E-04	3.3E-03	3.9E-03	3.5E-03	< 0.1%	0	0
Mn-54	2.6E-03	3.4E-04	9.6E-05	8.6E-05	< 0.1%	0	0
Ni-59	3.0E-06	1.0E-02	0	0	< 0.1%	0	0
Ni-63	2.9E-02	1.2E	2.0E-01	1.8E-01	< 0.1%	0	0
Pu-238	6.6E-04	2.9E-04	0	0	1.1E-03	990	1000
Pu-239	3.1E-03	1.2E-04	0	0	3.2E-02	16	20
Pu-240	1.2E-03	2.1E-05	0	0	5.5E-03	4.2	10
Pu-241	7.4E-02	7.4E-04	0	0	1.1E-01	200	10
Pu-242	5.7E-07	2.1E-09	0	0	< 0.1%	6.8E-04	0
Sr-90–Y90	4.1	1.0E-02	2.5	2.2	4.7E+01	0.01	49
Tc-99	3.2E-03	4.4E-04	3.5E-02	3.1E-02	< 0.1%	0	0
U-233	2.9E-06	2.4E-07	0	0	1.4E-03	0	0.03
U-234	3.6E-03	2.9E-04	0	0	4.6E-04	0	0
U-235	1.0E-04	4.6E-06	0	0	< 0.1%	0	1.0E-03
U-236	4.6E-04	5.4E-06	0	0	< 0.1%	0	0
U-238	5.8E-03	7.1E-05	0	0	5.1E-04	0	7.1E-05
Note: ILAW inventory also includes the following:							
Np-237	NA	NA	NA	NA	8.5E-04	NA	NA
Sm-151	NA	NA	NA	NA	8.2	NA	NA
Cd-113m	NA	NA	NA	NA	8.4E-02	NA	NA
Eu-154	NA	NA	NA	NA	4.0E-01	NA	NA
Ra-226	NA	NA	NA	NA	1.1E-02	NA	NA

(a) Source: FH (2004).
(b) Source: DOE (1997a). Units are Ci per shipment.
NA = not applicable.

Table H.10. Radionuclide Inventories (Ci per shipment) for Offsite Shipments

LLW												
Radionuclide	**BNL**	**GE**	**INEEL**	**ITRI**	**LLNL**	**ORR**	**PNTX**	**RFTS**	**SNL**	**SPRU**	**WVDP**	**MAX DRUM(b)**
H-3	2.1E-03	0	2.5E+03	1.4E-01	5.7E-02	3.1E+02	1.5E-02	1.3E-03	4.1E+01	5.2E-03	4.1E+01	2.5E+03
C-14	0	0	2.0E-01	5.8E-02	3.4E-05	3.6E-03	0	0	3.4E-02	1.1E-09	3.4E-02	2.0E-01
Co-60	7.4E-05	2.0E-02	6.9E+03	0	0	2.7	0	0	7.8E+01	5.9E-03	8.1E+01	6.9E+03
Ni-59	0	0	3.8E+01	0	0	1.2E-05	0	0	4.0E-01	7.5E-06	3.9E-01	3.8E+01
Ni-63	0	0	1.3E+03	0	0	4.9E+01	0	0	1.8E+01	3.3E-04	1.8E+01	1.3E+03
Sr-90	1.8E-02	1.0E-01	9.8E-01	0	0	2.0E-01	0	2.4E-09	2.1E+01	3.7E-02	2.2E+01	2.2E+01
Y-90	1.8E-02	1.0E-01	9.8E-01	0	0	2.0E-01	0	2.4E-09	2.1E+01	3.7E-02	2.2E+01	2.2E+01
Tc-99	0	0	1.2E-03	0	0	2.2E-05	0	0	3.5E-03	8.2E-08	3.5E-03	3.5E-03
Cs-137	2.9E-02	7.1E-02	1.9E+01	0	0	1.8E+01	0	8.8E-07	1.4E+01	5.7E-02	1.4E+01	1.9E+01
Ba-137m	2.8E-02	6.7E-02	1.8E+01	0	0	1.7E+01	0	8.4E-07	1.4E+01	5.4E-02	1.4E+01	1.8E+01
U-234	3.9E-06	0	2.7E-04	0	0	1.4E-02	1.9E-04	1.6E-05	1.2E-02	3.1E-04	1.2E-02	1.4E-02
U-235	1.4E-06	0	3.8E-03	0	0	6.2E-04	3.3E-05	4.8E-09	6.2E-04	1.4E-05	6.1E-04	3.8E-03
U-238	3.1E-06	0	1.6E-01	1.2E-02	9.8E-03	6.7E-03	2.0E-03	1.4E-05	2.8E-02	9.9E-04	2.8E-02	1.6E-01
MLLW												
	ETEC	**INEEL**	**LANL**	**ORR**	**PGDP**	**PORT**	**RFTS**	**SNL**	**SRS**	**WVDP**	**MAX DRUM(b)**	
H-3	0	2.4E+03	0	3.6E-03	0	0	2.1E-02	6.6	2.1E+03	2.1E-09	2.4E+03	
C-14	0	2.0E-01	0	0	0	0	0	0	1.4E-011	0	2.0E-01	
Co-60	0	6.9E+03	0	2.4E-06	3.8E-05	0	0	3.7E-05	1.7	0	6.9E+03	
Ni-59	0	3.7E+01	0	0	0	0	0	0	2.8E-010	0	3.7E+01	
Ni-63	0	1.3E+03	0	0	0	0	0	4.0E-01	0	0	1.3E+03	
Sr-90	1.8E-05	9.5E-01	0	1.2E-05	0	0	2.9E-09	0	1.0E-04	0	9.5E-01	
Y-90	1.8E-05	9.5E-01	0	1.2E-05	0	0	2.9E-09	0	1.0E-04	0	9.5E-01	
Tc-99	0	1.2E-03	0	9.0E-02	6.9E-02	7.3E-04	0	0	8.6E-05	0	9.0E-02	
Cs-137	6.2E-06	1.9E+01	0	1.3E-04	1.1E-04	0	1.0E-06	2.2E-03	4.9	2.8E-05	1.9E+01	
Ba-137m	5.9E-06	1.8E+01	0	1.2E-04	1.0E-04	0	1.0E-06	2.1E-03	4.7	2.6E-05	1.8E+01	
U-234	0	2.6E-04	1.1E-05	7.2E-04	3.4	0	1.1E-03	0	2.3E-02	0	3.4	
U-235	0	3.7E-03	5.1E-07	1.0E-05	1.5E-01	2.3E-06	9.4E-05	6.1E-05	1.1E-03	0	1.5E-01	
U-238	0	1.6E-01	1.1E-05	9.0E-03	3.3	9.8E-03	1.1E-03	8.6E-03	5.6E-02	0	3.3	

Table H.10. (contd)

TRU Wastes

	CH TRU Waste **Ci per TRUPACT[(c)]**	**RH TRU Waste** **Ci per RH 72[(c)]**
Co-60	6.4E-04	2.50
Sr-90	1.0E-02	4.9E+01
Cs-137	1.0E-02	4.9E+01
U-233	0	3.0E-02
U-235	0	1.0E-03
U-238	0	7.1E-05
Pu-238	9.9E+02	1.0E+03
Pu-239	1.6E+01	2.0E+01
Pu-240	4.2	1.0E+01
Am-241	3.6	1.2E+01
Pu-241	2.0E+02	1.0E+01
Pu-242	6.8E-04	0

BNL = Brookhaven National Laboratory
ETEC = Energy Technology Engineering Center
GE = General Electric Vallecitos
INEEL = Idaho National Engineering and Environmental Laboratory
ITRI = Inhalation Toxicology Research Institute
LANL = Los Alamos National Laboratory
LLNL = Lawrence Livermore National Laboratory
ORR = Oak Ridge Reservation
PGDP = Paducah Gaseous Diffusion Plant
PORT = Portsmouth Gaseous Diffusion Plant
PNTX = Pantex Plant
RFTS = Rocky Flats Technology Site
SNL = Sandia National Laboratory
SPRU = Separations Process Research Unit
SRS = Savannah River Site
WVDP = West Valley Demonstration Project

(a) Source: FH (2004) except where otherwise indicated.
(b) MAX DRUM = Maximum drum. This inventory is used for shipments from offsite other than those listed here.
(c) Source: Bounding case radionuclide inventories given in DOE (1997b).

Table H.11. Hazardous Chemical Inventories in Various Waste Types[(a)]

Hazardous Chemical	Hazardous Chemical Inventories (kg per 208-L [55-gal] Drum)							
	CH MLLW	**RH MLLW**	**MLLW Ready for Disposal**	**RH TRU Waste**	**CH TRU with PCBs**	**RH TRU Waste in Trenches**	**Elemental Lead**	**Elemental Mercury**
Acetone	3.7E-02	3.6E-02	3.7E-02	1.4E-04	0	0	0	0
Beryllium	9.5E-01	9.5E-01	9.5E-01	8.9E-02	8.9E-02	8.9E-02	0	0
Bromodichloro-methane	2.1E-04	0	2.1E-04	0	0	0	0	0
Carbon tetrachloride	7.5E-02	0	7.5E-02	2.4E-02	0	0	0	0
Diesel fuel	2.8E-02	0	2.8E-02	0	0	0	0	0
Formic acid	1.7E-01	0	1.7E-01	0	0	0	0	0
Lead	0	0	0	0	0	0	1.7E+02	0
Methyl ethyl ketone (MEK or 2-Butanone)	2.9E-02	0	2.9E-02	0	0	0	0	0
Mercury	8.8E-03	0	8.8E-03	8.6E-04	0	0	0	2.4E+01
Nitrate	4.1E-02	0	0	0	0	0	0	0
Nitric acid	1.2	1.2	1.2	0	0	0	0	0
Polychlorinated biphenyls (PCBs)[(b)]	1.0E-01	0	1.0E-01	0	3.2E-01	0	0	0
p-Chloroaniline	9.9E-02	0	9.9E-02	0	0	0	0	0
Sodium hydroxide	1.7	1.7	1.7	8.9E-02	8.9E-02	8.9E-02	0	0
Toluene	6.2E-02	1.9	6.2E-02	0	0	0	0	0
1,1,1-Trichloroethane	1.3E-01	0	1.3E-01	1.4E-04	0	0	0	0
Xylene	1.1E-02	1.8E-01	1.1E-02	7.2E-04	8.6E-01	8.6E-01	0	0

Note: 0 indicates no data was provided in the source document.

(a) Source: FH (2004). Hazardous chemical quantities were calculated assuming they are packaged in a 208-L (55-gal) drum at 85% packaging efficiency (i.e., 15% void space) or 0.18 m^3 of waste per drum.

(b) PCB's come in many forms (for example, Aroclor 1016, Arochor 1221). The actual chemical form of the PCB contaminants in solid waste is uncertain. Therefore, for conservatism, PCBs were assumed to be in the chemical form that presents the greatest hazard (that is, lowest exposure guidelines concentrations.

H.3 Results of Transportation Impact Analysis

The results of the transportation impact analysis are presented in this section. Section H.3.1 presents the onsite impact analysis results and Section H.3.2 presents the offsite impacts. Both sections present the aggregate radiological and non-radiological transportation impacts. Section H.3.2 also presents the results of the analysis of maximally exposed individuals under incident-free and accident conditions. Section H.3.3 presents a summary of the transportation impact analysis results and the results of two sensitivity studies.

H.3.1 Results of Onsite Transportation Impact Analysis

This section presents the results of the onsite transportation impact analysis. Separate subsections are presented for results of Alternative Groups A through E and the No Action Alternative. The accident impact analysis results for hazardous chemicals are presented in Section H.6. All of the impacts provided in the table are in fatalities except for the estimated number of traffic accidents. Fatalities are expressed as latent cancer fatalities (LCFs) for radiological impacts and for incident-free non-radiological emissions. For non-radiological accidents, impacts are expressed in terms of the predicted number of traffic accidents and fatalities from physical trauma resulting from those traffic accidents. Note that many of the entries in the table are expressed as fractional fatalities, for example, 1E-01 or 0.1 fatalities. The whole-number totals are determined by summing over all waste types and then rounding the sums to the nearest whole number.

H.3.1.1 Alternative Group A

The transportation impacts for Alternative Group A, Hanford Only waste volume, are presented in Table H.12. The table includes the impacts of onsite shipments of LLW, MLLW, TRU wastes, and ILAW in addition to shipments of the small volumes of Hanford LLW and MLLW to offsite treatment facilities and back. The impacts of shipments from offsite, which make up all the differences among the Hanford Only, Lower Bound, and Upper Bound waste volumes, are addressed in Section H.3.2.

H.3.1.2 Alternative Group B

Table H.13 presents the transportation impacts for Alternative Group B, Hanford Only waste volume. The table includes the impacts of transporting LLW, MLLW, TRU wastes, and ILAW onsite in addition to the impacts of transporting the small volumes of Hanford LLW and MLLW to offsite treatment facilities and back. Most MLLW and the non-conforming LLW would be treated onsite, so smaller volumes are shipped to offsite treatment facilities and back in this alternative than in Alternative Group A. Note that the shipping parameters and estimated impacts for onsite transportation of LLW and TRU wastes are the same in this alternative group as they are in Alternative Group A. ILAW transportation impacts are larger in Alternative Group B than in Alternative Group A because the shipping distance is longer. A smaller volume of MLLW is transported offsite for treatment and back in Alternative Group B than in Alternative Group A. Also note that the impacts of shipments from offsite, which make up all the differences among the Hanford Only, Lower Bound, and Upper Bound waste volumes, are addressed in Section H.3.2.

H.3.1.3 Alternative Group C

The results of the onsite transportation impact analysis for transport of solid waste under Alternative Group C are the same as those for Alternative Group A because there are no substantial differences in shipping parameters. This includes the onsite shipments of LLW, MLLW, TRU wastes, and ILAW as well as the small volumes of LLW and MLLW shipped to offsite treatment facilities and back. The small volumes of LLW and MLLW shipped offsite and back in this alternative are the same as those in Alternative Group A. Treatment and disposal facilities are located in the same areas of the Hanford Site in both alternative groups. Since most of these wastes were assumed to be transported from the 300 Area to 200 Area disposal facilities to bound the impacts, the exact locations of the disposal facilities have little effect on the potential transportation impacts.

H.3.1.4 Alternative Group D

The results of the onsite impact analysis for transport of solid waste under the Alternative Group D are the same as those for Alternative Group A because there are no substantial differences in shipping parameters. This includes the onsite shipments of LLW, MLLW, TRU wastes, and ILAW as well as the small volumes of LLW and MLLW shipped to offsite treatment facilities and back. The small volumes of LLW and MLLW shipped offsite and back in this alternative are the same as those in Alternative Group A.

H.3.1.5 Alternative Group E

The results of the impact analysis for transport of solid waste under Alternative Group E are the same as those for Alternative Group A because there are no substantial differences in shipping parameters. This includes the onsite shipments of LLW, MLLW, TRU wastes, and ILAW as well as the small volumes of LLW and MLLW shipped to offsite treatment facilities and back. The small volumes of LLW and MLLW shipped offsite and back in this alternative are the same as those in Alternative Group A.

H.3.1.6 No Action Alternative

Table H.14 presents the transportation impacts of the No Action Alternative. The table includes the impacts of transporting LLW, MLLW, and TRU wastes onsite plus the small volume of MLLW transported to offsite treatment facilities and back. In this alternative, a small volume of MLLW covered by existing contracts would be shipped offsite for treatment and back, and a small volume would also be treated onsite. Most MLLW and the non-conforming LLW would remain in storage at Hanford and would not be treated. There are no shipments of ILAW in this alternative because ILAW would be placed in concrete vaults adjacent to the WTP and thus is assumed not to involve transportation.

Table H.12. Transportation Impacts of Alternative Group A – Hanford Only Waste Volume, Number of Fatalities[(a)]

Onsite Shipments	Radiological Impacts, LCFs			Total Number of Accidents	Non-Radiological Impacts	
	Incident-Free Transport		Accidents			
	Workers	Public	Public		Number of Fatalities	Emissions LCFs
LLW						
WRAP						
1B–LLW Cat 1	5.6E-05	3.3E-04	1.6E-10	6.2E-03	2.7E-04	2.4E-04
2C–LLW Cat 3	1.8E-04	1.2E-03	1.2E-07	2.3E-02	9.9E-04	8.8E-04
T Plant Complex						
1B2–LLW Cat 1	1.5E-07	2.3E-06	6.2E-13	2.0E-05	8.8E-07	2.0E-06
2C2–LLW Cat 3	6.8E-07	1.0E-05	5.4E-10	9.0E-05	3.9E-06	8.7E-06
Offsite Commercial Facilities						
6–LLW (non-conforming)	5.0E-06	3.0E-05	1.5E-11	5.6E-04	2.4E-05	2.1E-05
Repackage in HICs, In-Trench Grouting						
2A–LLW Cat 3 direct disposal	4.3E-03	2.9E-02	2.9E-06	5.6E-01	2.4E-02	2.1E-02
2C1–LLW Cat 3 from WRAP	6.3E-06	9.2E-05	5.0E-09	8.3E-04	3.6E-05	8.0E-05
2C2–LLW Cat 3 from T Plant	1.0E-06	1.5E-05	8.1E-10	1.3E-04	5.8E-06	1.3E-05
200 W LLBG						
1A–LLW Cat 1 direct disposal	1.1E-03	6.7E-03	3.2E-09	1.2E-01	5.3E-03	4.8E-03
1A–LLW Cat 1 from Stream 11	2.6E-06	1.6E-05	7.7E-12	2.9E-04	1.3E-05	1.1E-05
1B1–LLW Cat 1 from WRAP	1.7E-06	2.5E-05	6.9E-12	2.3E-04	9.7E-06	2.2E-05
1B2–LLW Cat 1 from T Plant	2.3E-07	3.4E-06	9.3E-13	3.1E-05	1.3E-06	3.0E-06
6–LLW (non-conforming)	1.0E-05	6.0E-05	2.9E-11	1.1E-03	4.8E-05	4.3E-05
Total LLW	5.7E-03	3.8E-02	3.0E-06	7.1E-01	3.1E-02	2.8E-02
MLLW						
WRAP						
11–Wastes ready for disposal	6.0E-06	4.1E-05	1.5E-10	7.7E-04	3.3E-05	3.0E-05
13–Waste verification	3.3E-06	4.9E-05	1.0E-10	4.4E-04	1.9E-05	4.3E-05
13–Post verification	3.3E-06	4.9E-05	1.0E-10	4.4E-04	1.9E-05	4.3E-05
MLLW determined to be LLW	2.2E-08	3.3E-07	6.9E-13	3.0E-06	1.3E-07	2.9E-07
13A–CH standard (non-thermal) verification	1.3E-04	8.7E-04	3.3E-09	1.7E-02	7.1E-04	6.4E-04
13B - CH Standard (thermal) verification	1.0E-03	4.2E-03	1.2E-07	6.7E-02	1.5E-03	6.7E-03

Table H.12. (contd)

	Radiological Impacts, LCFs			Total Number of Accidents	Non-Radiological Impacts	
	Incident-Free Transport		Accidents			
Onsite Shipments	**Workers**	**Public**	**Public**		**Number of Fatalities**	**Emissions LCFs**
Modified T Plant						
12–RH MLLW	3.5E-04	2.4E-03	2.2E-08	4.6E-02	2.0E-03	1.8E-04
Commercial Treatment Facilities						
13A–CH standard (non-thermal)	6.4E-04	4.4E-03	4.0E-08	8.3E-02	3.5E-03	3.2E-03
13B–CH standard (thermal)	1.0E-02	4.2E-02	1.2E-06	6.6E-01	1.5E-02	6.7E-02
14–Elemental lead	0	0	0	2.5E-03	1.1E-04	9.5E-05
15–Elemental mercury	0	0	0	8.6E-05	3.7E-06	3.3E-06
MLLW Enhanced Trench Design						
11–Wastes ready for disposal	8.5E-04	5.8E-03	5.3E-08	1.1E-01	4.7E-03	4.2E-03
11–From WRAP verification	2.3E-06	3.4E-05	1.7E-10	3.1E-04	1.3E-05	3.0E-05
12–RH MLLW from Modified T Plant	5.1E-05	7.4E-04	3.8E-09	6.7E-03	2.9E-04	6.4E-04
13A–CH standard (non-thermal)	1.2E-03	7.9E-03	7.2E-08	1.5E-01	6.4E-03	5.7E-03
13B–CH standard (thermal)	9.4E-03	3.8E-02	1.0E-06	5.9E-01	1.3E-02	6.1E-02
13A–CH standard (non-thermal) - post-verification	5.0E-05	7.3E-04	3.8E-09	6.6E-03	2.8E-04	6.4E-04
13B–CH standard – post-verification	8.4E-06	1.2E-04	6.3E-10	1.1E-03	4.8E-05	1.1E-04
14–Elemental lead	0	0	0	4.9E-03	2.1E-04	1.9E-04
15–Elemental mercury	0	0	0	1.3E-03	5.5E-05	4.9E-05
22–WTP melters	1.7E-07	2.4E-06	1.2E-11	2.2E-05	9.4E-07	2.1E-06
Total MLLW	2.4E-02	1.1E-01	2.5E-06	1.8	4.9E-02	1.2E-01
TRU Wastes						
WRAP						
4–Retrievably stored drums in trenches	8.4E-06	1.2E-03	2.0E-08	2.8E-04	1.2E-05	2.7E-05
9–Newly generated and existing CH standard containers	1.6E-03	1.1E-02	4.3E-06	5.2E-02	2.2E-03	2.0E-03
T Plant Complex						
17–K Basin sludge	6.4E-05	1.2E-03	1.5E-07	2.2E-03	9.4E-05	8.4E-05
Modified T Plant Complex						
4–Retrievably stored drums in trenches	1.6E-05	2.4E-03	3.9E-08	5.3E-04	2.3E-05	5.1E-05
5–RH TRU waste in caissons	4.1E-07	1.6E-05	8.9E-10	1.4E-05	6.2E-07	1.4E-06
8–TRU commingled PCB waste	1.8E-07	2.6E-05	4.4E-10	6.0E-06	2.6E-07	5.7E-07

Table H.12. (contd)

Onsite Shipments	Radiological Impacts, LCFs			Total Number of Accidents	Non-Radiological Impacts	
	Incident-Free Transport		Accidents			
	Workers	Public	Public		Number of Fatalities	Emissions LCFs
10A–Newly generated CH non-standard	6.2E-05	4.3E-04	1.7E-07	2.0E-03	8.6E-05	7.7E-05
10B–Newly generated RH TRU waste	9.9E-04	1.8E-02	2.4E-06	3.4E-02	1.5E-03	1.3E-03
LLBGs						
4–TRU drums assayed in trench as LLW			Remains in trench – not transported			
4–TRU assayed as LLW in T Plant/WRAP	1.7E-06	2.5E-05	6.8E-12	2.2E-04	9.6E-06	2.2E-05
4–TRU assayed in T Plant as LLW	3.8E-06	6.7E-05	9.2E-09	1.3E-04	5.4E-06	1.2E-06
9–Drums assayed in WRAP as LLW	6.9E-07	1.0E-04	1.7E-09	2.3E-05	9.8E-07	2.2E-06
10A–TRU assayed in T Plant as CH LLW	1.2E-07	1.8E-06	4.9E-13	1.6E-05	6.9E-07	1.5E-06
10B–TRU assayed in T Plant as RH LLW	2.1E-06	3.0E-05	1.6E-09	2.7E-04	1.2E-05	2.6E-05
Total TRU	2.7E-03	3.4E-02	7.1E-06	9.1E-02	3.9E-03	3.6E-03
ILAW	5.4E-03	6.9E-02	1.6E-09	5.4E-02	2.3E-03	2.6E-03

Note: Due to rounding, the sums of the numbers in the table may not exactly match the totals.

(a) Radiological impacts (incident-free and accident) are expressed in units of LCFs. Non-radiological accident impacts are expressed as the expected number of accidents and the resulting non-radiological fatalities. Non-radiological emissions impacts are expressed as LCFs.

CH = contact-handled.
RH = remote-handled.
WTP = Waste Treatment Plant.

Table H.13. Transportation Impacts of Alternative Group B – Hanford Only Waste Volume, Number of Fatalities[(a)]

	Radiological Impacts, LCFs			Total Number of Accidents	Non-Radiological Impacts	
	Incident-Free Transport		Accidents			
Onsite Shipments	**Workers**	**Public**	**Public**		**Number of Fatalities**	**Emissions LCFs**
			LLW			
WRAP						
1B–LLW Cat 1	5.6E-05	3.3E-04	1.6E-10	6.2E-03	2.7E-04	2.4E-04
2C–LLW Cat 3	1.8E-04	1.2E-03	1.2E-07	2.3E-02	9.9E-04	8.8E-04
T Plant Complex						
1B2–LLW Cat 1	1.5E-07	2.3E-06	6.2E-13	2.0E-05	8.8E-07	2.0E-06
2C2–LLW Cat 3	6.8E-07	1.0E-05	5.4E-10	9.0E-05	3.9E-06	8.7E-06
Offsite Commercial Facilities						
6–LLW (non-conforming)	5.0E-06	3.0E-05	1.5E-11	5.6E-04	2.4E-05	2.1E-05
Repackage in HICs, In-trench Grouting						
2A–LLW Cat 3 direct disposal	4.3E-03	2.9E-02	2.9E-06	5.6E-01	2.4E-02	2.1E-02
2C1–LLW Cat 3 from WRAP	6.3E-06	9.2E-05	5.0E-09	8.3E-04	3.6E-05	8.0E-05
2C2–LW Cat 3 from T Plant	1.0E-06	1.5E-05	8.1E-10	1.3E-04	5.8E-06	1.3E-05
LLBGs						
1A–LLW Cat 1 direct disposal	1.1E-03	6.7E-03	3.2E-09	1.2E-01	5.3E-03	4.8E-03
1A–LLW Cat 1 from Stream 11	2.6E-06	1.6E-05	7.7E-12	2.9E-04	1.3E-05	1.1E-05
1B1–LLW Cat 1 from WRAP	1.7E-06	2.5E-05	6.9E-12	2.3E-04	9.7E-06	2.2E-05
1B2–LLW Cat 1 from T Plant	2.3E-07	3.4E-06	9.3E-13	3.1E-05	1.3E-06	3.0E-06
6–LLW (non-conforming)	1.0E-05	6.0E-05	2.9E-11	1.1E-03	4.8E-05	4.3E-05
Total LLW	5.7E-03	3.8E-02	3.0E-06	7.1E-01	3.1E-02	2.8E-02
			MLLW			
WRAP						
11–Wastes ready for disposal	6.0E-06	4.1E-05	1.5E-10	7.7E-04	3.3E-05	3.0E-05
13–Waste verification	3.3E-06	4.9E-05	1.0E-10	4.4E-04	1.9E-05	4.3E-05
13–Post-verification	3.3E-06	4.9E-05	1.0E-10	4.4E-04	1.9E-05	4.3E-05
MLLW determined to be LLW	2.2E-07	3.2E-06	6.8E-12	2.9E-05	1.2E-06	2.8E-06
13B–CH standard (thermal) verification	5.6E-05	2.2E-04	6.2E-09	3.5E-03	7.8E-05	3.6E-04
New Waste Processing Facility						
12–RH MLLW	1.4E-05	2.0E-04	1.9E-10	1.8E-03	7.8E-05	1.8E-04
13A, B–CH standard	3.3E-05	4.8E-04	1.8E-10	4.4E-03	1.9E-04	4.2E-04
14–Elemental lead	0	0	0	9.9E-05	4.2E-06	9.5E-06
15–Elemental mercury	0	0	0	3.5E-06	1.5E-07	3.3E-07
Offsite Treatment Facility						
13B–CH standard (thermal)	5.6E-04	2.2E-03	6.2E-08	3.5E-02	7.8E-04	3.6E-03
MLLW Enhanced Trench Design						
11–Wastes ready for disposal	8.5E-04	5.8E-03	2.2E-08	1.1E-01	4.7E-03	4.2E-03
11–From WRAP verification	2.3E-06	3.4E-05	7.2E-11	3.1E-04	1.3E-05	3.0E-06
12–RH MLLW from NWPF	5.1E-05	7.4E-04	3.8E-09	6.7E-03	2.9E-04	6.4E-04
13A,B–CH standard	5.8E-05	8.5E-04	1.8E-09	7.7E-02	3.3E-03	7.4E-03
13B–CH standard (thermal)	5.0E-04	2.0E-03	5.6E-08	3.2E-02	7.0E-04	3.2E-03

Table H.13. (contd)

Onsite Shipments	Radiological Impacts, LCFs			Total Number of Accidents	Non-Radiological Impacts	
	Incident-Free Transport		Accidents			
	Workers	Public	Public		Number of Fatalities	Emissions LCFs
14–Elemental lead	0	0	0	2.0E-03	8.5E-05	1.9E-04
15–Elemental mercury	0	0	0	5.1E-04	2.2E-05	4.9E-05
22–WTP melters	1.7E-07	2.4E-06	1.2E-11	2.2E-05	9.4E-07	2.1E-06
Total MLLW	2.1E-03	1.3E-02	1.6E-07	2.8E-01	1.0E-02	2.0E-02
TRU Wastes						
WRAP						
4–Retrievably stored drums in trenches	8.4E-06	1.2E-03	2.0E-08	2.8E-04	1.2E-05	2.7E-05
9–Newly generated and existing CH standard containers	1.6E-03	1.1E-02	4.3E-06	5.2E-02	2.2E-03	2.0E-03
T Plant Complex						
17–K Basin sludge	6.4E-05	1.2E-03	1.5E-07	2.2E-03	9.4E-05	8.4E-05
New Waste Processing Facility						
4–Retrievably stored drums in trenches	1.6E-05	2.4E-03	3.9E-08	5.3E-04	2.3E-05	5.1E-05
5–RH TRU waste in caissons	4.1E-07	1.6E-05	8.9E-10	1.4E-05	6.2E-07	1.4E-06
8–TRU commingled PCB waste	1.8E-07	2.6E-05	4.4E-10	6.0E-06	2.6E-07	5.7E-07
10A–Newly generated CH non-standard	6.2E-05	4.3E-04	1.7E-07	2.0E-03	8.6E-05	7.7E-05
10B–Newly generated RH TRU waste	9.9E-04	1.8E-02	2.4E-06	3.4E-02	1.5E-03	1.3E-03
LLBGs						
4–TRU drums assayed in trench as LLW	Remains in trench – not transported					
4–TRU assayed as LLW in NWPF/WRAP	1.7E-06	2.5E-05	6.8E-12	2.2E-04	9.6E-06	2.2E-05
4–TRU assayed in NWPF as LLW	3.8E-06	6.7E-05	9.2E-09	1.3E-04	5.4E-06	1.2E-05
9–Drums assayed in WRAP as LLW	1.7E-07	2.5E-06	6.9E-13	2.3E-05	9.8E-07	2.2E-06
10A–TRU assayed in NWPF as CH LLW	1.2E-07	1.8E-06	4.9E-13	1.6E-05	6.9E-07	1.5E-06
10B– TRU assayed in NWPF as RH LLW	2.1E-06	3.0E-05	1.6E-09	2.7E-04	1.2E-05	2.6E-05
Total TRU Wastes	2.7E-03	3.4E-02	7.1E-06	9.1E-02	3.9E-03	3.6E-03
ILAW	5.4E-02	6.9E-01	1.6E-08	5.4E-01	2.3E-02	2.6E-02

Note: Due to rounding, the sums of the numbers in the table may not exactly match the totals.

(a) Radiological impacts (incident-free and accident) are expressed in units of LCFs. Non-radiological accident impacts are expressed as the expected number of accidents and the resulting non-radiological fatalities. Non-radiological emissions impacts are expressed as LCFs.

CH = contact-handled.
RH = remote-handled.
NWPF = new waste processing facility.
WTP = Waste Treatment Plant.

Table H.14. Transportation Impacts for the No Action Alternative, Hanford Only Waste Volume, Number of Fatalities[(a)]

Onsite Shipments	Radiological Impacts, LCFs			Total Number of Accidents	Non-Radiological Impacts	
	Incident-Free Transport		Accidents			
	Workers	Public	Public		Number of Fatalities	Emissions LCFs
LLW						
WRAP						
1B–LLW Cat 1	5.6E-05	3.3E-04	1.6E-10	6.2E-03	2.7E-04	2.4E-04
2B–LLW Cat 3	1.8E-04	1.2E-03	1.2E-07	2.3E-02	9.9E-04	8.8E-04
T Plant Complex						
1B2–LLW Cat 1	1.5E-07	2.3E-06	6.2E-13	2.0E-05	8.8E-07	2.0E-05
2C2–LLW Cat 3	6.8E-07	1.0E-05	5.4E-10	9.0E-05	3.9E-06	8.7E-05
Repackage in HICs or Trench Grouting						
2A–LLW Cat 3 direct disposal	4.3E-03	2.9E-02	2.9E-06	5.6E-01	2.4E-02	2.1E-02
2C1–LLW Cat 3 from WRAP	6.3E-06	9.2E-05	5.0E-09	8.3E-04	3.6E-05	8.0E-04
2C2–LLW Cat 3 from the T Plant	1.0E-06	1.5E-05	8.1E-10	1.3E-04	5.8E-06	1.3E-04
LLBGs						
1A–LLW Cat 1 direct disposal	1.1E-03	6.7E-03	3.2E-09	1.2E-01	5.3E-03	4.8E-03
1A–LLW Cat 1 from Stream 11	2.6E-06	1.6E-05	7.7E-12	2.9E-04	1.3E-05	1.1E-05
1B1–LLW Cat 1 from WRAP	1.7E-05	2.5E-04	1.4E-08	2.3E-04	9.7E-06	2.2E-04
1B2–LLW Cat 1 from T Plant	2.3E-06	3.4E-05	1.9E-09	3.1E-05	1.3E-06	3.0E-05
Total LLW	5.7E-03	3.8E-02	3.0E-06	7.1E-01	3.0E-02	2.9E-02
MLLW						
WRAP						
11–Wastes ready for disposal	6.5E-06	4.5E-05	1.7E-10	8.4E-04	3.6E-05	3.2E-05
13–Waste verification	3.3E-06	4.9E-05	1.0E-10	4.4E-04	1.9E-05	4.3E-04
13–Offsite treatment verification	2.7E-07	1.9E-06	1.7E-11	3.5E-05	1.5E-06	1.4E-06
Commercial Treatment Facilities						
13B–CH standard (thermal)	2.7E-06	1.9E-05	1.7E-10	3.5E-04	1.5E-05	1.4E-05
Central Waste Complex						
11–Wastes ready for indefinite storage	5.8E-04	3.9E-03	1.5E-08	7.5E-02	3.2E-03	2.9E-03
–RH and non-standard packages	3.5E-04	2.4E-03	9.2E-09	4.6E-02	2.0E-03	1.8E-03
13A,B–CH solids and debris	8.5E-04	5.8E-03	2.2E-08	1.1E-01	4.7E-03	4.2E-03
13–Post WRAP verification	3.3E-06	4.9E-05	1.0E-10	4.4E-04	1.9E-05	4.3E-04
14–Elemental lead	0	0	0	2.5E-03	1.1E-04	9.5E-05
15–Elemental mercury	0	0	0	8.6E-05	3.7E-06	3.3E-06
22–WTP melters	1.7E-06	2.4E-05	5.1E-11	2.2E-04	9.4E-06	2.1E-05
200 E LLBG Existing Design Trenches						
11–Wastes ready for disposal	8.5E-04	5.8E-03	2.2E-08	1.1E-01	4.7E-03	4.2E-03
11–Post-verification wastes from WRAP	1.4E-06	2.1E-05	4.3E-11	1.9E-04	8.0E-06	1.8E-05
13B–CH standard (thermal) from WRAP verification	4.5E-07	6.6E-06	1.4E-11	5.9E-05	2.5E-06	5.7E-06

Table H.14. (contd)

	Radiological Impacts, LCFs			Total Number of Accidents	Non-Radiological Impacts	
	Incident-Free Transport		Accidents			
Onsite Shipments	**Workers**	**Public**	**Public**		**Number of Fatalities**	**Emissions LCFs**
13B–CH standard (thermal) from Comm Treat	2.5E-06	1.7E-05	1.5E-10	3.2E-04	1.4E-05	1.2E-05
Total MLLW	2.7E-03	1.8E-02	6.9E-08	3.4E-01	1.5E-02	1.4E-02
			TRU Wastes			
WRAP						
4–Retrievably stored drums in trenches	8.4E-05	1.5E-03	2.0E-07	2.8E-03	1.2E-04	2.7E-04
9–CH - standard containers						
- 208-L (55-gal) drums	3.5E-04	2.4E-03	9.5E-07	1.1E-02	4.9E-04	4.4E-04
- Standard waste boxes	1.6E-03	1.1E-02	4.4E-06	5.3E-02	2.3E-03	2.0E-03
Storage at CWC or T Plant Complex						
4–TRU to indefinite storage	1.6E-04	2.8E-03	3.9E-07	5.3E-03	2.3E-04	5.1E-04
5–RH TRU in caissons	4.1E-07	1.6E-05	8.9E-10	1.4E-05	6.2E-07	1.4E-05
8–TRU commingled PCB waste	4.6E-06	3.2E-05	1.2E-08	1.5E-04	6.4E-06	5.7E-06
10A– Newly generated CH non-standard	6.2E-05	4.3E-04	1.7E-07	2.0E-03	8.6E-05	7.7E-05
10B–Newly generated RH waste	9.9E-04	1.8E-02	2.4E-06	3.4E-02	1.5E-03	1.3E-03
17–K Basin sludge	6.4E-05	1.2E-03	1.5E-07	2.2E-03	9.4E-05	8.4E-05
LLBGs						
4–Drums assayed in WRAP as LLW	2.1E-07	3.1E-06	8.4E-13	2.8E-05	1.2E-06	2.7E-05
9–Drums assayed in WRAP as LLW	1.7E-07	2.5E-06	6.9E-13	2.3E-05	9.8E-07	2.2E-05
Total TRU Wastes	3.4E-03	3.7E-02	8.7E-06	1.1E-01	4.7E-03	4.8E-03
ILAW	Intrafacility Transfer					

Note: Due to rounding, the sums of the numbers in the table may not exactly match the totals.

(a) Radiological impacts (incident-free and accident) are expressed in units of LCFs. Non-radiological accident impacts are expressed as the expected number of accidents and the resulting non-radiological fatalities. Non-radiological emissions impacts are expressed as LCFs.

CH = contact-handled.
RH = remote-handled.
WTP = Waste Treatment Plant.

H.3.1.7 Summary of Transportation Impacts for the Hanford Only Waste Volume

Table H.15 presents the results of the analysis of potential transportation impacts of shipping Hanford Only waste volume of LLW, MLLW, TRU wastes, and ILAW onsite and the small volumes of Hanford LLW and MLLW to offsite treatment facilities and back. Shipments of additional LLW, MLLW, and TRU wastes to Hanford from offsite and shipments of TRU wastes from Hanford to WIPP are addressed in Section H.3.2. All of the impacts provided in Table H.15 are fatalities, except for the estimated number of traffic accidents. Fatalities are expressed as latent cancer fatalities (LCFs) for radiological impacts and for incident-free non-radiological emissions. For non-radiological accidents, impacts are expressed in terms of the predicted number of traffic accidents and fatalities from physical trauma resulting from those traffic accidents. Note that many of the entries in the table are expressed as fractional fatalities (for example, 1.0E-01 or 0.1 fatalities). However, fatalities occur only as whole numbers and the totals have been obtained by rounding to the nearest whole number.

Table H.15 indicates that the No Action Alternative results in the lowest total (that is, the sums across all waste types) potential onsite radiological impacts of all the alternative groups. This is primarily because, under the No Action Alternative, ILAW would be placed in concrete vaults adjacent to the Waste Treatment Plant (WTP) and, thus, is assumed not to involve transportation. For the action alternatives, Alternative Group B has the largest total radiological incident-free impacts. Radiological incident-free impacts are dominated by the large volume and high number of shipments of ILAW to a disposal facility located in the 200 West Area. The potential radiological incident-free impacts associated with ILAW transportation are lower for Alternative Groups A, C, D, and E than for Alternative Group B because in Alternative Groups A, C, D, and E, the shipping distance is shorter because the ILAW disposal facility is assumed to be located in the 200 East Area (the WTP is also located in the 200 East Area). In addition, the volumes of Hanford MLLW shipped to offsite treatment facilities and back are smaller in Alternative Group B than in the other action alternative groups. Only Alternative Group B was predicted to result in a radiological fatality from onsite shipments of solid waste due primarily to the longer ILAW shipping distance relative to the other action alternatives.

Table H.15. Summary of Impacts of Shipping Hanford Only Wastes Volume for Each Alternative Group[(a)(b)]

Waste Type	Radiological Impacts, LCFs			Total Number of Accidents	Non-Radiological Impacts	
	Occupational	Non-Occupational	Radiological Accidents		Accident Fatalities	Emissions, LCFs
Alternative Groups A, C, D, E						
LLW	5.7E-03	3.8E-02	3.0E-06	7.1E-01	3.1E-02	2.8E-02
MLLW	2.4E-02	1.1E-01	2.5E-06	1.8	4.7E-02	1.5E-01
TRU	2.7E-03	3.4E-02	7.1E-06	9.1E-02	3.9E-03	3.6E-03
ILAW	5.4E-03	6.9E-02	1.6E-09	5.4E-02	2.3E-03	2.6E-03
Total	0 (3.8E-02)	0 (2.5E-01)	0 (1.3E-05)	3 (2.6)	0 (8.5E-02)	0 (1.8E-01)
Alternative Group B						
LLW	5.7E-03	3.8E-02	3.0E-06	7.1E-01	3.1E-02	2.8E-02
MLLW	2.1E-03	1.3E-02	1.6E-07	2.8E-01	1.0E-02	2.0E-02
TRU	2.7E-03	3.4E-02	7.1E-06	9.1E-02	3.9E-03	3.6E-03
ILAW	5.4E-02	6.9E-01	1.6E-08	5.4E-01	2.3E-02	2.6E-02
Total	0 (6.4E-02)	1 (7.7E-01)	0 (1.0E-05)	2 (1.6)	0 (6.8E-02)	0 (7.8E-02)
No Action Alternative						
LLW	5.7E-03	3.8E-02	3.0E-06	7.1E-01	3.0E-02	2.9E-02
MLLW	2.7E-03	1.8E-02	6.9E-08	3.4E-01	1.5E-02	1.4E-02
TRU	3.4E-03	3.7E-02	8.7E-06	1.1E-01	4.7E-03	4.8E-03
ILAW	Intrafacility Transfer					
Total	0 (1.2E-02)	0 (9.4E-02)	0 (1.2E-05)	1 (1.2)	0 (5.0E-02)	0 (4.7E-02)

Note: Totals are rounded to one significant figure. Due to rounding, the sums of the numbers in the table may not exactly match the totals.

(a) This table presents the potential impacts of onsite shipments of LLW, MLLW, TRU wastes, and ILAW in addition to shipments of Hanford LLW and MLLW to offsite treatment facilities and back. The table does not include the impacts of shipments of LLW, MLLW, and TRU wastes from offsite or the impacts of transporting TRU wastes to WIPP (see Section H.3.2),

(b) Radiological impacts (incident-free and accident) are expressed in units of LCFs. Non-radiological accident impacts are expressed as the expected number of accidents and the resulting non-radiological fatalities. Non-radiological emissions impacts are expressed as LCFs.

Total non-radiological impacts are also lowest for the No Action Alternative. However, for the action alternatives, the potential impacts are larger for Alternative Groups A, C, D, and E than they are for Alternative Group B. This is because the potential non-radiological impacts are dominated by the shipments of Hanford Only waste volume of MLLW to offsite treatment facilities and back. There are fewer shipments to offsite treatment facilities and back in Alternative Group B than in Alternative Groups A, C, D, and E. None of the action alternative groups was predicted to result in a non-radiological fatality from shipments of the Hanford Only waste volume.

H.3.2 Results of Offsite Transportation Impact Analysis

This section presents the results of the offsite transportation impact analysis, except for the impacts of shipping Hanford MLLW to offsite treatment facilities and back that were presented in Section H.3.1. The results presented include the impacts of possible shipments to Hanford from offsite as well as the impacts of shipping TRU wastes from Hanford to WIPP. Section H.3.2.1 presents the potential radiological impacts to populations along the highway routes and Section H.3.2.2 presents the non-radiological impacts. The analysis of maximally exposed individuals to incident-free transport conditions is presented in Section H.3.2.3.

H.3.2.1 Potential Population Radiological Impacts of Offsite Shipments

The potential radiological impacts of offsite shipments of solid waste to and from Hanford through 2046 are shown in Table H.16. Impact estimates are presented for shipments of LLW, MLLW, and TRU wastes from offsite to Hanford under the Upper Bound and Lower Bound waste volume projections as well as shipments of TRU wastes from Hanford to WIPP under the action alternative groups and the No Action Alternative. Note that the impact estimates for the Lower Bound waste volume projection are dominated by shipments of TRU wastes from Hanford to WIPP. For the Upper Bound waste volume projection, additional shipments contribute to the total impacts, including shipments of LLW from ORR, Rocky Flats Field Office, and Argonne National Laboratory-East to Hanford as well as MLLW shipments from the Savannah River Site and ORR to Hanford. There are only small differences in TRU waste shipping volumes from Hanford to WIPP between the Lower Bound and Upper Bound waste volumes.

Table H.17 summarizes the radiological impacts of offsite shipments to and from Hanford by waste type. As shown, the sums of the radiological incident-free impact estimates (worker plus public) are 2 LCFs for the Hanford Only waste volume of TRU waste to WIPP under the No Action Alternative, 5 LCFs for the Hanford Only waste volume of TRU waste to WIPP under the action alternative groups, 5 LCFs for the Lower Bound waste volume projection, and 7 LCFs for the Upper Bound waste volume projection. Radiological accident impacts are 0 for all four waste volume projections. These values are small in comparison to the cancer fatalities from other causes that would be calculated over the next 40 years.

Table H.16. Radiological Transportation Impacts for Offsite Shipments(a)(b)

Waste Type/Generator	LOWER BOUND			UPPER BOUND		
	Radiological Impacts, LCFs			Radiological Impacts, LCFs		
	Incident-Free Transport		Accidents	Incident-Free Transport		Accidents
	Workers	Public	Public	Workers	Public	Public
LLW						
Ames Laboratory (Ames, Iowa)	8.6E-05	2.9E-04	7.8E-06	8.6E-05	2.9E-04	7.8E-06
Argonne National Laboratory-East	1.3E-02	4.6E-02	1.3E-03	1.3E-02	4.6E-02	1.3E-03
Battelle Columbus Laboratory	1.1E-03	4.3E-03	9.9E-05	1.1E-03	4.3E-03	9.9E-05
Bettis Atomic Power Laboratory	8.7E-04	3.7E-03	1.1E-04	8.7E-04	3.7E-03	1.1E-04
Bettis Atomic Power Shipyards	2.2E-05	9.4E-05	2.9E-06	2.2E-05	9.4E-05	2.9E-06
Brookhaven National Laboratory	3.0E-03	1.5E-02	6.1E-08	2.8E-02	1.4E-01	5.7E-07
Energy Technology Engineering Center	1.2E-03	7.0E-03	1.7E-04	1.3E-03	7.5E-03	1.9E-04
Fermi National Accelerator Laboratory	1.9E-03	6.4E-03	1.7E-04	1.9E-03	6.4E-03	1.7E-04
General Electric Vallecitos	0	0	0	1.9E-05	1.3E-04	1.0E-09
Grand Junction Projects Office	0	0	0	3.5E-05	2.3E-04	7.1E-06
Idaho National Engineering and Environmental Laboratory	0	0	0	2.4E-03	8.9E-03	2.5E-04

Table H.16. (contd)

Waste Type/Generator	LOWER BOUND			UPPER BOUND		
	Radiological Impacts, LCFs			Radiological Impacts, LCFs		
	Incident-Free Transport		Accidents	Incident-Free Transport		Accidents
Inhalation Toxicology Research Institute	0	0	0	6.5E-04	3.0E-03	9.2E-08
Knolls Atomic Power Shipyards	6.6E-04	2.9E-03	7.9E-05	6.6E-04	2.9E-03	7.9E-05
Lawrence Berkeley National Laboratory	1.2E-04	8.6E-04	2.2E-05	1.2E-04	8.6E-04	2.2E-05
Lawrence Livermore National Laboratory	0	0	0	7.3E-03	5.1E-02	1.2E-06
MIT/Bates Linear Accelerator Center	2.8E-05	1.3E-04	6.2E-06	2.8E-05	1.3E-04	6.2E-06
Oak Ridge Reservation	0	0	0	1.2E-01	4.9E-01	8.6E-04
Paducah Gaseous Diffusion Plant	7.7E-05	3.1E-04	1.1E-05	7.7E-05	3.1E-04	1.1E-05
Pantex Facility	0	0	0	1.2E-03	5.3E-03	2.9E-08
Princeton Plasma Physics Laboratory	3.8E-03	1.7E-02	7.7E-04	3.8E-03	1.7E-02	7.7E-04
Rocky Flats Plant	0	0	0	4.5E-02	1.8E-01	6.6E-09
Sandia National Laboratories	0	0	0	2.2E-03	1.1E-02	2.6E-05
Separations Process Research Unit	0	0	0	1.5E-02	6.7E-02	5.1E-07
Stanford Linear Accelerator	5.4E-04	4.4E-03	1.1E-04	5.4E-04	4.4E-03	1.1E-04
West Valley Nuclear Services	0	0	0	1.8E-02	7.9E-02	1.4E-04
Total LLW	2.7E-02	1.1E-01	2.9E-03	2.7E-01	1.1	4.2E-03
MLLW						
Battelle Columbus Laboratory	2.0E-05	6.8E-05	2.2E-06	2.0E-05	6.8E-05	2.2E-06
Energy Technology Engineering Center	0	0	0	1.1E-03	7.2E-03	5.6E-12
Idaho National Engineering and Environmental Laboratory	0	0	0	7.3E-05	2.8E-04	7.2E-06
Knolls Atomic Power Laboratory	2.6E-05	1.2E-04	3.8E-06	2.6E-05	1.2E-04	3.8E-06
Battelle Columbus Laboratory	2.0E-05	6.8E-05	2.2E-06	2.0E-05	6.8E-05	2.2E-06
Energy Technology Engineering Center	0	0	0	1.1E-03	7.2E-03	5.6E-12
Idaho National Engineering and Environmental Laboratory	0	0	0	7.3E-05	2.8E-04	7.2E-06
Knolls Atomic Power Laboratory	2.6E-05	1.2E-04	3.8E-06	2.6E-05	1.2E-04	3.8E-06
Los Alamos National Laboratory	0	0	0	2.6E-03	1.3E-02	4.3E-10
Oak Ridge Reservation	0	0	0	8.6E-02	3.4E-01	9.6E-06
Paducah Gaseous Diffusion Plant	0	0	0	3.6E-03	1.5E-02	1.5E-04
Portsmouth Gaseous Diffusion Plant	0	0	0	4.6E-03	2.0E-02	6.5E-07
Princeton Plasma Physics Laboratory	1.8E-04	8.2E-04	4.5E-05	1.8E-04	8.2E-04	4.5E-05
Puget Sound Naval Shipyards	3.4E-06	2.3E-05	3.9E-07	3.4E-06	2.3E-05	3.9E-07
Rocky Flats Plant	0	0	0	4.7E-02	1.9E-01	5.2E-07
Sandia National Laboratory	0	0	0	1.4E-04	7.1E-04	1.7E-08
Savannah River Site	0	0	0	1.1E-02	4.9E-02	3.3E-05
West Valley Nuclear Services	0	0	0	4.6E-05	2.0E-04	3.4E-13
Total MLLW	2.3E-04	1.0E-03	5.1E-05	1.6E-01	6.4E-01	2.5E-04
CH TRU Waste						
Battelle Columbus Laboratories	3.9E-05	3.4E-04	8.8E-07	3.9E-05	3.4E-04	8.8E-07
Energy Technology Engineering Center	2.3E-05	3.0E-04	6.6E-07	2.3E-05	3.0E-04	6.6E-07
General Electric-Vallecitos Nuclear Center.	0	0	0	7.2E-05	1.1E-03	2.6E-06
Lawrence Berkeley National Laboratory	0	0	0	1.8E-04	2.6E-04	6.5E-07
Lawrence Livermore National Laboratory	0	0	0	3.0E-03	4.4E-02	1.1E-04

Table H.16. (contd)

Waste Type/Generator	LOWER BOUND			UPPER BOUND		
	Radiological Impacts, LCFs			Radiological Impacts, LCFs		
	Incident-Free Transport		Accidents	Incident-Free Transport		Accidents
Nevada Test Site	0	0	0	4.9E-04	5.7E-03	1.9E-05
Total CH TRU Waste	6.2E-05	6.3E-04	1.5E-06	3.8E-03	5.1E-02	1.3E-04
RH TRU Waste						
Battelle Columbus Laboratories	1.1E-03	2.4E-02	2.2E-05	1.1E-03	2.4E-02	2.2E-05
Energy Technology Engineering Center	3.7E-04	1.3E-02	9.6E-06	3.7E-04	1.3E-02	9.6E-06
Framatome ANP	0	0	0	1.1E-06	7.4E-06	2.3E-11
General Electric-Vallecitos Nuclear Center	0	0	0	9.7E-04	3.7E-02	3.1E-05
Total RH TRU Waste	1.4E-03	3.7E-02	3.1E-05	2.4E-03	7.4E-02	6.2E-05
Shipments from Hanford to WIPP						
CH TRU waste to WIPP	1.9E-01	1.8	5.4E-03	2.0E-01	1.9	5.6E-03
RH TRU waste to WIPP	1.0E-01	2.6	2.6E-03	1.0E-01	2.6	2.7E-03
Total TRU to WIPP	2.9E-01	4.4	8.1E-03	3.0E-01	4.5	8.3E-03
Action Alternative Groups (Hanford Only Waste Volume of TRU Waste to WIPP)						
CH TRU waste to WIPP	1.9E-01	1.8	5.4E-03	Not Applicable		
RH TRU waste to WIPP	1.0E-01	2.5	2.6E-03			
Total TRU Waste to WIPP	2.9E-01	4.4	8.0E-03			
No Action Alternative (Hanford Only Waste Volume of TRU Waste to WIPP)						
CH TRU waste to WIPP	1.5E-01	1.4	4.3E-03	Not Applicable		

Note: Due to rounding, the sums of the numbers in the table may not exactly match the totals.

(a) Radiological impacts (incident-free and accident) are expressed in units of LCFs.

(b) The LCF numbers were calculated for each impact category (e.g., worker incident-free impacts) by summing across all waste types and shipments to and from Hanford. For radiological accidents, 0 LCFs were calculated for both the Upper Bound and Lower Bound projections. To illustrate the Upper Bound calculations, the subtotals for LLW, MLLW, and TRU shipments to Hanford were added together (2.9E-03 + 5.1E-05 + 1.5E-06 + 3.1E-05) and then the impacts of CH and RH TRU shipments from Hanford to WIPP (8.1E-03) were added in. The total is about 0.01 LCFs, which rounds to 0.

Table H.17. Summary of Potential Radiological Transportation Impacts for Offsite Shipments by Waste Type[(a)]

Waste Type	Radiological Impacts		
	Incident-Free Transport, LCFs		Accidents, LCFs
	Worker	Public	Public
Lower Bound			
LLW to Hanford	2.7E-02	1.1E-01	2.9E-03
MLLW to Hanford	2.3E-04	1.0E-03	5.1E-05
CH TRU waste to Hanford	6.2E-05	6.3E-04	1.5E-06
RH TRU waste to Hanford	1.4E-03	3.7E-02	3.1E-05
CH TRU waste to WIPP	1.9E-01	1.8	5.4E-03
RH TRU waste to WIPP	1.0E-01	2.6	2.6E-03
Total	0 (3.2E-01)	5 (4.5)	0 (1.1E-02)
Upper Bound			
LLW to Hanford	2.7E-01	1.1	4.2E-03
MLLW to Hanford	1.6E-01	6.4E-01	2.5E-04
CH TRU waste to Hanford	3.8E-03	5.1E-02	1.3E-04
RH TRU waste to Hanford	2.4E-03	7.4E-02	6.2E-05
CH TRU waste to WIPP	2.0E-01	1.9	5.6E-03
RH TRU waste to WIPP	1.0E-01	2.6	2.7E-03
Total	1 (7.3E-01)	6 (6.4)	0 (1.3E-02)
Action Alternative Groups (Hanford Only Waste Volume of TRU Waste)			
CH TRU waste to WIPP	1.9E-01	1.8	5.4E-03
RH TRU waste to WIPP	1.0E-01	2.5	2.6E-03
Total	0 (2.9E-01)	4 (4.4)	0 (8.0E-03)
No Action Alternative (Hanford Only Waste Volume of TRU Waste)			
CH TRU Waste to WIPP	0 (1.5E-01)	1 (1.4)	0 (4.3E-03)

Note: Totals are rounded to one significant figure. Due to rounding, the sums of the numbers in the table may not exactly match the totals.

(a) Radiological impacts (incident-free and accident) are expressed in units of LCFs.

H.3.2.2 Potential Non-Radiological Impacts of Offsite Shipments

The results of the non-radiological transportation impact analysis are presented in Table H.18 for each offsite generator. The table includes the number of traffic accidents, number of non-radiological fatalities from traffic accidents, and the projected impacts from non-radiological emissions. The table includes projections for both the Upper Bound and Lower Bound waste volumes.

Table H.19 summarizes the potential non-radiological impacts of offsite shipments by waste type. As shown, the non-radiological accident fatality estimates are 0 for the Hanford Only waste volume projection under the No Action Alternative, 1 fatality for the Hanford Only waste volume projection under the action alternative groups, 1 fatality for the Lower Bound waste volume projection, and 2 for the Upper Bound waste volume projection. Non-radiological emissions impacts (in LCFs) range from 0 for the Hanford Only waste volume projection under all alternative groups as well as the Lower Bound waste volume projection to 2 for the Upper Bound waste volume.

Table H.18. Non-Radiological Transportation Impacts for Offsite Shipments[(a)]

Waste Type/Generator	Lower Bound Volume			Upper Bound Volume		
	Total Number of Accidents	**Number of Fatalities**	**Emissions LCFs**	**Total Number of Accidents**	**Number of Fatalities**	**Emissions LCFs**
LLW						
Ames Laboratory (Ames, Iowa)	1.2E-02	3.8E-04	2.4E-04	1.2E-02	3.8E-04	2.4E-04
Argonne National Laboratory-East	1.7	5.7E-02	3.4E-02	1.7	5.7E-02	3.4E-02
Battelle Columbus Laboratory	1.3E-01	4.3E-03	3.5E-03	1.3E-01	4.3E-03	3.5E-03
Bettis Atomic Power Laboratory	1.0E-01	3.2E-03	3.4E-03	1.0E-01	3.2E-03	3.4E-03
Bettis Atomic Power Shipyards	2.6E-03	5.6E-05	8.7E-05	2.6E-03	5.6E-05	8.7E-05
Brookhaven National Laboratory	3.8E-01	1.2E-02	2.1E-02	3.6	1.1E-01	2.0E-01
Energy Technology Engineering Center	7.3E-02	4.8E-03	1.2E-02	7.8E-02	5.2E-03	1.3E-02
Fermi National Accelerator Laboratory	3.2E-01	1.0E-02	4.3E-03	3.2E-01	1.0E-02	4.3E-03
General Electric Vallecitos	0	0	0	1.1E-03	8.2E-05	2.2E-04
Grand Junction Projects Office	0	0	0	3.4E-03	1.3E-04	2.5E-04
Idaho National Engineering and Environmental Laboratory	0	0	0	2.4E-01	1.8E-02	6.8E-03
Inhalation Toxicology Research Institute	0	0	0	6.7E-02	2.5E-03	3.5E-03
Knolls Atomic Power Shipyards	7.2E-02	2.3E-03	2.7E-03	7.2E-02	2.3E-03	2.7E-03
Lawrence Berkeley National Laboratory	7.2E-03	5.3E-04	1.5E-03	7.2E-03	5.1E-04	1.5E-03
Lawrence Livermore National Laboratory	0	0	0	4.4E-01	3.2E-02	8.6E-02
MIT/Bates Linear Accelerator Center	3.2E-03	8.4E-05	1.4E-04	3.2E-03	8.4E-05	1.4E-04
Oak Ridge Reservation	0	0	0	1.6E+01	5.0E-01	4.0E-01
Paducah Gaseous Diffusion Plant	1.2E-2	3.6E-4	2.5E-04	1.2E-2	3.6E-4	2.5E-04
Pantex Facility	0	0	0	1.8E-01	7.3E-03	5.3E-03
Princeton Plasma Physics Laboratory	4.7E-01	1.4E-02	1.7E-02	4.7E-01	1.4E-02	1.7E-02
Rocky Flats Plant	0	0	0	6.9	1.8E-01	1.1E-01
Sandia National Laboratories	0	0	0	2.4E-01	1.0E-02	1.5E-02
Separations Process Research Unit	0	0	0	1.6	5.4E-02	6.3E-02
Stanford Linear Accelerator	3.1E-02	2.2E-03	9.2E-03	3.1E-02	2.2E-03	9.2E-03
West Valley Nuclear Services	0	0	0	2.0	6.6E-02	6.9E-02
Total LLW	3.3	1.1E-01	1.1E-01	3.4E+01	1.1	1.0
MLLW						
Battelle Columbus Laboratory	2.2E-03	6.4E-05	6.3E-05	2.2E-03	6.4E-05	6.3E-05
Energy Technology Engineering Center	0	0	0	7.0E-02	4.6E-03	1.2E-02
Idaho National Engineering and Environmental Laboratory	0	0	0	7.6E-03	5.5E-04	2.1E-04
Knolls Atomic Power Laboratory	2.9E-03	9.4E-05	1.1E-04	2.9E-03	9.4E-05	1.1E-04
Los Alamos National Laboratory	0	0	0	4.5E-01	1.3E-02	1.5E-02
Oak Ridge Reservation	0	0	0	1.1E+01	3.5E-1	2.8E-01
Paducah Gaseous Diffusion Plant	0	0	0	5.9E-1	1.8E-2	1.2E-02
Portsmouth Gaseous Diffusion Plant	0	0	0	5.7E-01	1.7E-02	1.9E-02
Princeton Plasma Physics Laboratory	2.2E-02	6.8E-04	7.9E-04	2.2E-02	6.8E-04	7.9E-04
Puget Sound Naval Shipyards	2.4E-04	3.0E-06	4.3E-05	2.4E-04	3.0E-06	4.3E-05

Table H.18. (contd)

Waste Type/Generator	Lower Bound Volume			Upper Bound Volume		
	Total Number of Accidents	Number of Fatalities	Emissions LCFs	Total Number of Accidents	Number of Fatalities	Emissions LCFs
Rocky Flats Plant	0	0	0	7.2	1.9E-01	1.2E-01
Sandia National Laboratory	0	0	0	1.5E-02	6.2E-04	9.3E-04
Savannah River Site	0	0	0	1.4	4.5E-02	5.1E-02
West Valley Nuclear Services	0	0	0	5.2E-03	1.7E-04	1.7E-04
Total MLLW	2.8E-02	8.4E-04	1.0E-03	2.1E+01	6.5E-01	5.0E-01
CH TRU Waste						
Battelle Columbus Laboratories	2.9E-03	7.3E-05	6.3E-05	2.4E-03	7.3E-05	6.3E-05
Energy Technology Engineering Center	7.3E-04	4.8E-05	1.2E-04	7.3E-04	4.8E-05	1.2E-04
General Electric-Vallecitos Nuclear Center	0	0	0	2.3E-03	1.6E-04	4.4E-04
Lawrence Berkeley National Laboratory	0	0	0	5.6E-04	4.1E-05	1.2E-04
Lawrence Livermore National Laboratory	0	0	0	9.4E-02	6.8E-03	1.9E-02
Nevada Test Site	0	0	0	2.5E-02	1.0E-03	1.8E-04
Total CH TRU Waste	3.6E-03	1.2E-04	1.9E-04	1.3E-01	8.2E-03	2.1E-02
RH TRU Waste						
Battelle Columbus Laboratories	6.9E-02	2.3E-03	1.8E-03	6.9E-02	2.3E-03	1.8E-03
Energy Technology Engineering Center	1.2E-02	8.2E-04	2.1E-03	1.2E-02	8.2E-04	2.1E-03
Framatome ANP	0	0	0	1.4E-04	6.7E-06	5.4E-06
General Electric-Vallecitos Nuclear Center	0	0	0	3.2E-02	2.3E-03	6.3E-03
Total RH TRU Waste	8.1E-02	3.1E-03	3.9E-03	1.1E-01	5.4E-03	1.0E-02
TRU From Hanford to WIPP	1.7E+01	5.5E-01	3.2E-01	1.7E+01	5.6E-01	3.3E-01
Action Alternative Groups (Hanford Only Waste Volume of TRU Waste)						
CH TRU Waste to WIPP	1.1E+01	3.5E-01	2.0E-01	Not Applicable		
RH TRU Waste to WIPP	6.0E+00	2.0E-01	1.2E-01			
Total TRU Waste to WIPP	17	5.4E-01	3.2E-01			
No Action Alternative (Hanford Only Waste Volume of TRU Waste)						
CH TRU Waste to WIPP	8.4E+00	2.8E-01	1.6E-01	Not Applicable		

Note: Totals are rounded to one significant figure. Due to rounding, the sums of the numbers in the table may not exactly match the totals.

(a) Non-radiological accident impacts are expressed as the expected number of accidents and the resulting non-radiological fatalities. Non-radiological emissions impacts are expressed as LCFs.

Table H.19. Summary of Non-Radiological Impacts for Offsite Shipments by Waste Type (Fatalities)[(a)]

Waste Type	Lower Bound			Upper Bound		
	Total Number of Accidents	**Number of Fatalities**	**Non-Radiological Emissions, LCFs**	**Total Number of Accidents**	**Number of Fatalities**	**Non-Radiological Emissions, LCFs**
LLW to Hanford	3.3	1.1E-01	1.1E-01	3.4E+01	1.1	1.0
MLLW to Hanford	2.8E-02	8.4E-04	1.0E-03	2.1E+01	6.3E-01	5.0E-01
CH TRU waste to Hanford	3.6E-03	1.2E-04	1.9E-04	1.3E-01	8.2E-03	2.1E-02
RH TRU waste to Hanford	8.1E-02	3.1E-03	3.9E-03	1.1E-01	5.4E-03	1.0E-02
Total from Offsite to Hanford	3.4	1.2E-01	1.1E-01	5.5E+01	1.7	1.6
TRU From Hanford to WIPP	1.7E+01	5.6E-01	3.3E-01	1.7E+01	5.6E-01	3.3E-01
Grand Total	20 (2.0E+01)	1 (6.6E-01)	0 (4.4E-01)	73 (7.3E+01)	2 (2.3)	2 (1.9)
Action Alternative Groups (Hanford Only Waste Volume of TRU Waste)						
CH and RH TRU Waste to WIPP	17	1 (5.4E-01)	0 (1.6E-01)	Not Applicable		
No Action Alternative (Hanford Only Waste Volume of TRU Waste)						
CH TRU waste to WIPP	8 (8.4)	0 (2.8E-01)	0 (1.6E-01)	Not Applicable		

Note: Totals are rounded to one significant figure. Due to rounding, the sums of the numbers in the table may not exactly match the totals.

(a) Non-radiological accident impacts are expressed as the expected number of accidents and the resulting non-radiological fatalities. Non-radiological emissions impacts are expressed as LCFs.

The impact estimates for shipments of TRU wastes from Hanford to WIPP are larger than those for shipping all waste types from offsite to Hanford in the Lower Bound case. For the Upper Bound waste volume, the non-radiological impact estimates are lower for the TRU waste shipments to WIPP than the shipments from offsite to Hanford. Note that there are only small differences in estimated impacts (not shown in Table H.19 due to rounding) between the Upper Bound and Lower Bound waste volumes for shipments from Hanford to WIPP. TRU waste shipments from offsite represent a small fraction of the impacts resulting from shipments of LLW and MLLW to Hanford for the Upper Bound waste volume.

H.3.2.3 Results of the Maximally Exposed Individual Impact Analysis

This section presents the results of the analysis of potential impacts to maximally exposed individuals (MEIs). Section H.3.2.3.1 presents the analysis of incident-free radiation exposures and Section H.3.2.3.2 presents the analysis of exposures under accident conditions.

H.3.2.3.1 Incident-Free Radiation Exposures to MEIs

Table H.20 provides the unit doses (rem per shipment) and estimates of the radiation doses and impacts to MEIs for shipments of solid waste to and from the Hanford Site. The risks are calculated for 40 years of shipments. As shown, state inspectors and truck crew members receive the highest individual radiation exposures.

Table H.20. Estimated Doses and Impacts to MEIs[(a)]

Individual	Unit Dose (rem per shipment)	Dose, Rem	Probability of LCF
Involved Worker			
Truck crew	Not applicable	80[(b)]	5E-02
Inspector	Not applicable	80[(b)]	5E-02
Public			
Resident along route[(c)]	3.8E-05	0.32	2E-04
Person in traffic jam[(d)]	0.016	0.016	1E-05
Person at service station[(e)]	3.0E-04	0.84	5E-04

(a) The assumed external dose rate is 10 mrem/hr at 2 m from the vehicle for all shipments.
(b) Totals for 40 years of operation assuming a 2 rem/year administrative dose limit.
(c) The maximally exposed resident along the highway route is assumed to be exposed to all CH and RH TRU shipments from Hanford to WIPP. An exposure distance of 30 m from the shipments was assumed (DOE 1997b).
(d) The person in a traffic jam is assumed to be exposed one time only (DOE 2002b).
(e) The person at a service station is assumed to be exposed to one-third of the CH and RH TRU waste shipments from Hanford to WIPP (based on a 3-shifts-per-day operation). The assumed exposure distance was 16 m (52 ft) and the exposure duration was 49 minutes (DOE 2002b).

DOE determined that the largest potential public radiation exposures would be received by a person at a truck service station who was assumed to be exposed to one-third of the shipments to Hanford from offsite and from Hanford to WIPP. This is based on an assumed 3-shifts-per-day operation for the service station. Based on information provided in Table H.20, the dose estimate to a service station attendant would be about 20 millirem per year. This value was calculated by dividing the total service station attendant dose of 0.84 rem (or 840 millirem) by 40 years of waste management operations. This equates to approximately 20 millirem per year. This would not exceed the maximum allowable dose to a member of the public (100 mrem/yr). Although it is unlikely that the same individual would be present for even one-third of the shipments to and from Hanford, given the extended time period over which shipments would occur, a potential traffic funnel exists at the port of entry into Washington through which all the shipments to and from Hanford could pass. However, actual doses likely are to be even smaller if actual package dose rates are used rather than the regulatory maximum limit.

H.3.2.3.2 Maximum Credible Accident Exposures

This section estimates the impacts from a severe transportation accident. The information in this section was extracted from the WIPP SEIS-II (DOE 1997b). The impacts presented in this section also are representative of the potential radiological impacts of a successful terrorist attack on a waste shipment. The potential impacts presented in this section also were considered to represent those that could occur from a terrorist attack. See Section H.8 for further information on terrorist attacks.

DOE (1997b) estimated the radiological impacts from bounding-case transportation accidents involving TRU wastes. In the analysis, it was assumed that a Severity Category VIII accident occurred, leading to a release of radioactive material from a shipping container. The accident was assumed to occur during very stable meteorological conditions. This has the effect of limiting the dispersion of the released radioactive material, which maximizes the calculated radiation doses. The accident was assumed to occur in an urban area. Bounding and average radionuclide inventories in CH and RH TRU waste accidents were used in this analysis. For conservatism elsewhere in this HSW EIS, the bounding inventories were used for all offsite CH and RH TRU waste shipments (see Table H.10). The results from DOE (1997b) were adjusted to reflect the health effects conversion factor used in the HSW EIS (that is, 6E-04 LCF per person-rem) and are summarized in Table H.21.

Table H.21. Summary of Impacts of Maximum Credible Accidents from DOE (1997b)

	Bounding Inventory				**Average Inventory**			
Waste Type	**Population Dose, person-rem**	**LCFs[a]**	**Maximum Individual Dose, rem**	**LCFs**	**Population Dose, person-rem**	**LCFs**	**Maximum Individual Dose, rem**	**LCFs**
CH TRU waste	31,800	19	123	0 (0.07)	6,370	4	80	0 (0.05)
RH TRU waste	32,500	20	125	0 (0.08)	72	0 (0.04)	1.4	0 (0.0008)

(a) LCFs were calculated by multiplying the dose estimates given in DOE (1997b) by 6E-04 LCF per person-rem (or rem).

H.3.3 Summary of Potential Impacts of Onsite and Offsite Waste Shipments

This section summarizes the potential impacts of onsite and offsite waste shipments under all the alternative groups and waste volume cases evaluated in this HSW EIS. In addition, this section presents the results of two sensitivity studies; one examined the potential impacts of increasing cross-country shipments of TRU wastes to Hanford, the other examined inclusion of the TRU wastes from West Valley, New York, to the Upper Bound waste volume.

H.3.3.1 Hanford Solid Waste Management Lifecycle Transportation Impacts

Tables H.22 through H.24 combine the potential transportation impacts of onsite and offsite shipments into three shipment origin-destination categories:

- shipments that take place entirely within the Hanford Site
- shipments of offsite waste to Hanford for treatment, processing, or disposal
- shipments of Hanford waste to offsite facilities for treatment or disposal.

Table H.22 presents the total shipment-miles in these three categories; Table H.23 provides the potential LCF impacts (including radiological incident-free, radiological accident, and non-radiological emissions impacts); and Table H.24 provides the potential non-radiological accident fatalities from traffic accidents. These results are illustrated in Figures H.2 through H.4.

Table H.22 shows that the No Action Alternative results in the lowest shipment-miles for the Hanford Only and Lower Bound waste volumes. This is because only small quantities of waste are transported to and from Hanford in the No Action Alternative. The lowest shipment-miles are projected for the No Action Alternative, Hanford Only waste volume. The action alternatives, Hanford Only waste volume, are the next lowest with respect to shipment-mileage. The projected mileage for Hanford Only waste volume, Alternative Group B, is slightly lower than for Alternative Groups A, C, D, and E due to the smaller volume of MLLW shipped offsite for treatment and back to Hanford for disposal. The greatest shipment-mileage projections are for the Upper Bound waste volume due to the relatively large volumes of MLLW and LLW that would be shipped from offsite to Hanford for disposal.

The potential radiological and non-radiological LCF impacts shown in Table H.23 range from about 2 LCFs for the No Action Alternative, Hanford Only waste volume, to 10 LCFs for the Upper Bound waste volume. Also, within each waste volume, the LCF impacts of Alternative Group B are larger than those for Alternative Groups A, C, D, and E. This is due to the longer ILAW shipping distance onsite in Alternative Group B, which more than offsets the impacts of the additional MLLW shipped offsite for treatment and back to Hanford for disposal in Alternative Groups A, C, D, and E.

The potential radiation and emissions LCF impacts in Table H.23 are projected to occur from exposures to carcinogens (radiation exposures to truck crews and nearby populations and exposures to pollutants in vehicle exhaust) that will take place over the approximately 40 years of waste operations. For perspective, according to the U.S. Centers for Disease Control, National Center for Health Statistics, a total of 10,802 residents of the state of Washington and 7,057 residents of the state of Oregon died of cancer in 2001 (CDC 2003). The cancer mortality rates were 193 and 196 per 100,000 residents, respectively. A total of 36,245 residents of Washington and Oregon were estimated by TRAGIS to live within 800 meters of the highway route between Hanford and Ontario, Oregon. Based on a cancer mortality rate of approximately 200 fatalities per year per 100,000 people, about 70 cancer fatalities per year, or about 2,800 cancer fatalities over a 40-year period, would be estimated in the population along the route from Hanford to Ontario, Oregon, due to causes unrelated to shipments of waste to and from Hanford.

Table H.24 shows that the projected number of fatalities from traffic accidents ranges from 0 for the No Action Alternative, Hanford Only waste volume to about 2 for the Upper Bound waste volume in the action alternative groups. All the other combinations of alternative groups and waste volume cases are projected to result in 1 fatality from traffic accidents.

For additional perspective, the potential transportation impacts from shipments of waste to, from, and within Hanford were compared with traffic accident fatalities from causes unrelated to Hanford waste shipments. According to the U.S. Department of Transportation, National Highway Traffic Safety Administration, there were a total of 649 traffic fatalities in the state of Washington and 488 traffic fatalities in the state of Oregon for a total of 1,137 fatalities in the two states combined for 2001 (DOT 2002). This represents about 3 traffic fatalities per day in the 2 states due to causes unrelated to waste shipments to and from Hanford. This can be compared with the total projected impacts of about 2 traffic fatalities over about 40 years for the Upper Bound waste volume shipments (approximately 0.0002 traffic fatalities per day). Therefore, the total numbers of projected traffic fatalities from 40 years of transporting solid waste to, from, and within Hanford are approximately the same as the traffic fatalities that occur, on average, every day in the states of Washington and Oregon.

Table H.22. Total Shipment-Miles (in millions of miles) by Shipment Origin and Waste Type

	Hanford Only Waste Volume			**Lower Bound Waste Volume**			**Upper Bound Waste Volume**		
	No Action Alternative	**Alternative Groups**		**No Action Alternative**	**Alternative Groups**		**No Action Alternative**	**Alternative Groups**	
		A,C,D, E	**B**		**A,C,D,E**	**B**		**A,C,D,E**	**B**
Onsite Shipments									
LLW	2.5	2.5	2.5	2.5	2.5	2.5	NA	2.5	2.5
MLLW	1.2	1.5	0.7	1.5	1.5	0.7	NA	1.5	0.7
TRU Wastes	0.4	0.3	0.3	0.4	0.3	0.3	NA	0.3	0.3
ILAW	0	0.2	1.9	0	0.2	1.9	NA	0.2	1.9
Total	4.1	4.6	5.5	4.1	4.6	5.5	NA	4.6	5.5
Offsite Shipments to Hanford									
LLW	NA	NA	NA	6.1	6.1	6.1	NA	59.8	59.8
MLLW (includes MLLW from ORR/Comm Treat and offsite)[a]	<0.1	2.4	0.1	<0.1	2.4	0.2	NA	38.1	35.8
TRU Wastes	NA	NA	NA	0.2	0.2	0.2	NA	0.7	0.7
Total	<0.1	2.4	0.1	6.4	8.7	6.5	NA	98.5	96.3
Hanford to Offsite Facilities									
MLLW to ORR/Comm Treat[a]	<0.1	2.4	0.1	<0.1	2.4	0.1	NA	2.4	0.1
TRU Wastes to WIPP	16.2	31.8	31.8	16.2	36.2	36.2	NA	36.9	36.9
Total	16.2	34.2	32.0	16.2	38.5	36.3	NA	39.3	37.1
GRAND TOTAL	20 (20.4)	41 (41.1)	38 (37.6)	27 (26.7)	52 (51.8)	48 (48.3)	NA	140 (142)	140 (139)

(a) These data include MLLW that is assumed to be shipped to ORR or an offsite commercial treatment facility (comm treat) for treatment and then returned to Hanford for disposal. The Lower Bound waste volume includes a small quantity of MLLW shipped to Hanford for disposal and the Upper Bound waste volume includes shipment of a much larger quantity of MLLW to Hanford for disposal.

NA = not applicable.

Table H.23. Latent Cancer Fatality (LCF) Impacts by Shipment Origin and Waste Type[(a)]

	Hanford Only Waste Volume			Lower Bound Waste Volume			Upper Bound Waste Volume		
	No Action Alternative	Alternative Groups		No Action Alternative	Alternative Groups		No Action Alternative	Alternative Groups	
		A,C,D, E	B		A,C,D,E	B		A,C,D,E	B
Onsite Shipments									
LLW	0.072	0.071	0.071	0.072	0.071	0.071	NA	0.071	0.071
MLLW (including melters)	0.035	0.042	0.022	0.035	0.042	0.022	NA	0.042	0.022
TRU Wastes	0.046	0.041	0.04	0.046	0.041	0.04	NA	0.041	0.04
ILAW	0	0.077	0.77	0	0.077	0.77	NA	0.077	0.77
Total	0.15	0.23	0.9	0.15	0.23	0.9	NA	0.23	0.9
Offsite Shipments to Hanford									
LLW	NA	NA	NA	0.25	0.25	0.25	NA	2.4	2.4
MLLW (includes MLLW from ORR/Comm Treat and offsite)[(b)]	<0.001	0.12	0.0064	<0.001	0.12	0.0087	NA	1.4	1.3
TRU Wastes	NA	NA	NA	0.043	0.043	0.043	NA	0.16	0.16
Total	<0.001	0.12	0.0064	0.29	0.41	0.3	NA	4.0	3.9
Hanford to Offsite									
MLLW to ORR/Comm Treat[(b)]	<0.001	0.12	0.0064	<0.001	0.12	0.0064	NA	0.12	0.0064
TRU Wastes to WIPP	1.8	5.0	5.0	1.8	5.0	5.0	NA	5.2	5.2
Total	1.8	5.1	5.0	1.8	5.1	5.0	NA	5.3	5.2
GRAND TOTAL	2 (1.9)	5 (5.4)	6 (5.9)	2 (2.2)	6 (5.8)	6 (6.2)	NA	10 (9.5)	10 (10.0)

Note: Totals are rounded to one significant figure. Due to rounding, the sums of the numbers in the table may not exactly match the totals.

(a) These values are the sums of the potential LCFs from incident-free radiological exposures, probability-weighted radiological accident risks, and incident-free non-radiological emissions.

(b) These data include MLLW that is assumed to be shipped to ORR or an offsite commercial treatment facility (comm treat) for treatment and then returned to Hanford for disposal. The Lower Bound waste volume includes a small quantity of MLLW to be shipped to Hanford for disposal and the Upper Bound waste volume includes shipment of a much larger quantity of MLLW to Hanford for disposal.

NA = not applicable.

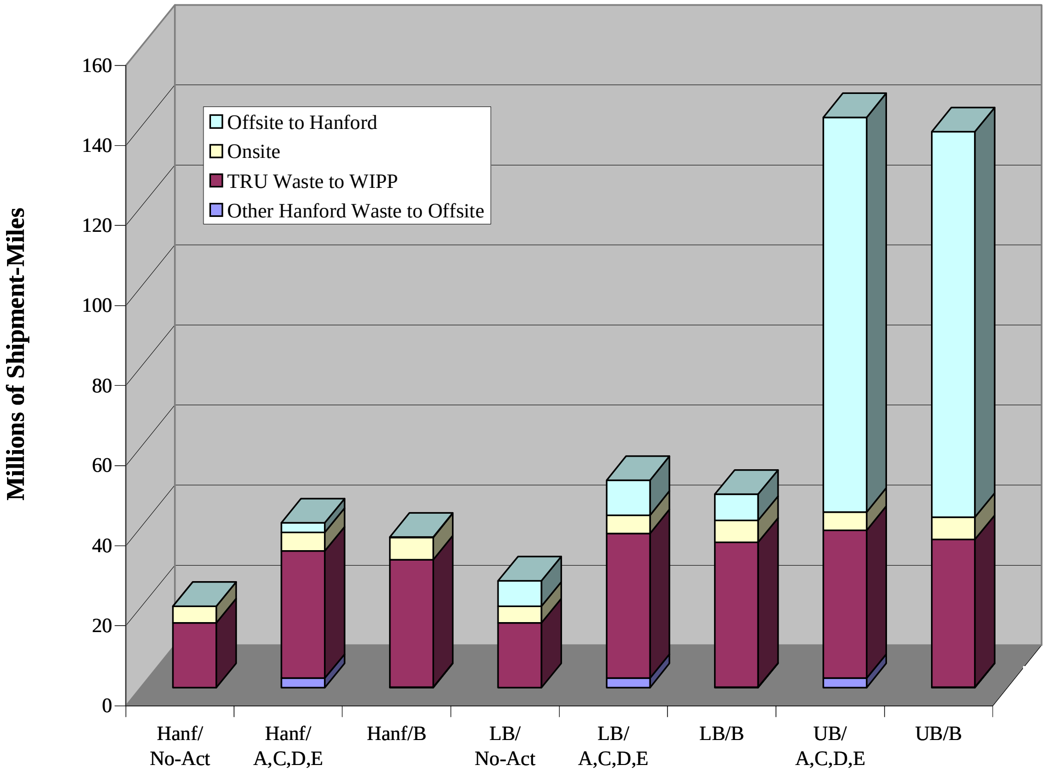
Table H.24. Non-Radiological Accident Impacts by Shipment Origin and Waste Type

	Hanford Only Waste Volume			**Lower Bound Waste Volume**			**Upper Bound Waste Volume**		
	No Action Alternative	**Alternative Groups**		**No Action Alternative**	**Alternative Groups**		**No Action Alternative**	**Alternative Groups**	
		A,C,D, E	**B**		**A,C,D,E**	**B**		**A,C,D,E**	**B**
Onsite Shipments									
LLW	0.03	0.031	0.031	0.03	0.031	0.031	NA	0.031	0.031
MLLW (including melters)	0.015	0.018	0.0087	0.015	0.018	0.0087	NA	0.018	0.0087
TRU Wastes	0.0047	0.0039	0.0039	0.0047	0.0039	0.0039	NA	0.0039	0.0039
ILAW	0	0.0023	0.023	0	0.0023	0.023	NA	0.0023	0.023
Total	0.05	0.055	0.067	0.05	0.055	0.067	NA	0.055	0.067
Offsite Shipments to Hanford									
LLW	NA	NA	NA	0.11	0.11	0.11	NA	1.1	1.1
MLLW (includes MLLW from ORR/Comm Treat and offsite) [(a)]	<0.0001	0.015	0.00081	<0.0001	0.016	0.0016	NA	0.66	0.65
TRU Wastes	NA	NA	NA	0.0032	0.0032	0.0032	NA	0.014	0.014
Total	<0.0001	0.015	0.00081	0.11	0.13	0.12	NA	1.8	1.7
Hanford to Offsite									
MLLW to ORR/Comm Treat[(a)]	<0.0001	0.015	0.00081	<0.001	0.015	0.00081	NA	0.015	0.00081
TRU Wastes to WIPP	0.28	0.54	0.54	0.28	0.55	0.55	NA	0.56	0.56
Total	0.28	0.56	0.54	0.28	0.56	0.55	NA	0.58	0.56
GRAND TOTAL	0 (0.33)	1 (0.63)	1 (0.61)	0 (0.44)	1 (0.75)	1 (0.73)	NA	2 (2.4)	2 (2.4)

Note: Totals are rounded to one significant figure. Due to rounding, the sums of the numbers in the table may not exactly match the totals.

(a) These data include MLLW that is assumed to be shipped to ORR or an offsite commercial treatment facilities (comm treat) for treatment and then returned to Hanford for disposal. The Lower Bound waste volume includes a small quantity of MLLW shipped to Hanford for disposal and the Upper Bound waste volume includes shipment of a much larger quantity of MLLW to Hanford for disposal.

NA = not applicable.



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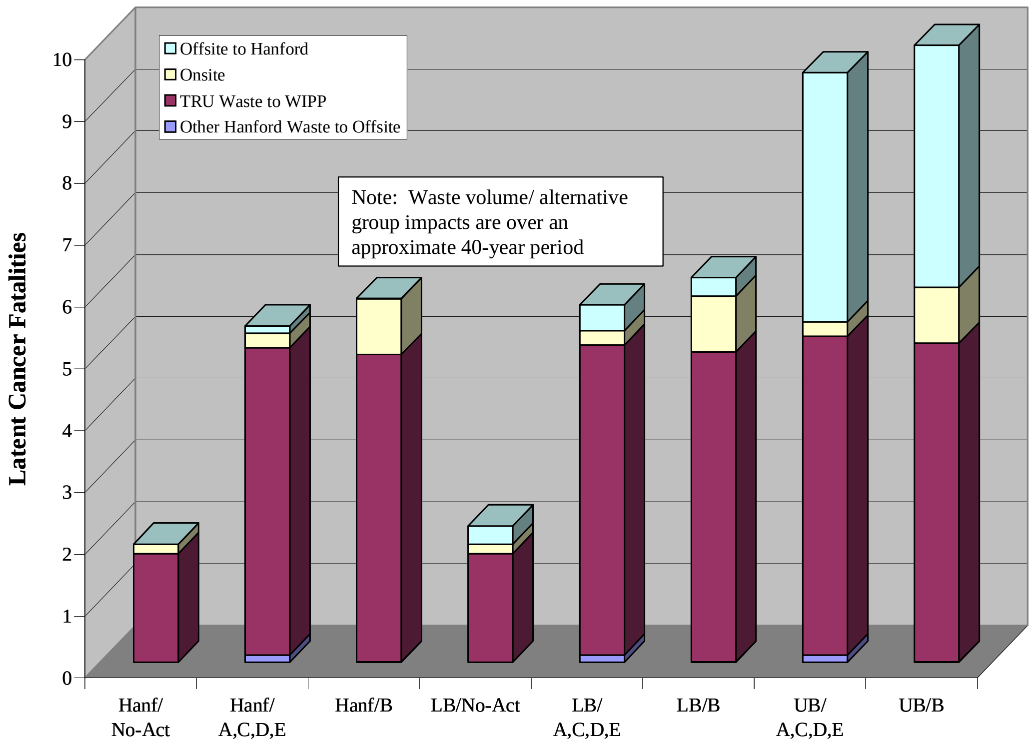
Hanf = Hanford Only waste volume
No Act = No Action Alternative
UB = Upper Bound
LB = Lower Bound
A,C,D,E = Alternative Groups A, C, D, and E
B = Alternative Group B

Figure H.2. Shipment-Miles for Onsite and Offsite Waste Shipments



Note: Waste volume/ alternative group impacts are over an approximate 40-year period

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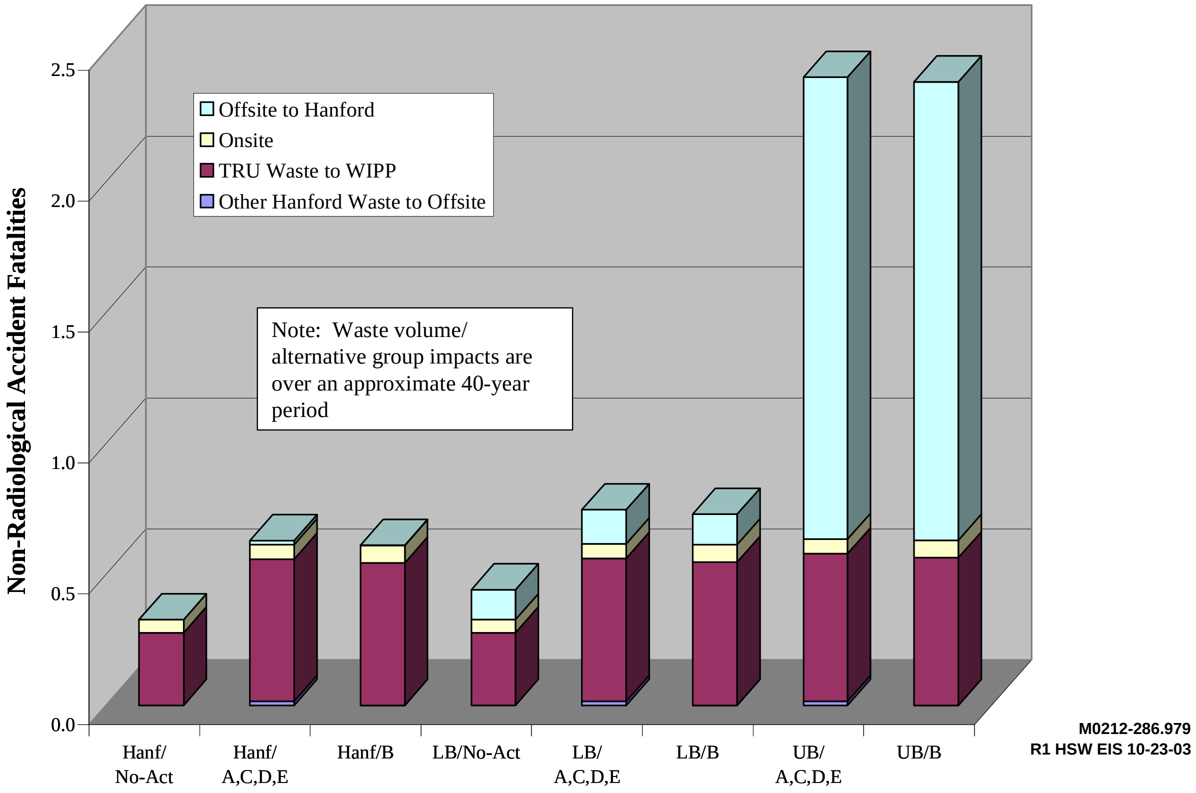
Hanf = Hanford Only waste volume
No Act = No Action Alternative
UB = Upper Bound
LB = Lower Bound
A,C,D,E = Alternative Groups A, C, D, and E
B = Alternative Group B

Figure H.3. Potential Transportation Impacts of Onsite and Offsite Waste Shipments—LCFs from Radiological Incident-Free Transport, Radiological Accidents, and Non-Radiological Emissions[(a)]

(a) Although fatalities should be expressed as whole numbers, fractional fatalities are presented to facilitate illustration. Elsewhere fractional fatalities of 0.5 and greater are rounded up to the next whole number.



Note: Waste volume/ alternative group impacts are over an approximate 40-year period

Hanf = Hanford Only waste volume
No Act = No Action Alternative
UB = Upper Bound
LB = Lower Bound
A,C,D,E = Alternative Groups A, C, D, and E
B = Alternative Group B

Figure H.4. Potential Transportation Impacts of Onsite and Offsite Waste Shipments—Non-Radiological Fatalities from Traffic Accidents[(a)]

H.3.3.2 Sensitivity Studies

This section presents the results of two sensitivity studies that were conducted to examine the effects on transportation impacts of alternative offsite TRU waste generators. The first study examines the effects of shifting a portion of the Upper Bound offsite TRU waste volume from the Western United States to the Eastern United States. The intent is to demonstrate the effects of increased TRU waste shipping distances on the transportation impact estimates for shipping TRU wastes to Hanford under the Upper Bound waste volume. The second sensitivity study examines the effects of receiving additional TRU wastes from West Valley, New York, on the transportation impacts estimates for the Upper Bound waste volume.

(a) Although fatalities should be expressed as whole numbers, fractional fatalities are presented to facilitate illustration. Elsewhere fractional fatalities of 0.5 and greater are rounded up to the next whole number.

H.3.3.2.1 Effects of Shifting some TRU Wastes Receipts from the Western United States to the Eastern United States

Because there is uncertainty about the generators that might ship TRU wastes to Hanford, a sensitivity study was conducted. This study examined the effects of shifting some TRU waste shipments from California to longer, cross-country shipments. It was assumed that 470 m^3 of CH TRU waste and 5 m^3 of RH TRU waste would be shifted from the Lawrence Livermore National Laboratory (LLNL) in California to the Separations Process Research Unit (SPRU) in New York. This would increase the overall shipping distance, yet maintain the total volume of TRU wastes from offsite at about 1550 m^3.

The results of this sensitivity study are shown in Table H.25. As shown, when compared to the base case (see Tables H.17 and H.19), the longer shipping distances increase the impacts. The impacts most strongly dependent on shipping distance—that is, worker (truck crew) incident-free radiological impacts and non-radiological accident fatalities—increase substantially. Those impacts less dependent on total miles traveled (for example, public radiological incident-free impacts and non-radiological emissions are influenced by both mileage and population density) increase by lesser amounts. The non-radiological emissions impacts did not change, which indicates that the affected population in urban zones is higher for the LLNL to Hanford shipments than for the SPRU to Hanford (see Table H.7). However, shifting some TRU wastes from LLNL to SPRU did not result in either a radiological or non-radiological fatality.

Table H.25. Results of Sensitivity Study (Fatalities) for Shifting TRU Waste Shipments from California to New York[(a)]

	Radiological Impacts			Total Number of Accidents	Non-Radiological Impacts	
	Incident-Free LCFs		Accident Public		Number of Fatalities	Emissions LCFs
	Worker	Public				
Base Case						
CH TRU waste	3.8E-03	5.1E-02	2.4E-05	1.3E-01	8.2E-03	2.1E-02
RH TRU waste	2.4E-03	7.4E-02	1.4E-05	1.1E-01	5.4E-03	1.0E-02
Total	6.2E-03	1.3E-01	3.7E-05	2.4E-01	1.4E-02	3.1E-02
Sensitivity Case						
CH TRU waste	5.8E-03	5.0E-02	2.4E-04	2.7E-01	1.2E-02	2.1E-02
RH TRU waste	2.6E-03	7.4E-02	3.5E-05	1.3E-01	5.7E-03	1.0E-02
Total	8.4E-03	1.2E-01	2.7E-04	4.0E-01	1.7E-02	3.1E-02

Note: Due to rounding, the sums of the numbers in the table may not exactly match the totals.

(a) Radiological impacts (incident-free and accident) are expressed in units of LCFs. Non-radiological accident impacts are expressed as the expected number of accidents and the resulting non-radiological fatalities. Non-radiological emissions impacts are expressed as LCFs.

H.3.3.2.2 Potential Incremental Transportation Impacts if West Valley TRU Wastes Were to be Shipped to Hanford

The *West Valley Demonstration Project Waste Management Environmental Impact Statement* (WV EIS) (DOE 2003) describes the environmental impacts of DOE's proposed action to ship radioactive wastes that are either currently in storage, or that will be generated from operations over the next 10 years, from the West Valley Site to offsite disposal locations and to continue ongoing waste management activities at the site. Under DOE's preferred alternative, LLW and MLLW would be shipped to Hanford or the Nevada Test Site for disposal, and TRU wastes would be shipped to WIPP for disposal. DOE's non-preferred alternative is the same as the preferred alternative with respect to LLW and MLLW. However, under DOE's non-preferred alternative, TRU wastes could be sent to Hanford, or other large DOE sites, for interim storage until those wastes could be shipped to WIPP. Although shipment of TRU wastes to Hanford is not the preferred alternative in the WV EIS, an analysis was conducted to examine the potential incremental transportation impacts of shipping West Valley TRU waste to Hanford.

Shipments of TRU wastes to Hanford from West Valley were not addressed in the draft or revised draft HSW EIS analyses because such shipments would not be consistent with the RODs for the WM PEIS (DOE 1997a; 63 FR 3629; 65 FR 82985; 66 FR 38646; 67 FR 56989) or the WIPP SEIS-II (DOE 1997b; 63 FR 3623). In addition, shipments of TRU waste from West Valley were not considered as part of the DOE national TRU waste performance management plan (DOE 2002d). The latter document considered shipment of CH TRU waste from West Valley to an "eastern hub" located at the Savannah River Site (SRS) and then on to WIPP. For RH TRU waste, DOE (2002d) is less specific, stating that RH TRU waste would be shipped to a hub site or existing facilities at RH TRU waste sites for characterization and certification. Shipments of West Valley LLW and MLLW to Hanford were included in the HSW EIS Upper Bound waste volumes; however, the LLW and MLLW volumes in the WV EIS are somewhat larger than those considered in the HSW EIS. As stated elsewhere in the HSW EIS, treatment and disposal of solid wastes at Hanford will be managed in accordance with the total waste volumes and not by generator. For all waste types, the waste volumes that could potentially be received at Hanford from West Valley are small relative to the total waste volumes considered in the HSW EIS. Consequently, inclusion of additional WV EIS waste volumes in the HSW EIS would not affect the impacts at Hanford or decisions to be made about solid waste management at Hanford.

The transportation impact analysis for the West Valley TRU waste shipments was conducted using methods and data that are consistent with those used in the HSW EIS so the incremental impacts are comparable to the impacts presented elsewhere in the HSW EIS. In general, the methods and data used in the WV EIS are similar to those used in the HSW EIS. For example, the RADTRAN 5 and TRAGIS computer codes were used in both documents. However, there are some differences (see below) that could affect comparisons of the impacts, so the HSW EIS assumptions and data were used to recalculate the impacts so they can be directly compared to the other transportation impacts presented in this HSW EIS. This analysis includes shipments of the additional TRU waste from West Valley to Hanford and shipments of those wastes from Hanford to WIPP.

The important differences in the data and assumptions used to calculate transportation impacts between the HSW EIS and WV EIS are discussed below. Many of the data and assumptions are the same or similar, such as the dose rates used for CH TRU and RH TRU waste shipments, CH TRU waste container capacity, route characteristics, accident rates, and release fractions.

Shipping containers. The TRUPACT-II shipping container used for CH TRU waste was assumed to be the same in both the WV EIS and HSW EIS. Consequently, the numbers of CH TRU waste shipments are comparable. However, the RH TRU waste shipping container assumed in the WV EIS is approximately two times the volume of the shipping containers assumed in the HSW EIS, so the number of shipments of RH TRU waste projected in the HSW EIS would be about twice that estimated in the WV EIS. This increased number of shipments resulted in larger transportation impact estimates for RH TRU waste in the HSW EIS than in the WV EIS.

Radionuclide inventories. Radionuclide inventories are used in the estimation of radiological accident impacts. The HSW EIS and WV EIS used CH TRU waste inventories from the WIPP SEIS-II (DOE 1997b). The radiological accident impacts associated with the CH TRU shipments are approximately the same. The RH TRU waste inventories used in the WV EIS were determined by scaling spent nuclear fuel radionuclide distributions to shipping container limits and are lower than those used in the HSW EIS. As a result, the radiological accident impacts presented in the WV EIS for RH TRU waste shipments are not directly comparable to those presented in the HSW EIS. However, since radiological accident impacts are small relative to incident-free and non-radiological emissions impacts, these differences would not affect the total transportation impacts.

Radiation doses at truck stops. Incident-free radiological doses at truck stops are a function of the time spent at truck stops for food, refueling, etc.; the number of people at the stop; and the dose rate to which people are exposed. The approaches that were used to calculate doses at truck stops in the WV EIS and HSW EIS were different. The WV EIS used stop dose factors that were developed for the Yucca Mountain EIS (DOE 2002b). The HSW EIS used the TRAGIS code to estimate stop times for all shipments. Default values were used to model the number of people exposed at stops and the average exposure distance (50 people at 20 m from the shipment). Application of the latter approach resulted in higher “stop” doses in the HSW EIS than in the WV EIS.

Conditional probabilities of accidental releases. The HSW EIS used conditional probabilities of accidental releases that were derived in NRC (1977). In the WV EIS, the conditional probabilities were derived by combining data in NRC (1977) with two reassessments (Fischer et al. 1987a, 1987b; Sprung et al. 2000). Since the reassessments focused on spent nuclear fuel and not the diverse waste materials and forms represented by TRU wastes at various DOE sites, it was decided that the HSW EIS would use bounding values developed in support of NRC (1977). The values used in the HSW EIS resulted in higher radiological accident impacts than those presented in the WV EIS.

Health effects conversion factors. The factors that were used to convert radiation dose estimates in person-rem to health effects (LCFs) were slightly different. In the HSW EIS, the factor used was 6E-04 LCFs per person-rem for both the general public and workers. The

WV EIS used 6E-04 LCFs per person-rem for the general public and 5E-04 LCFs per person-rem for workers. This would result in higher potential impacts to workers in the HSW EIS than the WV EIS.

Since some of the data and assumptions result in higher impact estimates for the HSW EIS and some result in higher estimates for the WV EIS, these data and assumptions offset each other. Overall, the HSW EIS is consistently more conservative than the WV EIS, with the possible exception of radiological accidents involving RH TRU waste, which has little effect on the overall potential transportation impacts. However, because of the differences discussed above, potential impacts from the shipments of West Valley TRU waste to Hanford presented in this section were prepared consistent with the HSW EIS data and assumptions to ensure the results of this analysis are comparable to other results presented in this HSW EIS.

The WV EIS evaluates shipment of about 1130 m^3 (40,000 ft^3) of CH TRU waste and 250 m^3 (9,000 ft^3) of RH TRU waste to Hanford. This amounts to 152 shipments of CH TRU waste and 287 shipments of RH TRU waste for the HSW EIS sensitivity analysis. This is approximately the same number of CH TRU waste shipments and twice the number of RH TRU waste shipments evaluated in the WV EIS (recall that the RH TRU waste shipping container used in the WV EIS has about twice the capacity of the shipping container used in the HSW EIS, so there would be about half as many shipments). The incremental impacts of these shipments are presented in Table H.26, which presents the shipment of TRU waste from West Valley to Hanford and shipment of the same quantity of TRU waste from Hanford to WIPP.

Table H.26. Potential Incremental Transportation Impacts if West Valley TRU Waste were to be Shipped to Hanford

Waste Type	Radiological Impacts, LCFs – Incident-Free – Workers	Radiological Impacts, LCFs – Incident-Free – Public	Radiological Impacts, LCFs – Accidents	Total Number of Accidents	Non-Radiological Impacts – Number of Fatalities	Non-Radiological Impacts – Emissions LCFs
West Valley TRU Waste to Hanford						
CH TRU Waste	0.0067	0.061	<0.001	0.39	0.013	0.013
RH TRU Waste	0.012	0.29	<0.001	0.74	0.024	0.025
Total	0 (0.019)	0 (0.35)	0 (<0.001)	1 (1.1)	0 (0.037)	0 (0.038)
West Valley TRU Waste from Hanford to WIPP						
CH TRU Waste	0.0055	0.053	<0.001	0.31	0.01	0.006
RH TRU Waste	0.0098	0.25	<0.001	0.58	0.019	0.011
Total	0 (0.015)	0 (0.3)	0 (<0.001)	1 (0.89)	0 (0.029)	0 (0.017)
Grand Total – All Shipments	0 (0.034)	1 (0.65)	0 (<0.001)	2 (2.0)	0 (0.066)	0 (0.055)

Note: Totals are rounded to one significant figure. Due to rounding, the sums of the numbers in the table may not exactly match the totals.

Table H.27 presents the potential impacts (that is, shipment-miles, LCFs, and non-radiological accident fatalities) for the HSW EIS Upper Bound waste volume and the HSW EIS Upper Bound waste volume plus the West Valley TRU waste shipments. Also presented are the percentage increases in potential impacts that would result from including the West Valley TRU waste in the HSW EIS analyses. Table H.27 indicates that total shipment-miles would increase by about 3 percent above the HSW EIS Upper Bound waste volume assumptions. This increased mileage results in a 3 percent increase in estimated non-radiological accident fatalities. The additional shipments of TRU waste from West Valley would increase the potential LCFs by about 8 percent. The percentage increase in LCFs is higher than the increase in non-radiological accident fatalities because of the higher assumed dose rates for TRU waste shipments than for LLW and MLLW. Thus radiological impacts from incident-free transport are more strongly influenced by the additional shipments than shipment-mileage and non-radiological accident fatality estimates. In either event, the potential transportation impacts of the additional West Valley TRU waste shipments represent a small fraction of the total transportation impacts estimated for the HSW EIS Upper Bound waste volume.

In addition, regardless of whether the West Valley TRU waste is shipped directly to WIPP or via a hub site, there would be potential transportation impacts. Based on the results presented in the WV EIS, the incremental increase in transportation impacts for shipping via a potential eastern hub at Savannah River or a potential western hub at Hanford would be about 15 to 70 percent, respectively.

Table H.27. Total Potential HSW Transportation Impacts With and Without West Valley TRU Waste Shipments

Scenario	Upper Bound Waste Volume Action Alternatives A,C,D,E	Upper Bound Waste Volume Action Alternatives B
Millions of Shipment Miles		
Onsite	4.6	5.5
Offsite shipments to Hanford	98.5	96.3
Offsite shipments from Hanford	2.4	0.1
Total HSW EIS Upper Bound waste volume without West Valley TRU waste	105.5	102.0
West Valley TRU waste to Hanford	2.3	2.3
West Valley TRU waste/Hanford to WIPP	0.6	0.6
Total HSW EIS Upper Bound waste volume with West Valley TRU waste	108.3	104.8
% increase due to West Valley TRU waste	3%	3%
Latent Cancer Fatalities[(a)]		
Onsite	0 (0.23)	1 (0.9)
Offsite shipments to Hanford	4 (4.0)	4 (3.9)
Offsite shipments from Hanford	5 (5.3)	5 (5.2)
Total HSW EIS Upper Bound waste volume without West Valley TRU waste	10 (9.5)	10 (10.0)
West Valley TRU waste to Hanford	0 (0.41)	0 (0.41)
West Valley TRU waste/Hanford to WIPP	0 (0.33)	0 (0.33)
Total HSW EIS Upper Bound waste volume with West Valley TRU waste	10 (10.3)	11 (10.7)
% increase due to West Valley TRU waste	8%	7%
Non-Radiological Accident Fatalities		
Onsite	0 (0.055)	0 (0.067)
Offsite shipments to Hanford	2 (1.8)	2 (1.7)
Offsite shipments from Hanford	1 (0.58)	1 (0.56)
Total HSW EIS Upper Bound waste volume without West Valley TRU waste	2 (2.4)	2 (2.4)
West Valley TRU waste to Hanford	0 (0.037)	0 (0.037)
West Valley TRU waste/Hanford to WIPP	0 (0.029)	0 (0.029)
Total HSW EIS Upper Bound waste volume with West Valley TRU waste	3 (2.5)	2 (2.4)
% increase due to West Valley TRU waste	3%	3%

Note: Totals are rounded to one significant figure. Due to rounding, the sums of the numbers in the table may not exactly match the totals.

(a) LCFs = Latent cancer fatalities. Includes radiological incident-free impacts to workers and the public, radiological accident impacts, and non-radiological emissions impacts.

H.4 Impacts of Transporting Construction and Capping Materials

This section evaluates the impacts of transporting materials required to construct new facilities, such as new disposal trenches and treatment facilities, as well as materials required to cap the disposal facilities after they are filled with waste. The quantities of these materials, which include concrete, asphalt, basalt, and steel, are compiled for each alternative group in Volume I, Section 5.10. This section evaluates the impacts of transporting these materials from their points of origin to the appropriate Hanford Site facility. Note that only the non-radiological impacts of transportation accidents are evaluated. No radiological impacts would occur because the shipments of construction and capping materials would not involve radioactive material.

The non-radiological accident impacts of transporting construction materials were estimated by first determining the numbers of shipments of each type of material. This calculation was done by dividing the total material requirements by the capacity of a typical shipment. Typically, the shipment capacities are limited to about 18,140 kg (40,000 lb) of cargo to ensure that the shipments are below legal-weight truck limits (36,290 kg [80,000 lb] gross vehicle-weight in most states). The next step was to determine the total distance traveled by these shipments or the product of the round-trip shipping distance and the number of shipments. Finally, the projected numbers of fatalities were determined by multiplying the travel distances by the accident and fatality rates for heavy-combination truck shipping. The accident rate used in this analysis was 1.75E-07 accidents per truck-kilometer (2.8E-07 accidents per truck-mile), and the fatality rate was 7.5E-09 fatalities per truck-kilometer (1.2E-08 fatalities per truck-mile). These rates are representative of accident and fatality rates on Washington state primary highways, similar to the highways and roadways to be used for most of the shipments. The rates used in this analysis were taken from Saricks and Tompkins (1999).

Table H.28 presents the input data and results of the impact analysis for the transport of construction and capping materials. The table includes the estimated impacts associated with each alternative group and waste volume. Although accidents are expected to occur, in no case were any fatalities projected to occur associated with the transport of construction and capping materials.

The results in Table H.28 indicate that there are not large differences in impacts among the alternative groups. For the Hanford Only waste volumes, the projected fatalities ranged from about 0.06 for Alternative Groups C, D, and E to 0.15 fatalities for the No Action Alternative. The impacts of all alternative groups except for the No Action Alternative are dominated by transport of asphalt, gravel/sand, silt/loam, and basalt, and bentonite to use as capping materials. The impacts for the No Action Alternative are dominated by the transport of steel and concrete.

Table H.28. Impacts of Transporting Construction and Backfill Materials

Alternative Group	Waste Volume	Total Material	Shipment Capacity	Total Shipments	Shipment Source	One-way Distance	Total Miles Traveled	Total Number of Accidents	Number of Fatalities
A	**Hanford Only**								
	Asphalt (1000 m^3)	392	12 m^3	32,667	Offsite	45	2.9E+06	5.1E-01	2.2E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2,394	20 m^3	119,700	Area C	15	3.6E+06	6.3E-01	2.7E-02
	Steel (MT)	1,720	10 MT	172	Unspecified	1,000	3.4E+05	6.0E-02	2.6E-03
	Concrete (1000 m^3)	8	10 m^3	831	Offsite	45	7.5E+04	1.3E-02	5.6E-04
	Bentonite (MT)	13,900	19 MT	732	Wyoming	1,000	1.5E+06	2.6E-01	1.1E-02
	Total						8.4E+06	1.5	6.3E-02
	Lower Bound								
	Asphalt (1000 m^3)	394	12 m^3	32,833	Offsite	45	3.0E+06	5.2E-01	2.2E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2,405	20 m^3	120,250	Area C	15	3.6E+06	6.3E-01	2.7E-02
	Steel (MT)	1,870	10 MT	187	Unspecified	1,000	3.7E+05	6.5E-02	2.8E-03
	Concrete (1000 m^3)	10	10 m^3	991	Offsite	45	8.9E+04	1.6E-02	6.7E-04
	Bentonite (MT)	13,900	19 MT	732	Wyoming	1,000	1.5E+06	2.6E-01	1.1E-02
	Total						8.5E+06	1.5	6.4E-02
	Upper Bound								
	Asphalt (1000 m^3)	416	12 m^3	34,667	Offsite	45	3.1E+06	5.5E-01	2.3E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2,500	20 m^3	125,000	Area C	15	3.8E+06	6.6E-01	2.8E-02
	Steel (MT)	2,280	10 MT	228	Unspecified	1,000	4.6E+05	8.0E-02	3.4E-03
	Concrete (1000 m^3)	14	10 m^3	1,431	Offsite	45	1.3E+05	2.3E-02	9.7E-04
	Bentonite (MT)	18,200	19 MT	958	Wyoming	1,000	1.9E+06	3.4E-01	1.4E-02
	Total						9.4E+06	1.6	7.0E-02
B	**Hanford Only**								
	Asphalt (1000 m^3)	438	12 m^3	36,500	Offsite	45	3.3E+06	5.7E-01	2.5E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2,552	20 m^3	127,600	Area C	15	3.8E+06	6.7E-01	2.9E-02
	Steel (MT)	1,800	10 MT	180	Unspecified	1,000	3.6E+05	6.3E-02	2.7E-03
	Concrete (1000 m^3)	10	10 m^3	1,021	Offsite	45	9.2E+04	1.6E-02	6.9E-04
	Bentonite (MT)	33,600	19 MT	1,768	Wyoming	1,000	3.5E+06	6.2E-01	2.7E-02
	Total						1.1E+07	1.9	8.3E-02
	Lower Bound								
	Asphalt (1000 m^3)	444	12 m^3	37,000	Offsite	45	3.3E+06	5.8E-01	2.5E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2,593	20 m^3	129,650	Area C	15	3.9E+06	6.8E-01	2.9E-02
	Steel (MT)	1,950	10 MT	195	Unspecified	1,000	3.9E+05	6.8E-02	2.9E-03
	Concrete (1000 m^3)	12	10 m^3	1,231	Offsite	45	1.1E+05	1.9E-02	8.3E-04
	Bentonite (MT)	33,600	19 MT	1,768	Wyoming	1,000	3.5E+06	6.2E-01	2.7E-02
	Total						1.1E+07	2.0	8.4E-02
	Upper Bound								
	Asphalt (1000 m^3)	498	12 m^3	41,500	Offsite	45	3.7E+06	6.5E-01	2.8E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2,827	20 m^3	141,350	Area C	15	4.2E+06	7.4E-01	3.2E-02
	Steel (MT)	2,380	10 MT	238	Unspecified	1,000	4.8E+05	8.3E-02	3.6E-03
	Concrete (1000 m^3)	16	10 m^3	1,631	Offsite	45	1.5E+05	2.6E-02	1.1E-03
	Bentonite (MT)	57,600	19 MT	3,032	Wyoming	1,000	6.1E+06	1.1	4.5E-02
	Total						1.5E+07	2.6	1.1E-01

Table H.28. (contd)

Alternative Group	Waste Volume	Total Material	Shipment Capacity	Total Shipments	Shipment Source	One-way Distance	Total Miles Traveled	Total Number of Accidents	Number of Fatalities
C	**Hanford Only**								
	Asphalt (1000 m^3)	372	12 m^3	31,000	Offsite	45	2.8E+06	4.9E-01	2.1E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2,174	20 m^3	108,700	Area C	15	3.3E+06	5.7E-01	2.4E-02
	Steel (MT)	1,720	10 MT	172	Unspecified	1,000	3.4E+05	6.0E-02	2.6E-03
	Concrete (1000 m^3)	8	10 m^3	800	Offsite	45	7.2E+04	1.3E-02	5.4E-04
	Bentonite (MT)	13,900	19 MT	732	Wyoming	1,000	1.5E+06	2.6E-01	1.1E-02
	Total						7.9E+06	1.4	5.9E-02
	Lower Bound								
	Asphalt (1000 m^3)	374	12 m^3	31,167	Offsite	45	2.8E+06	4.9E-01	2.1E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2,185	20 m^3	109,250	Area C	15	3.3E+06	5.7E-01	2.5E-02
	Steel (MT)	1,870	10 MT	187	Unspecified	1,000	3.7E+05	6.5E-02	2.8E-03
	Concrete (1000 m^3)	10	10 m^3	960	Offsite	45	8.6E+04	1.5E-02	6.5E-04
	Bentonite (MT)	13,900	19 MT	732	Wyoming	1,000	1.5E+06	2.6E-01	1.1E-02
	Total						8.0E+06	1.4	6.0E-02
	Upper Bound								
	Asphalt (1000 m^3)	396	12 m^3	33,000	Offsite	45	3.0E+06	5.2E-01	2.2E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2,280	20 m^3	114,000	Area C	15	3.4E+06	6.0E-01	2.6E-02
	Steel (MT)	2,280	10 MT	228	Unspecified	1,000	4.6E+05	8.0E-02	3.4E-03
	Concrete (1000 m^3)	14	10 m^3	1,400	Offsite	45	1.3E+05	2.2E-02	9.5E-04
	Bentonite (MT)	18,200	19 MT	958	Wyoming	1,000	1.9E+06	3.4E-01	1.4E-02
	Total						8.9E+06	1.6	6.7E-02
D	**Hanford Only**								
	Asphalt (1000 m^3)	371	12 m^3	30,917	Offsite	45	2.8E+06	4.9E-01	2.1E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2,174	20 m^3	108,700	Area C	15	3.3E+06	5.7E-01	2.4E-02
	Steel (MT)	1,710	10 MT	171	Unspecified	1,000	3.4E+05	6.0E-02	2.6E-03
	Concrete (1000 m^3)	8	10 m^3	800	Offsite	45	7.2E+04	1.3E-02	5.4E-04
	Bentonite (MT)	13,900	19 MT	732	Wyoming	1,000	1.5E+06	2.6E-01	1.1E-02
	Total						7.9E+06	1.4	5.9E-02
	Lower Bound								
	Asphalt (1000 m^3)	371	12 m^3	30,917	Offsite	45	2.8E+06	4.9E-01	2.1E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2,204	20 m^3	110,200	Area C	15	3.3E+06	5.8E-01	2.5E-02
	Steel (MT)	1,870	10 MT	187	Unspecified	1,000	3.7E+05	6.5E-02	2.8E-03
	Concrete (1000 m^3)	10	10 m^3	990	Offsite	45	8.9E+04	1.6E-02	6.7E-04
	Bentonite (MT)	13,900	19 MT	732	Wyoming	1,000	1.5E+06	2.6E-01	1.1E-02
	Total						8.0E+06	1.4	6.0E-02
	Upper Bound								
	Asphalt (1000 m^3)	383	12 m^3	31,917	Offsite	45	2.9E+06	5.0E-01	2.2E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2,331	20 m^3	116,550	Area C	15	3.5E+06	6.1E-01	2.6E-02
	Steel (MT)	2,280	10 MT	228	Unspecified	1,000	4.6E+05	8.0E-02	3.4E-03
	Concrete (1000 m^3)	14	10 m^3	1,400	Offsite	45	1.3E+05	2.2E-02	9.5E-04
	Bentonite (MT)	18,200	19 MT	958	Wyoming	1,000	1.9E+06	3.4E-01	1.4E-02
	Total						8.9E+06	1.6	6.7E-02

Table H.28. (contd)

Alternative Group	Waste Volume	Total Material	Shipment Capacity	Total Shipments	Shipment Source	One-way Distance	Total Miles Traveled	Total Number of Accidents	Number of Fatalities
E	**Hanford Only**								
	Asphalt (1000 m^3)	371	12 m^3	30,917	Offsite	45	2.8E+06	4.9E-01	2.1E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2,174	20 m^3	108,700	Area C	15	3.3E+06	5.7E-01	2.4E-02
	Steel (MT)	1,710	10 MT	171	Unspecified	1,000	3.4E+05	6.0E-02	2.6E-03
	Concrete (1000 m^3)	8	10 m^3	800	Offsite	45	7.2E+04	1.3E-02	5.4E-04
	Bentonite (MT)	13,900	19 MT	732	Wyoming	1,000	1.5E+06	2.6E-01	1.1E-02
	Total						7.9E+06	1.4	5.9E-02
	Lower Bound								
	Asphalt (1000 m^3)	371	12 m^3	30,917	Offsite	45	2.8E+06	4.9E-01	2.1E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2,185	20 m^3	109,250	Area C	15	3.3E+06	5.7E-01	2.5E-02
	Steel (MT)	1,870	10 MT	187	Unspecified	1,000	3.7E+05	6.5E-02	2.8E-03
	Concrete (1000 m^3)	10	10 m^3	990	Offsite	45	8.9E+04	1.6E-02	6.7E-04
	Bentonite (MT)	13,900	19 MT	732	Wyoming	1,000	1.5E+06	2.6E-01	1.1E-02
	Total						8.0E+06	1.4	6.0E-02
	Upper Bound								
	Asphalt (1000 m^3)	383	12 m^3	31,917	Offsite	45	2.9E+06	5.0E-01	2.2E-02
	Gravel/sand, silt/loam, basalt (1000 m^3)	2,280	20 m^3	114,000	Area C	15	3.4E+06	6.0E-01	2.6E-02
	Steel (MT)	2,280	10 MT	228	Unspecified	1,000	4.6E+05	8.0E-02	3.4E-03
	Concrete (1000 m^3)	14	10 m^3	1,400	Offsite	45	1.3E+05	2.2E-02	9.5E-04
	Bentonite (MT)	18,200	19 MT	958	Wyoming	1,000	1.9E+06	3.4E-01	1.4E-02
	Total						8.8E+06	1.5	6.6E-02
No Action	**Hanford Only**								
	Asphalt (1000 m^3)	35	12 m^3	2,933	Offsite	45	2.6E+05	4.6E-02	2.0E-03
	Gravel/sand, silt/loam, basalt (1000 m^3)	2,648	20 m^3	132,405	Area C	15	4.0E+06	7.0E-01	3.0E-02
	Steel (MT)	59,100	10 MT	5,910	Unspecified	1,000	1.2E+07	2.01	8.9E-02
	Concrete (1000 m^3)	420	10 m^3	42,000	Offsite	45	3.8E+06	6.6E-01	2.8E-02
	Bentonite (MT)	0	19 MT	0	Wyoming	1,000	0	0	0
	Total						2.0E+07	3.5	1.5E-01
	Lower Bound								
	Asphalt (1000 m^3)	35	12 m^3	2,933	Offsite	45	2.6E+05	4.6E-02	2.0E-03
	Gravel/sand, silt/loam, basalt (1000 m^3)	2,648	20 m^3	132,405	Area C	15	4.0E+06	7.0E-01	3.0E-02
	Steel (MT)	59,200	10 MT	5,920	Unspecified	1,000	1.2E+07	2.1	8.9E-02
	Concrete (1000 m^3)	422	10 m^3	42,200	Offsite	45	3.8E+06	6.6E-01	2.8E-02
	Bentonite (MT)	0	19 MT	0	Wyoming	1,000	0	0	0
	Total						2.0E+07	3.5	1.5E-01

H.5 Impacts on Traffic

The potential for adverse impacts on traffic would be limited to those associated with the transport of construction materials from offsite, which would be predominantly along 4- to 6-lane highways south of the Hanford Site; traffic congestion would not be expected. The transport of the majority of capping resources would be onsite as material from Area C likely would be delivered under State Route (SR) 240 by conveyors to a holding area in Area B on the Hanford Site east of SR 240. However, for a conservative view, the transportation-impact analysis assumed that all transport of capping material would be by truck.

H.6 Transportation Impacts of Offsite Shipments Within Washington and Oregon

This section estimates the potential impacts within the states of Washington and Oregon of offsite transportation of solid wastes to and from Hanford. Included are the impacts of transporting LLW, MLLW, and TRU wastes from offsite to Hanford Site treatment and disposal facilities; the impacts of transporting MLLW from Hanford to offsite commercial disposal facilities; and the impacts of transporting TRU wastes to WIPP.

H.6.1 Radiological Incident-Free Exposure and Accident Impact Analysis Parameters

The RADTRAN 5 computer code (Neuhauser et al. 2003) was used to perform the transportation-impact calculations. For offsite shipments, the key differences in RADTRAN 5 parameters are primarily related to the route characteristics (for example, shipping distances; travel fractions; and population densities in rural, suburban, and urban population zones). For the purposes of this HSW EIS, three actual routes through Oregon and Washington are assumed (see Figure H.5). The first enters Oregon at approximately Ashland, Oregon, on Interstate 5 (I-5) and travels north to Portland, Oregon. Near Portland, the shipment takes I-205 to I-84 and then travels up the Columbia River Gorge to Umatilla, Oregon. Near Umatilla, shipments exit I-84 onto I-82, cross into the state of Washington, and travel to Richland, Washington. Near Richland, shipments exit onto SR 240 and travels to the Hanford Site. The second route enters the state of Oregon near Ontario, Oregon, on I-84 and continues to Umatilla, Oregon, where it follows I-82 and the same path to Hanford described for the first route. Note that both routes enter the state of Washington at the Umatilla, Oregon/Plymouth, Washington ports of entry. The third route follows I-90 and I-82. This route could be used to transport a small volume (about 3 m^3) of MLLW from the Puget Sound Naval Shipyard to the Hanford Site. Because of the small volume of waste and activity contained therein, the potential impacts along this route would contribute negligibly to potential transportation impacts forecast for the state of Washington along the principal route.

The TRAGIS computer code (Johnson and Michelhaugh 2000) was used to develop the route characteristics information for the RADTRAN 5 runs. A summary of the route characteristics for transport within Washington and Oregon are shown in Table H.29.

Table H.30 summarizes the LLW, MLLW, and TRU wastes volumes that may be transported from offsite to Hanford under the Lower Bound and Upper Bound waste volume scenarios and the TRU waste volume that would be transported from Hanford to WIPP.

For comparison purposes, the remaining RADTRAN 5 parameters were assumed to be the same as for onsite shipments. This is a realistic assumption because the shipping containers for onsite shipments are required to meet equivalent packaging and transportation standards as shipping containers for offsite shipments. The incident-free exposure parameters used in the RADTRAN 5 calculations were presented previously in Table H.1. Note that route-specific estimates of stop time were used in the calculations.

Figure H.5. Transportation Routes in Washington and Oregon

Table H.29. Route Characteristics for Transport Within Washington and Oregon

Route Description	**Distance, km**	**Distance by Zone (km)**			**Population Density, per sq. km**		
		Rural	**Suburban**	**Urban**	**Rural**	**Suburban**	**Urban**
Enter OR at Ashland	825	557.2	214.0	53.6	10.6	366.8	2402.5
Enter OR at Ontario	425	366.2	49.2	9.6	6.5	411.4	2190.1

Table H.30. Offsite Shipping Volumes Used for Oregon and Washington Impacts Calculations

Waste Type	Route, via	Number of Shipments
Lower Bound Waste Volume		
Shipments to Hanford		
LLW	Ontario	1,297
	Ashland	166
MLLW	Ontario	10
	Ashland	0
CH TRU waste	Ontario	1
	Ashland	1
RH TRU waste	Ontario	29
	Ashland	17
Shipments from Hanford to WIPP (Ontario)		
CH TRU waste	Ontario	5,221
RH TRU waste	Ontario	2,986
Total Lower Bound Shipments		
	Ontario	9,544
	Ashland	184
Upper Bound Waste Volume		
Shipments to Hanford		
LLW	Ontario	14,436
	Ashland	943
MLLW	Ontario	9,732
	Ashland	96
CH TRU waste	Ontario	171
	Ashland	26
RH TRU waste	Ontario	39
	Ashland	74
Shipments from Hanford to WIPP (Ontario)		
CH TRU waste	Ontario	5,415
RH TRU waste	Ontario	3,052
Total Upper Bound Shipments		
	Ontario	32,845
	Ashland	1,139
Action Alternative Groups (Hanford Only Waste Volume of TRU Waste)		
CH TRU waste	Ontario	5,221
RH TRU waste	Ontario	2,941
Total TRU Waste Shipments	Ontario	8,162
No Action Alternative (Hanford Only Waste Volume of TRU Waste)		
CH TRU Waste	Ontario	4,161

Route-specific stop times were estimated using the number of stops identified by TRAGIS routing analyses and an assumed 30-minute duration per stop. The accident-analysis parameters used in the RADTRAN 5 calculations were shown previously in Table H.8.

H.6.2 Non-Radiological Impact Analysis Parameters

Potential health effects from two non-radiological impact categories are estimated in this section: 1) impacts from traffic accidents (fatalities) and 2) impacts from incident-free emissions of vehicular pollutants (latent cancer fatalities). Both categories of impacts were calculated by combining unit rates (that is, fatalities per kilometer traveled), distance per shipment, and the number of shipments. Unit fatality rates for traffic accidents in Washington and Oregon were taken from Saricks and Tompkins (1999). Oregon traffic fatality rate data was incomplete in Saricks and Tompkins (1999), so national average fatality rates, which are about four times higher than the average rates in Washington, were used. The unit fatality rate for vehicular emissions was taken from Biwer and Butler (1999).

H.6.3 Analysis Results

The potential transportation impacts in Washington and Oregon for offsite shipments of LLW, MLLW, and TRU wastes are presented in Table H.31. The table includes the impacts in Washington and Oregon for both the Lower Bound and Upper Bound waste volumes. Table H.32 presents the impacts by state. The estimates in Table H.32 were calculated by scaling the overall results in Table H.31 by the ratio of the mileages in each state to the total mileage traveled in Washington and Oregon. Note in Table H.32 that 1 radiological fatality (worker plus public fatalities) is estimated for the Lower Bound waste volume, primarily due to shipments from Hanford to WIPP. Due to the higher volume of LLW and MLLW shipments for the Upper Bound waste volume than for the Lower Bound waste volume, the impact estimates are higher; that is, 1 radiological fatality and 1 non-radiological fatality from traffic accidents are estimated.

Table H.31. Impacts in Washington and Oregon from Shipments of Solid Waste to Hanford from Offsite and Shipments of TRU Wastes to WIPP[(a)]

				Radiological Impacts, LCFs				Non-Radiological Impacts	
				Incident-Free Impacts					
Waste Type	**Route**	**State**	**No of Shipments**	**Worker**	**Public**	**Accidents**	**Total Number of Accidents**	**Number of Fatalities**	**Emissions LCFs**
Lower Bound Waste Volume									
Shipments to Hanford									
LLW	Ontario	WA	1,297	6.8E-04	2.8E-03	4.5E-05	6.1E-02	1.3E-03	5.6E-03
		OR		2.2E-03	8.9E-03	1.4E-04	1.9E-01	1.8E-02	3.6E-03
	Ashland	WA	166	1.1E-04	6.8E-04	2.7E-05	7.8E-03	1.7E-04	7.9E-04
		OR		8.1E-04	5.1E-03	2.0E-04	5.7E-02	5.4E-03	9.1E-03
MLLW	Ontario	WA	10	5.3E-06	2.1E-05	4.2E-07	4.7E-04	1.0E-05	4.4E-05
		OR		1.7E-05	6.8E-05	1.3E-06	1.4E-03	1.4E-04	2.8E-05
	Ashland	WA	0	0	0	0	0	0	0
		OR		0	0	0	0	0	0
CH TRU waste	Ontario	WA	1	1.0E-06	8.6E-06	1.7E-08	4.7E-05	1.0E-06	4.4E-06
		OR		3.2E-06	2.7E-05	5.4E-08	1.4E-04	1.4E-05	2.8E-06
	Ashland	WA	1	1.2E-06	1.6E-05	6.2E-08	4.7E-05	1.0E-06	4.8E-06
		OR		9.3E-06	1.2E-04	4.6E-07	3.4E-04	3.2E-05	5.5E-05
RH TRU waste	Ontario	WA	29	2.7E-05	6.2E-04	4.2E-07	1.4E-03	2.9E-05	1.3E-04
		OR		8.7E-05	2.0E-03	1.3E-06	4.2E-03	4.0E-04	8.1E-05
	Ashland	WA	17	2.0E-05	6.9E-04	8.9E-07	8.0E-04	1.7E-05	8.1E-05
		OR		1.5E-04	5.2E-03	6.7E-06	5.8E-03	5.5E-04	9.3E-04
Shipments From Hanford to WIPP									
CH TRU waste	Ontario	WA	5,221	5.3E-03	4.5E-02	8.8E-05	2.5E-01	5.2E-03	2.3E-02
		OR		1.7E-02	1.4E-01	2.8E-04	7.5E-01	7.1E-02	1.5E-02
RH TRU waste	Ontario	WA	2,986	2.8E-03	6.4E-02	4.3E-05	1.4E-01	3.0E-03	1.3E-02
		OR		9.0E-03	2.0E-01	1.4E-04	4/3E-01	4.1E-02	8.3E-03
Total, all waste types to and from Hanford	Ontario	WA	9,544	8.8E-03	1.1E-01	1.8E-04	4.5E-01	9.6E-03	4.2E-02
		OR		2.8E-02	3.6E-01	5.7E-04	1.4	1.3E-01	2.7E-02
	Ashland	WA	184	1.3E-04	1.4E-03	2.8E-05	8.7E-03	1.8E-04	8.8E-04
		OR		9.7E-04	1.0E-02	2.1E-04	6.1E-02	5.8E-03	1.0E-02
Total by State	All	WA	9,728	8.9E-03	1.1E-01	2.1E-04	4.6E-01	9.7E-03	4.2E-02
		OR		2.9E-02	3.7E-01	7.7E-04	1.4E+00	1.4E-01	3.7E-02
Grand Total			9,728	3.8E-02	4.8E-01	9.8E-04	1.9	1.5E-01	7.9E-02
Upper Bound Waste Volume									
Shipments to Hanford									
LLW	Ontario	WA	14,436	7.6E-03	3.1E-02	5.1E-04	6.8E-01	1.4E-02	6.3E-02
		OR		2.4E-02	9.9E-02	1.6E-03	2.1	2.0E-01	4.0E-02
	Ashland	WA	943	6.1E-04	3.9E-03	1.5E-04	4.4E-02	9.5E-04	4.5E-03
		OR		4.6E-03	2.9E-02	1.1E-03	3.2E-01	3.1E-02	5.2E-02
MLLW	Ontario	WA	9,732	5.1E-03	2.1E-02	4.1E-04	4.6E-01	9.8E-03	4.2E-02
		OR		1.6E-02	6.6E-02	1.3E-03	1.4	1.3E-01	2.7E-02
	Ashland	WA	96	6.2E-05	3.9E-04	1.9E-05	4.5E-03	9.6E-05	4.6E-04
		OR		4.7E-04	3.0E-03	1.4E-04	3.3E-02	3.1E-03	5.3E-03

Table H.31. (contd)

CH TRU waste	Ontario	WA	171	1.7E-04	1.5E-03	2.9E-06	8.1E-03	1.7E-04	7.4E-04
		OR		5.5E-04	4.7E-03	9.2E-06	2.5E-02	2.3E-03	4.8E-04
	Ashland	WA	26	3.2E-05	4.3E-04	1.6E-06	1.2E-03	2.6E-05	1.2E-04
		OR		2.4E-04	3.2E-03	1.2E-05	8.9E-03	8.4E-04	1.4E-03
RH TRU waste	Ontario	WA	39	3.7E-05	8.4E-04	5.6E-07	1.8E-03	3.9E-05	1.7E-04
		OR		1.2E-04	2.7E-03	1.8E-06	5.7E-03	5.3E-04	1.1E-04
	Ashland	WA	74	8.6E-05	3.0E-03	3.9E-06	3.5E-03	7.4E-05	3.5E-04
		OR		6.5E-04	2.3E-02	2.9E-05	2.5E-02	2.4E-03	4.1E-03
Shipments From Hanford to WIPP (Ontario)									
CH TRU waste	Ontario	WA	5,415	5.4E-03	4.6E-02	9.1E-05	2.6E-01	5.4E-03	2.4E-02
		OR		1.7E-02	1.5E-01	2.9E-04	7.8E-01	7.4E-02	1.5E-02
RH TRU waste	Ontario	WA	3,052	2.9E-03	6.5E-02	4.4E-05	1.4E-01	3.1E-03	1.3E-02
		OR		9.2E-03	2.1E-01	1.4E-04	4.4E-01	4.2E-02	8.5E-03
Total, all waste types to and from Hanford	Ontario	WA	32,845	2.1E-02	1.7E-01	1.1E-03	1.5E+00	3.3E-02	1.4E-01
		OR		6.8E-02	5.3E-01	3.4E-03	4.7E+00	4.5E-01	9.2E-02
	Ashland	WA	1,139	7.9E-04	7.7E-03	1.8E-04	5.4E-02	1.1E-03	5.4E-03
		OR		6.0E-03	5.8E-02	1.3E-03	3.8E-01	3.6E-02	6.2E-02
Total by State	All	WA	33,984	2.2E-02	1.7E-01	1.2E-03	1.6E+00	3.4E-02	1.5E-01
		OR		7.4E-02	5.9E-01	4.7E-03	5.1E+00	4.8E-01	1.5E-01
Grand Total			33,984	9.6E-02	7.6E-01	5.9E-03	6.7E+00	5.9E-03	3.0E-01
Action Alternative Groups (Hanford Only Waste Volume of TRU Waste)									
CH TRU Waste	Ontario	WA	5,221	5.3E-03	4.5E-02	8.8E-05	2.5E-01	5.2E-03	2.3E-02
		OR		1.7E-02	1.4E-01	2.8E-04	7.5E-01	7.1E-02	1.5E-02
RH TRU Waste	Ontario	WA	2,941	2.8E-03	6.3E-02	4.2E-05	1.4E-01	2.9E-03	1.3E-02
		OR		8.9E-03	2.0E-01	1.3E-04	4.3E-01	4.0E-02	8.2E-03
Total by State	**All**	WA	8,162	8.0E-03	1.1E-01	1.3E-04	3.8E-01	8.2E-03	3.6E-02
		OR		2.6E-02	3.4E-01	4.2E-04	1.2E+00	1.1E-01	2.3E-02
Grand Total			8,162	3.4E-02	4.5E-01	5.5E-04	1.6E+00	5.5E-04	5.8E-02
No Action Alternative (Hanford Only Waste Volume of TRU Waste)									
CH TRU Waste	Ontario	WA	4,161	4.2E-03	3.6E-02	7.0E-05	2.0E-01	4.2E-03	1.8E-02
		OR		1.3E-02	1.1E-01	2.2E-04	6.0E-01	5.7E-02	1.2E-02
	All		4,161	1.8E-02	1.5E-01	2.9E-04	8.0E-01	6.1E-02	3.0E-02

(a) Radiological impacts (incident-free and accident) are expressed in units of LCFs. Non-radiological accident impacts are expressed as the expected number of accidents and the resulting non-radiological fatalities. Non-radiological emissions impacts are expressed as LCFs.

Table H.32. Impacts in Washington and Oregon by State from Offsite Shipments of Solid Wastes to and from Hanford[(a)]

State	Radiological Incident-Free LCFs		Radiological Accident LCFs	Total Number of Accidents	Non-Radiological Impacts	
	Worker	**Public**			**Number of Fatalities**	**Emissions LCFs**
Lower Bound Waste Volume						
WA	0.0089	0.11	0.00021	0.46	0.0097	0.042
OR	0.029	0.37	0.00077	1.4	0.14	0.037
Total	0 (0.038)	0 (0.48)	0 (0.00098)	2 (1.9)	0 (0.15)	0 (0.079)
Upper Bound Waste Volume						
WA	0.022	0.17	0.0012	1.6	0.034	0.15
OR	0.074	0.59	0.0047	5.1	0.48	0.15
Total	0 (0.096)	1 (0.76)	0 (0.0059)	7 (6.7)	1 (0.52)	0 (0.3)
Action Alternative Groups (Hanford Only Waste Volume of TRU Waste)						
WA	0.008	0.11	0.00013	0.38	0.0083	0.036
OR	0.026	0.34	0.00042	1.2	0.11	0.023
Total	0 (0.034)	0 (0.45)	0 (0.00055)	2 (1.6)	0 (0.12)	0 (0.058)
No Action Alternative (Hanford Only Waste Volume of TRU Waste)						
WA	0.0042	0.036	0.00007	0.2	0.0042	0.018
OR	0.013	0.11	0.00022	0.6	0.057	0.012
Total	0 (0.18)	0 (0.15)	0 (0.00029)	1 (0.8)	0 (0.061)	0 (0.03)

(a) Radiological impacts (incident-free and accident) are expressed in units of LCFs. Non-radiological accident impacts are expressed as the expected number of accidents and the resulting non-radiological fatalities. Non-radiological emissions impacts are expressed as LCFs.

H.7 Results of Hazardous Chemical Impact Analysis

Downwind concentrations of hazardous chemicals released from a severe transportation accident are presented in this section. The resulting chemical concentrations are put in perspective by comparing them to safe exposure levels. The methods used are standard facility safety analysis techniques and are proven methods for assessing potential health effects from accidental releases of hazardous chemical materials. In addition, the impacts presented in this section are representative of the potential hazardous chemical impacts of a terrorist attack on a waste shipment.

The hazardous chemical constituents of MLLW and TRU wastes to be transported to and on the Hanford Site were shown previously in Table H.10. The downwind concentrations shown in Table H.33 were calculated assuming a shipment of maximum-inventory 208-L (55-gal) drums is involved in a severe accident and releases 0.5 percent of the total inventory of each hazardous chemical as respirable particles into the environment. The downwind concentrations are then compared to Temporary Emergency Exposure Limit-2 (TEEL-2) values given by Craig (2002). The TEEL-2 definition follows.

> **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-2 values are used here instead of the more widely accepted Emergency Response Planning Guidelines (ERPGs), because ERPG values do not exist for some of the chemicals listed in Table H.33. TEEL values are interim replacements for the peer-reviewed ERPG values and may be used when ERPG values are not available. ERPG-2 is analogous to TEEL-2 and is defined as follows:

> **ERPG-2**: The maximum concentration in air below which it is believed that nearly all individuals could be exposed *for up to 1 hour* without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.

The difference between TEEL-2 and ERPG-2 is that, for application of TEELs, the concentration at the receptor point is calculated as the peak 15-minute, time-weighted average.

The results of the hazardous-chemical-concentration calculations are shown in Table H.33. The results indicate that downwind concentrations of the hazardous chemicals would not exceed the TEEL-2 guidelines following a severe transportation accident involving a shipment of maximum-inventory 208-L (55-gal) drums. Additional analyses were performed to determine the impacts of assuming that all of the released materials become volatilized under the thermal effects of a transportation-related fire. This was done by changing the aerosol and respirable release fractions of all of the chemicals to 1.0. This resulted in three chemicals exceeding their TEEL-2 concentrations. These three chemicals are elemental lead, elemental mercury, and beryllium. The downwind concentrations of these three chemicals were then compared to their Immediately Dangerous to Life and Health (IDLH) values for an additional perspective. The exposure guideline concentrations are defined as follows:

> **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.
>
> **ERPG-3**: The maximum concentration in air below which it is believed nearly all individuals could be exposed *for up to one hour* without experiencing or developing life-threatening health effects.
>
> **IDLH**: The maximum concentration from which, in the event of respirator failure, a person could escape within 30 minutes without a respirator and without experiencing any escape-impairing (for example, severe eye irritation) or irreversible health effects.

The IDLH values for beryllium, lead, and mercury are 10, 700, and 4.1 mg/m^3, respectively. The downwind concentrations of all three of these chemicals are below their respective IDLH values.

The downwind concentration of beryllium was found to exceed its ERPG-3 concentration. However, the downwind concentrations of all three of the chemicals are below their respective IDLH values. Based on these observations, the conclusion is that releases of hazardous chemicals from transportation accidents are unlikely to result in a fatality.

Table H.33. Hazardous Chemical Concentrations 100 m (109 yd) Downwind from Severe Transportation Accidents (mg/m^3)

	CH MLLW	RH MLLW	MLLW Ready for Disposal	RH TRU Waste Boxes	CH TRU with PCBs	RH TRU Waste in Trenches	Elemental Lead	Elemental Mercury	TEEL-2[(a)]
Acetone	6.9E-03	6.7E-03	6.9E-03	2.6E-05	0	0	0	0	20,000
Beryllium	8.9E-04	8.9E-04	8.9E-04	8.4E-05	8.4E-05	8.4E-05	0	0	0.025
Bromodichloro-methane	3.9E-05	0	3.9E-05	0	0	0	0	0	30
Carbon tetrachloride	1.4E-02	0	1.4E-02	4.5E-03	0	0	0	0	639
Diesel fuel	2.7E-05	0	2.7E-05	0	0	0	0	0	500
Formic acid	3.2E-02	0	3.2E-02	0	0	0	0	0	15
Lead	0	0	0	0	0	0	1.6E-01	0	0.25
Methyl ethyl ketone (MEK or 2 Butanone)	5.4E-03	0	5.4E-03	0	0	0	0	0	750
Mercury	8.3E-06	0	8.3E-06	8.1E-07	0	0	0	2.3E-02	2.05
Nitrate	7.8E-03	0	0	0	0	0	0	0	50
Nitric acid	2.3E-01	2.3E-01	2.3E-01	0	0	0	0	0	15
Polychlorinated biphenyls (PCBs)	9.7E-05	0	9.7E-05	0	3.0E-04	0	0	0	1
p-Chloroaniline	1.9E-02	0	1.9E-02	0	0	0	0	0	50
Sodium hydroxide	3.2E-01	3.2E-01	3.2E-01	1.7E-02	1.7E-02	1.7E-02	0	0	5
Toluene	1.2E-02	3.6E-01	1.2E-02	0	0	0	0	0	1,125
1,1,1-Trichloroethane	2.5E-02	0	2.5E-02	2.6E-05	0	0	0	0	3,850
Xylene	2.1E-03	3.4E-02	2.1E-03	1.4E-04	1.6E-01	1.6E-01	0	0	750

(a) Source: Craig (2002).

The downwind hazardous chemical concentrations are calculated for a person 100 m (109 yd) away from the release point. This assumption is conservative for a member of the public, either offsite or onsite, who is unlikely to be 100 m (109 yd) from the release point for the entire duration of the release. In addition, the release duration used in these calculations was assumed to be 15 minutes. It is unlikely that an impact followed by a fire event would cause the dispersible fraction of the package contents to be released in such a short duration—the release duration is likely to be much longer, perhaps as much as one to two hours, and thus the peak concentrations at the receptor location likely will be lower. Furthermore, the maximum hazardous-chemical concentration for each waste type was modeled. This model includes, in the case of MLLW, 16 hazardous chemicals. It is extremely unlikely that any single 208-L (55-gal) drum would contain the maximum concentrations of all 16 hazardous chemicals. This information provides additional evidence that the results shown in Table H.33 are bounding.

The potential downwind concentrations of hazardous chemicals presented in Table H.33 also were considered to represent those that could occur from a terrorist attack. Note that no fatalities are projected to occur as a result of the exposure to hazardous chemicals. However, the radiological impacts of potential terrorist attacks (see Section H.3.2.3.2) may result in an inferred fatality (that is, an LCF). Therefore, the dominant potential impacts of a terrorist attack are from the release of radioactive materials.

H.8 Potential Impacts of Sabotage or Terrorist Attack

This section addresses the potential environmental impacts from sabotage or terrorist attacks on shipments of solid waste to and from the Hanford Site. The U.S. Department of Transportation has recently issued new requirements (see 68 FR 14510) for development and implementation of security plans for radioactive material shipments. The security plans must assess the security risks posed by the shipments and measures taken to address these risks, including personnel and en route security measures as well as measures taken to prevent unauthorized access. The DOE also has requirements that address the physical security of waste shipments (DOE 2002c), one of which requires preparation of a transportation plan that includes descriptions of cargo security arrangements, as appropriate. In addition to these requirements, DOE complies with the DOT and DOE regulations as described in Section 2.2.4.

These requirements are intended to minimize the possibility of sabotage and facilitate recovery of shipments that could fall under the control of unauthorized persons. The requirements are designed to minimize the impacts of malevolent acts during transport. Truck drivers for all hazardous material shipments are required to receive security training (68 FR 14510). The training must provide an awareness of security risks, recognition of potential security threats, and methods of responding to potential security threats. Truck drivers and other employees of hazardous material transportation companies that are required to have a security plan must receive in-depth training on the security plan and its implementation, including specific security procedures and actions to take in the event of a security breach. In accordance with DOE (2002b), DOE's Office of Transportation Safeguards conducts drills and exercises on a regular basis, including annual in-service tests with DOE and state response elements. Finally, DOE supports and provides assistance in the area of emergency preparedness and emergency response to transportation incidents, including sabotage events and terrorist attacks. These rules apply to offsite shipments in the general-public domain where conditions along transport routes cannot be controlled.

The shipping containers, themselves, provide substantial protection. Type B accident-resistant packaging systems are required for the most hazardous shipments, such as TRU wastes, and certain higher-radioactivity LLW and MLLW shipments, as well as ILAW containers. These packaging systems would provide a substantial amount of protection from terrorist attacks. As discussed in Section H.2, Type B packages are designed to withstand a series of hypothetical accident conditions that simulate the mechanical and thermal conditions a package could potentially be exposed to in a severe transportation accident. These hypothetical accident conditions include free drop onto an unyielding surface, drop onto a steel puncture probe, exposure to a long-duration engulfing fire, and immersion under water. Lower-hazard materials, including most LLW and MLLW shipments, are shipped in Type A packages. The less-hazardous shipments are considered unlikely to be attractive as terrorist targets because they would not involve a high-profile symbol of the United States nor would a successful attack produce a large number of immediate fatalities or injuries.

It is not possible to predict the likelihood of sabotage events or terrorist attacks or the nature of such events. The impacts of severe transportation accidents were used to approximate the potential impacts of a successful terrorist attack on a shipment of radioactive waste. In general, the most severe transportation accidents would involve high-speed impact conditions that result in functional failure or breach of the shipping container (for example, TRUPACT-II) and internal packaging (for example, 208-liter or 55-gal drums) fired by a long-duration engulfing fire that causes further functional failure and dispersal of the package contents. A potential terrorism event would involve a similar progression, that is, breach of external and internal packaging and exposure of the contents to thermal as well as explosion conditions that would lead to a release of and dispersal of the radioactive cargo.

The estimated consequences of a successful terrorist attack on a spent nuclear fuel shipment would bound the potential impacts on shipments of LLW, MLLW, and TRU wastes. This is because of the much greater radionuclide inventories in spent nuclear fuel than in the radioactive wastes to be shipped to or from Hanford. A recent study (Luna et al. 1999) investigated the potential damage effects of two explosive devices that might be used by terrorists on a spent nuclear fuel shipping cask. The devices were shown to be capable of penetrating the spent nuclear fuel shipping cask's thick shield wall and could lead to dispersal of a fraction of the radioactive material. It is postulated in the HSW EIS that the devices also would be capable of penetrating the shipping containers used to transport LLW, MLLW, and TRU wastes. However, the radionuclide inventories in spent nuclear fuel shipments are much larger than the radionuclide inventories in LLW, MLLW, and TRU waste shipments. In comparing the inventories in CH and RH TRU waste shipments (see Table H.10) with those of a spent nuclear fuel assembly (DOE 2002b), it was found that the inventories of plutonium isotopes are 2 to 2400 times higher in a spent nuclear fuel assembly than in TRU waste shipments. The inventory of americium-241 is 100 to 400 times higher and the inventories of cesium-137 and strontium-90 are about 500 times higher in a spent nuclear fuel assembly. Based on these comparisons, spent nuclear fuel represents a substantially higher hazard than CH or RH TRU waste. Shipments of LLW and MLLW, which contain no or only trace amounts of plutonium and americium, represent lower hazards than TRU wastes. Based on these comparisons, DOE concluded that the potential impacts of a successful terrorist attack on a spent nuclear fuel shipment would bound the potential impacts of a similar attack on LLW, MLLW, and TRU waste shipments.

Based on the above discussion, the potential impacts of a terrorist attack on a shipment of radioactive materials covered in this HSW EIS were approximated using the consequences of a successful attack on a spent nuclear fuel shipment (DOE 2002b). The results indicated that such an attack, if conducted successfully in an urban area under stable atmospheric conditions, could result in a population dose of about 96,000 person-rem. Such a population dose would result in about 24 excess LCFs in the exposed population. Maximally exposed individuals could potentially receive a committed dose of 110 rem, which is well below the exposure level that would result in an immediate radiation-induced fatality and would increase the individual's probability of an LCF by about 7 percent. If the attack occurred in a less-densely populated area, the consequences would be much lower. Also, as discussed in Section H.3.2.3.2, a severe but highly unlikely transportation accident in an urban area involving a bounding inventory TRU waste shipment could result in a population dose of about 32,000 person-rem, or about 16 LCFs. Maximum individual doses due to these accidents would be about 120 rem, or an LCF probability of about 0.08. The actual consequences likely would be lower because the vast majority of RH TRU waste shipments would contain less radioactivity than the bounding inventory. These are conservative estimates because they assume that the attack results in complete loss of containment. In addition, interdiction and other measures that would lessen the impacts are not taken into account. A successful terrorist attack on a shipment of LLW or MLLW would involve less-hazardous radionuclide inventories than TRU wastes or spent nuclear fuel and would be expected to have correspondingly smaller consequences.

The potential hazardous chemical impacts of a successful terrorist attack were approximated by increasing the amount of hazardous waste material dispersed as a result of a severe accident to more than that assumed in Section H.7. The additional release quantity would represent the potential additional material that would be available for release due to the explosive effects of a high-energy device that could be used by terrorists. It was assumed that the entire truckload of waste containers would be breached by the explosive device, leading to release and dispersal of the cargo. As was done in Section H.7, a respirable release fraction of 0.5 percent was applied to solid materials and 100 percent of the volatile chemicals were assumed to be released. The analysis did not account for the effects of increased dispersion by the explosive device, combustion of the hazardous materials that would result in a less-toxic material, or any processes that would reduce dispersal (for example, vapor plate-out, particle settlement/deposition, and chemical reactions). All of these phenomena would lessen the impacts. The results indicate that the concentrations of four chemicals—elemental lead, elemental mercury, elemental beryllium, and sodium hydroxide—could exceed the ERPG-2 (or equivalent TEEL-2) guidelines. This is one more chemical (that is, sodium hydroxide) than would potentially exceed the ERPG-2 concentrations after a severe transportation accident (see Section H.7). None of the chemical concentrations exceeds the ERPG-3 (or equivalent TEEL-3) concentrations.

An additional element to consider is most of the shipments of radioactive waste covered in this HSW EIS are within Hanford Site boundaries. Hanford is a controlled-access facility that is protected by various security measures, for example, security guards and visual surveillance systems. Onsite shipments of solid waste would be protected by these same systems, which lessen the likelihood of a successful terrorism incident at Hanford.

H.9 Comparison of HSW EIS Transportation Impacts to Those in Other Environmental Impact Statements

Two recent program-level EISs have been completed by DOE that address nationwide transportation of radioactive and hazardous wastes to or from the Hanford Site, including LLW, MLLW, and TRU wastes considered as part of the HSW EIS. The *Final Waste Management Programmatic Environmental Impact Statement* (WM PEIS, DOE 1997a) evaluated various aspects of managing radioactive and hazardous wastes across all DOE sites. The *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (WIPP SEIS-II, DOE 1997b) evaluated nationwide management of TRU wastes, including transportation to and disposal at WIPP. The following sections compare the scope, methods, data, and results among these studies.

H.9.1 Comparison to the Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste

The WM PEIS (DOE 1997a) evaluated the nationwide impacts of managing four types of radioactive (LLW, MLLW, TRU wastes, and high-level waste) and hazardous wastes. The purpose of the WM PEIS was to evaluate alternatives concerning configurations of sites for waste management activities. A Record of Decision (ROD) on the management of LLW and MLLW was issued on February 25, 2000 (65 FR 10061). DOE decided, among other things, to continue onsite disposal of LLW at four DOE sites and to make Hanford and the Nevada Test Site (NTS) available to DOE sites for the disposal of LLW and MLLW.

The HSW EIS and WM PEIS analyzed similar configurations for the treatment and disposal of LLW and MLLW; however, the HSW EIS used updated, state-of-the-art methods for calculating transportation impacts. For example, the WM PEIS used the HIGHWAY computer code (Johnson et al. 1993) for calculating route characteristics, whereas the HSW EIS used the TRAGIS computer code (Johnson and Michelhaugh 2000). The WM PEIS used RADTRAN 4 (Neuhauser and Kanipe 1992); the HSW EIS used RADTRAN 5 (Neuhauser et al. 2003) code to calculate radiological impacts. The WM PEIS used a non-radiological emissions approach and risk factors developed by Rao et al. (1982) and the HSW EIS used the approach and risk factors from Biwer and Butler (1999). In addition, more recent data sources were used in the HSW EIS that were not available when the WM PEIS was prepared, such as the 2000 population census information. Although these minor differences in approach led to somewhat different numerical results, the conclusions of the two documents are similar.

Comparisons were made between the transportation impacts calculated in the WM PEIS and HSW EIS in an effort to understand what the differences are, if any. The WM PEIS information was taken from the *Information Package on Pending Low-Level Waste and Mixed Low-Level Waste Disposal Decisions to be Made under the Final Waste Management Programmatic Environmental Impact Statement* (DOE 1998a) that was developed to support the February 25, 2000, LLW and MLLW ROD. The *Information Package* was prepared to enable the selection of preferred sites. It analyzed six options for disposal of LLW and five options for MLLW disposal. The *Information Package* summarized information from the original WM PEIS and conducted scaling analyses based on the original WM PEIS to support the site selection decisions described in the *Identification of Preferred Alternatives for the Department of Energy's Waste Management Program: Low-Level Waste and Mixed Low-Level Waste Disposal Site* (64 FR 69241) and the subsequent ROD (65 FR 10061). The comparisons were made against LLW Disposal Option 2 and MLLW Disposal Option D. In both of these options, substantial volumes of LLW (about 100,000 m^3) and MLLW (about 40,000 m^3) are shipped from offsite to Hanford for disposal.

A comparison of the offsite LLW and MLLW volumes shipped to Hanford and the radiological and non-radiological impacts in DOE (1998a) and the associated *Information Package* is presented in Table H.34. The comparisons indicate that the results presented in the HSW EIS for the Upper Bound waste volume are consistent with those in DOE (1998a). The offsite LLW volumes and impacts are about a factor of 2 different, based largely on the differences in the time frames analyzed in the two documents

(20 years for the WM PEIS, 43 years for the HSW EIS). Similarly, the offsite MLLW volumes and impacts are about a factor of 3 different. Consequently, even though there are differences in key assumptions, such as the waste volumes and specific generator sites that ship LLW and MLLW to Hanford, census data (that is, 1990 versus 2000 Census), accident fatality rates, the emissions approach and risk factors, and different computer codes that were used, the results between the two studies are comparable after adjusting for the increased waste volume in the HSW EIS. Note that an important input parameter to the radiological impact calculations is the TI, or radiation dose rate, at 1 m from the package. This parameter is the same for both studies, which accounts largely for the similarities in radiological impacts.

Non-radiological impacts are also similar between the HSW EIS and the WM PEIS after adjusting for the increased waste volume in the HSW EIS. The two most important input parameters to the non-radiological impacts are the shipping characteristics (that is, mileages and population zone information) and fatality rates. Reviews of the rates used in the WM PEIS (Saricks and Kvitek 1994) and the HSW EIS (Saricks and Tompkins 1999) were conducted to identify trends in the data. It was discovered that the results were recorded differently in the two EIS's and, thus, are difficult to compare on a state-by-state basis. However, the United States mean fatality rate on interstate highways is somewhat lower in Saricks and Tompkins (1999) (8.8E-9 fatalities/km) than in Saricks and Kvitek (1994) (2.03E-8 fatalities/km). This would tend to decrease the overall impacts calculated in the HSW EIS relative to the WM PEIS. The population densities along the routes were observed to increase somewhat due to the incorporation of 2000 Census data into TRAGIS (Johnson and Michelhaugh 2000). This would tend to cause the calculated non-radiological fatalities in the HSW EIS to be higher than the WM PEIS. Therefore, it appears that updates to these two parameters have essentially offset each other.

This exercise led to the following observation. Waste volume assumptions appear to be the main factor behind the differences between the WM PEIS, the WM PEIS *Information Package,* and the HSW EIS. The WM PEIS transportation calculations were based on 20 years, whereas the HSW EIS covers the lifecycle of the Hanford Solid Waste Management Program (through 2046). Consequently, the LLW and MLLW volume projections are different, leading to differences in the potential transportation impacts. In addition, the WM PEIS was published in 1997, so the waste-volume projections are several years older than the waste-volume projections used in the HSW EIS. The HSW EIS volumes from offsite represent more recent information from generator sites and are more current than waste volumes analyzed in the WM PEIS.

Table H.34. Comparison of Offsite LLW and MLLW Volumes and Impacts Between the WM PEIS, the WM PEIS Information Package, and the HSW EIS

Category	WM PEIS[(a)]	WM PEIS Information Package[(b)]	HSW EIS Upper Bound Waste Volume
Low-Level Waste			
LLW Volume Shipped to Hanford, m^3	~1,400,000 (20 years)	~100,000 (20 years)	~220,000 (43 years)
Radiological Incident-Free Impacts, LCFs[(c)]	15	0.5[(a)]	1.4
Non-Radiological Fatalities[(d)]	35	1.2	2.1
Mixed Low-Level Waste			
MLLW Volume Shipped to Hanford, m^3	~60,000 (20 years)	~40,000 (20 years)	~140,000 (43 years)
Radiological Incident-Free Impacts, LCFs[(c)]	0.4	0.2	0.8
Non-Radiological Fatalities[(d)]	0.9	0.4	1.2

NOTE: Use caution when comparing these values, because transportation impacts are a function of total shipping distance traveled and route characteristics between the shipping origin and destination sites. It was not possible to definitively determine which specific sites were assumed to ship to Hanford in the WM PEIS and WM PEIS Information Package, so there is substantial uncertainty associated with comparisons among these values.

(a) Source = WM PEIS (DOE 1997a). LLW volumes and impacts are for the WM PEIS Centralized 1 Alternative in which Hanford is the sole LLW disposal site. MLLW volumes and impacts are for WM PEIS Centralized Alternative for MLLW in which Hanford is the only MLLW disposal site.

(b) Source = Information Package (DOE 1998a). LLW and MLLW volumes shipped to Hanford and associated impacts are for LLW Disposal Option 2 and MLLW Disposal Option A, respectively.

(c) Includes worker and public LCFs from incident-free transportation.

(d) Includes non-radiological fatalities from traffic accidents and LCFs from incident-free non-radiological emissions.

H.9.2 Comparison to the Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement

The transportation impact analysis in the WIPP SEIS-II (DOE 1997b) was compared to the HSW EIS transportation impact analysis. Only the TRU waste transportation impact analyses are compared because DOE (1997b) only included analyses of TRU waste transportation impacts.

The HSW EIS used updated methods and data relative to DOE (1997b), including updated waste volume projections. Key differences in these areas are summarized below:

- In the HSW EIS, the transportation impact calculations were conducted using the RADTRAN 5 computer software. The computer code used in DOE (1997b) was the previous version of the computer software (that is, RADTRAN 4).

- The most recent highway routing model; that is, the GIS-based TRAGIS computer code, was used in the HSW EIS, whereas the HIGHWAY computer code was used in WIPP SEIS-II. Two completely different routing analysis methodologies are used in these codes. In addition, the TRAGIS outputs used in the HSW EIS are based on the 2000 Census data whereas the WIPP SEIS-II routing analyses were based on the 1990 Census.

- The HSW EIS TRU waste volume projections are more recent than the waste volume projections used in the WIPP SEIS-II. The HSW EIS TRU waste volume projections represent the current maximum forecast TRU waste volumes, including the TRU wastes already onsite, to be generated onsite, and to be shipped to Hanford from offsite.

- The HSW EIS used the non-radiological emissions impact methodology described by Biwer and Butler (1999). The WIPP SEIS-II used the methodology described by Rao et al. (1982). In general, application of Biwer and Butler (1999) resulted in more conservative (that is, the tendency to overstate potential impacts) emissions impact estimates due in part to higher incremental mortality estimates for a given exposure level (DOE 2002a).

- Non-radiological accident impacts were calculated using a similar approach in both the WIPP SEIS-II and the HSW EIS. However, the analyses in the HSW EIS used updated accident statistics relative to the WIPP SEIS-II. The impacts are somewhat smaller in the HSW EIS due to lower accident and fatality rates on the highway route between Hanford and WIPP. The other key reason is a decline in the projected number of shipments from Hanford to WIPP.

Table H.35 provides a comparison of some key results of the WIPP SEIS-II and HSW EIS impact analyses.

Number of CH TRU waste shipments. The projected number of shipments of CH TRU waste from Hanford to WIPP in the HSW EIS is lower than the preferred alternative in the WIPP SEIS-II. The projected number of RH TRU waste shipments in the HSW EIS is approximately the same as the preferred alternative in WIPP SEIS-II.

Radiological incident-free LCFs (public plus worker). Potential **r**adiological incident-free LCFs are higher in the HSW EIS than WIPP SEIS-II, even though the number of shipments is lower. The main reason for the higher incident-free LCFs is the enhanced precision of the routing model used in the HSW EIS, which resulted in longer travel distances in urban and suburban areas than were determined in the WIPP SEIS-II. In addition, the HSW EIS uses 2000 Census data whereas WIPP SEIS-II used the 1990 Census data. The effects of these two elements of the incident-free exposure analysis compound each

Table H.35. Comparison of Potential Transportation Impacts for Shipments of TRU Waste from Hanford to WIPP

Category	WIPP SEIS-II[(a)]	HSW EIS
CH TRU Waste		
Number of CH TRU Waste Shipments	13,666	5,415
Radiological Incident-Free LCFs (public plus worker)	1.9	2.1
Radiological Accident LCFs	0.3	0.006
Non-Radiological Accidents (number)	26	12
Non-Radiological Fatalities	2.3	0.4
Non-Radiological Emissions LCFs	0.1	0.2
RH TRU Waste		
Number of RH TRU Waste Shipments	3,178	3,052
Radiological Incident-Free LCFs (public plus worker)	0.4	2.7
Radiological Accident LCFs	0.004	0.003
Non-Radiological Accidents (number)	6	6
Non-Radiological Fatalities	0.5	0.2
Non-Radiological Emissions LCFs	0.02	0.1

(a) Source = DOE (1997b) or derived from information contained therein.

other. First, population growth has increased the number of exposed individuals along the transportation routes. Second, the TRAGIS output from the HSW EIS analysis had longer shipping distances in urban and suburban areas than were determined in the WIPP SEIS-II. This not only increases the number of potentially exposed individuals, it increases travel time in these areas, which increases exposure durations and, thus, increases the population dose. In addition, the dose-to-LCF conversion factor is higher in the HSW EIS than the WIPP SEIS-II. These effects more than offset the higher urban population densities that were used in the WIPP SEIS-II.

Radiological accident LCFs. Potential radiological accident impacts are lower in the HSW EIS than the WIPP SEIS-II. The main reason for this difference appears to be that the WIPP SEIS-II used a generic, national-average accident rate in the accident risk calculations from NUREG-0170 (NRC 1977). The approach used in the HSW EIS was to compute route-specific accident rates and use those rates to calculate the accident risks. There is 1 order of magnitude, or more, difference between the generic accident rate derived by NRC (1977) and that used in the WIPP SEIS-II to calculate the risks of accidental releases of radioactive material in transit and the route-specific accident rates used in the HSW EIS. In any event, this does not affect the overall total radiological impact estimates because the total estimates are, in general, dominated by incident-free impacts.

Non-radiological accidents (number) and non-radiological fatalities. Potential non-radiological accident impacts for CH TRU waste shipments are somewhat lower in the HSW EIS and potential RH TRU waste shipment impacts are approximately the same as those reported for the WIPP SEIS-II preferred alternative. The main differences in the results arise from the reduced number of CH TRU waste shipments and slightly lower accident and fatality rates used in the HSW EIS. RH TRU waste shipments are approximately the same. While similar approaches were used (that is, application of state-specific accident and fatality rates), the data used to calculate non-radiological accidents and fatalities in the HSW EIS are more current than those used in the WIPP SEIS-II.

Non-radiological emissions LCFs. Potential non-radiological emissions impact estimates are lower on a per-shipment basis in the WIPP SEIS-II than in the HSW EIS. These differences are due to the methodologies employed. Based on the results, the increases due to implementation of Biwer and Butler (1999) more than offset the reductions that would result from the lower number of projected CH TRU waste shipments and result in increased impacts due to RH TRU waste shipments.

In spite of these differences in computational tools and data, the overall impact estimates are similar. Despite the minor differences in numerical results between the two EIS's in terms of the total radiological (sum of radiological incident-free and accidental LCFs) and non-radiological impacts (sum of non-radiological accident fatalities and emissions LCFs), the conclusions of the two documents are comparable.

H.10 Effects of Transporting Solid Waste by Rail

The analyses in this appendix assumed that all of the onsite and offsite shipments of solid waste would be conducted using trucks over existing roads. It is possible that some of the shipments of solid waste and construction and/or capping materials could be transported by rail. Rail shipments generally result in lower impacts than truck shipments. These lower impacts for rail relative to truck shipping are documented in numerous EIS's (DOE 2002b; 1997a; 1997b). Generally, rail shipments result in lower impacts than truck shipments for a variety of reasons:

- Rail payload capacity is substantially greater than truck. This results in fewer shipments, which, in turn, results in lower transportation impacts.

- There are fewer people sharing rail lines than are sharing highways with truck shipments. This is somewhat offset by the lower average speeds for rail shipments, which increases the exposure time relative to truck shipments.

- When a rail shipment stops at a railyard, there are many other railcars that provide shielding between the shipping container and people. This shielding results in lower radiation dose rates, and thus lower radiation exposures, to bystanders and people living in the vicinity of rail stops relative to truck stops.

- According to recent data from Saricks and Tompkins (1999), fatality rates for truck and rail transport are comparable. For example, the nationwide accident and fatality rates for truck shipments are about 3.2E-07 accidents per truck-km and 1.4E-08 fatalities per truck-km, respectively (see Table 4 of Saricks and Tompkins [1999]). For rail shipments, the comparable nationwide accident rate is about 5.4E-08 accidents per railcar-km and the fatality rate is about 2.1E-08 fatalities per railcar-km (see Table 6 of Saricks and Tompkins [1999]). Although the fatality rate on a per-km basis is higher for rail than for truck shipments, the rail shipments travel fewer miles than truck shipments due to the higher payload capacity of the rail shipments. The higher payloads for rail shipments more than offset the difference in fatality rates, resulting in lower non-radiological accident impacts for rail shipments.

While rail shipments generally result in lower radiological incident-free and non-radiological accident impacts than truck shipments, the impacts of radiological accidents are likely to be higher for rail shipments. Recall that radiological accident impacts are calculated as the product of the frequency of an accident times its consequences. While the probability of a severe accident is comparable between the two modes as discussed above, the consequences of a severe rail accident could be greater due to the higher payload of rail shipments relative to truck shipments; that is, larger quantities of radioactive materials would be released from a rail shipment than a truck shipment. This leads to generally higher radiological accident impacts for rail shipments relative to truck shipments. However, a review of the impact estimates in Tables H.15 (onsite shipments) and H.17 (offsite shipments) indicates that radiological accident impacts are a small fraction of the radiological incident-free and non-radiological impacts. Therefore, the radiological accident impacts do not contribute substantially to the total impacts.

Although predicted impacts for rail shipments likely would be smaller than for truck shipments, a number of other variables must also be considered. First, general freight rail service is slower than truck shipping, resulting in longer travel times and possibly long stop times in rail yards waiting for train makeup. The longer shipping times for rail shipments may also lead to less efficient use of DOE shipping containers, depending on the waste types transported by rail and the truck/rail mix of the shipping campaigns. Second, not all generator sites, including Hanford, have rail service. In order for these sites to use rail service, new rail lines would have to be constructed, existing lines that have been abandoned would have to be rebuilt, or truck/rail intermodal transportation would have to be implemented (that is, deliver truck shipments to a railyard where the shipping containers would be offloaded from the trucks and loaded onto a rail car for subsequent transport; the opposite operation would be required for receiving sites not provided with rail service). This could lead to increased costs as well as increased impacts due to the additional handling activities required to offload and reload the containers onto or off of the railcars. Third, if a rail accident involving a derailment were to occur, the rail line could be disabled for a lengthy period of time. Although truck accidents also could involve closure of a highway, there is a greater potential for a detour around a closed highway than around a closed rail line.

There are two types of rail service available for radioactive waste shipments: 1) general freight rail, in which the railcars carrying the wastes would be added to an existing train and 2) dedicated rail service, in which a train would be made up solely of railcars carrying radioactive wastes to and/or from Hanford plus locomotives and buffer cars as needed. According to the *Final Environmental Impact Statement for the Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada* (DOE 2002b), dedicated rail service offers advantages over general freight rail service in incident-free transport but could lead to higher accident impacts. It was concluded that available information does not indicate a clear advantage for the use of either general freight or dedicated train service (DOE 2002b).

A final point relative to rail shipping is that the Hanford waste management facilities currently do not have rail service. New rail spurs and upgrades to existing rail lines would be needed to reach the Hanford solid waste management facilities. At this time, it is too speculative to assume that rail access to solid waste management facilities on the Hanford Site would be available, and an analysis of rail transport at this time does not appear warranted.

H.11 References

10 CFR 71. "Packaging and Shipping of Radioactive Materials." Code of Federal Regulations. Online at: http://www.access.gpo.gov/nara/cfr/waisidx_01/10cfr71_01.html

49 CFR 106-180. "Subtitle B–Other Regulations Relating to Transportation. Chapter I. Research and Special Programs Administration." Code of Federal Regulations. Online at: http://www.access.gpo.gov/nara/cfr/waisidx_02/49cfrv2_02.html

63 FR 3623. "Record of Decision for the Department of Energy's Waste Isolation Pilot Plant Disposal Phase." *Federal Register* (January 23, 1998). Online at: http://www.gpoaccess.gov/fr/index.html

63 FR 3629. "Record of Decision for the Department of Energy's Waste Management Program: Treatment and Storage of Transuranic Waste." *Federal Register* (January 23, 1998). Online at: http://www.gpoaccess.gov/fr/index.html

64 FR 69241. "Identification of the Preferred Alternatives for the Department of Energy's Waste Management Program: Low-Level Waste and Mixed Low-Level Waste Disposal Sites." *Federal Register* (December 10, 1999). Online at: http://www.gpoaccess.gov/fr/index.html

65 FR 10061. "Record of Decision for the Department of Energy's Waste Management Program: Treatment and Disposal of Low-Level Waste and Mixed Low-Level Waste; Amendment of the Record of Decision for the Nevada Test Site." *Federal Register* (February 25, 2000). Online at: http://www.gpoaccess.gov/fr/index.html

65 FR 82985. "Revision to the Record of Decision for the Department of Energy's Waste Management Program: Treatment and Storage of Transuranic Waste." *Federal Register* (December 29, 2000). Online at: http://www.gpoaccess.gov/fr/index.html

66 FR 38646. "Revision to the Record of Decision for the Department of Energy's Waste Management Program: Treatment and Storage of Transuranic Waste." *Federal Register* (July 25, 2001). Online at: http://www.gpoaccess.gov/fr/index.html

67 FR 56989. "Revision to the Record of Decision for the Department of Energy's Waste Management Program: Treatment and Storage of Transuranic Waste." *Federal Register* (September 6, 2002). Online at: http://www.gpoaccess.gov/fr/index.html

68 FR 14510. "Hazardous Materials: Security Requirements for Offerors and Transporters of Hazardous Materials, Research and Special Projects Administration." *Federal Register* (March 25, 2003). Online at: http://www.gpoaccess.gov/fr/index.html

Biwer, B. M. and J. P. Butler. 1999. "Vehicle Emission Unit Risk Factors for Transportation Risk Assessments." *Risk Analysis*, 19(6):1157-1171.

CDC. 2003. *Deaths, Age-adjusted Death Rates, and Comparisons by State for Selected Leading Causes of Death*. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics, Hyattsville, Maryland. Online at: http://www.cdc.gov/nchs/releases/03facts/mortalitytables.htm

Craig, D. K. 2002. *ERPGs and TEELs for Chemicals of Concern, Rev. 19*. WSMS-SAE-02-0171, Westinghouse Safety Management Systems, Aiken, South Carolina. Online at: http://tis.eh.doe.gov/web/chem_safety/teel.html

DOE. 1995. *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement*. DOE/EIS-0203-F, U.S. DOE, Office of Environmental Management, Idaho Operations Office.

DOE. 1997a. *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*. DOE/EIS-0200-F, Vol. 1-5, U.S. Department of Energy, Washington, D.C.

DOE. 1997b. *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement*. DOE/EIS-0026-S-2, U.S. Department of Energy, Carlsbad Area Office, Carlsbad, New Mexico.

DOE. 1998a. *Information Package on Pending Low-Level Waste and Mixed Low-Level Waste Disposal Decisions* (to be made under the *Final Waste Management Programmatic Environmental Impact Statement*). U.S. Department of Energy, Office of Environmental Management, Germantown, Maryland. Online at: http://www.em.doe.gov/em30

DOE. 1998b. *National Environmental Policy Act (NEPA) Compliance Guide, Volumes I and II.* U.S. Department of Energy, Washington, D. C. Online at: http://www.eh.doe.gov/nepa/guidance.html

DOE. 2002a. *A Resource Handbook for DOE Transportation Risk Assessment*. DOE/EM/NTP/HB-01. Prepared for the Office of Environmental Management, National Transportation Program, U.S. Department of Energy, Albuquerque Office, Albuquerque, New Mexico. Online at: http://www.ntp.doe.gov/transrisk_handbook.pdf

DOE. 2002b. *Final Environmental Impact Statement for the Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada.* DOE/EIS-0250F, U.S. Department of Energy, Washington D.C.

DOE. 2002c. *Radioactive Material Transportation Practices Manual for Use with DOE O 460.2*. DOE Manual 460.2-1, U.S. Department of Energy, Washington, D.C. Online at: http://www.directives.doe.gov/pdfs/doe/doetext/neword/460/m4602-1.pdf

DOE. 2002d. *Transuranic Waste Performance Management Plan*. U.S. Department of Energy, Carlsbad Field Office, Carlsbad, New Mexico. Online at: http://www.wipp.carlsbad.nm.us/suyw/july2002/FTWPMP.pdf

DOE. 2003. *West Valley Demonstration Project Waste Management Environmental Impact Statement*. DOE/EIS-0337F, U.S. Department of Energy, West Valley Area Office, West Valley, New York. Online at: http://tis.eh.doe.gov/nepa/eis/eis0337/index.html

DOT. 2002. *State Traffic Safety Information for Year 2001*. U.S. Department of Transportation, National Highway Traffic Safety Administration, Washington, D.C. Online at: http://www.nhtsa.dot.gov/STSI/index.cfm?Year=2001

Eckerman, K. F., R. W. Leggett, C. B. Nelson, J. S. Puskin, and A. C. B. Richardson. 1999. *Cancer Risk Coefficients for Environmental Exposure to Radionuclides. Federal Guidance Report No. 13.* EPA 402-R-99-001. Office of Radiation and Indoor Air, U.S. Environmental Protection Agency, Washington, D.C. Online at: http://www.epa.gov/radiation/federal/docs/fgr13.pdf

FH. 2004. *Hanford Site Solid Waste Management Environmental Impact Statement Technical Information Document*. HNF-4755, Rev. 2, Fluor Hanford, Inc., Richland, Washington.

Fischer, L. E., C. K. Chou, M. A. Gerhard, C. Y. Kimura, R. W. Martin, R. W. Mensing, M. E. Mount, and M. C. Witte. 1987a. *Shipping Container Response to Severe Highway and Railway Accident Conditions, Main Report*. NUREG/CR-4829, Vol. 1, U.S. Nuclear Regulatory Commission, Washington, D.C. Online at: http://ttd.sandia.gov/nrc/docs.htm

Fischer, L. E., C. K. Chou, M. A. Gerhard, C. Y. Kimura, R. W. Martin, R. W. Mensing, M. E. Mount, and M. C. Witte. 1987b. *Shipping Container Response to Severe Highway and Railway Accident Conditions, Appendices*. NUREG/CR-4829, Vol. 2, U.S. Nuclear Regulatory Commission, Washington, D.C. Online at: http://ttd.sandia.gov/nrc/docs.htm

Green, J. R., B. D. Flanagan, and H. W. Harris. 1996. *Hanford Site Truck Accident Rate, 1990-1995*. WHC-SD-TP-RPT-021, Rev. 0, Westinghouse Hanford Co., Richland, Washington.

Johnson, P. E., D. S. Joy, D. B. Clarke, and J. M. Jacobi. 1993. *HIGHWAY 3.1 – An Enhanced Highway Routing Model: Program Description, Methodology, and Revised User's Manual*. ORNL/TM-12124, Oak Ridge National Laboratory, Oak Ridge, Tennessee. Available online: http://ttd.sandia.gov/risk/docs/highway.txt

Johnson, P. E., and R. D. Michelhaugh. 2000. *Transportation Routing Analysis Geographic Information System (WebTRAGIS) User's Manual*. ORNL/TM-2000/86, Oak Ridge National Laboratory, Oak Ridge, Tennessee. Online: http://www.ornl.gov/~webworks/cpr/v823/rpt/106749.pdf

Luna, R. E., K. S. Neuhauser, and M. G. Vigil. 1999. *Projected Source Terms for Potential Sabotage Events Related to Spent Fuel Shipments*. SAND99-0963, Sandia National Laboratory, Albuquerque, New Mexico. Online at: http://infoserve.sandia.gov/sand_doc/1999/990963.pdf

Neuhauser, K. S., and F. L. Kanipe. 1992. *RADTRAN 4, Volume 3: User Guide*. SAND89-2370, Sandia National Laboratories, Albuquerque, New Mexico. Online at: http://ttd.sandia.gov/risk/docs/s8923703.pdf

Neuhauser, K. S., F. L. Kanipe, and R. F. Weiner. 2003. *RADTRAN 5 User Guide*. SAND2003-2354, Sandia National Laboratories, Albuquerque, New Mexico. Online at: http://infoserve.sandia.gov/sand_doc/2003/032354.pdf

NRC. 1977. *Final Environmental Impact Statement in the Transportation of Radioactive Material by Air and Other Modes*. NUREG-0170, Vol. 1 & 2, Office of Standards Development, U.S. Nuclear Regulatory Commission, Washington, D.C.

Rao, R. K., E. L. Wilmot, and R. E. Luna. 1982. *Non-Radiological Impacts of Transporting Radioactive Material*. SAND81-1703, TTC-0236, Sandia National Laboratories, Albuquerque, New Mexico.

Saricks, C. and T. Kvitek. 1994. *Longitudinal Review of State-Level Accident Statistics for Carriers of Interstate Freight*. ANL/ESD/TM-68, Argonne National Laboratory, Argonne, Illinois.

Saricks, C. L. and M. M. Tompkins. 1999. *State-Level Accident Rates of Surface Freight Transportation: A Reexamination*. ANL/ESD/TM-150, Argonne National Laboratory, Argonne, Illinois. Online at: http://www.ipd.anl.gov/anlpubs/1999/05/32608.pdf

Sprung J. L., D. J. Ammerman, N. L. Breivik, R. J. Dukart, F. L. Kanipe, J. A. Koski, G. S. Mills, K. S. Neuhauser, H. D. Radloff, R. F. Weiner, and H. R. Yoshimura. 2000. *Reexamination of Spent Fuel Shipment Risk Estimates*. NUREG/CR-6672, Vols. 1, 2, U.S. Nuclear Regulatory Commission, Washington, D.C. Online at: http://ttd.sandia.gov/nrc/docs.htm

Appendix I

Ecological Resources

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Ecological Resources

Appendix I provides additional information regarding potential impacts to terrestrial and aquatic ecological resources that may result from implementation of Alternative Groups A, B, C, D_1, D_2, D_3, E_1, E_2, and E_3, or the No Action Alternative. Potential impacts to terrestrial resources would occur in the near term, that is, during waste management operations. These relate primarily to surface disturbance associated with disposal in the Low Level Burial Grounds (LLBGs), the Environmental Restoration and Disposal Facility (ERDF), and in the proposed disposal facility near the PUREX Plant; Area C from which capping materials would be obtained and the associated stockpile area and conveyance road; and construction sites for the additional Central Waste Complex (CWC) facilities and new waste processing facility. Potential impacts to Columbia River riparian and aquatic resources could occur in the long term, that is, up to 10,000 years following the conclusion of waste management operations. These relate primarily to the eventual migration of radionuclides and other hazardous chemicals through the vadose zone to groundwater and on to the Columbia River.

I.1 Background

The 24 Command Fire, a range fire that occurred in late June–early July 2000 (DOE-RL 2000), burned 163,884 acres on the central part of the Hanford Site and the Fitzner/Eberhardt Arid Lands Ecology (ALE) Reserve (Baker 2000). The 24 Command Fire covered the 200 West Expansion Area, some of which has been identified for construction of the additional CWC facilities and the new waste processing facility; a large area west and south of that location, including Area C; and the southern portion of the corridor between the 200 West Area and 200 East Area, including ERDF. The 24 Command Fire did not affect the LLBGs in the 200 West Area (although some of these border the 200 West Expansion Area), nor did it reach the 200 East Area.

In general, approximately 85 percent of the burned area experienced severe fire intensity, resulting in complete destruction of all vegetation and organic litter on the soil surface (Baker 2000). In moderately burned areas, there was partial removal of the shrub layer and understory. Many of the severely and moderately burned areas have since been colonized by alien annual weeds, such as Russian thistle (*Salsola kali*) and cheatgrass (*Bromus tectorum*).

The most severely burned areas, particularly west and southwest of the 200 West Area (including the area identified for construction of the additional CWC facilities and the new waste processing facility), were, and continue to be severely eroded by wind (Becker and Sackschewsky 2001; Sackschewsky and Becker 2001). Much of the topsoil and likely much of the buried seed (Baker 2000) have been removed.

Plant communities in these areas, particularly the shrub components, may not recover before project-related surface disturbance because of a lack of buried seed (Baker 2000), relatively long distances to upwind seed sources, continued wind erosion, and competition by weedy species.

In contrast, some of the pre-fire shrub and understory vegetation in the moderately burned areas (including most of Area C and ERDF) was not removed or is recovering, and these areas have not been affected as severely by wind erosion. These plant communities thus have likely retained more of their buried seed than those that were severely burned; this seed may germinate when conditions are suitable. Consequently, some of these communities are expected to partially or fully recover before project-related disturbance, notwithstanding competition by weedy species.

I.2 Impacts to Terrestrial Resources Resulting from Surface Disturbance

I.2.1 Alternative Group A

LLBGs in the 200 East Area – Impacts to Habitats and Plant Species of Concern. The LLBGs in the 200 East Area are surveyed annually, consistent with the DOE *Ecological Compliance Assessment Management Plan* (ECAMP) (DOE-RL 1995a). The 218-E-10 and 218-E-12B LLBGs have been cleared of most of their original vegetation, greatly increasing their susceptibility to noxious weed invasion.

Noxious weeds on the Hanford Site are managed under the Integrated Pest Management (IPM) program (WHC 1995), and the primary means of control is herbicides. IPM personnel are required to obtain training, licenses, and certifications (WHC 1995) in order to ensure compliance with Washington State Department of Agriculture rules relating to the use of restricted herbicides in ground and aerial applications. Compliance with these rules facilitates effective control of target populations with minimal accidental overspray of and herbicide drift into non-target areas. Herbicide drift is minimized primarily by deploying herbicides under optimal weather conditions (Renne and Wolf 1976) and using drift retardants. Drift retardants increase droplet size and thus settling rate, rendering herbicides less susceptible to drift.

Cheatgrass and Sandberg's bluegrass (*Poa sandbergii*), a native perennial, dominate approximately two-thirds of the 218-E-10 and 218-E-12B LLBGs. Crested wheatgrass (*Agropyron cristatum*), a non-native perennial planted for a variety of purposes including dust suppression and reduction of water infiltration into the vadose zone, dominates the other one-third (Brandt 1998, 1999; Sackschewsky 2000, 2001, 2002a, 2003b). The 218-E-10 and 218-E-12B LLBGs receive regular herbicide applications and thus have limited habitat value for native broad-leaved species such as big sagebrush (*Artemisia tridentata*). Consequently, continued use of these LLBGs, or new disturbance of the extant plant communities within them, would not result in the loss of any habitats designated by the Washington Department of Fish and Wildlife (WDFW) as priority habitats (DOE-RL 2003). However, native habitats could develop if herbicide spraying ceases.

Two plant species of concern have been observed within the 218-E-10 and 218-E-12B LLBGs. The most notable is Piper's daisy (*Erigeron piperianus*). The State of Washington Natural Heritage Program (WNHP) lists Piper's daisy as sensitive (a taxon that is vulnerable or declining and could become endangered or threatened in Washington without active management or removal of threats [WNHP 2002]) (Sackschewsky and Downs 2001). Sensitive species are considered Level III resources (see Table I.1) under the *Hanford Site Biological Resources Management Plan* (BRMaP) (DOE-RL 2001). This species was observed within the 218-E-12B and 218-E-10 LLBGs during spring 1999 (Brandt 1999) but not in spring 2000, 2001, 2002, or 2003 (Sackschewsky 2000, 2001, 2002a, 2003b). Piper's daisy populations on these two LLBGs have been reduced or eliminated, likely as a result of regular herbicide applications. However, these populations could regenerate from buried seed, particularly if herbicide spraying ceases.

The other plant species of concern observed within the 218-E-10 and 218-E-12B LLBGs is the crouching milkvetch (*Astragalus succumbens*), a Washington State Watch List species (plant taxon that is of concern but is considered to be more abundant and/or less threatened in Washington than previously assumed [WNHP 2002]) (Sackschewsky and Downs 2001). Watch List species are considered Level I resources (see Table I.1) under BRMaP (DOE-RL 2001). This species was observed in spring 2000, 2001, and 2002 within Trench 94 in the 218-E-12B LLBG and on the northeast side of the 218-E-10 LLBG (Sackschewsky 2000, 2001, 2002a, 2003b). Crouching milkvetch is relatively common on the Central Plateau (Sackschewsky and Downs 2001). Therefore, disturbance of those individuals on the 218-E-12B and 218-E-10 LLBGs would not be likely to adversely affect the overall local population.

Table I.1. Hanford Site Biological Resources Management Plan Resource Levels and Associated Definitions

Resource Level	Definition
I	Those resources that—because of their recreational, commercial, or ecological role or previous protection status—require at a minimum some level of status monitoring. Mitigation is not normally required.
II	Those resources that—to show compliance with procedural and substantive laws such as NEPA (42 USC 4321), CERCLA (42 USC 9601), and the Migratory Bird Treaty Act (MBTA, 16 USC 703-712)—require consideration of potential adverse impacts. Mitigation is most often accomplished by avoidance and impact minimization, except in the case of recovering shrub-steppe habitat,(a) for which mitigation via rectification or compensation is recommended.
III	Those resources that—because of their state listing, potential for federal or state listing, unique or significant value for plant, fish, or wildlife species, special administrative designation, or environmental sensitivity—require mitigation. When avoidance and minimization are not possible or are insufficient, mitigation via rectification or compensation is recommended.
IV	Those resources that—because of their federally protected legal status or their regional and national significance—justify preservation and the primary management option. Typically, these cannot be mitigated unless it is by compensation via acquisition and protection of in-kind resources.

(a) Habitat characterized by short-statured, widely spaced, small-leaved shrubs, sometimes aromatic, with brittle stems and an understory dominated by perennial bunchgrasses.

LLBGs in the 200 West Area – Impacts to Habitats and Plant Species of Concern. The LLBGs in the 200 West Area are surveyed annually consistent with ECAMP (DOE-RL 1995a). The 218-W-3A, 218-W-3AE, 218-W-4B, and 218-W-5 LLBGs in the 200 West Area are sparsely colonized by cheatgrass, Russian thistle, and crested wheatgrass (Brandt 1998, 1999; Sackschewsky 2000, 2001, 2002a, 2003b). These receive regular herbicide applications and thus have limited habitat value for native species. Consequently, continued use of these LLBGs, or new disturbance of the extant plant communities within them, would not result in the loss of any habitats designated by WDFW as priority habitat (DOE-RL 2003). However, native habitats could develop if herbicide spraying ceases.

Most of the developed portion of the 218-W-4C LLBG, bounded on the west by Dayton Avenue and on the north and south by 19th and 16th streets, respectively, is highly disturbed and has a sparse cover of cheatgrass. However, some portions of this LLBG now have relatively thick stands of Indian ricegrass (*Oryzopsis hymenoides*) and needle-and-thread grass (*Stipa comata*) (Brandt 1998, 1999; Sackschewsky 2000, 2001, 2002a, 2003b), both native perennial species. This developed portion of the 218-W-4C LLBG receives regular herbicide applications and thus has limited habitat value for native species. Consequently, continued use of the developed portion of the 218-W-4C LLBG, or new disturbance of the extant plant communities within it, would not result in the loss of any habitats designated by WDFW as priority habitat (DOE-RL 2003). However, native habitats could develop if herbicide spraying ceases.

The undeveloped southeastern portion of the 218-W-4C LLBG, along 16th Street, is dominated by mature sagebrush, with gray and green rabbitbrush (*Chrysothmnus nauseosus*) as minor overstory components. The understory consists primarily of needle-and-thread grass, cheatgrass, and crested wheatgrass. Development of the southeastern portion of the 218-W-4C LLBG would result in the loss of sagebrush steppe (shrub-steppe dominated by sagebrush), considered a priority habitat by the State of Washington (DOE-RL 2003) and a Level III resource under BRMaP (DOE-RL 2001).

One plant species of concern has been observed within some of the 200 West LLBGs—stalked-pod milkvetch (*Astragalus sclerocarpus*), a Washington State Watch List species (Sackschewsky and Downs 2001) and thus a Level I resource (DOE-RL 2001). Stalked-pod milkvetch was observed in spring 1998, 1999, 2000, 2001, and 2002 at the extreme western edge of the 218-W-5 LLBG and within the undeveloped portion of the 218-W-4C LLBG (Brandt 1998, 1999; Sackschewsky 2000, 2001, 2002a, 2003b). Stalked-pod milkvetch is relatively common on the Central Plateau (Sackschewsky and Downs 2001). Therefore, disturbance of those individuals on the 218-W-5 and 218-W-4C LLBGs likely would not adversely affect the overall local population.

LLBGs in the 200 East Area and 200 West Area – Impacts to Wildlife and Wildlife Species of Concern. Wildlife that could be impacted by disturbance of the 200 East and 200 West Area LLBGs includes the mule deer (*Odocoileus hemionus*), Great Basin pocket mouse (*Perognathus parvus*), side-blotched lizard (*Uta stansburiana*), and several migratory bird species. Ground-nesting birds that have been observed, and that may nest within the 200 East and 200 West LLBGs, include the horned lark (*Eremophila alpestris*), killdeer (*Charadrius vociferous*), long-billed curlew (*Numenius americanus*), and Western meadowlark (*Sturnella neglecta*) (Sackschewsky 2001, 2002a, 2003b). Ground disturbance during the nesting season, generally March through July, could destroy eggs and young and temporarily displace nesting individuals into other areas of the Hanford Site. The nests, eggs, and young of migratory birds are protected under the MBTA (16 USC 703-712, as amended). Protection is generally accomplished by conducting ground-disturbing activities outside the nesting season, generally August through February.

Proposed Disposal Facility near the PUREX Plant in the 200 East Area – Impacts to Habitats and Plant Species of Concern. The proposed disposal facility near the PUREX Plant is surveyed annually consistent with ECAMP (DOE-RL 1995a). Unlike the majority of the LLBGs, the original vegetation in the proposed disposal facility near the PUREX Plant has not been cleared. The overstory is dominated by sagebrush (25 percent cover), with green rabbitbrush (*Chrysothmnus viscidiflorus*) as a minor component. The understory is dominated by cheatgrass and Sandberg's bluegrass. Development of the proposed disposal facility near the PUREX Plant would result in the loss of shrub-steppe, considered a priority habitat by the State of Washington (DOE-RL 2003) and a Level III resource under BRMaP (DOE-RL 2001). No plant species of concern were observed in the proposed disposal facility near the PUREX Plant during the annual field survey of summer 2002.

Proposed Disposal Facility near the PUREX Plant in the 200 East Area – Impacts to Wildlife and Wildlife Species of Concern. Wildlife that could be affected by disturbance of the proposed disposal facility near the PUREX Plant includes the black-tailed jackrabbit (*Lepus californicus*), mule deer (*Odocoileus hemionus*), coyote (*Canis latrans*), Northern pocket gopher (*Thomomys talpoides*), and several migratory bird species. Shrub- and ground-nesting birds that have been observed and that likely nest within the proposed disposal facility near the PUREX Plant include the sage sparrow (*Amphispiza belli*) and Western meadowlark (*Sturnella neglecta*), respectively. Ground disturbance during the nesting season, generally March through July, could destroy eggs and young and temporarily displace nesting individuals into other areas of the Hanford Site. The nests, eggs, and young of migratory birds are protected under the MBTA. Protection is generally accomplished by conducting ground-disturbing activities outside the nesting season, generally August through February.

Two wildlife species of concern were observed within the proposed disposal facility near the PUREX Plant—the black-tailed jackrabbit and sage sparrow, both Washington State Candidate species (species the Washington Department of Fish and Wildlife will review for possible listing as endangered, threatened, or sensitive [WDFW 2002]). The distribution of the black-tailed jackrabbit (BMNHC 2002) and sage sparrow within Washington is limited mostly to the Columbia Basin. Both species have a strong affinity for sagebrush habitat. Removal of sagebrush within the proposed disposal facility near the PUREX Plant would likely have a minimal impact on populations of these species within the Columbia Basin.

Area C – Impacts to Habitats. Much of the original vegetation in Area C was burned in the 24 Command Fire. Pre-fire plant communities and land cover types in Area C consisted of the following:

- needle-and-thread grass/Indian ricegrass
- big sagebrush/needle-and-thread grass
- bluebunch wheatgrass (*Agropyron spicatum*)/Sandberg's bluegrass
- rabbitbrush (*Chrysothamnus* spp.)/bunchgrass mosaic
- Sandberg's bluegrass/cheatgrass

- big sagebrush/Sandberg's bluegrass/cheatgrass
- abandoned old agricultural fields
- disturbed (inactive borrow pit) (Figure I.1).

Needle-and-Thread Grass/Indian Ricegrass. The pre-fire needle-and-thread grass/Indian ricegrass community was designated a potential bitterbrush (*Purshia tridentata*)/Indian ricegrass sand dune complex community (Figure I.2) by TNC of Washington. A potential plant community is one that, with the passage of time, is projected to dominate an undisturbed site, based on climate and other abiotic factors (Soll and Soper 1996). Thus, development of the potential bitterbrush/Indian ricegrass community is based on long-term colonization by bitterbrush and eventual domination of the understory by Indian ricegrass.

The pre-fire needle-and-thread grass/Indian ricegrass community was designated an element occurrence of the bitterbrush/Indian ricegrass sand dune complex community type (Figure I.3). An element occurrence of a community type is one that meets the minimum standards set by the WNHP for ecological condition, size, and the surrounding landscape. Element occurrences are generally considered to be of significant conservation value from a state and/or regional perspective. More specifically, element occurrences on the Hanford Site may be considered integral to the preservation and sustenance of biodiversity in the Columbia Basin shrub-steppe. Element occurrences are tracked by the WNHP.

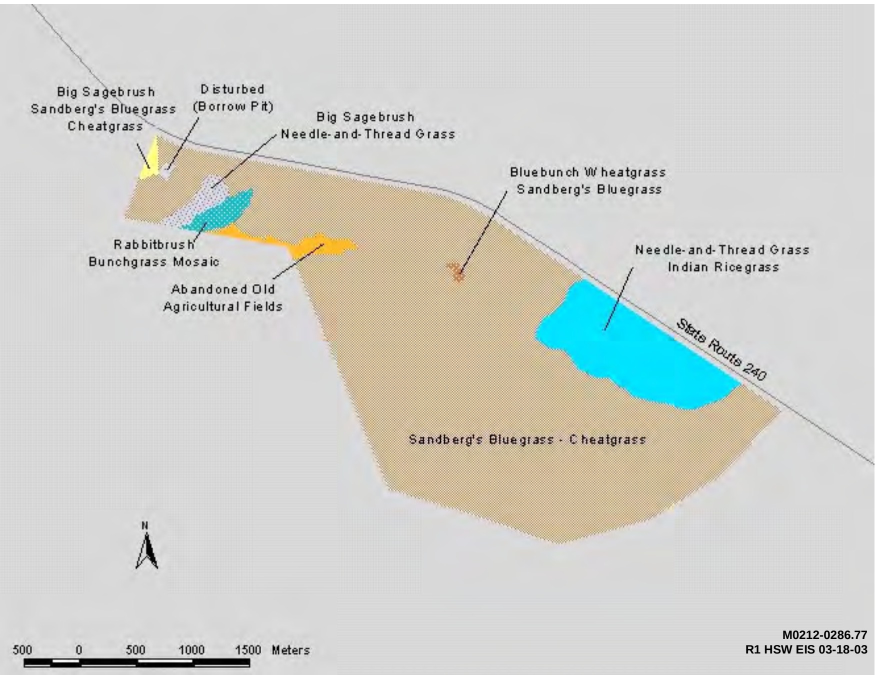


Figure I.1. Plant Communities in Area C Before the 24 Command Fire of June 2000[(a)]

(a) Data collected 1994 and 1997 by The Nature Conservancy (TNC) of Washington; 1991 and 1999 by Pacific Northwest National Laboratory (PNNL). Map created January 2002 by PNNL.

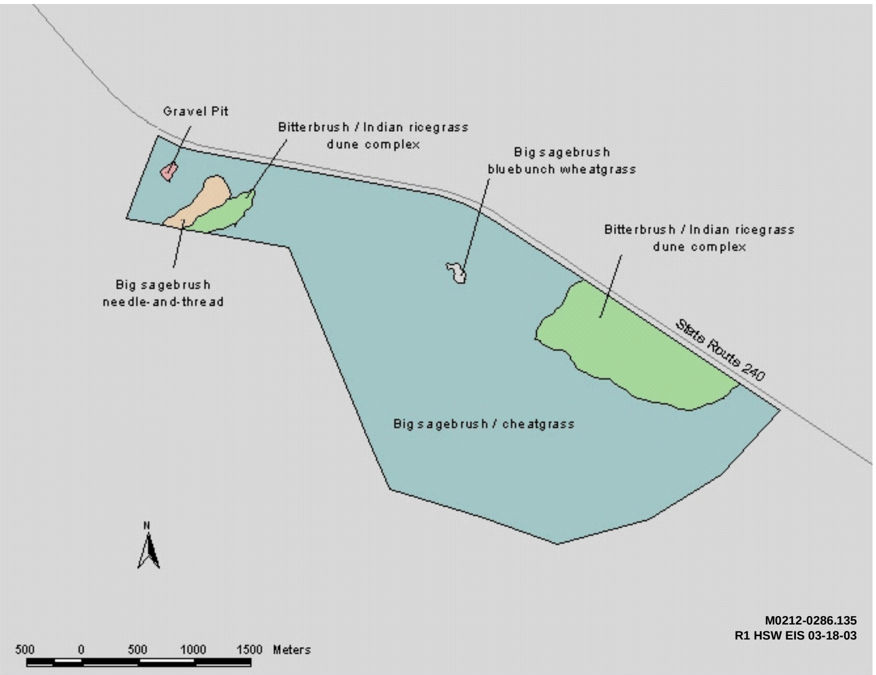


Figure I.2. Potential Plant Communities in Area C[(a)]

Element occurrences are designated Level IV resources (see Table I.1) in BRMaP (DOE-RL 2001), the highest level of resource designation at the Hanford Site. Element occurrences, because of their regional significance, justify preservation as the primary management option, and impacts to these should be avoided where possible (DOE-RL 2001).

The dominant plant species in this community, as determined by ocular estimation of percentage ground cover, currently are cheatgrass (50 percent), needle-and-thread grass (15 percent), and Indian ricegrass (10 percent) (Sackschewsky 2003a) (see Attachment A to this appendix). This needle-and-thread grass/Indian ricegrass community should thus be re-designated cheatgrass/needle-and-thread grass/Indian ricegrass (Figure I.4). Because bitterbrush currently is not present in this community (Sackschewsky 2003a) (see Attachment A to this appendix), it appears unlikely that it will become a bitterbrush/Indian ricegrass community prior to the start of new construction.

(a) Data collected 1994 and 1997 by TNC of Washington; 1991 and 1999 by PNNL. Map created January 2002 by PNNL.

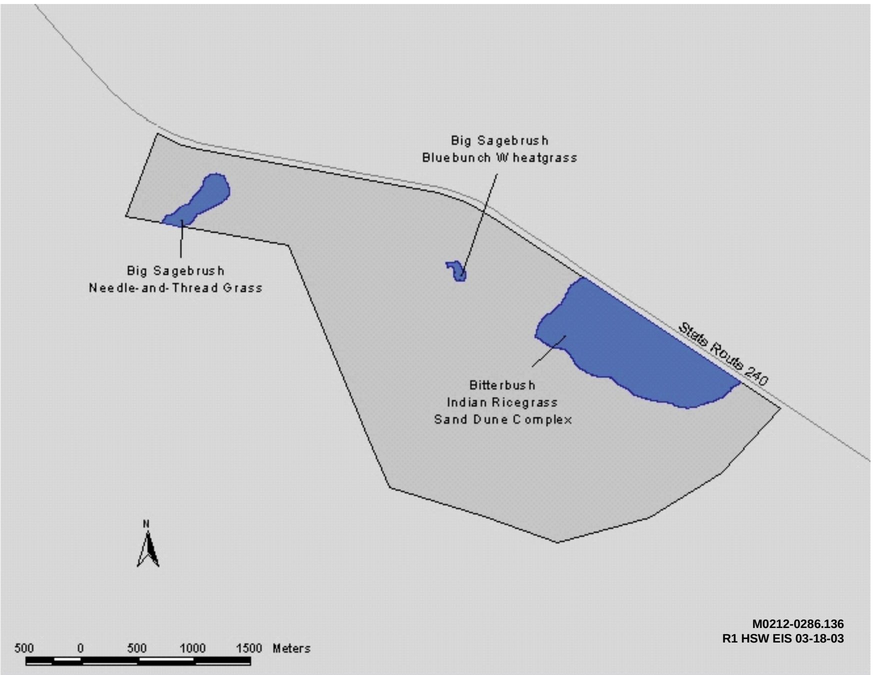


Figure I.3. Element Occurrences of Plant Community Types in Area C[(a)]

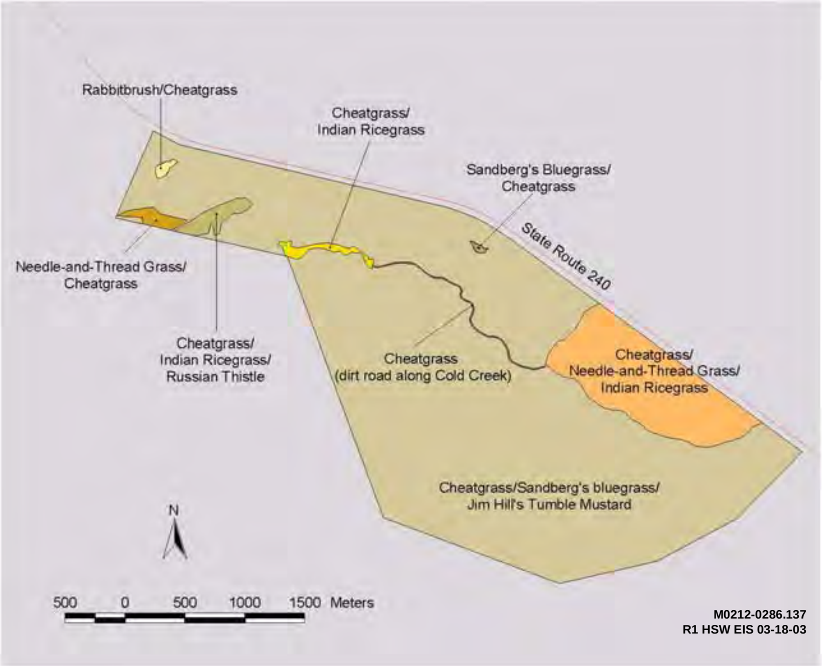


Figure I.4. Plant Communities in Area C After the 24 Command Fire of June 2000[(a)]

(a) Data collected 1994, 1995, and 1997 by TNC of Washington; 1996 by WNHP. Map created January 2002 by PNNL.

Big Sagebrush/Needle-and-Thread Grass. No potential (more advanced) community type has been designated by TNC for this pre-fire big sagebrush/needle-and-thread grass community (Figure I.2). This pre-fire community was designated an element occurrence (Figure I.3) (Soll and Soper 1996). However, big sagebrush appears to have been absent in the pre-fire community, based on observations made in the field in February and June 2002 (Sackschewsky 2002b, 2003a) (see Attachment A to this appendix), during which no burned shrub stumps and virtually no other burned shrub residue (for example, branches) were observed. Therefore, its designation as an element occurrence may have been erroneous. However, this determination can be made only by the WNHP.

This community currently is much smaller than that defined by TNC (compare Figures I.1, I.2, and I.3 with I.4). The dominant plant species in this community currently are needle-and-thread grass (20 percent) and cheatgrass (20 percent) (Sackschewsky 2003a) (see Attachment A to this appendix). This big sagebrush/needle-and-thread grass community should thus be redesignated needle-and-thread grass/cheatgrass (Figure I.4). Because sagebrush currently is not present in this community (Sackschewsky 2003a) (see Attachment A to this appendix), it appears unlikely that it could become a big sagebrush/needle-and-thread grass community prior to the start of new construction.

Bluebunch Wheatgrass/Sandberg's Bluegrass. The pre-fire bluebunch wheatgrass/Sandberg's bluegrass community, designated a potential big sagebrush/bluebunch wheatgrass community (Figure I.2) by Soll and Soper (1996), was designated an element occurrence of the big sagebrush/bluebunch wheatgrass community (Figure I.3) (Soll and Soper 1996).

The dominant plant species in this community currently are Sandberg's bluegrass (40 percent) and cheatgrass (10 percent). Bluebunch wheatgrass is a minor component of this community, that is, much less than 1 percent cover (Sackschewsky 2003a) (see Attachment A to this appendix). This bluebunch wheatgrass/Sandberg's bluegrass community should thus be re-designated Sandberg's bluegrass/cheatgrass (Figure I.4). The designation of this community as an element occurrence may be erroneous due to the insignificant amount of bluebunch wheatgrass. However, this determination can be made only through the WNHP. Because sagebrush currently is not present in this community (Sackschewsky 2003a) (see Attachment A to this appendix), it appears unlikely that it could become a big sagebrush/bluebunch wheatgrass community prior to the start of new construction.

Rabbitbrush/Bunchgrass Mosaic. This pre-fire rabbitbrush/bunchgrass mosaic community has been designated a potential bitterbrush/Indian ricegrass sand dune complex community (Figure I.2) by Soll and Soper (1996).

The dominant plant species in this community currently are cheatgrass (20 percent), Indian ricegrass (10 percent), and Russian thistle (10 percent). Scattered burned and living rabbitbrush were a minor component of this community, that is, much less than 1 percent cover (Sackschewsky 2003a) (see Attachment A to this appendix). This community should thus be re-designated cheatgrass/Indian ricegrass/Russian thistle (Figure I.4). Because living rabbitbrush are currently present (Sackschewsky 2003a) (see Attachment A to this appendix), and given the substantial Indian ricegrass component, this community will likely recover to its pre-fire condition (that is, rabbitbrush/bunchgrass mosaic community) before the start of new construction.

(a) Data collected June and July 2002 by PNNL. Map created October 2002 by PNNL.

Sandberg's Bluegrass/Cheatgrass. This area was designated a potential big sagebrush/cheatgrass community (Figure I.2) by Soll and Soper (1996). The dominant plant species in this community, except for the dirt road along Cold Creek, currently are cheatgrass (55 percent), Sandberg's bluegrass (15 percent), and Jim Hill's tumble mustard (*Sisymbrium altissimum*) (10 percent) (Sackschewsky 2003a) (see Attachment A to this appendix), an alien, annual weed. This community should thus be re-designated cheatgrass/Sandberg's bluegrass/Jim Hill's tumble mustard (Figure I.4). The dominant plant species along the dirt road along Cold Creek is cheatgrass (50 percent) (Sackschewsky 2003a) (see Attachment A to this appendix), and should be considered a separate community (Figure I.4).

Widely scattered mature big sagebrush (less than 1 percent cover in the area of its occurrence [Sackschewsky 2003a] [see Attachment A to this appendix]), of which approximately 10 percent were alive, were observed in the southeastern portion of this cheatgrass/Sandberg's bluegrass/Jim Hill's tumble mustard community, within approximately 200 m (656 ft) of the border of Area C. This portion of the cheatgrass/Sandberg's bluegrass/Jim Hill's tumble mustard community is thus a Level II resource (see Table I.1) under BRMaP (DOE-RL 2001). Seeding from remnant mature sagebrush may enable this portion of the community to become big sagebrush/cheatgrass before the start of new construction. However, because living, mature sagebrush are currently scarce and very limited in distribution, and given the relatively long upwind distance to external seed sources, the potential for sagebrush colonization of the remainder of this community before the start of new construction is expected to be low.

Big Sagebrush/Sandberg's Bluegrass/Cheatgrass. This area was designated a potential big sagebrush/cheatgrass community (Figure I.2) by Soll and Soper (1996). The dominant plant species in this community currently are cheatgrass (55 percent), Sandberg's bluegrass (15 percent), and Jim Hill's tumble mustard (Sackschewsky 2003a) (see Attachment A to this appendix). This community should thus be re-designated cheatgrass/Sandberg's bluegrass/Jim Hill's tumble mustard (Figure I.4). No evidence was found to indicate that sagebrush had been a component of the pre-fire community, and sagebrush currently is not present in this area (Sackschewsky 2003a) (see Attachment A to this appendix). Thus, it appears unlikely that this area could become a big sagebrush/cheatgrass community prior to the start of new construction.

Abandoned Old Agricultural Fields. This area was designated a potential big sagebrush/cheatgrass community (Figure I.2) by Soll and Soper (1996). The dominant plant species in this community currently are cheatgrass (20 percent) and Indian ricegrass (10 percent) (Sackschewsky 2003a) (see Attachment A to this appendix). This community should thus be designated cheatgrass/Indian ricegrass (Figure I.4) because the current designation provides no information on species composition. Because sagebrush currently is not present in this area (Sackschewsky 2003a), it appears unlikely that this area could become a big sagebrush/cheatgrass community prior to the start of new construction.

Disturbed (Inactive Borrow Pit). Based on observations made in the field in February and June 2002 (Sackschewsky 2002b, 2003a), the inactive borrow pit was virtually unaffected by the 24 Command Fire, although vegetation all around it was removed. The dominant plant species in this community currently are gray rabbitbrush (5 percent) and cheatgrass (30 percent). Sagebrush is a minor component, at 1 percent cover (Sackschewsky 2003a) (see Attachment A to this appendix). This community should thus be designated gray rabbitbrush/cheatgrass (Figure I.4) because the current designation provides no information on species composition. Because the overstory is dominated by rabbitbrush and sagebrush is sub-dominant, this community should be considered a Level II resource under BRMaP (DOE-RL 2001).

Area C – **Impacts to Wildlife**. Wildlife that could be affected by disturbance of Area C include mammals—the badger (*Taxidea taxus*), coyote, elk (*Cervus elaphus*), mule deer, and Northern pocket gopher; birds—the horned lark, lark sparrow (*Chondestes grammacus*), rock wren (*Salpinctes obsoletus*), short-eared owl (*Asio flammeus*), and Western meadowlark; and reptiles—the side-blotched lizard (Sackschewsky 2003a) (see Attachment A to this appendix).

Of these avian species, those that are ground-nesting and that may nest within Area C include the horned lark and Western meadowlark. Ground disturbance during the nesting season, generally March through July, could destroy eggs and young and temporarily displace nesting individuals into other areas of the Hanford Site. The same temporal restrictions (as set forth previously in the section titled "LLBGs in the 200 East Area and 200 West Area – Impacts to Wildlife and Wildlife Species of Concern") apply for conducting ground-disturbing activities outside the nesting season to protect the nests, eggs, and young of these species in this area.

An elk herd of several hundred animals uses the ALE Reserve and surrounding private lands. After the 24 Command Fire, little vegetation was available on the ALE Reserve. Core use areas during the calving (March through June) and post-calving (July to August) periods in 2000 generally centered along the southern border of the ALE Reserve, largely on private lands in range and agricultural areas. However, one of the core areas used by bulls during the calving period centered on State Route 240 and included part of the Hanford Central Plateau southeast of Area C (Tiller et al. 2000). In addition, elk are known to also move extensively north of State Route (SR) 240, east and south of Area C, from fall through spring. Although most of these movements onto the Hanford Central Plateau are located east and south of Area C, elk also have been observed using Area C (for example, during summer 2002 [see Attachment A to this appendix]). Use of Area C appears to be restricted to foraging and loafing. Calving generally occurs at the upper elevations of Rattlesnake Mountain.

Blasting and use of heavy equipment to remove borrow materials from Area C undoubtedly will disturb elk and displace some animals into adjacent areas, particularly if conducted during the winter months. However, because Area C is only a small portion of their overall range and is not known to be particularly important for either overwintering or calving, the effect on the population is likely to be minimal.

Blasting and use of heavy equipment to remove borrow materials from Area C undoubtedly also will disturb the other mammalian species listed above and displace some individuals into adjacent areas. However, because Area C is not known to be particularly important for any of these species, the effects on local populations of these are likely to be minimal.

Area C – **Impacts to Plant and Wildlife Species of Concern**. According to Soll and Soper (1996), there was a rare plant population of an unnamed species located within Area C, although its purported location did not correspond to any of the areas searched by TNC during the rare plant surveys it conducted on the ALE Reserve in the 1990s. In addition, this population was not referenced in the BRMaP (DOE-RL 2001). This discrepancy was resolved during fieldwork conducted in June and July 2002, during which no rare plant population was observed (Sackschewsky 2003a).

The only plant species of concern observed within the Area C plant communities were purple mat (*Nama densum* var. *parviflorum*), crouching milkvetch, and stalked-pod milkvetch (Sackschewsky 2003a) (see Attachment A to this appendix). Purple mat is a Washington State Review 1 species (plant taxon of potential concern that is in need of additional field work before a status can be assigned [WNHP 2002]). Review 1 species are considered Level II resources under BRMaP (DOE-RL 2001).

Purple mat occurs occasionally throughout central Hanford. Crouching milkvetch and stalked-pod milkvetch are relatively common on the Central Plateau (Sackschewsky and Downs 2001). Consequently, disturbance of the individuals of these three species located in the Area C plant communities likely would not adversely affect the overall local populations. The Area C plant communities (Figure I.4) in which these three species were observed are provided in Table I.2.

No wildlife species of concern were observed in any of the Area C plant communities (Sackschewsky 2003a) (see Attachment A to this appendix).

Table I.2. Area C Plant Communities in Which Purple Mat, Crouching Milkvetch, and/or Stalked-Pod Milkvetch Were Observed (Sackschewsky 2003a) (see Attachment A to this appendix)

Plant Community	**Species**		
	Crouching Milkvetch	**Purple Mat**	**Stalked-Pod Milkvetch**
Cheatgrass/needle-and-thread grass/Indian ricegrass	(a)	X	X
Needle-and-thread grass/cheatgrass	X		
Sandberg’s bluegrass/cheatgrass			
Cheatgrass/Indian ricegrass/Russian thistle			X
Cheatgrass/Sandberg’s bluegrass/Jim Hill’s tumble mustard	X	X	
Cheatgrass	X		
Cheatgrass/Indian ricegrass	X		
Gray rabbitbrush/cheatgrass			X

(a) Blank cells indicate that the species have not been found in the corresponding plant communities.

Area C Stockpile Area and Conveyance Road – Impacts to Habitats and Wildlife. The area identified for the stockpile area and conveyance road north of SR 240 was severely burned in the 24 Command Fire. This area continues to be severely eroded by wind (Becker and Sackschewsky 2001; Sackschewsky and Becker 2001). Much of the topsoil, and likely much of the buried seed (Baker 2000), has been removed. Because of a lack of buried seed, relatively long distances to external upwind seed sources, continued wind erosion, and competition by weedy species, sagebrush recovery would be expected to minimal before the start of new construction.

The dominant plant species in this area currently are Russian thistle (30 percent), cheatgrass (15 percent), and dune scurfpea (*Psoralea lanceolata*) (10 percent) (Sackschewsky 2003a) (see Attachment A to this appendix).

Wildlife that could be affected by disturbance of the stockpile and conveyance road area include mammals—the black-tailed jackrabbit and coyote—and birds—the horned lark, mourning dove (*Zenaida macroura*), Western kingbird (*Tyrannus verticalis*), and Western meadowlark (Sackschewsky 2003a) (see Attachment A to this appendix).

Of these avian species, those that are ground-nesting and that may nest within the stockpile and conveyance road area include the horned lark and Western meadowlark. The same temporal restrictions as set forth above apply for conducting ground-disturbing activities outside the nesting season to protect the nests, eggs, and young of these species in this area.

Area C Stockpile Area and Conveyance Road – Impacts to Plant and Wildlife Species of Concern. The only plant species of concern observed within the area identified for the stockpile and conveyance road was stalked-pod milkvetch (Sackschewsky 2003a) (see Attachment A to this appendix). Because stalked-pod milkvetch is relatively common on the Central Plateau (Sackschewsky and Downs 2001), disturbance of the individuals located within the stockpile and conveyance road area likely would not adversely affect the overall local population.

Only one wildlife species of concern was observed within this area—the black-tailed jackrabbit (Sackschewsky 2003a) (see Attachment A to this appendix). Because of its relatively small areal extent and because sagebrush recovery in the area identified for the stockpile and conveyance road likely would be minimal before the start of new construction, the impact of its eventual removal on the black-tailed jackrabbit within the Columbia Basin is likely to be minimal.

I.2.2 Alternative Group B

LLBGs in the 200 East Area. No other impacts in addition to those described for habitats and plant and animal species under Alternative Group A are expected to occur under Alternative Group B. No other field surveys in addition to those described under Alternative Group A would be required under Alternative Group B.

LLBGs in the 200 West Area. Other potential impacts in addition to those described for habitats and plant and animal species under Alternative Group A may occur under Alternative Group B due to disposal in the 218-W-6 LLBG.

Most of the eastern half of the 218-W-6 LLBG has been previously disturbed and replanted to crested wheatgrass (Brandt 1998, 1999; Sackschewsky 2000, 2001, 2002a, 2003b). The entire western half and a portion of the eastern half (on the northern edge) of the burial ground had not been disturbed prior to late 2001–early 2002 and consisted of sagebrush, spiny hopsage (*Grayia spinosa*), and Sandberg's bluegrass.

However, these areas also were treated with herbicide during late 2001–early 2002 (Sackschewsky 2001, 2002a, 2003b) prior to anticipated mechanical removal of vegetation (Sackschewsky 2002c) for the purpose of fire suppression.

With the exception of the northeastern corner, the eastern half of the 218-W-6 LLBG receives regular herbicide applications and thus has limited habitat value for native species. Vegetation on the western half and the northeastern corner of the 218-W-6 LLBG has been removed since the initial herbicide application of late 2001–early 2002, and these areas will continue to receive herbicide applications on a regular basis. Thus they will have limited habitat value for native species. Consequently, continued use of the 218-W-6 LLBG, or new disturbance of the extant plant communities within them, would not result in the loss of any habitats designated by WDFW as priority habitat (DOE-RL 2003). However, native habitats could develop if herbicide spraying ceases.

New Waste Processing Facility – **Impacts to Habitats and Wildlife**. The area identified for construction of the new waste processing facility consisted of mature sagebrush habitat before the 24 Command Fire. The dominant plant species in this area currently is bur ragweed (*Ambrosia acanthacarpa*), a native annual weed (see Attachment A to this appendix).

This area was severely burned and continues to be severely eroded by wind (Becker and Sackschewsky 2001; Sackschewsky and Becker 2001). Much of the topsoil and likely much of the buried seed (Baker 2000) have been removed. Because of a lack of buried seed, relatively long distances to external upwind seed sources, continued wind erosion, and competition by weedy species, sagebrush recovery would be expected to be minimal within the time frame before the start of new construction.

Wildlife that could be affected by disturbance of the area identified for construction of the new waste processing facility include the coyote (see Attachment A to this appendix).

New Waste Processing Facility – Impacts to Plants and Wildlife Species of Concern. The only plant species of concern observed within the area identified for the new waste processing facility was stalked-pod milkvetch (see Attachment A to this appendix). Because stalked-pod milkvetch is relatively common on the Central Plateau (Sackschewsky and Downs 2001), disturbance of the individuals located within the stockpile and conveyance road area likely would not adversely affect the overall local population.

No wildlife species of concern were observed in this area (see Attachment A to this appendix).

ILAW Disposal Facility – **Impacts to Habitats and Wildlife**. The area identified for construction of the ILAW disposal facility was divided into two areas for the summer 2002 field surveys (Sackschewsky 2003a) (see Attachment A to this appendix)—the W-5 Expansion Area and the area located north of 16th Street and west of Dayton Avenue. Both areas consisted of mature big sagebrush habitat before the 24 Command Fire.

The dominant plant species in the W-5 Expansion Area currently are Sandberg’s bluegrass (20 percent), cheatgrass (15 percent), Indian ricegrass (10 percent), and Russian thistle (10 percent)

(Sackschewsky 2003a) (see Attachment A to this appendix). The dominant plant species in the area located north of 16th Street and west of Dayton Avenue currently is Russian thistle (Sackschewsky 2003a) (see Attachment A to this appendix).

Wildlife that could be affected by disturbance of the W-5 Expansion Area include mammals—the badger, coyote, Great Basin pocket mouse, and mule deer; and birds—the horned lark, mourning dove, and Western meadowlark (Sackschewsky 2003a) (see Attachment A to this appendix). Only the coyote and Western meadowlark were observed in the area north of 16th Street and west of Dayton Avenue (Sackschewsky 2003a) (see Attachment A to this appendix).

Of these avian species, those that are ground-nesting and that may nest within the W-5 Expansion Area and the area located north of 16th Street and west of Dayton Avenue include the horned lark and Western meadowlark. The same temporal restrictions as set forth above apply for conducting ground-disturbing activities outside the nesting season to protect the nests, eggs, and young of these species in these areas.

The W-5 Expansion Area and the area north of 16th Street and west of Dayton Avenue were severely burned and continue to be severely eroded by wind (Becker and Sackschewsky 2001; Sackschewsky and Becker 2001). Much of the topsoil and likely much of the buried seed (Baker 2000) have been removed. Because of a lack of buried seed, relatively long distances to external upwind seed sources, continued wind erosion, and competition by weedy species, sagebrush recovery would be expected to be minimal within the time frame before the start of new construction.

ILAW Disposal Facility – Impacts to Plant and Wildlife Species of Concern. The only plant species of concern observed in the W-5 Expansion Area were crouching milkvetch, stalked-pod milkvetch, and purple mat (Sackschewsky 2003a) (see Attachment A to this appendix). Crouching milkvetch and purple mat were the only plant species of concern observed in the area north of 16th Street and west of Dayton Avenue (Sackschewsky 2003a) (see Attachment A to this appendix). Because purple mat occurs occasionally throughout central Hanford, and crouching milkvetch and stalked-pod milkvetch are relatively common on the Central Plateau (Sackschewsky and Downs 2001), disturbance of the individuals of these three species located in the W-5 Expansion Area and the area north of 16th Street and west of Dayton Avenue likely would not adversely affect the overall local populations.

No wildlife species of concern were observed in the W-5 Expansion Area and the area located north of 16th Street and west of Dayton Avenue (Sackschewsky 2003a) (see Attachment A to this appendix).

Area C. No other impacts to habitats and species in addition to those described under Alternative Group A are expected to occur under Alternative Group B. No other field surveys in addition to those described under Alternative Group A would be required under Alternative Group B.

Area C Stockpile Area and Conveyance Road. No other impacts to habitats and species in addition to those described under Alternative Group A are expected to occur under Alternative Group B. No other field surveys in addition to those described under Alternative Group A would be required under Alternative Group B.

I.2.3 Alternative Group C

LLBGs in the 200 East Area and 200 West Area. No other impacts in addition to those described for habitats and plant and animal species under Alternative Group A are expected to occur under Alternative Group C. No other field surveys in addition to those described under Alternative Group A would be required under Alternative Group C.

Proposed Disposal Facility near the PUREX Plant in the 200 East Area. No other impacts in addition to those described for habitats and plant and animal species under Alternative Group A are expected to occur under Alternative Group C. No other field surveys in addition to those described under Alternative Group A would be required under Alternative Group C.

Area C. No other impacts in addition to those described for habitats and plant and animal species under Alternative Group A are expected to occur under Alternative Group C. No other field surveys in addition to those described under Alternative Group A would be required under Alternative Group C.

Area C Stockpile Area and Conveyance Road. No other impacts in addition to those described for habitats and plant and animal species under Alternative Group A are expected to occur under Alternative Group C. No other field surveys in addition to those described under Alternative Group A would be required under Alternative Group C.

I.2.4 Alternative Groups D_1, D_2, and D_3

LLBGs in the 200 East Area and 200 West Area. No other impacts in addition to those described for habitats and plant and animal species under Alternative Group A are expected to occur under Alternative Groups D_1, D_2, or D_3. No other field surveys in addition to those described under Alternative Group A would be required under Alternative Groups D_1, D_2, or D_3.

Proposed Disposal Facility near the PUREX Plant in the 200 East Area. Proposed disposal near the PUREX Plant occurs only under Alternative Group D_1. No other impacts in addition to those described for habitats and plant and animal species under Alternative Group A are expected to occur under Alternative Group D_1. No other field surveys in addition to those described under Alternative Group A would be required under Alternative Group D_1.

ERDF – Impacts to Habitats and Plant Species of Concern. Disposal at ERDF occurs only under Alternative Group D_3 and would most likely be located just east of the existing ERDF disposal cells. Therefore, the area within 1 km (0.62 mi) of the existing ERDF disposal cells was surveyed in spring 2003. This site and some of the surrounding area, including the area surveyed, was burned in the 24 Command Fire. The area comprising the ERDF site before the 24 Command Fire generally consisted of mature sagebrush (from 25 to 50 percent cover in the northern portion of ERDF [Brandt 1994]) habitat with varying understory components. The dominant understory component over approximately 90 percent of the area was a mix of cheatgrass (from 50 to 75 percent cover in the northern portion of

ERDF [Brandt 1994]) and Sandberg's bluegrass. The dominant understory component over approximately 10 percent of the area was a mix of cheatgrass and needle-and-thread grass (DOE-RL 1995c).

Currently, vegetation in the surveyed area consists primarily of cheatgrass at 40 percent cover. There are just a few mature sagebrush remaining in this area (that is, much less than one percent cover). The only observed plant species of concern was stalked-pod milkvetch. Stalked-pod milkvetch is relatively common on the Central Plateau (Sackschewsky and Downs 2001). Therefore, disturbance of those individuals in the surveyed area likely would not adversely affect the overall local population.

ERDF – Impacts to Wildlife and Wildlife Species of Concern. Wildlife species observed within 1 km of the current ERDF eastern boundary include the coyote, northern pocket gopher, side-blotched lizard, and several migratory bird species—the horned lark, Western meadowlark, and loggerhead shrike (*Lanius ludovicianus*). The latter is a Washington State Candidate species and a federal species of concern (species whose conservation standing is of concern to the U.S. Fish and Wildlife Service but for which status information still is needed).

The horned lark and Western meadowlark are ground-nesting species. The same temporal restrictions as set forth above apply for conducting ground-disturbing activities outside the nesting season to protect the nests, eggs, and young of these species in this area. The loggerhead shrike generally nests in shrubs and trees. There are no trees in the surveyed area and shrubs are very scarce. Therefore, it is unlikely that the shrikes observed during the spring 2003 survey were nesting in the surveyed area.

Area C. No other impacts in addition to those described for habitats and plant and animal species under Alternative Group A are expected to occur under Alternative Groups D_1, D_2, or D_3. No other field surveys in addition to those described under Alternative Group A would be required under Alternative Groups D_1, D_2, or D_3.

Area C Stockpile Area and Conveyance Road. No other impacts in addition to those described for habitats and plant and animal species under Alternative Group A are expected to occur under Alternative Groups D_1, D_2, or D_3. No other field surveys in addition to those described under Alternative Group A would be required under Alternative Groups D_1, D_2, or D_3.

I.2.5 Alternative Groups E_1, E_2, and E_3

LLBGs in the 200 East Area and 200 West Area. No other impacts in addition to those described for habitats and plant and animal species under Alternative Group A are expected to occur under Alternative Groups E_1, E_2, or E_3. No other field surveys in addition to those described under Alternative Group A would be required under Alternative Groups E_1, E_2, or E_3.

Proposed Disposal Facility near the PUREX Plant in the 200 East Area. Proposed disposal near the PUREX Plant occurs only under Alternative Groups E_2 and E_3. No other impacts in addition to those described for habitats and plant and animal species under Alternative Group A are expected to occur under Alternative Groups E_2 or E_3. No other field surveys in addition to those described under Alternative Group A would be required under Alternative Groups E_2 or E_3.

ERDF. No other impacts in addition to those described for habitats and plant and animal species under Alternative Group D_3 are expected to occur under Alternative Groups E_1, E_2, or E_3. No other field surveys in addition to those described under Alternative Group D_3 would be required under Alternative Groups E_1, E_2, or E_3.

Area C. No other impacts in addition to those described for habitats and plant and animal species under Alternative Group A are expected to occur under Alternative Groups E_1, E_2, or E_3. No other field surveys in addition to those described under Alternative Group A would be required under Alternative Groups E_1, E_2, or E_3.

Area C Stockpile Area and Conveyance Road. No other impacts in addition to those described for habitats and plant and animal species under Alternative Group A are expected to occur under Alternative Groups E_1, E_2, or E_3. No other field surveys in addition to those described under Alternative Group A would be required under Alternative Groups E_1, E_2, or E_3.

I.2.6 No Action Alternative

LLBGs in the 200 East Area and 200 West Area. No other impacts in addition to those described for habitats and plant and animal species under Alternative Group A are expected to occur under the No Action Alternative. No other field surveys in addition to those described under Alternative Group A would be required under the No Action Alternative.

Proposed Disposal Facility near the PUREX Plant in 200 East Area. No other impacts in addition to those described for habitats and plant and animal species under Alternative Group A are expected to occur under the No Action Alternative. No other field surveys in addition to those described under Alternative Group A would be required under the No Action Alternative.

Additional CWC Buildings. No other impacts in addition to those described for habitats and plant and animal species under Alternative Group B are expected to occur under the No Action Alternative. No other field surveys in addition to those described under Alternative Group B would be required under the No Action Alternative.

Area C. No other impacts in addition to those described for habitats and plant and animal species under Alternative Group A are expected to occur under the No Action Alternative. No other field surveys in addition to those described under Alternative Group A would be required under the No Action Alternative.

Area C Stockpile Area and Conveyance Road. No other impacts in addition to those described for habitats and plant and animal species under Alternative Group A are expected to occur under the No Action Alternative. No other field surveys in addition to those described under Alternative Group A would be required under the No Action Alternative.

I.2.7 Mitigation

Most biological resources in the Industrial-Exclusive Area of the Central Plateau were destroyed or displaced during the 24 Command Fire. However, some habitats and species could be subject to mitigation under existing biological conditions and current mitigation guidelines, as prescribed in BRMaP (DOE-RL 2001) and the *Hanford Site Biological Resources Mitigation Strategy* (BRMiS) (DOE-RL 2003).

This section sets forth what the current mitigation requirements for these habitats/species would be if these were to be disturbed in their current condition under current mitigation guidelines. This is done for the purpose of comparison among the alternative groups because current biological conditions and mitigation guidelines are inappropriate for determining actual mitigation requirements for impacts that would not occur for at least another decade. In the interim, habitats and species assemblages may change (for example, fire-damaged habitats may recover), as might mitigation guidelines at Hanford. Consequently, actual mitigation requirements would depend on the results of field surveys conducted during the growing season just prior to initiating operations, as well as on the mitigation guidelines in effect at Hanford at that time.

According to DOE-RL (2001), mitigation should be considered for biological resources categorized as Level II and above (see Table I.3). The current mitigation requirements for the Level II and above resources described in the preceding sections are discussed below.

Level I Habitat Resources. All habitats described in the preceding sections that were not designated Level II or above are considered Level I resources, and no mitigation is required (see Table I.3) (DOE- RL 2001).

Level II Habitat Resources. Mitigation of Level II habitat resources generally is accomplished by avoidance and impact minimization (see Table I.3). However, in some cases where Level II resources fall into the category of recovering shrub-steppe habitat, and field surveys of the affected area confirm that sagebrush recovery (defined as sagebrush habitat with immature sagebrush regenerated through natural processes) is well under way, replacement mitigation (rectification or compensation [Table I.3]) is recommended (DOE-RL 2001).

Replacement mitigation for disturbance of the widely scattered mature big sagebrush located in the southeastern portion of the cheatgrass/Sandberg’s bluegrass/Jim Hill’s tumble mustard community in Area C (see Figure I.4) is not recommended. Because no immature sagebrush was observed during the summer 2002 field survey (Sackschewsky 2003a), sagebrush recovery currently is not occurring, by definition. Nonetheless, this habitat would be subject to mitigation via avoidance and impact minimization (see Table I.3).

Replacement mitigation for disturbance of the sagebrush habitat within the gray rabbitbrush/cheatgrass community in Area C (see Figure I.4) is not required. The sagebrush within this community occurs over an area smaller than the current mitigation threshold for the 600 Area (0.5 ha [1.25 ac]) (DOE-RL 2003), and it covers only 1 percent of the area in which it occurs, which is much less than the

Table I.3. General Classes of Mitigation Actions and Biological Resource Levels of Concern to Which They Apply (DOE-RL 2001)

Class of Mitigation Action	Resource Level[(a)]			
	I	**II**	**III**	**IV**
Avoidance[(b)]/Minimization[(c)]	No	Yes	Yes	Yes
Replacement by Rectification[(d)]/Compensation[(e)]	No	No	Yes	Yes[(f)]

(a) See Table I.1 for resource level definitions.
(b) Avoidance = eliminate all or part of a project or alter the timing, location, or implementation to avoid injury to biological resources of concern.
(c) Minimization = alter project timing, location, or implementation to minimize injury to biological resources of concern.
(d) Rectification = replace biological resources of concern on the site to be disturbed.
(e) Compensation = replace lost biological resources of concern away from the site to be disturbed.
(f) Rectification is probably not possible nor an appropriate means of mitigation at this level; compensatory mitigation can be used but only when it is achieved by acquisition and/or protection of in-kind resources.

current mitigation requirement of at least 10 percent cover (DOE-RL 2003). Nonetheless, this habitat would be subject to mitigation via avoidance and impact minimization (see Table I.3).

Level III Habitat Resources. Disturbance of 5 ha or more of mature sagebrush habitat is the mitigation threshold in the southern half of the 200 East Area (DOE-RL 2003). Mitigation for disturbance of the mature sagebrush habitat on the site of the proposed disposal facility near the PUREX Plant would first be by avoidance and impact minimization. However, when avoidance and impact minimization are not possible or their application still results in adverse residual impacts above 5 ha, as would be the case in construction of the disposal facility, replacement mitigation is required (DOE-RL 2001).

Since the developed portion of the 218-W-4C LLBG would not be expanded into the undeveloped southeastern portion of the 218-W-4C LLBG, no impacts to shrub-steppe are expected and thus a requirement for mitigation would not be expected.

Level IV Habitat Resources. Element occurrences are defined as Level IV resources (see Table I.1) because they are of such high quality (that is, they show little or no indication of human impact or invasion by non-native species, or they have significant wildlife usage) and/or rarity that they cannot be mitigated unless it is by compensation via the setting aside and protection of in-kind (that is, similar type and quality) resources (DOE-RL 2001). There are three element occurrences in Area C. Mitigation recommendations for these follow.

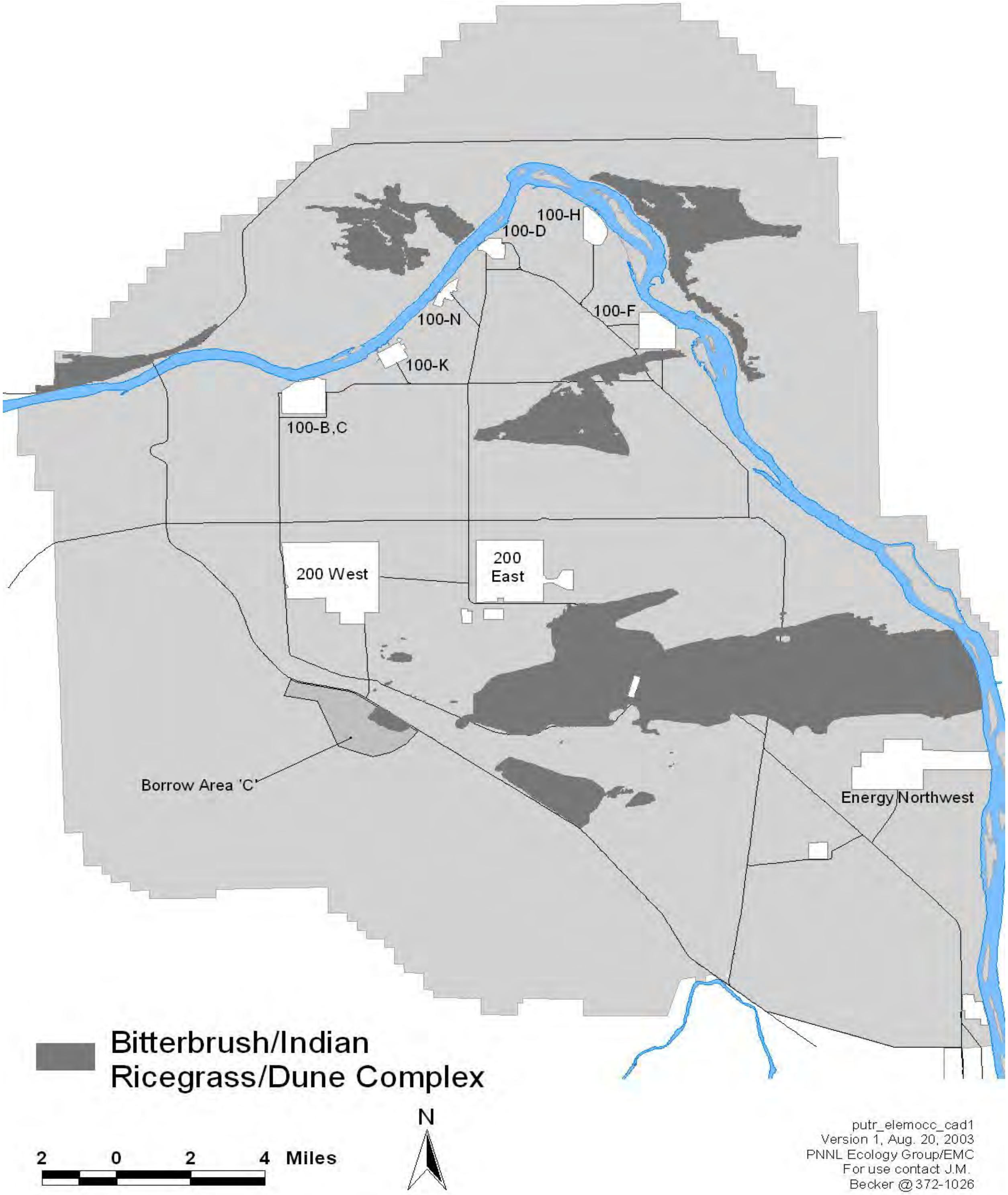
The cheatgrass/needle-and-thread grass/Indian ricegrass community (Figure I.4) is an element occurrence of the bitterbrush/Indian ricegrass sand dune complex community type (Figure I.3). Disturbance of the cheatgrass/needle-and-thread grass/Indian ricegrass community would be mitigated via the setting aside and protection of an element occurrence of the bitterbrush/Indian ricegrass sand dune complex community type located away from Area C. The size of the replacement community should approximate that of the lost community, 97 ha (241 ac). Ample element occurrences of this community type currently exist elsewhere in the 600 Area of the Hanford Site and on adjacent lands on ALE and the Wahluke Slope (lands jointly managed by DOE) to satisfy this size constraint (Figure I.5).

The needle-and-thread grass/cheatgrass community (Figure I.4) is an element occurrence of the sagebrush/needle-and-thread grass community type (Figure I.3). Disturbance of the needle-and-thread grass/cheatgrass community would be mitigated via the setting aside and protection of an element occurrence of the sagebrush/needle-and-thread grass community type located away from Area C. The size of the replacement community should approximate that of the lost community, 5 ha (12.5 ac). Ample element occurrences of this community type currently exist elsewhere in the 600 Area of the Hanford Site and on adjacent lands on ALE and the Wahluke Slope to satisfy this size constraint (Figure I.6).

The Sandberg’s bluegrass/cheatgrass community (Figure I.4) is an element occurrence of the big sagebrush/bluebunch wheatgrass community type (Figure I.3). Disturbance of the Sandberg’s bluegrass/cheatgrass community would be mitigated via the setting aside and protection of an element occurrence of the big sagebrush/bluebunch wheatgrass community type. The size of the replacement community should approximate that of the lost community, 1.5 ha (4 ac). Ample element occurrences of this community type currently exist elsewhere in the 600 Area of the Hanford Site and on adjacent lands on ALE and the Wahluke Slope (Figure I.7). **Level I Species Resources**. Crouching milkvetch (located in the 218-E-10 and 218-E-12B LLBGs in the 200 East Area and in Area C) and stalked-pod milkvetch (located in the 218-W-5 LLBG in the 200 West Area, Area C, the stockpile area and conveyance road area, the area designated for the new processing facility, and ERDF) are considered a Washington State Watch List species, the lowest level of listing for plant species of concern in the state. Watch List species are thus considered Level I resources under BRMaP, for which no mitigation is required (see Table I.3) (DOE-RL 2001).

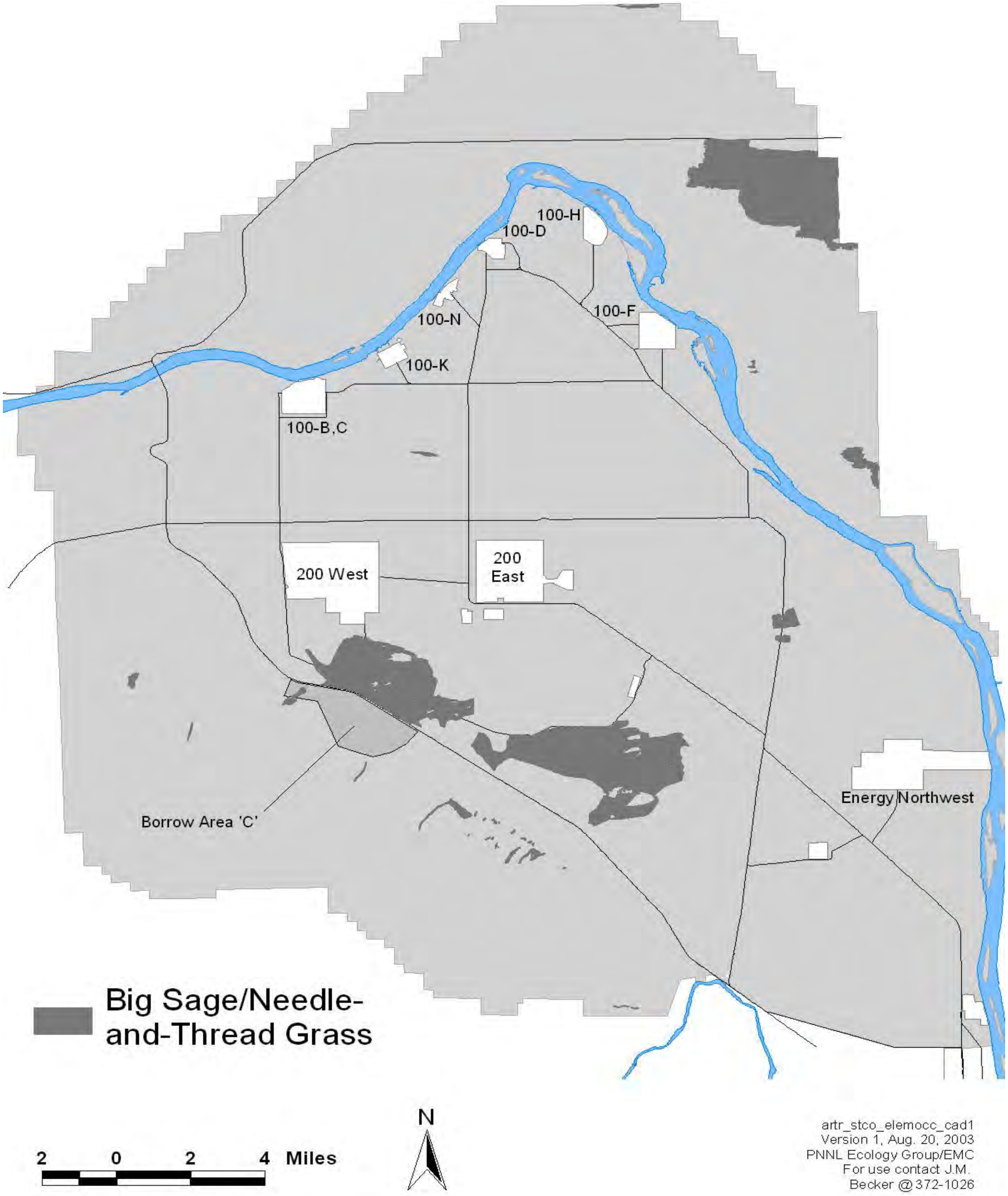
Level II Species Resources. Purple mat (located in Area C) is considered a Washington State Review 1 species. Review 1 species are considered Level II resources under BRMaP, for which mitigation requirements consist of avoidance and impact minimization (see Table I.3) (DOE-RL 2001).

Level III Species Resources. Piper’s daisy was formerly present in the 218-E-12B and 218-E-10 LLBGs in the 200 East Area. Mitigation for this species would not currently be required because it is now absent in the areas where it formerly occurred. However, mitigation would be considered if populations were to recover prior to initiating operations. Therefore, the presence/absence of Piper’s daisy populations on the 218-E-12B and 218-E-10 LLBGs should be determined via a field survey during the growing season just prior to initiating operations.



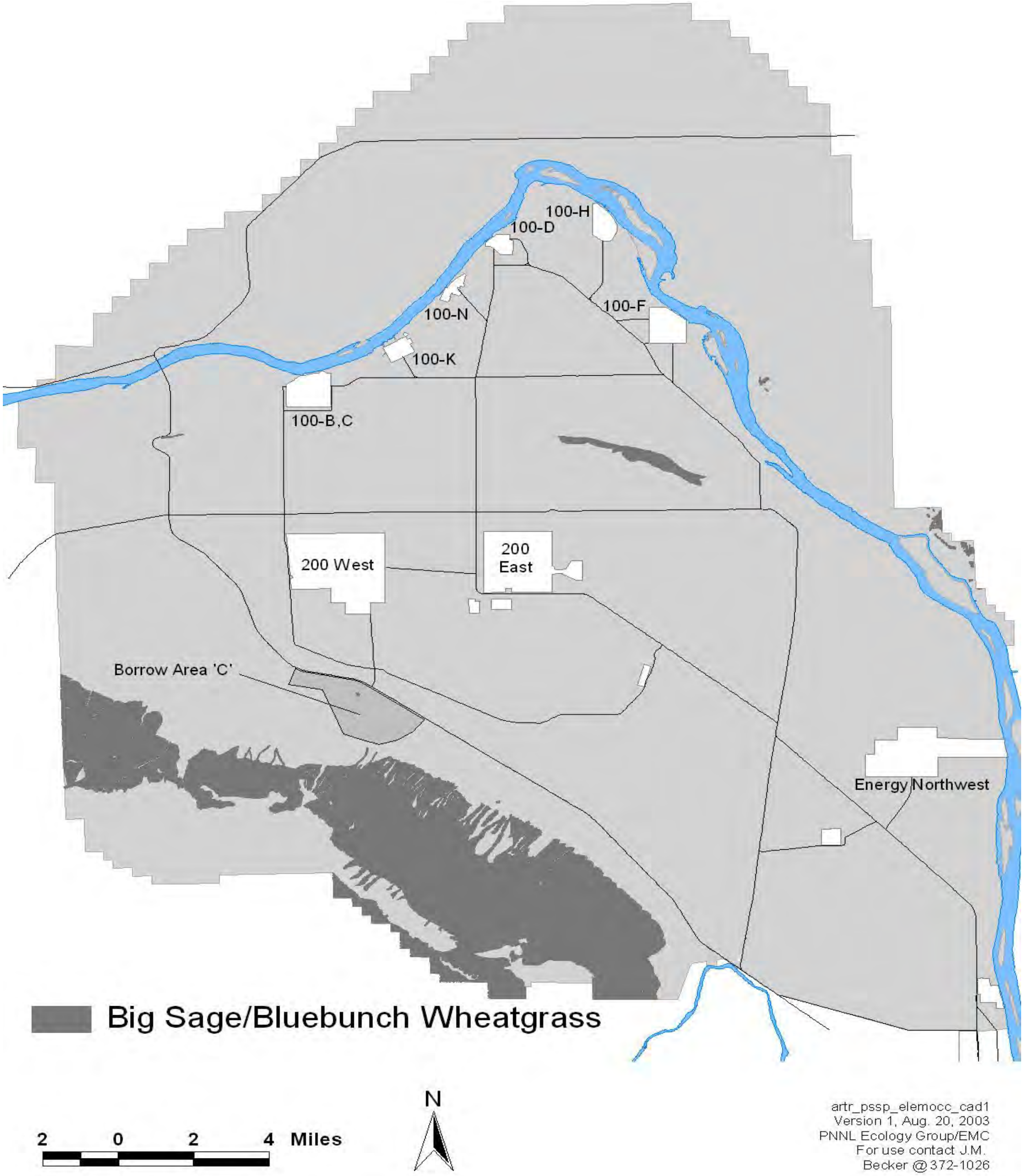
putr_elemocc_cad1
Version 1, Aug. 20, 2003
PNNL Ecology Group/EMC
For use contact J.M.
Becker @ 372-1026

Figure I.5. Element Occurrences of Bitterbrush/Indian Ricegrass Sand Dune Complex Community Type Outside Area C in the 600 Area of Hanford Site, **ALE (area west and south of Area C), and the Wahluke Slope (area north of the Columbia River)**



artr_stco_elemocc_cad1
Version 1, Aug. 20, 2003
PNNL Ecology Group/EMC
For use contact J.M.
Becker @ 372-1026

Figure I.6. Element Occurrences of Big Sagebrush/Needle-and-Thread Grass Community Type Outside Area C in the 600 Area of Hanford Site, **ALE (area west and south of Area C), and the Wahluke Slope (area north of the Columbia River)**



artr_pssp_elemocc_cad1
Version 1, Aug. 20, 2003
PNNL Ecology Group/EMC
For use contact J.M.
Becker @372-1026

Figure I.7. Element Occurrences (on Gable Mountain and at Vernita Quarry) of Big Sagebrush/Bluebunch Wheatgrass Community Type Outside Area C in the 600 Area of Hanford Site, **ALE (area west and south of Area C), and the Wahluke Slope (area north of the Columbia River)**

Summary. The habitats and species that might be subject to mitigation based on existing conditions and current mitigation guidelines are summarized by alternative group in Table I.4. All habitats/species subject to mitigation, with their associated mitigation actions, occur in each of the alternative groups, with the exception of the mature sagebrush habitat at the site of the proposed disposal facility near the PUREX Plant (see Table I.4). Consequently, the alternative groups can be differentiated only with respect to mitigation of this habitat.

The areal extent of disturbance of the mature sagebrush habitat in the proposed disposal facility near the PUREX Plant varies by alternative group (see Table I.4), and so would the corresponding mitigation requirements. Thus, the areas of disturbance may be used to differentiate the alternative groups. These are provided in Table 5.1 in Section 5.1 of Volume 1 of this HSW EIS.

Table I.4. Habitats and Species Subject to Mitigation Based on Existing Conditions[(a)] and Current Mitigation Guidelines[(b)]

Alternative Group(s)	Habitat/Species	Resource Ranking	Location	Area (ha [ac])	Class of Mitigation Action
Alternative Groups A, B, C, D_1, D_2, D_3, E_1, E_2, E_3, and No Action	Purple mat	II	Area C	NA	Avoidance/minimization
Alternative Groups A, B, C, D_1, D_2, D_3, E_1, E_2, E_3, and No Action	Widely scattered mature big sagebrush in the southeastern portion of the cheatgrass/Sandberg's bluegrass/Jim Hill's tumble mustard community	II	Area C	Unknown	Avoidance/minimization
Alternative Groups A, B, C, D_1, D_2, D_3, E_1, E_2, E_3, and No Action	Sagebrush habitat within the gray rabbitbrush/cheatgrass community	II	Area C	<0.5 (1.25)	Avoidance/minimization
Alternative Groups A, C, D_1, E_2, E_3, and No Action	Mature sagebrush steppe	III	Site of the proposed disposal facility near PUREX	Varies by alternative group[(c)]	Avoidance/minimization or rectification/compensation
Alternative Groups A, B, C, D_1, D_2, D_3, E_1, E_2, E_3, and No Action	Cheatgrass/needle-and-thread grass/Indian ricegrass community (element occurrence of the bitterbrush/Indian ricegrass sand dune complex community type)	IV	Area C	97 (241)	Compensation – setting aside and protection of in-kind resources
Alternative Groups A, B, C, D_1, D_2, D_3, E_1, E_2, E_3, and No Action	Needle-and-thread grass/cheatgrass community (element occurrence of the sagebrush/needle-and-thread grass community type)	IV	Area C	5 (12.5)	Compensation – setting aside and protection of in-kind resources
Alternative Groups A, B, C, D_1, D_2, D_3, E_1, E_2, E_3, and No Action	Sandberg's bluegrass/cheatgrass community (element occurrence of the big sagebrush/bluebunch wheatgrass community type)	IV	Area C	1.5 (4)	Compensation – setting aside and protection of in-kind resources

(a) Existing conditions represent element occurrences established prior to the 24 Command Fire. They do not necessarily represent element occurrences that would require mitigation.

(b) This table sets forth what the current mitigation requirements for these habitats/species would be if these were to be disturbed in their current condition under current mitigation guidelines. Actual mitigation requirements would depend on the results of field surveys conducted during the growing season just prior to initiating operations, as well as on the mitigation guidelines in effect at Hanford at that time.

(c) The area of mature sagebrush habitat to be disturbed varies depending on alternative group, ranging from about 5 ha (12 ac) for the Hanford Only waste volume of Alternative Group E_2 to 32 ha (79 ac) for Alternative Group A.

I.2.8 Biodiversity

The potential effects on biodiversity that might result from the waste management and related operations described in this HSW EIS are best considered on an ecosystem or regional scale (CEQ 1993). The Hanford Site is located within the Columbia Basin ecoregion, an area that historically included over 6 million ha (14.8 million ac) of steppe and shrub-steppe vegetation across most of central and south-eastern Washington state, as well as portions of north-central Oregon. The pre-settlement vegetation consisted primarily of shrubs, perennial bunchgrasses, and a variety of forbs. An estimated 60 percent of shrub-steppe in Washington has been converted to agriculture or other uses. Much of what remains is in small parcels, in shallow rocky soils, or has been degraded by historic land uses (mostly livestock grazing) (TNC 1999).

The Hanford Site retains some of the largest remaining blocks of relatively undisturbed shrub-steppe in the Columbia Basin ecoregion. Hanford's importance as a refuge for the shrub-steppe ecosystem is not solely size-related, however. The presence of a high diversity of physical features and examples of rare, undeveloped deep and sandy soil has led to a corresponding diversity of plant and animal communities. Many places on the Hanford Site are relatively free of non-native species and are extensive enough to retain characteristic populations of shrub-steppe plants and animals that are absent or scarce in other areas. Because of its location, the site provides important connectivity with other undeveloped portions of the ecoregion (TNC 1999).

The 24 Command Fire removed virtually all the shrub-steppe on areas (outside the LLBGs) that would be disturbed by new construction described in the HSW EIS (that is, Area C and the areas identified for construction of the additional CWC facilities and the new waste processing facility). Plant communities in these areas now are dominated largely by exotic, invasive "weedy" species and support only relatively common and generally ubiquitous plant and animal taxa that are not characteristic of shrub-steppe (see Sections I.2.1–3 and Attachment A to this appendix). These plant and animal taxa are relatively unimportant in terms of their contribution to the maintenance of ecoregional biodiversity. In addition, the 24 Command Fire removed most of the adjacent shrub-steppe, interrupting the connectivity of these areas with other undeveloped portions of the ecoregion.

Prior to the start of new construction as described in the HSW EIS, re-colonization by characteristic shrub-steppe plants and animals in these (and adjacent) areas may occur. The need for mitigation of ecological impacts in these areas would depend on the results of surveys conducted just prior to initiating operations because those operations are not expected for a decade or more. Biological resources would be subject to mitigation based on existing conditions and applicable mitigation guidelines at that time, such as the *Hanford Site Biological Resources Management Plan* (DOE-RL 2001) and the *Hanford Site Biological Resources Mitigation Strategy* (DOE-RL 2003). Although new construction would result in temporary habitat loss in these areas, its loss would likely have no long-term effect on ecoregional biodiversity.

I.2.9 Microbiotic Crusts

Microbiotic (cryptogamic) crusts generally occur in the top 1 to 4 mm of soil and are formed by living organisms and their by-products, creating a crust of soil particles bound together by organic materials. These crusts are common in the semiarid Columbia Basin, where they tend to be dominated by green algae (Johansen et al. 1993). The functions of microbiotic crusts include soil stability and erosion, fixation of atmospheric nitrogen, nutrient contributions to plants, soil-plant water relations, water infiltration, seedling germination, and plant growth.

The relative importance of biological crusts and their ecological roles is highly dependent on the relative cover of various crustal components. Carbon inputs are higher when mosses and lichens are present than when crust is dominated by cyanobacteria. Nitrogen inputs are higher with greater infiltration and soil surface stability, which are related to cyanobacterial biomass as well as moss and lichen cover (Belnap et al. 2001). The lichens and mosses of the Hanford Site were surveyed and evaluated by Link et al. (2000). They found 29 soil lichen species in 19 genera, comprising 4 different growth forms, and 6 moss species in 4 genera.

Disruption of microbiotic crusts may result in decreased diversity of microbiota, soil nutrients, and organic matter (Belnap and Harper 1995; Belnap et al. 2001). The 24 Command Fire intensely burned the soil surface in areas (outside the LLBGs) that would be disturbed by new construction as described in the HSW EIS. This undoubtedly resulted in the virtual complete destruction of soil microbiota, facilitating the severe wind erosion experienced in these areas (Becker and Sackschewsky 2001; Sackschewsky and Becker 2001). Recovery of microbiotic crusts following disturbance is generally a slow process. For example, in burned areas on the ALE Reserve, soil algae recovery took place during the winter months of the second year following the fire of 1984 (Johansen et al. 1993). The recovery time required by soil microbiota following construction is no exception.

Deep burial such as would result from construction described in the HSW EIS would kill crusts (Shields et al. 1957). Re-colonization of Area C and the areas identified for the additional CWC facilities and the new waste processing facility would undoubtedly require several years following construction, the speed of which may largely depend on the availability of nearby sources (Belnap 1993). Consequently, a temporary loss of benefits derived from microbiotic crusts would ensue.

I.3 Potential Impacts to Columbia River Aquatic and Riparian Resources Resulting from Future Contaminant Releases

Potential adverse impacts posed by future releases of contaminants to aquatic and terrestrial species known to occur in the Columbia River and its riparian corridor were analyzed in an ecological risk assessment framework. The risk assessments conducted for this analysis of impacts generally follow U.S. Environmental Protection Agency (EPA) guidance for conducting such assessments (EPA 1992, 1998) and the corresponding Hanford Site risk assessment methodology (DOE-RL 1995b).

These risk assessments emphasize the analysis and risk characterization phases of the EPA risk assessment paradigm, in order to characterize the relative magnitude of potential impacts between the alternative groups. The problem formulation phase of the EPA risk assessment framework is not well represented in these risk assessments because the inventory, location, release, and migration of contaminants of interest to the Columbia River are covered elsewhere in the EIS.

The risk of future adverse effects was analyzed using the Ecological Contaminant Exposure Model (ECEM) (Eslinger et al. 2002) developed for the Columbia River Comprehensive Impact Assessment (DOE-RL 1998).

I.3.1 Assumptions Regarding Contaminants

Contaminant concentrations used in the risk assessment consisted of predicted peak concentrations of key radionuclides at a hypothetical well along the Columbia River during any given year within 10,000 years of 2046 (see Appendix G). These well concentrations were assumed to apply also to pore water (water in the interstitial spaces of the substrate that forms the bottom of the Columbia River, such as groundwater in springs between rocks). Predicted peak concentrations of key radionuclides in the river also were used. These were derived from maximum amounts of radionuclides entering the river within the affected area in any 10-year period within 10,000 years of 2046 (see Appendix G). River concentrations were derived by diluting the maximum amount of a radionuclide by the average volume of river flow within a generic 10-year period (based on an average annual flow rate of 3300 m^3/sec).

The 10,000 years were divided into two time periods, early and late. An individual risk assessment was performed for each time period within each alternative group. The early time period applies to the radionuclides with a distribution or partition coefficient (K_d) of zero—technetium-99 and iodine-129—whose arrival times at the river well and river are less than 2500 years. The late time period applies to the radionuclides with a K_d greater than zero—carbon-14 and the uranium isotopes—whose arrival times are from 2500 to 10,000 years.

Concentrations of individual radionuclides were summed over the 200 West Area and 200 East Area source areas and over all waste categories within each time period and alternative group. Concentrations of technetium-99 and iodine-129 in grouted Category 3 LLW and ungrouted Category 1 LLW within each alternative group were combined if their arrival times were within the same time period.

Concentrations of radionuclides often were separated temporally within a given time period and alternative group. For example, arrival times of the same radionuclide at a given location—that is, at the well or river—varied depending on the source area and waste stream (see Appendix G). Further, the same radionuclide from the same source area and waste stream arrived later at the river than at the well (see Appendix G), generally on the order of decades.

Concentrations of radionuclides also were separated spatially within a given time period and alternative group. For example, well concentrations represented a single location whose position varied depending on the radionuclide, source area, or waste stream. In contrast, river concentrations represented the entire length of the river in the affected area downstream from the point of entry.

The assumptions just described in the five foregoing paragraphs underly the radionuclide concentrations used in the risk assessments. These assumptions render the assessments extremely conservative by assuming simultaneous exposure to maximum contaminant concentrations that, based on groundwater modeling (see Appendix G), do not always occur concurrently in time and space. Thus, the risk assessments estimate maximum possible exposure and risk for receptors.

I.3.2 Assumptions Regarding Partitioning of Contaminants to Abiotic Media

Two exposure scenarios were evaluated—Hanford contribution (hereafter expressed as Hanford) and Hanford-Plus-Background. The assumptions used to derive the abiotic media concentrations used in these two scenarios are summarized in Table I.5.

In both scenarios, radionuclide concentrations in the well are released from groundwater into shoreline seeps, and the background groundwater contribution is assumed to be zero (see Table I.5). Because seeps are located below the high water mark and river water levels fluctuate substantially, seep concentrations are based on mixing groundwater and surface water at a ratio of approximately 0.48:0.52, respectively (see Table I.5) (Bryce et al. 2002). Background surface water concentrations for iodine-129, technetium-99, and uranium-234, -235, -236, and -238 were obtained from Kincaid et al. (2000). Background surface water concentrations for carbon-14 were obtained from DOE-RL (1998). Soil concentrations were calculated by multiplying seep concentrations by partition coefficients (K_d). Background pore water concentrations were assumed equal only to background surface water concentrations (see Table I.5) because the background groundwater contribution is assumed to be zero.

Table I.5. Summary of Assumptions Used to Derive Abiotic Media Concentrations Used in Hanford and Hanford-Plus-Background Exposure Scenarios

Exposure Scenario	
Hanford Contribution	**Hanford Contribution Plus Background**
Groundwater = peak concentrations of key radionuclides in well water (Appendix G) at the hypothetical near-river location	Groundwater = peak concentrations of key radionuclides in well water (Appendix G) at the hypothetical near-river location
Seep water = mix of 48% groundwater and 52% surface water	Seep water = mix of 48% groundwater and 52% surface water (including background surface water concentrations)
Soil = Seep water × K_d	Soil = Seep water × K_d
Pore water = groundwater	Pore water = groundwater + background surface water concentrations
Sediment = pore water × K_d	Sediment = pore water × K_d
Surface water = maximum concentrations entering the river (Appendix G) diluted by average river flow volume within a generic 10-year period	Surface water = maximum concentrations entering the river (Appendix G) + background surface water concentrations diluted by average river flow volume within a generic 10-year period

Sediment concentrations were calculated by multiplying pore water concentrations by partition coefficients (K_d). Best estimates were used for soil and sediment K_d values. These were obtained from Table G.1 in Appendix G.

Hanford and Hanford-Plus-Background radionuclide and total uranium concentrations in the various abiotic media, as calculated, are presented for each time period and alternative group in Tables I.6 and I.7.

I.3.3 Ecological Contaminant Exposure Model

The Ecological Contaminant Exposure Model, or ECEM, consists of two parts, terrestrial and aquatic (Eslinger et al. 2002). The terrestrial portion estimates wildlife exposures to contaminants in air through inhalation, in water through dermal exposure and ingestion, in soil through dermal exposure and ingestion, and in foods. The aquatic portion estimates exposures to contaminants in surface water and pore water via gill or respiratory uptake, in sediment via dermal exposure and ingestion, and in foods.

The ECEM was developed earlier for other more complex risk assessments of Columbia River biota (DOE-RL 1998; Bryce et al. 2002) and thus is based on a food web architecture that is specific to the Hanford Site. The ECEM estimates exposures for 57 terrestrial and aquatic animal and plant receptors (see Table I.8). One of the ECEM's aquatic receptors, the generic salmon, serves as a surrogate for the steelhead (*Oncorhynchus mykiss*) because its conceptual exposure to contaminated abiotic media and prey are essentially the same.

The ECEM was run deterministically (single calculation using a single value for each input parameter—radionuclide concentration, partition coefficient, species uptake rates, and so on). Model output consisted of estimated equilibrium exposures for receptors (see Table I.8) potentially affected by the (1) combined radiological toxicity of individual radionuclides (see Section I.3.4) and (2) chemical toxicity of total uranium (Labrot et al. 1999; Domingo 2001) (see Section I.3.5).

I.3.4 Combined Radiological Toxicity

Estimated equilibrium exposures for terrestrial and aquatic animal and plant receptors consisted of total radiological dose (rad/day). Risk is assessed via calculation of environmental hazard quotients (EHQs). The EHQ, or level of risk, is indicated by the ratio of the estimated exposure to a measurement (effect) endpoint such as a radiological dose limit or standard.

Radiological risk EHQs are calculated by dividing the estimated total radiological dose by the applicable DOE dose limit or standard. These dose limits and standards are 1 rad/day for native aquatic animals (DOE 1993), 0.1 rad/day for terrestrial animals, and 1 rad/day for aquatic and terrestrial plants (DOE 2002). An EHQ greater than 1 indicates a potential risk of radiotoxic effects.

Table I.6. Hanford and Hanford-Plus-Background Radionuclide Concentrations in Well Water, Pore Water, Sediment, Soil, and River Water for Each Time Period and Alternative Group[(a)]

Constituent	EIS Alternative Group and Waste Volume	Time Period (y)	Hanford Concentrations					Hanford-Plus-Background Concentrations				
			Well Water (pCi/L)	Pore Water (pCi/L)	Sediment (pCi/kg)	Soil (pCi/kg)	River Water (pCi/L)	Well Water (pCi/L)	Pore Water (pCi/L)	Sediment (pCi/kg)	Soil (pCi/kg)	River Water (pCi/L)
C-14	A - Hanford Only	10,000	2.66E-01	2.66E-01	0.00E+00	0.00E+00	1.70E-06	2.66E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	A - Lower Bound	10,000	2.66E-01	2.66E-01	0.00E+00	0.00E+00	1.70E-06	2.66E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	A - Upper Bound	10,000	2.67E-01	2.67E-01	0.00E+00	0.00E+00	1.70E-06	2.67E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	B - Hanford Only	10,000	2.66E-01	2.66E-01	0.00E+00	0.00E+00	3.34E-06	2.66E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	B - Lower Bound	10,000	2.66E-01	2.66E-01	0.00E+00	0.00E+00	9.15E-06	2.66E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	B - Upper Bound	10,000	2.67E-01	2.67E-01	0.00E+00	0.00E+00	7.90E-05	2.67E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	C - Hanford Only	10,000	2.66E-01	2.66E-01	0.00E+00	0.00E+00	1.70E-06	2.66E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	C - Lower Bound	10,000	2.66E-01	2.66E-01	0.00E+00	0.00E+00	1.70E-06	2.66E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	C - Upper Bound	10,000	2.66E-01	2.66E-01	0.00E+00	0.00E+00	1.70E-06	2.66E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	D_1 - Hanford Only	10,000	2.66E-01	2.66E-01	0.00E+00	0.00E+00	1.70E-06	2.66E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	D_1 - Lower Bound	10,000	2.66E-01	2.66E-01	0.00E+00	0.00E+00	1.70E-06	2.66E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	D_1 - Upper Bound	10,000	2.70E-01	2.70E-01	0.00E+00	0.00E+00	1.64E-05	2.70E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	D_2 - Hanford Only	10,000	2.67E-01	2.67E-01	0.00E+00	0.00E+00	1.70E-06	2.67E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	D_2 - Lower Bound	10,000	2.67E-01	2.67E-01	0.00E+00	0.00E+00	1.70E-06	2.67E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	D_2 - Upper Bound	10,000	2.74E-01	2.74E-01	0.00E+00	0.00E+00	1.72E-06	2.74E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	D_3 - Hanford Only	10,000	2.66E-01	2.66E-01	0.00E+00	0.00E+00	1.70E-06	2.66E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	D_3 - Lower Bound	10,000	2.66E-01	2.66E-01	0.00E+00	0.00E+00	1.70E-06	2.66E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	D_3 - Upper Bound	10,000	2.66E-01	2.66E-01	0.00E+00	0.00E+00	1.70E-06	2.66E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	E_1 - Hanford Only	10,000	2.67E-01	2.67E-01	0.00E+00	0.00E+00	1.70E-06	2.67E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	E_1 - Lower Bound	10,000	2.67E-01	2.67E-01	0.00E+00	0.00E+00	1.70E-06	2.67E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	E_1 - Upper Bound	10,000	2.74E-01	2.74E-01	0.00E+00	0.00E+00	1.72E-06	2.74E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	E_2 - Hanford Only	10,000	2.66E-01	2.66E-01	0.00E+00	0.00E+00	1.70E-06	2.66E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	E_2 - Lower Bound	10,000	2.66E-01	2.66E-01	0.00E+00	0.00E+00	1.70E-06	2.66E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	E_2 - Upper Bound	10,000	2.70E-01	2.70E-01	0.00E+00	0.00E+00	1.74E-06	2.70E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	E_3 - Hanford Only	10,000	2.66E-01	2.66E-01	0.00E+00	0.00E+00	1.70E-06	2.66E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	E_3 - Lower Bound	10,000	2.66E-01	2.66E-01	0.00E+00	0.00E+00	1.70E-06	2.66E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	E_3 - Upper Bound	10,000	2.66E-01	2.66E-01	0.00E+00	0.00E+00	1.70E-06	2.66E-01	1.47E+00	0.00E+00	0.00E+00	1.20E+00
C-14	No Action - Hanford Only	10,000	3.97E-01	3.97E-01	0.00E+00	0.00E+00	2.50E-06	3.97E-01	1.60E+00	0.00E+00	0.00E+00	1.20E+00

Table I.6. (contd)

Constituent	EIS Alternative Group and Waste Volume	Time Period (y)	Hanford Concentrations					Hanford-Plus-Background Concentrations				
			Well Water (pCi/L)	Pore Water (pCi/L)	Sediment (pCi/kg)	Soil (pCi/kg)	River Water (pCi/L)	Well Water (pCi/L)	Pore Water (pCi/L)	Sediment (pCi/kg)	Soil (pCi/kg)	River Water (pCi/L)
C-14	No Action - Lower Bound	10,000	3.97E-01	3.97E-01	0.00E+00	0.00E+00	2.50E-06	3.97E-01	1.60E+00	0.00E+00	0.00E+00	1.20E+00
Tc-99	A - Hanford Only	2,500	4.13E+01	4.13E+01	0.00E+00	0.00E+00	4.36E-04	4.13E+01	4.13E+01	0.00E+00	0.00E+00	3.03E-02
Tc-99	A - Lower Bound	2,500	4.16E+01	4.16E+01	0.00E+00	0.00E+00	4.39E-04	4.16E+01	4.16E+01	0.00E+00	0.00E+00	3.03E-02
Tc-99	A - Upper Bound	2,500	4.55E+01	4.55E+01	0.00E+00	0.00E+00	4.75E-04	4.55E+01	4.56E+01	0.00E+00	0.00E+00	3.04E-02
Tc-99	B - Hanford Only	2,500	4.32E+01	4.32E+01	0.00E+00	0.00E+00	4.50E-04	4.32E+01	4.32E+01	0.00E+00	0.00E+00	3.04E-02
Tc-99	B - Lower Bound	2,500	4.35E+01	4.35E+01	0.00E+00	0.00E+00	3.06E-03	4.35E+01	4.35E+01	0.00E+00	0.00E+00	3.30E-02
Tc-99	B - Upper Bound	2,500	4.71E+01	4.71E+01	0.00E+00	0.00E+00	3.09E-03	4.71E+01	4.72E+01	0.00E+00	0.00E+00	3.30E-02
Tc-99	C - Hanford Only	2,500	4.12E+01	4.12E+01	0.00E+00	0.00E+00	4.31E-04	4.12E+01	4.12E+01	0.00E+00	0.00E+00	3.03E-02
Tc-99	C - Lower Bound	2,500	4.14E+01	4.14E+01	0.00E+00	0.00E+00	4.35E-04	4.14E+01	4.15E+01	0.00E+00	0.00E+00	3.03E-02
Tc-99	C - Upper Bound	2,500	4.32E+01	4.32E+01	0.00E+00	0.00E+00	4.67E-04	4.32E+01	4.32E+01	0.00E+00	0.00E+00	3.04E-02
Tc-99	D_1 - Hanford Only	2,500	3.30E+01	3.30E+01	0.00E+00	0.00E+00	4.25E-04	3.30E+01	3.30E+01	0.00E+00	0.00E+00	3.03E-02
Tc-99	D_1 - Lower Bound	2,500	3.23E+01	3.23E+01	0.00E+00	0.00E+00	4.33E-04	3.23E+01	3.24E+01	0.00E+00	0.00E+00	3.03E-02
Tc-99	D_1 - Upper Bound	2,500	3.63E+01	3.63E+01	0.00E+00	0.00E+00	4.63E-04	3.63E+01	3.64E+01	0.00E+00	0.00E+00	3.04E-02
Tc-99	D_2 - Hanford Only	2,500	5.30E+01	5.30E+01	0.00E+00	0.00E+00	4.67E-04	5.30E+01	5.30E+01	0.00E+00	0.00E+00	3.04E-02
Tc-99	D_2 - Lower Bound	2,500	5.33E+01	5.33E+01	0.00E+00	0.00E+00	4.70E-04	5.33E+01	5.34E+01	0.00E+00	0.00E+00	3.04E-02
Tc-99	D_2 - Upper Bound	2,500	5.71E+01	5.71E+01	0.00E+00	0.00E+00	5.05E-04	5.71E+01	5.71E+01	0.00E+00	0.00E+00	3.04E-02
Tc-99	D_3 - Hanford Only	2,500	3.64E+01	3.64E+01	0.00E+00	0.00E+00	4.22E-04	3.64E+01	3.65E+01	0.00E+00	0.00E+00	3.03E-02
Tc-99	D_3 - Lower Bound	2,500	3.67E+01	3.67E+01	0.00E+00	0.00E+00	4.25E-04	3.67E+01	3.67E+01	0.00E+00	0.00E+00	3.03E-02
Tc-99	D_3 - Upper Bound	2,500	4.00E+01	4.00E+01	0.00E+00	0.00E+00	4.60E-04	4.00E+01	4.00E+01	0.00E+00	0.00E+00	3.04E-02
Tc-99	E_1 - Hanford Only	2,500	5.25E+01	5.25E+01	0.00E+00	0.00E+00	4.65E-04	5.25E+01	5.26E+01	0.00E+00	0.00E+00	3.04E-02
Tc-99	E_1 - Lower Bound	2,500	5.29E+01	5.29E+01	0.00E+00	0.00E+00	4.70E-04	5.29E+01	5.30E+01	0.00E+00	0.00E+00	3.04E-02
Tc-99	E_1 - Upper Bound	2,500	5.67E+01	5.67E+01	0.00E+00	0.00E+00	5.06E-04	5.67E+01	5.67E+01	0.00E+00	0.00E+00	3.04E-02
Tc-99	E_2 - Hanford Only	2,500	3.27E+01	3.27E+01	0.00E+00	0.00E+00	4.25E-04	3.27E+01	3.27E+01	0.00E+00	0.00E+00	3.03E-02
Tc-99	E_2 - Lower Bound	2,500	3.29E+01	3.29E+01	0.00E+00	0.00E+00	4.29E-04	3.29E+01	3.29E+01	0.00E+00	0.00E+00	3.03E-02
Tc-99	E_2 - Upper Bound	2,500	3.61E+01	3.61E+01	0.00E+00	0.00E+00	4.63E-04	3.61E+01	3.61E+01	0.00E+00	0.00E+00	3.04E-02
Tc-99	E_3 - Hanford Only	2,500	3.70E+01	3.70E+01	0.00E+00	0.00E+00	4.26E-04	3.70E+01	3.70E+01	0.00E+00	0.00E+00	3.03E-02

Table I.6. (contd)

Constituent	EIS Alternative Group and Waste Volume	Time Period (y)	Hanford Concentrations					Hanford-Plus-Background Concentrations				
			Well Water (pCi/L)	Pore Water (pCi/L)	Sediment (pCi/kg)	Soil (pCi/kg)	River Water (pCi/L)	Well Water (pCi/L)	Pore Water (pCi/L)	Sediment (pCi/kg)	Soil (pCi/kg)	River Water (pCi/L)
Tc-99	E_3 - Lower Bound	2,500	3.73E+01	3.73E+01	0.00E+00	0.00E+00	4.29E-04	3.73E+01	3.73E+01	0.00E+00	0.00E+00	3.03E-02
Tc-99	E_3 - Upper Bound	2,500	4.04E+01	4.04E+01	0.00E+00	0.00E+00	4.63E-04	4.04E+01	4.04E+01	0.00E+00	0.00E+00	3.04E-02
Tc-99	No Action - Hanford Only	2,500	2.93E+01	2.93E+01	0.00E+00	0.00E+00	3.08E-04	2.93E+01	2.93E+01	0.00E+00	0.00E+00	3.02E-02
Tc-99	No Action - Lower Bound	2,500	2.95E+01	2.95E+01	0.00E+00	0.00E+00	3.11E-04	2.95E+01	2.96E+01	0.00E+00	0.00E+00	3.02E-02
I-129	A - Hanford Only	2,500	1.57E-01	1.57E-01	1.03E-01	4.98E-02	1.42E-06	1.57E-01	1.57E-01	1.03E-01	4.98E-02	1.44E-06
I-129	A - Lower Bound	2,500	1.58E-01	1.58E-01	1.04E-01	5.02E-02	1.44E-06	1.58E-01	1.58E-01	1.04E-01	5.02E-02	1.46E-06
I-129	A - Upper Bound	2,500	1.62E-01	1.62E-01	1.07E-01	5.15E-02	1.46E-06	1.62E-01	1.62E-01	1.07E-01	5.15E-02	1.48E-06
I-129	B - Hanford Only	2,500	1.65E-01	1.65E-01	1.09E-01	5.24E-02	1.48E-06	1.65E-01	1.65E-01	1.09E-01	5.24E-02	1.50E-06
I-129	B - Lower Bound	2,500	1.66E-01	1.66E-01	1.10E-01	5.29E-02	1.49E-06	1.66E-01	1.66E-01	1.10E-01	5.29E-02	1.51E-06
I-129	B - Upper Bound	2,500	1.69E-01	1.69E-01	1.11E-01	5.36E-02	1.51E-06	1.69E-01	1.69E-01	1.11E-01	5.36E-02	1.53E-06
I-129	C - Hanford Only	2,500	1.57E-01	1.57E-01	1.03E-01	4.98E-02	1.42E-06	1.57E-01	1.57E-01	1.03E-01	4.98E-02	1.44E-06
I-129	C - Lower Bound	2,500	1.58E-01	1.58E-01	1.04E-01	5.02E-02	1.44E-06	1.58E-01	1.58E-01	1.04E-01	5.02E-02	1.46E-06
I-129	C - Upper Bound	2,500	1.53E-01	1.53E-01	1.00E-01	4.85E-02	1.46E-06	1.53E-01	1.53E-01	1.00E-01	4.85E-02	1.48E-06
I-129	D_1 - Hanford Only	2,500	1.39E-01	1.39E-01	9.13E-02	4.41E-02	1.40E-06	1.39E-01	1.39E-01	9.13E-02	4.41E-02	1.42E-06
I-129	D_1 - Lower Bound	2,500	1.40E-01	1.40E-01	9.20E-02	4.44E-02	1.42E-06	1.40E-01	1.40E-01	9.20E-02	4.44E-02	1.44E-06
I-129	D_1 - Upper Bound	2,500	1.43E-01	1.43E-01	9.41E-02	4.55E-02	1.43E-06	1.43E-01	1.43E-01	9.41E-02	4.55E-02	1.46E-06
I-129	D_2 - Hanford Only	2,500	1.64E-01	1.64E-01	1.08E-01	5.21E-02	1.44E-06	1.64E-01	1.64E-01	1.08E-01	5.21E-02	1.47E-06
I-129	D_2 - Lower Bound	2,500	1.65E-01	1.65E-01	1.09E-01	5.25E-02	1.46E-06	1.65E-01	1.65E-01	1.09E-01	5.25E-02	1.48E-06
I-129	D_2 - Upper Bound	2,500	1.68E-01	1.68E-01	1.11E-01	5.35E-02	1.48E-06	1.68E-01	1.68E-01	1.11E-01	5.35E-02	1.50E-06
I-129	D_3 - Hanford Only	2,500	1.43E-01	1.43E-01	9.42E-02	4.55E-02	1.38E-06	1.43E-01	1.43E-01	9.42E-02	4.55E-02	1.40E-06
I-129	D_3 - Lower Bound	2,500	1.44E-01	1.44E-01	9.49E-02	4.58E-02	1.39E-06	1.44E-01	1.44E-01	9.49E-02	4.58E-02	1.41E-06
I-129	D_3 - Upper Bound	2,500	1.47E-01	1.47E-01	9.70E-02	4.68E-02	1.41E-06	1.47E-01	1.47E-01	9.70E-02	4.68E-02	1.43E-06
I-129	E_1 - Hanford Only	2,500	1.63E-01	1.63E-01	1.08E-01	5.20E-02	1.44E-06	1.63E-01	1.63E-01	1.08E-01	5.20E-02	1.47E-06
I-129	E_1 - Lower Bound	2,500	1.65E-01	1.65E-01	1.09E-01	5.24E-02	1.46E-06	1.65E-01	1.65E-01	1.09E-01	5.24E-02	1.48E-06
I-129	E_1 - Upper Bound	2,500	1.68E-01	1.68E-01	1.11E-01	5.34E-02	1.48E-06	1.68E-01	1.68E-01	1.11E-01	5.34E-02	1.50E-06
I-129	E_2 - Hanford Only	2,500	1.30E-01	1.30E-01	8.57E-02	4.14E-02	1.28E-06	1.30E-01	1.30E-01	8.57E-02	4.14E-02	1.30E-06

Table I.6. (contd)

Constituent	EIS Alternative Group and Waste Volume	Time Period (y)	Hanford Concentrations					Hanford-Plus-Background Concentrations				
			Well Water (pCi/L)	Pore Water (pCi/L)	Sediment (pCi/kg)	Soil (pCi/kg)	River Water (pCi/L)	Well Water (pCi/L)	Pore Water (pCi/L)	Sediment (pCi/kg)	Soil (pCi/kg)	River Water (pCi/L)
I-129	E_2 - Lower Bound	2,500	1.39E-01	1.39E-01	9.18E-02	4.44E-02	1.41E-06	1.39E-01	1.39E-01	9.18E-02	4.44E-02	1.44E-06
I-129	E_2 - Upper Bound	2,500	1.34E-01	1.34E-01	8.85E-02	4.27E-02	1.31E-06	1.34E-01	1.34E-01	8.85E-02	4.27E-02	1.33E-06
I-129	E_3 - Hanford Only	2,500	1.45E-01	1.45E-01	9.55E-02	4.61E-02	1.39E-06	1.45E-01	1.45E-01	9.55E-02	4.61E-02	1.41E-06
I-129	E_3 - Lower Bound	2,500	1.46E-01	1.46E-01	9.62E-02	4.65E-02	1.40E-06	1.46E-01	1.46E-01	9.62E-02	4.65E-02	1.43E-06
I-129	E_3 - Upper Bound	2,500	1.49E-01	1.49E-01	9.83E-02	4.75E-02	1.43E-06	1.49E-01	1.49E-01	9.83E-02	4.75E-02	1.45E-06
I-129	No Action - Hanford Only	2,500	1.09E-01	1.09E-01	7.17E-02	3.46E-02	9.80E-07	1.09E-01	1.09E-01	7.17E-02	3.46E-02	1.00E-06
I-129	No Action - Lower Bound	2,500	1.10E-01	1.10E-01	7.25E-02	3.50E-02	9.92E-07	1.10E-01	1.10E-01	7.25E-02	3.50E-02	1.01E-06
U-233	A - Hanford Only	10,000	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07
U-233	A - Lower Bound	10,000	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07
U-233	A - Upper Bound	10,000	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07
U-233	B - Hanford Only	10,000	1.97E-02	1.97E-02	1.18E-02	7.60E-03	1.24E-07	1.97E-02	1.97E-02	1.18E-02	7.60E-03	1.24E-07
U-233	B - Lower Bound	10,000	1.97E-02	1.97E-02	1.18E-02	7.63E-03	1.24E-07	1.97E-02	1.97E-02	1.18E-02	7.63E-03	1.24E-07
U-233	B - Upper Bound	10,000	2.16E-02	2.16E-02	1.30E-02	8.36E-03	1.24E-07	2.16E-02	2.16E-02	1.30E-02	8.36E-03	1.24E-07
U-233	C - Hanford Only	10,000	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07
U-233	C - Lower Bound	10,000	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07
U-233	C - Upper Bound	10,000	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07
U-233	D_1 - Hanford Only	10,000	1.93E-02	1.93E-02	1.16E-02	7.44E-03	1.24E-07	1.93E-02	1.93E-02	1.16E-02	7.44E-03	1.24E-07
U-233	D_1 - Lower Bound	10,000	1.93E-02	1.93E-02	1.16E-02	7.45E-03	1.25E-07	1.93E-02	1.93E-02	1.16E-02	7.45E-03	1.25E-07
U-233	D_1 - Upper Bound	10,000	1.93E-02	1.93E-02	1.16E-02	7.46E-03	1.25E-07	1.93E-02	1.93E-02	1.16E-02	7.46E-03	1.25E-07
U-233	D_2 - Hanford Only	10,000	1.93E-02	1.93E-02	1.16E-02	7.45E-03	1.24E-07	1.93E-02	1.93E-02	1.16E-02	7.45E-03	1.24E-07
U-233	D_2 - Lower Bound	10,000	1.93E-02	1.93E-02	1.16E-02	7.45E-03	1.24E-07	1.93E-02	1.93E-02	1.16E-02	7.45E-03	1.24E-07
U-233	D_2 - Upper Bound	10,000	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07
U-233	D_3 - Hanford Only	10,000	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07
U-233	D_3 - Lower Bound	10,000	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07
U-233	D_3 - Upper Bound	10,000	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07
U-233	E_1 - Hanford Only	10,000	1.93E-02	1.93E-02	1.16E-02	7.46E-03	1.24E-07	1.93E-02	1.93E-02	1.16E-02	7.46E-03	1.24E-07

Table I.6. (contd)

Constituent	EIS Alternative Group and Waste Volume	Time Period (y)	Hanford Concentrations					Hanford-Plus-Background Concentrations				
			Well Water (pCi/L)	Pore Water (pCi/L)	Sediment (pCi/kg)	Soil (pCi/kg)	River Water (pCi/L)	Well Water (pCi/L)	Pore Water (pCi/L)	Sediment (pCi/kg)	Soil (pCi/kg)	River Water (pCi/L)
U-233	E_1 - Lower Bound	10,000	1.93E-02	1.93E-02	1.16E-02	7.47E-03	1.24E-07	1.93E-02	1.93E-02	1.16E-02	7.47E-03	1.24E-07
U-233	E_1 - Upper Bound	10,000	1.94E-02	1.94E-02	1.16E-02	7.50E-03	1.24E-07	1.94E-02	1.94E-02	1.16E-02	7.50E-03	1.24E-07
U-233	E_2 - Hanford Only	10,000	1.93E-02	1.93E-02	1.16E-02	7.44E-03	1.24E-07	1.93E-02	1.93E-02	1.16E-02	7.44E-03	1.24E-07
U-233	E_2 - Lower Bound	10,000	1.93E-02	1.93E-02	1.16E-02	7.45E-03	1.25E-07	1.93E-02	1.93E-02	1.16E-02	7.45E-03	1.25E-07
U-233	E_2 - Upper Bound	10,000	1.93E-02	1.93E-02	1.16E-02	7.46E-03	1.25E-07	1.93E-02	1.93E-02	1.16E-02	7.46E-03	1.25E-07
U-233	E_3 - Hanford Only	10,000	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07
U-233	E_3 - Lower Bound	10,000	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07
U-233	E_3 - Upper Bound	10,000	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07	1.92E-02	1.92E-02	1.15E-02	7.43E-03	1.24E-07
U-233	No Action - Hanford Only	10,000	1.93E-02	1.93E-02	1.16E-02	7.46E-03	1.48E-07	1.93E-02	1.93E-02	1.16E-02	7.46E-03	1.48E-07
U-233	No Action - Lower Bound	10,000	1.93E-02	1.93E-02	1.16E-02	7.47E-03	1.48E-07	1.93E-02	1.93E-02	1.16E-02	7.47E-03	1.48E-07
U-234	A - Hanford Only	10,000	1.06E-03	1.06E-03	6.36E-04	4.09E-04	6.71E-09	1.06E-03	1.07E-03	6.41E-04	4.13E-04	9.52E-06
U-234	A - Lower Bound	10,000	1.10E-03	1.10E-03	6.59E-04	4.24E-04	6.92E-09	1.10E-03	1.11E-03	6.65E-04	4.28E-04	9.52E-06
U-234	A - Upper Bound	10,000	1.79E-03	1.79E-03	1.07E-03	6.92E-04	1.22E-08	1.79E-03	1.80E-03	1.08E-03	6.95E-04	9.52E-06
U-234	B - Hanford Only	10,000	2.48E-03	2.48E-03	1.49E-03	9.57E-04	1.06E-08	2.48E-03	2.49E-03	1.49E-03	9.61E-04	9.52E-06
U-234	B - Lower Bound	10,000	4.41E-03	4.41E-03	2.64E-03	1.70E-03	2.13E-08	4.41E-03	4.42E-03	2.65E-03	1.71E-03	9.53E-06
U-234	B - Upper Bound	10,000	7.33E-03	7.33E-03	4.40E-03	2.83E-03	9.78E-08	7.33E-03	7.34E-03	4.41E-03	2.84E-03	9.61E-06
U-234	C - Hanford Only	10,000	1.05E-03	1.05E-03	6.29E-04	4.05E-04	6.57E-09	1.05E-03	1.06E-03	6.34E-04	4.09E-04	9.52E-06
U-234	C - Lower Bound	10,000	1.09E-03	1.09E-03	6.52E-04	4.20E-04	6.78E-09	1.09E-03	1.10E-03	6.58E-04	4.24E-04	9.52E-06
U-234	C - Upper Bound	10,000	1.78E-03	1.78E-03	1.07E-03	6.87E-04	9.79E-09	1.78E-03	1.79E-03	1.07E-03	6.91E-04	9.52E-06
U-234	D_1 - Hanford Only	10,000	1.17E-03	1.17E-03	7.05E-04	4.54E-04	9.50E-09	1.17E-03	1.18E-03	7.10E-04	4.58E-04	9.52E-06
U-234	D_1 - Lower Bound	10,000	1.19E-03	1.19E-03	7.12E-04	4.59E-04	9.64E-09	1.19E-03	1.20E-03	7.18E-04	4.63E-04	9.52E-06
U-234	D_1 - Upper Bound	10,000	2.24E-03	2.24E-03	1.35E-03	8.66E-04	1.88E-08	2.24E-03	2.25E-03	1.35E-03	8.70E-04	9.53E-06
U-234	D_2 - Hanford Only	10,000	1.09E-03	1.09E-03	6.55E-04	4.22E-04	6.68E-09	1.09E-03	1.10E-03	6.61E-04	4.26E-04	9.52E-06
U-234	D_2 - Lower Bound	10,000	1.11E-03	1.11E-03	6.65E-04	4.28E-04	6.75E-09	1.11E-03	1.12E-03	6.71E-04	4.32E-04	9.52E-06
U-234	D_2 - Upper Bound	10,000	1.79E-03	1.79E-03	1.07E-03	6.90E-04	6.77E-09	1.79E-03	1.79E-03	1.08E-03	6.94E-04	9.52E-06
U-234	D_3 - Hanford Only	10,000	8.05E-04	8.05E-04	4.83E-04	3.11E-04	5.19E-09	8.05E-04	8.15E-04	4.89E-04	3.15E-04	9.52E-06

Table I.6. (contd)

Constituent	EIS Alternative Group and Waste Volume	Time Period (y)	Hanford Concentrations					Hanford-Plus-Background Concentrations				
			Well Water (pCi/L)	Pore Water (pCi/L)	Sediment (pCi/kg)	Soil (pCi/kg)	River Water (pCi/L)	Well Water (pCi/L)	Pore Water (pCi/L)	Sediment (pCi/kg)	Soil (pCi/kg)	River Water (pCi/L)
U-234	D_3 - Lower Bound	10,000	8.05E-04	8.05E-04	4.83E-04	3.11E-04	5.19E-09	8.05E-04	8.15E-04	4.89E-04	3.15E-04	9.52E-06
U-234	D_3 - Upper Bound	10,000	1.27E-03	1.27E-03	7.65E-04	4.92E-04	7.42E-09	1.27E-03	1.28E-03	7.70E-04	4.96E-04	9.52E-06
U-234	E_1 - Hanford Only	10,000	1.15E-03	1.15E-03	6.90E-04	4.44E-04	6.68E-09	1.15E-03	1.16E-03	6.96E-04	4.48E-04	9.52E-06
U-234	E_1 - Lower Bound	10,000	1.18E-03	1.18E-03	7.06E-04	4.55E-04	6.75E-09	1.18E-03	1.19E-03	7.12E-04	4.59E-04	9.52E-06
U-234	E_1 - Upper Bound	10,000	2.16E-03	2.16E-03	1.30E-03	8.36E-04	1.14E-08	2.16E-03	2.17E-03	1.30E-03	8.40E-04	9.52E-06
U-234	E_2 - Hanford Only	10,000	1.21E-03	1.21E-03	7.24E-04	4.66E-04	9.50E-09	1.21E-03	1.22E-03	7.29E-04	4.70E-04	9.52E-06
U-234	E_2 - Lower Bound	10,000	1.22E-03	1.22E-03	7.34E-04	4.73E-04	9.64E-09	1.22E-03	1.23E-03	7.40E-04	4.77E-04	9.52E-06
U-234	E_2 - Upper Bound	10,000	2.32E-03	2.32E-03	1.39E-03	8.96E-04	1.88E-08	2.32E-03	2.33E-03	1.40E-03	8.99E-04	9.53E-06
U-234	E_3 - Hanford Only	10,000	8.06E-04	8.06E-04	4.83E-04	3.11E-04	5.29E-09	8.06E-04	8.15E-04	4.89E-04	3.15E-04	9.52E-06
U-234	E_3 - Lower Bound	10,000	8.06E-04	8.06E-04	4.83E-04	3.11E-04	5.29E-09	8.06E-04	8.15E-04	4.89E-04	3.15E-04	9.52E-06
U-234	E_3 - Upper Bound	10,000	1.27E-03	1.27E-03	7.64E-04	4.92E-04	7.52E-09	1.27E-03	1.28E-03	7.70E-04	4.96E-04	9.52E-06
U-234	No Action - Hanford Only	10,000	4.20E-02	4.20E-02	2.52E-02	1.62E-02	5.88E-09	4.20E-02	4.20E-02	2.52E-02	1.62E-02	9.52E-06
U-234	No Action - Lower Bound	10,000	4.37E-02	4.37E-02	2.62E-02	1.69E-02	5.90E-09	4.37E-02	4.37E-02	2.62E-02	1.69E-02	9.52E-06
U-235	A - Hanford Only	10,000	5.51E-05	5.51E-05	3.31E-05	2.13E-05	2.36E-10	5.51E-05	1.30E-03	7.80E-04	5.36E-04	1.25E-03
U-235	A - Lower Bound	10,000	5.57E-05	5.57E-05	3.34E-05	2.15E-05	2.40E-10	5.57E-05	1.30E-03	7.81E-04	5.37E-04	1.25E-03
U-235	A - Upper Bound	10,000	6.68E-05	6.68E-05	4.01E-05	2.58E-05	4.52E-10	6.68E-05	1.31E-03	7.87E-04	5.41E-04	1.25E-03
U-235	B - Hanford Only	10,000	2.20E-04	2.20E-04	1.32E-04	8.50E-05	3.21E-10	2.20E-04	1.47E-03	8.79E-04	6.00E-04	1.25E-03
U-235	B - Lower Bound	10,000	2.74E-04	2.74E-04	1.65E-04	1.06E-04	4.96E-10	2.74E-04	1.52E-03	9.12E-04	6.21E-04	1.25E-03
U-235	B - Upper Bound	10,000	9.84E-04	9.84E-04	5.90E-04	3.80E-04	8.59E-09	9.84E-04	2.23E-03	1.34E-03	8.95E-04	1.25E-03
U-235	C - Hanford Only	10,000	5.46E-05	5.46E-05	3.28E-05	2.11E-05	2.31E-10	5.46E-05	1.30E-03	7.80E-04	5.36E-04	1.25E-03
U-235	C - Lower Bound	10,000	5.52E-05	5.52E-05	3.31E-05	2.13E-05	2.34E-10	5.52E-05	1.30E-03	7.80E-04	5.36E-04	1.25E-03
U-235	C - Upper Bound	10,000	6.63E-05	6.63E-05	3.98E-05	2.56E-05	4.11E-10	6.63E-05	1.31E-03	7.87E-04	5.41E-04	1.25E-03
U-235	D_1 - Hanford Only	10,000	7.08E-05	7.08E-05	4.25E-05	2.73E-05	4.42E-10	7.08E-05	1.32E-03	7.90E-04	5.42E-04	1.25E-03
U-235	D_1 - Lower Bound	10,000	7.33E-05	7.33E-05	4.40E-05	2.83E-05	4.72E-10	7.33E-05	1.32E-03	7.91E-04	5.43E-04	1.25E-03
U-235	D_1 - Upper Bound	10,000	1.02E-04	1.02E-04	6.15E-05	3.96E-05	7.65E-10	1.02E-04	1.35E-03	8.09E-04	5.55E-04	1.25E-03
U-235	D_2 - Hanford Only	10,000	7.49E-05	7.49E-05	4.49E-05	2.89E-05	3.17E-10	7.49E-05	1.32E-03	7.92E-04	5.44E-04	1.25E-03

Table I.6. (contd)

Constituent	EIS Alternative Group and Waste Volume	Time Period (y)	Hanford Concentrations					Hanford-Plus-Background Concentrations				
			Well Water (pCi/L)	Pore Water (pCi/L)	Sediment (pCi/kg)	Soil (pCi/kg)	River Water (pCi/L)	Well Water (pCi/L)	Pore Water (pCi/L)	Sediment (pCi/kg)	Soil (pCi/kg)	River Water (pCi/L)
U-235	D$_2$ - Lower Bound	10,000	7.83E-05	7.83E-05	4.70E-05	3.03E-05	3.32E-10	7.83E-05	1.32E-03	7.94E-04	5.45E-04	1.25E-03
U-235	D$_2$ - Upper Bound	10,000	6.67E-05	6.67E-05	4.00E-05	2.58E-05	4.12E-10	6.67E-05	1.31E-03	7.87E-04	5.41E-04	1.25E-03
U-235	D$_3$ - Hanford Only	10,000	4.89E-05	4.89E-05	2.93E-05	1.89E-05	2.08E-10	4.89E-05	1.29E-03	7.76E-04	5.34E-04	1.25E-03
U-235	D$_3$ - Lower Bound	10,000	4.89E-05	4.89E-05	2.93E-05	1.89E-05	2.08E-10	4.89E-05	1.29E-03	7.76E-04	5.34E-04	1.25E-03
U-235	D$_3$ - Upper Bound	10,000	5.66E-05	5.66E-05	3.39E-05	2.19E-05	2.44E-10	5.66E-05	1.30E-03	7.81E-04	5.37E-04	1.25E-03
U-235	E$_1$ - Hanford Only	10,000	8.52E-05	8.52E-05	5.11E-05	3.29E-05	3.17E-10	8.52E-05	1.33E-03	7.98E-04	5.48E-04	1.25E-03
U-235	E$_1$ - Lower Bound	10,000	9.07E-05	9.07E-05	5.44E-05	3.51E-05	3.32E-10	9.07E-05	1.34E-03	8.02E-04	5.50E-04	1.25E-03
U-235	E$_1$ - Upper Bound	10,000	1.34E-04	1.34E-04	8.01E-05	5.16E-05	4.86E-10	1.34E-04	1.38E-03	8.27E-04	5.67E-04	1.25E-03
U-235	E$_2$ - Hanford Only	10,000	6.98E-05	6.98E-05	4.19E-05	2.70E-05	4.42E-10	6.98E-05	1.32E-03	7.89E-04	5.42E-04	1.25E-03
U-235	E$_2$ - Lower Bound	10,000	7.25E-05	7.25E-05	4.35E-05	2.80E-05	4.71E-10	7.25E-05	1.32E-03	7.91E-04	5.43E-04	1.25E-03
U-235	E$_2$ - Upper Bound	10,000	1.04E-04	1.04E-04	6.21E-05	4.00E-05	7.65E-10	1.04E-04	1.35E-03	8.09E-04	5.55E-04	1.25E-03
U-235	E$_3$ - Hanford Only	10,000	5.08E-05	5.08E-05	3.05E-05	1.96E-05	2.13E-10	5.08E-05	1.30E-03	7.78E-04	5.35E-04	1.25E-03
U-235	E$_3$ - Lower Bound	10,000	5.08E-05	5.08E-05	3.05E-05	1.96E-05	2.13E-10	5.08E-05	1.30E-03	7.78E-04	5.35E-04	1.25E-03
U-235	E$_3$ - Upper Bound	10,000	5.83E-05	5.83E-05	3.50E-05	2.25E-05	2.48E-10	5.83E-05	1.30E-03	7.82E-04	5.38E-04	1.25E-03
U-235	No Action - Hanford Only	10,000	1.25E-03	1.25E-03	7.50E-04	4.83E-04	2.19E-10	1.25E-03	2.50E-03	1.50E-03	9.98E-04	1.25E-03
U-235	No Action - Lower Bound	10,000	1.30E-03	1.30E-03	7.82E-04	5.04E-04	2.22E-10	1.30E-03	2.55E-03	1.53E-03	1.02E-03	1.25E-03
U-236	A - Hanford Only	10,000	5.07E-05	5.07E-05	3.04E-05	1.96E-05	1.26E-10	5.07E-05	5.07E-05	3.04E-05	1.96E-05	1.26E-10
U-236	A - Lower Bound	10,000	5.14E-05	5.14E-05	3.08E-05	1.99E-05	1.30E-10	5.14E-05	5.14E-05	3.08E-05	1.99E-05	1.30E-10
U-236	A - Upper Bound	10,000	6.43E-05	6.43E-05	3.86E-05	2.48E-05	1.45E-10	6.43E-05	6.43E-05	3.86E-05	2.48E-05	1.45E-10
U-236	B - Hanford Only	10,000	7.45E-05	7.45E-05	4.47E-05	2.88E-05	1.96E-10	7.45E-05	7.45E-05	4.47E-05	2.88E-05	1.96E-10
U-236	B - Lower Bound	10,000	1.11E-04	1.11E-04	6.67E-05	2.92E-04	3.96E-10	1.11E-04	1.11E-04	6.67E-05	2.92E-04	3.96E-10
U-236	B - Upper Bound	10,000	1.64E-04	1.64E-04	9.82E-05	6.32E-04	7.21E-10	1.64E-04	1.64E-04	9.82E-05	6.32E-04	7.21E-10
U-236	C - Hanford Only	10,000	5.02E-05	5.02E-05	3.01E-05	1.94E-05	1.21E-10	5.02E-05	5.02E-05	3.01E-05	1.94E-05	1.21E-10
U-236	C - Lower Bound	10,000	5.10E-05	5.10E-05	3.06E-05	1.97E-05	1.25E-10	5.10E-05	5.10E-05	3.06E-05	1.97E-05	1.25E-10
U-236	C - Upper Bound	10,000	6.39E-05	6.39E-05	3.83E-05	2.47E-05	9.83E-11	6.39E-05	6.39E-05	3.83E-05	2.47E-05	9.83E-11
U-236	D$_1$ - Hanford Only	10,000	5.30E-05	5.30E-05	3.18E-05	2.05E-05	1.81E-10	5.30E-05	5.30E-05	3.18E-05	2.05E-05	1.81E-10

Table I.6. (contd)

Constituent	EIS Alternative Group and Waste Volume	Time Period (y)	Hanford Concentrations					Hanford-Plus-Background Concentrations				
			Well Water (pCi/L)	Pore Water (pCi/L)	Sediment (pCi/kg)	Soil (pCi/kg)	River Water (pCi/L)	Well Water (pCi/L)	Pore Water (pCi/L)	Sediment (pCi/kg)	Soil (pCi/kg)	River Water (pCi/L)
U-236	D_1 - Lower Bound	10,000	5.33E-05	5.33E-05	3.20E-05	2.06E-05	1.84E-10	5.33E-05	5.33E-05	3.20E-05	2.06E-05	1.84E-10
U-236	D_1 - Upper Bound	10,000	7.26E-05	7.26E-05	4.35E-05	2.80E-05	3.50E-10	7.26E-05	7.26E-05	4.35E-05	2.80E-05	3.50E-10
U-236	D_2 - Hanford Only	10,000	5.16E-05	5.16E-05	3.10E-05	2.00E-05	1.26E-10	5.16E-05	5.16E-05	3.10E-05	2.00E-05	1.26E-10
U-236	D_2 - Lower Bound	10,000	5.20E-05	5.20E-05	3.12E-05	2.01E-05	1.28E-10	5.20E-05	5.20E-05	3.12E-05	2.01E-05	1.28E-10
U-236	D_2 - Upper Bound	10,000	6.40E-05	6.40E-05	3.84E-05	2.47E-05	1.26E-10	6.40E-05	6.40E-05	3.84E-05	2.47E-05	1.26E-10
U-236	D_3 - Hanford Only	10,000	4.25E-05	4.25E-05	2.55E-05	1.64E-05	9.50E-11	4.25E-05	4.25E-05	2.55E-05	1.64E-05	9.50E-11
U-236	D_3 - Lower Bound	10,000	4.25E-05	4.25E-05	2.55E-05	1.64E-05	9.50E-11	4.25E-05	4.25E-05	2.55E-05	1.64E-05	9.50E-11
U-236	D_3 - Upper Bound	10,000	5.13E-05	5.13E-05	3.08E-05	1.98E-05	1.37E-10	5.13E-05	5.13E-05	3.08E-05	1.98E-05	1.37E-10
U-236	E_1 - Hanford Only	10,000	4.99E-05	4.99E-05	2.99E-05	1.93E-05	1.25E-10	4.99E-05	4.99E-05	2.99E-05	1.93E-05	1.25E-10
U-236	E_1 - Lower Bound	10,000	5.06E-05	5.06E-05	3.03E-05	1.95E-05	1.27E-10	5.06E-05	5.06E-05	3.03E-05	1.95E-05	1.27E-10
U-236	E_1 - Upper Bound	10,000	6.82E-05	6.82E-05	4.09E-05	2.64E-05	2.11E-10	6.82E-05	6.82E-05	4.09E-05	2.64E-05	2.11E-10
U-236	E_2 - Hanford Only	10,000	5.39E-05	5.39E-05	3.24E-05	2.08E-05	1.80E-10	5.39E-05	5.39E-05	3.24E-05	2.08E-05	1.80E-10
U-236	E_2 - Lower Bound	10,000	5.49E-05	5.49E-05	3.29E-05	2.12E-05	1.84E-10	5.49E-05	5.49E-05	3.29E-05	2.12E-05	1.84E-10
U-236	E_2 - Upper Bound	10,000	7.64E-05	7.64E-05	4.58E-05	2.95E-05	3.49E-10	7.64E-05	7.64E-05	4.58E-05	2.95E-05	3.49E-10
U-236	E_3 - Hanford Only	10,000	4.57E-05	4.57E-05	2.74E-05	1.77E-05	9.91E-11	4.57E-05	4.57E-05	2.74E-05	1.77E-05	9.91E-11
U-236	E_3 - Lower Bound	10,000	4.57E-05	4.57E-05	2.74E-05	1.77E-05	9.91E-11	4.57E-05	4.57E-05	2.74E-05	1.77E-05	9.91E-11
U-236	E_3 - Upper Bound	10,000	5.44E-05	5.44E-05	3.27E-05	2.10E-05	1.41E-10	5.44E-05	5.44E-05	3.27E-05	2.10E-05	1.41E-10
U-236	No Action - Hanford Only	10,000	5.36E-03	5.36E-03	3.22E-03	2.07E-03	1.25E-10	5.36E-03	5.36E-03	3.22E-03	2.07E-03	1.25E-10
U-236	No Action - Lower Bound	10,000	5.58E-03	5.58E-03	3.35E-03	2.16E-03	1.25E-10	5.58E-03	5.58E-03	3.35E-03	2.16E-03	1.25E-10
U-238	A - Hanford Only	10,000	1.87E-03	1.87E-03	1.12E-03	7.23E-04	5.77E-09	1.87E-03	1.74E-01	1.04E-01	7.17E-02	1.72E-01
U-238	A - Lower Bound	10,000	1.88E-03	1.88E-03	1.13E-03	7.27E-04	5.83E-09	1.88E-03	1.74E-01	1.04E-01	7.17E-02	1.72E-01
U-238	A - Upper Bound	10,000	2.06E-03	2.06E-03	1.23E-03	7.94E-04	1.07E-08	2.06E-03	1.74E-01	1.04E-01	7.18E-02	1.72E-01
U-238	B - Hanford Only	10,000	3.63E-03	3.63E-03	2.18E-03	1.40E-03	6.92E-09	3.63E-03	1.75E-01	1.05E-01	7.24E-02	1.72E-01
U-238	B - Lower Bound	10,000	4.37E-03	4.37E-03	2.62E-03	1.69E-03	9.63E-09	4.37E-03	1.76E-01	1.06E-01	7.27E-02	1.72E-01
U-238	B - Upper Bound	10,000	1.33E-02	1.33E-02	7.97E-03	5.13E-03	1.62E-07	1.33E-02	1.85E-01	1.11E-01	7.61E-02	1.72E-01
U-238	C - Hanford Only	10,000	1.86E-03	1.86E-03	1.12E-03	7.19E-04	5.65E-09	1.86E-03	1.74E-01	1.04E-01	7.17E-02	1.72E-01

Table I.6. (contd)

Constituent	EIS Alternative Group and Waste Volume	Time Period (y)	Hanford Concentrations					Hanford-Plus-Background Concentrations				
			Well Water (pCi/L)	Pore Water (pCi/L)	Sediment (pCi/kg)	Soil (pCi/kg)	River Water (pCi/L)	Well Water (pCi/L)	Pore Water (pCi/L)	Sediment (pCi/kg)	Soil (pCi/kg)	River Water (pCi/L)
U-238	C - Lower Bound	10,000	1.87E-03	1.87E-03	1.12E-03	7.23E-04	5.71E-09	1.87E-03	1.74E-01	1.04E-01	7.17E-02	1.72E-01
U-238	C - Upper Bound	10,000	2.05E-03	2.05E-03	1.23E-03	7.91E-04	1.00E-08	2.05E-03	1.74E-01	1.04E-01	7.18E-02	1.72E-01
U-238	D_1 - Hanford Only	10,000	2.05E-03	2.05E-03	1.23E-03	7.92E-04	8.21E-09	2.05E-03	1.74E-01	1.04E-01	7.18E-02	1.72E-01
U-238	D_1 - Lower Bound	10,000	2.08E-03	2.08E-03	1.25E-03	8.03E-04	8.55E-09	2.08E-03	1.74E-01	1.04E-01	7.18E-02	1.72E-01
U-238	D_1 - Upper Bound	10,000	2.51E-03	2.51E-03	1.51E-03	9.71E-04	1.29E-08	2.51E-03	1.74E-01	1.05E-01	7.20E-02	1.72E-01
U-238	D_2 - Hanford Only	10,000	2.09E-03	2.09E-03	1.25E-03	8.07E-04	6.62E-09	2.09E-03	1.74E-01	1.04E-01	7.18E-02	1.72E-01
U-238	D_2 - Lower Bound	10,000	2.13E-03	2.13E-03	1.28E-03	8.23E-04	6.79E-09	2.13E-03	1.74E-01	1.04E-01	7.18E-02	1.72E-01
U-238	D_2 - Upper Bound	10,000	2.05E-03	2.05E-03	1.23E-03	7.94E-04	7.86E-09	2.05E-03	1.74E-01	1.04E-01	7.18E-02	1.72E-01
U-238	D_3 - Hanford Only	10,000	1.70E-03	1.70E-03	1.02E-03	6.57E-04	5.29E-09	1.70E-03	1.73E-01	1.04E-01	7.17E-02	1.72E-01
U-238	D_3 - Lower Bound	10,000	1.70E-03	1.70E-03	1.02E-03	6.57E-04	5.29E-09	1.70E-03	1.73E-01	1.04E-01	7.17E-02	1.72E-01
U-238	D_3 - Upper Bound	10,000	1.82E-03	1.82E-03	1.09E-03	7.04E-04	5.85E-09	1.82E-03	1.74E-01	1.04E-01	7.17E-02	1.72E-01
U-238	E_1 - Hanford Only	10,000	2.13E-03	2.13E-03	1.28E-03	8.23E-04	6.60E-09	2.13E-03	1.74E-01	1.04E-01	7.18E-02	1.72E-01
U-238	E_1 - Lower Bound	10,000	2.19E-03	2.19E-03	1.32E-03	8.47E-04	6.77E-09	2.19E-03	1.74E-01	1.04E-01	7.19E-02	1.72E-01
U-238	E_1 - Upper Bound	10,000	2.81E-03	2.81E-03	1.68E-03	1.08E-03	9.03E-09	2.81E-03	1.75E-01	1.05E-01	7.21E-02	1.72E-01
U-238	E_2 - Hanford Only	10,000	2.00E-03	2.00E-03	1.20E-03	7.73E-04	8.20E-09	2.00E-03	1.74E-01	1.04E-01	7.18E-02	1.72E-01
U-238	E_2 - Lower Bound	10,000	2.04E-03	2.04E-03	1.22E-03	7.88E-04	8.53E-09	2.04E-03	1.74E-01	1.04E-01	7.18E-02	1.72E-01
U-238	E_2 - Upper Bound	10,000	2.54E-03	2.54E-03	1.52E-03	9.80E-04	1.28E-08	2.54E-03	1.74E-01	1.05E-01	7.20E-02	1.72E-01
U-238	E_3 - Hanford Only	10,000	1.80E-03	1.80E-03	1.08E-03	6.96E-04	5.40E-09	1.80E-03	1.73E-01	1.04E-01	7.17E-02	1.72E-01
U-238	E_3 - Lower Bound	10,000	1.80E-03	1.80E-03	1.08E-03	6.96E-04	5.40E-09	1.80E-03	1.73E-01	1.04E-01	7.17E-02	1.72E-01
U-238	E_3 - Upper Bound	10,000	1.92E-03	1.92E-03	1.15E-03	7.42E-04	5.96E-09	1.92E-03	1.74E-01	1.04E-01	7.18E-02	1.72E-01
U-238	No Action - Hanford Only	10,000	6.81E-02	6.81E-02	4.09E-02	2.63E-02	5.26E-09	6.81E-02	2.40E-01	1.44E-01	9.73E-02	1.72E-01
U-238	No Action - Lower Bound	10,000	7.09E-02	7.09E-02	4.25E-02	2.74E-02	5.30E-09	7.09E-02	2.43E-01	1.46E-01	9.84E-02	1.72E-01

Table I.7. Hanford and Hanford-Plus-Background Total Uranium Concentrations in Well Water, Pore Water, Sediment, Soil, and River Water for Each Time Period and Alternative Group[(a)]

EIS Alternative Group and Waste Volume	Time Period (y)	Hanford Concentrations					Hanford-Plus-Background Concentrations				
		Well Water (µg/L)	Pore Water (µg/L)	Sediment (µg/kg)	Soil (µg/kg)	River Water (µg/L)	Well Water (µg/L)	Pore Water (µg/L)	Sediment (µg/kg)	Soil (µg/kg)	River Water (µg/L)
A - Hanford Only	10,000	5.59E-03	5.59E-03	3.36E-03	2.16E-03	1.73E-08	5.59E-03	5.17E-01	3.10E-01	2.13E-01	5.11E-01
A - Lower Bound	10,000	5.62E-03	5.62E-03	3.37E-03	2.17E-03	1.75E-08	5.62E-03	5.17E-01	3.10E-01	2.13E-01	5.11E-01
A - Upper Bound	10,000	6.14E-03	6.14E-03	3.69E-03	2.37E-03	3.20E-08	6.14E-03	5.17E-01	3.10E-01	2.14E-01	5.11E-01
B - Hanford Only	10,000	1.09E-02	1.09E-02	6.54E-03	4.22E-03	2.07E-08	1.09E-02	5.22E-01	3.13E-01	2.16E-01	5.11E-01
B - Lower Bound	10,000	1.31E-02	1.31E-02	7.88E-03	5.08E-03	2.89E-08	1.31E-02	5.24E-01	3.14E-01	2.16E-01	5.11E-01
B - Upper Bound	10,000	3.99E-02	3.99E-02	2.40E-02	1.54E-02	4.84E-07	3.99E-02	5.51E-01	3.31E-01	2.27E-01	5.11E-01
C - Hanford Only	10,000	5.56E-03	5.56E-03	3.34E-03	2.15E-03	1.69E-08	5.56E-03	5.17E-01	3.10E-01	2.13E-01	5.11E-01
C - Lower Bound	10,000	5.59E-03	5.59E-03	3.36E-03	2.16E-03	1.71E-08	5.59E-03	5.17E-01	3.10E-01	2.13E-01	5.11E-01
C - Upper Bound	10,000	6.12E-03	6.12E-03	3.67E-03	2.36E-03	2.99E-08	6.12E-03	5.17E-01	3.10E-01	2.14E-01	5.11E-01
D_1 - Hanford Only	10,000	6.13E-03	6.13E-03	3.68E-03	2.37E-03	2.46E-08	6.13E-03	5.17E-01	3.10E-01	2.14E-01	5.11E-01
D_1 - Lower Bound	10,000	6.22E-03	6.22E-03	3.73E-03	2.40E-03	2.57E-08	6.22E-03	5.17E-01	3.10E-01	2.14E-01	5.11E-01
D_1 - Upper Bound	10,000	7.52E-03	7.52E-03	4.51E-03	2.91E-03	3.86E-08	7.52E-03	5.18E-01	3.11E-01	2.14E-01	5.11E-01
D_2 - Hanford Only	10,000	6.25E-03	6.25E-03	3.75E-03	2.41E-03	1.98E-08	6.25E-03	5.17E-01	3.10E-01	2.14E-01	5.11E-01
D_2 - Lower Bound	10,000	6.37E-03	6.37E-03	3.82E-03	2.46E-03	2.03E-08	6.37E-03	5.17E-01	3.10E-01	2.14E-01	5.11E-01
D_2 - Upper Bound	10,000	6.14E-03	6.14E-03	3.68E-03	2.37E-03	2.36E-08	6.14E-03	5.17E-01	3.10E-01	2.14E-01	5.11E-01
D_3 - Hanford Only	10,000	5.08E-03	5.08E-03	3.05E-03	1.96E-03	1.58E-08	5.08E-03	5.16E-01	3.10E-01	2.13E-01	5.11E-01
D_3 - Lower Bound	10,000	5.08E-03	5.08E-03	3.05E-03	1.96E-03	1.58E-08	5.08E-03	5.16E-01	3.10E-01	2.13E-01	5.11E-01
D_3 - Upper Bound	10,000	5.45E-03	5.45E-03	3.27E-03	2.10E-03	1.75E-08	5.45E-03	5.16E-01	3.10E-01	2.13E-01	5.11E-01
E_1 - Hanford Only	10,000	6.37E-03	6.37E-03	3.82E-03	2.46E-03	1.98E-08	6.37E-03	5.17E-01	3.10E-01	2.14E-01	5.11E-01
E_1 - Lower Bound	10,000	6.56E-03	6.56E-03	3.94E-03	2.54E-03	2.03E-08	6.56E-03	5.18E-01	3.11E-01	2.14E-01	5.11E-01
E_1 - Upper Bound	10,000	8.41E-03	8.41E-03	5.04E-03	3.25E-03	2.71E-08	8.41E-03	5.19E-01	3.12E-01	2.15E-01	5.11E-01
E_2 - Hanford Only	10,000	5.98E-03	5.98E-03	3.59E-03	2.31E-03	2.46E-08	5.98E-03	5.17E-01	3.10E-01	2.14E-01	5.11E-01
E_2 - Lower Bound	10,000	6.09E-03	6.09E-03	3.66E-03	2.36E-03	2.56E-08	6.09E-03	5.17E-01	3.10E-01	2.14E-01	5.11E-01
E_2 - Upper Bound	10,000	7.59E-03	7.59E-03	4.55E-03	2.93E-03	3.86E-08	7.59E-03	5.19E-01	3.11E-01	2.14E-01	5.11E-01
E_3 - Hanford Only	10,000	5.38E-03	5.38E-03	3.23E-03	2.08E-03	1.62E-08	5.38E-03	5.16E-01	3.10E-01	2.13E-01	5.11E-01
E_3 - Lower Bound	10,000	5.38E-03	5.38E-03	3.23E-03	2.08E-03	1.62E-08	5.38E-03	5.16E-01	3.10E-01	2.13E-01	5.11E-01
E_3 - Upper Bound	10,000	5.74E-03	5.74E-03	3.44E-03	2.22E-03	1.78E-08	5.74E-03	5.17E-01	3.10E-01	2.14E-01	5.11E-01
No Action - Hanford Only	10,000	2.03E-01	2.03E-01	1.22E-01	7.85E-02	1.57E-08	2.03E-01	7.14E-01	4.28E-01	2.90E-01	5.11E-01
No Action - Lower Bound	10,000	2.11E-01	2.11E-01	1.27E-01	8.17E-02	1.59E-08	2.11E-01	7.22E-01	4.33E-01	2.93E-01	5.11E-01

Table I.8. Ecological Contaminant Exposure Model Receptors

Common Name	**Scientific Name**
Terrestrial Animals	
American coot	*Fulica americana*
American kestrel	*Falco sparverius*
American white pelican	*Pelecanus erythrorhynchos*
Beaver	*Castor canadensis*
Bald eagle	*Haliaeetus leucocephalus*
Bufflehead	*Bucephala albeola*
California quail	*Callipepla californica*
Canada goose	*Branta canadensis*
Cliff swallow	*Petrochelidon pyrrhonota*
Common snipe	*Gallinago gallinago*
Coyote	*Canis latrans*
Forster’s tern	*Sterna forsteri*
Great blue heron	*Ardea herodias*
Harvest mouse	*Reithrodontomys megalotis*
Lizards (generic)(a)	
Mallard	*Anas platyrhynchos*
Mule deer	*Odocoileus hemionus*
Muskrat	*Ondatra zibethica*
Northern harrier	*Circus cyaneus*
Raccoon	*Procyon lotor*
Terrestrial arthropods (generic)	
Western aquatic garter snake	*Thamnophis elegans*
Weasel	*Mustela* spp.
Woodhouse’s toad (adult)	*Bufo woodhousei*
Terrestrial Plants	
Black cottonwood	*Populus trichocarpa*
Columbia yellowcress	*Rorippa columbiae*
Dense sedge	*Carex densa*
Fern (generic)	
Fungi (generic)	
Mulberry	*Morus alba*
Reed canarygrass	*Phalaris arundinacea*
Rushes	*Juncus* spp.
Tule	*Scirpus* spp.

Table I.8. (contd)

Common Name	Scientific Name
Aquatic Animals	
Carp	*Cyprinus carpio*
Channel catfish	*Ictalurus punctatus*
Clams (generic)	
Columbia pebblesnail	*Flumicola columbiana*
Crayfish (generic)	
Water flea	*Daphnia magna*
Fresh-water shrimp	*Hyallela* spp.
Largescale/mountain sucker	*Catostomus macrocheilus*/*C. platyrhynchus*
Mayfly (generic)	
Mountain whitefish	*Prosopium williamsoni*
Mussels (generic)	
Pacific lamprey (juvenile)	*Entosphenus tridentatus*
Rainbow trout (adult)	*Oncorhynchus mykiss*
Rainbow trout (eggs)	*Oncorhynchus mykiss*
Rainbow trout (juvenile)	*Oncorhynchus mykiss*
Salmon (generic) (adult)	*Oncorhynchus* spp.
Salmon (generic) (eggs)	*Oncorhynchus* spp.
Salmon (generic) (juvenile)	*Oncorhynchus* spp.
Smallmouth bass	*Micropterus dolomieui*
Woodhouse’s toad (tadpole)	*Bufo woodhousei*
White sturgeon	*Acipenser transmontanus*
Aquatic Plants	
Periphyton (generic)	
Phytoplankton (generic)	
Water milfoil	*Myriophyllum* spp.

(a) generic = not specific to a species or genus. Thus none provided under “scientific name.”

Environmental hazard quotients based on total dose from all radiological constituents are provided for the Hanford and Hanford-Plus-Background exposure scenarios for the one receptor in Table I.8 that was at maximal risk in each alternative group and time period. These receptors were the mayfly for all alternative groups in the 0- to 2500-year time period (Figure I.8) and Woodhouse’s toad tadpole for all alternative groups in the 0- to 10,000-year time period (Figure I.9).

Results are provided for only those waste volumes that yielded maximal risk (that is, the Lower Bound waste volume for the No Action Alternative and the Upper Bound waste volume for Alternative Groups A, B, D_1, D_2, D_3, E_1, and E_3 for the 0- to 2500-year and the 2500- to 10,000-year time periods, as well as Lower and Upper Bound waste volumes for Alternative Groups C and E_2 for the 0- to 2500-year and 2500- to 10,000-year time periods, respectively).

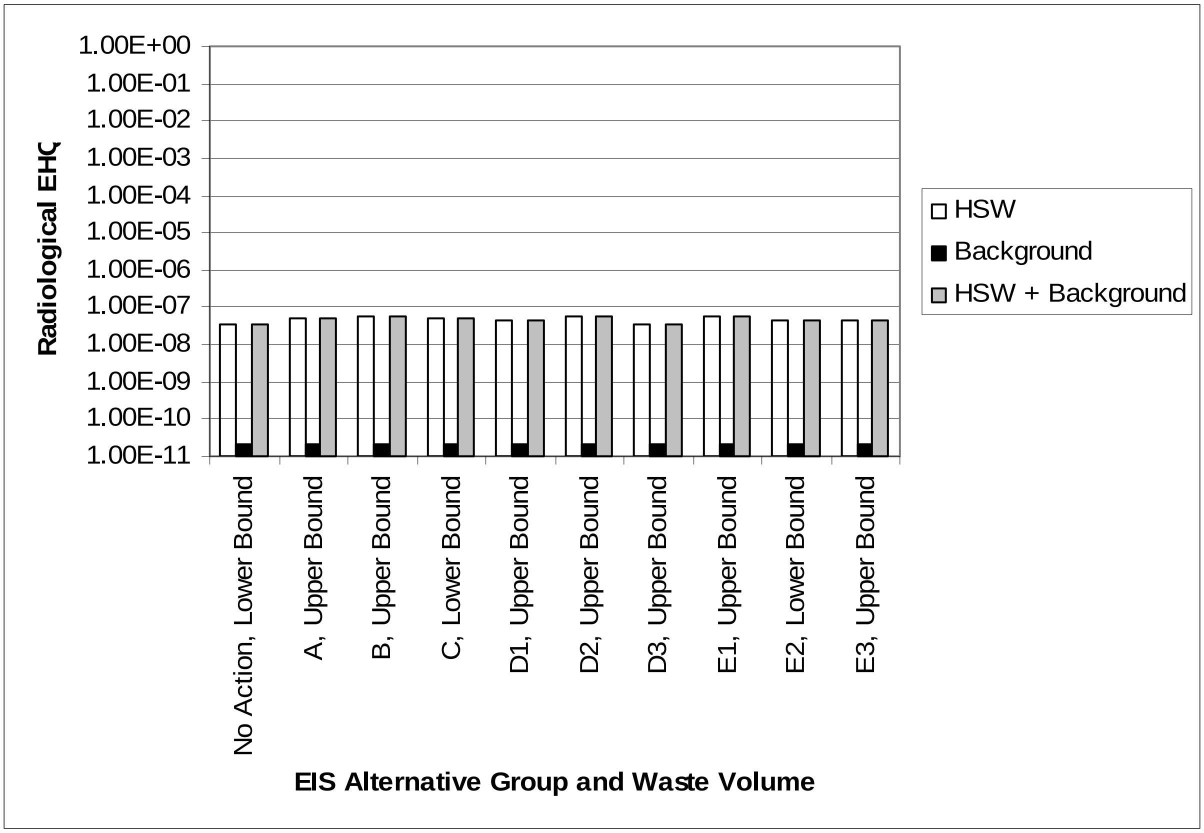


Figure I.8. Mayfly Radiological EHQs for Each Alternative Group in the 0- to 2500-Year Time Period for Background Compared with the Hanford and Hanford-Plus-Background Scenarios

The discussion below covers three points of interest: 1) Hanford's contribution to risk relative to the background contribution, 2) risk as a discriminator among the alternative groups, and 3) the magnitude of risk under each alternative group relative to a minimal level of concern (EHQ of 1).

Mayfly EHQs for the Hanford scenario are much larger than for background (Figure I.8), indicative of miniscule background concentrations of technetium-99 and iodine-129. Mayfly EHQs for both the Hanford and Hanford-Plus-Background scenarios were at least seven orders of magnitude below the minimal level of concern (EHQ of 1) (Figure I.8). Consequently, there is essentially no risk of adverse radiological impacts under any of the alternative groups for the 0- to 2500-year time period. Further, radiological risk does not appear to be an important discriminator among the alternative groups in the 0- to 2500-year time period because the mayfly EHQs were essentially the same for all the alternative groups (Figure I.8).

Woodhouse's toad tadpole EHQs for the Hanford scenario are up to one order of magnitude smaller than for background under all the Alternative Groups (Figure I.9). Woodhouse's toad tadpole EHQs for both the Hanford and Hanford-Plus-Background scenarios were at least four orders of magnitude below the minimal level of concern (EHQ of 1) (Figure I.9). Consequently, there is essentially no risk of

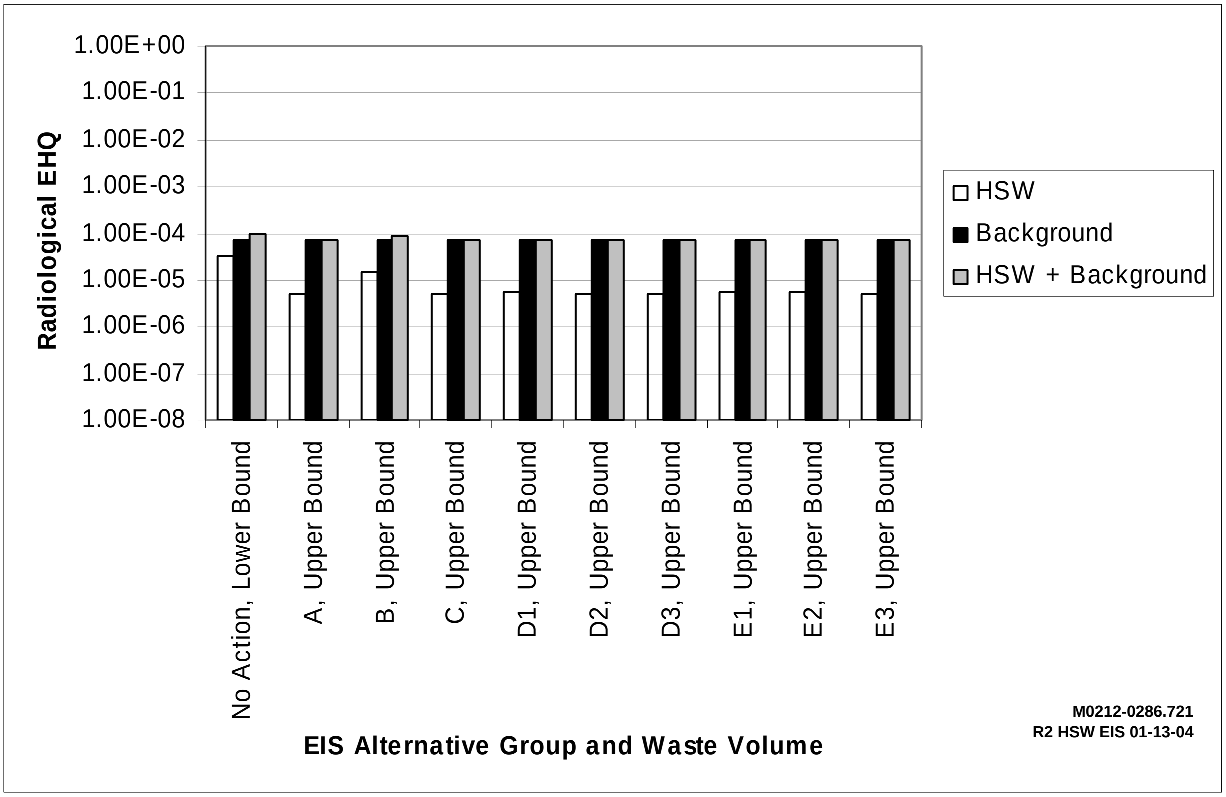


Figure I.9. Woodhouse's Toad Tadpole Radiological EHQs for Each Alternative Group in the 2500- to 10,000-Year Time Period for Background Compared with the Hanford and Hanford-Plus-Background Scenarios

adverse radiological impacts under any of the alternative groups for the 2500- to 10,000-year time period. Further, except for the No Action Alternative and Alternative Group B, radiological risk does not appear to be an important discriminator among the alternative groups in the 2500- to 10,000-year time period because the Woodhouse's toad tadpole EHQs were essentially the same (Figure I.9).

I.3.5 Chemical Toxicity of Total Uranium

Terrestrial Receptors. Estimated equilibrium exposures for terrestrial receptors consisted of absorbed daily dose (μg/kg/day). Chemical toxicity EHQs for terrestrial animal receptors were calculated by dividing the estimated absorbed daily dose by the lowest dose known to produce a clinically toxic response in any member of a population (that is, the lowest observed effects level or LOEL). The LOEL, based on chronic exposure, was selected because it was deemed to be most representative of effects that might occur during a long-term contaminant release.

Few data are available for assessing the toxic effects of non-pesticide chemicals on wildlife (Suter 1993). Consequently, it is generally necessary to use toxicity data for domestic animals that differ taxonomically (often widely so) from the species of interest. Also, the endpoint (for example, LOEL) of a toxicity test may not apply to the exposure conditions of interest (for example, mortality endpoint, such as an LD_{50} [median lethal dose, typically based on a 96-hour test] used to assess risk of lowest adverse effects to terrestrial animals under chronic exposure conditions). Such situations often require extrapolation of toxicity data across taxa and endpoints using uncertainty factors.

The chemical toxicity data used in calculating EHQs for terrestrial animal exposure to total uranium were as follows. Only two suitable uranium toxicity values were available; a LOEL of 6.13 mg/kg/day based on toxicity to mice (*Mus* spp.) (Opresko et al. 1995) was used. This value falls well within the range of doses known to cause reproductive and developmental effects in mice and rats (Domingo 2001). The mouse LOEL was extrapolated for use with all other terrestrial animal receptors by dividing it by an uncertainty factor of 10 (0.613 mg/kg/day). This extrapolation between taxa is consistent with DOE-RL (1998).

In addition, a no observed adverse effects level (NOAEL) of 16 mg/kg/day, based on toxicity to black ducks (*Anas rubripes*) (Opresko et al. 1995) was used. The black duck NOAEL was multiplied by a factor of 10 to derive a LOEL (160 mg/kg/day) for use with all other terrestrial animal receptors. This extrapolation between endpoints is based on Dourson and Stara (1983) and is consistent with DOE-RL (1998).

Because neither the derived black duck nor the derived mouse LOEL was considered more reliable, the former was used to calculate low and the latter high EHQs for all terrestrial animal receptors.

Low and high EHQs for total uranium, based on the derived black duck and mouse LOELs, respectively, are provided for the Hanford scenario and background (Figure I.10) and the Hanford-Plus-Background scenario (Figure I.11) for the one terrestrial animal receptor in Table I.8 that is at maximal risk in each alternative group in the 2500- to 10,000-year time period—the American coot. Results are provided only for those waste volumes that yielded maximal risk (that is, the Lower Bound waste volume for the No Action Alternative and the Upper Bound waste volume for all other alternative groups).

The low and high coot EHQs for the Hanford scenario are less than for background under all the alternative groups (Figure I.10). The high coot EHQs were approximately two to three orders of magnitude greater than the low EHQs for the Hanford (Figure I.10) and Hanford-Plus-Background (Figure I.11) scenarios. Neither the low nor high coot EHQs exceeded the minimal level of concern (EHQ of 1) for either the Hanford (Figure I.10) or Hanford-Plus-Background (Figure I.11) scenarios. Because the entire range of coot EHQs was below an EHQ of 1 for both scenarios (Figures I.10 and I.11), only a negligible risk of uranium chemical toxicity to terrestrial receptors exists under all the alternative groups.

Except for the No Action Alternative and Alternative Group B, the uranium chemical toxicity risk to terrestrial receptors does not appear to be an important discriminator among the alternative groups because coot EHQs were essentially the same (see Figure I.10).

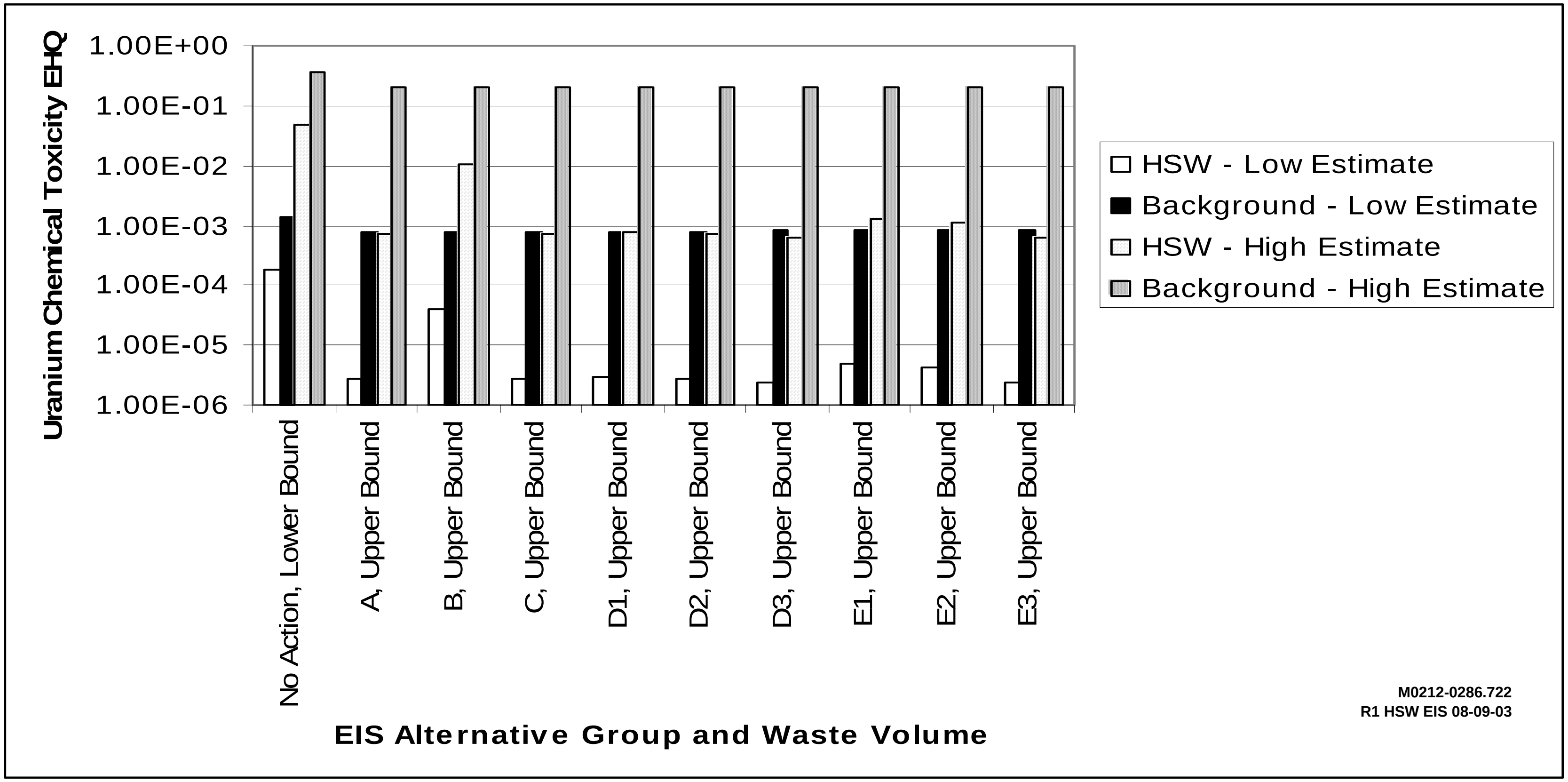


Figure I.10. American Coot Low and High Uranium Chemical Toxicity EHQs for Each Alternative Group in the 2500- to 10,000-Year Time Period for Background and the Hanford Scenario

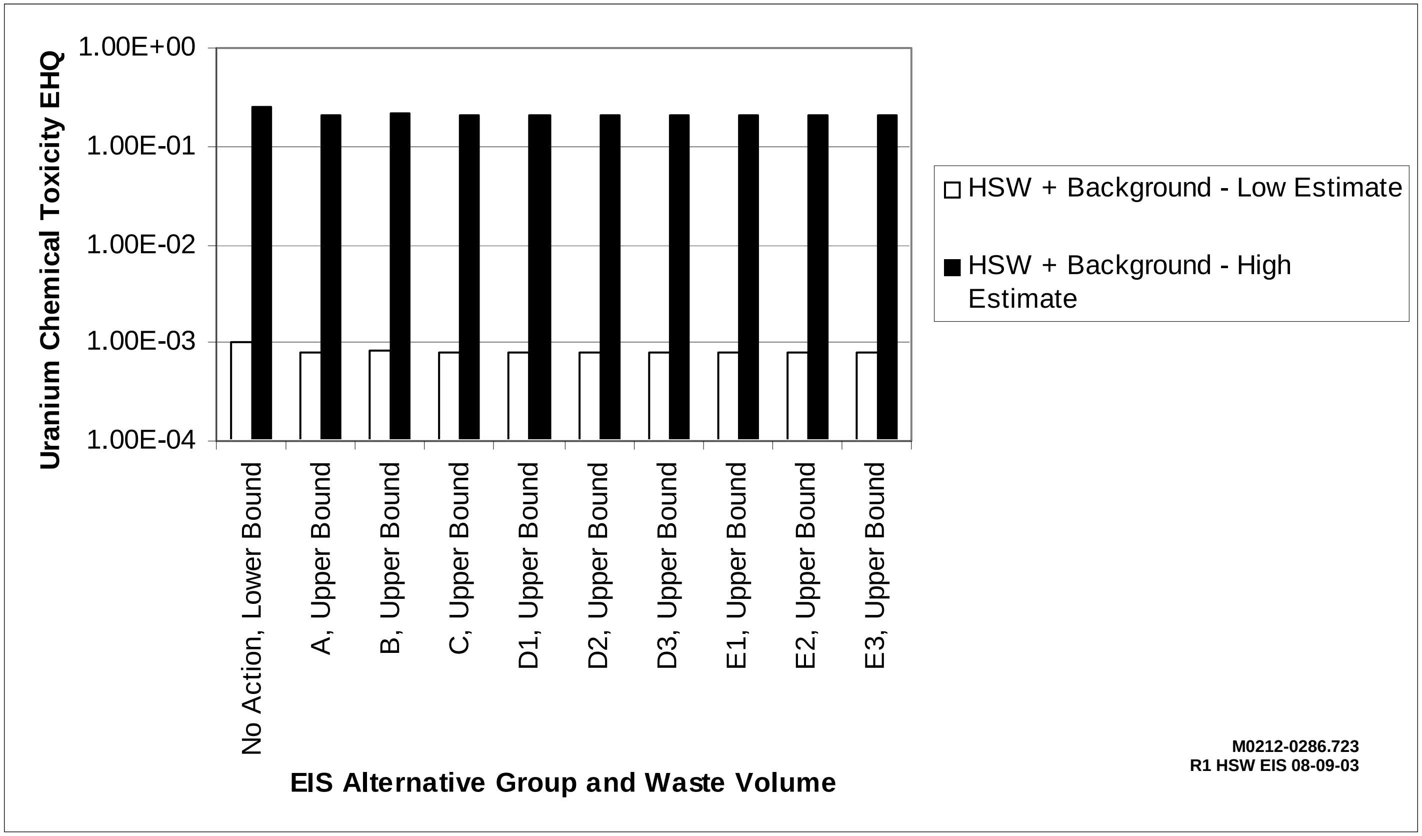


Figure I.11. American Coot Low and High Uranium Chemical Toxicity EHQs for Each Alternative Group in the 2500- to 10,000-Year Time Period for the Hanford-Plus-Background Scenario

Aquatic Receptors. Estimated equilibrium exposures for aquatic receptors are tissue concentrations expressed in terms of micrograms per kilogram (µg/kg). One way of calculating chemical toxicity EHQs for aquatic animal receptors is by dividing the estimated tissue concentration by the lowest tissue concentration known to produce a clinically toxic response (that is, the lowest observed effects concentration, or LOEC), where such concentrations are available. The LOEC, based on chronic exposure, was selected because it was deemed to be most representative of effects that might occur during a long-term contaminant release.

LOECs or other tissue-concentration–based toxicity data were unavailable for aquatic animal receptors, so water-concentration–based toxicity data were used. EHQs thus were calculated by comparing the equivalent water concentration for the receptor with the lowest water concentration known to produce a clinically toxic response.

The equivalent water concentration in micrograms per liter (µg/L) is derived by dividing the receptor's estimated tissue concentration (µg/kg) by the bioconcentration factor (BCF) in liters per kilogram (L/kg). The BCF is the ratio of the tissue concentration of an aquatic organism to the water concentration where uptake is limited to water alone, usually derived in an experimental setting. Thus, the equivalent water concentration is the water concentration that would result in the receptor's estimated tissue concentration via gill/respiratory uptake and dermal uptake alone (that is, excluding uptake from foods, ingestion of sediment, and dermal uptake from sediment). The ratio of an equivalent water concentration to a water-concentration-based toxicity benchmark is equivalent to the ratio of a tissue concentration to a tissue-concentration-based toxicity benchmark such as a LOEC.

The BCF values used in deriving the equivalent water concentrations were those reported in conjunction with the aquatic toxicity data described below (that is, 8.87E-03 for the teleost fish [of or belonging to a large group of fishes with bony skeletons] [*Brachydanio rerio*] and 55.67E-03 for the bivalve mollusk [*Corbicula fluminea*] [Labrot et al. 1999]). The teleost fish BCF was used to calculate equivalent water concentrations for fish, lamprey, and the Woodhouse's toad tadpole. The *Corbicula* BCF was used to calculate equivalent water concentrations for crayfish, mayfly, clams, mussels, and the Columbia pebble snail. In addition, more conservative BCFs from the literature (that is, 50, the upper end of a range of BCFs [2 to 50] for generic fish, and 1000, the upper end of a range of BCFs [100 to 1000] for generic aquatic invertebrates [Fellows et al. 1998]) were similarly used. Because neither the generic nor species-specific BCFs were considered more reliable, the former were used to estimate low EHQs and the latter high EHQs.

As is the case with toxicity data for terrestrial receptors, it is frequently necessary to extrapolate aquatic toxicity data across taxa and endpoints using uncertainty factors. The chemical toxicity data used in calculating EHQs for aquatic animal exposure to total uranium were as follows. Only two suitable uranium values were available. Because LOECs and tissue-concentration-based toxicity data were lacking for uranium, a uranium 96-hour LC_{50} (median lethal concentration) (3.05 mg/L) for the teleost fish (Labrot et al. 1999) was used. This value was divided by 10 to yield a LOEC (0.305 mg/L). The derived teleost fish LOEC was used to calculate EHQs for fish, lamprey, and the Woodhouse's toad tadpole. A uranium 96-hour LC_{50} (1,872.08 mg/L) for the bivalve mollusk (Labrot et al. 1999) was divided by 10 to yield a LOEC (187.208 mg/L). The derived *Corbicula* LOEC was used to calculate

EHQs for crayfish, mayfly, clams, mussels, and the Columbia pebble snail. The above extrapolations from acute to chronic toxicity values are based on Dourson and Stara (1983) and are consistent with DOE-RL (1998).

Low and high EHQs for total uranium, based on the generic and Labrot et al. (1999) BCFs, respectively, are provided for the Hanford scenario and background (Figure I.12) and the Hanford-Plus-Background scenario (Figure I.13) for the one aquatic animal receptor in Table I.8 that is at maximal risk in each alternative group in the 2500- to 10,000-year time period—Woodhouse's toad tadpole. Results are provided for only those waste volumes that yielded maximal risk (that is, the Lower Bound waste volume for the No Action Alternative and the Upper Bound waste volume for all the other alternative groups).

The high and low Woodhouse's toad tadpole EHQs for the Hanford scenario are less than background under all the alternative groups (Figure I.12). The high toad tadpole EHQs were approximately three to four orders of magnitude greater than the low EHQs (Figures I.12 and I.13). The low tadpole EHQs were all two to four orders of magnitude below 1 under the Hanford scenario (Figure I.12) and at least one order of magnitude below 1 in the Hanford-Plus-Background scenario (Figure I.13). The high EHQs for all the alternative groups, except the No Action Alternative and Alternative Group B, were slightly above or slightly below 1 under the Hanford scenario (Figure I.12). The high EHQs for Alternative Group B and the No Action Alternative under the Hanford scenario were approximately one and two orders of magnitude, respectively, above 1 (Figure I.12). The high EHQs for all the alternative groups under the Hanford-Plus-Background scenario (Figure I.13) were at least two orders of magnitude above 1.

Based on the range of the EHQs alone, it is inconclusive whether or not there would be a non-discountable uranium chemical toxicity risk to Woodhouse's toad tadpole (for the No Action Alternative and Alternative Group B under the Hanford scenario high estimate [Figure I.12] and for all the alternative groups under the Hanford-Plus-Background scenario high estimate [Figure I.13]). However, this is unlikely for the following reasons. First, the modeling of contaminants in groundwater in the hypothetical well near the river and in the river was conservative (see Appendix G). Second, simultaneous exposure to maximum contaminant concentrations, which do not always occur concurrently in time and space, was assumed for this risk assessment (see Section I.3.1). Further, it is important to note that low and high tadpole EHQs are based on uptake parameters (BCFs) and a toxicity benchmark from fish, which have questionable applicability when evaluating risk in toad tadpoles. Consequently, the EHQs of fish receptors at maximal risk should be examined as well.

The carp had the next highest EHQs behind Woodhouse's toad tadpole. Because largescale/mountain sucker and smallmouth bass EHQs differed from those of the carp by no more than 0.01 in any alternative group and scenario, the three species are considered together.

Low and high EHQs for total uranium, based on the generic and Labrot et al. (1999) BCFs, respectively, are provided for the Hanford scenario and background (Figure I.14) and the Hanford-Plus-Background scenario (Figure I.15) for the carp (and largescale/mountain sucker and smallmouth bass) in each alternative group in the 2500- to 10,000-year time period. Results are provided for only those waste volumes that yielded maximal risk (that is, the Lower Bound waste volume for the No Action Alternative and the Upper Bound waste volume for all other alternative groups).

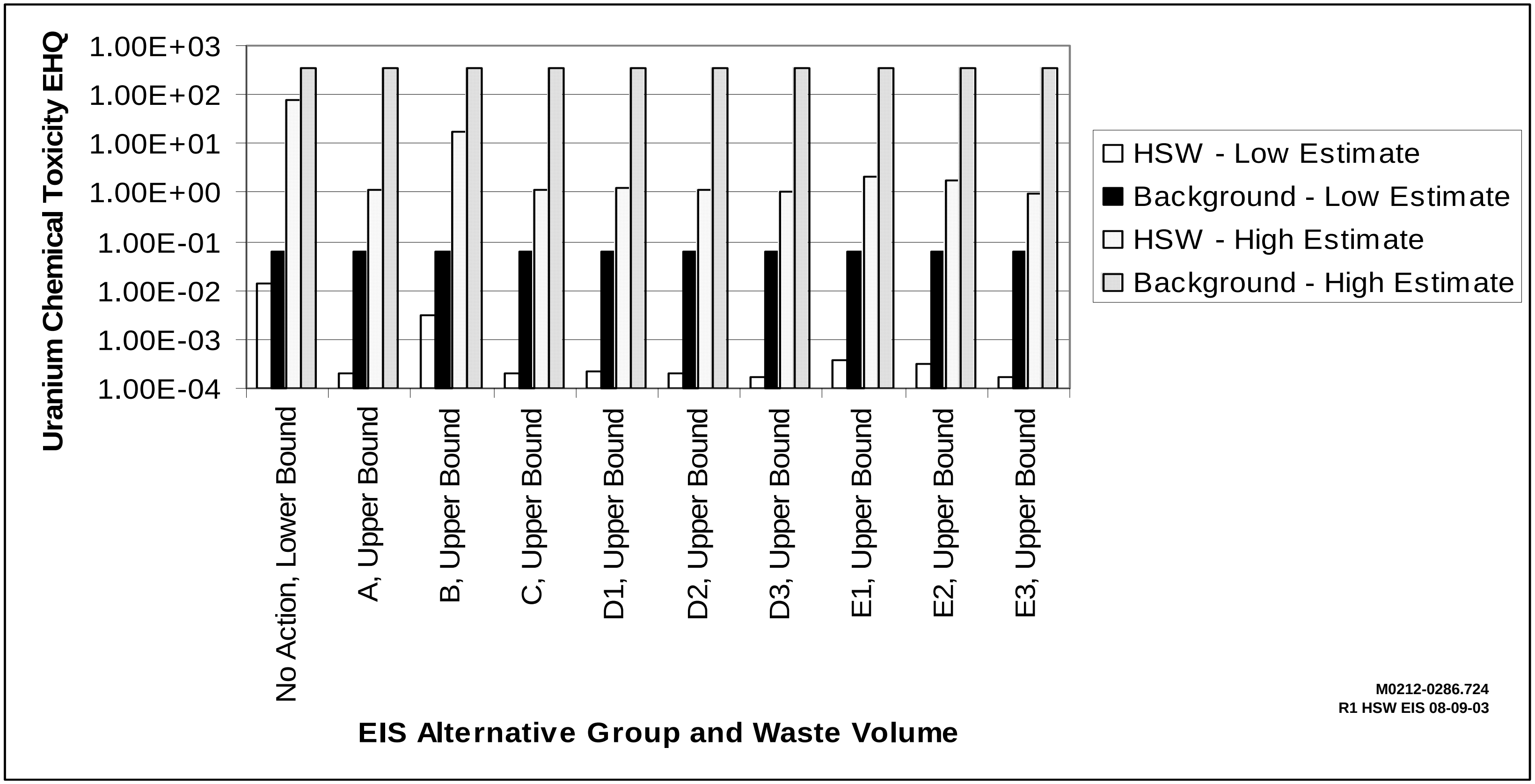


Figure I.12. Woodhouse's Toad Tadpole Low and High Uranium Chemical Toxicity EHQs for Each Alternative Group in the 2500- to 10,000-Year Time Period for Background and the Hanford Scenario

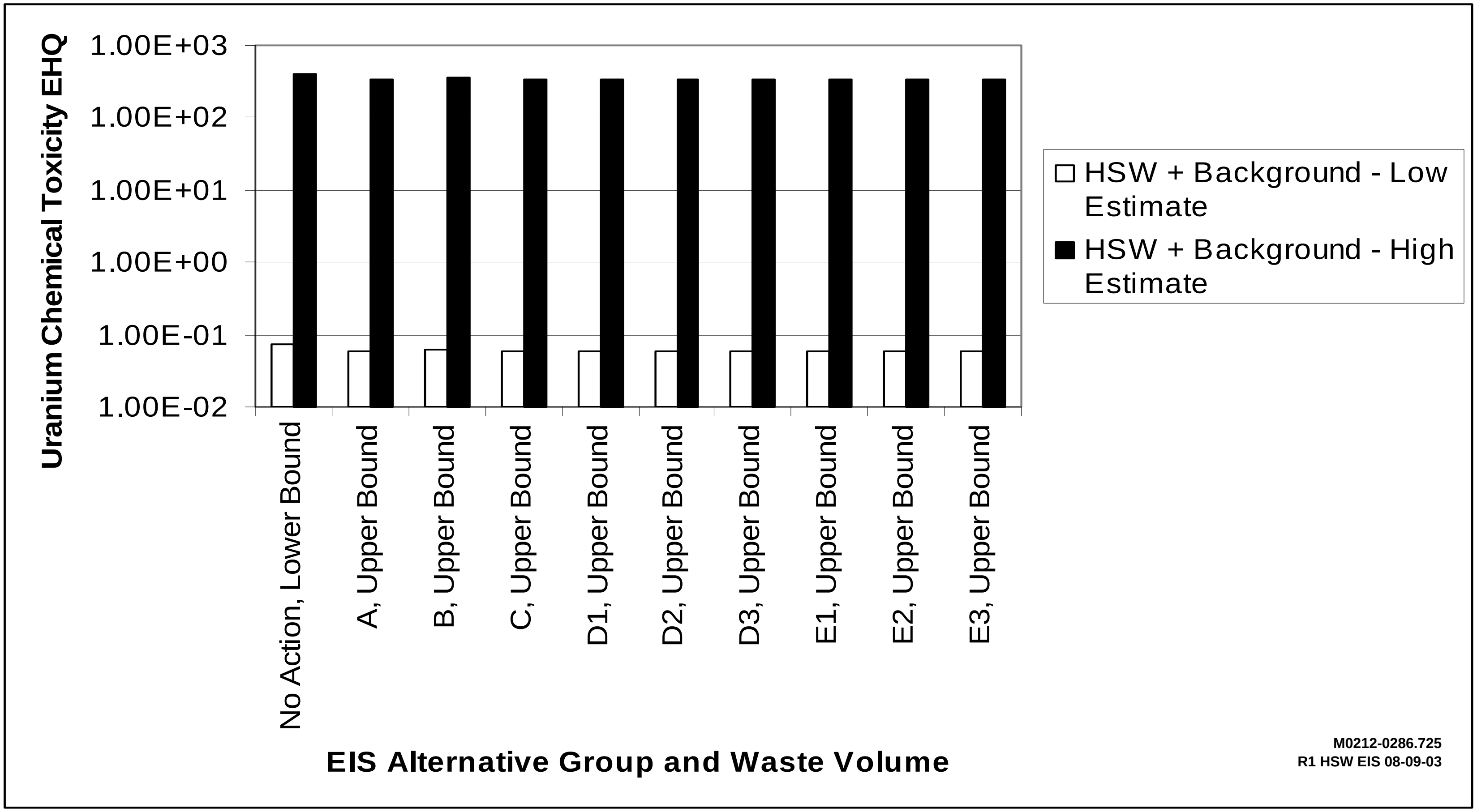


Figure I.13. Woodhouse's Toad Tadpole Low and High Uranium Chemical Toxicity EHQs for Each Alternative Group in the 2500- to 10,000-Year Time Period for the Hanford-Plus-Background Scenario

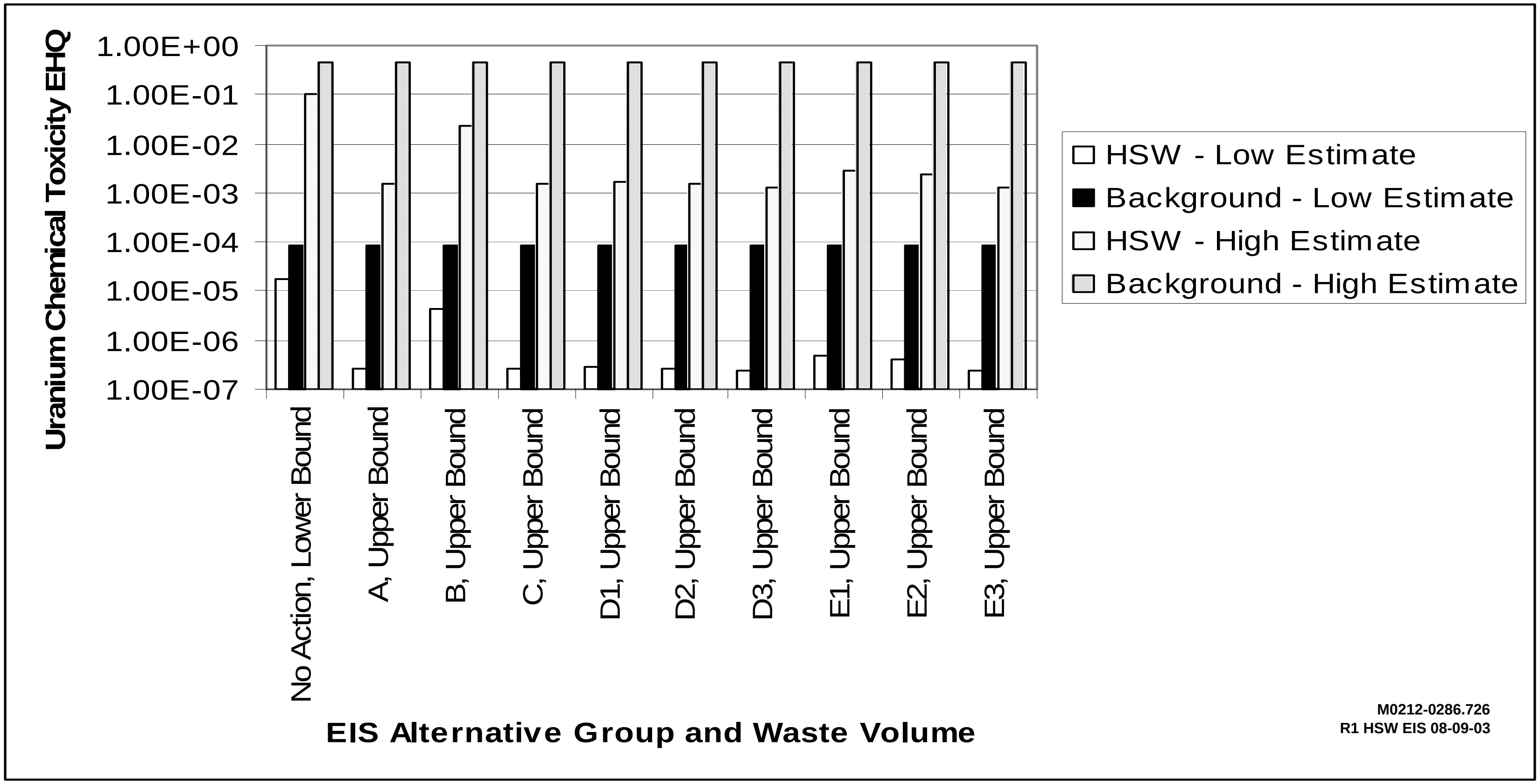


Figure I.14. Carp Low and High Uranium Chemical Toxicity EHQs for Each Alternative Group in the 2,500- to 10,000-Year Time Period for Background and the Hanford Scenario

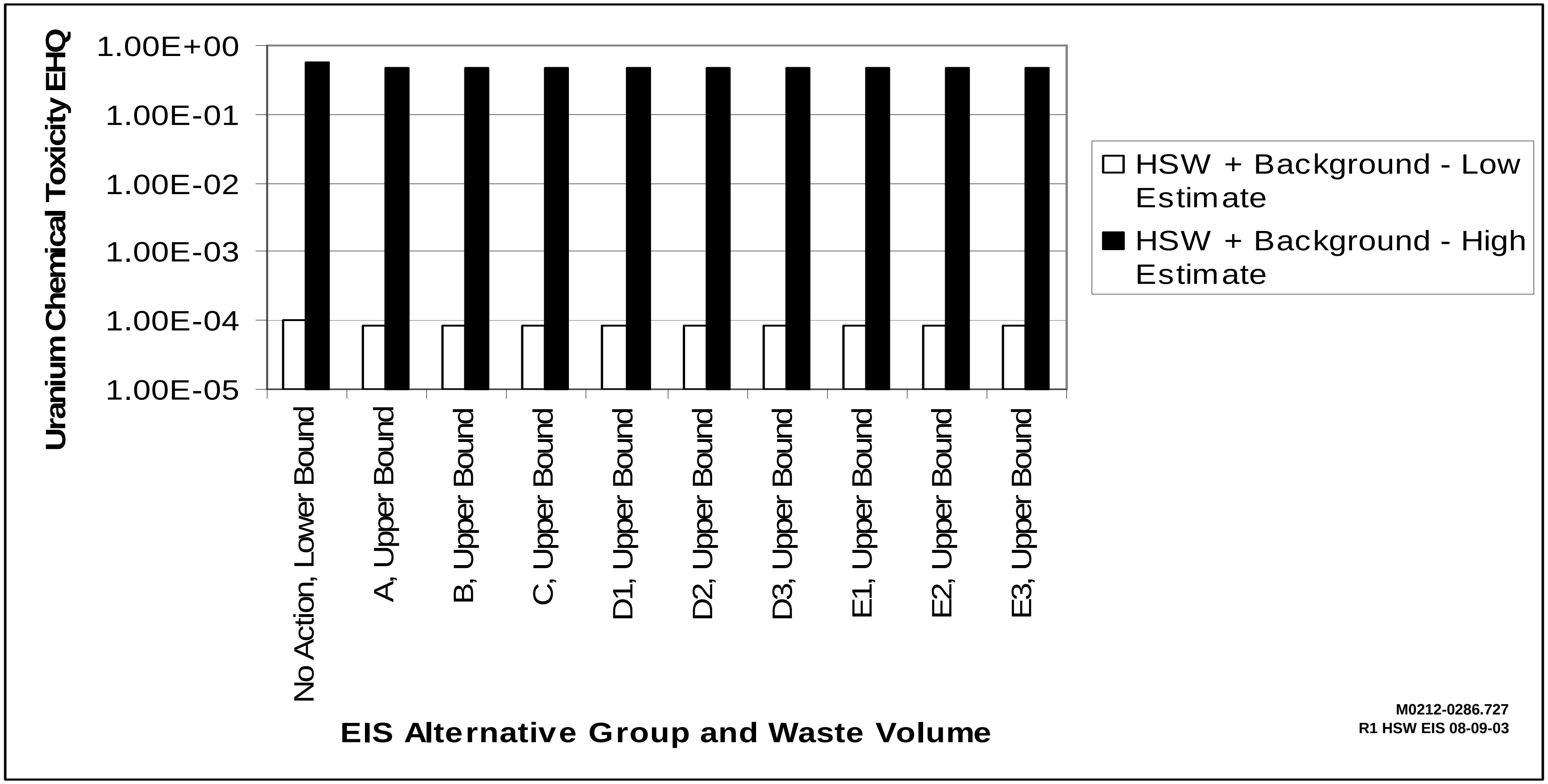


Figure I.15. Carp Low and High Uranium Chemical Toxicity EHQs for Each Alternative Group in the 2,500- to 10,000-Year Time Period for the Hanford-Plus-Background Scenario

The high and low carp (and largescale/mountain sucker and smallmouth bass) EHQs for the Hanford scenario are less than those for background under all the alternative groups (Figure I.14). The high carp EHQs were approximately three to four orders of magnitude greater than the low EHQs (Figures I.14 and I.15). Neither the high nor the low carp EHQs exceeded 1 for the Hanford (Figure I.14), or the Hanford-Plus-Background (Figure I.15) scenarios. Consequently, only a negligible risk of uranium chemical toxicity to these fish receptors exists under any of the alternative groups.

Carp (and largescale/mountain sucker and smallmouth bass) EHQs were virtually the same for all alternative groups, except for Alternative Group B and the No Action Alternative, which were approximately one to two orders of magnitude, respectively, higher than the other alternative groups (Figure I.14). Consequently, except for the No Action Alternative and Alternative Group B, risk of uranium chemical toxicity to fish receptors does not appear to be an important discriminator among the alternative groups.

All other aquatic animal receptors had EHQs that were less than those of carp, largescale/mountain sucker, and smallmouth bass. Therefore, only a negligible risk of uranium chemical toxicity to these receptors exists under all the alternative groups.

I.4 Consultations

DOE consults with the U.S. Fish and Wildlife Service and National Marine Fisheries Service regarding potential actions that may affect threatened and endangered species and critical habitats, where such occur on the Hanford Site. Copies of the DOE consultation letters and agency responses are included in Attachment B to this appendix.

I.5 References

16 USC 703-712. Migratory Bird Treaty Act. Online at: http://www4.law.cornell.edu/

42 USC 4321 et seq. National Environmental Policy Act (NEPA) of 1969, as amended. Online at: http://www4.law.cornell.edu

42 USC 9601 et seq. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. Online at: http://www4.law.cornell.edu

Baker, S. 2000. *Effects of Fire on Soil Seed Banks on the Hanford Site*. PNNL-13888, Pacific Northwest National Laboratory, Richland, Washington.

Becker, J. M., and M. R. Sackschewsky. 2001. *Addendum to the 200 West Area Dust Mitigation Strategies: Treatment of the Dust Source Area*. PNNL-13884, Pacific Northwest National Laboratory, Richland, Washington.

Belnap, J. 1993. "Recovery Rates of Cryptobiotic Crusts: Innoculant Use and Assessment Methods." *Great Basin Naturalist* 53(1):89-95.

Belnap, J. and K. T. Harper. 1995. "Influence of Cryptobiotic Crusts on Elemental Content of Tissue of Two Desert Seed Plants." *Arid Soil Research and Rehabilitation* 9:107-115.

Belnap, J., J. H. Kaltenecker, R. Rosentreter, J. Williams, S. Leonard, and D. Eldrige. 2001. *Biological Soil Crusts: Ecology and Management*. Technical Reference 1730-1732. Bureau of Land Management, Denver, Colorado. Online at: http://www.blm.gov/nstc/library/pdf/CrustManual.pdf

BMNHC. 2002. Descriptions of habitat requirements of Washington's mammals. Burke Museum of Natural History and Culture, University of Washington, Seattle. Online at: http://www.washington.edu/burkemuseum/mammalogy/mamwash/mamwash.html

Brandt, C. A. 1994. *Biological Review for the Environmental Restoration Disposal Facility (ERDF) Rail Line*. PNNL-14142, Pacific Northwest National Laboratory, Richland, Washington.

Brandt, C. A. 1998. *Blanket Biological Review for General Maintenance Activities within Active Burial Grounds, 200 E and 200 W Areas, ECR #98-200-031a*. PNNL-14141, Pacific Northwest National Laboratory, Richland, Washington.

Brandt, C. A. 1999. *Blanket Biological Review for General Maintenance Activities within Active Burial Grounds, 200 E and 200 W Areas, ECR #99-200-042*. PNNL-13878, Pacific Northwest National Laboratory, Richland, Washington.

Bryce, R. W., C. T. Kincaid, P. W. Eslinger, and L. F. Morasch (eds.). 2002. *An Initial Assessment of Hanford Impact Performed with the System Assessment Capability*. PNNL-14027, Pacific Northwest National Laboratory, Richland, Washington. Online at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-14027/PNNL-14027.pdf

CEQ. 1993. *Incorporating Biodiversity Considerations into Environmental Impact Analysis Under the National Environmental Policy Act*. Council on Environmental Quality, Executive Office of the President, Washington, D.C.

DOE. 1993. *Radiation Protection of the Public and the Environment*. DOE Order 5400.5, U.S. Department of Energy, Washington, D.C. Online at: http://www.directives.doe.gov

DOE. 2002. "DOE Standard: A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota." DOE-STD-1153-2002, U.S. Department of Energy, Washington, D.C. Online at: http://tis.eh.doe.gov/techstds

DOE-RL. 1995a. *Ecological Compliance Assessment Management Plan*. DOE/RL-95-11, Rev. 1., U.S. Department of Energy, Richland, Operations Office, Richland, Washington.

DOE-RL. 1995b. *Hanford Site Risk Assessment Methodology*. DOE/RL-91-45, Rev. 3, U.S. Department of Energy, Richland, Washington.

DOE-RL. 1995c. *Mitigation Action Plan for the Environmental Restoration Disposal Facility*. DOE/RL-95-24, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL. 1998. *Screening Assessment and Requirements for a Comprehensive Assessment: Columbia River Comprehensive Impact Assessment*. DOE/RL-96-16, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL. 2000. *Type B Accident Investigation – U.S. Department of Energy Response to the 24 Command Wildland Fire on the Hanford Site – June 27-July 1, 2000.* DOE/RL-2000-63, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Online at: http://www.hanford.gov/docs/rl-2000-63/index.html

DOE-RL. 2001. *Hanford Site Biological Resources Management Plan*. DOE/RL-96-32, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL. 2003. *Hanford Site Biological Resources Mitigation Strategy*. DOE/RL-96-88, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Online at: http://www.pnl.gov/ecomon/Docs/BRMiS.pdf

Domingo, J. L. 2001. "Reproductive and Developmental Toxicity of Natural and Depleted Uranium: a Review." *Reproductive Toxicology* 15:603-609.

Dourson, M. L. and J. F. Stara. 1983. "Regulatory History and Experimental Support of Uncertainty (Safety) Factors." *Regulatory Toxicology and Pharmacology* 3(3):224-238.

EPA. 1992. *Framework for Ecological Risk Assessment*. EPA/630/R-92/001, U.S. Environmental Protection Agency, Washington D.C.

EPA. 1998. *Guidelines for Ecological Risk Assessment*. EPA/630/R-95/002F, U.S. Environmental Protection Agency, Washington D.C. Online at: http://cfpub.epa.gov/ncea/cfm/ecorsk.cfm?ActType=default

Eslinger, P. W., C. Arimescu, B. A. Kanyid, and T. B. Miley. 2002. *User Instructions for the Systems Assessment Capability, Rev. 0, Computer Codes. Volume 2: Impact Modules*. PNNL-13932-Volume 2, Pacific Northwest National Laboratory, Richland, Washington. Online at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13932-v.2.pdf

Fellows, R. J., C. C. Ainsworth, C. J. Driver, and D. A. Cataldo. 1998. "Dynamics and Transformations of Radionuclides in Soils and Ecosystem Health." In *Soil Chemistry and Ecosystem Health*, ed. P. M. Huang, pp. 85-132. Soil Science Society of America, Madison, Wisconsin.

Johansen, J. R., J. Ashley, and W. R. Rayburn. 1993. "Effects of Rangefire on Soil Algal Crusts in Semiarid Shrub-Steppe of the Lower Columbia Basin and Their Subsequent Recovery." *Great Basin Naturalist* 53(1):73-88.

Kincaid, C. T., P. W. Eslinger, W. E. Nichols, A. L. Bunn, R. W. Bryce, T. B. Miley, M. C. Richmond, S. F. Snyder, and R. L. Aaberg. 2000. *Groundwater/Vadoes Zone Integration Project System Assessment Capability (Revision 0) Assessment Description, Requirements, Software Design, and Test Plan*. BHI-01365, Draft A, Bechtel Hanford, Inc., Richland, Washington.

Labrot, F., J. F. Narbonne, P. Ville, M. Saint Denis, and D. Ribera. 1999. "Acute Toxicity, Toxicokinetics, and Tissue Target of Lead and Uranium in the Clam Corbicula fluminea and the Worm Eisenia fetida: Comparison with the Fish Brachydanio rerio." *Archives of Environmental Contamination and Toxicology* 36:167-178.

Link, S. O., B. D. Ryan, J. L. Downs, L. L. Cadwell, J. A. Soll, M. A. Hawke, and J. Ponzetti. 2000. "Lichens and Mosses on Shrub-steppe Soils in Southeastern Washington." *Northwest Science* 74(1):50-56.

Opresko, D. M., B. E. Sample, and G. W. Suter II. 1995. *Toxicological Benchmarks for Wildlife: 1995 Revision*. ES/ER/TM-86/R2, Lockheed Martin Energy Systems, Inc., Oak Ridge, Tennessee. Online at: http://www.osti.gov/dublincore/ecd/servlets/purl/455959-nmGylo/webviewable/455959.pdf

Renne, D. S. and M. A. Wolf. 1976. *Experimental Studies of Herbicide Drift Characteristics*. BNWL-SA-5848, Pacific Northwest Laboratory, Richland, Washington.

Sackschewsky, M. R. 2000. *Blanket Biological Review for General Maintenance Activities within Active Burial Grounds, 200 E and 200 W Areas, ECR #2000-200-013*. PNNL-13886, Pacific Northwest National Laboratory, Richland, Washington.

Sackschewsky, M. R. 2001. *Blanket Biological Review for General Maintenance Activities within Active Burial Grounds, 200 E and 200 W Areas, ECR #2001-200-048*. PNNL-13887, Pacific Northwest National Laboratory, Richland, Washington.

Sackschewsky, M. R. 2002a. *Blanket Biological Review for General Maintenance Activities within Active Burial Grounds, 200 East and 200 West Areas, ECR #2002-200-034*. PNNL-14133, Pacific Northwest National Laboratory, Richland, Washington.

Sackschewsky, M. R. 2002b. *Ecological Compliance Review for the Hanford Solid Waste EIS – Borrow Area C, 600 Area, ECR #2002-600-012*. PNNL-13882, Pacific Northwest National Laboratory, Richland, Washington.

Sackschewsky, M. R. 2002c. *Ecological Compliance Review for the Vegetation Removal on 218-W-6, 200 West Area, ECR #2002-200-031*. PNNL-14132, Pacific Northwest National Laboratory, Richland, Washington.

Sackschewsky, M. R. 2003a. *Biological Review for the Hanford Solid Waste EIS - Borrow Area C (600 Area), Stockpile and Conveyance Road Area (600 Area), Environmental Restoration Disposal Facility (ERDF) (600 Area), Central Waste Complex (CWC) Expansion (200 West), 218-W-5 Expansion Area (200 West), New Waste Processing Facility (200 West), Undeveloped Portion of 218-W-4C (200 West), Western Half & Northeastern Corner of 218-W-6 (200 West), Disposal Facility Near Plutonium-Uranium Extraction (Purex) Facility (200 East), ECR #2002-600-012b*. PNNL-14233, Pacific Northwest National Laboratory, Richland, Washington.

Sackschewsky, M. R. 2003b. *Blanket Biological Review for General Maintenance Activities Within Active Burial Grounds, 200 East and 200 West Areas, ECR #2003-200-035*. PNNL-14379. Pacific Northwest National Laboratory, Richland, Washington.

Sackschewsky, M. R. and J. M. Becker. 2001. *200 West Area Dust Mitigation Strategies*. PNNL-13883, Pacific Northwest National Laboratory, Richland, Washington.

Sackschewsky, M. R. and J. L. Downs. 2001. *Vascular Plants of the Hanford Site*. PNNL-13688, Pacific Northwest National Laboratory, Richland, Washington.

Shields, L. M., C. Mitchell, and F. Drouet. 1957. "Alga- and Lichen-Stabilized Surface Crusts as Soil Nitrogen Sources." *American Journal of Botany* 44:489-498.

Soll, J. A., and C. Soper (eds). 1996. *Biodiversity Inventory and Analysis of the Hanford Site, 1995 Annual Report*. The Nature Conservancy of Washington, Seattle, Washington.

Suter. G. W. 1993. *Ecological Risk Assessment*. Lewis Publishers, Chelsea, Michigan.

Tiller B. L., R. K. Zufelt, S. D. Turner, L. L. Cadwell, L. Bender, and G. K. Turner. 2000. *Population Characteristics and Seasonal Movement Patterns of the Rattlesnake Hills Elk Herd - Status Report 2000*. PNNL-13331, Pacific Northwest National Laboratory, Richland, Washington. Online at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13331.pdf

TNC. 1999. *Biodiversity Inventory and Analysis of the Hanford Site: Final Report 1994-1999*. The Nature Conservancy of Washington, Seattle, Washington.

WDFW. 2002. Animal Species of Concern lists and status definitions. Washington Department of Fish and Wildlife, Olympia, Washington. Online at: http://www.wdfw.wa.gov/wlm/diversty/soc/concern.htm

WHC. 1995. *Guidelines for Coordinated Management of Noxious Weeds at the Hanford Site*. WHC-SD-EN-AP-187, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WNHP. 2002. Rare plant lists and status definitions. Washington State Natural Heritage Program, Washington State Department of Natural Resources, Olympia, Washington. Online at: http://www.dnr.wa.gov/nhp/refdesk/plants.html

Attachment A

Ecological Survey Results for Summers 2002 and 2003

Attachment A

Ecological Survey Results for Summers 2002 and 2003

This attachment consists of tables listing surveyed areas and descriptors of plant communities that occur within each area surveyed. Areas surveyed in summer 2002 include Area C, the stockpile and conveyance road area, the area for the new waste processing facility, the Central Waste Complex (CWC) expansion area, and the W-5 Expansion Area. Note that the plant community descriptors listed for Area C are based on the results of this survey (not the pre-24 Command Fire plant community designations noted in Appendix I). The only area surveyed in summer 2003 was at the Environmental Restoration Disposal Facility (ERDF).

The following notations are used throughout Tables IA.1 through IA.13:

(a) Percent plant cover was visually estimated

(b) Blank cells indicate percent cover less than a trace (+)

(c) R1 = Review Group 1—plant taxon of potential concern that is in need of additional field work before a status can be assigned (WNHP 2002)

(d) W = Watch List—plant taxon that is of concern, but is considered to be more abundant and/or less threatened in Washington than previously assumed (WNHP 2002)

(e) + = Trace

(f) C = Candidate—a species that the Washington Department of Fish and Wildlife will review for possible listing as state endangered, threatened, or sensitive (WDFW 2002)

(g) SC = Species of Concern—a species whose conservation standing is of concern to the U.S. Fish and Wildlife Service but for which status information still is needed.

Table IA.1. Borrow Area C—Cheatgrass/Needle-and-Thread Grass/Indian Ricegrass

Common Name	**Scientific Name**	**Plant Cover (%)$^{(a, b)}$**	**Federal Status**	**State Status**
Animals				
coyote	*Canis latrans*			
elk	*Cervus elaphus*			
horned lark	*Eremophila alpestris*			
Northern pocket gopher	*Thomomys talpoides*			
short-eared owl	*Asio flammeus*			
side-blotched lizard	*Uta stansburiana*			
Western meadowlark	*Sturnella neglecta*			
Plants				
bastard toadflax	*Comandra umbellata*			
buckwheat milkvetch	*Astragalus caricinus*			
bur ragweed	*Ambrosia acanthicarpa*			
Carey's balsamroot	*Balsamorhiza careyana*			
cheatgrass	*Bromus tectorum*	50		
Cusick's sunflower	*Helianthus cusickii*			
cutleaf ladysfoot mustard	*Thelypodium laciniatum*			
desert mat	*Tiquilia nuttallii*			
dune scurfpea	*Psoralea lanceolata*			
fiddleneck	*Amsinckia lycopsoides*			
Franklin's sandwort	*Arenaria franklinii*			
green rabbitbrush	*Chrysothamnus viscidiflorus*			
hoary aster	*Machaeranthera canescens*			
hoary falseyarrow	*Chaenactis douglasii*			
Indian ricegrass	*Oryzopsis hymenoides*	10		
Jim Hill's tumblemustard	*Sisymbrium altissimum*			
lamb's quarters	*Chenopodium album*			
longleaf phlox	*Phlox longifolia*			
low lupine	*Lupinus pusillus*			

Table IA.1. (contd)

Common Name	**Scientific Name**	**Plant Cover (%)[a, b]**	**Federal Status**	**State Status**
matted cryptantha	*Cryptantha circumscissa*			
needle-and-thread grass	*Stipa comata*	15		
Nuttall's coldenia	*Coldenia nutallii*			
pale evening primrose	*Oenothera pallida*	5		
pine bluegrass	*Poa scabrella*			
prairie Junegrass	*Koeleria cristata*			
prickly lettuce	*Lactuca serriola*			
purple mat	*Nama densum* var. *parviflorum*			R1(c)
rough wallflower	*Erysimum asperum*			
Russian thistle	*Salsola kali*			
sagebrush mariposa lily	*Calochortus macrocarpus*			
sand beardtongue	*Penstemon acuminatus*	5		
Sandberg's bluegrass	*Poa sandbergii*			
shy gilia	*Gilia sinuata*			
slender hawksbeard	*Crepis atrabarba*			
stalked-pod milkvetch	*Astragalus sclerocarpus*			W(d)
starvation pricklypear	*Opuntia polyacantha*			
turpentine springparsley	*Cymopteris terebithinus*	+(e)		
white sand verbena	*Abronia millefolium*			
whiteleaf scorpionweed	*Phacelia hastata*			
winged dock	*Rumex venosus*			
yarrow	*Achillea millefolium*			
yellow salsify	*Tragopogon dubius*			

Table IA.2. Borrow Area C—Needle-and-Thread Grass/Cheatgrass

Common Name	**Scientific Name**	**Plant Cover (%)**[a, b]	**Federal Status**	**State Status**
Animals				
Northern pocket gopher	*Thomomys talpoides*			
Plants				
buckwheat milkvetch	*Astragalus caricinus*			
bulbous bluegrass	*Poa bulbosa*	1		
bur ragweed	*Ambrosia acanthicarpa*			
cheatgrass	*Bromus tectorum*	20		
crested wheatgrass	*Agropyron cristatum*	5		
crouching milkvetch	*Astragalus succumbens*			W
fiddleneck	*Amsinckia lycopsoides*			
hoary aster	*Machaeranthera canescens*			
Indian ricegrass	*Oryzopsis hymenoides*			
Jim Hill's tumblemustard	*Sisymbrium altissimum*			
longleaf phlox	*Phlox longifolia*			
needle-and-thread grass	*Stipa comata*	20		
prickly lettuce	*Lactuca serriola*			
Russian thistle	*Salsola kali*	5		
sagebrush mariposa lily	*Calochortus macrocarpus*			
Sandberg's bluegrass	*Poa sandbergii*			
slimleaf goosefoot	*Chenopodium leptophyll*			
yellow salsify	*Tragopogon dubius*			

Table IA.3. Borrow Area C—Sandberg’s Bluegrass/Cheatgrass

Common Name	**Scientific Name**	**Plant Cover (%)[a, b]**	**Federal Status**	**State Status**
Animals				
coyote	*Canis latrans*			
side-blotched lizard	*Uta stansburiana*			
Plants				
bluebunch wheatgrass	*Agropyron spicatum*			
bottlebrush grass	*Sitanion hystrix*			
bur ragweed	*Ambrosia acanthicarpa*			
Carey’s balsamroot	*Balsamorhiza careyana*			
cheatgrass	*Bromus tectorum*	10		
fiddleneck	*Amsinckia lycopsoides*			
gray rabbitbrush	*Chrysothamnus nauseosus*	+		
green rabbitbrush	*Chrysothamnus viscidiflorus*			
hoary aster	*Machaeranthera canescens*			
Indian ricegrass	*Oryzopsis hymenoides*			
Jim Hill’s tumblemustard	*Sisymbrium altissimum*			
pale evening primrose	*Oenothera pallida*			
prickly lettuce	*Lactuca serriola*			
rock buckwheat	*Eriogonum sphaerocephalum*			
Russian thistle	*Salsola kali*			
Sandberg’s bluegrass	*Poa sandbergii*	40		
slender hawksbeard	*Crepis atrabarba*			
starvation pricklypear	*Opuntia polyacantha*			
yellow salsify	*Tragopogon dubius*			

Table IA.4. Borrow Area C—Cheatgrass/Indian Ricegrass/Russian Thistle

Common Name	**Scientific Name**	**Plant Cover (%)$^{(a, b)}$**	**Federal Status**	**State Status**
Animals				
elk	*Cervus elaphus*			
horned lark	*Eremophila alpestris*			
side-blotched lizard	*Uta stansburiana*			
Plants				
asparagus	*Asparagus officinalis*			
big sagebrush	*Artemisia tridentata*	+		
buckwheat milkvetch	*Astragalus caricinus*			
bulbous bluegrass	*Poa bulbosa*			
bur ragweed	*Ambrosia acanthicarpa*			
cheatgrass	*Bromus tectorum*	20		
crested wheatgrass	*Agropyron cristatum*			
dune scurfpea	*Psoralea lanceolata*			
fiddleneck	*Amsinckia lycopsoides*			
gray rabbitbrush	*Chrysothamnus nauseosus*			
green rabbitbrush	*Chrysothamnus viscidiflorus*			
hoary aster	*Machaeranthera canescens*			
Indian ricegrass	*Oryzopsis hymenoides*	10		
Jim Hill's tumblemustard	*Sisymbrium altissimum*			
longleaf phlox	*Phlox longifolia*			
low lupine	*Lupinus pusillus*			
matted cryptantha	*Cryptantha circumscissa*			
needle-and-thread grass	*Stipa comata*	1		
Nuttall's coldenia	*Coldenia nutallii*			
pale evening primrose	*Oenothera pallida*			
prairie Junegrass	*Koeleria cristata*			
prickly lettuce	*Lactuca serriola*			
Russian thistle	*Salsola kali*	10		
sagebrush mariposa lily	*Calochortus macrocarpus*			
Sandberg's bluegrass	*Poa sandbergii*	1		
slender hawksbeard	*Crepis atrabarba*			
stalked-pod milkvetch	*Astragalus sclerocarpus*			W
stiff wirelettuce	*Stephanomeria paniculata*			
turpentine springparsley	*Cymopteris terebithinus*			
yarrow	*Achillea millefolium*			
yellow bell	*Fritillaria pudica*			
yellow salsify	*Tragopogon dubius*			

Table IA.5. Borrow Area C—Cheatgrass/Sandberg's Bluegrass/Jim Hill's Tumblemustard

Common Name	**Scientific Name**	**Plant Cover (%)[a, b]**	**Federal Status**	**State Status**
Animals				
badger	*Taxidea taxus*			
coyote	*Canis latrans*			
elk	*Cervus elaphus*			
horned lark	*Eremophila alpestris*			
mule deer	*Odocoileus hemionus*			
northern pocket gopher	*Thomomys talpoides*			
side-blotched lizard	*Uta stansburiana*			
Western meadowlark	*Sturnella neglecta*			
Plants				
annual Jacob's ladder	*Polemonium micranthum*			
bastard toadflax	*Comandra umbellata*			
big sagebrush	*Artemisia tridentata*			
blue mustard	*Chorispora tenella*			
bluebunch wheatgrass	*Agropyron spicatum*			
bottlebrush grass	*Sitanion hystrix*			
buckwheat milkvetch	*Astragalus caricinus*			
bulbous bluegrass	*Poa bulbosa*			
bur ragweed	*Ambrosia acanthicarpa*			
Carey's balsamroot	*Balsamorhiza careyana*			
cheatgrass	*Bromus tectorum*	55		
crested wheatgrass	*Agropyron cristatum*			
crouching milkvetch	*Astragalus succumbens*			W
Cusick's sunflower	*Helianthus cusickii*			
cutleaf ladysfoot mustard	*Thelypodium laciniatum*			
desert mat	*Tiquilia nuttallii*			
dune scurfpea	*Psoralea lanceolata*			
fiddleneck	*Amsinckia lycopsoides*			
giant wildrye	*Elymus cinereus*			
gray rabbitbrush	*Chrysothamnus nauseosus*			
green rabbitbrush	*Chrysothamnus viscidiflorus*			
hoary aster	*Machaeranthera canescens*			
hoary falseyarrow	*Chaenactis douglasii*			
Indian ricegrass	*Oryzopsis hymenoides*	+		
jagged chickweed	*Holosteum umbellatum*			
Jim Hill's tumblemustard	*Sisymbrium altissimum*	10		
lamb's quarters	*Chenopodium album*			
longleaf phlox	*Phlox longifolia*			
low lupine	*Lupinus pusillus*			

Table IA.5. (contd)

Common Name	**Scientific Name**	**Plant Cover (%)$^{(a, b)}$**	**Federal Status**	**State Status**
matted cryptantha	*Cryptantha circumscissa*			
Munro’s globemallow	*Sphaeralcea munroana*			
needle-and-thread grass	*Stipa comata*			
Nuttall’s coldenia	*Coldenia nutallii*			
pale evening primrose	*Oenothera pallida*			
prairie Junegrass	*Koeleria cristata*			
prickly lettuce	*Lactuca serriola*			
purple mat	*Nama densum*			R1
rough wallflower	*Erysimum asperum*			
rush skeletonweed	*Chondrilla juncea*			
Russian thistle	*Salsola kali*			
sagebrush mariposa lily	*Calochortus macrocarpus*			
sand beardtongue	*Penstemon acuminatus*			
Sandberg’s bluegrass	*Poa sandbergii*	15		
shaggy fleabane	*Erigeron pumilis*			
shy gilia	*Gilia sinuata*			
slender hawksbeard	*Crepis atrabarba*			
slimleaf goosefoot	*Chenopodium leptophyll*			
spiny hopsage	*Grayia spinosa*			

Table IA.6. Borrow Area C—Cheatgrass

Common Name	Scientific Name	Plant Cover (%)[a, b]	Federal Status	State Status
Animals				
coyote	*Canis latrans*			
elk	*Cervus elaphus*			
side-blotched lizard	*Uta stansburiana*			
Plants				
big sagebrush	*Artemisia tridentata*			
buckwheat milkvetch	*Astragalus caricinus*			
bur ragweed	*Ambrosia acanthicarpa*			
cheatgrass	*Bromus tectorum*	50		
crouching milkvetch	*Astragalus succumbens*			W
dune scurfpea	*Psoralea lanceolata*			
gray rabbitbrush	*Chrysothamnus nauseosus*			
green rabbitbrush	*Chrysothamnus viscidiflorus*			
hoary aster	*Machaeranthera canescens*	1		
Indian ricegrass	*Oryzopsis hymenoides*	1		
jagged chickweed	*Holosteum umbellatum*			
Jim Hill’s tumblemustard	*Sisymbrium altissimum*			
lamb’s quarters	*Chenopodium album*			
low lupine	*Lupinus pusillus*			
Munro’s globemallow	*Sphaeralcea munroana*			
needle-and-thread grass	*Stipa comata*			
pale evening primrose	*Oenothera pallida*			
prickly lettuce	*Lactuca serriola*			
Russian thistle	*Salsola kali*			
sand beardtongue	*Penstemon acuminatus*			
Sandberg’s bluegrass	*Poa sandbergii*	5		
tall willowherb	*Epilobium paniculatum*			
turpentine springparsley	*Cymopteris terebithinus*			
white sand verbena	*Abronia millefolium*			
yarrow	*Achillea millefolium*			
yellow salsify	*Tragopogon dubius*			

Table IA.7. Borrow Area C—Cheatgrass/Indian Ricegrass

Common Name	Scientific Name	Plant Cover (%)[(a, b)]	Federal Status	State Status
Plants				
blue verbena	*Verbena hastata*			
buckwheat milkvetch	*Astragalus caricinus*			
bur ragweed	*Ambrosia acanthicarpa*			
cheatgrass	*Bromus tectorum*	20		
crouching milkvetch	*Astragalus succumbens*	+		W
desert mat	*Tiquilia nuttallii*			
dune scurfpea	*Psoralea lanceolata*			
fiddleneck	*Amsinckia lycopsoides*			
gray rabbitbrush	*Chrysothamnus nauseosus*			
green rabbitbrush	*Chrysothamnus viscidiflorus*			
hoary aster	*Machaeranthera canescens*			
Indian ricegrass	*Oryzopsis hymenoides*	10		
Jim Hill’s tumblemustard	*Sisymbrium altissimum*			
low lupine	*Lupinus pusillus*			
Munro’s globemallow	*Sphaeralcea munroana*			
needle-and-thread grass	*Stipa comata*	1		
pale evening primrose	*Oenothera pallida*			
Russian thistle	*Salsola kali*	+		
sand beardtongue	*Penstemon acuminatus*			
turpentine springparsley	*Cymopteris terebithinus*			
white sand verbena	*Abronia millefolium*			

Table IA.8. Borrow Area C—Gray Rabbitbrush/Cheatgrass

Common Name	**Scientific Name**	**Plant Cover (%)**$^{(a, b)}$	**Federal Status**	**State Status**
Animals				
coyote	*Canis latrans*			
horned lark	*Eremophila alpestris*			
lark sparrow	*Chondestes grammacus*			
rock wren	*Salpinctes obsoletus*			
Plants				
big sagebrush	*Artemisia tridentata*	1		
blazingstar	*Mentzelia laevicaulis*	1		
bottlebrush grass	*Sitanion hystrix*			
bulbous bluegrass	*Poa bulbosa*			
cheatgrass	*Bromus tectorum*	30		
fiddleneck	*Amsinckia lycopsoides*			
gray rabbitbrush	*Chrysothamnus nauseosus*	5		
hoary aster	*Machaeranthera canescens*			
hoary falseyarrow	*Chaenactis douglasii*			
Jim Hill's tumblemustard	*Sisymbrium altissimum*			
longleaf phlox	*Phlox longifolia*			
prickly lettuce	*Lactuca serriola*			
Sandberg's bluegrass	*Poa sandbergii*	5		
slender hawksbeard	*Crepis atrabarba*			
spiny hopsage	*Grayia spinosa*			
stalked-pod milkvetch	*Astragalus sclerocarpus*			W
threadleaf fleabane	*Erigeron filifolius*			
whitestem stickleaf	*Mentzelia albicaulis*			
yellow salsify	*Tragopogon dubius*			

Table IA.9. Stockpile and Conveyance Road Area—Russian Thistle/Cheatgrass/Dune Scurfpea

Common Name	Scientific Name	Plant Cover (%)[a, b]	Federal Status	State Status
Animals				
black-tailed jackrabbit	*Lepus californicus*			C[f]
coyote	*Canis latrans*			
horned lark	*Eremophila alpestris*			
mourning dove	*Zenaida macroura*			
Western kingbird	*Tyrannus verticalis*			
Western meadowlark	*Sturnella neglecta*			
Plants				
bastard toadflax	*Comandra umbellata*			
big sagebrush	*Artemisia tridentata*			
bur ragweed	*Ambrosia acanthicarpa*			
Carey's balsamroot	*Balsamorhiza careyana*			
cheatgrass	*Bromus tectorum*	15		
desert mat	*Tiquilia nuttallii*			
dune scurfpea	*Psoralea lanceolata*	10		
hoary aster	*Machaeranthera canescens*			
Indian ricegrass	*Oryzopsis hymenoides*	5		
Jim Hill's tumblemustard	*Sisymbrium altissimum*			
lamb's quarters	*Chenopodium album*			
longleaf phlox	*Phlox longifolia*			
low lupine	*Lupinus pusillus*			
matted cryptantha	*Cryptantha circumscissa*			
needle-and-thread grass	*Stipa comata*	1		
oat	*Avena sativa*			
pale evening primrose	*Oenothera pallida*			
prickly lettuce	*Lactuca serriola*			
purple mat	*Nama densum*			R1
Russian thistle	*Salsola kali*	30		
sagebrush mariposa lily	*Calochortus macrocarpus*			
sand beardtongue	*Penstemon acuminatus*			
Sandberg's bluegrass	*Poa sandbergii*	5		
sheep fescue	*Festuca ovina*			
slender hawksbeard	*Crepis atrabarba*			
slimleaf goosefoot	*Chenopodium leptophyll*			
stalked-pod milkvetch	*Astragalus sclerocarpus*			W
tall willowherb	*Epilobium paniculatum*			
thickspike wheatgrass	*Agropyron dasytachyum*			
turpentine springparsley	*Cymopteris terebithinus*			
Western tansymustard	*Descurainia pinnata*			
white sand verbena	*Abronia millefolium*			

Table IA.9. (contd)

Common Name	Scientific Name	Plant Cover (%)[a, b]	Federal Status	State Status
whitestem stickleaf	*Mentzelia albicaulis*			
winged dock	*Rumex venosus*			
yarrow	*Achillea millefolium*			
yellow salsify	*Tragopogon dubius*			

Table IA.10. Area for the New Waste Processing Facility—Bur Ragweed

Common Name	Scientific Name	Plant Cover (%)$^{(a, b)}$	Federal Status	State Status
Animals				
cliff swallow	*Hirundo pyrrhonota*			
coyote	*Canis latrans*			
Plants				
bastard toadflax	*Comandra umbellata*			
big sagebrush	*Artemisia tridentata*			
bigseed desertparsley	*Lomatium macrocarpum*			
blue wildrye	*Elymus glaucus*			
bottlebrush grass	*Sitanion hystrix*			
buckwheat milkvetch	*Astragalus caricinus*			
bur ragweed	*Ambrosia acanthicarpa*	10		
Carey’s balsamroot	*Balsamorhiza careyana*			
cheatgrass	*Bromus tectorum*			
crested wheatgrass	*Agropyron cristatum*			
Douglas’ clusterlily	*Brodiaea douglasii*			
fiddleneck	*Amsinckia lycopsoides*			
fourwing saltbush	*Atriplex canescens*			
green rabbitbrush	*Chrysothamnus viscidiflorus*			
hoary aster	*Machaeranthera canescens*			
hoary falseyarrow	*Chaenactis douglasii*			
Indian ricegrass	*Oryzopsis hymenoides*			
Jim Hill’s tumblemustard	*Sisymbrium altissimum*			
longleaf phlox	*Phlox longifolia*			
low lupine	*Lupinus pusillus*			
matted cryptantha	*Cryptantha circumscissa*			
needle-and-thread grass	*Stipa comata*			
prickly lettuce	*Lactuca serriola*			
Russian thistle	*Salsola kali*			
sagebrush mariposa lily	*Calochortus macrocarpus*			
sand beardtongue	*Penstemon acuminatus*			
Sandberg’s bluegrass	*Poa sandbergii*	+		
slender hawksbeard	*Crepis atrabarba*			
slender sixweeks	*Festuca octoflora*			
slimleaf goosefoot	*Chenopodium leptophyll*			
stalked-pod milkvetch	*Astragalus sclerocarpus*			W
turpentine springparsley	*Cymopteris terebithinus*			
Western tansymustard	*Descurainia pinnata*			
yarrow	*Achillea millefolium*			
yellow salsify	*Tragopogon dubius*			

Table IA. 11. W-5 Expansion Area—Sandberg's Bluegrass/Cheatgrass/Indian Ricegrass/Russian Thistle

Common Name	Scientific Name	Plant Cover (%)[a, b]	Federal Status	State Status
Animals				
badger	*Taxidea taxus*			
coyote	*Canis latrans*			
Great Basin pocket mouse	*Perognathus parvus*			
horned lark	*Eremophila alpestris*			
mourning dove	*Zenaida macroura*			
mule deer	*Odocoileus hemionus*			
Western meadowlark	*Sturnella neglecta*			
Plants				
annual mountain dandelion	*Agoseris heterophylla*			
bastard toadflax	*Comandra umbellata*			
big sagebrush	*Artemisia tridentata*			
bigseed desertparsley	*Lomatium macrocarpum*			
bluebunch wheatgrass	*Agropyron spicatum*			
bottlebrush grass	*Sitanion hystrix*			
broom buckwheat	*Eriogonum vimineum*			
buckwheat milkvetch	*Astragalus caricinus*			
bur ragweed	*Ambrosia acanthicarpa*			
Carey's balsamroot	*Balsamorhiza careyana*			
cheatgrass	*Bromus tectorum*	15		
crested wheatgrass	*Agropyron cristatum*			
crouching milkvetch	*Astragalus succumbens*			W
cutleaf ladysfoot mustard	*Thelypodium laciniatum*			
desert mat	*Tiquilia nuttallii*			
Douglas' clusterlily	*Brodiaea douglasii*			
false buckwheat	*Oxytheca dendroides*			
fiddleneck	*Amsinckia lycopsoides*			
flattop broomrape	*Orobanche corymbosa*			
flixweed	*Descurainia sophia*			
fourwing saltbush	*Artriplex canescens*			
gray rabbitbrush	*Chrysothamnus nauseosus*			
green rabbitbrush	*Chrysothamnus viscidiflorus*			
hoary aster	*Machaeranthera canescens*			
hoary falseyarrow	*Chaenactis douglasii*			
Indian ricegrass	*Oryzopsis hymenoides*	10		
Jim Hill's tumblemustard	*Sisymbrium altissimum*			
lamb's quarters	*Chenopodium album*			
longleaf phlox	*Phlox longifolia*			
low lupine	*Lupinus pusillus*			
matted cryptantha	*Cryptantha circumscissa*			

Table IA.11. (contd)

Common Name	Scientific Name	Plant Cover (%)[a, b]	Federal Status	State Status
Munro’s globemallow	*Sphaeralcea munroana*			
needle-and-thread grass	*Stipa comata*			
oat	*Avena sativa*			
pink microsteris	*Microsteris gracilis*			
prickly lettuce	*Lactuca serriola*			
purple mat	*Nama densum*			R1
Russian thistle	*Salsola kali*	10		
sagebrush mariposa lily	*Calochortus macrocarpus*			
sand beardtongue	*Penstemon acuminatus*			
sand dropseed	*Sporobolus cryptandrus*			
Sandberg’s bluegrass	*Poa sandbergii*	20		
shy gilia	*Gilia sinuata*			
slender hawksbeard	*Crepis atrabarba*			
slender sixweeks	*Festuca octoflora*			
slimleaf goosefoot	*Chenopodium leptophyll*			
squirreltail barley	*Hordeum jubatum*			
stalked-pod milkvetch	*Astragalus sclerocarpus*			W
sticky scorpionweed	*Phacelia glandulifera*			
stiff wirelettuce	*Stephanomeria paniculata*	+		
tall willowherb	*Epilobium paniculatum*			
thickspike wheatgrass	*Agropyron dasytachyum*			
threadleaf fleabane	*Erigeron filifolius*			
turpentine springparsley	*Cymopteris terebithinus*	5		
Western tansymustard	*Descurainia pinnata*			
whitestem stickleaf	*Mentzelia albicaulis*			
yarrow	*Achillea millefolium*			
yellow bell	*Fritillaria pudica*			
yellow salsify	*Tragopogon dubius*			

Table IA.12. CWC Expansion Area—Russian Thistle

Common Name	Scientific Name	Plant Cover (%)[a, b]	Federal Status	State Status
Animals				
coyote	*Canis latrans*			
Western meadowlark	*Sturnella neglecta*			
Plants				
bastard toadflax	*Comandra umbellata*			
big sagebrush	*Artemisia tridentata*			
bottlebrush grass	*Sitanion hystrix*			
bur ragweed	*Ambrosia acanthicarpa*			
Carey's balsamroot	*Balsamorhiza careyana*			
cheatgrass	*Bromus tectorum*	5		
common groundsel	*Senecio vulgaris*			
crested wheatgrass	*Agropyron cristatum*	1		
fiddleneck	*Amsinckia lycopsoides*			
flixweed	*Descurainia sophia*			
fourwing saltbush	*Atriplex canescens*			
hoary aster	*Machaeranthera canescens*			
Indian ricegrass	*Oryzopsis hymenoides*			
Jim Hill's tumblemustard	*Sisymbrium altissimum*			
longleaf phlox	*Phlox longifolia*			
needle-and-thread grass	*Stipa comata*			
prickly lettuce	*Lactuca serriola*			
purple mat	*Nama densum*			R1
Russian thistle	*Salsola kali*	20		
rye	*Secale cereale*			
sagebrush mariposa lily	*Calochortus macrocarpus*			
shy gilia	*Gilia sinuata*			
slender hawksbeard	*Crepis atrabarba*			
slender sixweeks	*Festuca octoflora*			
squirreltail barley	*Hordeum jubatum*			
stalked-pod milkvetch	*Astragalus sclerocarpus*			W
tall willowherb	*Epilobium paniculatum*			
thickspike wheatgrass	*Agropyron dasytachyum*			
threadleaf scorpionweed	*Phacelia linearis*			
turpentine springparsley	*Cymopteris terebithinus*			
Western tansymustard	*Descurainia pinnata*			
wheat	*Triticum aestivum*			
whitestem stickleaf	*Mentzelia albicaulis*			
yarrow	*Achillea millefolium*			
yellow bell	*Fritillaria pudica*			
yellow salsify	*Tragopogon dubius*			

Table IA.13. At the ERDF Site (within 1 km of ERDF)—Cheatgrass

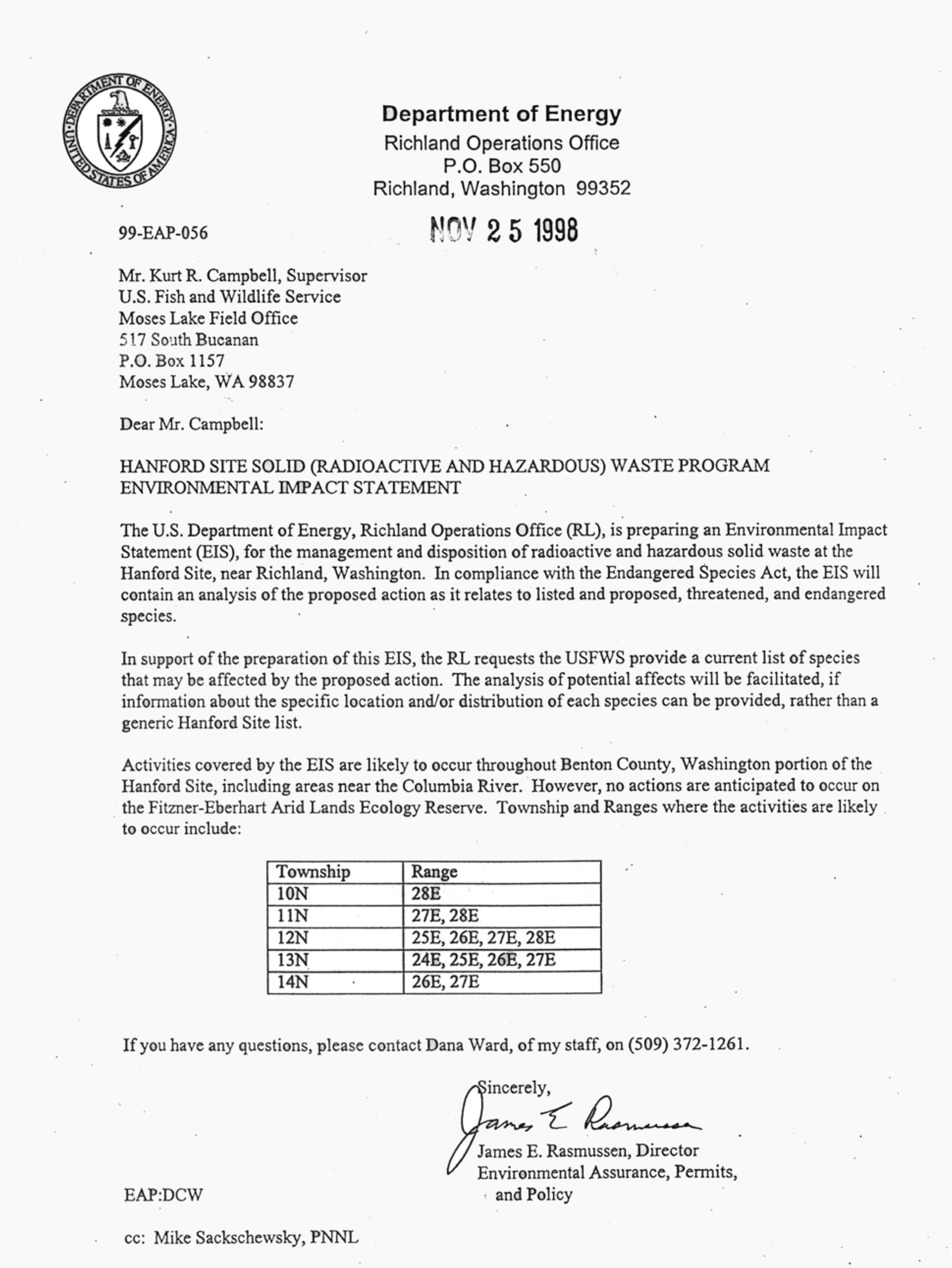
Common Name	**Scientific Name**	**Plant Cover (%)**[a, b]	**Federal Status**	**State Status**
Animals				
coyote	*Canis latrans*			
horned lark	*Eremophila alpestris*			
loggerhead shrike	*Lanius ludovicianus*		SC[g]	C
Northern pocket gopher	*Thomomys talpoides*			
side-blotched lizard	*Uta stansburiana*			
Western meadowlark	*Sturnella neglecta*			
Plants				
annual mountain dandelion	*Agoseris heterophylla*			
asparagus	*Asparagus officinalis*			
bastard toadflax	*Comandra umbellata*			
big sagebrush	*Artemisia tridentata*			
bottlebrush grass	*Sitanion hystrix*			
broom buckwheat	*Eriogonum vimineum*			
buckwheat milkvetch	*Astragalus caricinus*			
bulbous bluegrass	*Poa bulbosa*			
bur ragweed	*Ambrosia acanthicarpa*			
carey's balsamroot	*Balsamorhiza careyana*			
cheatgrass	*Bromus tectorum*	40		
devil's lettuce	*Amsinckia tessellata*			
fiddleneck	*Amsinckia lycopsoides*			
flixweed	*Descurainia sophia*			
gray rabbitbrush	*Chrysothamnus nauseosus*			
green rabbitbrush	*Chrysothamnus viscidiflorus*			
hoary aster	*Machaeranthera canescens*	1		
hoary falseyarrow	*Chaenactis douglasii*			
Indian ricegrass	*Oryzopsis hymenoides*			
jagged chickweed	*Holosteum umbellatum*			
Jim Hill's tumblemustard	*Sisymbrium altissimum*	1		
longleaf phlox	*Phlox longifolia*			
matted cryptantha	*Cryptantha circumscissa*	+		
Munro's globemallow	*Sphaeralcea munroana*			
needle-and-thread grass	*Stipa comata*			
pale evening primrose	*Oenothera pallida*			
pine bluegrass	*Poa scabrella*			
pink microsteris	*Microsteris gracilis*			
prickly lettuce	*Lactuca serriola*			
Russian thistle	*Salsola kali*	1		
sagebrush mariposa lily	*Calochortus macrocarpus*			
Sandberg's bluegrass	*Poa sandbergii*			
shy gilia	*Gilia sinuata*			

Table IA.13. (contd)

Common Name	Scientific Name	Plant Cover (%)[a, b]	Federal Status	State Status
slender hawksbeard	*Crepis atrabarba*			
slender sixweeks	*Festuca octoflora*			
small sixweeks	*Festuca macrostachys*			
Spring whitlowgrass	*Draba verna*			
stalked-pod milkvetch	*Astragalus sclerocarpus*			W
tall willowherb	*Epilobium paniculatum*			
thickspike wheatgrass	*Agropyron dasytachyum*			
threadleaf scorpionweed	*Phacelia linearis*			
turpentine springparsley	*Cymopteris terebithinus*			
upland larkspur	*Delphinium nuttallianum*			
Western tansymustard	*Descurainia pinnata*			
white-daisy tidytips	*Layia glandulosa*			
whitestem stickleaf	*Mentzelia albicaulis*			
winged cryptantha	*Cryptantha pterocarya*			
yarrow	*Achillea millefolium*			
yellow bell	*Fritillaria pudica*			

Attachment B

Letters from Consulting Agencies



Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

99-EAP-056

NOV 25 1998

Mr. Kurt R. Campbell, Supervisor
U.S. Fish and Wildlife Service
Moses Lake Field Office
517 South Bucanan
P.O. Box 1157
Moses Lake, WA 98837

Dear Mr. Campbell:

HANFORD SITE SOLID (RADIOACTIVE AND HAZARDOUS) WASTE PROGRAM ENVIRONMENTAL IMPACT STATEMENT

The U.S. Department of Energy, Richland Operations Office (RL), is preparing an Environmental Impact Statement (EIS), for the management and disposition of radioactive and hazardous solid waste at the Hanford Site, near Richland, Washington. In compliance with the Endangered Species Act, the EIS will contain an analysis of the proposed action as it relates to listed and proposed, threatened, and endangered species.

In support of the preparation of this EIS, the RL requests the USFWS provide a current list of species that may be affected by the proposed action. The analysis of potential affects will be facilitated, if information about the specific location and/or distribution of each species can be provided, rather than a generic Hanford Site list.

Activities covered by the EIS are likely to occur throughout Benton County, Washington portion of the Hanford Site, including areas near the Columbia River. However, no actions are anticipated to occur on the Fitzner-Eberhart Arid Lands Ecology Reserve. Township and Ranges where the activities are likely to occur include:

Township	Range
10N	28E
11N	27E, 28E
12N	25E, 26E, 27E, 28E
13N	24E, 25E, 26E, 27E
14N	26E, 27E

If you have any questions, please contact Dana Ward, of my staff, on (509) 372-1261.

Sincerely,

James E Rasmussen

James E. Rasmussen, Director
Environmental Assurance, Permits,
and Policy

EAP:DCW

cc: Mike Sackschewsky, PNNL

Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

02-OSS-0126

MAR 25 2002

Mr. Dennis Carlson
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
510 Desmond Dr. SE, Suite 103
Lacey, Washington 98503

Dear Mr. Carlson:

HANFORD SITE SOLID (RADIOACTIVE AND HAZARDOUS) WASTE PROGRAM ENVIRONMENTAL IMPACT STATEMENT (EIS)

The U.S. Department of Energy (DOE) is preparing an EIS for the management and disposition of radioactive and hazardous solid waste at the Hanford Site near Richland, Washington. In compliance with the Endangered Species Act, the EIS will contain an analysis of the proposed action as it relates to listed and proposed, threatened, and endangered species.

In support of the preparation of this EIS, DOE requests the National Marine Fisheries Service provide a current list of species that may be affected by the proposed action. Activities covered by the EIS may impact areas near the Columbia River between River Mile 342 and River Mile 392.

If you have any questions regarding this request please contact Dana Ward, of my staff, on (509) 372-1261.

Sincerely,

Steven H. Wisness, Director
Office of Site Services

OSS:DCW

M0212-0286.200I
HSW EIS 01-28-03

Response to DOE consultation letter to the National Marine Fisheries Service was received via telephone on Friday, April 26, 2002. Dennis Carlson of that agency indicated the currently listed species could be obtained from

http://www.nwr.noaa.gov/1habcon/habweb/ listnwr.htm.

The following list was reproduced from this Web site on April 29, 2002. The same Web site was visited again on March 20, 2003. There were no changes (additions or deletions) in the species, nor were there any changes in the associated run, evolutionary significant unit (ESU), or status as listed below.

Endangered, Threatened, Proposed, and Candidate Species under National Marine Fisheries Service Jurisdiction that Occur in Oregon, Washington, and Idaho

Listed Species

Coho Salmon (*Oncorhynchus kisutch*)

- Southern Oregon/Northern California Coasts ESU (Threatened)
- Oregon Coast ESU (Threatened)

Chinook Salmon (*O. tshawytscha*)

- Snake River Fall-Run ESU (Threatened)
- Snake River Spring/Summer-Run ESU (Threatened)
- Puget Sound ESU (Threatened)
- Lower Columbia River ESU (Threatened)
- Upper Willamette River ESU (Threatened)
- Upper Columbia River Spring-Run ESU (Endangered)

Chum Salmon (*O. keta*)

- Hood Canal Summer-Run ESU (Threatened)
- Columbia River ESU (Threatened)

Sockeye Salmon (*O. nerka*)

- Snake River ESU (Endangered)
- Ozette Lake ESU (Threatened)

Steelhead (*O. mykiss*)

- Upper Columbia River ESU (Endangered)
- Snake River Basin ESU (Threatened)
- Lower Columbia River ESU (Threatened)
- Upper Willamette River ESU (Threatened)
- Middle Columbia River ESU (Threatened)

Sea-run Cutthroat Trout (*O. clarki clarki*)

- Umpqua River ESU (Endangered)

Proposed for Listing

Chinook Salmon

- Southern Oregon/Northern California Coastal ESU (Proposed Threatened)

Sea-run Cutthroat Trout

- Southwestern Washington/Columbia River ESU (Proposed Threatened)

Candidates for Listing

Coho Salmon

- Puget Sound/Straight of Georgia ESU
- Lower Columbia River/Southwest Washington ESU

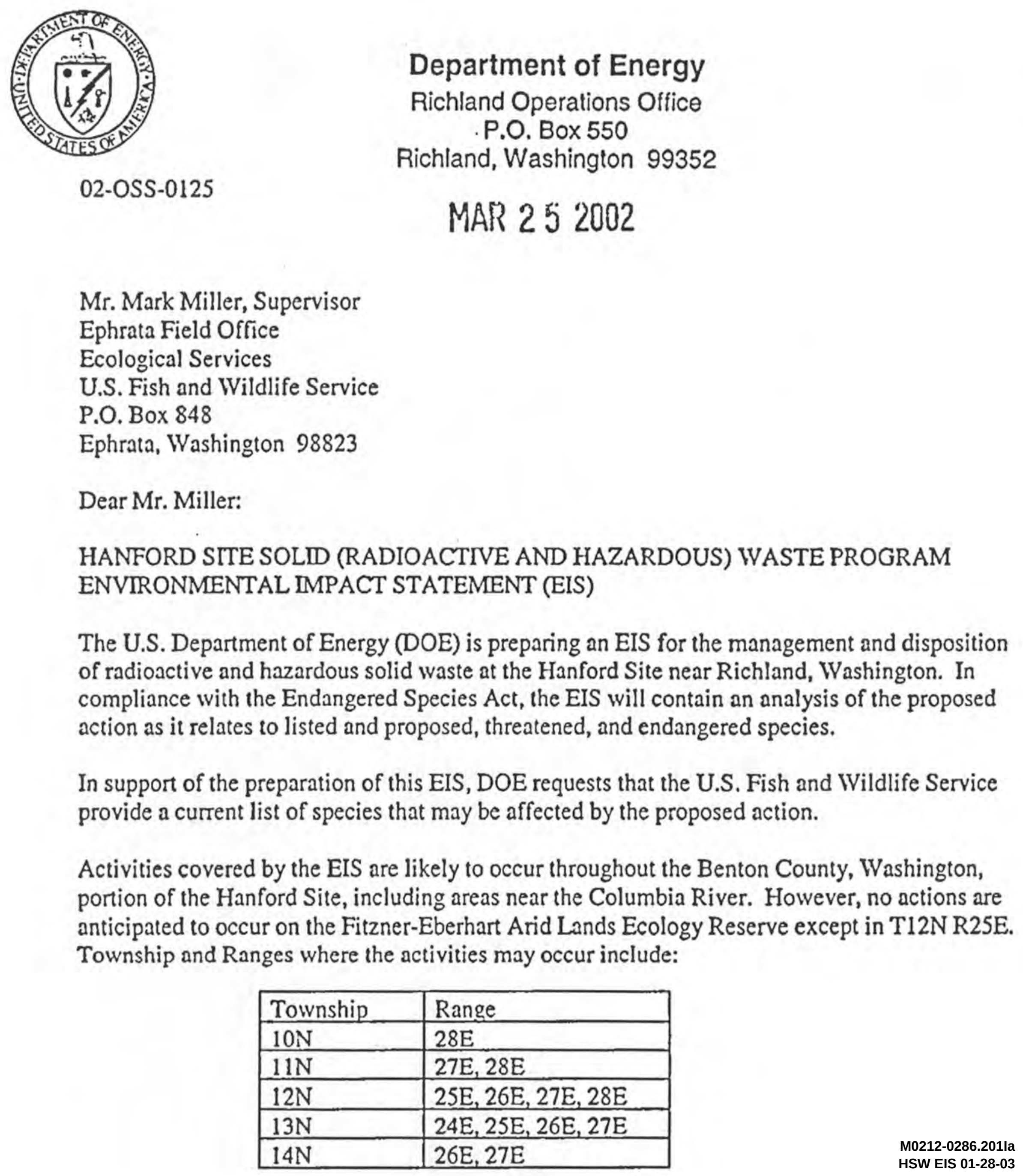
Steelhead

- Klamath Mountains Province ESU
- Oregon Coast ESU

Sea-Run Cutthroat Trout

- Oregon Coast ESU

Office of Habitat Conservation, HQ | NMFS Northwest Region | NMFS | NOAA | DOC
Updated February 2, 2000
Species List Updated April 1999



Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

02-OSS-0125

MAR 25 2002

Mr. Mark Miller, Supervisor
Ephrata Field Office
Ecological Services
U.S. Fish and Wildlife Service
P.O. Box 848
Ephrata, Washington 98823

Dear Mr. Miller:

HANFORD SITE SOLID (RADIOACTIVE AND HAZARDOUS) WASTE PROGRAM ENVIRONMENTAL IMPACT STATEMENT (EIS)

The U.S. Department of Energy (DOE) is preparing an EIS for the management and disposition of radioactive and hazardous solid waste at the Hanford Site near Richland, Washington. In compliance with the Endangered Species Act, the EIS will contain an analysis of the proposed action as it relates to listed and proposed, threatened, and endangered species.

In support of the preparation of this EIS, DOE requests that the U.S. Fish and Wildlife Service provide a current list of species that may be affected by the proposed action.

Activities covered by the EIS are likely to occur throughout the Benton County, Washington, portion of the Hanford Site, including areas near the Columbia River. However, no actions are anticipated to occur on the Fitzner-Eberhart Arid Lands Ecology Reserve except in T12N R25E. Township and Ranges where the activities may occur include:

Township	Range
10N	28E
11N	27E, 28E
12N	25E, 26E, 27E, 28E
13N	24E, 25E, 26E, 27E
14N	26E, 27E

M0212-0286.201Ia
HSW EIS 01-28-03

If you have any questions regarding this request, please contact Dana Ward, of my staff, on (509) 372-1261.

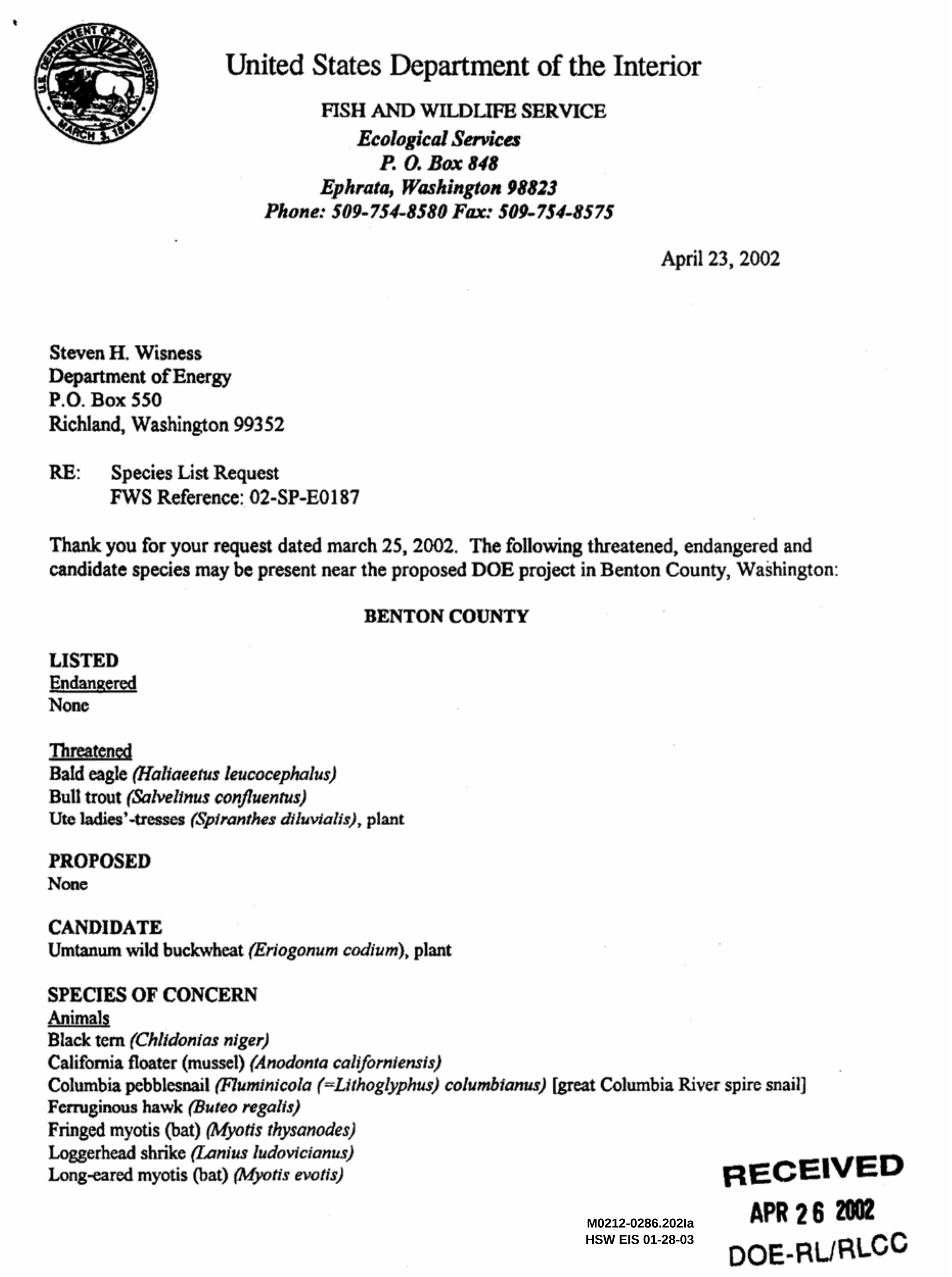
Sincerely,

Steven H. Wisness, Director
Office of Site Services

OSS:DCW

cc: G. Hughes, USFWS

M0212-0286.201Ib
HSW EIS 01-28-03



United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
P. O. Box 848
Ephrata, Washington 98823
Phone: 509-754-8580 Fax: 509-754-8575

April 23, 2002

Steven H. Wisness
Department of Energy
P.O. Box 550
Richland, Washington 99352

RE: Species List Request
FWS Reference: 02-SP-E0187

Thank you for your request dated march 25, 2002. The following threatened, endangered and candidate species may be present near the proposed DOE project in Benton County, Washington:

BENTON COUNTY

LISTED
Endangered
None

Threatened
Bald eagle *(Haliaeetus leucocephalus)*
Bull trout *(Salvelinus confluentus)*
Ute ladies'-tresses *(Spiranthes diluvialis)*, plant

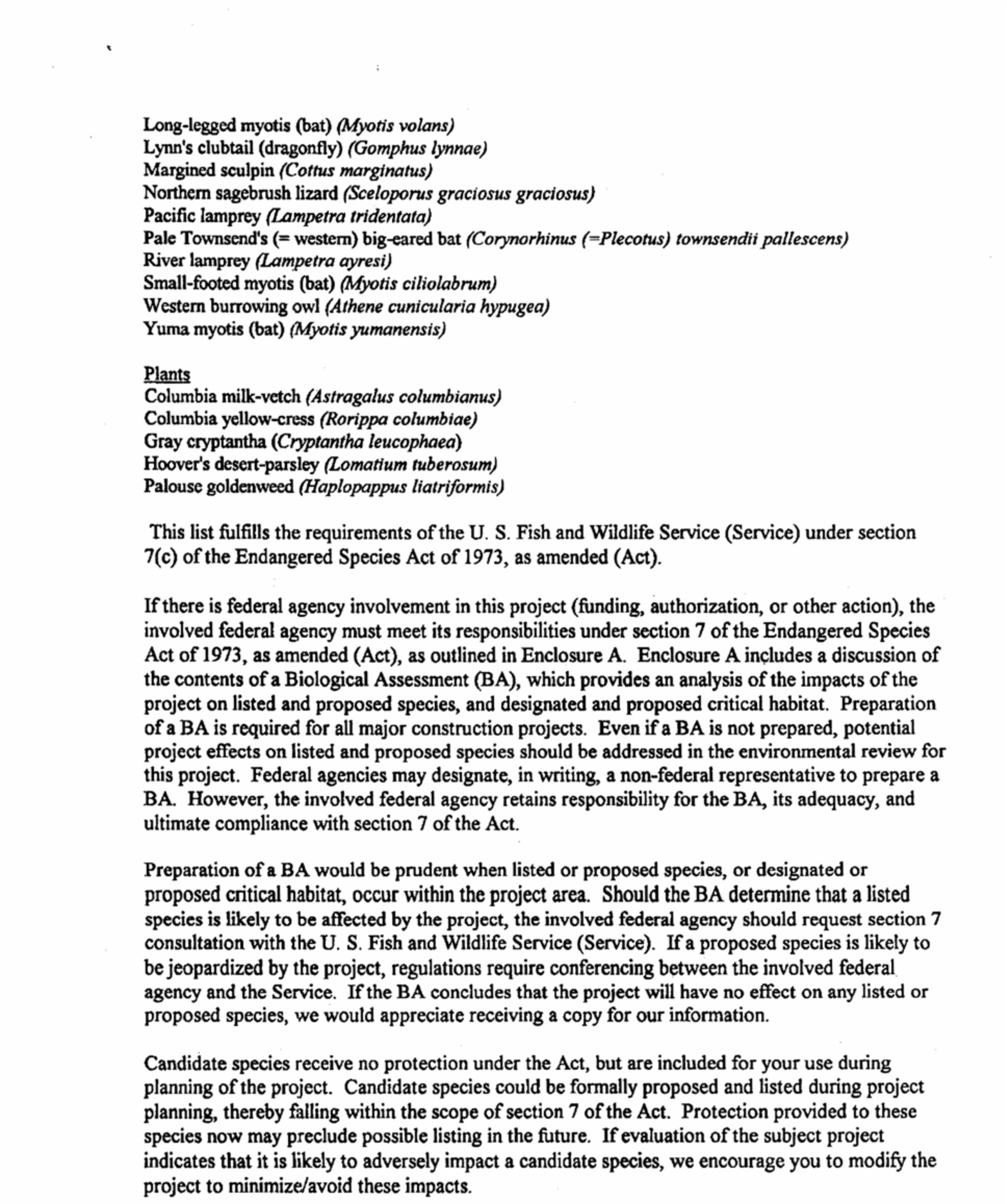
PROPOSED
None

CANDIDATE
Umtanum wild buckwheat *(Eriogonum codium)*, plant

SPECIES OF CONCERN
Animals
Black tern *(Chlidonias niger)*
California floater (mussel) *(Anodonta californiensis)*
Columbia pebblesnail *(Fluminicola (=Lithoglyphus) columbianus)* [great Columbia River spire snail]
Ferruginous hawk *(Buteo regalis)*
Fringed myotis (bat) *(Myotis thysanodes)*
Loggerhead shrike *(Lanius ludovicianus)*
Long-eared myotis (bat) *(Myotis evotis)*

RECEIVED
APR 26 2002
DOE-RL/RLCC

M0212-0286.202Ia
HSW EIS 01-28-03



Long-legged myotis (bat) *(Myotis volans)*
Lynn's clubtail (dragonfly) *(Gomphus lynnae)*
Margined sculpin *(Cottus marginatus)*
Northern sagebrush lizard *(Sceloporus graciosus graciosus)*
Pacific lamprey *(Lampetra tridentata)*
Pale Townsend's (= western) big-eared bat *(Corynorhinus (=Plecotus) townsendii pallescens)*
River lamprey *(Lampetra ayresi)*
Small-footed myotis (bat) *(Myotis ciliolabrum)*
Western burrowing owl *(Athene cunicularia hypugea)*
Yuma myotis (bat) *(Myotis yumanensis)*

Plants
Columbia milk-vetch *(Astragalus columbianus)*
Columbia yellow-cress *(Rorippa columbiae)*
Gray cryptantha (*Cryptantha leucophaea*)
Hoover's desert-parsley *(Lomatium tuberosum)*
Palouse goldenweed *(Haplopappus liatriformis)*

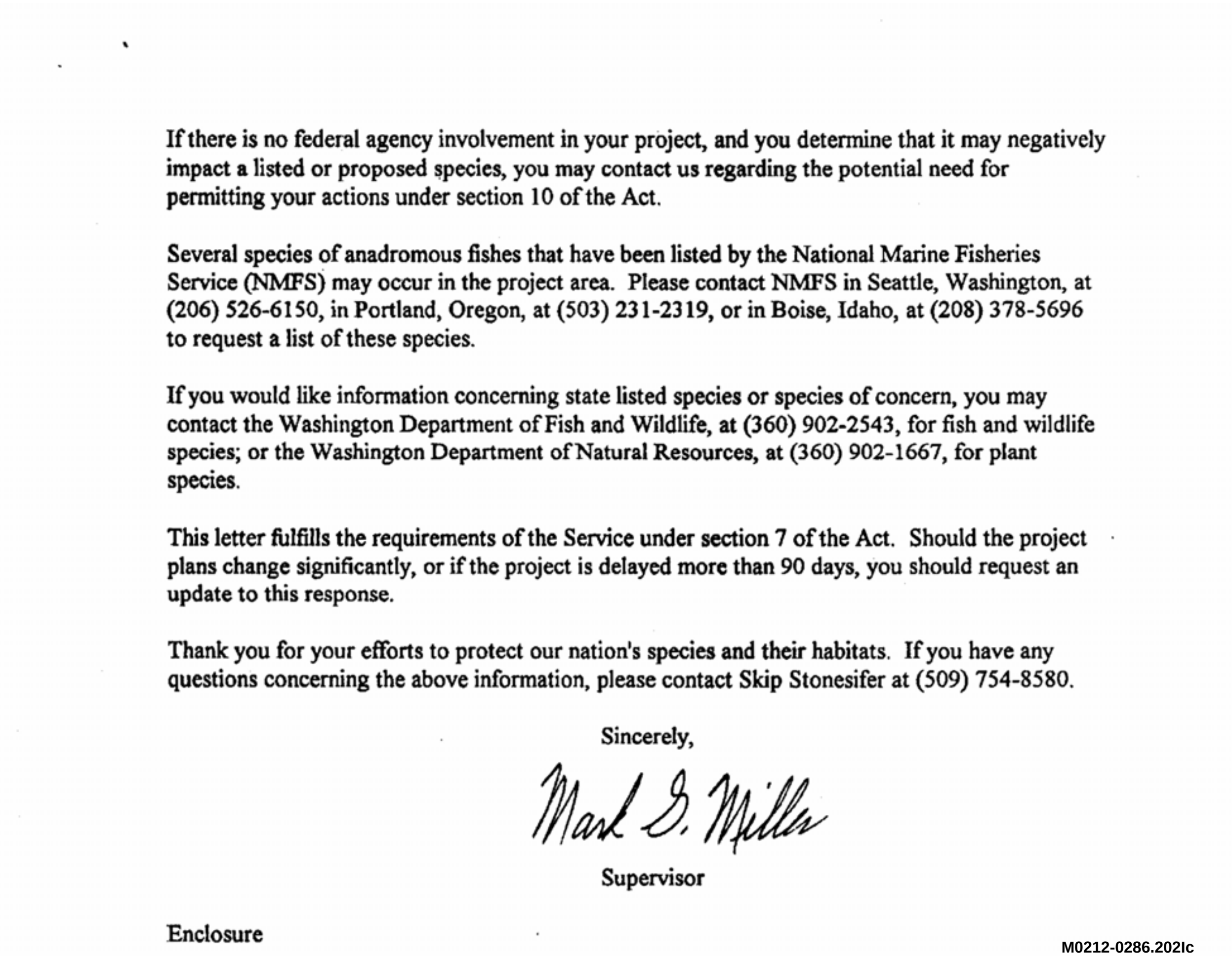
This list fulfills the requirements of the U. S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act of 1973, as amended (Act).

If there is federal agency involvement in this project (funding, authorization, or other action), the involved federal agency must meet its responsibilities under section 7 of the Endangered Species Act of 1973, as amended (Act), as outlined in Enclosure A. Enclosure A includes a discussion of the contents of a Biological Assessment (BA), which provides an analysis of the impacts of the project on listed and proposed species, and designated and proposed critical habitat. Preparation of a BA is required for all major construction projects. Even if a BA is not prepared, potential project effects on listed and proposed species should be addressed in the environmental review for this project. Federal agencies may designate, in writing, a non-federal representative to prepare a BA. However, the involved federal agency retains responsibility for the BA, its adequacy, and ultimate compliance with section 7 of the Act.

Preparation of a BA would be prudent when listed or proposed species, or designated or proposed critical habitat, occur within the project area. Should the BA determine that a listed species is likely to be affected by the project, the involved federal agency should request section 7 consultation with the U. S. Fish and Wildlife Service (Service). If a proposed species is likely to be jeopardized by the project, regulations require conferencing between the involved federal agency and the Service. If the BA concludes that the project will have no effect on any listed or proposed species, we would appreciate receiving a copy for our information.

Candidate species receive no protection under the Act, but are included for your use during planning of the project. Candidate species could be formally proposed and listed during project planning, thereby falling within the scope of section 7 of the Act. Protection provided to these species now may preclude possible listing in the future. If evaluation of the subject project indicates that it is likely to adversely impact a candidate species, we encourage you to modify the project to minimize/avoid these impacts.

M0212-0286.202Ib
HSW EIS 01-28-03



If there is no federal agency involvement in your project, and you determine that it may negatively impact a listed or proposed species, you may contact us regarding the potential need for permitting your actions under section 10 of the Act.

Several species of anadromous fishes that have been listed by the National Marine Fisheries Service (NMFS) may occur in the project area. Please contact NMFS in Seattle, Washington, at (206) 526-6150, in Portland, Oregon, at (503) 231-2319, or in Boise, Idaho, at (208) 378-5696 to request a list of these species.

If you would like information concerning state listed species or species of concern, you may contact the Washington Department of Fish and Wildlife, at (360) 902-2543, for fish and wildlife species; or the Washington Department of Natural Resources, at (360) 902-1667, for plant species.

This letter fulfills the requirements of the Service under section 7 of the Act. Should the project plans change significantly, or if the project is delayed more than 90 days, you should request an update to this response.

Thank you for your efforts to protect our nation's species and their habitats. If you have any questions concerning the above information, please contact Skip Stonesifer at (509) 754-8580.

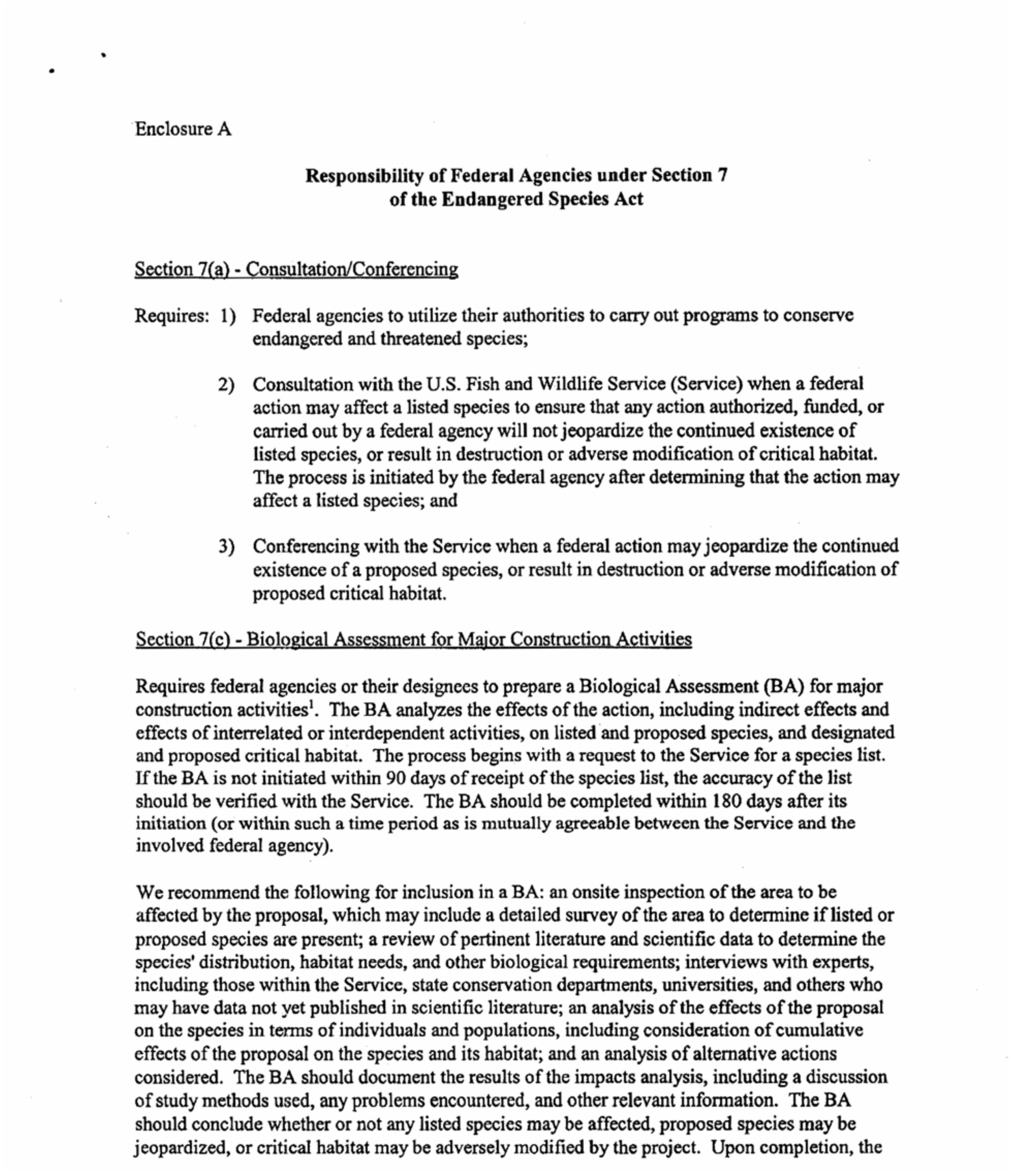
Sincerely,

Mark G. Miller

Supervisor

Enclosure

M0212-0286.202Ic
HSW EIS 01-28-03



Enclosure A

Responsibility of Federal Agencies under Section 7 of the Endangered Species Act

Section 7(a) - Consultation/Conferencing

Requires:
1) Federal agencies to utilize their authorities to carry out programs to conserve endangered and threatened species;
2) Consultation with the U.S. Fish and Wildlife Service (Service) when a federal action may affect a listed species to ensure that any action authorized, funded, or carried out by a federal agency will not jeopardize the continued existence of listed species, or result in destruction or adverse modification of critical habitat. The process is initiated by the federal agency after determining that the action may affect a listed species; and
3) Conferencing with the Service when a federal action may jeopardize the continued existence of a proposed species, or result in destruction or adverse modification of proposed critical habitat.

Section 7(c) - Biological Assessment for Major Construction Activities

Requires federal agencies or their designees to prepare a Biological Assessment (BA) for major construction activities[1]. The BA analyzes the effects of the action, including indirect effects and effects of interrelated or interdependent activities, on listed and proposed species, and designated and proposed critical habitat. The process begins with a request to the Service for a species list. If the BA is not initiated within 90 days of receipt of the species list, the accuracy of the list should be verified with the Service. The BA should be completed within 180 days after its initiation (or within such a time period as is mutually agreeable between the Service and the involved federal agency).

We recommend the following for inclusion in a BA: an onsite inspection of the area to be affected by the proposal, which may include a detailed survey of the area to determine if listed or proposed species are present; a review of pertinent literature and scientific data to determine the species' distribution, habitat needs, and other biological requirements; interviews with experts, including those within the Service, state conservation departments, universities, and others who may have data not yet published in scientific literature; an analysis of the effects of the proposal on the species in terms of individuals and populations, including consideration of cumulative effects of the proposal on the species and its habitat; and an analysis of alternative actions considered. The BA should document the results of the impacts analysis, including a discussion of study methods used, any problems encountered, and other relevant information. The BA should conclude whether or not any listed species may be affected, proposed species may be jeopardized, or critical habitat may be adversely modified by the project. Upon completion, the

BA should be forwarded to the Service.

Major concerns that should be addressed in a BA for listed and proposed animal species include:

1. Level of use of the project area by the species, and amount or location of critical habitat;
2. Effect(s) of the project on the species' primary feeding, breeding, and sheltering areas;
3. Impacts from project construction and implementation (*e.g.*, increased noise levels, increased human activity and/or access, loss or degradation of habitat) that may result in disturbance to the species and/or their avoidance of the project area or critical habitat.

Major concerns that should be addressed in a BA for listed or proposed plant species include:

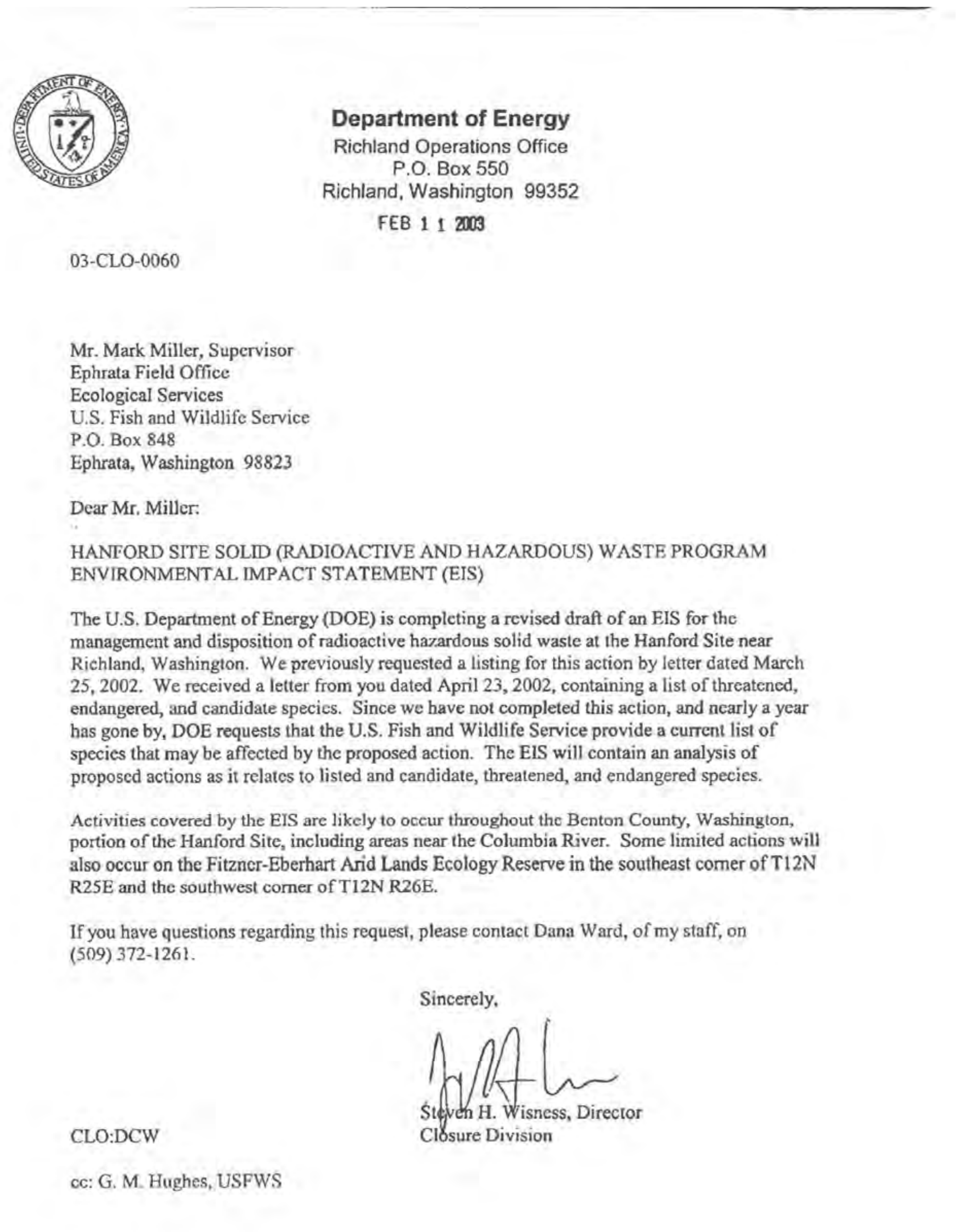
1. Distribution of the taxon in the project area;
2. Disturbance (*e.g.*, trampling, collecting) of individual plants or loss of habitat; and
3. Changes in hydrology where the taxon is found.

Section 7(d) - Irreversible or Irretrievable Commitment of Resources

Requires that, after initiation or reinitiation of consultation required under section 7(a)(2), the Federal agency and any applicant shall make no irreversible or irretrievable commitment of resources with respect to the action which has the effect of foreclosing the formulation or implementation of any reasonable and prudent alternatives which would avoid violating section 7(a)(2). This prohibition is in force during the consultation process and continues until the requirements of section 7(a)(2) are satisfied.

---

[1] A major construction activity is a construction project, or other undertaking having similar physical impacts, which is a major action significantly affecting the quality of the human environment as referred to in the National Environmental Policy Act [42 U.S.C. 4332 (2)(c)].



Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

FEB 1 1 2003

03-CLO-0060

Mr. Mark Miller, Supervisor
Ephrata Field Office
Ecological Services
U.S. Fish and Wildlife Service
P.O. Box 848
Ephrata, Washington 98823

Dear Mr. Miller:

HANFORD SITE SOLID (RADIOACTIVE AND HAZARDOUS) WASTE PROGRAM ENVIRONMENTAL IMPACT STATEMENT (EIS)

The U.S. Department of Energy (DOE) is completing a revised draft of an EIS for the management and disposition of radioactive hazardous solid waste at the Hanford Site near Richland, Washington. We previously requested a listing for this action by letter dated March 25, 2002. We received a letter from you dated April 23, 2002, containing a list of threatened, endangered, and candidate species. Since we have not completed this action, and nearly a year has gone by, DOE requests that the U.S. Fish and Wildlife Service provide a current list of species that may be affected by the proposed action. The EIS will contain an analysis of proposed actions as it relates to listed and candidate, threatened, and endangered species.

Activities covered by the EIS are likely to occur throughout the Benton County, Washington, portion of the Hanford Site, including areas near the Columbia River. Some limited actions will also occur on the Fitzner-Eberhart Arid Lands Ecology Reserve in the southeast corner of T12N R25E and the southwest corner of T12N R26E.

If you have questions regarding this request, please contact Dana Ward, of my staff, on (509) 372-1261.

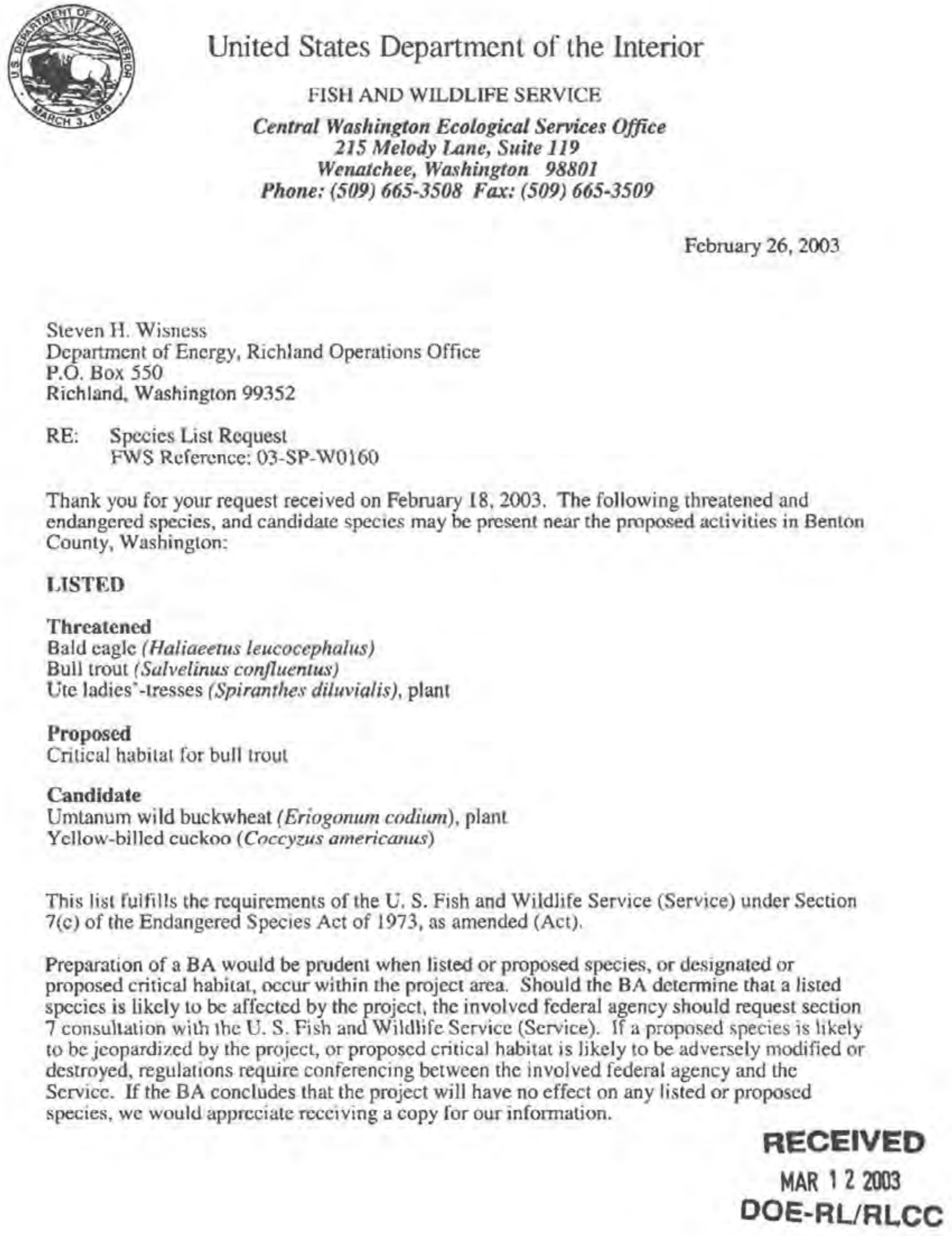
Sincerely,

Steven H. Wisness, Director
Closure Division

CLO:DCW

cc: G. M. Hughes, USFWS

M0212-0286.870
HSW EIS 03-26-03



United States Department of the Interior

FISH AND WILDLIFE SERVICE

Central Washington Ecological Services Office
215 Melody Lane, Suite 119
Wenatchee, Washington 98801
Phone: (509) 665-3508 Fax: (509) 665-3509

February 26, 2003

Steven H. Wisness
Department of Energy, Richland Operations Office
P.O. Box 550
Richland, Washington 99352

RE: Species List Request
FWS Reference: 03-SP-W0160

Thank you for your request received on February 18, 2003. The following threatened and endangered species, and candidate species may be present near the proposed activities in Benton County, Washington:

LISTED

Threatened
Bald eagle *(Haliaeetus leucocephalus)*
Bull trout *(Salvelinus confluentus)*
Ute ladies'-tresses *(Spiranthes diluvialis)*, plant

Proposed
Critical habitat for bull trout

Candidate
Umtanum wild buckwheat *(Eriogonum codium)*, plant
Yellow-billed cuckoo (*Coccyzus americanus*)

This list fulfills the requirements of the U. S. Fish and Wildlife Service (Service) under Section 7(c) of the Endangered Species Act of 1973, as amended (Act).

Preparation of a BA would be prudent when listed or proposed species, or designated or proposed critical habitat, occur within the project area. Should the BA determine that a listed species is likely to be affected by the project, the involved federal agency should request section 7 consultation with the U. S. Fish and Wildlife Service (Service). If a proposed species is likely to be jeopardized by the project, or proposed critical habitat is likely to be adversely modified or destroyed, regulations require conferencing between the involved federal agency and the Service. If the BA concludes that the project will have no effect on any listed or proposed species, we would appreciate receiving a copy for our information.

RECEIVED
MAR 12 2003
DOE-RL/RLCC

M0212-0286.871a
HSW EIS 03-26-03

Candidate species receive no protection under the Act, but are included for your use during planning of the project. Candidate species could be formally proposed and listed during project planning, thereby falling within the scope of section 7 of the Act. Protection provided to these species now may preclude possible listing in the future. If evaluation of the subject project indicates that it is likely to adversely impact a candidate species, we encourage you to modify the project to minimize/avoid these impacts.

Several species of anadromous fishes that have been listed by NOAA Fisheries (NOAA) may occur in the project area. Please contact NOAA in Ellensburg, Washington, at (509) 5962-8911 to request a list of these species.

If you would like information concerning state listed species or species of concern, you may contact the Washington Department of Fish and Wildlife, at (360) 902-2543, for fish and wildlife species; or the Washington Department of Natural Resources, at (360) 902-1667, for plant species.

This letter fulfills the requirements of the Service under section 7 of the Act. Should the project plans change significantly, or if the project is delayed more than 90 days, you should request an update to this response.

Thank you for your efforts to protect our nation's species and their habitats. If you have any questions concerning the above information, please contact Gregg Kurz at (509) 665-3508 extension 22.

Sincerely,

Mark G. Miller

Supervisor

Appendix J

Construction Noise – Method of Assessment

Appendix J

Construction Noise – Method of Assessment

Heavy equipment such as earthmovers and graders may generate higher levels of noise than operational equipment such as exhaust fans or generators. For example, pulse driers produce a noise level of 70 decibels (dB). Diesel-powered earthmoving equipment is inherently noisy and would be used in the construction of trenches and obtaining fill material from the borrow pits in Area C south of State Route 240.

The Washington State Department of Ecology (Ecology) implements rules consistent with federal noise control legislation through Washington Administrative Code (WAC) 173-60. Maximum noise levels are defined for the zoning of the area in accordance with the environmental designation for noise abatement (EDNA). The Hanford Site is classified as a Class C EDNA on the basis of industrial activities. Unoccupied areas also are classified as Class C areas by default because they are neither Class A (residential) nor Class B (commercial). Maximum noise levels are established based on the EDNA classification of the receiving area and the source area (see Table J.1). The benchmark for industrial noise levels in the state of Washington is 70 A-weighted decibels (dBA).

Table J.1. Applicable State Noise Limitations Based on Source and Receptor EDNA Designation

Source - Hanford Site	**Receptor**		
	Class A Residential (dBA)	**Class B Commercial (dBA)**	**Class C Industrial (dBA)**
Class C - Day	60	65	70
Night	50	NA	NA
NA = not applicable.			

J.1 Assessment of Noise Impacts

The assessment of noise impacts relies on evaluating critical distances between sources of noise and receptors and a conservative source term that is likely to overestimate impacts.

J.1.1 Critical Distances

Because the 200 Area is isolated, no human residences are likely to be impacted due to the great distances from source to receptor. The nearest residences are farmhouses along Highway 24 on the western perimeter of the Hanford Site (10 km [6.2 mi] from the western border of the 200 West Area).

Distances exceed 10 km (6.2 mi) from Area C to these residences. The shortest distance between the western perimeter of the 200 Areas and State Route 240 is about 2 km (1.25 mi).

J.1.2 Source Term

To ensure that noise levels were not underestimated, the noise generated by a diesel locomotive engine was used as a conservative source term for heavy construction equipment. Screening estimates were based on non-A-weighted (pure total sound) adjustments and A-weighted adjustments. For this analysis, each octave band frequency from 63 to 8000 hertz (Hz) was modeled from the 132-dBA locomotive engine source term (Hanson et al. 1991). Noise propagation and attenuation were based on hemispherical spreading, molecular absorption, and anomalous excess attenuation under standard day conditions (EEI 1984). For a 132-dBA source to attenuate to 70 dB, about 43 to 70 dB must be attenuated (adsorbed or dispersed) based on frequency (see Table J.2). The distance of attenuation for this source (63 Hz and 8000 Hz), based on reduction to a 70-dBA level, ranged from 40 m to 250 m (130 ft to 820 ft).

The distance of attenuation required for achieving a reduction to 70 dB was taken from tables in EEI (1984). The maximum distance of attenuation to 70 dB was 250 m (820 ft) at 500 and 1000 Hz. Effectively, no frequency would attain a sound-pressure level greater than 70 dBA at 250 m (820 ft). The overall noise level at this distance would be dominated by these frequencies. Based on decibel addition, the A-weighted decibel level would approach 75 dB for all octave bands at 250 m (820 ft). The A-weighted decibel level would decrease to 70 dBA at 400 m (1312 ft) and to 67 dBA at 500 m (1640 ft).

Table J.2. Estimated Distances of Attenuation by Octave Band (Hertz) for a 132-dBA Diesel Locomotive (conservative surrogate for heavy construction equipment)

Hertz	**Correction by frequency (dB @ 30 m)**	**Corrected Source Term (dB @ 30 m)**	**Estimated Source Term (dB)**	**Distance of Attenuation 45 dBA(a)**			**Distance of Attenuation 70 dBA(b)**		
				Attenuated dB	**A wt Corrected**	**Distance (m)**	**Attenuated dB**	**A wt Corrected**	**Distance (m)**
63	2.7	98.7	135.7	90.7	64.7	630	65.7	39.7	40
125	5.3	101.3	138.3	93.3	77.3	1700	68.3	52.3	160
250	-6	90	127	82	73	1200	57	48	100
500	-3.3	92.7	129.7	84.7	81.7	1600	59.7	56.7	250
1000	-4.7	91.3	128.3	83.3	83.3	1300	58.3	58.3	250
2000	-9	87	124	79	80	820	54	55	160
4000	-14	82	119	74	75	410	49	50	90
8000	-22.3	73.7	112.7	67.7	66.7	223	42.7	41.7	40

(a) The value of 45 dBA is routinely associated with quiet residential areas and is 5 dB below the level commonly used for a residential night-time noise standard of 50 dBA. This provides a 5-dBA margin of safety.

(b) The noise standard for industrial zones during daylight hours is 70 dBA (WAC 173-60).

A “region of influence” for heavy equipment would be set at 500 m (1640 ft) for operations in the 200 Areas and at Area C. A 500-m (1640-ft) region of influence would allow for the simultaneous operation of two pieces of heavy equipment such that estimated noise levels would not exceed 70 dBA at 500 m.

J.2 References

EEI. 1984. “Community Noise Criteria.” Chapter 2 in *Electric Power Plant Environmental Noise Guide, Volume 1*. Edison Electric Institute, Washington, D.C.

Hanson, C. E., H. J. Saurenman, and D. A. Towers. 1991. “Rail Transportation Noise and Vibration.” In *Handbook of Acoustical Measurements and Noise Control.* C. M. Harris (ed.), 3rd ed., pp. 46.1–46.24, McGraw-Hill, Inc., New York.

WAC 173-60. “Maximum Environmental Noise Levels.” Washington Administrative Code, Olympia, Washington. Online at:
http://www.leg.wa.gov/wac/index.cfm?fuseaction=chapterdigest&chapter=173-60

Appendix K

Cultural Resources

Appendix K

Cultural Resources

K.1 Introduction

This appendix provides details regarding known and potential cultural resources in areas in which the Hanford Solid Waste (HSW) Program activities, as described in Section 3 of this *Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement* (HSW EIS), may take place. These areas are portions (including Low Level Burial Grounds [LLBGs] and the immobilized low-activity waste [ILAW] disposal area near the PUREX Plant) of the 200 West and 200 East Areas (including the Central Waste Complex [CWC] expansion area), Area C containing borrow pit material, access roads, and a stockpile area north of State Route 240 near the 200 West Area.

Cultural resources reviews, in accordance with the National Historic Preservation Act (16 USC 470), are conducted to ensure that potential impacts to cultural resources and historic properties are considered in advance of federal undertakings. Copies of letters of consultation (for this HSW EIS) with the State of Washington Office of Archaeology and Historic Preservation are attached.

K.1.1 200 East and 200 West Areas

Since 1987, a total of 41 cultural resources reviews have been conducted for various projects associated with the LLBGs, surrounding areas in the 200 West and 200 East Areas, and mineral source locations (see Table K.1). New reviews are completed when any change in project scope or location occurs. Thus cultural resources reviews would be initiated for project activities associated with alternative groups considered in this EIS to determine whether or not the proposed activities associated with waste management operations would have the potential to cause effects on historic properties [36 CFR 800.3(a)(1)].

The only buildings and structures that are eligible for listing in the National Register of Historic Places and have the potential to be affected by projects associated with the Hanford Solid Waste (HSW) Program activities in the 200 West and 200 East Areas include certain facilities within the T Plant Complex. Modifications of these facilities, as proposed for all alternative groups (except Alternative Group B and the No Action Alternative), may require additional cultural resources reviews.

Table K.1. Previously Conducted Cultural Resources Reviews[(a)]

Hanford Cultural Resource Case Number	Title	Activities Reviewed	Cultural Resources
87-200-016	Cultural Resources Survey of the Proposed 200-West 218-W-3A, 218-W-3AE, and 218-W-5 Waste Trenches.	Trench construction in 218 W-5, 218-W-3A, 218-W-3AE.	No archaeological, historic, paleontological, or Native American cultural sites.
87-200-021	Cultural Resources Survey of the Proposed PCB/PU Storage Facility HCRC# 87-200-021 and of the Proposed Hanford Center Waste Complex HCRC# 88-200-005.	200 East and 200 West Areas. Construction of plutonium/ polychlorinated biphenyl storage facility and the steam tie lines and water system upgrade tie lines between areas.	White Bluffs Road.
88-200-005	Cultural Resources Review of the Hanford CWC.	100 ac tract of land bounded on the south by 19th Street, on the east by Dayton Avenue, and on the north by 23rd Street.	White Bluffs Road, 2 isolated finds, and 1 site.
88-600-001	Cultural Resource Review of Barrier Development Program Fine Soil Borrow Pit at McGee Ranch.	McGee Ranch fine soils borrow pit use.	Review not completed numerous archaeological sites.
89-200-005	Cultural Resources Review of the 218-E-12B Special Naval Disposal Trench Expansion.	218-E-12B. Excavation to the west for 80 ft and to a depth of 30 ft below existing ground surface.	No effect on any historic properties.
89-200-006	Cultural Resources Review of the 218-W-2A and 216-T-18 Cleanup.	218-W-2A, 216-T-18, 218 W-3, 218-W-4, borrow area west of 213-W-3.	No known National Register properties.
89-200-008	Cultural Resources Review of the LLBG Permit Application.	218-E-10, 218-12B, 218-W 3A, 218-W-3AE, 218 W-4B, 218-W-4C, 218-W-5, 218-W-6 LLBGs. Maximum depth of excavation: 3 ft.	White Bluffs Road, historic artifacts.
89-200-023	Cultural Resources Review of the Effluent Retention and Treatment Complex (Effluent Retention and Treatment Complex (ERTC).	84.9 ha to develop facilities and a 26 km pipeline corridor to the Columbia River.	White Bluffs Road, 45BN307, HT-89-029, HT-90-002, HT-89-030, HT-89-031, HI-89-016.
91-600-006	Cultural Resources Review of the Privatization Steam Plant.	Gravel Pit 30. 23 acres at northwest corner of the junction between Route 3 and Route 4 South.	HT-99-007 (recorded in 1999).
91-600-012	Cultural Resources Review of the Action Plan for Characterization of McGee Ranch Oil.	McGee Ranch boring and sampling to select and characterize potential borrow locations for fine-textured soils.	Cultural properties present, survey recommended.
93-200-001	Cultural Resources Review of the Environmental Restoration Disposal Facility (ERDF)	A disposal site for waste exhumed during Hanford Site CERCLA and RCRA cleanup actions. Excavations at the site will be extensive and may be up to 12 meters deep.	Four archaeological sites, one paleontologic site, and nine isolated artifacts.

Table K.1. (contd)

Hanford Cultural Resource Case Number	Title	Activities Reviewed	Cultural Resources
93-200-004	Cultural Resources Review of 200-BP-1 Hanford Prototype.	Vernita Basalt Quarry. Total potential volume of McGee Ranch silt - 80,000 yd^3, basalt riprap - 115,000 yd^3, and batch plant - 180,000 yd^3.	No known cultural resources or historic properties in quarry boundary.
93-200-008	Cultural Resources Review of the Transuranic (TRU) Waste Retrieval/Characterization Pilot Program.	LLBG trenches T01, 4C; T04, 4C; T07, 4B; T20, 4C; T24, 4C.	No known cultural resources or historic properties.
93-200-074	Cultural Resources Review of the Solid Waste Retrieval Complex, Phase I (W-113) and Enhanced Radioactive and Mixed waste Storage Facility Project.	200 West Area. Phase I Retrieval complex for retrieving transuranic solid waste including support buildings and facilities. Construction of Phase V Facility for storage of waste containers.	White Bluffs Road, 2 isolated finds, and 1 historic site.
93-200-137	Cultural Resources Review of the W-026, Waste Receiving and Processing 1 Facility (WRAP) Project.	200 West Area. Construction of the WRAP 1 facility in the CWC located southwest of the intersection of 23rd Street and Dayton Avenue.	No known cultural resources or historic properties.
93-200-154	Cultural Resources Review of the CWC and TRU Storage and Assay Facility (TRUSAF) Paving Project.	200 West Area. Paving of 4 gravel and dirt areas.	No known cultural resources or historic properties.
93-600-002	Cultural Resources Review for the Expansion of Gravel Pits 23 and 30 Project.	Gravel Pits 30 and 23 expansion.	No known cultural resources.
94-200-018	Cultural Resources Review of the Geologic Testing of Mixed Waste Trench Project.	218-W-5. Maximum size of excavation: 4 test pits, 17 ft deep.	No known cultural resources or historic properties.
94-200-068	Cultural Resources Review of the 200/Solid Waste/CWC Facility Project.	200 West Area. Service pole holes adjacent to 2403-WB facility. Maximum size of excavation: 2 ft in diameter and 6 ft deep.	No known cultural resources or historic properties.
94-200-077	Cultural Resources Review of the Burial Ground Increase Trench #33 Project.	218-W-4C. Maximum size of excavation: trench enlarged from 6 ft deep to 24 ft deep with base widened to 24 ft.	No known cultural resources or historic properties.
94-200-200	Cultural Resources Review of the Storage of Long Length Radioactive Mixed Waste Project.	200 West Area. 24,000 ft^2 for 2 structures, storage for a crane and rails near the intersection of 19th Street and Dayton Avenue.	No known cultural resources or historic properties.
94-200-097	Cultural Resources Review of the W-236A, Multi-Function Waste Tank Facility, 1994 Project.	Adjacent to Gravel Pit 30. Project modification from previous 93-600-004 cultural review.	HT-99-007 (recorded in 1999).
94-600-001	Cultural Resources Review of the Spent Nuclear Fuel Storage Facility Project.	Survey adjacent to Gravel Pit 30 (northern and eastern boundary).	HI-94-003.

Table K.1. (contd)

Hanford Cultural Resource Case Number	Title	Activities Reviewed	Cultural Resources
94-600-032	Survey Narrative for the Topographic Survey of a portion of the ERDF Project	Topographic survey of project area by 4-wheeled off road vehicles that will drive over the entire area; most of which was previously surveyed for ERDF	No known cultural resources or historic properties.
94-600-034	Cultural Resources Review of the ERDF Project W-296, NE Portion Project	Additional 1.126 km^2 added to the original 11.0 km^2 of area surveyed for ERDF.	Two isolated artifacts: an Army (Camp Hanford era) communication line and round metal can.
95-200-066	Cultural Resources Review of the 218-E-12B Trench 94 Project.	218-E-12B. Excavation in bottom of trench to maximum depth of 3 ft.	No known cultural resources or historic properties.
95-200-124	Cultural Resources Review of Removal of Contaminated Soils in and around 218-W-4B Burial Grounds.	218-W-4B.	No known cultural resources or historic properties.
95-200-065	Cultural Resources Review of the 218-W-4C Trench 14 - High Integrity Containers Project.	218-W-4C. Maximum excavation size: 6 holes 36 inches in diameter and 19 ft deep in bottom of trench.	No known cultural resources or historic properties.
95-200-104	Cultural Resources Review of the Solid Waste Retrieval complex, Enhanced Radioactive and Mixed Waste Storage Facility, Infrastructure Upgrades, and Central Waste Support Complex.	200 West Area. Entire area previously reviewed except for future drain field.	White Bluffs Road, 1 site, 2 isolated finds.
96-200-058	200 Area Block Survey.	Remainder of undisturbed ground within 200 East and West Areas not previously surveyed.	HI-96-002, HI-96-003, HI-96-004, HI 96 005, HI-96-006, HI-96-007, HT-96-002, HT-96-010.
96-200-059	Cultural Resources Review of the 218-W-4C Trench 14 - Culvert Containers.	218-W-4C. Maximum excavation size: 25 ft wide by 25 ft long by 8 ft deep.	No known cultural resources or historic properties.
96-200-076	Cultural Resources Review of the Routine Operation of Grouting in the 200 West Burial Grounds.	218-W-5, 218-W-3A, 218-W-3AE, 218-W-4C. Maximum depth of excavation: up to 8 ft below trench floor.	No known cultural resources or historic properties.
96-200-102	Cultural Resources Review of the Widening and Deepening of Trench 36, 218-E-12B	218-E-12B. Maximum size of excavation: 80 ft wide at top, 20 ft wide at bottom, and 20 ft deep.	No known cultural resources or historic properties.
97-200-023	Cultural Resources Review of the Burial Ground 218-W-5 Trench 33 Expansion.	218-W-5. Maximum size of excavation: trench widening to 40 ft for length of trench (1160 ft), excavation to 20 ft.	No known cultural resources or historic properties.
97-200-062	Cultural Resources Review of the Burial Ground 218-W-5 Trench 34 Rain Curtain.	218-W-5. Maximum size of excavation: 1 to 2 ft deep trenches around Trench 34 and down inner edge of truck ramp.	No known cultural resources or historic properties.

Table K.1. (contd)

Hanford Cultural Resource Case Number	Title	Activities Reviewed	Cultural Resources
98-200-031	Cultural Resources Review of the Subsidence Repair and Maintenance in the Low Level Burial Grounds.	218-E-10, 218-E-12B, 218 W-3A, 218-W-3AE, 218-W-4B, 218-W-4C, 218-W-5, 218-W-6.	No known National Register properties.
99-200-008	Cultural Resources Review for Widening Trench 36 218-E-12B Burial Ground.	218-E-12B. Maximum size of excavation: 900 ft long, 16 ft deep, and 25 width added.	No known National Register properties.
01-200-006	Cultural Resources Review for the Storage of K Basin Sludge at the 221-T and the 271-T Facilities	221-T and 271-T Facility upgrades to safety and security systems, 221-T modifications to hot cells.	No effect on facility characteristics that make them eligible for National Register.
02-200-050	Cultural Resources Review of Immobilized Low-Activity Waste (ILAW) Disposal Facility	Low-activity waste to be disposed of in six lined trenches southwest of the PUREX Plant in the 200 East Area.	No effect on historic properties.
02-200-051	Cultural Resources Review of Melter Trench	Disposal of melters into a specifically designed trench in 3 alternative locations in the 200 East Area.	No effect on historic properties.
02-200-054	Cultural Resources Review of Groundwater Well Installation	Four groundwater wells to be installed in several locations in the 200 West Area.	No effect on historic properties.

(a) Note that some reviews include areas that are not considered in this HSW EIS, for example the McGee Ranch, which is now within the Hanford Reach National Monument.

K.1.2 Central Waste Complex Expansion Area

Under the No Action Alternative, the CWC in the 200 West Area would continue to receive and store newly generated wastes. With existing storage capacity reaching its limit, the CWC would be expanded. Expansion would occur in a 36-ha (89-ac) area south of the existing CWC and a 30-ha (74-ac) area west of the CWC and south of the 218-W-5 expansion area. Depth of excavation would be 0.9 m (3 ft) for the CWC buildings.

Staff of the Hanford Cultural Resources Laboratory (HCRL) conducted a records and literature search that revealed the project area had been previously surveyed for cultural resources. Cultural resources identified within the project area are provided in Table K.2

The cultural resources surveys of the project area concluded that no known historic properties are located within the CWC expansion area.

Table K.2. Cultural Resources Identified in Project Area

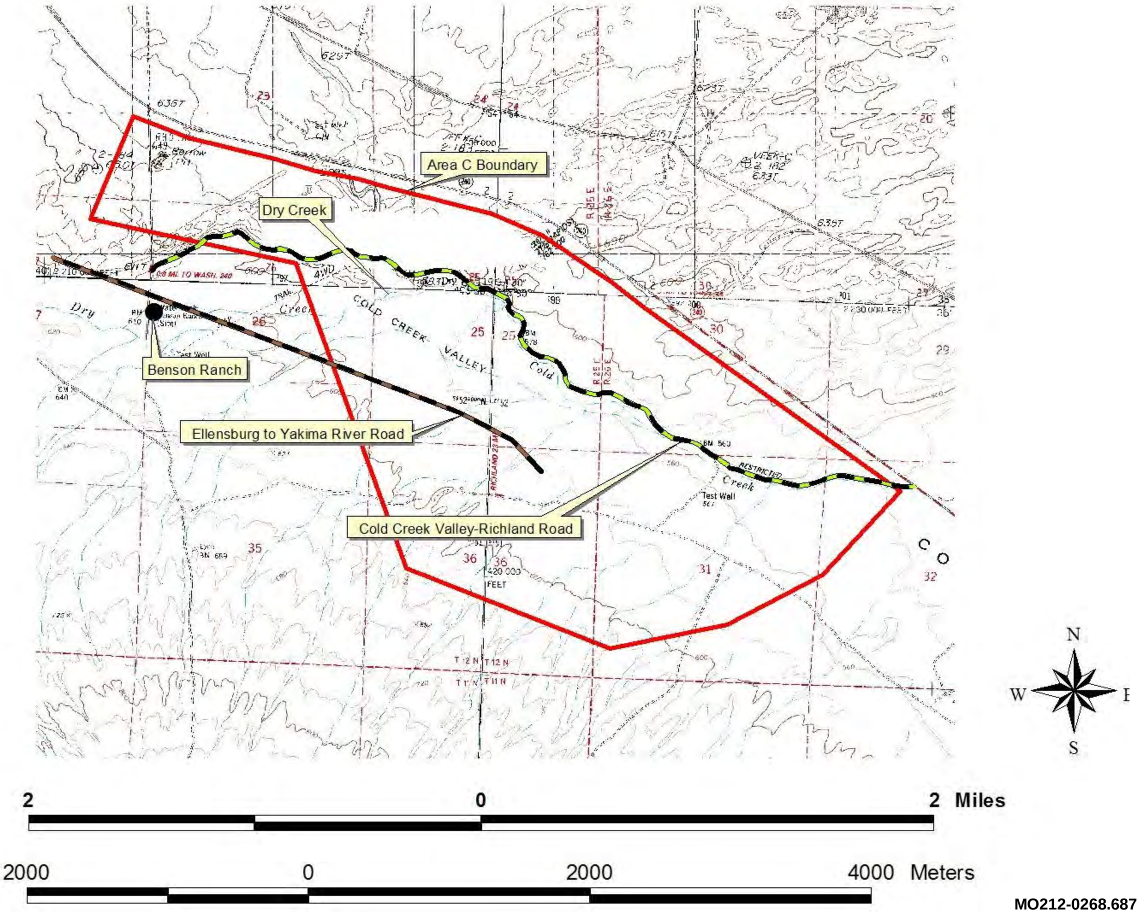
Survey Number/Name	Cultural Resources Identified in the Project Area	Eligible to the National Register
HCRC# 88-200-038, Archaeological Survey of the 200 East and 200 West Areas.	HT-88-009, 1920s/1930s can and bottle scatter - possible sheepherder/cowboy camp.	Determined not eligible.
HCRC# 96-200-058, 200 Area Block Survey.	HT-96-002: sparse scatter of cryptocrystalline silica (ccs) flakes and historic debris. HI-96-004: ccs utilized flake. HI-96-005: ccs flake.	Determined not eligible.
HCRC# 95-200-104, Solid Waste Retrieval Complex (Infrastructure).	No cultural resources located.	NA
HCRC# 2000-600-023, White Bluffs Road Survey.	H3-121, White Bluffs Road and associated features.	Determined eligible to the National Register. The section that runs through the 200 West Area and through the project area, however, has been determined to be non-contributing due to lack of physical integrity.
HCRC = Hanford Cultural Resources Case; see Appendix L for details on source. NA = not applicable.		

K.1.3 New Waste Processing Facility

The location of the new waste processing facility that would be constructed, if Alternative Group B were to be implemented, is directly west of WRAP in the 200 West Area. The previous cultural resources surveys conducted in the CWC expansion area concluded that no known historic properties are located within the footprint of the new waste processing facility.

K.2 Area C – Borrow Pits, Stockpile Area, and Access Roads

Area C borrow pits would be used for excavation of basalt and fine textured material, such as silt loam, gravel, or sand, for the construction of closure covers to be placed over low-level waste (LLW) trenches in Alternative Groups A through E and MLLW trenches in all alternatives. The HCRL conducted a cultural resources review of the 926-ha (2287-ac) Area C borrow pit in February 2002 (see Figure K.1).



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HSW EIS 03-21-03

Figure K.1. Area C - Historical Features

K.2.1 Literature and Record Search – Previous Cultural Resources Surveys

Staff of HCRL conducted a records and literature search that revealed a small section of Area C had been previously surveyed in 1994 for cultural resources (Duranceau 1995). The survey was conducted in the northwestern portion of Area C. Three isolated finds were recorded in the project area:

ISOLATE NUMBER	DESCRIPTION
HI-94-032	Two white cryptocrystalline silica (ccs) flakes.
HI-94-036	A historic "fence jack"—a rock pile with remains of a split rail.
HI-94-037	A large historic riveted metal collared cylinder.

A previous cultural resources survey three miles west of the project area resulted in the establishment of the Rattlesnake Springs Archaeological District and listing in the National Register of Historic Places (Rice 1968). Sites recorded by the survey include evidence of prehistoric activity near Rattlesnake Springs and Dry Creek. The historic White Bluffs Road, which passed through Rattlesnake Springs was identified in the survey and is listed in the National Register. The road was an important Native American and Euro-American route from Yakima to the town of White Bluffs on the Columbia River and gives evidence to the fact that the Rattlesnake Springs area was a crossroad for Native Americans as well as early Euro-American settlers in the region.

K.2.2 Research Initiatives and Field Reconnaissance

For the purposes of this EIS, a cultural resources survey of Area C is recommended prior to the commencement of excavation activities. HCRL staff has conducted a variety of research initiatives to assess the potential cultural resources impacts the project may have. These activities are summarized below.

Historical research. During the literature and records search, previous cultural resources investigations, historic maps, land records, and local histories were reviewed. Former residents of the Hanford area were also contacted to see what, if any, historic activity they recalled. Results of this research indicated that portions of Area C, located in the Rattlesnake Flats section of Cold Creek Valley, were used for grazing and ranching from the 1880s to 1943 (see Figure K.1). Irrigation was undertaken at ranches west (Benson Ranch) and south (Snively Ranch) of the project area. Large-scale irrigation efforts for the entire Cold Creek Valley were promoted, but they never reached fruition (Van Arsdol 1972).

A review of the 1881 General Land Office map of the Cold Creek Valley revealed that the Ellensburg to Yakima River Road traversed the project area in an east-west direction and was possibly used as an Indian trail prior to Euro-American settlement. The 1943 Real Estate maps depict another road connecting Cold Creek Valley with Richland. The road parallels Dry Creek along the northern section of the project area. The maps also note that at the time of the establishment of the Hanford Site, ownership of the project area was divided among the State of Washington, Northern Pacific Railroad, and United States government.

The Benson Ranch, located on the western boundary of the project area, is an unrecorded archaeological site that is noted on the 1915 U.S. Geological Survey topographic maps. The Benson Ranch obtained its water for irrigation from Rattlesnake Springs in order to grow alfalfa and other crops, and a well-used trail connected the ranch with the springs (Hinds and Rodgers 1991). Rattlesnake Springs was valued by both prehistoric peoples and Euro-American settlers for its year-round water supply and source of plentiful game. Further, Rattlesnake Springs holds prehistoric significance as there is evidence of aboriginal occupation some distance from the Columbia River. Until recently, most prehistoric archaeological investigations of the mid-Columbia Basin have been conducted along major rivers and tributaries. It was noted that surface findings in the vicinity of Rattlesnake Springs indicate possible human presence as far back as 8000 to 10,000 years.

Photogrammetry. Aerial photographs from recent decades were analyzed to determine if historic roads still existed and to see if any additional historic activity could be located. The analysis confirmed the location of roads along with various probable cultural features; however, no major sites, such as farmsteads or military encampments (that is, Camp Hanford’s forward positions), were observed. In 1963, the U.S. Army conducted maneuvers, called Operation Braveshield, for several weeks in the Cold

Creek Valley. The troops proceeded north to Rattlesnake Springs and followed the Cold Creek drainage to the Yakima Firing Range (DOE-RL 1995). At this point, however, little evidence suggests that Area C was used for Army exercises.

Ethnographic research. From previous ethnographic interviews conducted by HCRL with local Native Americans, the area has been identified as a travel route for Native Americans between Rattlesnake Springs and the Yakima and Columbia rivers. The area lies in close proximity to Rattlesnake Mountain, a place considered important by local Native American tribes.

Archaeological research and field reconnaissance. Previous archaeological surveys in the area, limited to only one small survey (Duranceau 1995), identified minimal presence of archaeological remains from the prehistoric and historic periods. To gain additional perspective on the likelihood that significant archaeological remains are located in Area C, staff conducted a field reconnaissance of high potential areas identified by a predictive model developed by the HCRL for the Hanford Site (see Figure K.2). The model indicated the areas located along the dry beds of Cold Creek and Dry Creek would have a moderately high chance of containing archaeological sites. Four staff members conducted a field reconnaissance, principally along the creeks, their tributaries, and along the dirt road parallel to Dry Creek. Cultural material observed included one cryptocrystalline silica flake, numerous rusted cans and contemporary beer cans, military telephone wire, and barbwire fence lines that run parallel to Dry Creek and the dirt road. If significant archaeological remains are present in Area C, they are most likely buried under wind blown deposition.

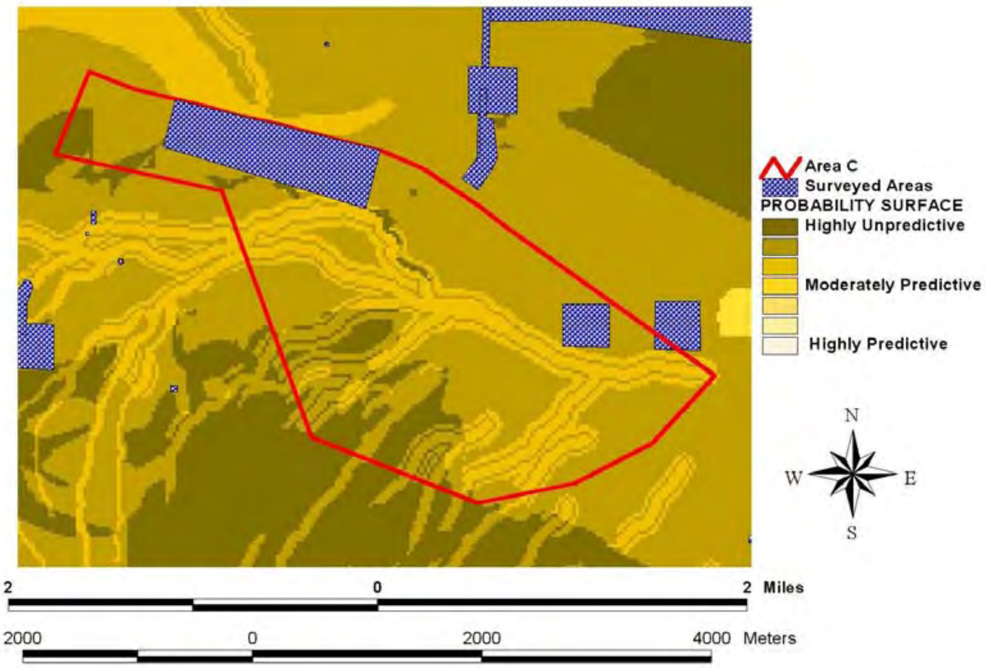

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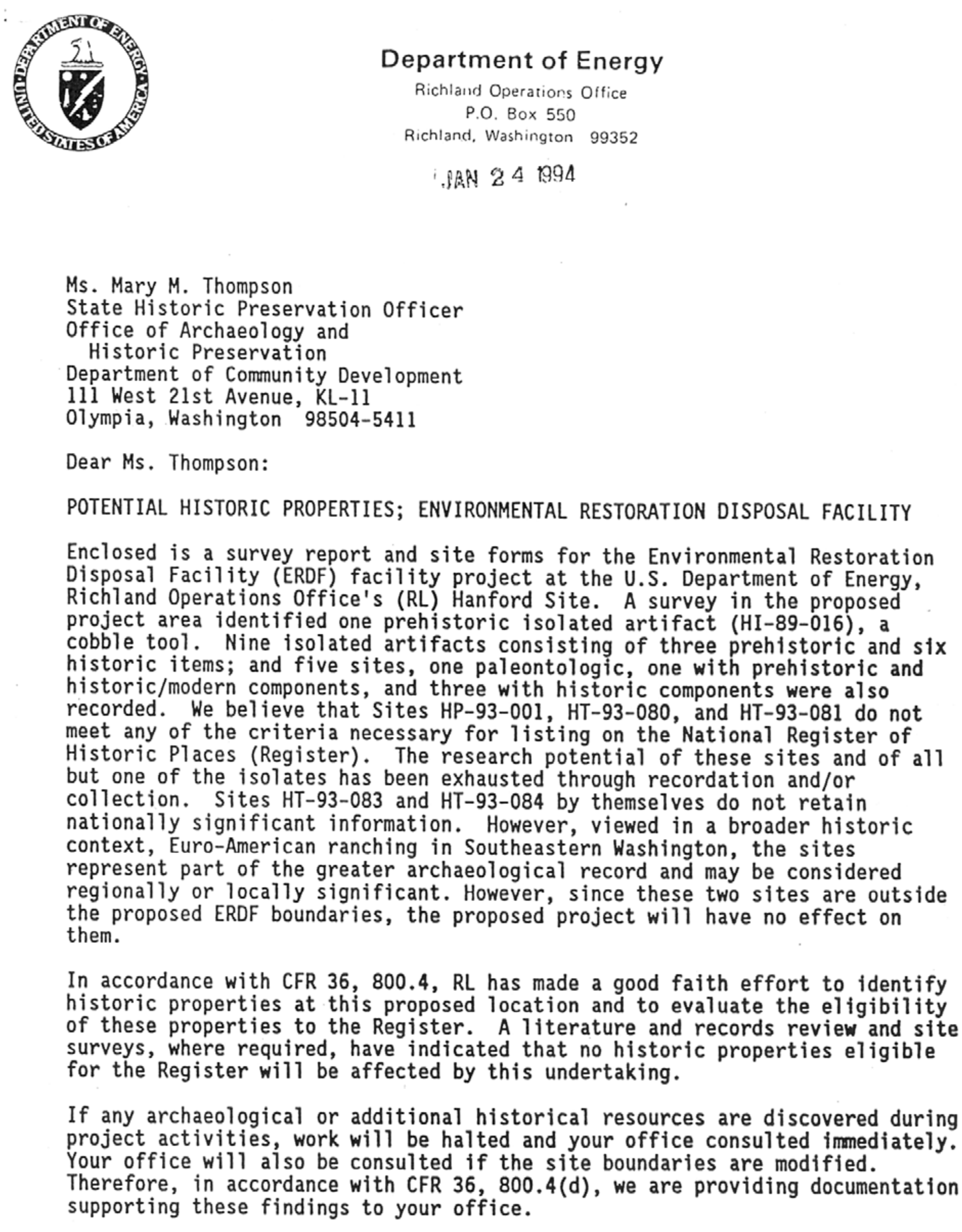
Figure K.2. Area C Predictive Model



Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

JAN 24 1994

Ms. Mary M. Thompson
State Historic Preservation Officer
Office of Archaeology and
Historic Preservation
Department of Community Development
111 West 21st Avenue, KL-11
Olympia, Washington 98504-5411

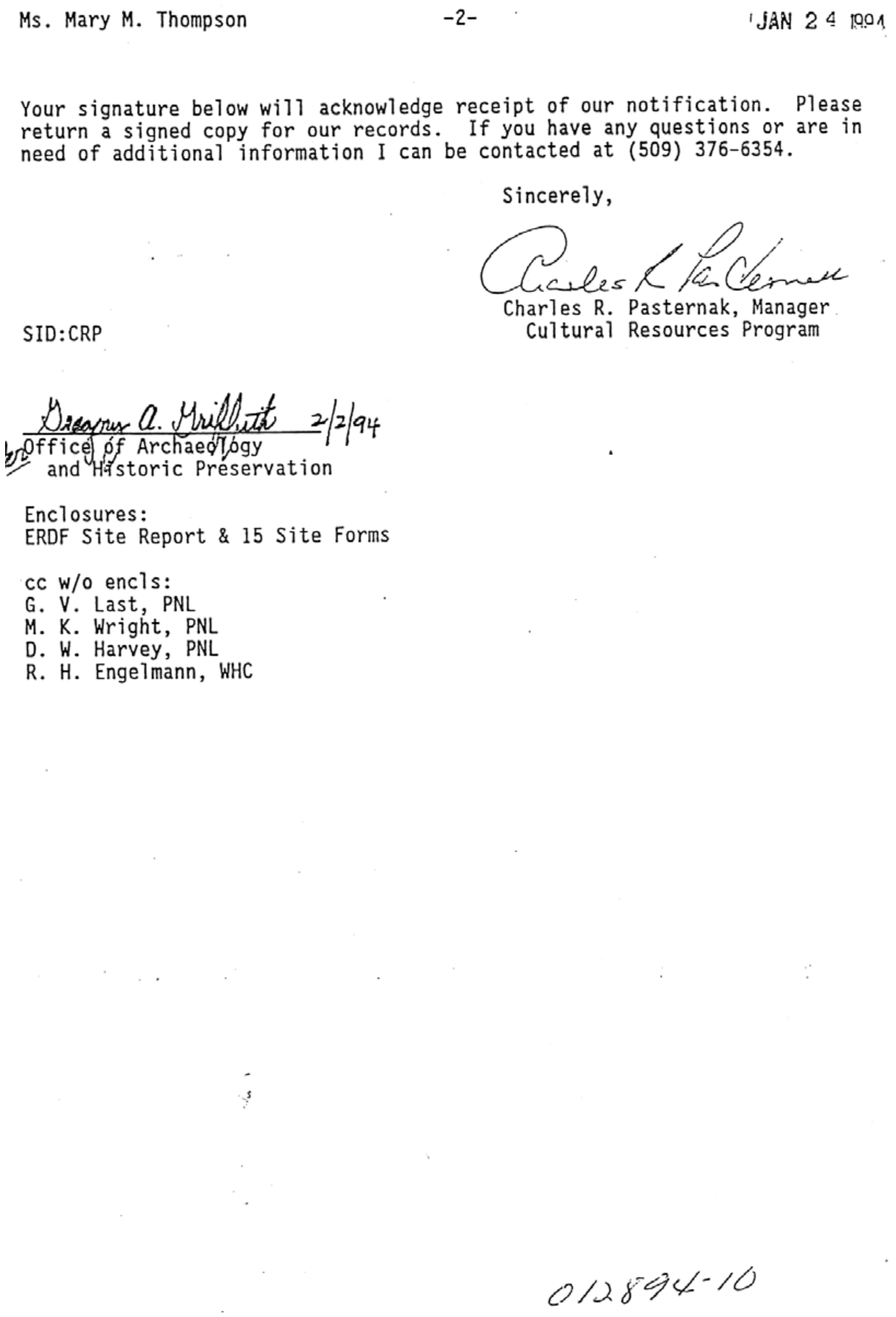
Dear Ms. Thompson:

POTENTIAL HISTORIC PROPERTIES; ENVIRONMENTAL RESTORATION DISPOSAL FACILITY

Enclosed is a survey report and site forms for the Environmental Restoration Disposal Facility (ERDF) facility project at the U.S. Department of Energy, Richland Operations Office's (RL) Hanford Site. A survey in the proposed project area identified one prehistoric isolated artifact (HI-89-016), a cobble tool. Nine isolated artifacts consisting of three prehistoric and six historic items; and five sites, one paleontologic, one with prehistoric and historic/modern components, and three with historic components were also recorded. We believe that Sites HP-93-001, HT-93-080, and HT-93-081 do not meet any of the criteria necessary for listing on the National Register of Historic Places (Register). The research potential of these sites and of all but one of the isolates has been exhausted through recordation and/or collection. Sites HT-93-083 and HT-93-084 by themselves do not retain nationally significant information. However, viewed in a broader historic context, Euro-American ranching in Southeastern Washington, the sites represent part of the greater archaeological record and may be considered regionally or locally significant. However, since these two sites are outside the proposed ERDF boundaries, the proposed project will have no effect on them.

In accordance with CFR 36, 800.4, RL has made a good faith effort to identify historic properties at this proposed location and to evaluate the eligibility of these properties to the Register. A literature and records review and site surveys, where required, have indicated that no historic properties eligible for the Register will be affected by this undertaking.

If any archaeological or additional historical resources are discovered during project activities, work will be halted and your office consulted immediately. Your office will also be consulted if the site boundaries are modified. Therefore, in accordance with CFR 36, 800.4(d), we are providing documentation supporting these findings to your office.



Your signature below will acknowledge receipt of our notification. Please return a signed copy for our records. If you have any questions or are in need of additional information I can be contacted at (509) 376-6354.

Sincerely,

Charles R. Pasternak, Manager
Cultural Resources Program

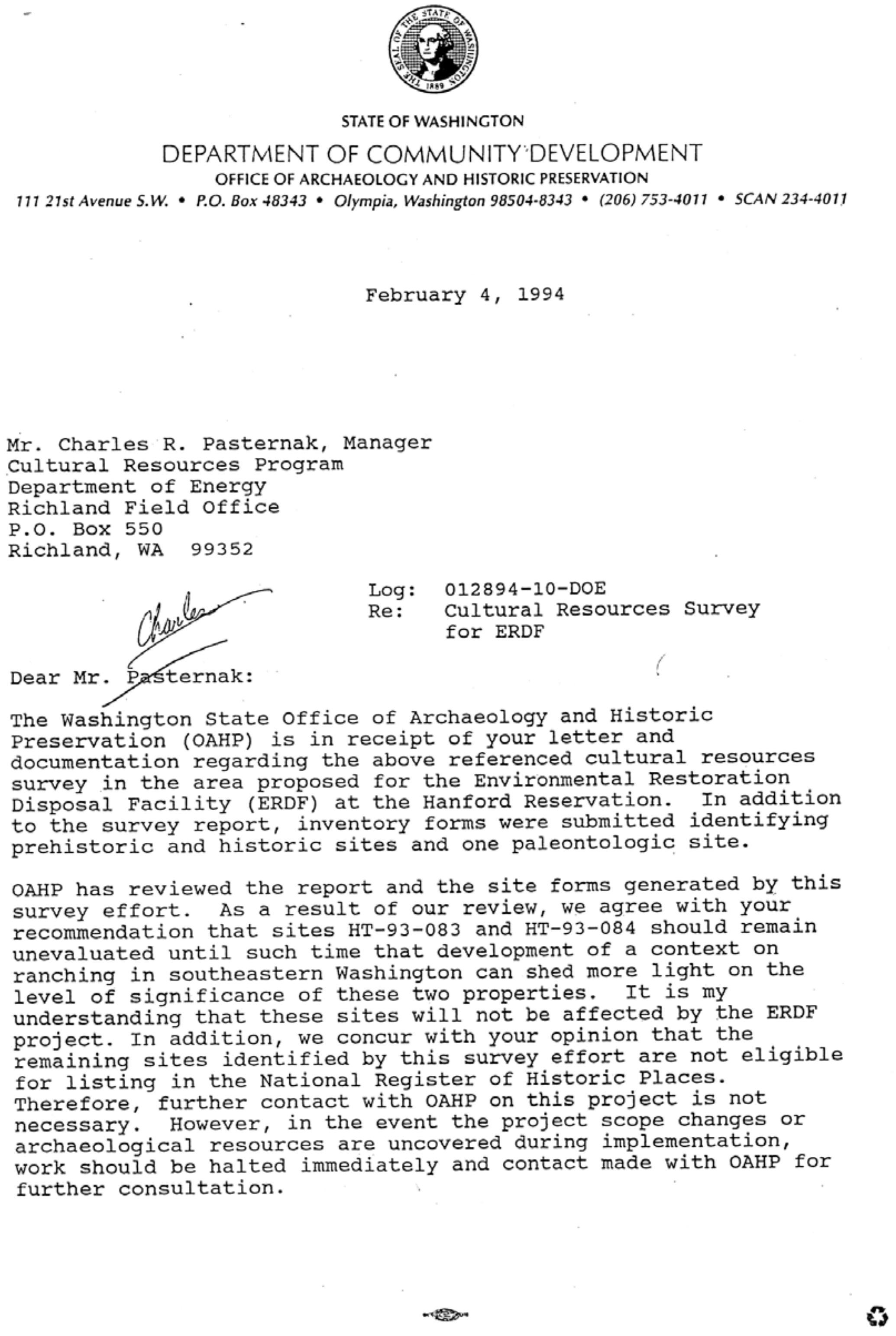
SID:CRP

Gregory A. Griffith 2/2/94
Office of Archaeology
and Historic Preservation

Enclosures:
ERDF Site Report & 15 Site Forms

cc w/o encls:
G. V. Last, PNL
M. K. Wright, PNL
D. W. Harvey, PNL
R. H. Engelmann, WHC

012894-10



STATE OF WASHINGTON
DEPARTMENT OF COMMUNITY DEVELOPMENT
OFFICE OF ARCHAEOLOGY AND HISTORIC PRESERVATION
111 21st Avenue S.W. • P.O. Box 48343 • Olympia, Washington 98504-8343 • (206) 753-4011 • SCAN 234-4011

February 4, 1994

Mr. Charles R. Pasternak, Manager
Cultural Resources Program
Department of Energy
Richland Field Office
P.O. Box 550
Richland, WA 99352

Charles

Log: 012894-10-DOE
Re: Cultural Resources Survey for ERDF

Dear Mr. Pasternak:

The Washington State Office of Archaeology and Historic Preservation (OAHP) is in receipt of your letter and documentation regarding the above referenced cultural resources survey in the area proposed for the Environmental Restoration Disposal Facility (ERDF) at the Hanford Reservation. In addition to the survey report, inventory forms were submitted identifying prehistoric and historic sites and one paleontologic site.

OAHP has reviewed the report and the site forms generated by this survey effort. As a result of our review, we agree with your recommendation that sites HT-93-083 and HT-93-084 should remain unevaluated until such time that development of a context on ranching in southeastern Washington can shed more light on the level of significance of these two properties. It is my understanding that these sites will not be affected by the ERDF project. In addition, we concur with your opinion that the remaining sites identified by this survey effort are not eligible for listing in the National Register of Historic Places. Therefore, further contact with OAHP on this project is not necessary. However, in the event the project scope changes or archaeological resources are uncovered during implementation, work should be halted immediately and contact made with OAHP for further consultation.

Charles, thank you for the opportunity to comment on this action. Should you have any questions, please feel free to contact me at (206) 753-9116.

Sincerely,

Greg

Gregory A. Griffith
Comprehensive Planning Specialist

GAG:aa
Enclosure

cc: Mona Wright

Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

April 15, 1994

Ms. Mary M. Thompson
State Historic Preservation Officer
Office of Archaeology and Historic Preservation
Department of Community Development
111 West Twenty-first Avenue, KL-11
Olympia, Washington 98504-5411

Dear Ms. Thompson:

CHANGE IN SCOPE: ENVIRONMENTAL RESTORATION DISPOSAL FACILITY (ERDF) - NO KNOWN HISTORIC PROPERTIES

Since your concurrence with our January 24, 1994, findings on February 4, 1994, the scope of the above mentioned proposed project has been modified. In response to a cultural resources review for a topographic survey of the proposed area it was noted that the sites boundaries had been expanded. The U.S. Department of Energy, Richland Operations Office (RL) Cultural Resources Laboratory has completed surveying the additional area. In accordance with 36 CFR 800.4, RL has made a good faith effort to identify historic properties at this proposed location and to evaluate the eligibility of these properties to the Register. A literature and records review and a survey have indicated that no historic properties eligible for the Register will be affected by these undertakings.

If any archaeological or additional historical resources are discovered during project activities, work will be halted and your office consulted immediately. If the scope of the proposed undertakings are revised, your office will also notified immediately. Therefore, in accordance with 36 CFR 800.4(d), we are providing documentation supporting these findings to your office.

Your signature below will acknowledge receipt of our notification. Please return a signed copy for our files. If you have any questions or are in need of additional information I can be contacted at (509) 376-6354.

Sincerely,

Charles R. Pasternak, Manager
Cultural Resources Program
Site Infrastructure Division

SID:CRP

____
Office of Archaeology
and Historic Preservation

Enclosure: HCRC #94-600-032

cc w/o encl:
P. Nickens, PNL file
D. Harvey, PNL
M. Wright, PNL
R. Phillips, PNL
R. Engelmann, WHC
J. Van Pelt, CTUIR, w/encl.

Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

FEB 27 2002

02-RCA-0201

Dr. Allyson Brooks
Office of Archaeology and
Historic Preservation
P. O. Box 48343
Olympia, Washington 95804

Dear Dr. Brooks:

THREE CULTURAL RESOURCE REVIEWS FOR HANFORD SITE SOLID WASTE DRAFT ENVIRONMENTAL IMPACT STATEMENT (EIS): 1) USE OF AREA C, HCRC# 2002-600-012; 2) EXPANSION OF THE CENTRAL WASTE COMPLEX, HCRC# 2002-600-012A; and 3) RAIL SPUR TO THE WASTE RECEIVING AND PROCESSING (WRAP) FACILITY, HCRC# 2002-600-12B

Enclosed are three cultural resource reviews completed by the U.S. Department of Energy, Richland Operations Office (RL). These cultural resource reviews are in support of the Hanford Site Solid Waste EIS analysis. The subject projects are located in the 200 West Area and 600 Area of the Hanford Site, Richland, Washington. The results of the records and literature review conducted by staff at the Hanford Cultural Resources Laboratory (HCRL) are described in the attached cultural resource reviews. The results of the reviews indicate the following:

1. USE OF AREA C, HCRC# 2002-600-012 (Enclosure 1)
   Based on the information collected by the field reconnaissance and research, this project may affect historic properties. HCRL is unable to make a final determination of finding for the purposes of compliance with 36CFR 800 until additional work is completed. This area is adjacent to, but not included in, the Hanford Reach National Monument.

2. EXPANSION OF THE CENTRAL WASTE COMPLEX, HCRC# 2002-600-012A (Enclosure 2)
   Based on the information collected during the records and literature search, the expansion of the Central Waste Complex for the Hanford Site Solid Waste Program will have no affect on historic properties.

3. RAIL SPUR TO THE WRAP FACILITY, HCRC# 2002-600-12B (Enclosure 3)
   Based on the information collected during the records and literature search and the cultural resources survey, that there are no historic properties located within the Area of Potential Effect. This project will have no effect to historic properties.

Pursuant to 36CFR 800.2 (4) we are providing documentation to support these findings and to involve your office as a consulting party in the National Historic Preservation Act, Section 106, Review process. If you have any questions or are in need of additional information, please contact Annabelle Rodriguez, of my staff, on (509) 372-0277 within 30 days of the date of this letter.

Sincerely,

Joel Hebdon

Joel Hebdon, Director
Regulatory Compliance and Analysis Division

RCA:ALR

Enclosures

cc:w/encls:
A. Fyall, Benton County
J. Gaston, USFWS
C. Hulse, EBCHS
A. Heriford, HWBP
J. Sonderman, FCHS
P. Vinther, HRA
G. Weisskoph, BRMA

cc w/o encls:
E. L. Prendergast, PNNL
K. Rhoads, PNNL

This letter, cultural resource review and historic inventory forms have been sent to the following individuals:

Washington State Historic Preservation Officer
Dr. Allyson Brooks

Confederated Tribes of the Umatilla Indian Reservation
Jeff Van Pelt
Armand Minthorn
J. Longenecker (Richland Office)

Confederated Tribes and Bands of the Yakama Nation
Russell Jim

Confederated Tribes of the Colville Reservation
Adeline Fredin

Nez Perce Tribe
Lenora Seelatsee
Rex Buck, Jr.

U.S. Fish and Wildlife Service
Jenna Gaston

B Reactor Museum Association
Gene Weisskoph

Benton County
Adam Fyall

East Benton County Historical Society
Corene Hulse

Franklin County Historical Society
Jaqui Sonderman

Hanford Retirees Association
Paul Vinther

Hanford White Bluffs Pioneers
Annette Heriford

STATE OF WASHINGTON

OFFICE OF COMMUNITY DEVELOPMENT
Office of Archaeology and Historic Preservation
1063 S. Capitol Way, Suite 106 • PO Box 48343 • Olympia, Washington 98504-8343 • (360) 586-3065 Fax Number (360) 586-3067 • http://www.oahp.wa.gov

March 6, 2002

Mr. Joel Hebdon
Regulatory Compliance & Analysis Division
Richland Operations Office
Department of Energy
PO Box 550
Richland, WA 99352

Re: Solid Waste DEIS
Log No.: 030502-14-DOE
Code: HCRC # 2002-600-012/2002-600-012A/2002-600-012B

Dear Mr. Hebdon;

Thank you for providing a copy of the cultural resources survey assessment of the proposed Site Waste DEIS analysis in the 200 West Area and 600 Area of the Hanford Site. We concur with their professional recommendations and your finding that no cultural resources are in the identified impact area as of this date. We concur with the recommendation that further survey efforts be undertaken in Area C and we look forward to receiving these reports when available.

We would appreciate receiving any correspondence or comments from concerned tribes or other parties that you receive as you consult under the requirements of 36CFR800.4(a)(4).

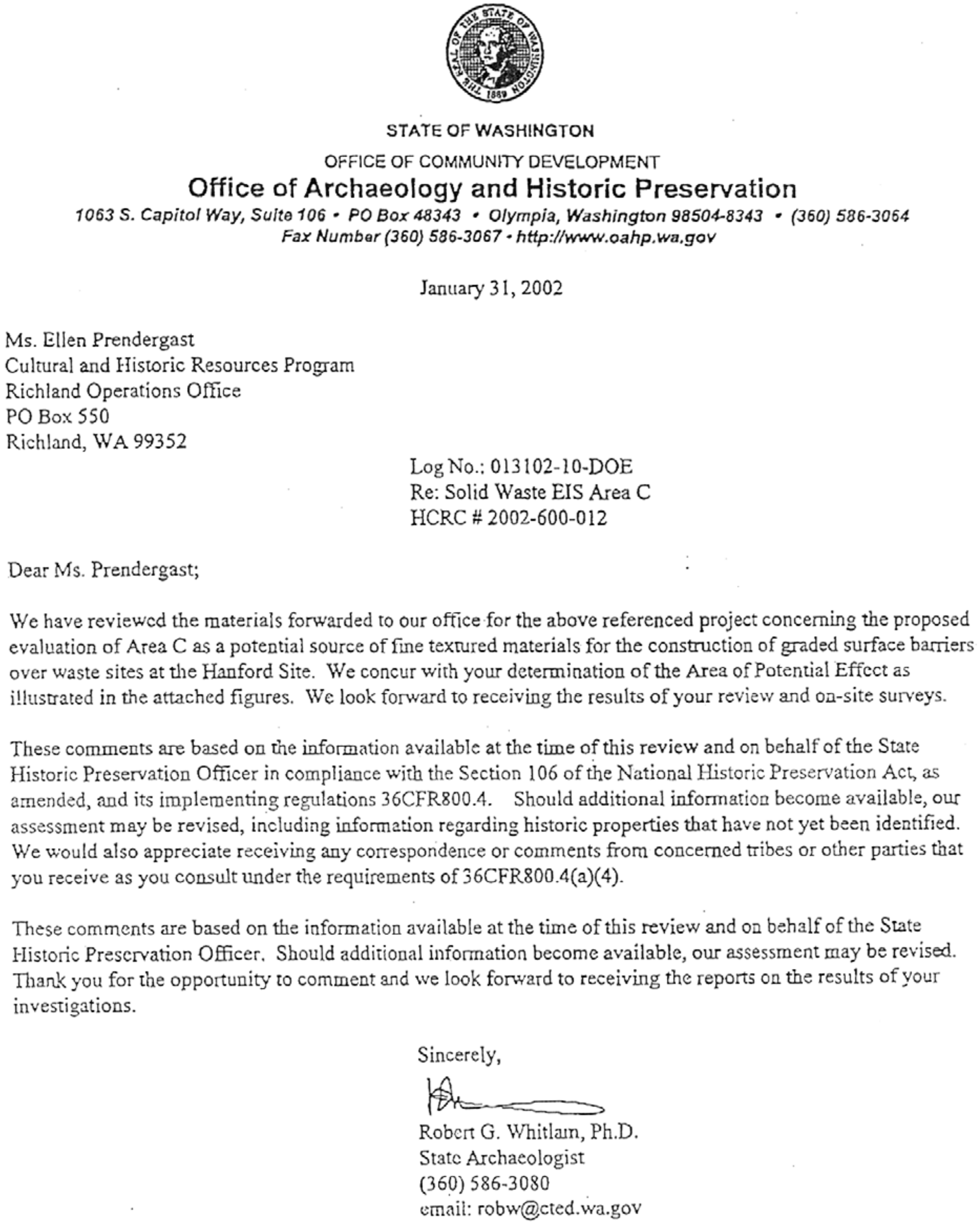
These comments are based on the information available at the time of this review and on the behalf of the State Historic Preservation Officer in conformance with Section 106 of the National Historic Preservation Act, as amended, and its implementing regulations 36CFR800. Should additional information become available, our assessment may be revised. In the event that archaeological or historic materials are discovered during project activities, work in the immediate vicinity should be discontinued, the area secured, and this office notified.

Thank you for the opportunity to comment and a copy of these comments should be included in subsequent environmental documents.

Sincerely,

Robert G. Whitlam, Ph.D.
State Archaeologist
(360) 586-3080
email: robw@cted.wa.gov

RECEIVED
MAR 1 2 2002
DOE RL / CCC



1889

STATE OF WASHINGTON
OFFICE OF COMMUNITY DEVELOPMENT
Office of Archaeology and Historic Preservation
1063 S. Capitol Way, Suite 106 • PO Box 48343 • Olympia, Washington 98504-8343 • (360) 586-3064
Fax Number (360) 586-3067 • http://www.oahp.wa.gov

January 31, 2002

Ms. Ellen Prendergast
Cultural and Historic Resources Program
Richland Operations Office
PO Box 550
Richland, WA 99352

Log No.: 013102-10-DOE
Re: Solid Waste EIS Area C
HCRC # 2002-600-012

Dear Ms. Prendergast;

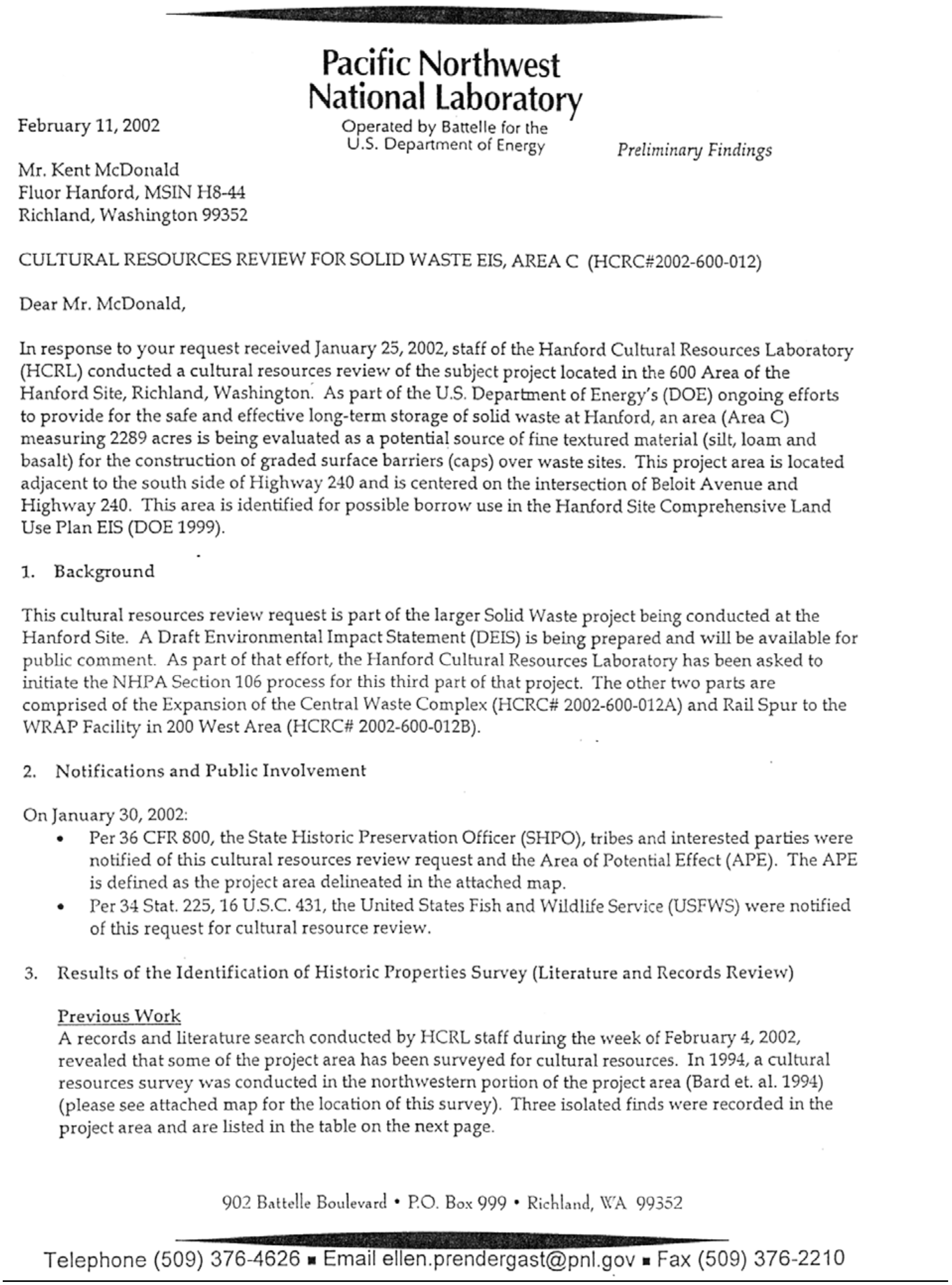
We have reviewed the materials forwarded to our office for the above referenced project concerning the proposed evaluation of Area C as a potential source of fine textured materials for the construction of graded surface barriers over waste sites at the Hanford Site. We concur with your determination of the Area of Potential Effect as illustrated in the attached figures. We look forward to receiving the results of your review and on-site surveys.

These comments are based on the information available at the time of this review and on behalf of the State Historic Preservation Officer in compliance with the Section 106 of the National Historic Preservation Act, as amended, and its implementing regulations 36CFR800.4. Should additional information become available, our assessment may be revised, including information regarding historic properties that have not yet been identified. We would also appreciate receiving any correspondence or comments from concerned tribes or other parties that you receive as you consult under the requirements of 36CFR800.4(a)(4).

These comments are based on the information available at the time of this review and on behalf of the State Historic Preservation Officer. Should additional information become available, our assessment may be revised. Thank you for the opportunity to comment and we look forward to receiving the reports on the results of your investigations.

Sincerely,

Robert G. Whitlam, Ph.D.
State Archaeologist
(360) 586-3080
email: robw@cted.wa.gov



Pacific Northwest
National Laboratory
Operated by Battelle for the
U.S. Department of Energy

February 11, 2002

Preliminary Findings

Mr. Kent McDonald
Fluor Hanford, MSIN H8-44
Richland, Washington 99352

CULTURAL RESOURCES REVIEW FOR SOLID WASTE EIS, AREA C (HCRC#2002-600-012)

Dear Mr. McDonald,

In response to your request received January 25, 2002, staff of the Hanford Cultural Resources Laboratory (HCRL) conducted a cultural resources review of the subject project located in the 600 Area of the Hanford Site, Richland, Washington. As part of the U.S. Department of Energy's (DOE) ongoing efforts to provide for the safe and effective long-term storage of solid waste at Hanford, an area (Area C) measuring 2289 acres is being evaluated as a potential source of fine textured material (silt, loam and basalt) for the construction of graded surface barriers (caps) over waste sites. This project area is located adjacent to the south side of Highway 240 and is centered on the intersection of Beloit Avenue and Highway 240. This area is identified for possible borrow use in the Hanford Site Comprehensive Land Use Plan EIS (DOE 1999).

1. Background

This cultural resources review request is part of the larger Solid Waste project being conducted at the Hanford Site. A Draft Environmental Impact Statement (DEIS) is being prepared and will be available for public comment. As part of that effort, the Hanford Cultural Resources Laboratory has been asked to initiate the NHPA Section 106 process for this third part of that project. The other two parts are comprised of the Expansion of the Central Waste Complex (HCRC# 2002-600-012A) and Rail Spur to the WRAP Facility in 200 West Area (HCRC# 2002-600-012B).

2. Notifications and Public Involvement

On January 30, 2002:

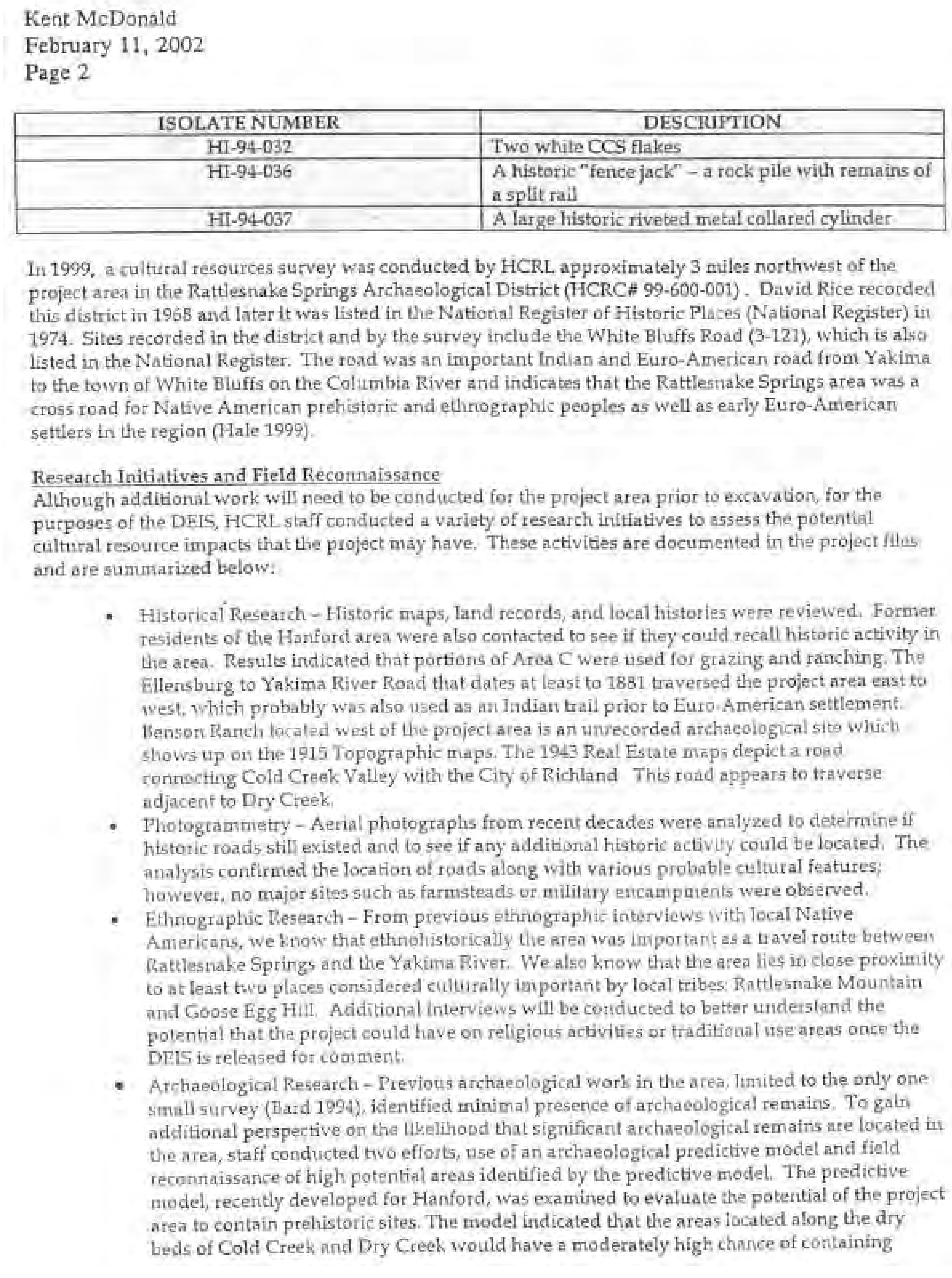
- Per 36 CFR 800, the State Historic Preservation Officer (SHPO), tribes and interested parties were notified of this cultural resources review request and the Area of Potential Effect (APE). The APE is defined as the project area delineated in the attached map.
- Per 34 Stat. 225, 16 U.S.C. 431, the United States Fish and Wildlife Service (USFWS) were notified of this request for cultural resource review.

3. Results of the Identification of Historic Properties Survey (Literature and Records Review)

Previous Work

A records and literature search conducted by HCRL staff during the week of February 4, 2002, revealed that some of the project area has been surveyed for cultural resources. In 1994, a cultural resources survey was conducted in the northwestern portion of the project area (Bard et. al. 1994) (please see attached map for the location of this survey). Three isolated finds were recorded in the project area and are listed in the table on the next page.

902 Battelle Boulevard • P.O. Box 999 • Richland, WA 99352
Telephone (509) 376-4626 ▪ Email ellen.prendergast@pnl.gov ▪ Fax (509) 376-2210



ISOLATE NUMBER	DESCRIPTION
HI-94-032	Two white CCS flakes
HI-94-036	A historic "fence jack" – a rock pile with remains of a split rail
HI-94-037	A large historic riveted metal collared cylinder

In 1999, a cultural resources survey was conducted by HCRL approximately 3 miles northwest of the project area in the Rattlesnake Springs Archaeological District (HCRC# 99-600-001). David Rice recorded this district in 1968 and later it was listed in the National Register of Historic Places (National Register) in 1974. Sites recorded in the district and by the survey include the White Bluffs Road (3-121), which is also listed in the National Register. The road was an important Indian and Euro-American road from Yakima to the town of White Bluffs on the Columbia River and indicates that the Rattlesnake Springs area was a cross road for Native American prehistoric and ethnographic peoples as well as early Euro-American settlers in the region (Hale 1999).

Research Initiatives and Field Reconnaissance
Although additional work will need to be conducted for the project area prior to excavation, for the purposes of the DEIS, HCRL staff conducted a variety of research initiatives to assess the potential cultural resource impacts that the project may have. These activities are documented in the project files and are summarized below:

- Historical Research – Historic maps, land records, and local histories were reviewed. Former residents of the Hanford area were also contacted to see if they could recall historic activity in the area. Results indicated that portions of Area C were used for grazing and ranching. The Ellensburg to Yakima River Road that dates at least to 1881 traversed the project area east to west, which probably was also used as an Indian trail prior to Euro-American settlement. Benson Ranch located west of the project area is an unrecorded archaeological site which shows up on the 1915 Topographic maps. The 1943 Real Estate maps depict a road connecting Cold Creek Valley with the City of Richland This road appears to traverse adjacent to Dry Creek.
- Photogrammetry – Aerial photographs from recent decades were analyzed to determine if historic roads still existed and to see if any additional historic activity could be located. The analysis confirmed the location of roads along with various probable cultural features; however, no major sites such as farmsteads or military encampments were observed.
- Ethnographic Research – From previous ethnographic interviews with local Native Americans, we know that ethnohistorically the area was important as a travel route between Rattlesnake Springs and the Yakima River. We also know that the area lies in close proximity to at least two places considered culturally important by local tribes: Rattlesnake Mountain and Goose Egg Hill. Additional interviews will be conducted to better understand the potential that the project could have on religious activities or traditional use areas once the DEIS is released for comment.
- Archaeological Research – Previous archaeological work in the area, limited to the only one small survey (Bard 1994), identified minimal presence of archaeological remains. To gain additional perspective on the likelihood that significant archaeological remains are located in the area, staff conducted two efforts, use of an archaeological predictive model and field reconnaissance of high potential areas identified by the predictive model. The predictive model, recently developed for Hanford, was examined to evaluate the potential of the project area to contain prehistoric sites. The model indicated that the areas located along the dry beds of Cold Creek and Dry Creek would have a moderately high chance of containing

archaeological sites. Four staff members conducted a field reconnaissance principally along the creeks, their tributaries, and also along the old road. One tan CCS flake was geo-referenced and is identified in the attached map. Numerous rusted cans and barbwire were also observed.

4. Findings and Actions Required

It is the finding of HCRL that based on the information collected by the field reconnaissance and research, this project may affect historic properties. HCRL is unable to make a final determination of finding for the purposes of compliance with 36CFR 800 until more work is completed. However, we can provide the following preliminary assessment and recommendations:

Preliminary Findings
Historic use of Area C seems to have been centered on sheep and cattle grazing, and travel. Farmsteads (i.e. Benson Ranch) have been identified west of the project area where irrigated water allowed for the cultivation of alfalfa. Ethnohistoric Native American use appears to have been limited to travel. Native American use prior to Euro American contact and extending back as far as 10,000 years probably occurred.

In terms of cultural resource impacts that the Area C excavation may have on Native American spirituality, we do not understand the potential relationships between the project area and Rattlesnake Mountain or Goose Egg Hill well enough to offer an opinion. Those comments will have to come directly from Native Americans during the EIS review process. Since the project area is within the APE of the viewshed from Rattlesnake, we can say that the project may have an indirect effect to the characteristics that contribute to the cultural and religious significance of Rattlesnake Mountain to local tribes. There is a reasonable probability that sites are located within the project boundaries. Any sites, however, are likely to be buried, as the field reconnaissance failed to locate any on the surface. As little is known about the pre-contact use of the Cold Creek Valley, any sites located there would provide an opportunity to gain new knowledge about past life (Criterion D, NHPA). Further, if campsites or village sites are located there, human remains and possible cemeteries may also be located there.

Actions Required
Prior to construction, additional work will be needed to address potential cultural impacts. At a minimum, a standard pedestrian archaeological survey will be needed. Given the likelihood for buried deposits, some methodology will be needed to observe the subsurface. Shovel testing or backhoe testing might be appropriate, as might construction monitoring for cultural resources. Before deciding about further work required, we recommend waiting for cultural resource-related input from Native Americans and other interested parties that will be collected during the DEIS review.

RL's Hanford Cultural Resources Program will submit official documentation of our findings to the SHPO and consulting parties. The SHPO will respond within 30 days of receipt of this letter. No project activities can begin until the SHPO has concurred with our findings stated above.

The workers must be directed to watch for cultural materials (e.g., historic artifacts) during all work activities. If any are encountered, work in the vicinity of the discovery must stop until an HCRL staff member has been notified to assess the significance of the find, and, if necessary, arrange for mitigation of the impacts to the find. HCRL must be notified if any changes to project location or scope are anticipated. This project is a Class 5 case, defined as projects that "Involve Undisturbed Ground." If you have any questions, please call me at 376-4626. Please use the HCRC# above for any future.

Very truly yours,

Ellen Prendergast

Ellen Prendergast, M. A.
Research Scientist/Anthropologist
Cultural Resources Project

Concurrence:
D. C. Stapp, Project Manager
Cultural Resources Project

Review and Concurrence: Annabelle S Rodriguez
A. L. Rodriguez
DOE, Richland Operations Office, Hanford Cultural Resources Program

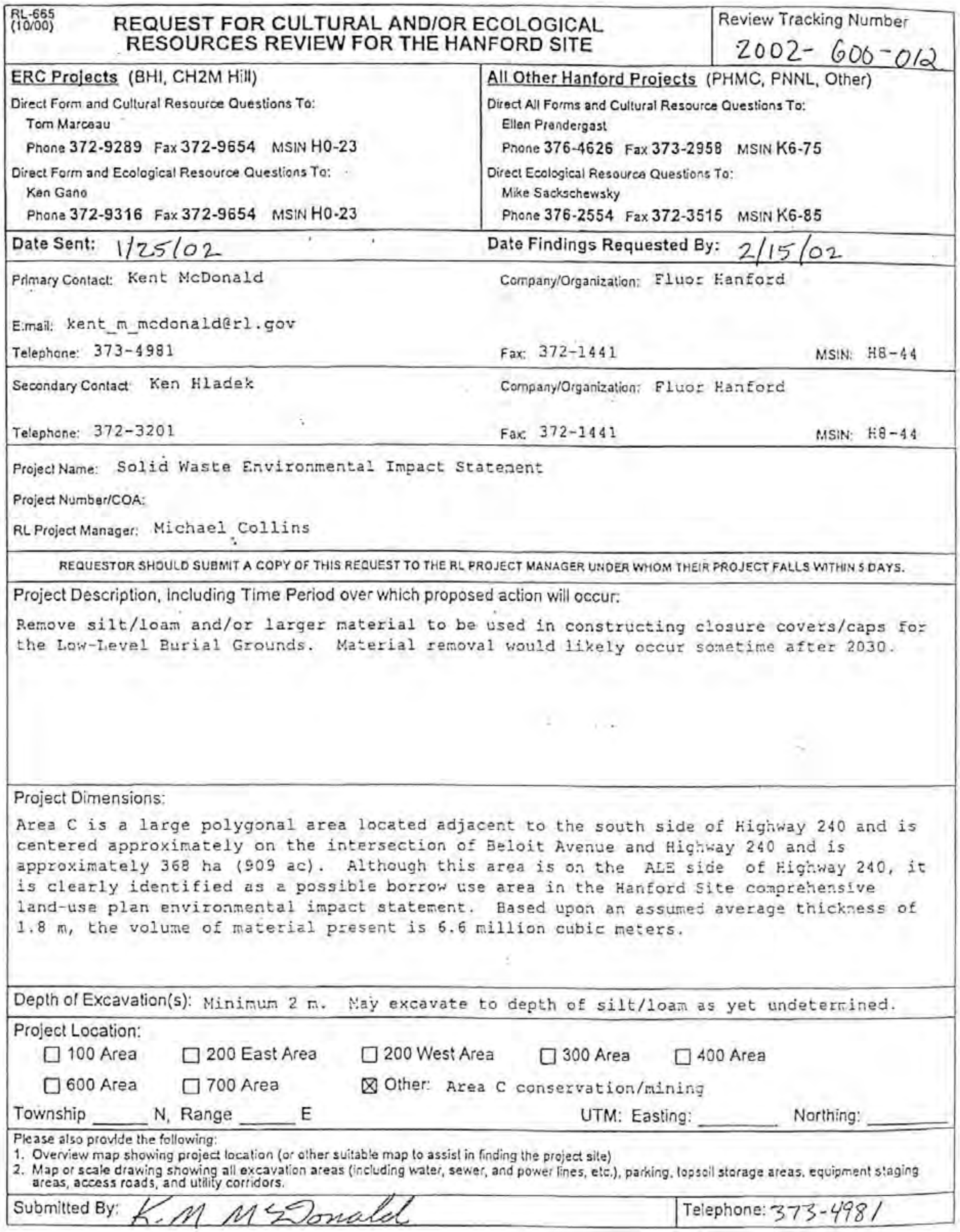
cc: A. L. Rodriguez, A5-58 (2)
Environmental Portal, A3-01
K.R. Welsch, N1-25
File/LB

References

Bard, JC, Robin McClintock, and JB Cox. 1994. "A Cultural Resources Inventory of Proposed Basalt Quarry Sites at the Department of Energy's Hanford Site, Benton County, Washington." CH2M Hill, Inc. Richland, Washington.

Hale, LL. 1999 "Cultural Resources Report Narrative- The Rattlesnake Springs Survey (HCRC#99-600-001)." Prepared for the U. S. Department of Energy, Richland Operations Office, Richland, Washington.

Rice, D.G. 1968. "Archaeological Reconnaissance: Hanford Atomic Works." Washington State University. Pullman, Washington.



RL-665
(10/00)

REQUEST FOR CULTURAL AND/OR ECOLOGICAL RESOURCES REVIEW FOR THE HANFORD SITE

Review Tracking Number 2002-600-012

ERC Projects (BHI, CH2M Hill)	**All Other Hanford Projects** (PHMC, PNNL, Other)
Direct Form and Cultural Resource Questions To: Tom Marceau Phone 372-9289 Fax 372-9654 MSIN H0-23	Direct All Forms and Cultural Resource Questions To: Ellen Prendergast Phone 376-4626 Fax 373-2958 MSIN K6-75
Direct Form and Ecological Resource Questions To: Ken Gano Phone 372-9316 Fax 372-9654 MSIN H0-23	Direct Ecological Resource Questions To: Mike Sackschewsky Phone 376-2554 Fax 372-3515 MSIN K6-85

Date Sent: 1/25/02

Date Findings Requested By: 2/15/02

Primary Contact: Kent McDonald

Company/Organization: Fluor Hanford

E-mail: kent_m_mcdonald@rl.gov

Telephone: 373-4981

Fax: 372-1441

MSIN: H8-44

Secondary Contact: Ken Hladek

Company/Organization: Fluor Hanford

Telephone: 372-3201

Fax: 372-1441

MSIN: H8-44

Project Name: Solid Waste Environmental Impact Statement

Project Number/COA:

RL Project Manager: Michael Collins

REQUESTOR SHOULD SUBMIT A COPY OF THIS REQUEST TO THE RL PROJECT MANAGER UNDER WHOM THEIR PROJECT FALLS WITHIN 5 DAYS.

Project Description, Including Time Period over which proposed action will occur:

Remove silt/loam and/or larger material to be used in constructing closure covers/caps for the Low-Level Burial Grounds. Material removal would likely occur sometime after 2030.

Project Dimensions:

Area C is a large polygonal area located adjacent to the south side of Highway 240 and is centered approximately on the intersection of Beloit Avenue and Highway 240 and is approximately 368 ha (909 ac). Although this area is on the ALE side of Highway 240, it is clearly identified as a possible borrow use area in the Hanford Site comprehensive land-use plan environmental impact statement. Based upon an assumed average thickness of 1.8 m, the volume of material present is 6.6 million cubic meters.

Depth of Excavation(s): Minimum 2 m. May excavate to depth of silt/loam as yet undetermined.

Project Location:

☐ 100 Area ☐ 200 East Area ☐ 200 West Area ☐ 300 Area ☐ 400 Area

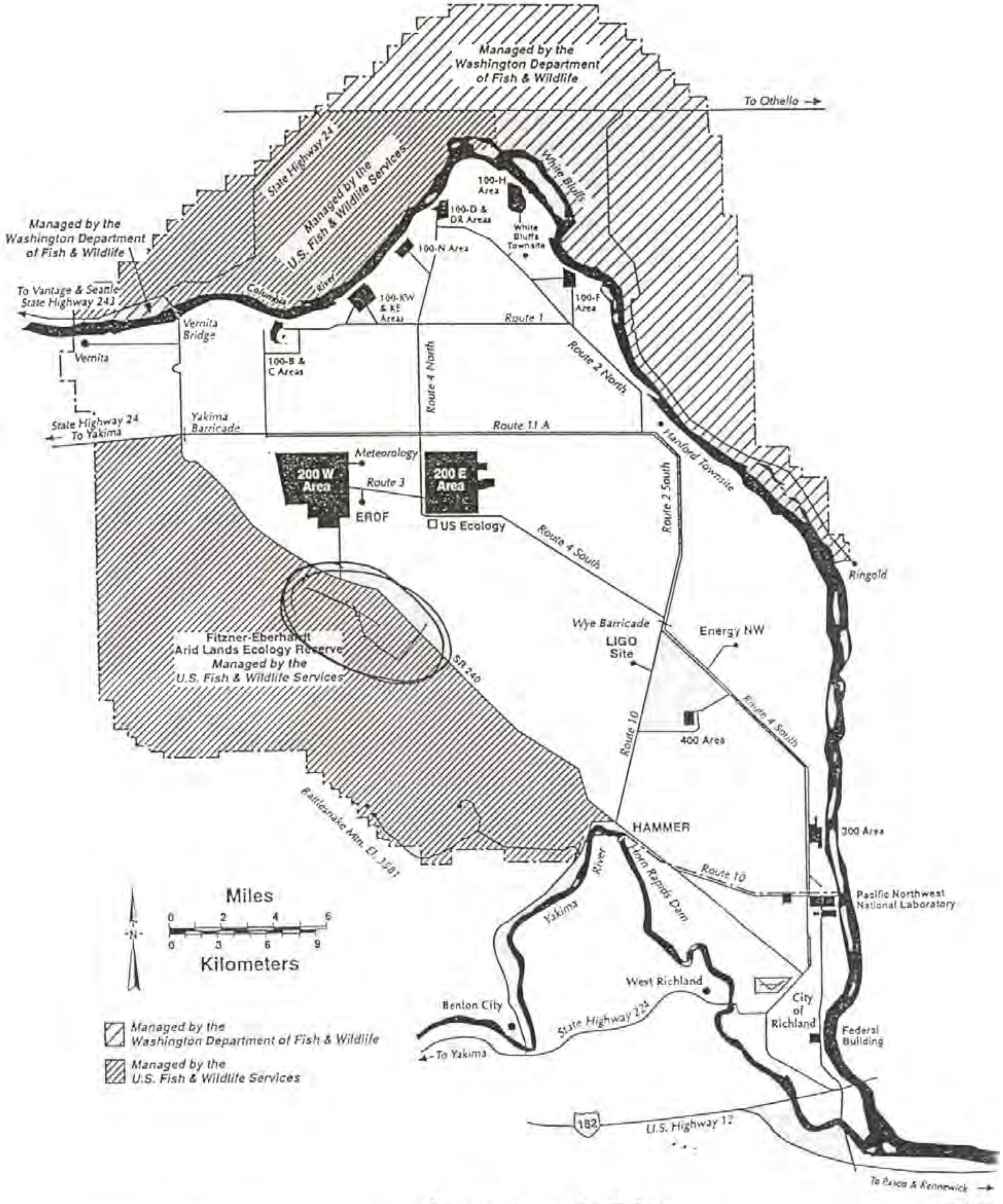
☐ 600 Area ☐ 700 Area ☒ Other: Area C conservation/mining

Township _____ N, Range _____ E UTM: Easting: ______ Northing: ______

Please also provide the following:
1. Overview map showing project location (or other suitable map to assist in finding the project site)
2. Map or scale drawing showing all excavation areas (including water, sewer, and power lines, etc.), parking, topsoil storage areas, equipment staging areas, access roads, and utility corridors.

Submitted By: K.M McDonald

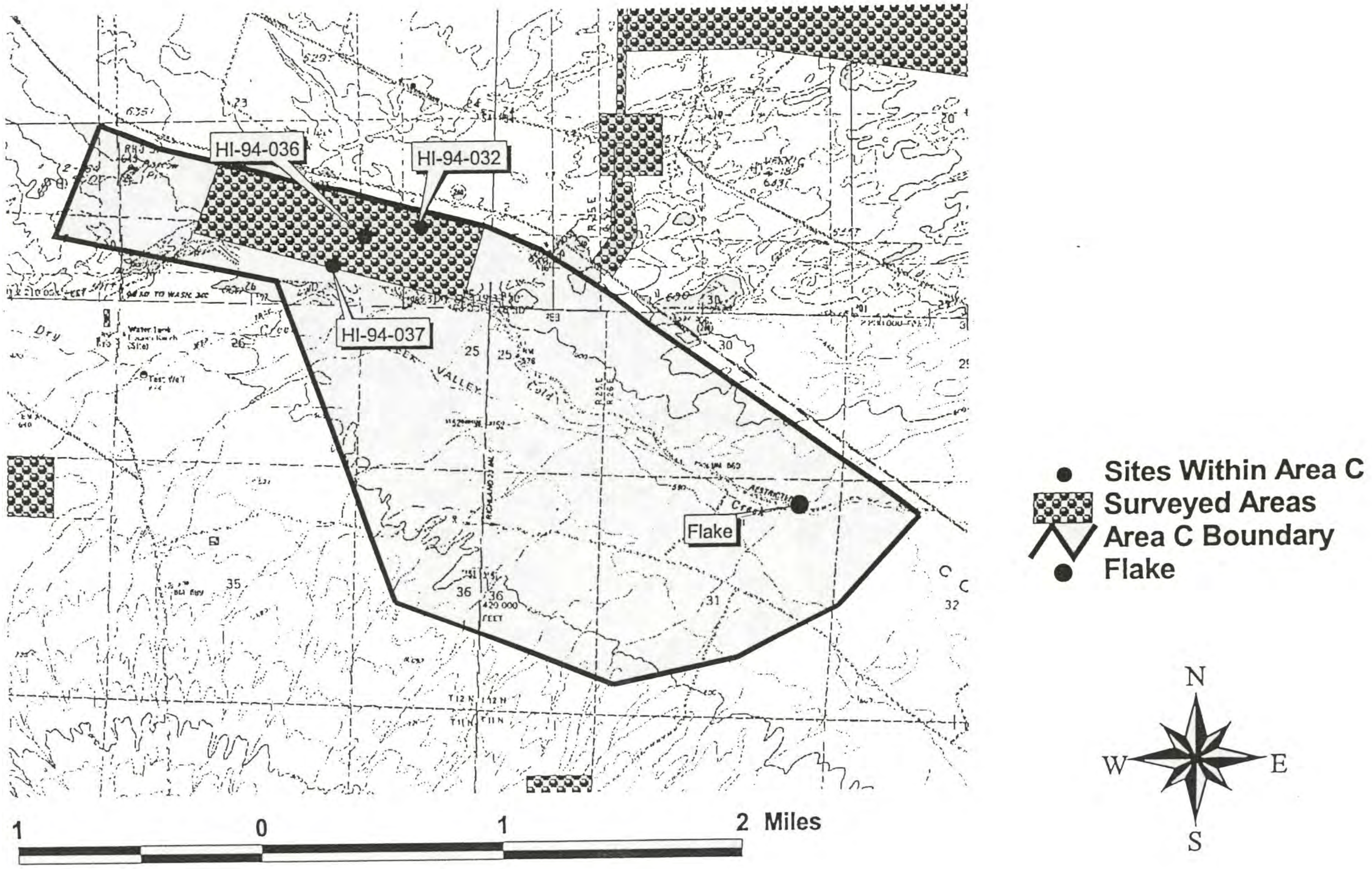
Telephone: 373-4981

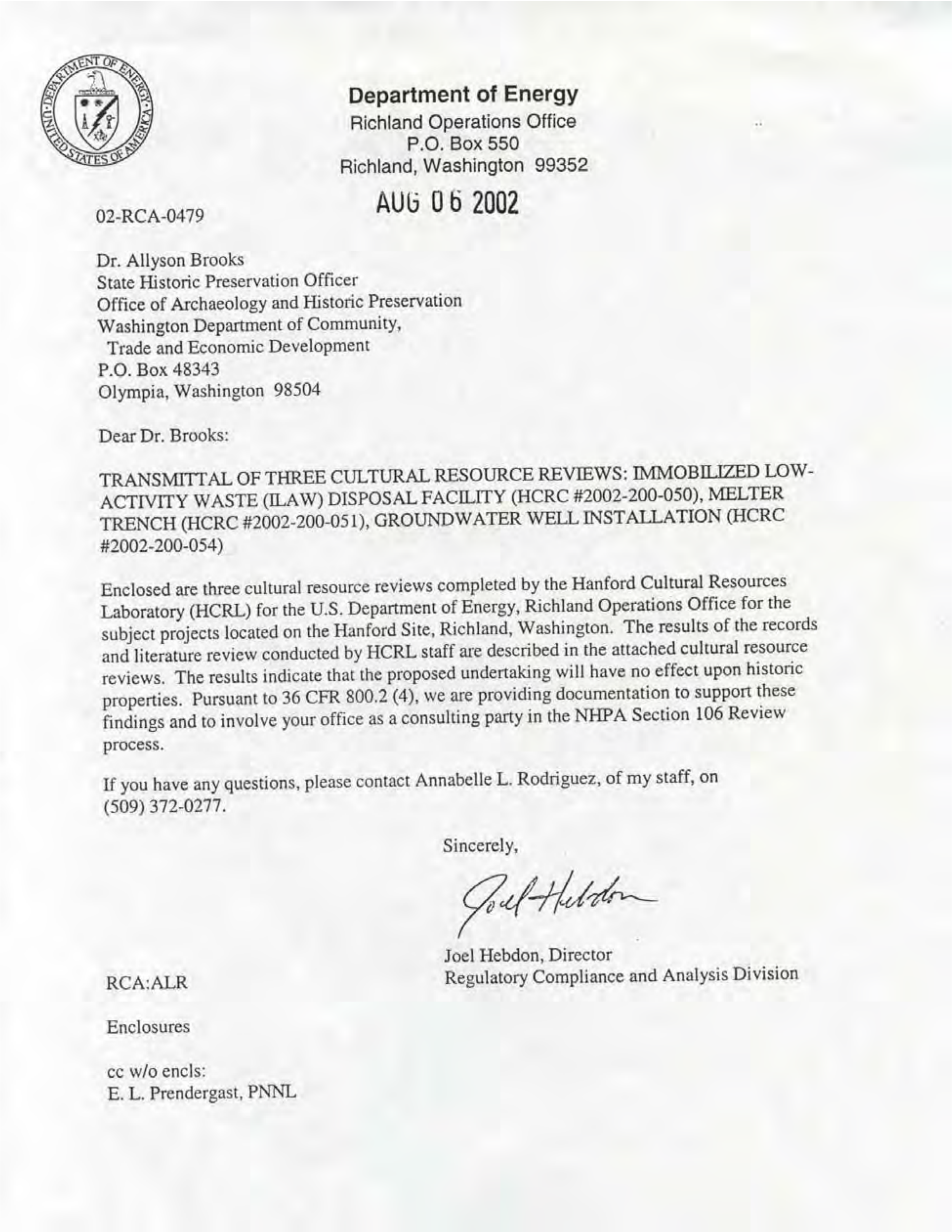


U.S. Department of Energy
Office of External Affairs
Richland, Washington 99352
(509) 376-7501

Hanford Site
U.S. Department of Energy

HCRC 2002-600-012





Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

AUG 06 2002

02-RCA-0479

Dr. Allyson Brooks
State Historic Preservation Officer
Office of Archaeology and Historic Preservation
Washington Department of Community,
  Trade and Economic Development
P.O. Box 48343
Olympia, Washington 98504

Dear Dr. Brooks:

TRANSMITTAL OF THREE CULTURAL RESOURCE REVIEWS: IMMOBILIZED LOW-ACTIVITY WASTE (ILAW) DISPOSAL FACILITY (HCRC #2002-200-050), MELTER TRENCH (HCRC #2002-200-051), GROUNDWATER WELL INSTALLATION (HCRC #2002-200-054)

Enclosed are three cultural resource reviews completed by the Hanford Cultural Resources Laboratory (HCRL) for the U.S. Department of Energy, Richland Operations Office for the subject projects located on the Hanford Site, Richland, Washington. The results of the records and literature review conducted by HCRL staff are described in the attached cultural resource reviews. The results indicate that the proposed undertaking will have no effect upon historic properties. Pursuant to 36 CFR 800.2 (4), we are providing documentation to support these findings and to involve your office as a consulting party in the NHPA Section 106 Review process.

If you have any questions, please contact Annabelle L. Rodriguez, of my staff, on (509) 372-0277.

Sincerely,

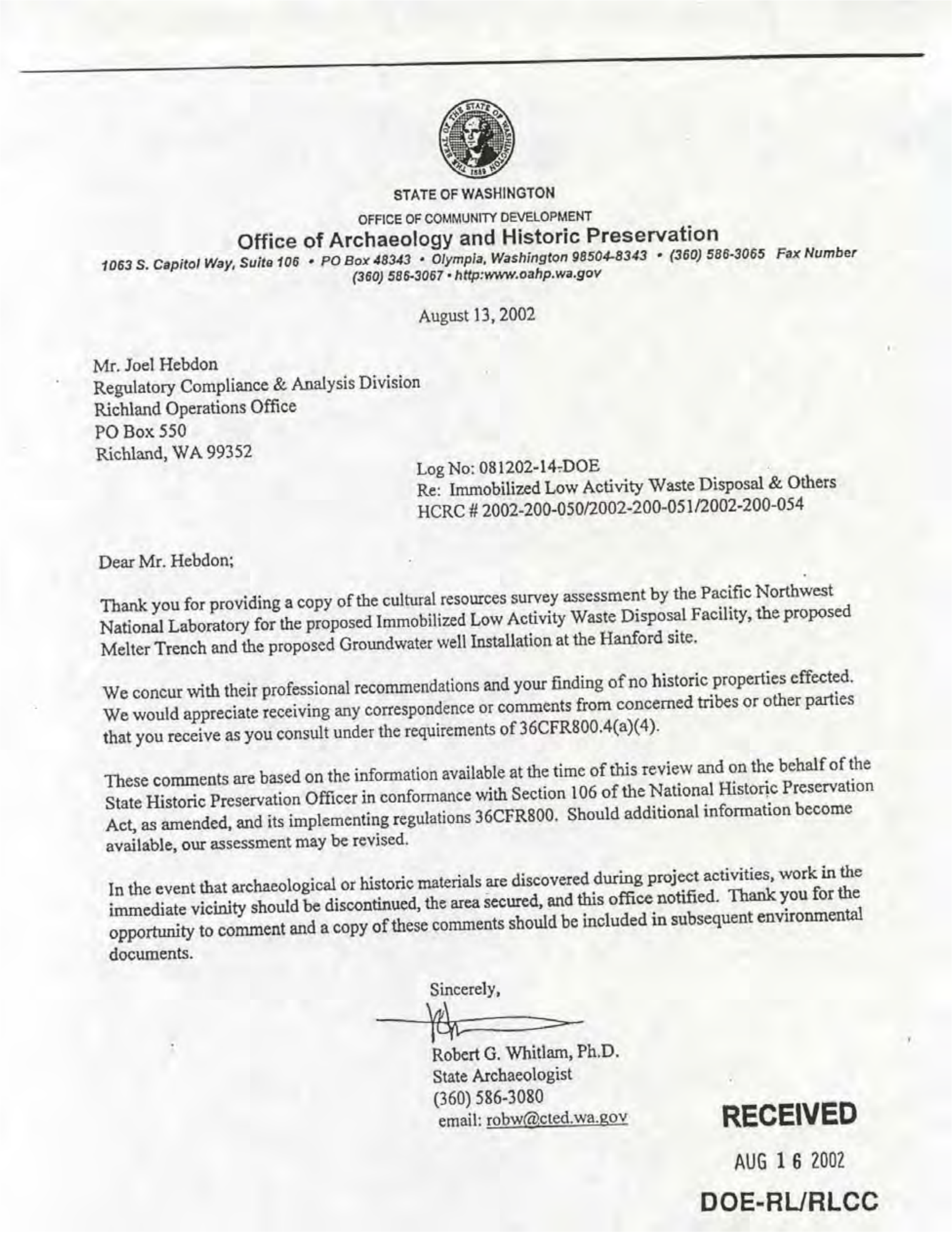
Joel Hebdon

Joel Hebdon, Director
Regulatory Compliance and Analysis Division

RCA:ALR

Enclosures

cc w/o encls:
E. L. Prendergast, PNNL



STATE OF WASHINGTON
OFFICE OF COMMUNITY DEVELOPMENT
Office of Archaeology and Historic Preservation
1063 S. Capitol Way, Suite 106 • PO Box 48343 • Olympia, Washington 98504-8343 • (360) 586-3065 Fax Number (360) 586-3067 • http:www.oahp.wa.gov

August 13, 2002

Mr. Joel Hebdon
Regulatory Compliance & Analysis Division
Richland Operations Office
PO Box 550
Richland, WA 99352

Log No: 081202-14-DOE
Re: Immobilized Low Activity Waste Disposal & Others
HCRC # 2002-200-050/2002-200-051/2002-200-054

Dear Mr. Hebdon;

Thank you for providing a copy of the cultural resources survey assessment by the Pacific Northwest National Laboratory for the proposed Immobilized Low Activity Waste Disposal Facility, the proposed Melter Trench and the proposed Groundwater well Installation at the Hanford site.

We concur with their professional recommendations and your finding of no historic properties effected. We would appreciate receiving any correspondence or comments from concerned tribes or other parties that you receive as you consult under the requirements of 36CFR800.4(a)(4).

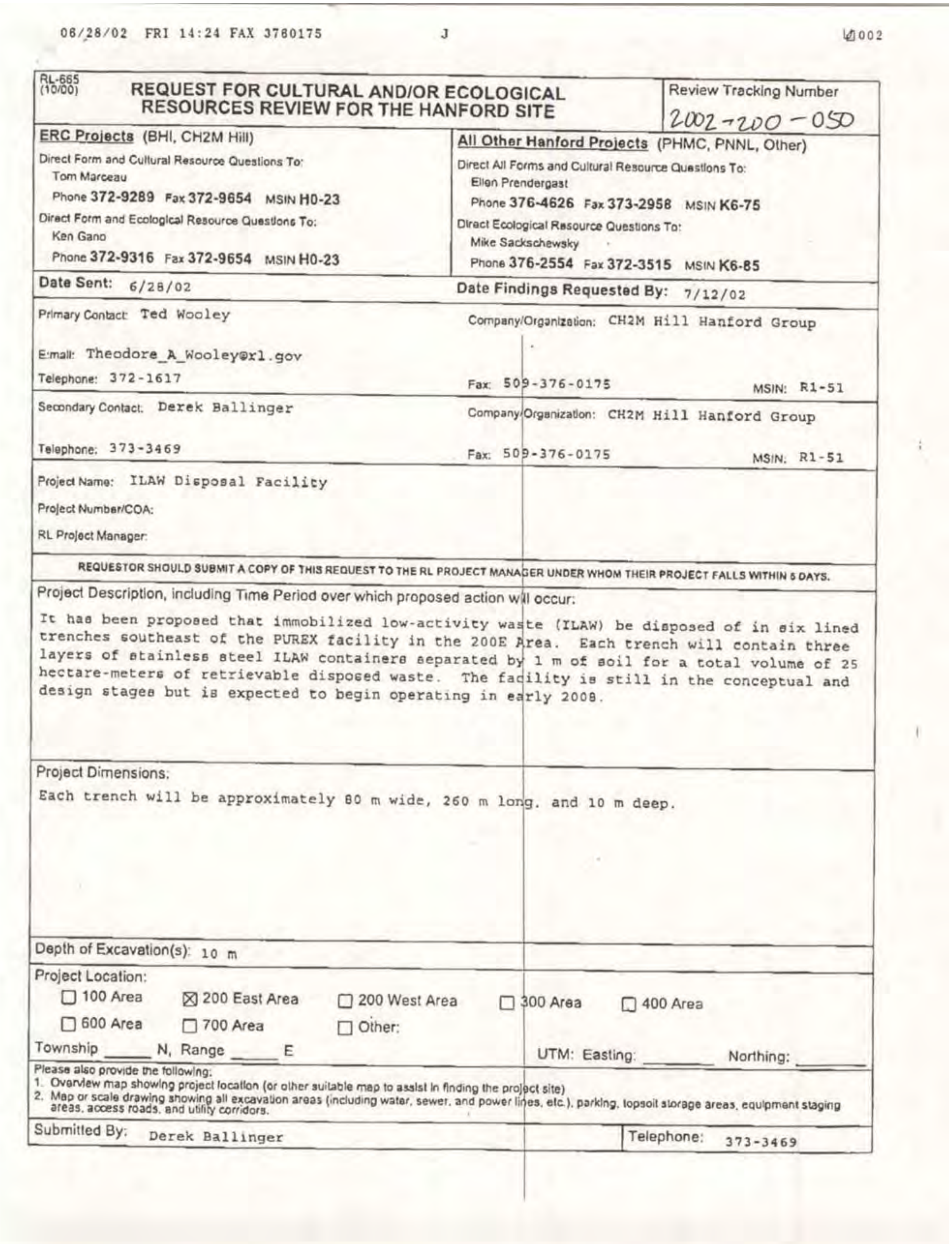
These comments are based on the information available at the time of this review and on the behalf of the State Historic Preservation Officer in conformance with Section 106 of the National Historic Preservation Act, as amended, and its implementing regulations 36CFR800. Should additional information become available, our assessment may be revised.

In the event that archaeological or historic materials are discovered during project activities, work in the immediate vicinity should be discontinued, the area secured, and this office notified. Thank you for the opportunity to comment and a copy of these comments should be included in subsequent environmental documents.

Sincerely,

Robert G. Whitlam, Ph.D.
State Archaeologist
(360) 586-3080
email: robw@cted.wa.gov

RECEIVED
AUG 16 2002
DOE-RL/RLCC



06/28/02 FRI 14:24 FAX 3760175 J 002

RL-665
(10/00)

REQUEST FOR CULTURAL AND/OR ECOLOGICAL RESOURCES REVIEW FOR THE HANFORD SITE

Review Tracking Number 2002-200-050

ERC Projects (BHI, CH2M Hill) Direct Form and Cultural Resource Questions To: Tom Marceau Phone **372-9289** Fax **372-9654** MSIN **H0-23** Direct Form and Ecological Resource Questions To: Ken Gano Phone **372-9316** Fax **372-9654** MSIN **H0-23**	**All Other Hanford Projects** (PHMC, PNNL, Other) Direct All Forms and Cultural Resource Questions To: Ellen Prendergast Phone **376-4626** Fax **373-2958** MSIN **K6-75** Direct Ecological Resource Questions To: Mike Sackschewsky Phone **376-2554** Fax **372-3515** MSIN **K6-85**
Date Sent: 6/28/02	**Date Findings Requested By:** 7/12/02

Primary Contact: Ted Wooley
Company/Organization: CH2M Hill Hanford Group
E-mail: Theodore_A_Wooley@rl.gov
Telephone: 372-1617
Fax: 509-376-0175
MSIN: R1-51

Secondary Contact: Derek Ballinger
Company/Organization: CH2M Hill Hanford Group
Telephone: 373-3469
Fax: 509-376-0175
MSIN: R1-51

Project Name: ILAW Disposal Facility
Project Number/COA:
RL Project Manager:

REQUESTOR SHOULD SUBMIT A COPY OF THIS REQUEST TO THE RL PROJECT MANAGER UNDER WHOM THEIR PROJECT FALLS WITHIN 5 DAYS.

Project Description, including Time Period over which proposed action will occur:

It has been proposed that immobilized low-activity waste (ILAW) be disposed of in six lined trenches southeast of the PUREX facility in the 200E Area. Each trench will contain three layers of stainless steel ILAW containers separated by 1 m of soil for a total volume of 25 hectare-meters of retrievable disposed waste. The facility is still in the conceptual and design stages but is expected to begin operating in early 2008.

Project Dimensions:

Each trench will be approximately 80 m wide, 260 m long, and 10 m deep.

Depth of Excavation(s): 10 m

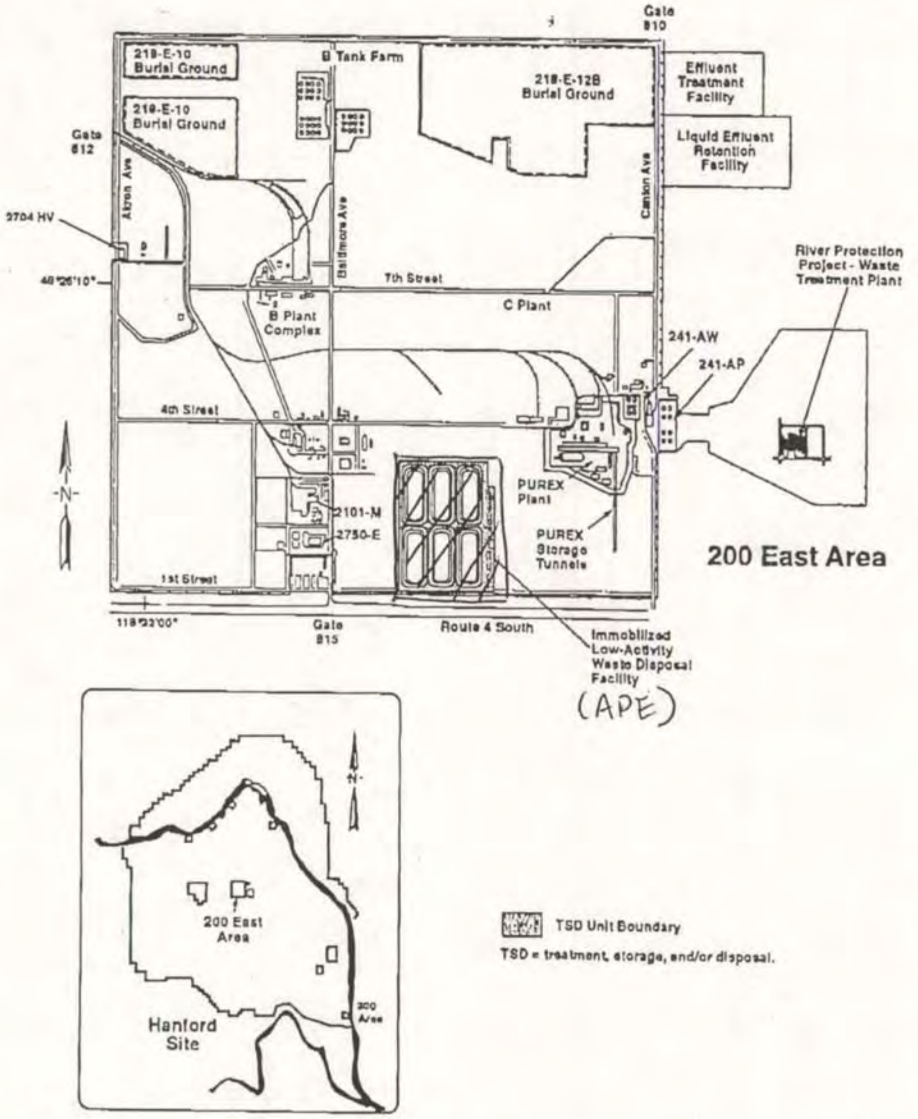
Project Location:

☐ 100 Area ☒ 200 East Area ☐ 200 West Area ☐ 300 Area ☐ 400 Area
☐ 600 Area ☐ 700 Area ☐ Other:

Township ______ N, Range ______ E
UTM: Easting: ________ Northing: ________

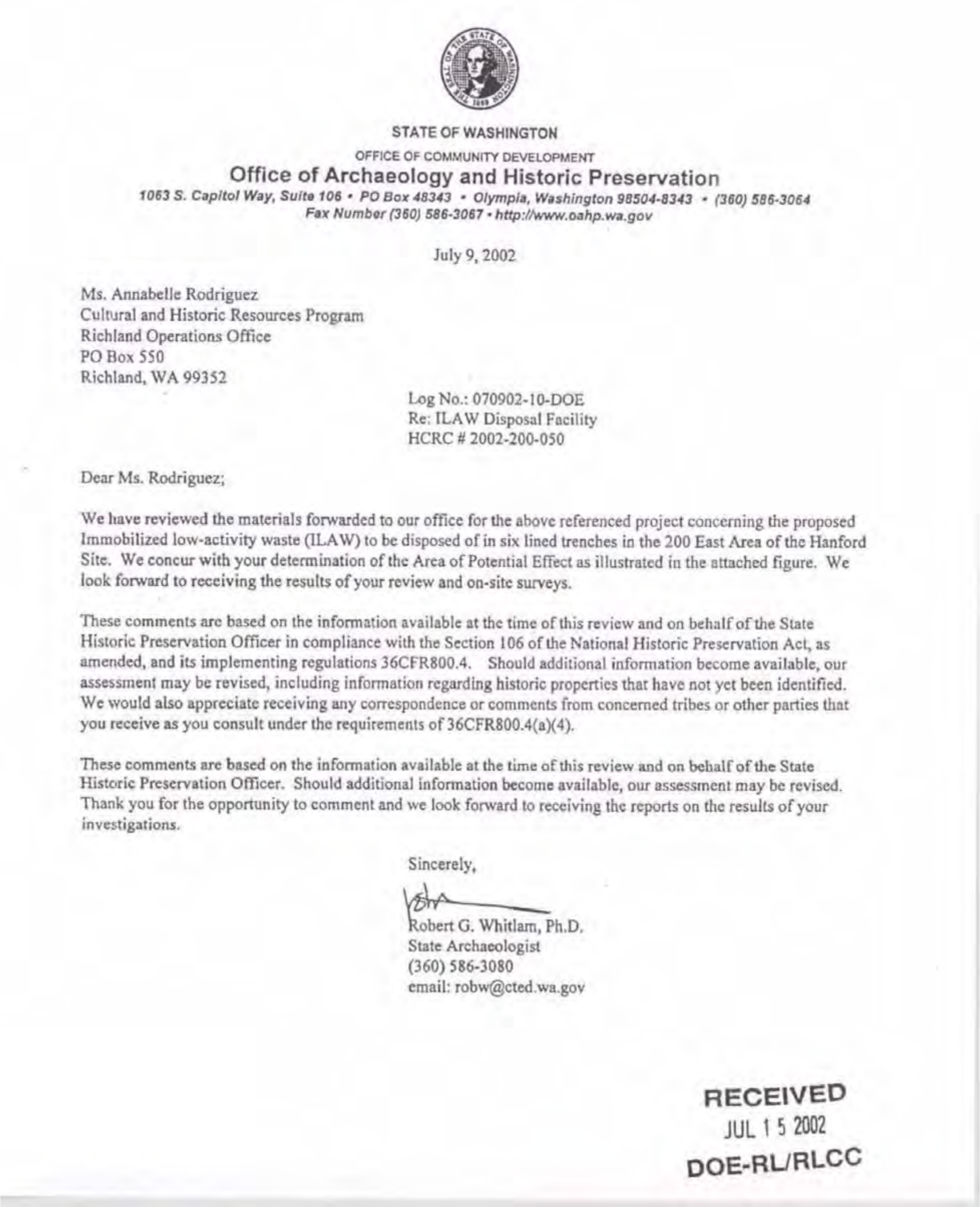
Please also provide the following:
1. Overview map showing project location (or other suitable map to assist in finding the project site)
2. Map or scale drawing showing all excavation areas (including water, sewer, and power lines, etc.), parking, topsoil storage areas, equipment staging areas, access roads, and utility corridors.

Submitted By: Derek Ballinger
Telephone: 373-3469



M0106-1,10
6-18-01

Figure 2-1. Immobilized Low-Activity Waste Disposal Facility Site Plan.



STATE OF WASHINGTON
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Fax Number (360) 586-3067 • http://www.oahp.wa.gov

July 9, 2002

Ms. Annabelle Rodriguez
Cultural and Historic Resources Program
Richland Operations Office
PO Box 550
Richland, WA 99352

Log No.: 070902-10-DOE
Re: ILAW Disposal Facility
HCRC # 2002-200-050

Dear Ms. Rodriguez;

We have reviewed the materials forwarded to our office for the above referenced project concerning the proposed Immobilized low-activity waste (ILAW) to be disposed of in six lined trenches in the 200 East Area of the Hanford Site. We concur with your determination of the Area of Potential Effect as illustrated in the attached figure. We look forward to receiving the results of your review and on-site surveys.

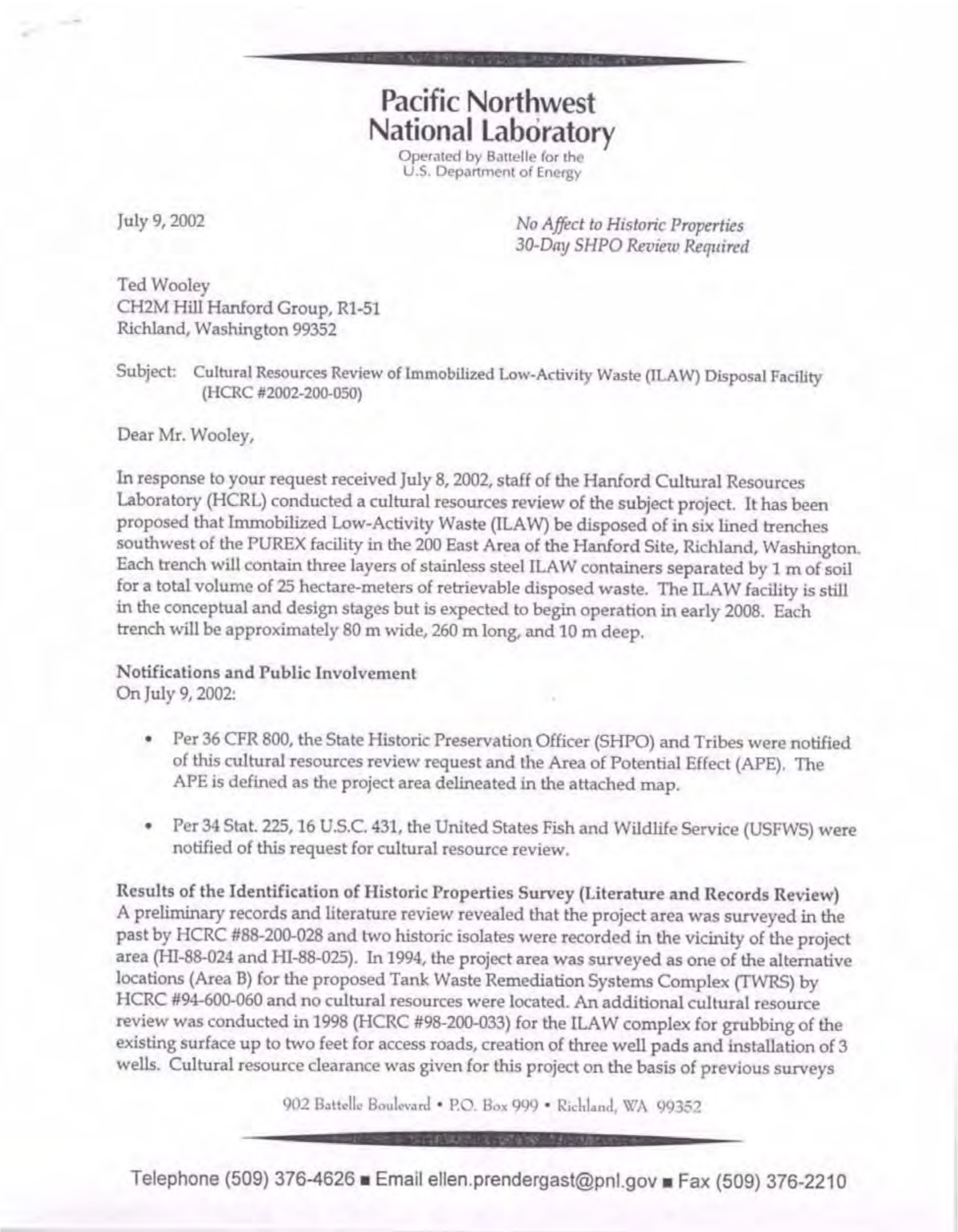
These comments are based on the information available at the time of this review and on behalf of the State Historic Preservation Officer in compliance with the Section 106 of the National Historic Preservation Act, as amended, and its implementing regulations 36CFR800.4. Should additional information become available, our assessment may be revised, including information regarding historic properties that have not yet been identified. We would also appreciate receiving any correspondence or comments from concerned tribes or other parties that you receive as you consult under the requirements of 36CFR800.4(a)(4).

These comments are based on the information available at the time of this review and on behalf of the State Historic Preservation Officer. Should additional information become available, our assessment may be revised. Thank you for the opportunity to comment and we look forward to receiving the reports on the results of your investigations.

Sincerely,

Robert G. Whitlam, Ph.D.
State Archaeologist
(360) 586-3080
email: robw@cted.wa.gov

RECEIVED
JUL 15 2002
DOE-RL/RLCC



Pacific Northwest
National Laboratory
Operated by Battelle for the
U.S. Department of Energy

July 9, 2002

No Affect to Historic Properties
30-Day SHPO Review Required

Ted Wooley
CH2M Hill Hanford Group, R1-51
Richland, Washington 99352

Subject: Cultural Resources Review of Immobilized Low-Activity Waste (ILAW) Disposal Facility (HCRC #2002-200-050)

Dear Mr. Wooley,

In response to your request received July 8, 2002, staff of the Hanford Cultural Resources Laboratory (HCRL) conducted a cultural resources review of the subject project. It has been proposed that Immobilized Low-Activity Waste (ILAW) be disposed of in six lined trenches southwest of the PUREX facility in the 200 East Area of the Hanford Site, Richland, Washington. Each trench will contain three layers of stainless steel ILAW containers separated by 1 m of soil for a total volume of 25 hectare-meters of retrievable disposed waste. The ILAW facility is still in the conceptual and design stages but is expected to begin operation in early 2008. Each trench will be approximately 80 m wide, 260 m long, and 10 m deep.

Notifications and Public Involvement
On July 9, 2002:

- Per 36 CFR 800, the State Historic Preservation Officer (SHPO) and Tribes were notified of this cultural resources review request and the Area of Potential Effect (APE). The APE is defined as the project area delineated in the attached map.
- Per 34 Stat. 225, 16 U.S.C. 431, the United States Fish and Wildlife Service (USFWS) were notified of this request for cultural resource review.

Results of the Identification of Historic Properties Survey (Literature and Records Review)
A preliminary records and literature review revealed that the project area was surveyed in the past by HCRC #88-200-028 and two historic isolates were recorded in the vicinity of the project area (HI-88-024 and HI-88-025). In 1994, the project area was surveyed as one of the alternative locations (Area B) for the proposed Tank Waste Remediation Systems Complex (TWRS) by HCRC #94-600-060 and no cultural resources were located. An additional cultural resource review was conducted in 1998 (HCRC #98-200-033) for the ILAW complex for grubbing of the existing surface up to two feet for access roads, creation of three well pads and installation of 3 wells. Cultural resource clearance was given for this project on the basis of previous surveys

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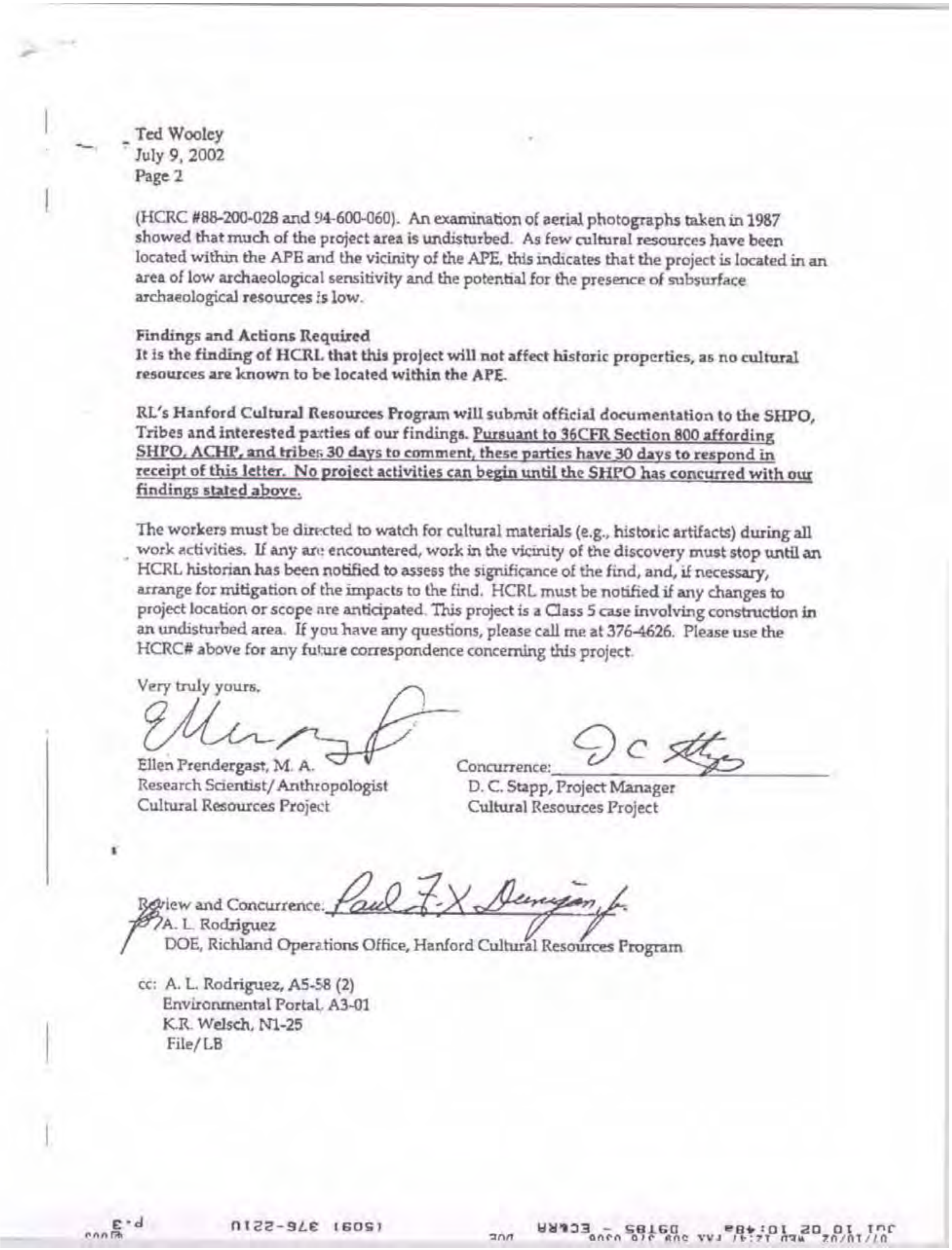


Ted Wooley
July 9, 2002
Page 2

(HCRC #88-200-028 and 94-600-060). An examination of aerial photographs taken in 1987 showed that much of the project area is undisturbed. As few cultural resources have been located within the APE and the vicinity of the APE, this indicates that the project is located in an area of low archaeological sensitivity and the potential for the presence of subsurface archaeological resources is low.

Findings and Actions Required
It is the finding of HCRL that this project will not affect historic properties, as no cultural resources are known to be located within the APE.

RL's Hanford Cultural Resources Program will submit official documentation to the SHPO, Tribes and interested parties of our findings. Pursuant to 36CFR Section 800 affording SHPO, ACHP, and tribes 30 days to comment, these parties have 30 days to respond in receipt of this letter. No project activities can begin until the SHPO has concurred with our findings stated above.

The workers must be directed to watch for cultural materials (e.g., historic artifacts) during all work activities. If any are encountered, work in the vicinity of the discovery must stop until an HCRL historian has been notified to assess the significance of the find, and, if necessary, arrange for mitigation of the impacts to the find. HCRL must be notified if any changes to project location or scope are anticipated. This project is a Class 5 case involving construction in an undisturbed area. If you have any questions, please call me at 376-4626. Please use the HCRC# above for any future correspondence concerning this project.

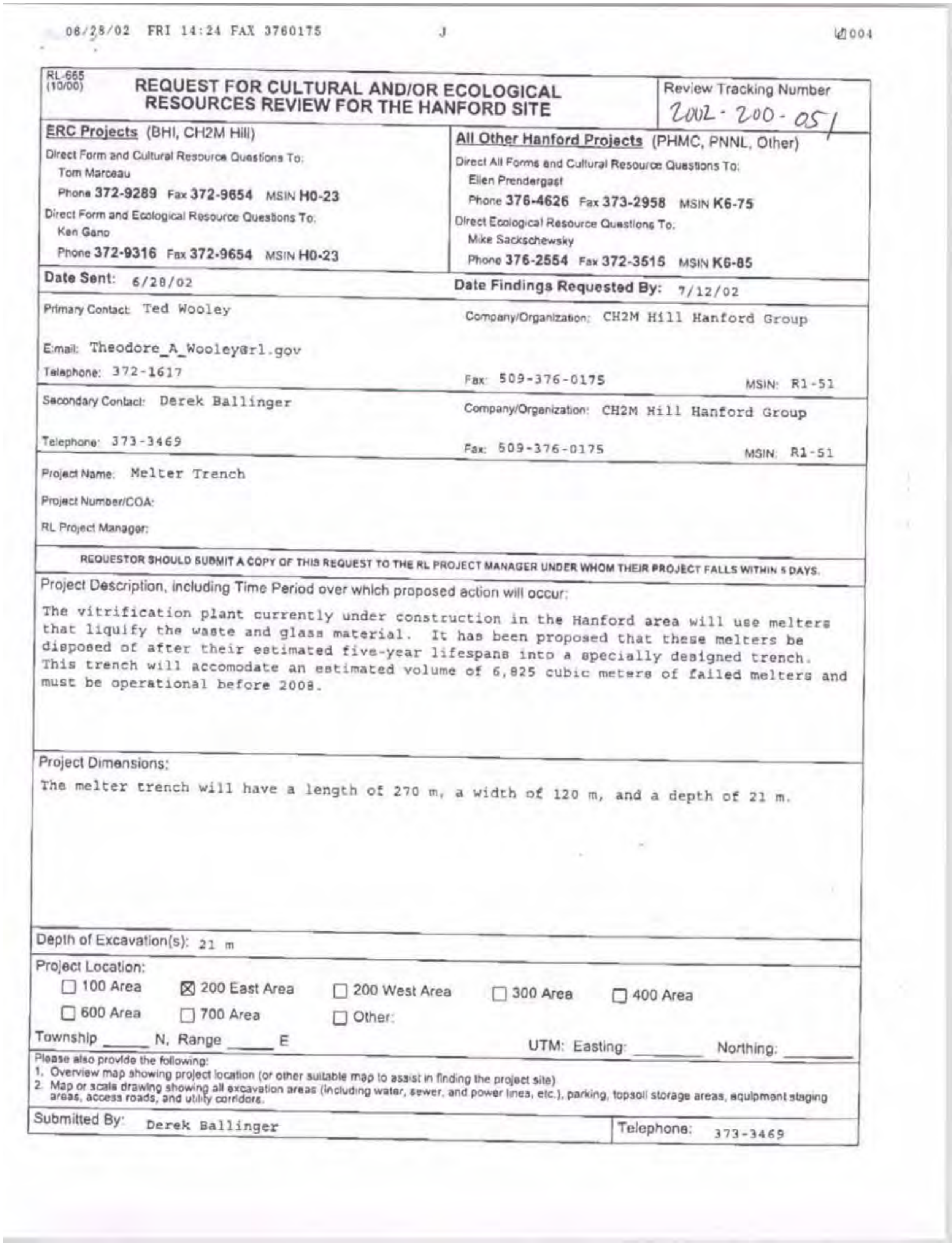
Very truly yours,

Ellen Prendergast, M. A.
Research Scientist/Anthropologist
Cultural Resources Project

Concurrence: D C Stapp
D. C. Stapp, Project Manager
Cultural Resources Project

Review and Concurrence: Paul F.X. Dunigan, Jr.
for A. L. Rodriguez
DOE, Richland Operations Office, Hanford Cultural Resources Program

cc: A. L. Rodriguez, A5-58 (2)
Environmental Portal, A3-01
K.R. Welsch, N1-25
File/LB



06/28/02 FRI 14:24 FAX 3760175 J 004

RL-665
(10/00)

REQUEST FOR CULTURAL AND/OR ECOLOGICAL RESOURCES REVIEW FOR THE HANFORD SITE

Review Tracking Number 2002 - 200 - 051

ERC Projects (BHI, CH2M Hill)	**All Other Hanford Projects** (PHMC, PNNL, Other)
Direct Form and Cultural Resource Questions To: Tom Marceau Phone **372-9289** Fax **372-9654** MSIN **H0-23**	Direct All Forms and Cultural Resource Questions To: Ellen Prendergast Phone **376-4626** Fax **373-2958** MSIN **K6-75**
Direct Form and Ecological Resource Questions To: Ken Gano Phone **372-9316** Fax **372-9654** MSIN **H0-23**	Direct Ecological Resource Questions To: Mike Sackschewsky Phone **376-2554** Fax **372-3515** MSIN **K6-85**
Date Sent: 6/28/02	**Date Findings Requested By:** 7/12/02

Primary Contact: Ted Wooley

Company/Organization: CH2M Hill Hanford Group

E-mail: Theodore_A_Wooley@rl.gov

Telephone: 372-1617

Fax: 509-376-0175

MSIN: R1-51

Secondary Contact: Derek Ballinger

Company/Organization: CH2M Hill Hanford Group

Telephone: 373-3469

Fax: 509-376-0175

MSIN: R1-51

Project Name: Melter Trench

Project Number/COA:

RL Project Manager:

REQUESTOR SHOULD SUBMIT A COPY OF THIS REQUEST TO THE RL PROJECT MANAGER UNDER WHOM THEIR PROJECT FALLS WITHIN 5 DAYS.

Project Description, including Time Period over which proposed action will occur:

The vitrification plant currently under construction in the Hanford area will use melters that liquify the waste and glass material. It has been proposed that these melters be disposed of after their estimated five-year lifespans into a specially designed trench. This trench will accomodate an estimated volume of 6,825 cubic meters of failed melters and must be operational before 2008.

Project Dimensions:

The melter trench will have a length of 270 m, a width of 120 m, and a depth of 21 m.

Depth of Excavation(s): 21 m

Project Location:

☐ 100 Area ☒ 200 East Area ☐ 200 West Area ☐ 300 Area ☐ 400 Area

☐ 600 Area ☐ 700 Area ☐ Other:

Township _____ N, Range _____ E UTM: Easting: _______ Northing: _______

Please also provide the following:

1. Overview map showing project location (or other suitable map to assist in finding the project site)
2. Map or scale drawing showing all excavation areas (including water, sewer, and power lines, etc.), parking, topsoil storage areas, equipment staging areas, access roads, and utility corridors.

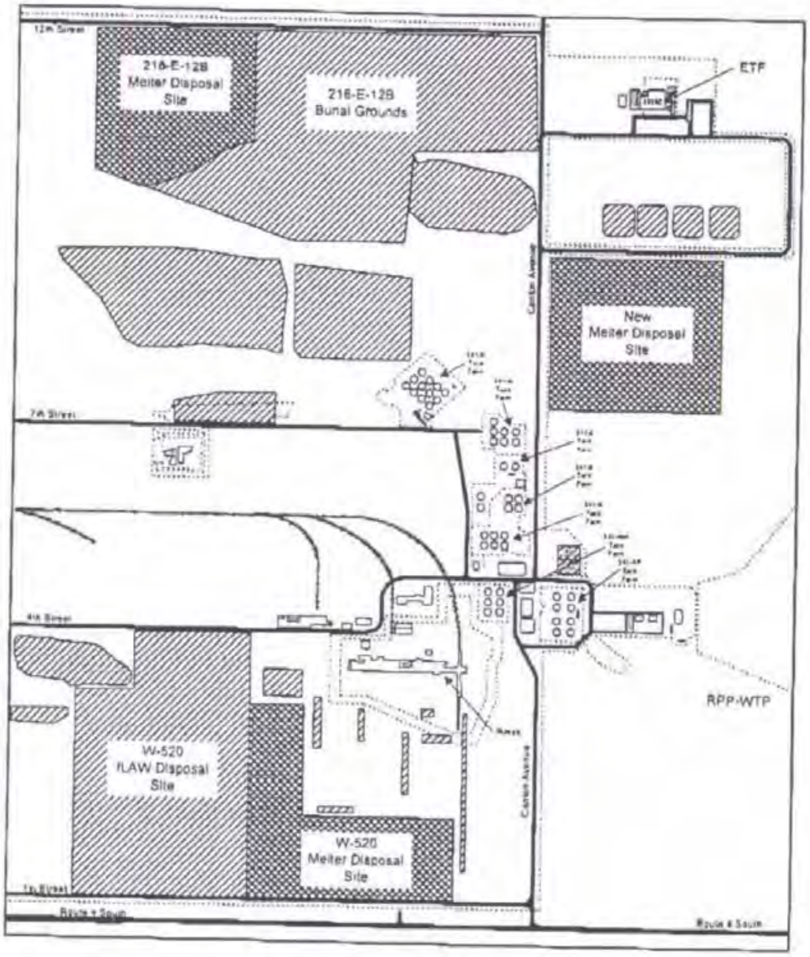
Submitted By: Derek Ballinger

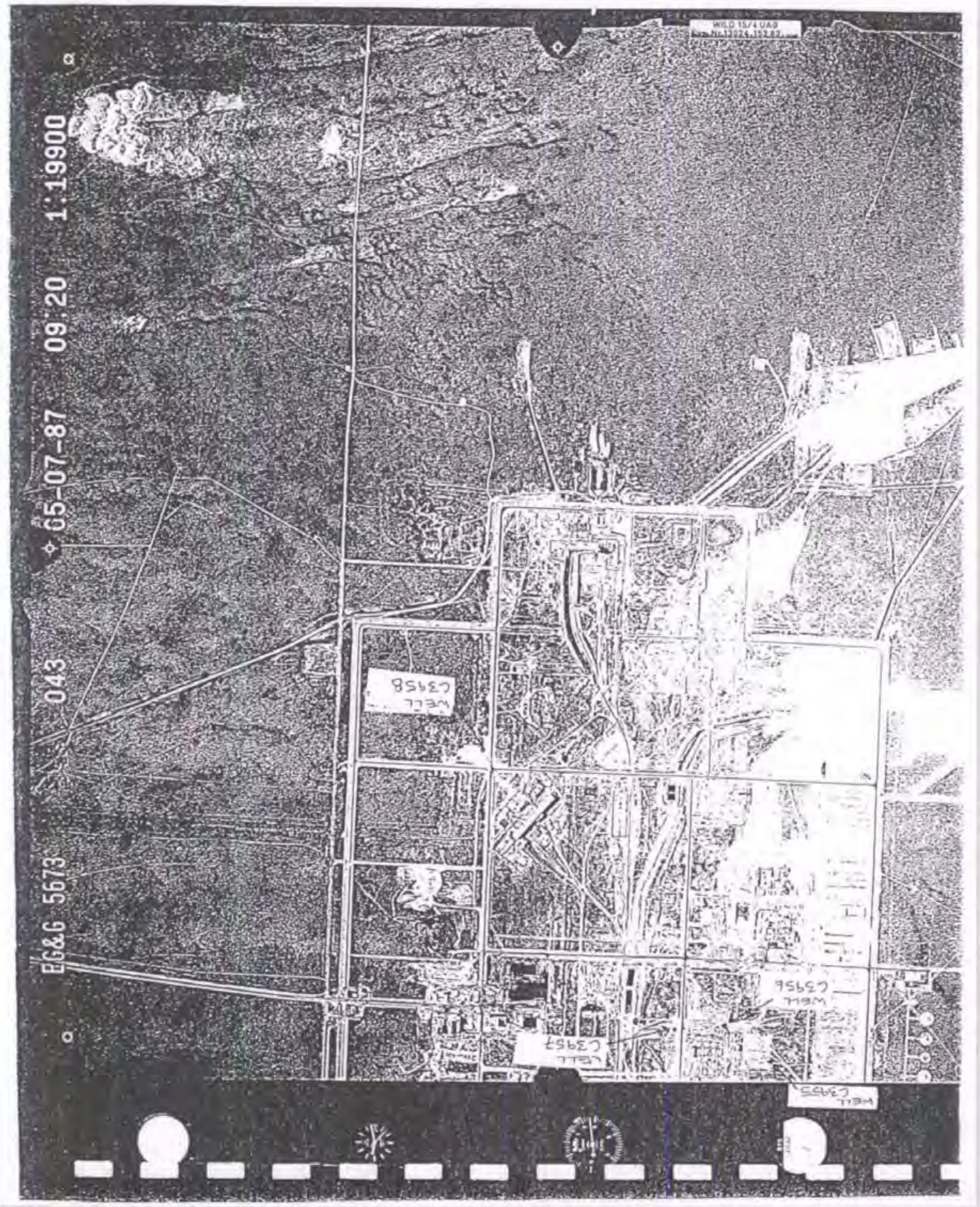
Telephone: 373-3469

4.1.1 Alternative Description

The following describes each disposal site alternative. Figure 4-3 presents the general location of disposal site alternatives, excluding the multiuse burial trench site (Alternative 1C). As discussed in the Alternative 1C description, the multiuse burial trench program is at such an early stage of development that a site has not been selected.

Figure 4-3. Potential Failed Melter Disposal Sites.




EG&G 5673
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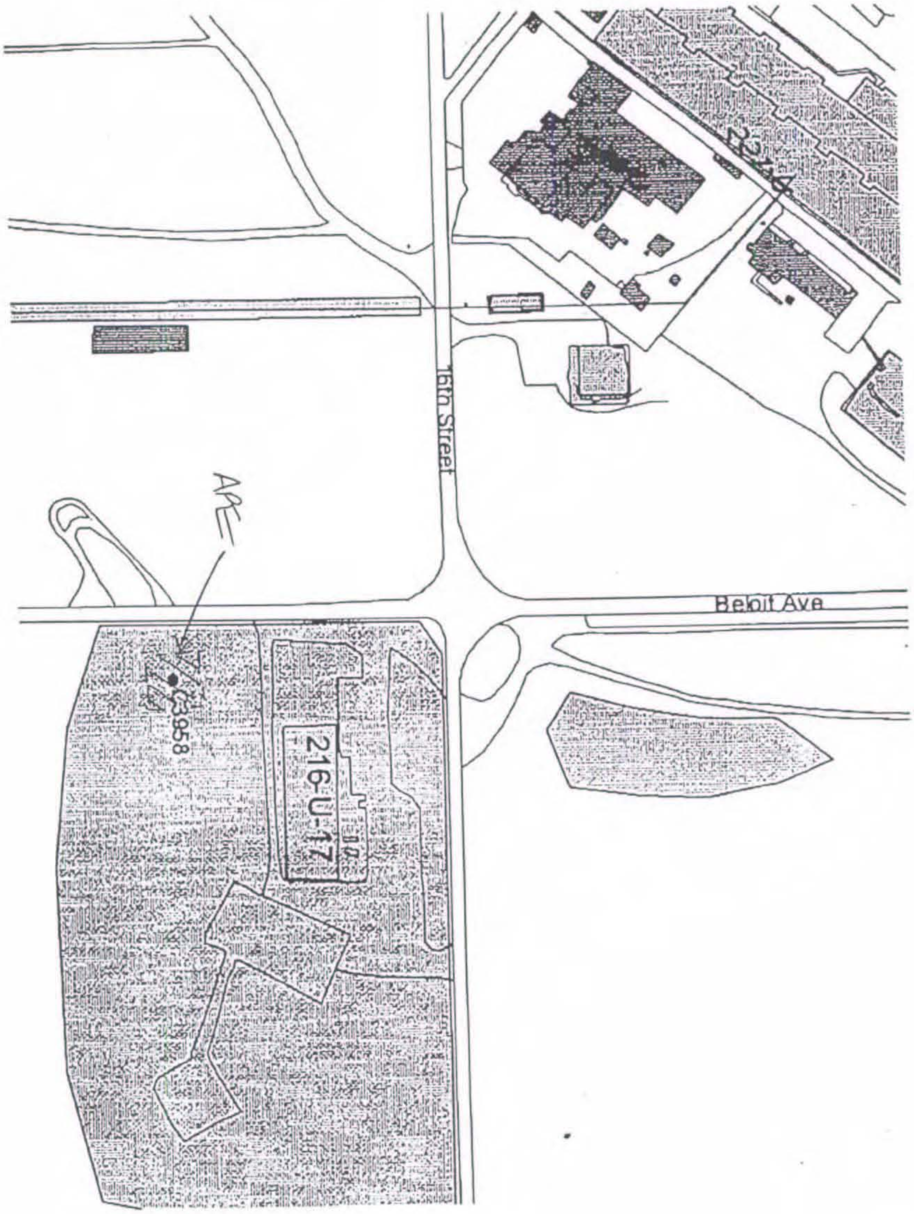
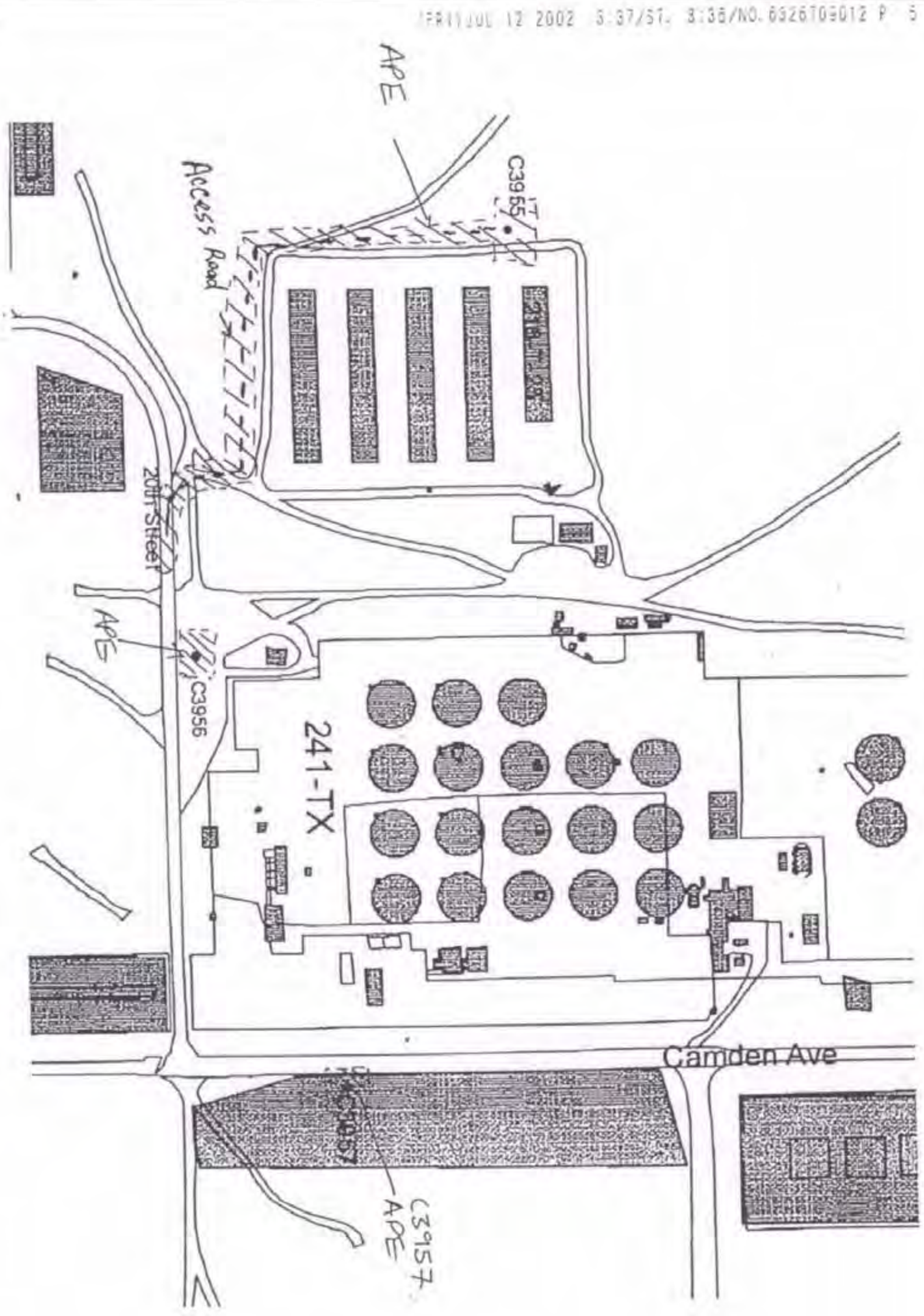
05-07-87
09:20
1:19900
WILD 15/4 UAG
WELL C3958
WELL C3957
WELL C3956
WELL C3955

FROM (FRI)JUL 12 2002 3:37/ST. 3:36/NO.6326709012 P 4

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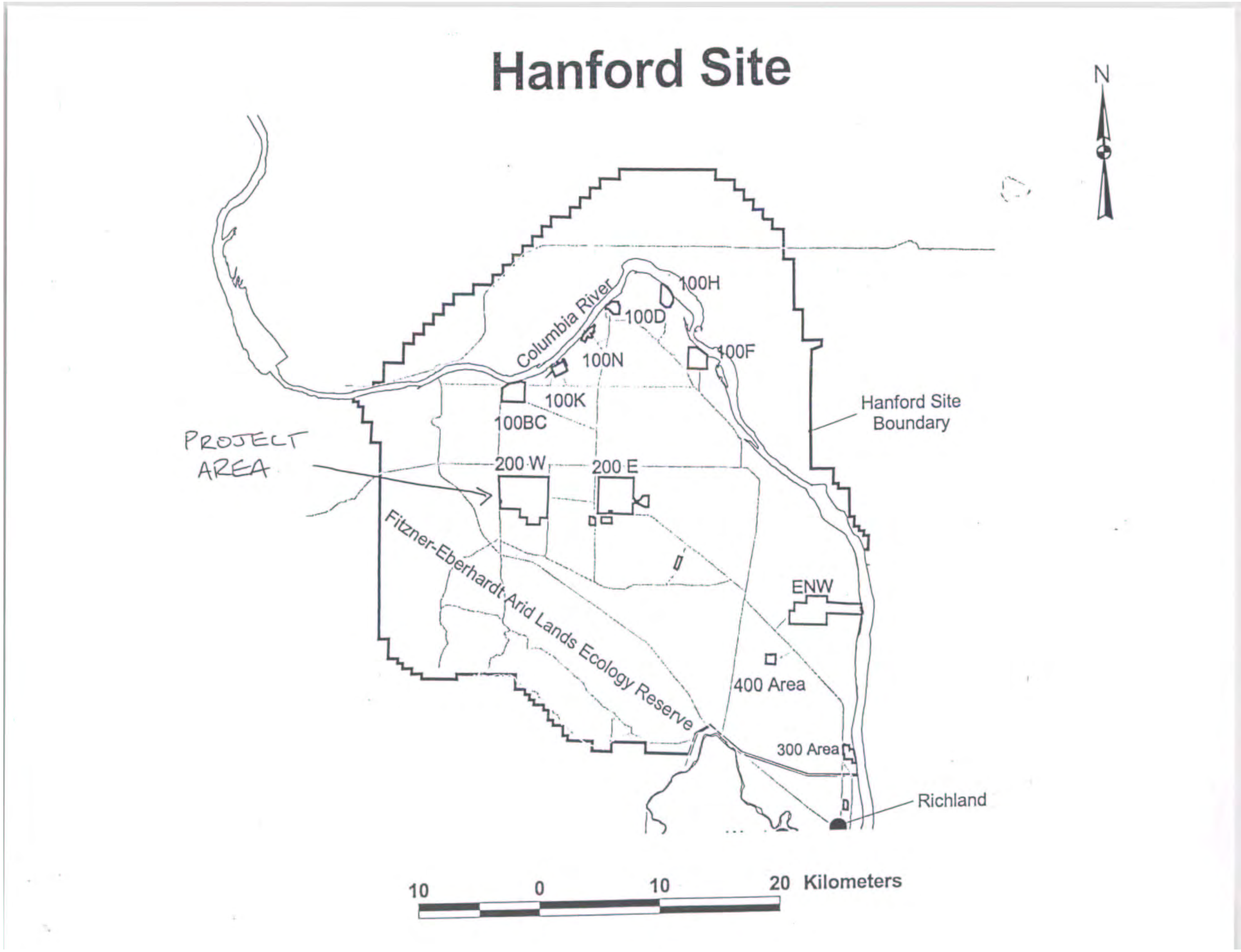
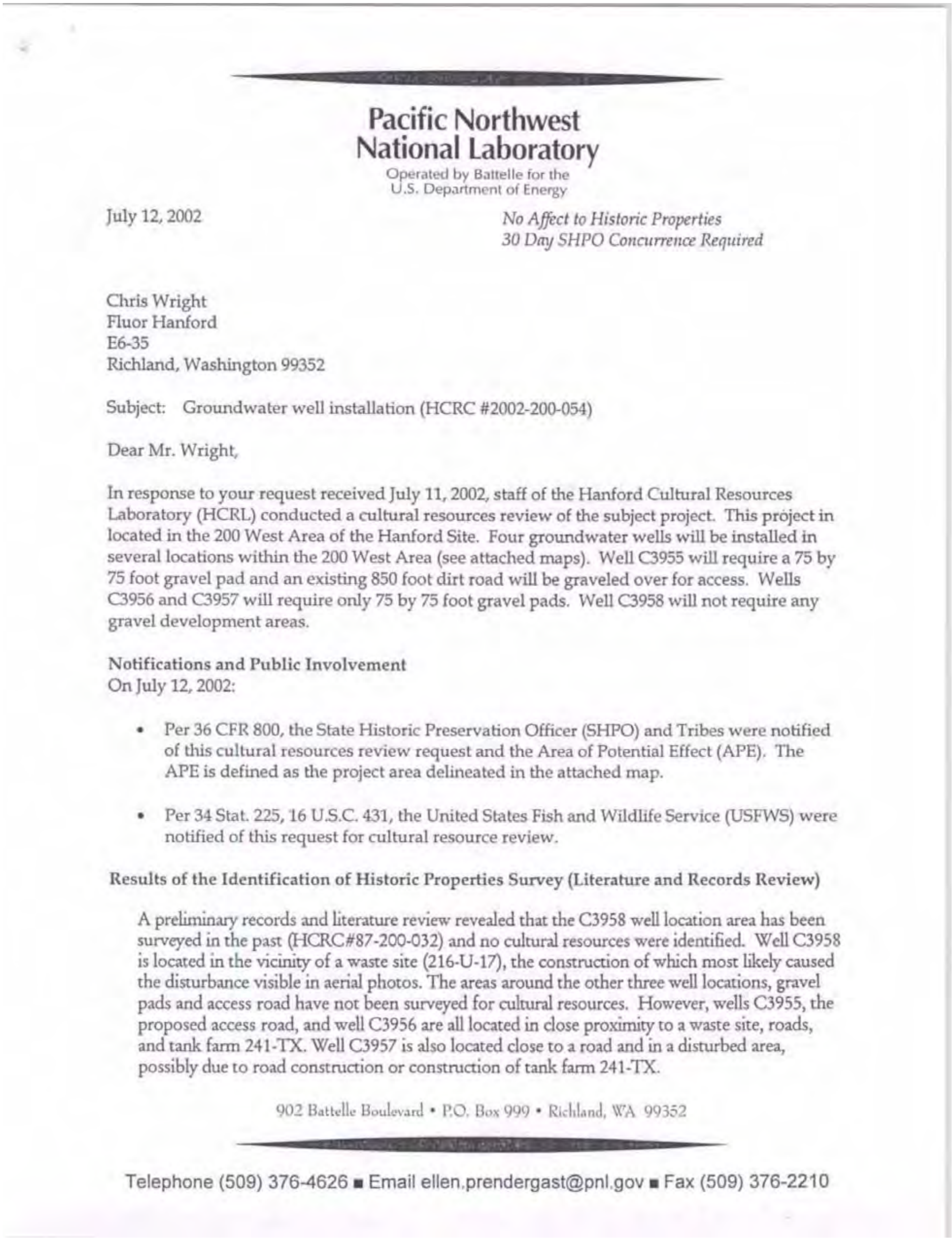
C3955
Access Road
20th Street
APE
C3956
241-TX
Camden Ave
C3957
APE


Hanford Site
N
PROJECT AREA
Columbia River
100H
100D
100F
100N
100K
100BC
200 W
200 E
Hanford Site Boundary
Fitzner-Eberhardt Arid Lands Ecology Reserve
ENW
400 Area
300 Area
Richland
10
0
10
20 Kilometers



Pacific Northwest
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July 12, 2002

No Affect to Historic Properties
30 Day SHPO Concurrence Required

Chris Wright
Fluor Hanford
E6-35
Richland, Washington 99352

Subject: Groundwater well installation (HCRC #2002-200-054)

Dear Mr. Wright,

In response to your request received July 11, 2002, staff of the Hanford Cultural Resources Laboratory (HCRL) conducted a cultural resources review of the subject project. This project in located in the 200 West Area of the Hanford Site. Four groundwater wells will be installed in several locations within the 200 West Area (see attached maps). Well C3955 will require a 75 by 75 foot gravel pad and an existing 850 foot dirt road will be graveled over for access. Wells C3956 and C3957 will require only 75 by 75 foot gravel pads. Well C3958 will not require any gravel development areas.

Notifications and Public Involvement
On July 12, 2002:

- Per 36 CFR 800, the State Historic Preservation Officer (SHPO) and Tribes were notified of this cultural resources review request and the Area of Potential Effect (APE). The APE is defined as the project area delineated in the attached map.

- Per 34 Stat. 225, 16 U.S.C. 431, the United States Fish and Wildlife Service (USFWS) were notified of this request for cultural resource review.

Results of the Identification of Historic Properties Survey (Literature and Records Review)

A preliminary records and literature review revealed that the C3958 well location area has been surveyed in the past (HCRC#87-200-032) and no cultural resources were identified. Well C3958 is located in the vicinity of a waste site (216-U-17), the construction of which most likely caused the disturbance visible in aerial photos. The areas around the other three well locations, gravel pads and access road have not been surveyed for cultural resources. However, wells C3955, the proposed access road, and well C3956 are all located in close proximity to a waste site, roads, and tank farm 241-TX. Well C3957 is also located close to a road and in a disturbed area, possibly due to road construction or construction of tank farm 241-TX.

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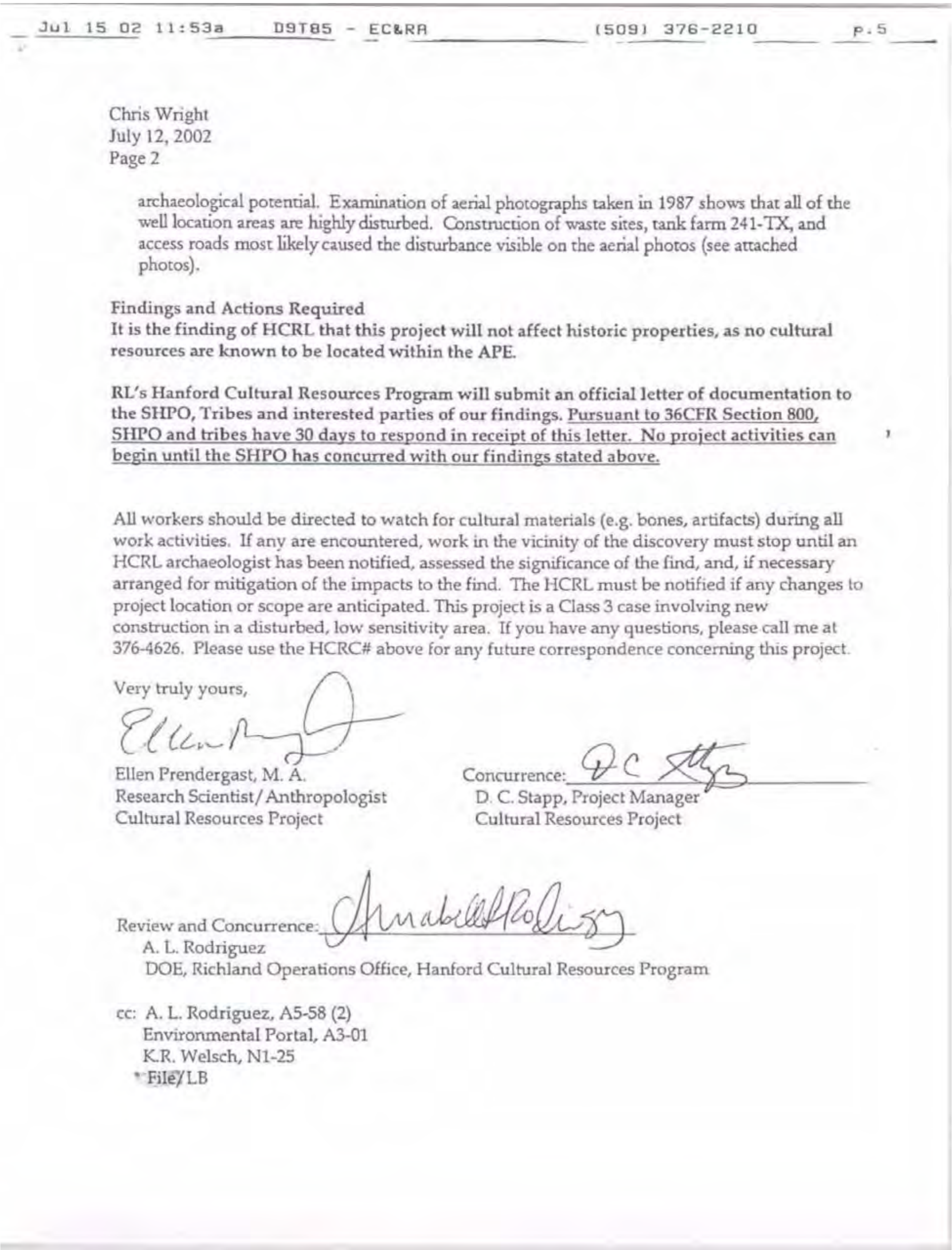


Chris Wright
July 12, 2002
Page 2

archaeological potential. Examination of aerial photographs taken in 1987 shows that all of the well location areas are highly disturbed. Construction of waste sites, tank farm 241-TX, and access roads most likely caused the disturbance visible on the aerial photos (see attached photos).

Findings and Actions Required
It is the finding of HCRL that this project will not affect historic properties, as no cultural resources are known to be located within the APE.

RL's Hanford Cultural Resources Program will submit an official letter of documentation to the SHPO, Tribes and interested parties of our findings. Pursuant to 36CFR Section 800, SHPO and tribes have 30 days to respond in receipt of this letter. No project activities can begin until the SHPO has concurred with our findings stated above.

All workers should be directed to watch for cultural materials (e.g. bones, artifacts) during all work activities. If any are encountered, work in the vicinity of the discovery must stop until an HCRL archaeologist has been notified, assessed the significance of the find, and, if necessary arranged for mitigation of the impacts to the find. The HCRL must be notified if any changes to project location or scope are anticipated. This project is a Class 3 case involving new construction in a disturbed, low sensitivity area. If you have any questions, please call me at 376-4626. Please use the HCRC# above for any future correspondence concerning this project.

Very truly yours,

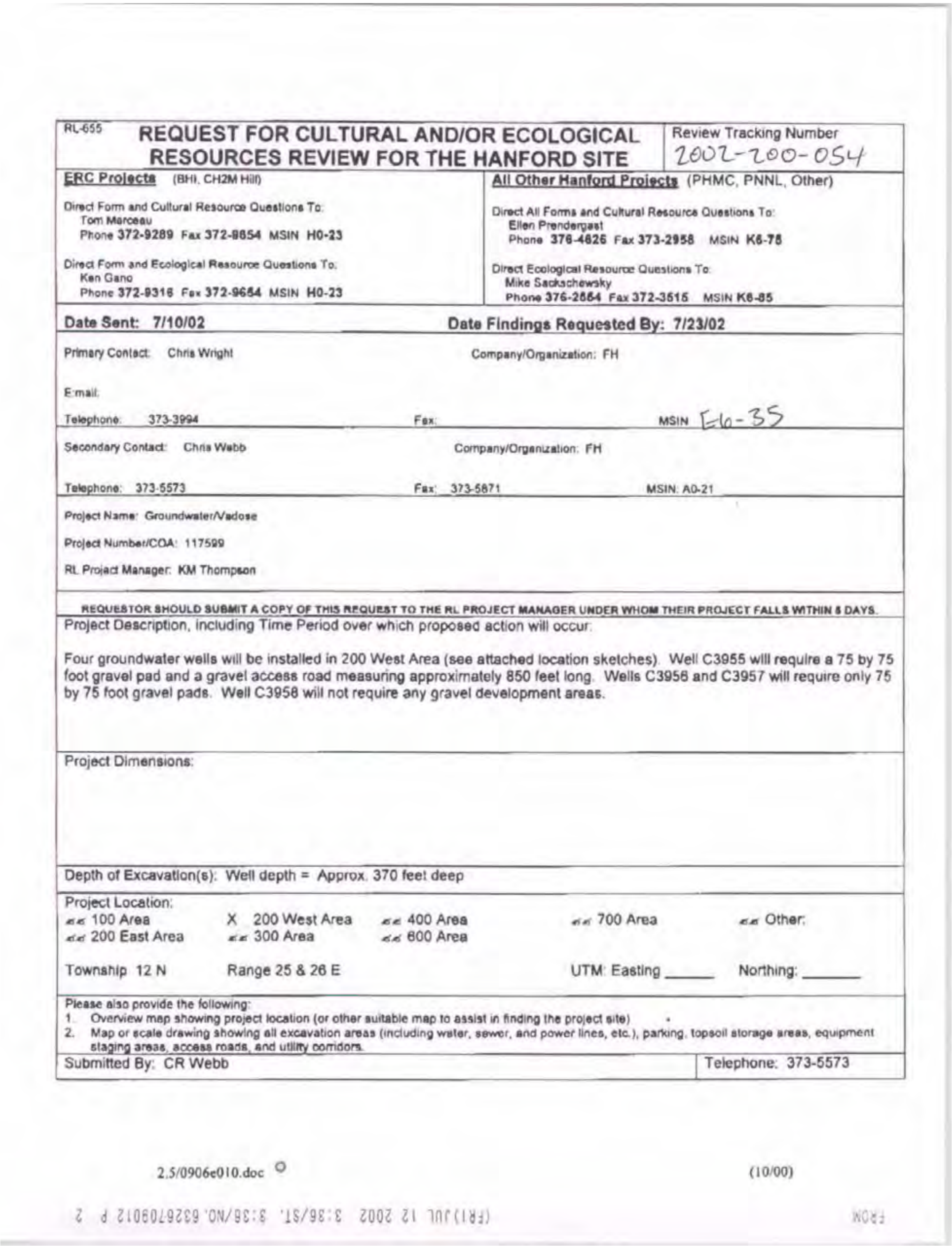
Ellen

Ellen Prendergast, M. A.
Research Scientist/Anthropologist
Cultural Resources Project

Concurrence: DC Stapp
D. C. Stapp, Project Manager
Cultural Resources Project

Review and Concurrence: Annabelle Rodriguez
A. L. Rodriguez
DOE, Richland Operations Office, Hanford Cultural Resources Program

cc: A. L. Rodriguez, A5-58 (2)
Environmental Portal, A3-01
K.R. Welsch, N1-25
File/LB



RL-655

REQUEST FOR CULTURAL AND/OR ECOLOGICAL RESOURCES REVIEW FOR THE HANFORD SITE

Review Tracking Number 2002-200-054

ERC Projects (BHI, CH2M Hill)

Direct Form and Cultural Resource Questions To:
Tom Marceau
Phone **372-9289** Fax **372-9654** MSIN **H0-23**

Direct Form and Ecological Resource Questions To:
Ken Gano
Phone **372-9316** Fax **372-9654** MSIN **H0-23**

All Other Hanford Projects (PHMC, PNNL, Other)

Direct All Forms and Cultural Resource Questions To:
Ellen Prendergast
Phone **376-4626** Fax **373-2958** MSIN **K6-75**

Direct Ecological Resource Questions To:
Mike Sackschewsky
Phone **376-2554** Fax **372-3515** MSIN **K6-85**

Date Sent: 7/10/02 **Date Findings Requested By: 7/23/02**

Primary Contact: Chris Wright
Company/Organization: FH
E-mail:
Telephone: 373-3994
Fax:
MSIN E6-35

Secondary Contact: Chris Webb
Company/Organization: FH
Telephone: 373-5573
Fax: 373-5871
MSIN: A0-21

Project Name: Groundwater/Vadose
Project Number/COA: 117599
RL Project Manager: KM Thompson

REQUESTOR SHOULD SUBMIT A COPY OF THIS REQUEST TO THE RL PROJECT MANAGER UNDER WHOM THEIR PROJECT FALLS WITHIN 5 DAYS.

Project Description, including Time Period over which proposed action will occur:

Four groundwater wells will be installed in 200 West Area (see attached location sketches). Well C3955 will require a 75 by 75 foot gravel pad and a gravel access road measuring approximately 850 feet long. Wells C3956 and C3957 will require only 75 by 75 foot gravel pads. Well C3958 will not require any gravel development areas.

Project Dimensions:

Depth of Excavation(s): Well depth = Approx. 370 feet deep

Project Location:
☐ 100 Area
☐ 200 East Area
X 200 West Area
☐ 300 Area
☐ 400 Area
☐ 600 Area
☐ 700 Area
☐ Other:

Township 12 N
Range 25 & 26 E
UTM: Easting _____
Northing: _______

Please also provide the following:
1. Overview map showing project location (or other suitable map to assist in finding the project site)
2. Map or scale drawing showing all excavation areas (including water, sewer, and power lines, etc.), parking, topsoil storage areas, equipment staging areas, access roads, and utility corridors.

Submitted By: CR Webb
Telephone: 373-5573

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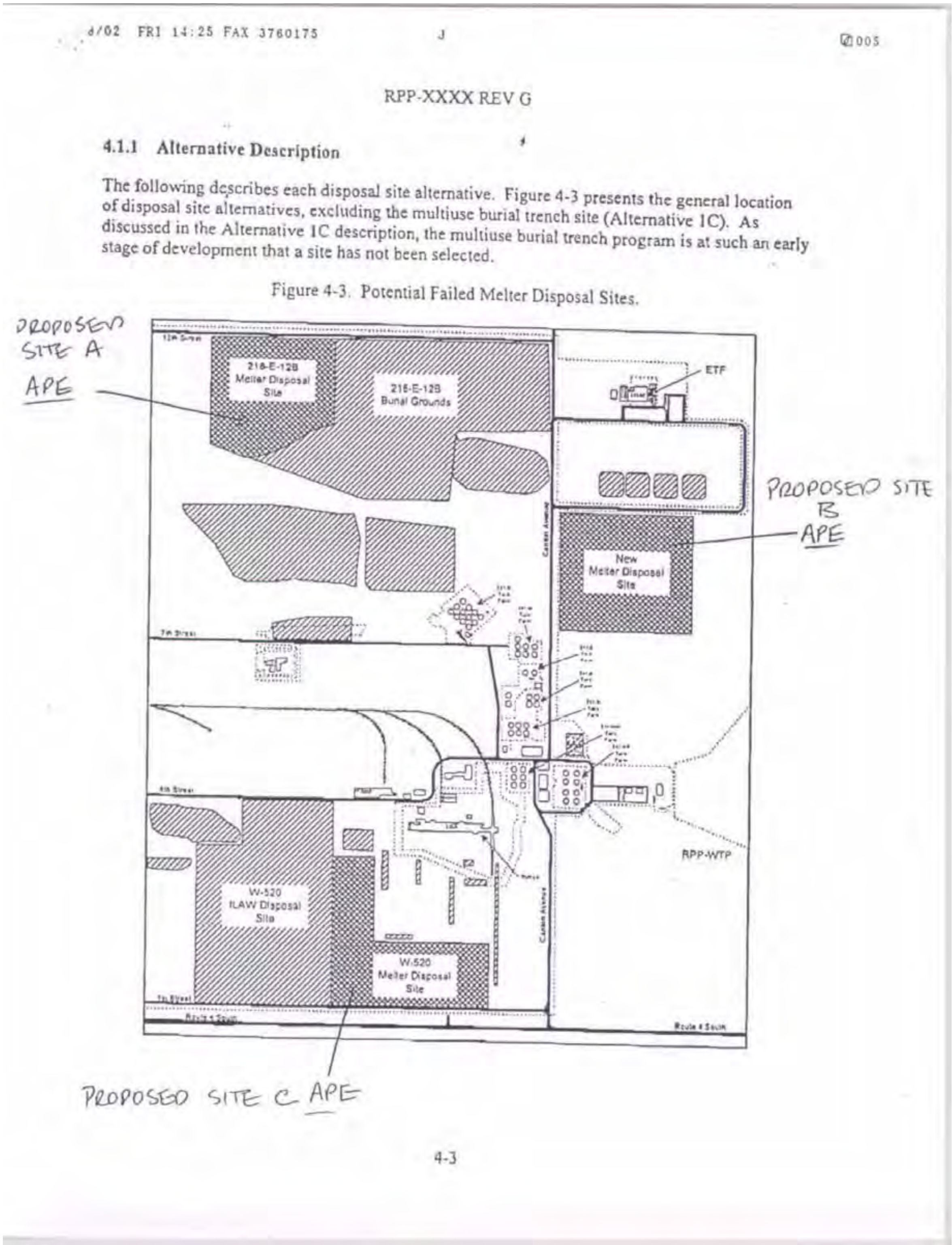


4.1.1 Alternative Description

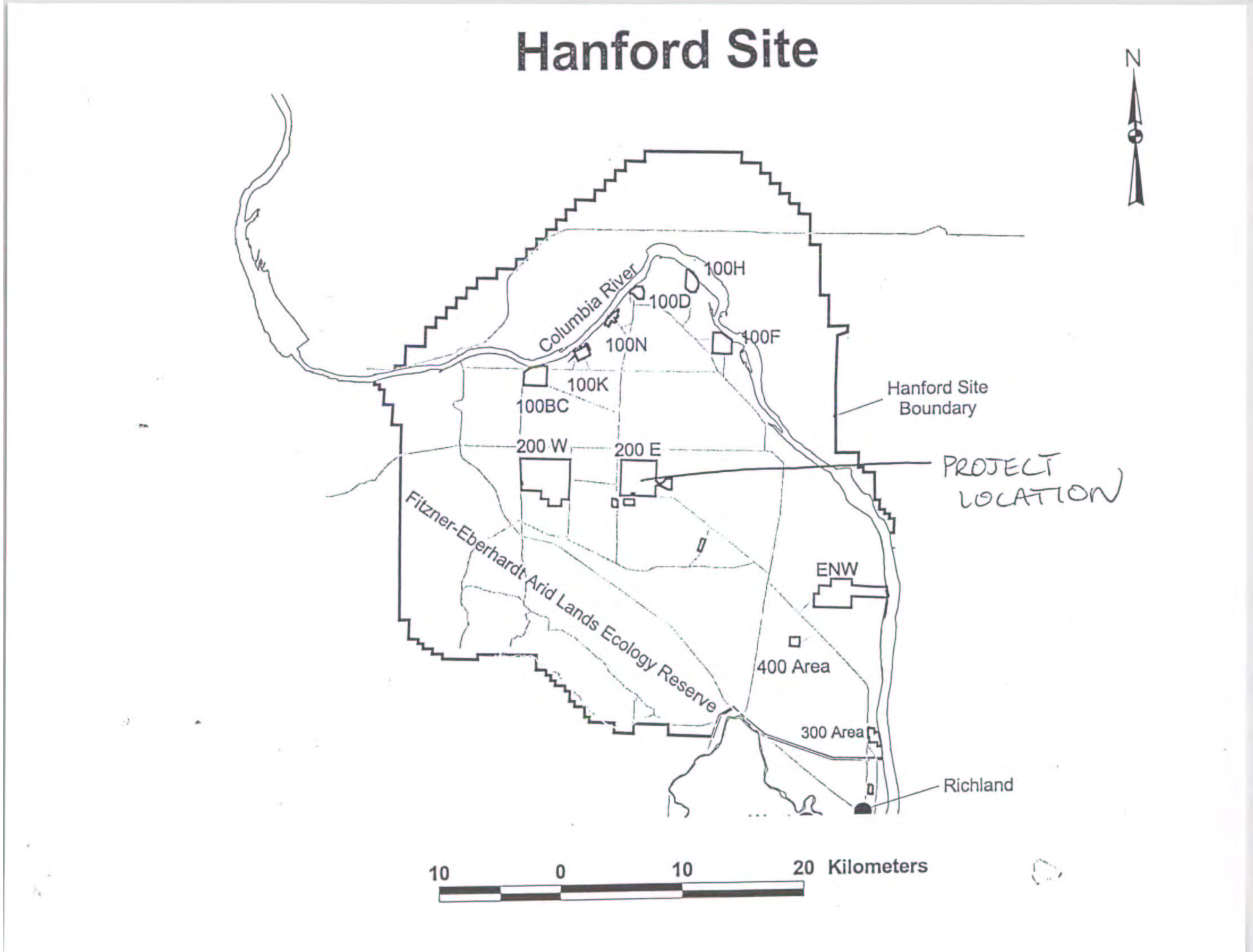
The following describes each disposal site alternative. Figure 4-3 presents the general location of disposal site alternatives, excluding the multiuse burial trench site (Alternative 1C). As discussed in the Alternative 1C description, the multiuse burial trench program is at such an early stage of development that a site has not been selected.

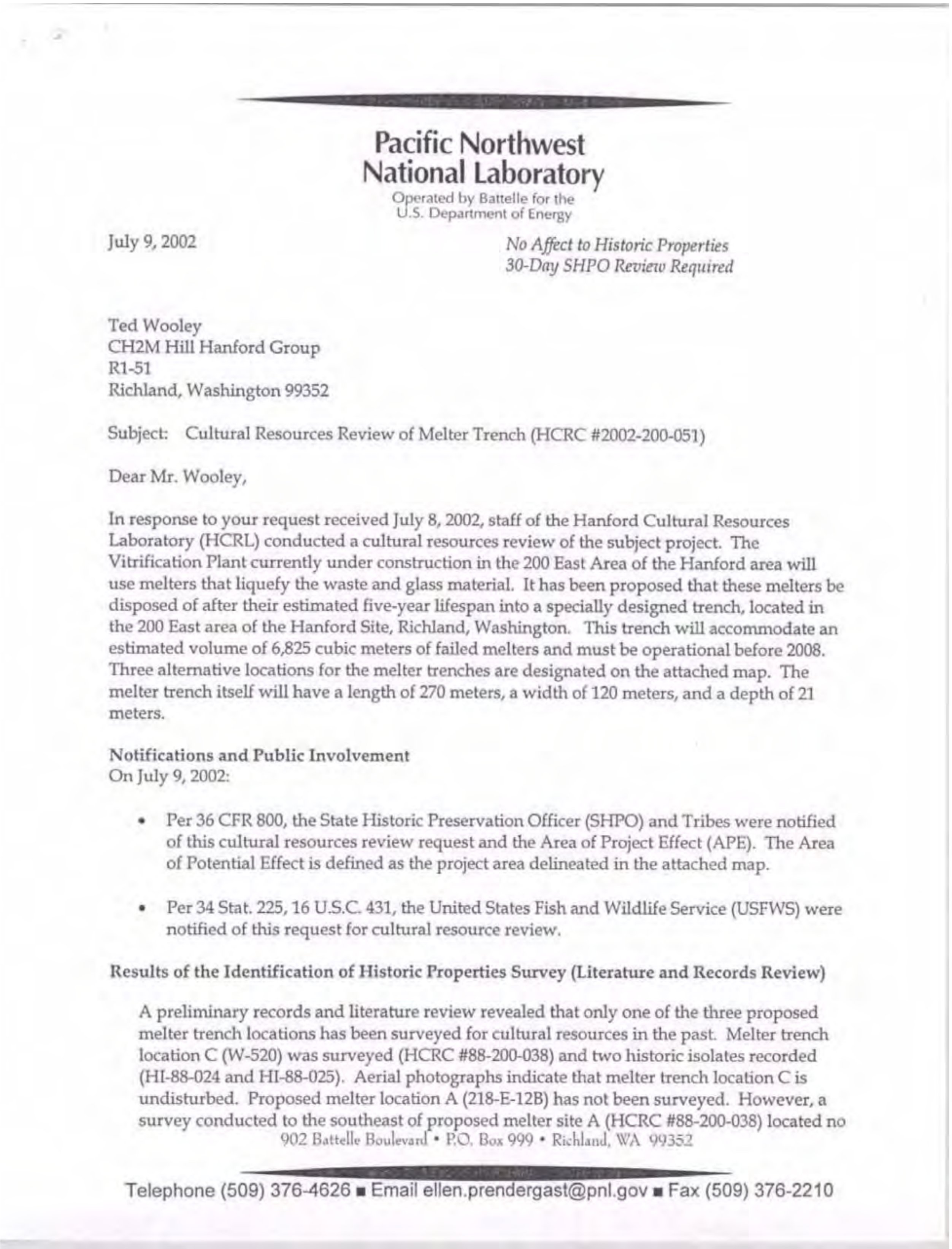
Figure 4-3. Potential Failed Melter Disposal Sites.

PROPOSED SITE A APE

PROPOSED SITE B APE

PROPOSED SITE C APE


Hanford Site
N
Columbia River
100H
100D
100F
100N
100K
100BC
Hanford Site Boundary
200 W
200 E
PROJECT LOCATION
Fitzner-Eberhardt Arid Lands Ecology Reserve
ENW
400 Area
300 Area
Richland
10
0
10
20
Kilometers



Pacific Northwest
National Laboratory
Operated by Battelle for the
U.S. Department of Energy

July 9, 2002

No Affect to Historic Properties
30-Day SHPO Review Required

Ted Wooley
CH2M Hill Hanford Group
R1-51
Richland, Washington 99352

Subject: Cultural Resources Review of Melter Trench (HCRC #2002-200-051)

Dear Mr. Wooley,

In response to your request received July 8, 2002, staff of the Hanford Cultural Resources Laboratory (HCRL) conducted a cultural resources review of the subject project. The Vitrification Plant currently under construction in the 200 East Area of the Hanford area will use melters that liquefy the waste and glass material. It has been proposed that these melters be disposed of after their estimated five-year lifespan into a specially designed trench, located in the 200 East area of the Hanford Site, Richland, Washington. This trench will accommodate an estimated volume of 6,825 cubic meters of failed melters and must be operational before 2008. Three alternative locations for the melter trenches are designated on the attached map. The melter trench itself will have a length of 270 meters, a width of 120 meters, and a depth of 21 meters.

Notifications and Public Involvement
On July 9, 2002:

- Per 36 CFR 800, the State Historic Preservation Officer (SHPO) and Tribes were notified of this cultural resources review request and the Area of Project Effect (APE). The Area of Potential Effect is defined as the project area delineated in the attached map.
- Per 34 Stat. 225, 16 U.S.C. 431, the United States Fish and Wildlife Service (USFWS) were notified of this request for cultural resource review.

Results of the Identification of Historic Properties Survey (Literature and Records Review)

A preliminary records and literature review revealed that only one of the three proposed melter trench locations has been surveyed for cultural resources in the past. Melter trench location C (W-520) was surveyed (HCRC #88-200-038) and two historic isolates recorded (HI-88-024 and HI-88-025). Aerial photographs indicate that melter trench location C is undisturbed. Proposed melter location A (218-E-12B) has not been surveyed. However, a survey conducted to the southeast of proposed melter site A (HCRC #88-200-038) located no

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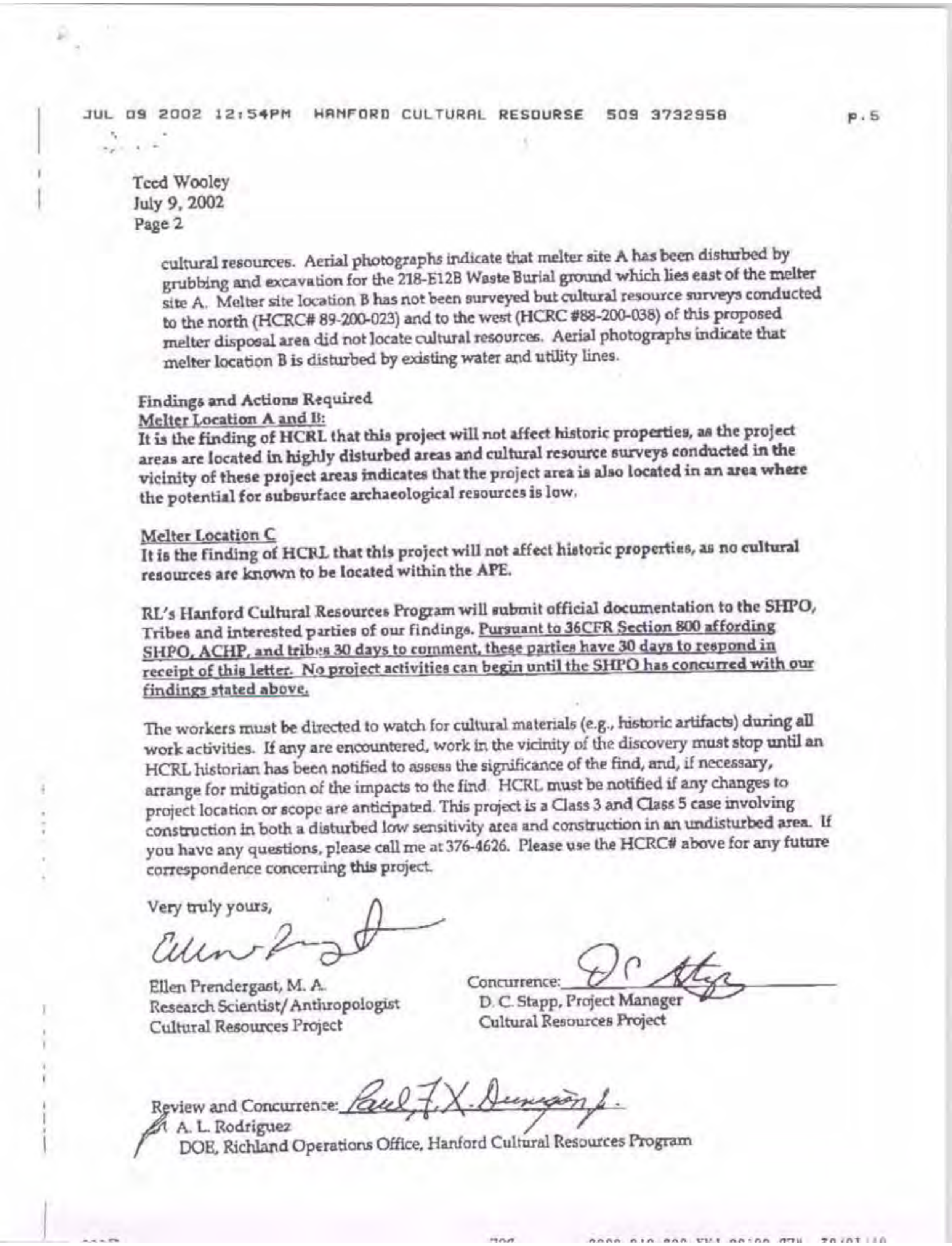


Teed Wooley
July 9, 2002
Page 2

cultural resources. Aerial photographs indicate that melter site A has been disturbed by grubbing and excavation for the 218-E12B Waste Burial ground which lies east of the melter site A. Melter site location B has not been surveyed but cultural resource surveys conducted to the north (HCRC# 89-200-023) and to the west (HCRC #88-200-038) of this proposed melter disposal area did not locate cultural resources. Aerial photographs indicate that melter location B is disturbed by existing water and utility lines.

Findings and Actions Required

Melter Location A and B:

It is the finding of HCRL that this project will not affect historic properties, as the project areas are located in highly disturbed areas and cultural resource surveys conducted in the vicinity of these project areas indicates that the project area is also located in an area where the potential for subsurface archaeological resources is low.

Melter Location C

It is the finding of HCRL that this project will not affect historic properties, as no cultural resources are known to be located within the APE.

RL's Hanford Cultural Resources Program will submit official documentation to the SHPO, Tribes and interested parties of our findings. Pursuant to 36CFR Section 800 affording SHPO, ACHP, and tribes 30 days to comment, these parties have 30 days to respond in receipt of this letter. No project activities can begin until the SHPO has concurred with our findings stated above.

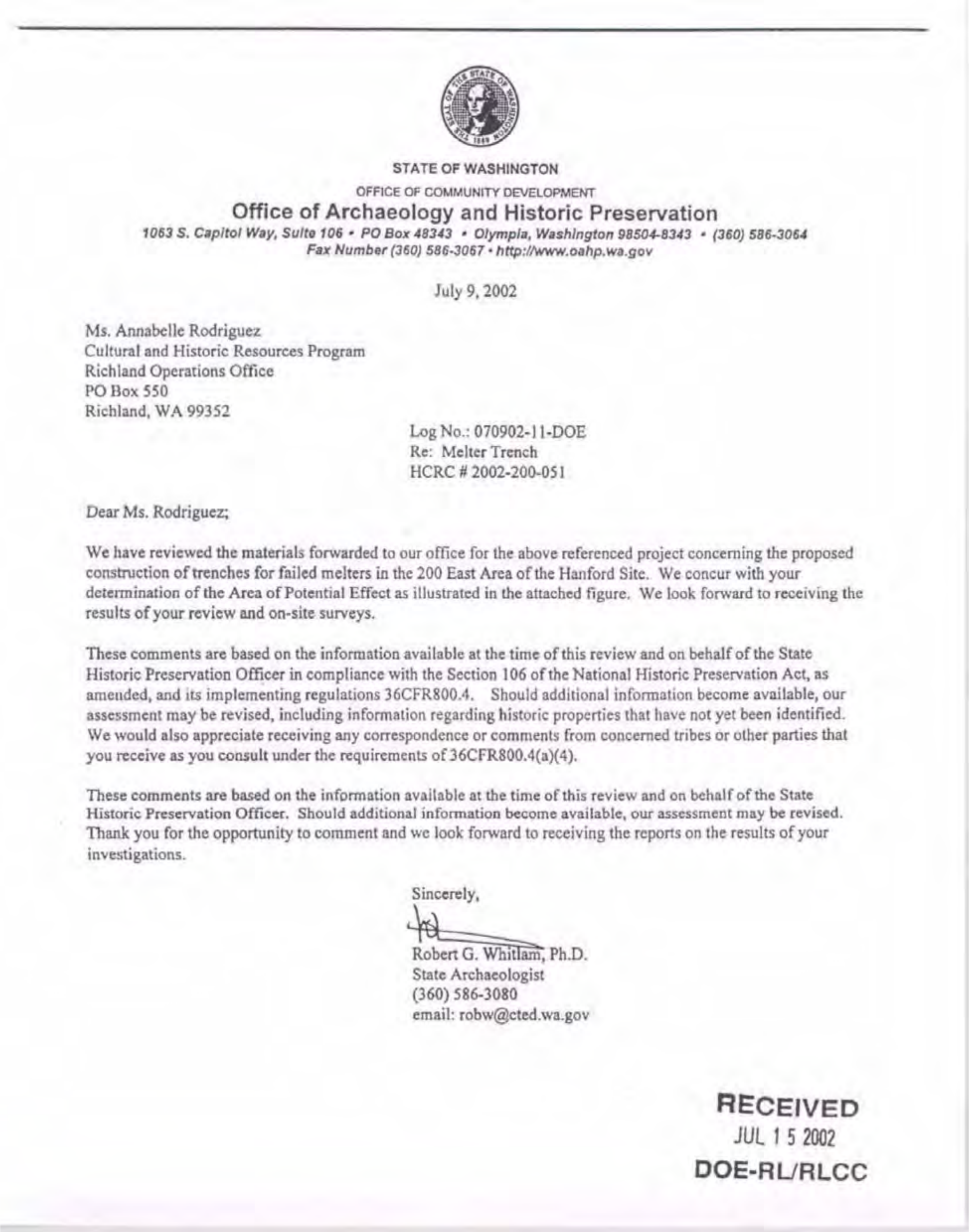
The workers must be directed to watch for cultural materials (e.g., historic artifacts) during all work activities. If any are encountered, work in the vicinity of the discovery must stop until an HCRL historian has been notified to assess the significance of the find, and, if necessary, arrange for mitigation of the impacts to the find. HCRL must be notified if any changes to project location or scope are anticipated. This project is a Class 3 and Class 5 case involving construction in both a disturbed low sensitivity area and construction in an undisturbed area. If you have any questions, please call me at 376-4626. Please use the HCRC# above for any future correspondence concerning this project.

Very truly yours,

Ellen Prendergast, M. A.
Research Scientist/Anthropologist
Cultural Resources Project

Concurrence: DC Stapp
D. C. Stapp, Project Manager
Cultural Resources Project

Review and Concurrence: Paul F. X. Dunigan Jr.
for A. L. Rodriguez
DOE, Richland Operations Office, Hanford Cultural Resources Program



STATE OF WASHINGTON
OFFICE OF COMMUNITY DEVELOPMENT
Office of Archaeology and Historic Preservation
1063 S. Capitol Way, Suite 106 • PO Box 48343 • Olympia, Washington 98504-8343 • (360) 586-3064
Fax Number (360) 586-3067 • http://www.oahp.wa.gov

July 9, 2002

Ms. Annabelle Rodriguez
Cultural and Historic Resources Program
Richland Operations Office
PO Box 550
Richland, WA 99352

Log No.: 070902-11-DOE
Re: Melter Trench
HCRC # 2002-200-051

Dear Ms. Rodriguez;

We have reviewed the materials forwarded to our office for the above referenced project concerning the proposed construction of trenches for failed melters in the 200 East Area of the Hanford Site. We concur with your determination of the Area of Potential Effect as illustrated in the attached figure. We look forward to receiving the results of your review and on-site surveys.

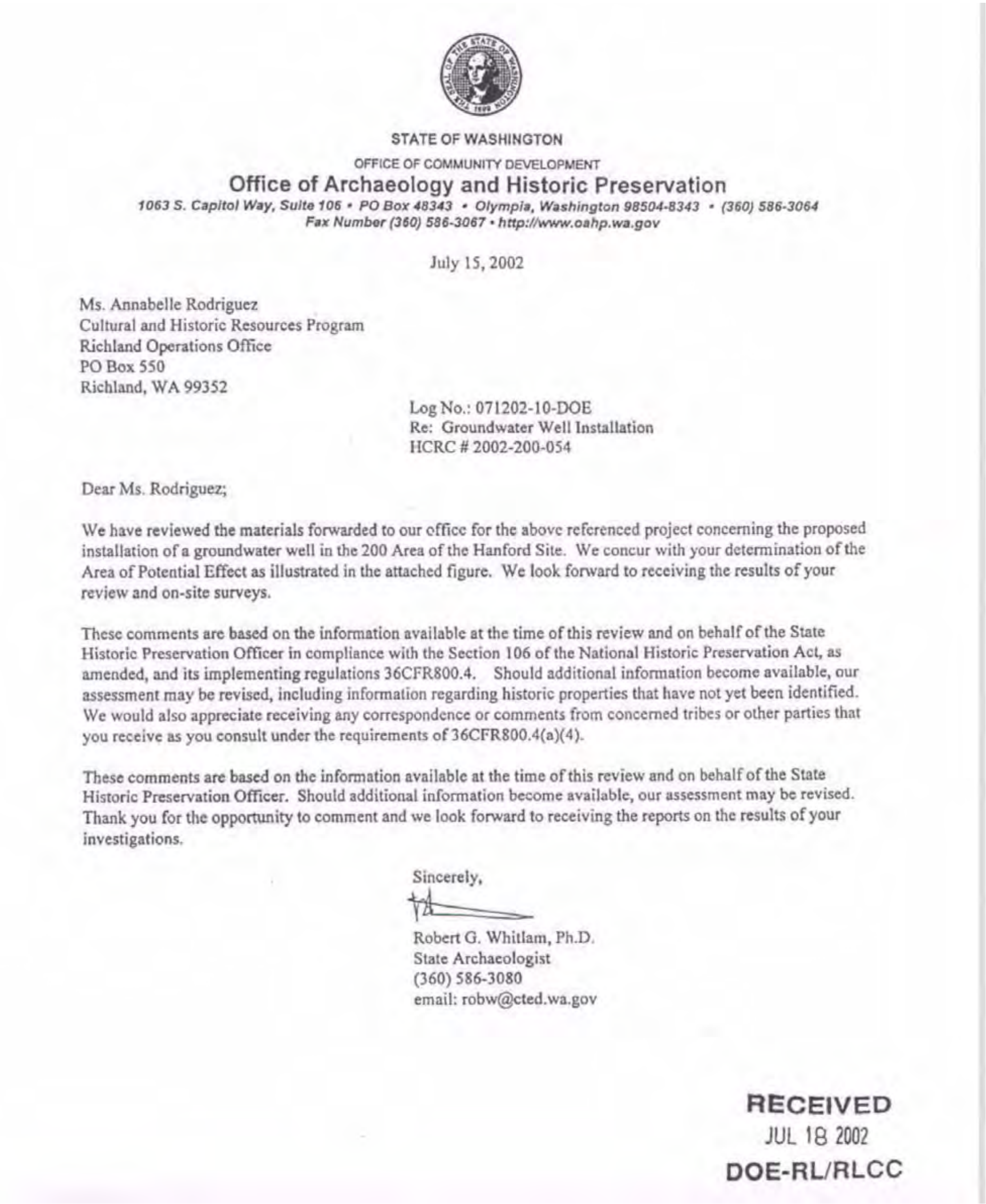
These comments are based on the information available at the time of this review and on behalf of the State Historic Preservation Officer in compliance with the Section 106 of the National Historic Preservation Act, as amended, and its implementing regulations 36CFR800.4. Should additional information become available, our assessment may be revised, including information regarding historic properties that have not yet been identified. We would also appreciate receiving any correspondence or comments from concerned tribes or other parties that you receive as you consult under the requirements of 36CFR800.4(a)(4).

These comments are based on the information available at the time of this review and on behalf of the State Historic Preservation Officer. Should additional information become available, our assessment may be revised. Thank you for the opportunity to comment and we look forward to receiving the reports on the results of your investigations.

Sincerely,

Robert G. Whitlam, Ph.D.
State Archaeologist
(360) 586-3080
email: robw@cted.wa.gov

RECEIVED
JUL 15 2002
DOE-RL/RLCC



STATE OF WASHINGTON
OFFICE OF COMMUNITY DEVELOPMENT
Office of Archaeology and Historic Preservation
1063 S. Capitol Way, Suite 106 • PO Box 48343 • Olympia, Washington 98504-8343 • (360) 586-3064
Fax Number (360) 586-3067 • http://www.oahp.wa.gov

July 15, 2002

Ms. Annabelle Rodriguez
Cultural and Historic Resources Program
Richland Operations Office
PO Box 550
Richland, WA 99352

Log No.: 071202-10-DOE
Re: Groundwater Well Installation
HCRC # 2002-200-054

Dear Ms. Rodriguez;

We have reviewed the materials forwarded to our office for the above referenced project concerning the proposed installation of a groundwater well in the 200 Area of the Hanford Site. We concur with your determination of the Area of Potential Effect as illustrated in the attached figure. We look forward to receiving the results of your review and on-site surveys.

These comments are based on the information available at the time of this review and on behalf of the State Historic Preservation Officer in compliance with the Section 106 of the National Historic Preservation Act, as amended, and its implementing regulations 36CFR800.4. Should additional information become available, our assessment may be revised, including information regarding historic properties that have not yet been identified. We would also appreciate receiving any correspondence or comments from concerned tribes or other parties that you receive as you consult under the requirements of 36CFR800.4(a)(4).

These comments are based on the information available at the time of this review and on behalf of the State Historic Preservation Officer. Should additional information become available, our assessment may be revised. Thank you for the opportunity to comment and we look forward to receiving the reports on the results of your investigations.

Sincerely,

Robert G. Whitlam, Ph.D.
State Archaeologist
(360) 586-3080
email: robw@cted.wa.gov

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K.3 References

36 CFR 800. *Protection of Historic Properties*." Code of Federal Regulations. Online at: http://www.access.gpo.gov/nara/cfr/waisidx_01/36cfr800_01.html

16 USC 470 et seq. National Historic Preservation Act (NHPA) of 1966. Online at: http://www4.law.cornell.edu

DOE-RL. 1995. *Ordnance and Explosive Waste Records Search Report*. DOE/RL-94-07, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Duranceau, D. A. 1995. *Site Evaluation Report for Candidate Basalt Quarry Sites*. BHI-00005, Rev. 00, Bechtel Hanford, Inc., Richland, Washington.

Hinds, N. R. and L. E. Rodgers. 1991. *Ecological Perspectives of Land Use History: The Arid Lands Ecology (ALE) Reserve*. PNL-7750, UC-702, prepared for the U.S. Department of Energy, Pacific Northwest Laboratory, Richland, Washington.

Rice, D. G. 1968. *Archaeological Reconnaissance: Hanford Atomic Works*. U.S. Atomic Energy Commission, National Park Service, and Washington State University, Pullman, Washington.

Van Arsdol, T. 1972. Desert Boom and Bust – The Story of Irrigation Efforts and Town-Building in Benton County, Washington, 1888-1904. Vancouver, Washington.

Appendix L

System Assessment Capability:
A 10,000-Year Post-Closure Assessment

Appendix L

System Assessment Capability:
A 10,000-Year Post-Closure Assessment

L.1 Introduction

In late 1997, the U.S. Department of Energy (DOE) established the Groundwater/Vadose Zone Integration Project with Bechtel Hanford, Inc. (BHI), the Hanford Site environmental restoration contractor, as manager. The project transitioned to Fluor Hanford, the Project Hanford management contractor, in July 2002, and has been renamed the Groundwater Protection Program. Pacific Northwest National Laboratory (PNNL) is a partner in the program. The mission of the program is to coordinate and integrate projects that characterize, monitor, and clean up contaminants in the groundwater and vadose zone (the soil between the ground surface and the groundwater) beneath the Hanford Site. The Groundwater Protection Program also incorporates other task areas that complement these projects and several areas that represent accelerated actions leading to earlier site cleanup and closure.

In 1999, under the Integration Project, DOE initiated development of an assessment tool that will enable users to model the movement of contaminants from all waste sites at Hanford through the vadose zone, the groundwater, and the Columbia River, and to estimate the impact of contaminants on human health, ecology, and the local cultures and economy. This tool is called the System Assessment Capability (SAC).

The approach taken by the SAC is consistent with the methods, characteristics, and controls associated with a composite analysis as described by the Columbia River Comprehensive Impact Assessment (CRCIA) team (DOE-RL 1998). The CRCIA was a study initiated by DOE, the Washington State Department of Ecology, and the U.S. Environmental Protection Agency (EPA) to assess the effects of Hanford-derived materials and contaminants on the Columbia River environment, river-dependent life, and users of river resources. Part I of CRCIA is a study of present-day impacts to the Columbia River from Hanford contaminants. Part II is a suite of requirements for the development of a comprehensive impact assessment for the Columbia River. The two key elements of the SAC approach are 1) ensuring that dominant risk factors are included and 2) providing an understanding of the uncertainty of the results. Dominant factors were identified through scoping studies and the development of conceptual models for each of the analysis modules used. A stochastic modeling approach was taken to estimate uncertainty in the results. Aspects of uncertainty that could not be included in the calculation were considered in the analysis of the modeling results and discussed in the document presenting initial assessment results (Bryce et al. 2002). The analysis modules included in the SAC parallel those identified by CRCIA and were developed through work group meetings that included regulator and stakeholder participation.

Several key modules were adopted directly from the CRCIA, including the module used to calculate human health impacts (the HUMAN code) (Eslinger et al. 2002b) and the module used to calculate impacts to ecological species (the ECEM code) (Eslinger et al. 2002a, 2002b).

An initial assessment recently was completed with the SAC to demonstrate its functional assessment capability. Future modifications to the tool will be driven by the requirements of specific assessments. Improvements in the results obtained from use of the SAC will be realized as the input data are refined through characterization and scientific research. Bryce et al. (2002) reported the results of that assessment, which is the basis for application of the SAC to provide a sitewide perspective of waste disposal and remedial actions in this *Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement* (HSW EIS). Much of the material presented in this appendix has been taken from Bryce et al. (2002).

To simplify the discussion presented in this appendix, the term "SAC" refers to the software package used for this assessment, but it should be noted that the SAC is an evolving and maturing capability.

The initial assessment in FY 2002:

- Modeled the movement of contaminants from 533 locations throughout the Hanford Site representing 890 waste sites through the vadose zone, the groundwater, and the Columbia River.
- Incorporated data on 10 radioactive and chemical contaminants—carbon tetrachloride, cesium-137, chromium, iodine-129, plutonium-239/240, tritium, strontium-90, technetium-99, total uranium (chemical), and uranium (radionuclide).
- Focused on subsurface transport, the Columbia River, risks to human and ecological health, and the economy and culture.
- Included the geographic region from Rattlesnake Mountain to the Columbia River and from Vernita Bridge to McNary Dam on the Columbia River.
- Included the cleanup actions in Hanford's cleanup plans and agreements as of October 2000.
- Consisted of a stochastic simulation for the period from 1944 to 3050 using 25 realizations, thus providing insight into the median response and an initial look at uncertainty.
- Simulated a 1000-year post-closure period. Three waste forms known to release after that time were not included—immobilized low-activity waste (ILAW), melters, and naval reactor compartments.

For the waste sites located on the Hanford Central Plateau and their associated contaminant plumes, the findings of the initial assessment paralleled those of the composite analysis (Kincaid et al. 1998). The results also are consistent with concentrations in environmental media measured by the Hanford Environmental Surveillance Program (Poston et al. 2002). Both the monitoring results and the assessment reported here indicate that Hanford impacts to the Columbia River have peaked and are now declining.

For the purposes of the HSW EIS, the SAC is a "best available technology" and, while it remains a tool under development, the SAC Rev. 0 tool is adequate to provide valuable information through quantification of cumulative risks and impacts associated with solid waste disposal at the Hanford Site.

L.1.1 Context of SAC Runs

The principal SAC simulations made in support of the HSW EIS were a series of 25 stochastic simulations run for the period from 1944 through 12,050 A.D. (that is, a 10,000-year post-closure period) for the Hanford Site Disposition Baseline (HSDB) scenario. This simulation includes a stochastic representation of inventory, release, and transport, and a deterministic representation of exposure and dose. In addition, a median-value input case, based on the median value of each input parameter represented by a distribution in the stochastic model, was simulated.

The HSDB scenario represented in the FY 2002 initial assessment are based on a number of cleanup assumptions including waste, debris, and contaminated soil will be removed from the 100 Areas, and the remaining soil will meet residential use standards. Similarly, waste, debris, and contaminated soil will be removed from the 300 Areas, but the remaining soil will meet industrial use standards. In this scenario, retrievably stored transuranic (TRU) waste will be recovered, tested to determine waste content, repackaged, and sent offsite for disposal at the Waste Isolation Pilot Plant in New Mexico. The waste in Burial Grounds 618-10 and 618-11 will be removed, and the TRU waste will be repackaged and removed from the Hanford Site, while the low-level waste (LLW) will be disposed of in solid waste disposal facilities in the Central Plateau. Ninety-nine percent of the tank waste volume will be recovered from the tanks, and a 1 percent residual volume will remain. Losses to the subsurface during waste recovery are assumed to average 30,280 L (8000 gal) per single-shell tank recovered. The recovered tank waste will be separated into low-activity and high-activity fractions. Immobilization of both waste fractions was assumed. Low-activity waste will be disposed of onsite, while the high-activity fraction will be disposed of in the national repository. All spent fuel also will be stored in a stable configuration for shipment to and disposal in the national repository.

The initial assessment and this analysis assume that the future regional and local climate will remain unchanged for the period of the analysis. Furthermore, it is assumed that major engineered structures in the region (for example, the reservoir system on the Columbia River) will remain in place. The recorded climate and environmental response (for example, Columbia River stage and discharge records) since startup of the site operations were used to simulate the period from 1944 to the present. The climate record from 1961 to 1990 was used to represent the future climate. Consequently, the Hanford Site remains a semiarid, shrub-steppe environment in the simulations. The riparian zone, Columbia River, and river ecosystem are assumed to remain essentially unchanged for the duration of the analysis. Also, the human population will be unchanged and will be based on the current socioeconomic setting. Analyses of alternate future climates (for example, global climate change or onset of an ice age and glacial flooding) and potential future events (for example, failure or removal of the Columbia River reservoir system) are not addressed.

Where the initial assessment addressed the period from 1944 to 3050 (that is, essentially a 1000-year post-closure simulation), simulations for this EIS were carried out over a 10,000-year post-closure period.

Within the SAC, a single transport pathway element, the Columbia River model, is limited to the year 10,000 A.D. in its simulation algorithm, but all other transport pathways (release, vadose zone, groundwater) can execute for the full 10,000-year post-closure period.

The stochastic simulations supporting the HSW EIS are based on the parameter distributions assembled for the initial assessment. In addition to the environmental pathway and risk/impact model parameters, the inventory and future disposal and remedial actions assembled for the initial assessment are included. Differences between the inventory used in this extended simulation of the initial assessment and that used in the HSW EIS are described in Section L.2.2.2. Principal differences lie in the methods used to forecast solid waste disposal actions until site closure, both for onsite generators (for example, Waste Treatment Plant contributions) and for offsite generators.

The potential contaminants of greatest concern include technetium-99, iodine-129, and uranium. These contaminants appear in solid waste performance assessments (Wood et al. 1995; Wood 1996) that analyze solid waste disposals in the 200 West and East Areas. Of necessity, simulation of iodine-129 will include an initial condition for iodine-129 representative of prior releases to the unconfined aquifer, simulation of future releases of iodine-129 per the initial assessment, and superposition of the ILAW contribution to iodine-129 risk and impact. This approach to the iodine-129 simulation will include events attributed to past liquid discharges (current groundwater plumes), future solid waste releases, and long-term future releases from immobilized low-activity tank waste. The inventory estimated to exist in the unconfined aquifer and the estimate of iodine-129 in low-activity tank waste to remain at Hanford will be used in this estimate of the iodine-129 contribution to risk/impact. As in the original 1000-yr initial assessment, simulation of technetium-99 and uranium will use the complete history and forecast of their disposal and begin in 1944 with a clean subsurface environment.

It is unlikely that the plumes from these three classes of release events will superimpose in time. The liquid discharge and unplanned release (for example, tank leak) sites have created groundwater plumes and likely will continue to release to groundwater during the immediate future. Releases from dry solid waste disposals have some containment (for example, boxes, drums, plastic bags) and less driving force (infiltration) and, therefore, likely will release later than the liquid releases. Finally, the substantially stable and long-term waste forms, like vitrified low-activity tank waste, will not corrode and release for thousands of years. It is unlikely that peaks from each of these types of release will superimpose in space and time.

L.1.2 Relationship to EIS Calculations

The EIS calculations focus on the impacts associated with alternatives to the disposal of solid waste. The SAC represents a holistic examination of the radioactive and chemical waste legacy of the Hanford Site. For this reason, it can be used to examine the relative risk and impact associated with disposal and remedial action alternatives and the relative role of different segments of Hanford waste (for example, solid waste, past-practice liquid discharges, or tank wastes). Used in this way, the SAC provides an ability to visualize the change in impact associated with various options and wastes. This kind of impact assessment provides a larger-scale cumulative context from which to view the alternatives and influence disposal decisions.

A line of analysis approximately 1-km from an operational area or waste disposal site was used in the 1998 composite analysis (Kincaid et al. 1998), the initial assessment completed with the SAC (Bryce et al. 2002), and in the simulations supporting this HSW EIS. The travel distance between the source and the uptake location is consistent with the groundwater model grid (that is, 375 m) and the longitudinal dispersivity (that is, 95 m) used in the sitewide groundwater model. In general, the rule of thumb for selecting an appropriate longitudinal dispersivity is to use approximately 10 percent of the mean travel distance of interest. A 1-km travel distance implies a 100-m longitudinal dispersivity. To control model stability and artificial dispersivity, the model grid Peclet number (that is, grid spacing/longitudinal dispersivity = 375 m/95 m) is typically selected to be no greater than 4 for finite element models. The existing model for the cumulative impacts was not configured to produce results at the 100-m travel distance. To achieve results at a 100-m line of analysis for cumulative impacts would require development of a local-scale model based on an approximate grid size of 40 m and longitudinal dispersivity of 10 m.

The EIS calculations provide a detailed evaluation of each specific alternative. The SAC is only able, at this time, to present the single case of an extended analysis (for example, 10,000-year post closure) of the HSDB. In essence, the SAC provides an estimate of the contribution made to risk and impact from technetium-99, iodine-129, and uranium from other Hanford waste disposal and remedial actions not explicitly considered in the HSW EIS alternative groups, and contrasts that with the contribution from solid wastes.

L.2 Methods and Approach

Historically, DOE has used various tools to assess the effects of waste management and cleanup activities on the environment. Assessments have been performed to address a range of questions. Some assessments have focused on individual waste sites or waste types—for example, the assessment performed to evaluate the future performance of the glass waste form proposed for isolating low-activity waste currently in tanks (Mann et al. 2001). Others have looked at contaminants from a variety of sources. The Hanford Environmental Dose Reconstruction Project estimated human health impacts from past releases to the atmosphere and river (Farris et al. 1994) during Hanford operations from 1944 to 1972. The CRCIA examined ecological and human health effects that might result from the 1990 to 1996 distribution of contaminants in the environment in and near the Columbia River (DOE-RL 1998). The composite analysis performed in 1997 considered the impact of selected radionuclides from approximately 280 waste sites in the 200 Areas (Kincaid et al. 1998). In 2001, Bergeron et al. (2001) issued an addendum to the composite analysis that considered about 360 additional waste sites on the Central Plateau.

The collective impact of all of the wastes that will remain at Hanford, however, had not yet been integrated to provide an understanding of the cumulative effects of Hanford activities on the Central Plateau as well as in the river corridor. The SAC was developed to fill this gap and has benefited from the lessons learned in previous assessments.

The initial assessment and this extension to a 10,000-year post-closure analysis considers solid waste disposals in the Central Plateau as occurring within aggregated solid waste disposal facilities in the northern and southern portions of the 200 West and East Areas. Annual inventories for each disposal facility within a subregion of the site are aggregated to create an annual solid waste inventory for the subregion. The areal footprints of disposal facilities within a subregion are aggregated to create a total solid waste disposal facility areal footprint. Contaminants from the aggregated disposal facility are released to the unconfined aquifer at the centroid coordinates of the aggregated disposal facility. Thus use of an aggregated representation of solid waste disposal facilities is an approximation in a number of ways. Notably, the inventory actually placed in individual trenches within each disposal facility is represented as distributed over the entire areal footprint of the disposal facility. Hence, the aggregated inventory is distributed over the aggregated areal footprint of all solid waste disposal facilities in a subregion of the site. Because of the scale of the aggregation (that is, half an operational area), the centroid of the aggregated area and, hence, the point where contaminants are introduced into the aquifer may lie outside an actual solid waste disposal facility.

The waste form used to represent the disposal of low-activity waste is the vitrified waste form described and analyzed in the ILAW performance assessment (PA) (Mann et al. 2001). The ILAW presents a unit release analysis of the waste inventory, contaminant release, and migration in the vadose zone and groundwater. The contribution of the ILAW source to groundwater and surface water impacts can be estimated by scaling (that is, for inventory and spatial position). These results can then be superimposed onto the groundwater and surface water impacts predicted for all other Hanford waste sources to achieve a cumulative impact projection. For the initial assessment (Bryce et al. 2002), all contaminants were simulated from 1944 forward in time to estimate the distribution of contamination in the environment. For some contaminants (for example, tritium), sufficient process knowledge and data existed to complete a history match against tritium field data. For other contaminants (for example, technetium-99, iodine-129, uranium), work is under way to improve the understanding of inventory and mobility to enable improved comparisons with field observations from Hanford’s groundwater.

L.2.1 Modular Components of SAC

The SAC development task involved assembling software and gathering the data needed to assess the cumulative impact of radioactive and chemical waste at Hanford. Computer codes that were well tested at the Hanford Site were used when possible and new software was written when necessary to simulate the features and processes that affect the release of contaminants into the environment, transport of contaminants through the environment, and the impact those contaminants have on living systems, cultures, and the local economy. The components were organized to simulate the transport and fate of contaminants from their presence in Hanford waste sites—through their release to the vadose zone, to their movement in the groundwater, and into the Columbia River. Components such as the groundwater model, the ecological impact component, and the human health component originally were developed and tested for previous Hanford assessments.

The elements of the SAC computational tool include:

Inventory Module—develops an inventory of specific waste disposal and storage locations for the period from 1944 to December 2050 based on disposal records, process knowledge, and the results of tank and field samples. December 2050 was used because it had been identified as the date of site closure. However, for the purposes of this EIS, the Hanford closure date is considered to be 2046. Future analyses will use the current closure date. This module identifies the material scheduled for disposal in offsite repositories including high-level waste (HLW), TRU waste, and spent fuel.

Release Module—simulates the annual release of contaminants to the vadose zone from the variety of waste types in the modeled waste sites. Waste types explicitly modeled include soil-debris wastes as solubility limited desorption, cemented waste as diffusion limited, salt cake tank residuals as nitrate salt dissolution, and graphite cores of production reactors as an empirically defined release. Because they release after the 1000-year analysis period, waste types not included in the original SAC design included ILAW, melters, and naval reactor compartments. This module also simulates Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC 9601) remedial actions that move waste to the Environmental Restoration Disposal Facility (ERDF) trench.

Vadose Zone Module—simulates the flow and transport of contaminants in the vadose zone, which is the unsaturated sediment between the land surface and the unconfined aquifer. Vadose zone simulations use a one-dimensional version of the well-established and documented Subsurface Transport Over Multiple Phases (STOMP) code.

Groundwater Module—simulates the flow of water and the transport of contaminants in the unconfined aquifer that underlies Hanford using the three-dimensional, sitewide groundwater model. Groundwater simulations use the Coupled Fluid, Energy, and Solute Transport (CFEST) code.

River Module—simulates river flow and contaminant/sediment transport in the Hanford Reach from Vernita Bridge downstream to McNary Dam. This model simulates background concentrations and background plus the Hanford Site contribution to enable an assessment of the Hanford Site incremental impact to the Columbia River and its ecosystem. The river model is an extension of the Modular Aquatic Simulation System 2D (MASS2) code developed and applied to support studies of the Snake and Columbia rivers.

Riparian Zone Module—uses river and groundwater information to simulate the concentration of contaminants in seep or spring water and in the wet soil near the shoreline of the river.

Risk/Impact Module—performs risk/impact analysis in four topical areas: human health, ecological health, economic impact, and cultural impact, with economic and cultural impacts being two new impact metrics for Hanford assessments.

The conceptual illustration of SAC (Figure L.1) portrays a linear flow of information. In general, data flows in the initial assessment in the following manner: the Inventory Module provides input to the Release Module, which provides input to the Vadose Zone, Groundwater, and River Modules. The Vadose Zone Module provides input to the Groundwater Module. Finally, both the Groundwater and River Modules provide input to the Risk/Impact Modules. This version of the SAC conceptual model does not allow feedback among modules and does not include either atmospheric or terrestrial ecological pathways and, hence, receptors.

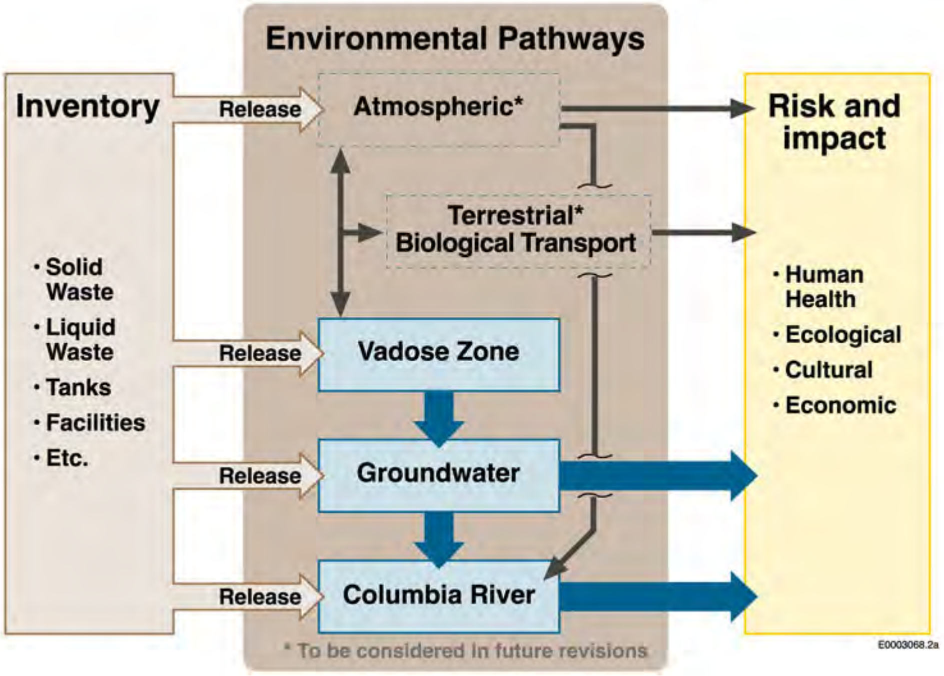

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Figure L.1. Conceptual Model of the System Assessment Capability

The data used in the initial assessment came from a variety of sources, including environmental monitoring activities on the Hanford Site, Hanford historical records, a waste site information database, and other geohydrologic and physical property databases. The remediation actions included in the assessment are based on the collection of disposal and remedial actions identified in the Tri-Party Agreement (Ecology et al. 1989) that are planned to occur as the Hanford Site moves toward closure.

L.2.2 Inventory

Inventory consists of the quantity of radiological and chemical constituents used and created at the Hanford Site, and their distribution in individual facilities and waste disposal sites. For the initial assessment, inventory was defined as the volume and concentration of contamination introduced annually to waste disposal sites (for example, the solid waste disposal facilities), facilities (for example, the canyon building), and the environment (for example, the vadose zone via liquid discharge sites, the Columbia River via reactor cooling water retention basins). In the initial assessment, export of contaminants to offsite locations was accounted for by collecting exports at the conclusion of the analysis. The movement of onsite waste from one location to another is included in the Release Module but is limited to the movement of excavated CERCLA wastes to ERDF trench. Finally, tank waste moves into the Inventory Module of the initial assessment only after it leaks to the environment, is defined as a tank residual, or is recovered from tanks and processed into waste forms that are disposed of onsite or shipped offsite.

The initial assessment included 533 waste site locations throughout the Hanford Site, representing 890 waste sites that were identified for consideration. Each of the 890 sites had a likelihood of containing one or more of the contaminants of interest. Some sites were combined, or aggregated, thus reducing the total to 722 sites for analysis. However, of the 722 sites chosen for analysis, only 533 sites were assigned inventories because some waste disposal and unplanned release inventories were further aggregated. For example, individual disposal ditches and ponds were all identified in the list of 722 sites, but the ditch inventories were assigned to the receptor pond. Accordingly, the inventories for the ditches leading to Gable Mountain Pond, B Pond, and U Pond were assigned zero inventories. The Inventory Module of the SAC generates annual inventories for the selected contaminants at 533 sites for the period from 1944 through 2050, and each of 25 realizations for the stochastic analysis. For the initial assessment, this represented in excess of 782,000 pieces of non-zero inventory data.

Regarding chemicals in solid waste disposals, as in the case of radionuclides, it is unlikely that chemical impacts from liquid discharges and solid waste will superimpose in time. It is believed that the majority of chemicals were either discharged to cribs and trenches or stored in tanks, as opposed to being disposed of as solid waste. When the Hanford Site moved away from liquid discharge of chemicals in the late 1960s and early 1970s, substantial chemical waste streams were routed to tanks. Mixed low-level radioactive waste currently is being stored and will be treated prior to disposal under the Resource and Conservation Recovery Act (RCRA) (42 USC 6901) and past-practice CERCLA guidelines to ensure long-term safety.

For example, the presence of carbon tetrachloride in the aquifer underlying the 200 West Area is a direct result of the disposal of liquid waste streams containing carbon tetrachloride. The mean value inventory of carbon tetrachloride in the initial assessment shows approximately 813,000 kg being released to liquid discharge sites in the 200 West Area. In comparison, all of the carbon tetrachloride in HSW is reported to be in "stored" solid waste; none is reported in "buried" solid waste, and the total inventory reported to be stored through 1997 was approximately 5000 kg. Storage is occurring in radioactive mixed waste storage facilities (primarily CWC) and the 218-W-3A, 218-W-4B, and 218-W-4C LLBGs. While there is no record of past disposals, some carbon tetrachloride might have been disposed of in HSW disposal facilities. However, it is likely that the amount, its rate of release, and its potential impact on groundwater would not be substantial compared to that of past releases to liquid discharge facilities.

An analysis of chemical inventories in solid waste disposals on the same scale as the initial assessment cannot be supported on the basis of current data and information. However, based on available information, chemicals in solid waste do not appear to be as important in terms of human health impacts as the key radionuclides—technetium-99, iodine-129, and uranium.

Carbon tetrachloride and chromium in Hanford solid waste are not expected to add substantially to impacts of those substances from other Hanford sources. For further discussion of the potential impacts from hazardous chemical constituents in Hanford solid waste see Volume I, Sections 5.3.2 and 5.3.5.

L.2.2.1 Initial Assessment Inventory

Methods used to assemble the annual inventory database for all waste sites are described in Appendix A of Bergeron et al. (2001) issued in September 2001. Additional detail on the methods used to merge record data and estimates for the Hanford Site inventory were provided by Cooney (2002). The addendum to the composite analysis includes a summary of the inventory in each waste site at the close of 2000 and at the assumed time of Hanford Site closure in 2050 (Bergeron et al. 2001). The inventory shown in the initial assessment inventory differs from the summary inventory presented in the addendum; however, the data in the addendum provides a representative picture of the site inventory.

L.2.2.2 Comparison of HSW EIS and Initial Assessment Inventories

The initial assessment inventory was developed over a period of time, beginning in FY 2000 with final entries completed during the spring of 2002. Some of the data entries date from September 1999, which was the close of FY 1999. The HSW EIS inventory was developed over a similar time period, but it reflects changes as recent as the summer of 2002. Table L.1 shows a comparison of the initial assessment (SAC) and the EIS (Alternative Group D_1, preferred alternative) as their respective inventories existed in September 2002. The inventories addressed within the scope of the HSW EIS include wastes in the LLBGs and future disposal facilities, and, therefore, while being more current for solid waste, they do not reflect all potential sources that were evaluated for the SAC initial assessment of cumulative impacts. The HSW EIS inventories shown do not reflect inventories in other waste forms that will remain at Hanford including graphite cores of production reactors, liquid discharge and unplanned release sites, and past tank leaks and future tank residuals. Table L.1 and the discussion of inventory differences provide a review of the inventories in the two assessments and indicate the relative inventories treated by a soil-debris, cement, or liquid release models.

Table L.1. Comparison of Initial Assessment and HSW EIS Inventories

Summary of Technetium-99, Iodine-129, and Uranium Inventories at the Time of Hanford Site Closure							
		Initial Assessment (a)			**HSW EIS(b)**		
		Tc-99	**I-129**	**U**	**Tc-99**	**I-129**	**U**
Waste Stream	**Type**	**Ci**	**Ci**	**Ci**	**Ci**	**Ci**	**Ci**
200 East	Solid waste as soil debris	25.3(c)	0.39(c)	0.12	12(c)	0.065(c)	22.9(d,e)
200 East	Solid waste as cement	0.08	0	0	3700(d,f)	5.1(f)	2000(f)
200 East	Tank leaks/residuals	259	0.35	24.8			
200 East	Liquid/UPR(g)	791	0.40	66.2			
200 East	Total Activity	1075	1.14	91.3			
200 West	Solid waste as soil debris	343(c)	0.41(c)	209(h)	3.1(c)	0.045(c)	150(h)
200 West	Solid waste as cement	1291(c,i)	64.2(c,i)	1837(h,i)	130	0.008	1000(h)
200 West	Tank leaks/residuals	327	0.61	13.2			
200 West	Liquid/UPR	40.9	0.10	24.7			
200 West	Total Activity	1712	64.9	1803			

Table L.1. (contd)

Summary of Technetium-99, Iodine-129, and Uranium Inventories at the Time of Hanford Site Closure							
		Initial Assessment (a)			**HSW EIS**(b)		
		Tc-99	**I-129**	**U**	**Tc-99**	**I-129**	**U**
Waste Stream	**Type**	**Ci**	**Ci**	**Ci**	**Ci**	**Ci**	**Ci**
ERDF(j) (600-148)		2.6	0.0017	54.0			
SALDS(k) (600-211)	"soil"	0.310	2.17	0.00133			
Graphite cores (100 Areas)	"core"	0.012	.000089	0			
ILAW (200 East)	"glass"	25,550(i)	0(i)	52.97(i)	25,550(l)	22(l)	230(e,l)
Melters (200 East)	"glass"	37.8	0	1.70	38.9	0	1.8
Naval reactors (200 East)	"rxcomp"	5.18	1.3E-5	0			
US Ecology, Inc. (600 Area)	"soil"	60.7	5.45	11390			
Other 200 Area remaining onsite(m)		730(n,o)	0.065(n)	8.6(n)			
Other Areas remaining onsite(m)		13.8	0.0044	33.4			

(a) Initial assessment inventory values are median values from a stochastic simulation of the inventory.

(b) Alternate Group D_1 Upper Bound waste volume.

(c) The initial assessment includes technetium-99 and iodine-129 inventories estimated using a fuel-ratio method for fission product inventories not reported on original records or prior estimates. The HSW EIS inventories of technetium-99 and iodine-129 include only reported or record values.

(d) The HSW EIS includes inventories of mixed low-level waste (MLLW) that are included elsewhere in the initial assessment inventory for the SAC (see note "m" below).

(e) The HSW EIS includes an inventory of uranium-233 not included in the initial assessment conducted using the SAC.

(f) The HSW EIS includes inventory forecasts obtained from the Solid Waste Information Forecast Tool (SWIFT) that includes a life-cycle forecast of the composition of secondary waste streams from tank waste; in Alternative Group D_1, ILAW, melter, and future solid waste inventories are disposed of in an integrated disposal facility near PUREX.

(g) UPR = unplanned release.

(h) The initial assessment includes uranium inventories estimated using somewhat different uranium isotopic ratios and estimation methods than used in the HSW EIS.

(i) The initial assessment includes inventory forecasts obtained from a Hanford Tank Waste Operating System (HTWOS) (Kirkbride et al. 2002) simulation that used potentially out-of-date factors for secondary waste streams; the technetium-99 inventory is a current estimate to be routed to low-activity disposal.

(j) ERDF = Environmental Restoration Disposal Facility.

(k) SALDS = State-Approved Land Disposal Site.

(l) The HSW EIS includes inventory forecasts obtained from the ILAW performance assessment (Mann et al. 2001) for isotopes, and from a current estimate of technetium-99 that will be routed to low-activity waste disposal. These inventories, that are somewhat higher than initial assessment inventories for iodine-129 and uranium, are applied in simulations that superimpose ILAW contaminants and dose onto the contaminant and dose from all other waste site releases. Results of these superimpositions appear near the end of this Appendix.

(m) Does not include waste listed above.

(n) The initial assessment includes inventories of MLLW at the Hanford Site that will be routed though the Radioactive Mixed Waste Storage Facility prior to disposal onsite.

(o) Of the 730 Ci of technetium-99 shown, approximately 660 Ci are designated for offsite disposal.

The differences in the initial assessment and HSW EIS inventories highlight an issue that exists whenever knowledge evolves as fast as, or faster than, the ability to perform assessments; that is, more recent assessments have available to them more current knowledge. Thus estimates of inventory vary. Since the summer of 2002 when the HSW EIS inventories were assembled for analysis, simulations have been published creating a new baseline estimate of radionuclides created in Hanford production reactors

(Wootan and Finfrock 2002). Previous inventory estimates relied on the earlier publication by Watrous and Wootan (1997). Some substantial changes have occurred in production estimates based on Wootan and Finfrock (2002), for example, the earlier estimate of 64.1 Ci of iodine-129 has been superceded with an estimate of 49.4 Ci. The annual revision of the best basis (tank) inventory has been issued in the *Tank Farm Contractor Operation and Utilization Plan* (Kirkbride et al. 2002). An online version of this inventory is updated quarterly to reflect any further refinement of this information.

Another issue with inventories is the conservatism adopted by various projects and programs that have been responsible for compilation and publication of an inventory. Often, it requires fewer resources to generate a conservative estimate, and such an estimate may provide all a project or program needs. For example, designing and sizing a treatment process may rely on the largest inventory that may be processed and may not require knowledge of a best estimate or median inventory or the possible range of the inventory. Accordingly, when inventories from a variety of projects and programs are merged to create a total Hanford Site inventory (based on the summation of inventory estimates for waste discharge, disposal sites, and for stored tank waste), that total inventory may differ from the total inventory estimated based on production reactor operation. Conservative estimates of individual inventories tend to overestimate the actual amount of material in existence. Accordingly, the sum of these inventories tends to exceed independent estimates concerning the total amount of waste generated. Thus while use of conservative estimates for individual inventories may be used to bound environmental impacts, they may not necessarily be summed to arrive at the best estimate for a total inventory. As the activities related to Hanford waste site characterization, facility decommissioning, and tank waste disposal proceed, the conservatism found in inventory estimates may be reduced.

The SAC was applied in the HSW EIS to generate both a stochastic simulation and a median-inputs deterministic simulation. The inventory values reported for the initial assessment in Table L.1 are median values of the stochastic distribution. Thus, a varied inventory is analyzed, and each of the 25 realizations is based on a Latin hypercube selection procedure. For sites not modeled using process knowledge and a stochastic simulator (Simpson et al. 2001), site-specific inventories prior to 1970 are modeled as twenty-fold uncertain; that is, the maximum is approximately 20 times the inventory database value, and the minimum is approximately one-twentieth of the inventory database value. After 1970, the inventories for these sites are modeled as twofold uncertain; that is, the maximum is approximately twice the inventory database value, and the minimum is approximately half the database value.

The inventory analyzed by the sitewide groundwater model and the unit release approach in the HSW EIS was provided by Fluor Hanford. The inventory analyzed using the SAC tool is based on available records and was augmented with estimated inventories for fission products (for example, technetium-99 and iodine-129) and uranium isotopes where they are absent from the record. The augmented values are only estimates and should not be considered record values.

There are differences in the compilations shown in Table L.1. Solid waste deposits in the 200 East and 200 West Areas differ primarily as follows: 1) the initial assessment technetium-99 and iodine-129 inventories include fuel-ratio estimates of this fission product, 2) the initial assessment uranium inventories include estimates based on uranium-isotopic ratio methods of estimation that differ from those of the EIS, 3) the HSW EIS uranium inventories include MLLW inventories that are accounted for elsewhere in the initial assessment, 4) HSW EIS solid waste disposal facility uranium inventories include uranium-233, which was omitted from the initial assessment, and 5) large inventories in the HSW EIS–200 East Area, solid waste as cement type and in the initial assessment–200 West Area, solid waste as cement type reflect different assumptions regarding the disposal location.

Inventory Assumptions

Initial Assessment SAC Inventory Assumptions

- Past solid waste inventories were drawn from the Solid Waste Information Tracking System (SWITS).
- Future solid waste inventories were estimated using data from SWITS and the assumption that past disposals were indicative of future waste receipts.
- The vitrification process will drive off volatile gases including iodine, and, therefore, the iodine-129 inventory in ILAW essentially will be zero.
- The Hanford Tank Waste Operations Simulator and associated secondary waste stream factors provided by the Tank Farm contractor are appropriate for estimating the amounts of key contaminants.
- An amount of iodine-129 was lost to air emissions during the chemical separation, and, therefore, most of the iodine-129 produced in the reactors was processed and put in the single- and double-shell tanks.
- Commercial low-level radioactive waste inventories are based on WDOH and Ecology (2000) and the closure plan published by US Ecology, Inc. (1996).

HSW-EIS Inventory Assumptions

- Past solid waste inventories were drawn from SWITS.
- Future solid waste inventories were estimated using SWIFT and waste generator estimates of future disposals.
- The baseline inventories of iodine were held in ILAW.
- More current (summer 2002) estimates from the tank farm contractor provided the best estimate of secondary waste stream inventories.
- In addition to the 27.1 Ci of iodine-129 accounted for in the HSW EIS inventory under ILAW and the 200 East Area solid waste, some iodine-129 was emitted to the atmosphere during chemical separation activities, and there are plans to capture the majority of the iodine-129 in tank waste in the high-level waste glass.

A major difference in inventories in the 200 East and 200 West Area solid waste disposal facility "as cement" deposits and in ILAW deposits lies in the use of different resources to estimate future disposals and secondary wastes from the processing and solidification of tank wastes at Hanford. The initial assessment relied on the Hanford Tank Waste Operation System (HTWOS) model that relied on a suite of potentially out-of-date factors to estimate secondary waste stream composition. This resulted in nearly 1300 Ci of technetium-99 and 65 Ci of iodine-129 being disposed of in the 200 West Area as solid waste in cement. The initial assessment inventory also relied on an earlier estimate of ILAW inventory that assumed no iodine-129 would be retained in the glass waste form. The HSW EIS relies on more current ILAW and secondary waste inventory estimates. Accordingly, the HSW EIS shows 3700 Ci of technetium-99 and 5 Ci of iodine-129 being disposed of in the 200 East Area as solid waste in cement, and 22 Ci of iodine-129 being disposed of in the ILAW glass. Inventories with the greatest differences either are simulated as cement waste forms that release relatively slowly (for example, the 200 East and West Areas solid waste cement) or are not simulated by the initial assessment (for example, ILAW and melter waste). A difference of approximately 2000 Ci in technetium-99 exists between the two estimates of secondary technetium-99 wastes. Similarly, a difference of approximately 60 Ci in iodine-129 exists. These differences will be reconciled as projections are updated; however, all of this waste would be disposed of in cement to minimize the hazard. In the analyses undertaken for both the initial assessment and the HSW EIS, the majority of the future uranium inventory is disposed of in cement to minimize the hazard.

Finally, because of the original design objectives of the SAC (that is, a 1000-year analysis), the initial assessment does not include the release model(s) necessary to forecast the long-term release of the ILAW and melter wastes. Hence, the influence of ILAW and melter inventories is not included in the initial assessment results or in the extended (10,000-year) initial assessment presented here. Naval reactor compartments also are omitted from SAC analyses at this time. However, for the greatest of these inventories (ILAW), their influence is introduced to the cumulative assessment by superimposing the results of the ILAW PA (Mann et al. 2001) onto the initial assessment result. Thus the influence of ILAW PA inventories shown in Table L.1 under the HSW EIS is superimposed on the initial assessment.

There is uncertainty with respect to the total inventory of iodine-129 in spent fuel irradiated at Hanford. The inventory data and information assembled for the initial assessment (Bryce et al. 2002) revealed that approximately 75 Ci of iodine-129 were generated during the irradiation of nuclear fuel in Hanford reactors. Most of the spent fuel was processed in facilities on the Central Plateau; however, some spent fuel remains onsite and is being moved to a central location on the Central Plateau prior to shipment to a national repository. Some of the iodine-129 inventory is conservatively counted in individual waste site inventories. When summed, the inventories disposed of at waste sites, released to the environment (for example, from cribs, into the atmosphere, and into the Columbia River), and stored for future disposal at offsite locations equals approximately 100 Ci, which exceeds the 75-Ci production estimate.

Iodine is found in all three phases (solid, liquid, and gas) and has been identified in each of these waste types. Accordingly, some iodine-129 is found in solid waste, some in liquid discharges, and some in atmospheric releases. There is considerable uncertainty in the amount of iodine-129 that appears in each. In prior inventory compilations and in the initial assessment, it was assumed that most of the iodine-129 resides in single-shell and double-shell tanks in the Central Plateau. Furthermore, it was assumed that all of the iodine-129 would be captured in secondary waste streams from waste separation and solidification processes, and that these wastes would be treated and the iodine primarily disposed of in solid waste disposal facilities. Of the 100 Ci in the initial assessment and in this cumulative impact analysis estimated to be present at Hanford at the time of site closure, approximately 65 Ci reside in solid waste; 19 Ci may have been released to the atmosphere; 7 Ci reside in spent fuel; 5.5 Ci reside in commercial low-level radioactive waste disposal; 3 Ci were discharged to cribs and trenches; and 1 Ci is associated with the past leaks, estimated future losses, and residuals of tanks. None of the 65 Ci of iodine-129 associated with solid waste in the initial assessment is assigned to ILAW because the early assumption was that iodine was too volatile to remain in the solidified low-activity tank waste. However, this inventory of 65 Ci is almost entirely from byproduct streams from waste separation and vitrification processing (that is, spent resins and ILAW and HLW secondary waste streams—not glass).

As a result of recent estimates of iodine retention in immobilized tank waste, about 22 Ci of the iodine-129 in the tank waste was assumed, for impact modeling purposes and evaluation of alternatives in this EIS, to be disposed of as part of the ILAW waste form. The HSW EIS analysis of alternative groups assumes an additional 5 Ci are contained in the solid waste to be disposed of (see Appendix B, Table B.19). Thus the groundwater modeling performed for the alternate actions in this EIS assumes a total source term of 27 Ci of iodine-129 in the combined ILAW and solid wastes. Some iodine-129 was emitted to the atmosphere during chemical separation. The remaining inventory of iodine-129 is not shown in the HSW EIS inventory used in the alternative analyses because it is not assumed to be part of solid wastes evaluated in the alternative groups. However, for the cumulative impact analysis an additional inventory of approximately 60 Ci of iodine-129 are accounted for as solid waste in a cement waste form.

Inventories included in the initial assessment for the commercial low-level radioactive waste disposal site operated by US Ecology, Inc., at Hanford are based in part on the published State of Washington draft EIS (WDOH and Ecology 2000) and the closure plan for the site published by US Ecology, Inc. (1996). The State of Washington now is reviewing the inventory for the commercial site during its early years of operation. Hanford staff are in contact with a representative of the Washington State Department of Health, and as soon as an updated inventory is available, it will be incorporated into Hanford assessments. Certainly, uranium inventories for the commercial low-level radioactive waste disposal site appear to be relatively high in the initial assessment.

L.2.3 Release

Release is the rate at which radioactive and chemical contaminants find their way into the environment. The SAC Release Module handles liquid releases and releases from solid waste forms. It is important to note that because the initial assessment was originally designed as a 1000-year analysis; several waste forms that will not be released in this period were not analyzed and were not analyzed in this extended 10,000-year post-closure analysis even though they may be released in the 10,000-year time frame. These waste forms include naval reactor compartments, immobilized low-activity waste, and components of melter systems. Liquid discharges, liquid unplanned releases including tank leaks, and future tank losses are handled as a simple pass-through to the vadose zone or the Columbia River. The solid waste forms are primarily in solid waste disposal facilities including past-practice sites (pre-1988), active sites (post-1988), and at ERDF. Other solid waste includes residual waste in the single-shell tanks, the graphite cores of the retired production reactors, and concrete and cement waste forms associated with caissons, canyon buildings, and grouted waste.

The Release Module applies release models to waste inventory from the Inventory Module and also accounts for site remediation activities (for example, waste movement) as a function of time. The resulting releases to the vadose zone, expressed as time profiles of annual rates, become source terms for the Vadose Zone Module. Radioactive decay is accounted for in all inputs and outputs of the Release Module. The Release Module is implemented as the VADose zone Environmental Release (VADER) computer code (Eslinger et al. 2002a).

L.2.3.1 Conceptual Model

Waste containment facilities have a number of features that influence the rate at which contaminants can be released from waste. The waste may be placed in a trench or may reside in a tank. The trench, tank, or other engineered structure may have features that serve as barriers to prevent infiltrating water from making contact with and transporting contaminants from the waste to the vadose zone. Waste inside an engineered structure (for example, a trench) may also be contained in a waste package (for example, a metal drum or high-integrity concrete container). The drum or concrete container acts as an additional barrier that prevents transport of the contaminants from the waste. Major containment materials for Hanford waste are concrete, steel, and bituminous layers and coatings. The stability and permeability of concrete materials change over time, and, likewise, time affects the features that dominate water or contaminant migration in containment materials. Surface covers on an engineered system and liners (geomembrane and geosynthetic) and leachate collection systems at the bottom of a system further restrict infiltrating water from transporting contaminants to the vadose zone. Surface covers are particularly important because migration of infiltrating pore water may be limited as long as the cover maintains its integrity. Individual waste sites have one or more of these features. However, none of the waste sites in the initial assessment had all of the features in the conceptual model.

A number of key processes govern how much contaminant at any given time is released from the waste to the infiltrating water. One process is the affinity of contaminants to be retained by the waste (for example, sorption to soil or waste material). Another process is the ability of waste to dissolve and, in some cases, to form new precipitates, thus allowing some contaminants to be released to the infiltrating water while others remain trapped in the precipitated solids. Release from the waste may also be limited by the solubility of the contaminant in the infiltrating water.

Water infiltrating an engineered system may contact and react with fill materials (for example, soil, basalt, or grout), containment materials in various states of degradation, and different types of waste. Reaction with these materials will change the water chemistry and the physical and hydraulic properties over time. The water composition, pH, and redox state at any given time will influence the extent to which these processes influence contaminant release from the waste.

L.2.3.2 Implementation Model

The Release Module accounts for releases that occurred in the early years of Hanford operations, releases that may be expected while the site is being cleaned up over the next several decades, and future releases that may continue until the entire inventory is released. The Release Module relies on several sources for input. Input from the Inventory Module includes contaminant mass (for chemicals) and activity deposits (for radionuclides). Some of the release models (that is, soil-debris, cement) require site or waste feature information (that is, site cross-sectional area, site volume, or waste surface area or volume). Recharge rate is an important parameter for the salt cake and soil-debris models. Key process parameters are distribution coefficient (soil-debris model), solubility (soil-debris, C_{sol}, and salt cake models), diffusion coefficient (cement model), and fractional release rate (reactor block model).

To capture uncertainty in the SAC simulations, contaminant inventories and numerical model parameters are expressed in terms of statistical distributions. Each realization of the initial assessment used sample parameter values for randomly distributed variables such as bulk soil density, soil moisture content, sorption or distribution coefficient, salt cake density, and cement diffusion coefficient. Other model parameters were held to constant values over all realizations.

L.2.3.3 Numerical Models Relevant to HSW EIS

L.2.3.3.1 Soil-Debris Model

The soil-debris model is used to model contaminant release from unconsolidated wastes mixed with soil. Source zones composed of this waste-form type are permeable to percolating water; therefore, all surfaces of the waste come in contact with the percolating water as it passes through the zone in a manner similar to the way infiltrating water passes through natural vadose zone material. The soil-debris model is applied to the release of contaminants from all solid waste disposal facilities, including ERDF, and the commercial low-level radioactive waste disposal facility operated by US Ecology, Inc.

For the SAC initial assessment, the model used the high-impact values of the distribution coefficient parameter (K_d) associated with the vadose zone nearest the disposal facility. For solid waste disposal facilities, the K_d category used by the soil-debris model is that associated with sites that have a low organic and low salt content and near-neutral pH. The K_d best-estimate values for this category were 0 mL/g, 0.5 mL/g, and 3 mL/g for technetium-99, iodine-129, and uranium, respectively.

For radionuclides for which no specific solubility values were available, the aqueous solubility was fixed at an arbitrarily high default value ($1x10^{10}$ mg/L) so that the soil-debris model automatically selected algorithms for sorption (K_d) control in these cases (Kincaid et al. 1998). Technetium-99 solubility ($1x10^{10}$ mg/L or $1.7x10^2$ Ci/cm^3) was assigned using this approach. Iodine-129 solubility ($1x10^{10}$ mg/L or 1.77×10^0 Ci/cm^3) also was assigned using this approach. Uranium solubility (86.9 mg/L or $2.95x10^{-11}$ Ci/cm^3) was estimated in Hanford groundwater assuming that the solid controlling uranium solubility was $UO_2 (OH)_2 \cdot H_2O$ (Wood et al. 1995).

In the simulation runs, K_d, θ_w, and ß were treated as stochastic over the 25 realizations, and Q_w and C_{sol} were fixed to a constant value for all analytes except tritium. For tritium, K_d was set to zero over all realizations.

Sites with soil wastes include the “118,” “218,” and “618” sites listed in Bergeron et al. (2001).

Analytical Solution for Instantaneous Release—Soil-Debris Model

The rate of loss of contaminant for a given contaminant by the soil-debris model is given by Kincaid et al. (1998) as:

$$dM / dt = - Q_w A C_w \tag{L.1}$$

where $C_w = C_{sol}$ when the release process is solubility controlled and $C_w = M/(\theta RAh)$ when the release process is desorption-controlled where:

$$R = 1 + (\beta K_d) / \theta \tag{L.2}$$

Switching regimes is controlled by comparing the remaining mass with the maximum mass M_{max} consistent with an aqueous phase saturated with the contaminant. If M, the mass remaining in the waste form, is larger than the quantity M_{max} where:

$$M_{max} = \theta R C_{sol} A h \tag{L.3}$$

the release process is considered to be solubility controlled. Otherwise, it is considered desorption-controlled.

Coupling the soil-debris model with an aggregated waste site representation leads to a lower calculated waste concentration, a reduced likelihood of a solubility-controlled release, and a greater likelihood of a desorption-controlled release. Because the release occurs over a larger area than really occupied by the waste deposit, the calculated release is a function of a greater amount of infiltrating water contacting the waste. Thus, all contaminants are leached and for mobile contaminants such as technetium-99 that are not solubility controlled, the release is greater for an aggregated site approach.

Definitions

- M_{max} is the maximum amount of contaminant possible in the source zone (in Ci or kg) without a precipitated phase.
- M = M(t) is the current quantity of contaminant contained in the source zone (Ci or kg).
- Q_w is the recharge rate for the site in cm/yr. Q_w can be considered to be constant, or it can be time-dependent based on site climate and remediation activities.
- A is the surface area of the soil waste form exposed to the release mechanism (cm^2).
- h is the depth of the waste form in the site (cm).
- C_w is a coefficient expressing the effective release of the contaminant (Ci/cm^3 or kg/cm^3).
- C_{sol} expresses aqueous solubility of the contaminant (Ci/cm^3 or kg/cm^3).

- R is either a retardation factor or a soil apportionment factor (unitless) that depends on the following factors:
  - β Soil bulk density in g/cm^3
  - K_d Sorption factor (cm^3/g)
  - θ Soil volumetric content of water in soil (unitless fraction).

- dM/dt is the rate of loss of contaminant from the source zone (the rate the contaminant crosses the soil waste form boundary and enters the environment).

- t is the elapsed time (years) from the beginning of release from containment.

L.2.3.3.2 C_{sol} (Solubility) Model

The C_{sol} model is the independently operated, solubility-controlled analytical solution component of the soil-debris model. As such, it is applied to the same types of solid wastes that are applied to the soil-debris model. The difference is that the process represented by the C_{sol} model is that of a constant concentration release. The concentration at which a contaminant is released from a waste often is at its solubility limit in some aqueous medium (for example, groundwater, or grout leachate) but is not a requirement. This is different from application of the same analytical solution within the soil-debris model in which the model determines the process (solubility controlled vs. sorption controlled) that is appropriate for application at any time within a simulation. In addition, release is always at what is considered to be the solubility limit of the contaminant in the aqueous media of interest. The analytical solution and key parameters are the same as those described in the previous section for the solubility-controlled analytical solution component of the soil-debris model.

Initial application of this release model within the SAC Release Module was undertaken to provide a comparative evaluation of uranium release from a cemented waste form using three different release models (see Section L.2.3.4).

Assume that a solubility-controlled release was prescribed for several scales of disposal from aggregated areas to individual waste trenches and that each disposal scale contained the same inventory. The larger the waste site area, the greater the infiltrating water quantity contacting waste, the greater the mass or curie flux from the waste site, and the more rapid the release.

L.2.3.3.3 Cement Model

The cement model generally is applied to cementitious waste forms. Knowledge of the total external surface area and the volume of the waste form is required. The area-to-volume ratio is assumed to be constant (that is, the waste form is assumed not to degrade in terms of shape over the duration of the contaminant release process). In the SAC initial assessment, the cement model was used to simulate release of contaminants from cementitious wastes within selected solid waste disposal facilities. Delay of contaminant release from containerized waste can be accomplished with the current capability by arbitrarily assigning a time of delay. In the SAC initial assessment, however, no credit was taken for container integrity. Plans call for incorporating one or more models into a future revision of the SAC capability that will accommodate delay of release from contained waste based on specific processes (for example, metal corrosion).

The range in diffusion coefficient values (1.58×10^{-4} cm/yr to 1.89×10^{-3} cm/y) used in the SAC initial assessment for technetium-99 was obtained from recent laboratory work (Mattigod et al. 2000). The diffusion coefficient for uranium (3.15×10^{-5} cm/yr) was obtained from Serne et al. (1992). In the simulations, the diffusion coefficient for technetium-99 was stochastic; for uranium, it was set to a constant for all realizations.

Sites containing cementitious wastes include the "202," "221," "224," and "276" sites listed in Bergeron et al. (2001).

<u>Analytical Solution for Instantaneous Release—Cement Model</u>

The contaminant release mechanism of the cement model is diffusion in the pore water of the solidified waste material to the outer surface of the waste form. The rate-of-loss for a given contaminant is given by Kincaid et al. (1998) as:

$$dM/dt = M_0(A/V)\sqrt{D/\pi t} \tag{L.4}$$

where:

M_0 = the original quantity of the contaminant contained in the cement (Ci or kg)
M = current quantity of the contaminant contained in the cement (Ci or kg)
A = the surface area of the cement structure (cm^2)
V = the volume of the cement structure (cm^3)
D = the diffusion coefficient of the contaminant (cm^2/yr)
t = the elapsed time (years) from the beginning of release from containment
dM/dt = the rate of loss of contaminant from the cement waste form
π = 3.14159.

Note, the original quantity M_0 can be seen as a function of concentration (kg/cm^3 or Ci/cm^3) and volume (cm^3).

With regard to the scale of the disposal, assuming the aggregated area of an aggregated volume is simply the exterior surface of the volume, the larger the disposal area, the smaller the ratio of area to volume (A/V) in the equation above. Accordingly, if the contaminant mass or Ci and the diffusion coefficient are unchanged for multiple scales of waste site, then the larger aggregated site will exhibit a lower release rate.

L.2.3.3.4 Containment

The release models implemented in the current version of SAC have no provisions for specifically modeling containment of wastes, such as high-integrity steel containers. The models do have a provision for delaying release to a specific start year (that is, the STARTREL argument in the MODELS keyword). The default start year is the year the waste begins to be deposited at the site. In the initial assessment, STARTREL was set to 1944 throughout the simulation, so for the initial assessment, the release mechanism was active as soon as wastes were deposited.

L.2.3.4 Comparison of Release Model Parameters

A comparison of key source-term release models (that is, soil-debris, solubility-controlled, and cement) and values of key parameters used in the SAC analysis, the HSW EIS analysis (described in Appendix G), and the solid waste burial ground (SWBG) PAs for the 200 West and East Areas (as described by Wood et al. [1995] and Wood [1996]) is summarized in Table L.2. The three constituents addressed are technetium-99, iodine-129, and uranium. This summary of parameter values, coupled with the release model formulations of the preceding section, allows a comparison of relative release characteristics included in the three assessments. The parameter values shown here are somewhat generic and not necessarily related to specific waste streams and, therefore, could be changed according to specific waste disposal conditions for application in specific wastes and especially for regulatory compliance simulations (that is, a performance assessment for a specific disposal).

There are several key differences in the way these different analysis approaches address selective contaminant releases from the source term. The SAC analysis differs from the other two analyses in the way that uranium is released from LLW. For non-cemented waste, the SAC analysis uses a soil-debris model coupled with uranium specific solubility-limits to simulate uranium release. For cemented wastes, the SAC analysis uses a cement (that is, diffusion-controlled) release model to simulate uranium release. In contrast, the release of uranium in HSW EIS analysis and the SWBG PAs relies on a solubility-controlled release model with uranium-specific solubility limits depending on whether the uranium inventory is contained in non-cemented wastes or in cemented wastes (for example, 64 mg/L for non-cemented wastes and 0.23 mg/L for cemented wastes).

The SAC application of the cement model to technetium-99, iodine-129, and uranium releases assumed a cemented waste and a surface A/V ratio based on a waste volume that constituted a number of aggregated burial ground sites. In contrast, the HSW EIS and SWBG PA analyses relied on a conceptualization of surface A/V ratio based on the surface area and volume of individual waste containers (for example, individual steel barrels, boxes, high integrity containers that would contain grouted wastes). As a result, the surface A/V ratio for the SAC source term was up to 10 times lower than those reported for HSW EIS and SWBG PA analyses. Lower releases of technetium-99, iodine-129, and uranium from the SAC analysis would be expected based on this difference alone. However, when the diffusion coefficient is roughly one order of magnitude higher in the SAC application, the lower A/V ratio is partially offset by the higher diffusion coefficient.

Table L.2. Comparison of Selected Values of Key Parameters Used in Source-Term Release Models for the System Assessment Capability Analysis Described in this Appendix, the HSW EIS Analysis Described in Appendix G, and the Solid Waste Burial Ground Performance Assessments for the 200 West and East Areas Described by Wood et al. (1995) and Wood (1996)

	System Assessment Capability (SAC)	HSW EIS	Solid Waste Performance Assessment
Source-Term Release Models			
Soil-Debris Model			
Model or Zone/Parameter	**Data/Statistical Treatment**		
Volumetric Moisture Content (%)	0.0594 ± 0.0310[a] (mean/standard deviation, normal distribution)	0.05	0.05
Bulk Density (g/cm^3)	1.535 ± 0.1085[a] (mean/standard deviation, normal distribution)	1.6	1.5
Waste Thickness (m)	5.349[b] (deterministic)	6	4.5
K_d uranium (mL/g)	Low organic/low salt/near neutral, high impact: (best estimate, min and max)[c] best estimate: 3, min: 0.1, max: 500	Mobility Class (K_d=0.6)[h] covering constituents with K_ds between 0.6 and 0.9999	Mobility Class (K_d=0.0) covering constituents with K_ds between 0.0 and 0.9999
K_d technetium-99 (mL/g)	Low organic/low salt/near neutral, high impact: (best estimate, min and max)[c] best estimate: 0; min: 0; max: 0.1	Mobility Class (K_d=0.0)[h] covering constituents with K_ds between 0.0 and 0.5999	Mobility Class (K_d=0.0) covering constituents with K_ds between 0.0 and 0.9999
K_d iodine-129 (mL/g)	Low organic/low salt/near neutral, high impact: (triangular distribution, mode, min and max)[c] median: 0.5; min: 0; max: 15	Mobility Class (K_d=0.0)[h] covering constituents with K_ds between 0.0 and 0.5999	Mobility Class (K_d=0.0) covering constituents with K_ds between 0.0 and 0.9999
Solubility; uranium (mg/L)	86.9 (2.95×10^{-11} Ci/cm^3)[d] (deterministic) (non-cemented wastes)	NA[l]	NA
Solubility; technetium-99 (mg/L)	1×10^{10} (1.7×10^{2} Ci/cm^3)[e] (deterministic) (non-cemented wastes)	NA	NA
Solubility; iodine-129 (mg/L)	1×10^{10} (1.77×10^{0} Ci/cm^3)[e] deterministic (non-cemented wastes)	NA	NA
Solubility-Control Model			
Model or Zone/Parameter	**Data/Statistical Treatment**		
Solubility; uranium (mg/L)	86.9 (2.95×10^{-11} Ci/cm^3)[d] (deterministic) (non-cemented wastes)	64 (non-cemented wastes); 0.23 (cemented wastes)	64 (non-cemented wastes); 0.23 (cemented wastes)
Solubility; technetium-99 (mg/L)	1×10^{10} (1.7×10^{2} Ci/cm^3)[e] (deterministic) (non-cemented wastes)	NA	NA
Solubility; iodine-129 (mg/L)	1×10^{10} (1.77×10^{0} Ci/cm^3)[e] (deterministic) (non-cemented wastes)	NA	NA
Cement Model			
Model or Zone/Parameter	**Statistical Treatment**		
Area to Volume Ratio (m^2/m^3)	0.378 [k]	1.55 to 1.93	5.33[i]
Diffusion Coefficient; uranium (cm^2/yr)	3.15×10^{-5} (1×10^{-12} cm^2/s)[e, f] (deterministic)	NA	NA
Diffusion Coefficient; technetium-99 (cm^2/yr)	(uniform distribution, median, min, max) median: 1.02×10^{-3}, min: 1.58×10^{-4}, max: 1.89×10^{-3}[g]	3.15×10^{-4} (range - min: 1.58×10^{-4}, max: 1.89×10^{-3})[g]	3.15×10^{-5} to 31.5[j]
Diffusion Coefficient (iodine-129) (cm^2/yr)	3.5×10^{-5}[g]	3.15×10^{-5}	3.15×10^{-5} to 31.5[j]

(a) Values based on statistical treatment of individual data points measured or calculated over a depth ranging from 0- to 20-ft values calculated from bulk density and moisture content data from Fayer et al. (1999).

(b) An average height calculated for burial ground sites based on available height information in the Waste Information Database System (WIDS).

(c) Based on revision of K_ds in Kincaid et al. (1998) resulting from a recent compilation and evaluation of distribution coefficient data in Hanford sediments (Cantrell et al. 2002).

(d) Estimated solubility in Hanford groundwater assuming solid controlling solubility was $UO_2(OH)_2 \cdot H_2O$ (Wood et al. 1995).

(e) Default value from Table D.2 of Kincaid et al. (1998).

(f) Recommended value (default) for generic grout performance assessment when actual grout-specific data is lacking (Table 6, Serne et al. 1992).

(g) Based on results obtained from Mattigod et al. (2000).

(h) Best estimate K_d values after Cantrell et al. (2002).

(i) Values as low as 1.7 m^2/m^3 have been used in subsequent waste stream specific analyses.

(j) A range of values was considered for an unspecified constituent in the PA analysis (Wood et al. 1995).

(k) Based on all cemented waste placed in aggregate area 218-W@T-6-12 (SAC Rev. 0).

(l) NA = not applicable; the process or parameter was not used in the assessment.

From the formulations of the soil-debris model, which is the release model associated with early solid waste disposals at Hanford (that is, pre-1970 wastes), it is apparent that the use of larger aggregated areas as opposed to burial ground, trench, or caisson scales to represent waste, leads to lower initial concentrations of waste but exposes waste to greater infiltration and, hence, leaching. Use of aggregated representations and the soil-debris model tends to release waste more rapidly than would occur if simulations were conducted on the burial ground or trench scale.

L.2.4 Vadose Zone Module

The Vadose Zone Module is designed to simulate the transport and fate of contaminants as they move through the hydrogeologic region that extends from the land surface to the regional water table. Kincaid et al. (2000) identified the STOMP computer code (White and Oostrom 1996) as the code for the Vadose Zone Flow and Transport Module for SAC. Inputs to the Vadose Zone Module come primarily from the inventory and release elements, including recharge, and the mass flux and concentrations of the selected constituents. Other inputs include the effectiveness and timing of remedial actions that might either reduce the mass and/or concentration of contaminants in the vadose zone or that might reduce the flux of deep infiltrating moisture (that is, capping). These inputs include infiltration rates from both natural events (for example, precipitation) and operational activities (for example, excavation or capping). A few major hydro-stratigraphic units that are of uniform thickness and horizontal with homogeneous and isotropic properties were used to represent each site. Hydraulic and geochemical parameters for each hydro-stratigraphic unit are represented by stochastic distributions that reflect the uncertainty in measured properties. Definitions of the hydro-stratigraphy and the associated hydraulic, transport, and geochemical properties of the one-dimensional soil column were based on existing geologic, soil physics, and geochemical databases.

L.2.4.1 Distribution Coefficients (K_ds) for Technetium-99, Iodine-129, and Uranium

The SAC initial assessments used K_d values that were assigned to each hydrogeologic unit in a manner similar to that done for the Composite Analysis (Kincaid et al. 1998). The waste characteristics were assumed to dominate the near-field mobility of the contaminants in the vadose zone. After being in contact with vadose zone sediments and soil water for some distance, the waste undergoes a change in its mobility based on buffering of the contaminant solution by the vadose zone sediments. Thus, distribution coefficients were defined separately for each contaminant in the upper vadose zone (near-field or high-impact zone) and in the lower vadose zone (far-field or intermediate-impact zone) (Kincaid et al. 1998).

Distribution coefficient zones were defined as either high-impact or intermediate-impact depending on the nature of the contaminant. Zones in which the organic concentration, pH, or salt concentration in the fluids may have affected the K_d values were designated high-impact. Zones in which the acidic or basic nature of the wastes was estimated to have been neutralized by the natural soil were designated intermediate-impact. Kincaid et al. (1998) estimated the depths of this transition zone by examining the peak location of beta/gamma contamination, as presented by Fecht et al. (1977a, b), for 200 Area cribs receiving very acid or high-salt/very basic waste. In general, these transition depths ranged from 10 to 40 m (33 to 130 ft). Given the limited data available on which to base further interpretations on the depths of transition and the desire to simplify the numerical simulations, a slightly different approach was used here. Generally, the hydrogeologic unit into which waste streams were introduced was designated as high-impact regardless of waste stream characteristics. If those hydrogeologic units were thin (for example, less than 10 m), then the hydrogeologic unit immediately below that into which the waste stream was introduced was also designated as high-impact. All other hydrogeologic units lower in the profile were designated intermediate-impact. This approach kept the numerical simulations relatively simple by using the existing number of hydrogeologic units (that is, new layers did not need to be added to make the K_d change where it might have occurred within a single hydrogeologic unit). At the same time, the depths of change, corresponding to the thickness of the hydrogeologic units, are still on the same scale (tens of meters) as those used by Kincaid et al. (1998). A summary of the K_d values used for technetium-99, iodine-129, and uranium is presented in Tables L.3, L.4, and L.5, respectively.

Carbon-14 was not simulated in this cumulative assessment but was simulated in the evaluation of alternative groups in this EIS. The composite analysis (Kincaid et al. 1998) assigned carbon in solid waste disposal facilities a distribution coefficient of 5 mL/g. Consequently, the release and migration of carbon-14 from solid waste is substantially retarded compared with those of uranium, and carbon-14 impacts to groundwater would occur after the 10,000-year post-closure period analyzed for the cumulative assessment.

Table L.3. Technetium-99 Distribution Coefficients (mL/g)

	Vadose Zone				
		Intermediate-Impact (Far-Field)			
Waste Chemistry	High-Impact (Near-Field)	Sand	Gravel	Groundwater	Riparian Zone
All	**0** (0-0.1)	**0** (0- 0.1)	**0** (0-0.01)	**0** (0-0.1)	**0** (0-0.1)

Values are listed as **best** (minimum–maximum).

Table L.4. Iodine Distribution Coefficients (mL/g)

	Vadose Zone				
		Intermediate-Impact (Far-Field)			
Waste Chemistry	High-Impact (Near-Field)	Sand	Gravel	Groundwater	Riparian Zone
High Organic/Very Acidic; Low Organic/Low Salts/Acidic	**4** (0-15)	**0.2** (0-2)	**0.02** (0-0.2)	**0.2** (0-2)	**0.2** (0-2)
High Organic/Near Neutral; Very High Salt/Very Basic; Chelates/High Salts; Low Organic/Low Salt/ Near Neutral	**0.2** (0-2)				

Values are listed as **best** (minimum–maximum).

Table L.5. Uranium Distribution Coefficients (mL/g)

Waste Chemistry	Vadose Zone			Groundwater	Riparian Zone
	High-Impact (Near-Field)	Intermediate-Impact (Far-Field)			
		Sand	Gravel		
High Organic/Very Acidic; Chelates/High Salts; Low Organic/Low Salts/Acidic	**0.2** (0-4)	**0.8** (0.2-4)	**0.08** (0.02-0.4)	**0.8** (0.2-4)	**0.8** (0.2-4)
High Organic/Near Neutral; Very High Salt/Very Basic; Low Organic/Low Salt/ Near Neutral	**0.8** (0.2-4)				

Values are listed as **best** (minimum–maximum).

L.2.4.2 Vadose Zone Strata and Hydraulic Properties

Of the more than 2600 waste sites at Hanford cataloged in Waste Information Database System (WIDS), a subset of 533 was selected for simulation in the initial assessment. Because of the aggregation of solid waste disposal facilities, unplanned releases, and various liquid discharge sites into fewer global waste sites within operational areas or portions of operational areas, these 533 sites represent 890 waste sites.

L.2.4.2.1 Geologic Profiles

Each of these sites was assigned to one of 64 base templates defined on the basis of 1) the type of waste site, 2) its geographic location (that is, area/geology), and 3) the characteristics of the waste stream.

Generalized hydrostratigraphic columns were specified for each of the 13 geographic areas. These columns were assembled from existing information, including:

- logs (from drillers, geologists, and geophysicists)
- published interpretive depths to the top and bottom surfaces of hydrogeologic units
- surface elevations (to convert hydrogeologic unit depths to elevations)
- elevation of the 1944 water table (to define the bottom of the vadose zone prior to waste disposal).

The generalized hydrostratigraphic units used in this study are summarized in Table L.6.

Table L.6. Summary of Hydrogeologic Units Used in This Study

Hydrogeologic Units	Facies/Subunit	Description
Not applicable	Backfill	Poorly sorted gravel, sand, and silt derived from the Hanford formation and/or Holocene deposits.
Holocene	Eolian	Dune sand and silt.
Hanford formation	Silt-dominated	Interbedded silt and fine to coarse sand.
	Fine sand-dominated	Stratified fine sand with minor pebbles and minor laterally discontinuous silt interbeds.
	Coarse sand-dominated	Stratified coarse sand with minor pebbles and minor laterally discontinuous silt interbeds.
	Gravelly sand	Cross bedded, interstratified coarse sand with up to 30 wt% very fine pebble to cobble.
	Gravel-dominated	Cross bedded, interstratified coarse sand and gravel with greater than 30 wt% very fine pebble to boulder.
	Undifferentiated	Undifferentiated sand and gravel with minor discontinuous silt interbeds.
Plio-Pleistocene unit	Silt/sand dominated	Very fine sand to clayey silt sequence. Interstratified silt to silty very fine sand and clay deposits.
	Carbonate rich	Carbonate-rich sequence. Weathered and naturally altered sandy silt to sandy gravel, moderately to strongly cemented with secondary pedogenic calcium carbonate.
Ringold Formation	Fluvial sand (member of Taylor Flat)	Interstratified sand and silt deposits.
	Fluvial gravel (member of Wooded Island, subunit E)	Moderate to strongly cemented well-rounded gravel and sand deposits, and interstratified finer-grained deposits.
	Overbank/Lacustrine deposits (lower mud sequence)	Predominantly mud (silt and clay) with well-developed argillic to calcic paleosols.

In general, the depth and thickness of each hydrogeologic layer (strata) for each geographic area were taken from published maps and cross sections. The estimated average strata thickness was used for the generalized columns extending from the surface to the 1944 water table (Kipp and Mudd 1974). Because the sum of the average thickness did not always equal the distance from the land surface to the groundwater, small adjustments were made to the average strata thickness.

L.2.4.2.2 Hydraulic Properties

Hydraulic property data were primarily taken from Khaleel and Freeman (1995) as supplemented by Khaleel (1999) and Khaleel et al. (2000). Because this data set is rather limited in terms of the spatial location of samples and the soil types represented, individual stochastic data sets were selected to represent each hydrogeologic strata present in the 13 geographical areas. Care was taken to ensure that the soil classifications for which hydraulic property data was available could be correlated to the sediment facies within each template.

The statistical distributions of the van Genuchten model (van Genuchten 1980) parameters, saturated hydraulic conductivity, and bulk density data were taken primarily from Khaleel and Freeman (1995) and Khaleel et al. (2000), and the distributions for longitudinal dispersivity were primarily taken from Ho et al. (1999). Values for residual saturation (Sr) were calculated by dividing the raw residual water content (θR) by the raw saturated content (θs), as provided by Khaleel and Freeman (1995). Effective porosity is assumed to be equal to the saturated water content (θs). Note that all model nodes within a single hydrogeologic unit are assigned the same hydraulic properties for a single realization.

L.2.4.3 Surface Covers

The SAC incorporates recharge estimates into the STOMP model to provide deterministic values that change stepwise as the surface cover changes and to represent the degradation of engineered covers following their design life. The recharge rates (actually, deep drainage rates) used for the SAC were estimated for all surface conditions under consideration for the initial assessments. These conditions included four different barrier designs, degraded barriers, the natural conditions that surround the barriers, and the unique conditions created by human activities (for example, facility construction, gravel-covered tank farms). Recharge estimates were based on the best available data (Fayer and Walters 1995; Fayer et al. 1999; Murphy et al. 1996; Prych 1998).

L.2.4.3.1 Barrier Recharge Estimates

Recharge through engineered surface covers was estimated based on the Focused Feasibility Study (FFS) conducted by DOE-RL (1996). The FFS was conducted to determine the barrier needs at Hanford and to identify a set of barrier designs to meet those needs. Table L.8 identifies the four barrier designs that were proposed. According to the FFS, the Modified RCRA Subtitle C Barrier design will be the predominant barrier type. DOE-RL (1996) used the HELP model[a] to simulate the recharge rate through the Hanford Barrier, modified RCRA barriers, and the standard RCRA barriers. The estimates ranged from 0.2 to 0.8 mm/yr, assuming that the annual mean precipitation remained at 160 mm/yr (6.3 in/yr). Subsequent to the FFS, additional data and model results became available. As a result, the recharge rates for the barriers were updated as reflected in Table L.7.

Table L.7. Barrier Design Lifetimes and Estimated Recharge Rates (actual rates are expected to be less than shown)

DOE-RL Design	Design Life (yr)	Recharge Rate (mm/yr)	Source
Hanford Barrier	1000	0.1	Based on lysimeter data and simulation results (Fayer et al. 1999).
Modified RCRA Subtitle C	500	0.1	Based on lysimeter data and simulation results (Fayer et al. 1999).
Standard RCRA Subtitle C	30	0.1	No data; recommendation is based on presence of geomembrane, 2-ft thick clay admix layer, and short design life.
Modified RCRA Subtitle D	100	0.1	Based on simulation results using parameters from Fayer et al. (1999).

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[a] Hydrologic Evaluation of Landfill Performance model, after Schroeder (1997).

No guidance is available for specifying barrier performance after the design life. However, an immediate decrease in performance is not expected, and it is likely that some of these barriers will perform as designed far beyond their design life. Without data to understand and predict that long-term performance, however, an assumption was made that the performance would degrade stepwise after reaching its design life, until the recharge rate matches the rate in the surrounding environment. This approach is based on the assumption that a degraded cover eventually will return to its natural state and, at that time, will behave like the surrounding environment. A further assumption was that the period of degradation would be the same as the design life. For example, the Modified RCRA Subtitle C Cover would perform as designed for 500 years and then degrade stepwise in five equal steps over the next 500 years to the point at which recharge rates are equivalent to the rates of the natural surrounding environment.

The schedule and type of engineered cover to be applied to each site was based on the Hanford Disposition Baseline as defined by Kincaid et al. (2000).

L.2.4.3.2 Natural (Non-Barrier) Recharge Rates

Most of the waste sites at Hanford have not had a surface barrier, and it is assumed that many sites will not have a surface barrier applied prior to site closure. The effort to estimate recharge in these areas addressed four site conditions:

- undisturbed soil and shrub-steppe vegetation
- undisturbed soil with no vegetation
- disturbed soil with no vegetation
- disturbed soil with shrub-steppe vegetation.

The Hanford soil map (Hajek 1966) was examined to identify the soil types prevalent in the waste areas. Table L.8 lists the four soil types that dominate the areas being evaluated in the initial assessment and their recharge rates. It was assumed that these soils, in their undisturbed condition, support a shrub-steppe plant community.

For some Hanford activities, the shrub-steppe plant community often was removed while leaving the existing soil type relatively intact. For other activities, the sites were excavated, which removed the existing soil structure, and then backfilled with Hanford formation sand or gravel. Some activities also covered selected surface areas with a layer of gravel (for example, the tank farms). Table L.9 shows the estimated recharge rates for native soils and backfilled sediments without vegetation. Eventually, the disturbed areas may become revegetated and a shrub-steppe plant community re-established. Under these conditions, it is assumed that the estimated recharge rate will return to that equivalent to the pre-Hanford conditions after a period of 100 years.

Table L.8. Estimated Recharge Rates for Predominant Soil Types and Sediments with a Shrub-Steppe Plant Community

Soil Type	Recharge Rate Estimate (mm/yr)	Description
Ephrata stony loam (Eb)	1.5	No data; used estimate for El, which is a similar soil.
Ephrata sandy loam (El)	1.5	Average of two estimates (1.2; 1.8) from deep (> 10 m) chloride data collected from the two boreholes B17 and B18 (Prych 1998).
Burbank loamy sand (Ba)	3.0	Average of three estimates (0.66, 2.8, 5.5) from deep (> 10 m) chloride data collected from the three boreholes B10, B12, and B20 (Prych 1998).
Rupert sand (Rp) inside the 200 East Area	0.9	Average of four estimates (0.16, 0.58, 1.0, and 1.8) from deep (> 10 m) chloride data collected from the four boreholes E24-161, E24-162, B8501, B8502 (Fayer et al. 1999).
Rupert sand (Rp) outside the 200 East Area	4.0	Estimated from chloride data collected from a borehole near the Wye Barricade (Murphy et al. 1996).
Hanford formation sand	4.0	No data; used estimate for Rupert sand outside the 200 East Area.

Table L.9. Estimated Recharge Rates for Native Soils and Backfilled Sediments without Vegetation

Soil Type	Recharge Rate Estimate (mm/yr)	Description
Ephrata stony loam (Eb)	17.3	Simulation estimate from Fayer and Walters (1995).
Ephrata sandy loam (El)	17.3	Simulation estimate from Fayer and Walters (1995).
Burbank loamy sand (Ba)	52.5	Simulation estimate from Fayer et al. (1999).
Rupert sand (Rp)	44.3	Simulation estimate from Fayer et al. (1999).
Hanford formation sand	55.4	8-yr lysimeter record for Hanford sand (Fayer and Walters 1995).
Graveled surface	104	8-yr lysimeter record for graveled surface (Fayer et al. 1999).

L.2.4.3.3 Summary of Recharge Estimates for the Initial Assessment

The estimated recharge rates for various surface conditions for each of the 13 geographic areas included in the initial assessment are provided in Table L.10. This table presents a brief description of each setting and identifies the major soil type that was identified visually for each area using the soil map developed by Hajek (1966). If a substantial secondary soil type was present, that soil type is shown in parentheses. Likewise, its recharge rate also is shown in parentheses. Figure L.2 illustrates how the recharge rates for various surface covers were assumed to change over time as performance degrades.

Table L.10. Recharge Estimates for the Initial Assessment (substantial secondary soil types and their associated recharge estimates are shown in parentheses)

Area Label	Brief Description	Major (secondary) Soil Type(s) (a)	Recharge Rates Used in the Initial SAC Assessment(s) (mm/yr)			
			Pre- and Post-Hanford (shrub-steppe)	Operations (soil intact, no vegetation)	Operations (soil disturbed, with/without vegetation)	Operations (gravel surface, no vegetation)
C	Reactor along river	Eb (Ba)	1.5 (3.0)	17.3 (52.5)	4.0 / 55.4	104
K	Reactor along river	Eb (El)	1.5 (1.5)	17.3 (17.3)	4.0 / 55.4	104
N	Reactor along river	Eb	1.5	17.3	4.0 / 55.4	104
D	Reactor along river	El	1.5	17.3	4.0 / 55.4	104
H	Reactor along river	Ba	3.0	52.5	4.0 / 55.4	104
F	Reactor along river	Rp (El)	4.0 (1.5)	44.3 (17.3)	4.0 / 55.4	104
R	300 Area	Rp (El)	4.0 (1.5)	44.3 (17.3)	4.0 / 55.4	104
G	200 N Area	El (Ba)	1.5 (3.0)	17.3 (52.5)	4.0 / 55.4	104
T	Northern 200 West Area	Rp (Ba)	4.0 (3.0)	44.3 (52.5)	4.0 / 55.4	104
S	Southern 200 West Area and ERDF	Rp	4.0	44.3	4.0 / 55.4	104
A	Southern 200 East Area	Rp (Ba)	0.9 (3.0)	44.3 (52.5)	4.0 / 55.4	104
B	Northwestern 200 East Area	El	1.5	17.3	4.0 / 55.4	104
E	Eastern 200 East Area	Ba (Rp)	3.0 (0.9)	52.5 (44.3)	4.0 / 55.4	104

Eb = Ephrata stony loam El = Ephrata sandy loam Ba = Burbank loamy sand Rp = Rupert sand

(a) Note: Only the major soil types were used to represent each aggregate area.

The recharge rates estimated for the initial assessment do not account for overland flow from roadways or roofs, water line leaks, or any other anthropogenic additions of water. The rates also do not account for variations within soil type, plant community succession (for example, a takeover by cheatgrass), dune sand deposition, or climate change. Finally, these rates were developed for fairly large geographic areas and may not represent the local recharge rates at specific locations.

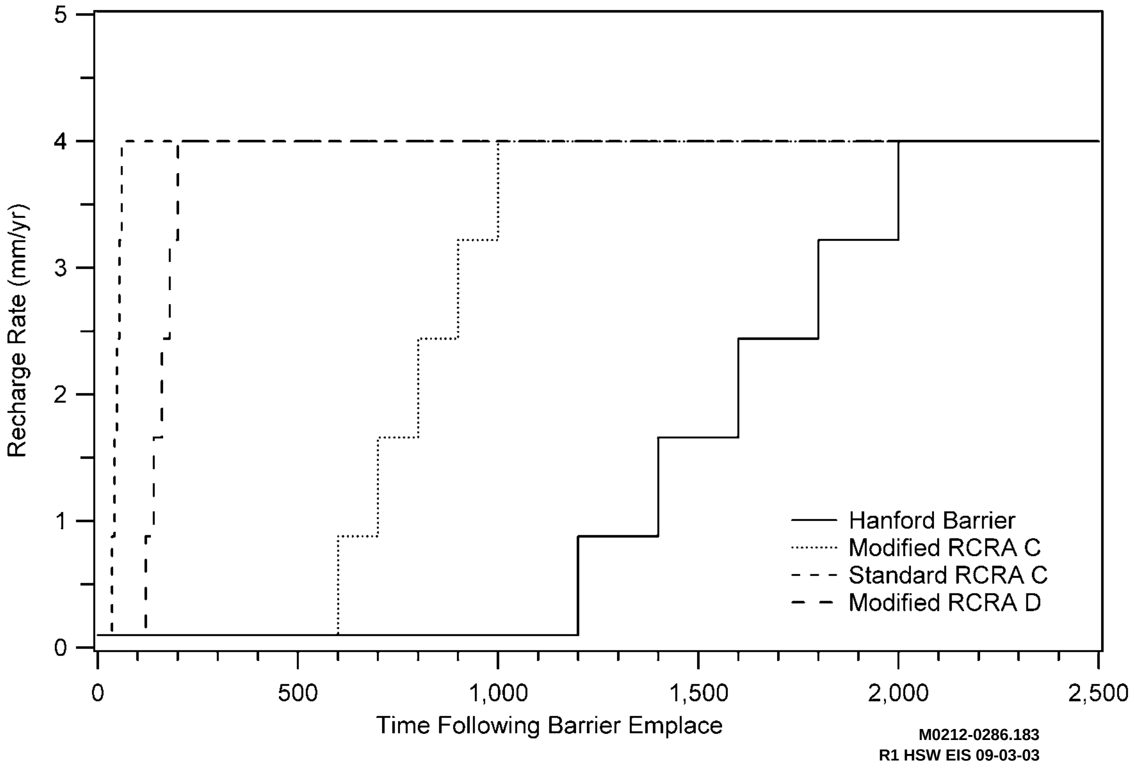

Figure L.2. Recharge Through Covers as a Function of Time

L.2.5 Groundwater Module

The Groundwater Module focuses on groundwater that is part of the upper most saturated zone on the Hanford Site. This zone, commonly referred to as the unconfined aquifer, offers a pathway for contaminants released through the vadose zone from past, present, and future site activities to reach the environment accessible to man. Radioactive and hazardous chemicals have been released on the Hanford Site from a variety of sources including ponds, cribs, ditches, injection wells (referred to as reverse wells), surface spills, and tank leaks. Many of these sources have already affected the groundwater, and some may affect it in the future. Once in the groundwater, contaminants move along the pathways of least resistance, from higher to lower potentials (for example, elevations), where some contaminants may ultimately discharge into the Columbia River.

The goal of the Groundwater Module is to evaluate the transport of contaminants released from the vadose zone to points of regional discharge of groundwater along the Columbia River within the assessment period. Contaminants released to the groundwater form plumes, some of which extend from their source areas to the Columbia River. The Groundwater Module calculates the concentrations of contaminants in the groundwater for direct use in impact and risk calculations.

Information concerning characterization, modeling, and monitoring of the groundwater system, described in DOE-RL (1999), provides the primary basis for the conceptual model and numerical implementation of the Groundwater Module supporting the initial assessment. The groundwater conceptual model is an interpretation or working description of the characteristics and dynamics of the physical hydrogeologic system, and it consolidates Hanford Site data (for example, geologic, hydraulic, transport, and contaminant data) into a set of assumptions and concepts that can be quantitatively evaluated.

The Groundwater Module takes the results of the analyses from the vadose zone technical element in the form of contaminant flux from various waste sources. In addition to the influx from the vadose zone element, the Groundwater Module requires information that defines the physical characteristics of the hydrologic system, transport parameters, and natural and artificial recharge rates. Driving forces, including natural recharge from precipitation and artificial recharge from waste disposal activities, contribute to the movement of the contaminants through the vadose zone and into the groundwater of the unconfined aquifer. Several important fate and transport processes, including advection and dispersion, first-order radioactive decay, thermal and chemical interactions with the water and sediment, and contaminant density, may control the fate and transport of the contaminants in the groundwater. For the initial assessment, the thermal and chemical processes considered in the groundwater transport element were limited to assumptions of isothermal conditions, uniform density, and adsorption using the linear sorption isotherm model and, hence, the distribution coefficient, K_d, concept.

The definition of the hydrologic system is based on previous subsurface investigations from which data on the hydrologic units, unit boundaries, hydraulic conductivity, hydraulic heads, storativity, and specific yield were assembled. Transport parameters are based on both site-specific work of previous investigations and published literature values for parameters including effective porosity, dispersivity, contaminant-specific retardation coefficients, and vertical and horizontal anisotropy. The groundwater flow and transport model also requires estimates of natural recharge rates and locations and magnitude of artificial recharge to the hydrologic system, which are available from historic records and direct measurements. Model domain boundaries are established for the flow system based on site-specific knowledge and output data requirements. Boundaries are established along the northern and eastern portion of the site corresponding to the course of the Columbia River and along the southeastern portion of the model along the course of the Yakima River. Basalt ridgelines and the Cold Creek Valley form the western model domain boundaries. Lower flow boundaries are established between the confined basalt aquifer system and the overlying unconfined aquifer. A complete description of the groundwater conceptual model is provided in Appendix D of DOE-RL (1999).

The conceptual model of the groundwater system used in this assessment is based on nine major hydrogeologic units identified in Thorne and Chamness (1992), Thorne and Newcomer (1992), and Thorne et al. (1993, 1994). Although nine hydrogeologic units were defined, only seven are found in the unconfined aquifer during the period of interest. The Hanford formation combined with the pre-Missoula gravel deposits were designated as model unit 1. Model units 2 and 3 correspond to the early Palouse soil and Plio-Pleistocene deposits, respectively. Odd-numbered Ringold model units (5, 7, and 9) are predominantly coarse-grained sediment. Even-numbered Ringold model units (4, 6, and 8) are predominantly fine-grained sediment with low permeability. The underlying basalt was designated model unit 10. However, the basalt was assigned a very low hydraulic conductivity and was essentially treated as an impermeable unit in the model.

A complete description of the sitewide groundwater flow and transport model used in the current assessment is provided in Cole et al. (2001a). The current Hanford sitewide groundwater model is implemented with the CFEST code (Gupta et al. 1987). The current model has been transient-inverse calibrated to the record of hydraulic head (that is, water-table elevation) measurements from Hanford startup in 1944 to the present.

Simulated flow conditions during the historical period of operations that provided the basis for all transport calculations are described in Cole et al. (2001b). These flow conditions incorporate the effect of large-volume discharges of wastewater to a variety of waste facilities since the inception of the Hanford Site in 1943. These operational discharges have raised the water table, created groundwater mounds, and been the source of local- and regional-scale contaminant plumes under waste management sites and facilities along the Columbia River and in the Central Plateau. Since 1988, the mission of the Hanford Site has changed from weapons material production to environmental restoration. As a result, wastewater discharges have declined substantially, which caused the water table to decline substantially over the past decade. Simulation of future water table decline indicates that the aquifer would return to more natural levels within 150 to 300 years. These results are consistent with previous work on future water table declines described in Cole et al. (1997) and Kincaid et al. (1998).

The SAC has been inverse calibrated to the hydraulic head data, and history matched to the most abundant data, that for tritium the most mobile of radioactive contaminants. Use of the hydraulic head and tritium data sets provide confidence that the underlying liquid release, vadose zone, and groundwater models duplicate the essential features of the tritium groundwater plume; extent of tritium contamination, its arrival at the Columbia River, and its decay as a function of time.

Historical field data specific to solid waste disposal facilities are not available. Solid wastes disposed in containers of either cardboard, wood, plastic, or metal construction are not believed to have released from their containers and contaminated the sediments immediately below the disposal facilities. It may be decades or centuries before contaminants in some solid waste disposal facilities reach the underlying groundwater and are available for detection. Thus history matching to solid waste releases is not feasible at this time.

Calculation of dose, risk, or impact from contaminated groundwater requires groundwater contaminant concentrations. The three-dimensional groundwater model includes nodes throughout each vertical profile of the unconfined aquifer. To define the maximum concentration of each contaminant at a land surface location above the aquifer, all values in the underlying vertical profile are considered. Thus the suite of maximum concentrations at a given location are selected regardless of their vertical position within the aquifer model, and the maximums used for different contaminants need not come from the same vertical horizon of the model. This is a conservatism in the groundwater contaminant concentrations used in all dose, risk, and impact simulations.

L.2.6 River Transport Module

The River Transport Module simulates the Columbia River between the Vernita Bridge and McNary Dam and includes inputs from groundwater and the Yakima and the Snake Rivers. The contaminants modeled in the river come from three sources:

- those already in the river when water reaches the Vernita Bridge from upstream sources and atmospheric fallout
- contaminant influx from Hanford waste sites through groundwater
- direct discharge to the river from Hanford facilities.

Groundwater and irrigation return discharges to the river along the shore opposite Hanford are not included in the initial assessment.

The MASS2 code provides the basis of the River Transport Module (Richmond et al. 2000). MASS2 is a two-dimensional, depth-averaged hydrodynamics model that provides the capability to simulate the lateral (bank-to-bank) variation of flow and transport of sediments and contaminants. The model incorporates river hydraulics (velocity and water depth), contaminant influx to the river through groundwater and point sources, sediment and contaminant transport, and adsorption/desorption of contaminant to sediments.

The Columbia River is the largest North American River to discharge into the Pacific Ocean. The river originates in Canada and flows south 1953 km (1212 mi) to the Pacific Ocean. The watershed drains a total of 670,000 km^2 (258,620 mi^2) and receives water from seven states and one Canadian province. Key contributors to the flow are runoff from the Cascade Mountains in Washington and Oregon and from the western slopes of the Rocky Mountains in Idaho, Montana, and British Columbia. Average annual flows below Priest Rapids and The Dalles dams are approximately 3360 m^3/s (120,000 ft^3/s) and 5376 m^3/s (192,000 ft^3/s), respectively. Numerous dams within the United States and Canada regulate flow on the main stem of the Columbia River. Priest Rapids Dam is the nearest dam upstream of the Hanford Site, and McNary Dam is the nearest downstream. The dams on the lower Columbia River greatly increase the water travel times from the upper reaches of the river to the mouth, subsequently reducing the sediment loads discharged downstream. The increased travel times also allow for greater radionuclide deposition and decay.

The Snake, Yakima, and Walla Walla rivers all contribute suspended sediment to the Columbia River; contributions from the Snake River are the most substantial. Since completion of McNary Dam in 1953, much of the sediment load has been trapped behind the dam. However, at McNary Dam and other Columbia River dams, some of the trapped sediment is resuspended and transported downstream by seasonal high discharges. As expected, much of this material is redeposited behind dams located farther downstream. Within the domain of this model that only extends to McNary Dam, sediment accumulates faster on the Oregon shore than on the Washington shore because sediment input from the Snake and Walla Walla rivers stays near the shore on the Oregon side. Sediment-monitoring samples taken for the

Hanford Sitewide Surface Environmental Surveillance Project indicated cobble and coarse- and fine-sand bed sediments at sampling locations along the Hanford Site (Blanton et al. 1995). Silt and clay sediment was observed at the McNary Dam sampling site.

The conceptual model used in the initial assessment included the environmental pathways and transport processes that affect contaminant transport in surface water systems. The physical processes include river hydrodynamics and suspended sediment transport, deposition, and resuspension. Because of run-time constraints, suspended and bed sediments were modeled with only the silt-size fraction. The contaminant transport processes include surface water advection and dispersion, sorption and desorption to sediments, decay, and exchange between bed pore water and the overlying surface water. The initial assessment River Transport Module, which is the MASS2 model, included these key features, events, and processes in the mathematical implementation of the conceptual model.

L.2.7 Risk and Impact

The SAC has implemented a suite of impact assessment modules that treat ecological, economic, cultural, and human impacts and include internal stochastic capabilities. An initial assessment of the Hanford Site using these modules is provided in Bryce et al. (2002). The HUMAN code (Eslinger et al. 2002b) was used in calculations for this EIS. The human impact model includes exposure pathways from ingestion, inhalation, skin contact, and direct radiation exposure. Relative exposures to these sources depend on individual lifestyles or exposure scenarios.

The human exposure scenarios for the EIS were limited to the ingestion of water. In addition, the ingestion dose factors were selected as deterministic rather than stochastic factors. With these assumptions, annual human dose calculations do not depend on stochastic variables internal to the human exposure model. Thus, all variability in the human doses arises from the variability in the inventory, release, and transport models. The dose factor used for ingestion of technetium-99 was 1.5×10^{-9} rem/pCi, uranium-238 was 2.5×10^{-7} rem/pCi, and iodine-129 was 2.7×10^{-7} rem/pCi. These values were obtained by converting the values in Table 2.2 of Eckerman et al. (1988) from Sv/Bq to rem/pCi (the values were multiplied by a conversion factor of 3700).

Intrusion events by man, vegetation, or animals and the potential for terrestrial ecological pathways to be impacted by Hanford Site wastes in shallow earth deposits is an intrusion analysis—not a long-term exposure analysis. Intrusion analyses are part of the site-specific or waste-specific analyses included in remedial investigation/feasibility studies required under CERCLA, and performance assessment required by DOE Order 435.1 (DOE 2001). Intrusion analyses contribute to our understanding of the waste concentration that can be safely disposed of (that is, at levels less than chronic and acute intruder dose limits), and of the performance necessary in a barrier system to prevent intrusion by man, vegetation, or animals. However, because intrusion exposures are not included in long-term exposure scenarios, such analyses are not included in the sitewide assessment tool (the SAC).

The version of SAC applied to the initial assessment (Bryce et al. 2002) and in the HSW EIS does not include a terrestrial ecological pathway analysis. Essentially, the SAC does not analyze intruder exposure/risk scenarios. Design of the SAC tool was predicated on the assumption that the Hanford Site would be closed following the remediation of all sites, and the further assumption that any contaminants at substantial levels in the subsurface would be covered with a proven infiltration and intrusion barrier. A Modified RCRA Subtitle C Barrier has been proposed for waste sites receiving surface barriers on the Central Plateau. Thus, the long-term exposure scenarios do not include intrusion as a source of contamination.

L.2.8 Uncertainty

The SAC was designed to provide a stochastic simulation capability able to quantify uncertainty through a Monte Carlo analysis. An uncertainty analysis can be completed for the SAC results. The goal of such an uncertainty analysis is to determine the model parameters that contribute the most variability to the performance measures. Results of the stochastic realizations can also be used to reveal the maximum–minimum range of performance measures.

The uncertainty analysis addresses the role of uncertainty as caused by the variation of parameters within the modeling systems. It does not address causes of errors between modeled and observed data. It does not address uncertainty due to the use of different models. In addition, the analysis of uncertainty does not differentiate between uncertainties due to lack of knowledge and uncertainty due to natural variability in the parameters.

The uncertainty analysis can identify controlling sources of variability in the simulation estimates of the performance measure, but not necessarily the source of the overall magnitude of the performance measure. However, the source of the overall magnitude is obtained from direct examination of model results.

The uncertainty analysis technique employed is a step-wise linear regression analysis using the output results and input parameters of an assessment. Because the SAC uses a sequential analysis structure (that is, analysis progressively treats inventory, release, vadose zone), a top-down hierarchal analysis is performed to identify first-tier quantities (for example, derived quantities like tritium concentration in groundwater), and associated second-tier parameters (for example, unsaturated hydraulic properties, distribution coefficient) responsible for variability.

The initial assessment (Bryce et al. 2002) demonstrated that a relatively small number of input parameters could determine most of the variability in calculated performance measures. It was observed that when the performance measure is human dose, variability with regard to individual behavior and exposure affects uncertainty in the estimated dose more than variability in inventory, release, or environmental transport of the contaminants.

L.3 Results

Results of the initial assessment for a 10,000-year period conducted using the SAC software are presented below in three sections. Section L.3.1 details the release of contamination to the groundwater from the vadose zone. Section L.3.2 presents the drinking water dose that occurs from a 2-L/d drinking water exposure to groundwater at various points in the environment. Section L.3.3 presents the drinking water dose from consumption of water in the Columbia River at the City of Richland pump station.

L.3.1 Release to Groundwater Results

Releases to the unconfined aquifer from the vadose zone predicted using the SAC software and data are summarized in this section. Vadose zone releases to the groundwater are aggregated into the following categories for the numerous vadose zone sites simulated:

- solid waste disposal facilities (only "218" sites)
- tanks (only "241" sites)
- liquid discharge ("216" sites plus unplanned release sites and the State-Approved Land Disposal Site)
- ERDF
- commercial low-level radioactive waste disposal (referred to as the US Ecology, Inc., site)
- other sites in the 200 East or 200 West Areas not included in the above categories
- all sites not in the 200 East or 200 West Areas (that is, 100, 300, 400, and 600 Areas).

For each result, both annual releases and the cumulative of all annual releases (undecayed) are presented. Note, releases from ILAW, melters, and naval reactor compartments are omitted. The stochastic capability of the SAC was employed for these simulations, so the following results are shown in each plot:

- individual stochastic results (25 realizations)
- the median result of the 25 realizations—that is, the realization that resulted in the median cumulative release in the year 12,050 A.D. (at the end of the simulation) is emphasized
- the median-inputs simulation—that is, a separate single-realization simulation with SAC using the median value of all stochastic input variables.

The median result as defined by the cumulative release to the groundwater is highlighted in both the annual release and cumulative release plots. Each new pair of annual and cumulative plots identifies a new median case from the 25 realizations simulated.

The annual release plots have the appearance of being either a series of piecewise constant (stair-step) values, a smooth continuous curve, or a variable width curve. This is a function of the temporal resolution of both the release model and the vadose zone simulation. Piecewise constant curves result when the release rate is constant over a period of time and the vadose zone model is able to adopt relatively long time steps (for example, hundreds of years). When either the release or vadose zone model use a fine time step to forecast a more variable release, the release to groundwater appears as a smooth and continuous curve. The appearance of a variable width curve reflects a numerical artifact of the method used to calculate mass release from the vadose zone to the groundwater in the presence of a transient water table. The oscillation in annual values is most pronounced for very small mass releases over long time periods, which is the case for iodine-129. The oscillation is purely cosmetic, because the annual mass release tracks correctly to produce the cumulative mass release and the simulation exhibits mass conservation. In reality, all the annual curves are a series of piecewise constant values.

Figures L.3 through L.14 present the vadose zone release to groundwater results for the sum of all solid waste disposal facilities. Each cumulative plot showing the 25 stochastic realizations provides information on the range of cumulative response as well as the median for solid waste disposals. Cumulative releases to groundwater for solid waste disposed of in the Central Plateau range from approximately 323 to approximately 445 Ci for technetium-99 during the 10,000-year analysis period. However, for uranium the release is nil—none in any realization in the 200 East Area and only 5 of 25 realizations exhibit any release in 200 West Area. The median uranium releases for both 200 East and 200 West Areas are zero essentially. For iodine-129, the median release from 200 East Area deposits is approximately 0 Ci, while for 200 West Area it is approximately 0.1 Ci. Iodine-129 releases range from 0 to approximately 2.2 Ci.

Figures L.15 through L.26 present the results for vadose zone releases to groundwater for the sum of all tank sites. Cumulative releases to groundwater for tank waste (that is, past leaks, future losses, and residuals) in the Central Plateau range from approximately 440 to approximately 645 Ci for technetium-99 during the 10,000-year analysis period. As in the case of solid waste, uranium in tank waste does not exhibit substantial release during the 10,000-year period. Only 5 of 25 realizations show uranium releases from 200 East Area tank sites, and hence, the median release is zero. For 200 West Area tank sites, the median case predicts release of approximately 1 Ci of uranium to groundwater during the entire 10,000-year period. For iodine-129, the median releases from 200 East and West Area tank sites are approximately 0.018 and 0.065 Ci, respectively. Iodine-129 releases from tanks range from approximately 0.01 to 0.22 Ci.

Figures L.27 through L.38 present the vadose zone release to groundwater results for the sum of all liquid discharge and unplanned release (UPR) sites and (in the case of 200 West) the SALDS facility. Cumulative releases to groundwater for liquid releases in the Central Plateau range from approximately 735 to approximately 1030 Ci for technetium-99 during the 10,000-year analysis period. The vast majority of this activity is associated with 200 East Area. The liquid release of uranium ranges between approximately 5 and approximately 100 Ci for the Central Plateau with median values of approximately 26 Ci for 200 East Area and approximately 5 Ci for 200 West Area. In addition to iodine-129 estimated to reside in the groundwater aquifer today (that is, 0.82 Ci in solution and 5.1 Ci overall in solution and sorbed), future releases range between 0 and approximately 1 Ci during the period of analysis. Median values for 200 East and 200 West Area releases to the water table are approximately 0.015 and 0.15 Ci, respectively.

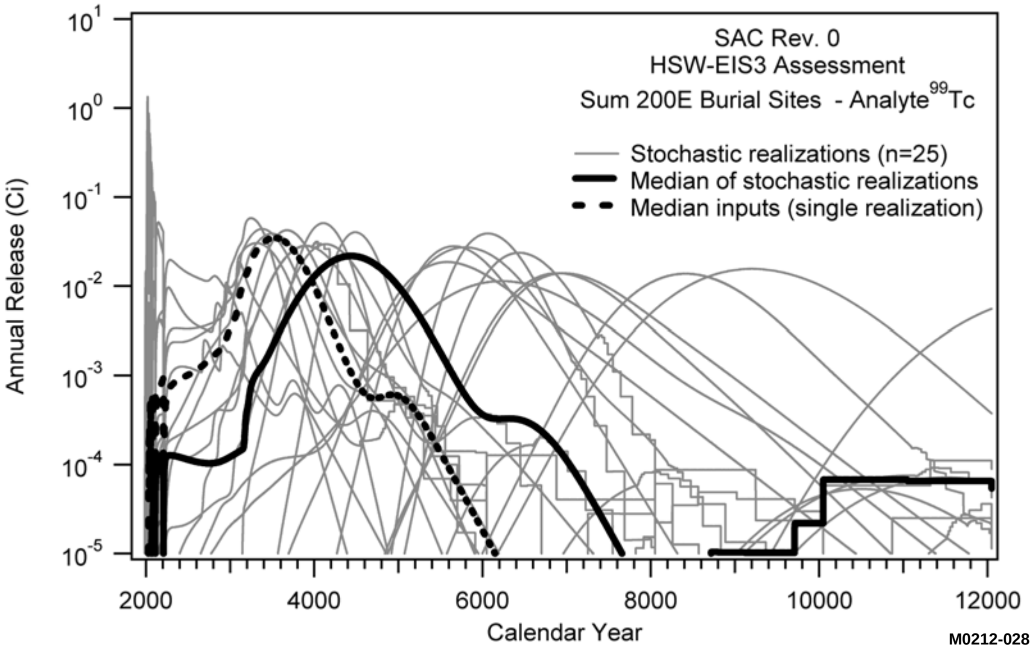

Figure L.3. SAC Results for Annual Vadose Zone Release of Technetium-99 from All Solid Waste Disposal Facilities Sites in the 200 East Area (including all "218" sites except 218-E-14 and 218-E-15, and excluding ILAW)

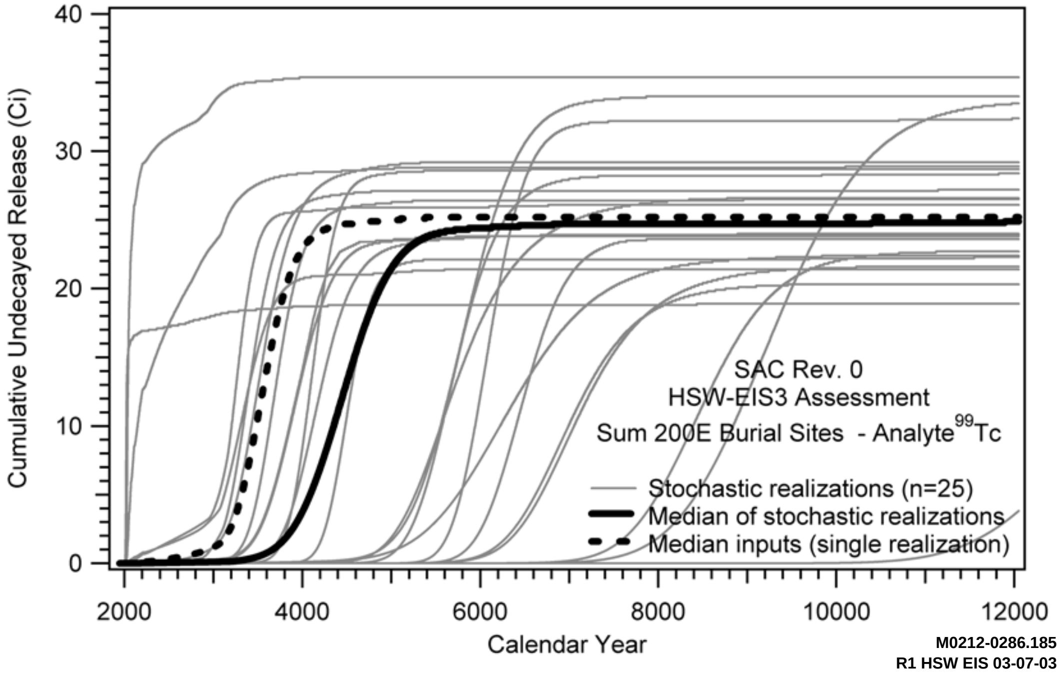

Figure L.4. SAC Results for Cumulative (undecayed) Vadose Zone Release of Technetium-99 from All Solid Waste Disposal Facilities Sites in the 200 East Area (including all "218" sites except 218-E-14 and 218-E-15, and excluding ILAW)

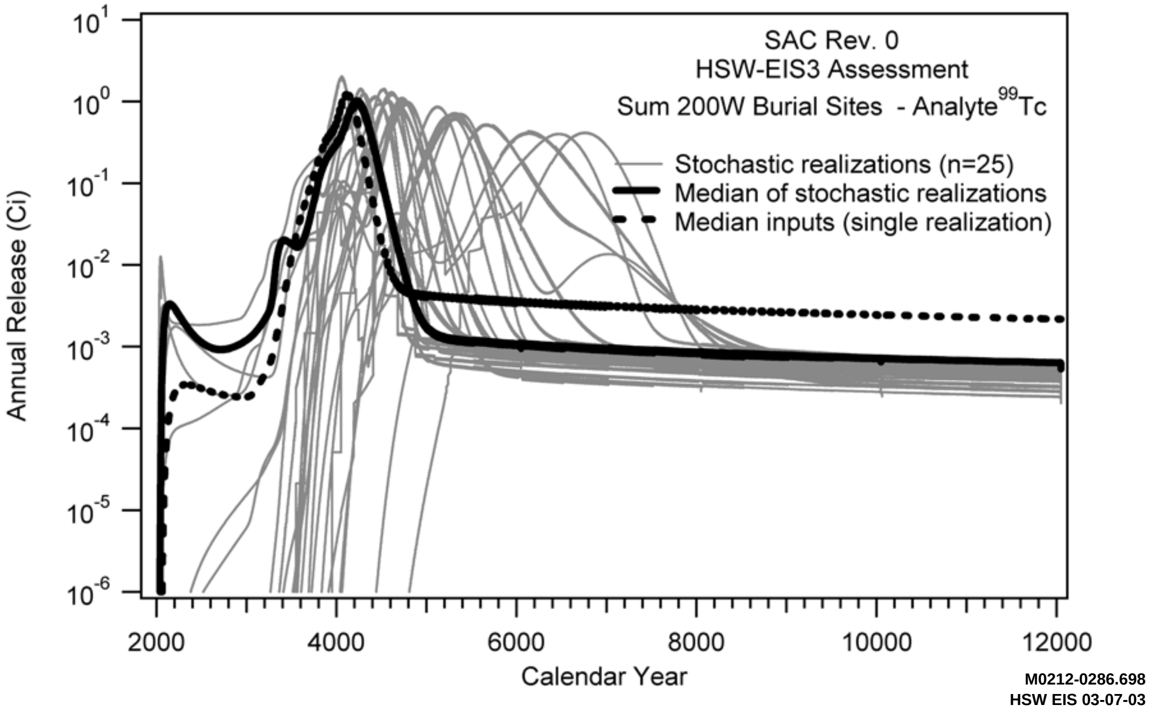

Figure L.5. SAC Results for Annual Vadose Zone Release of Technetium-99 from All Solid Waste Disposal Facilities Sites in the 200 West Area (including all “218” sites)

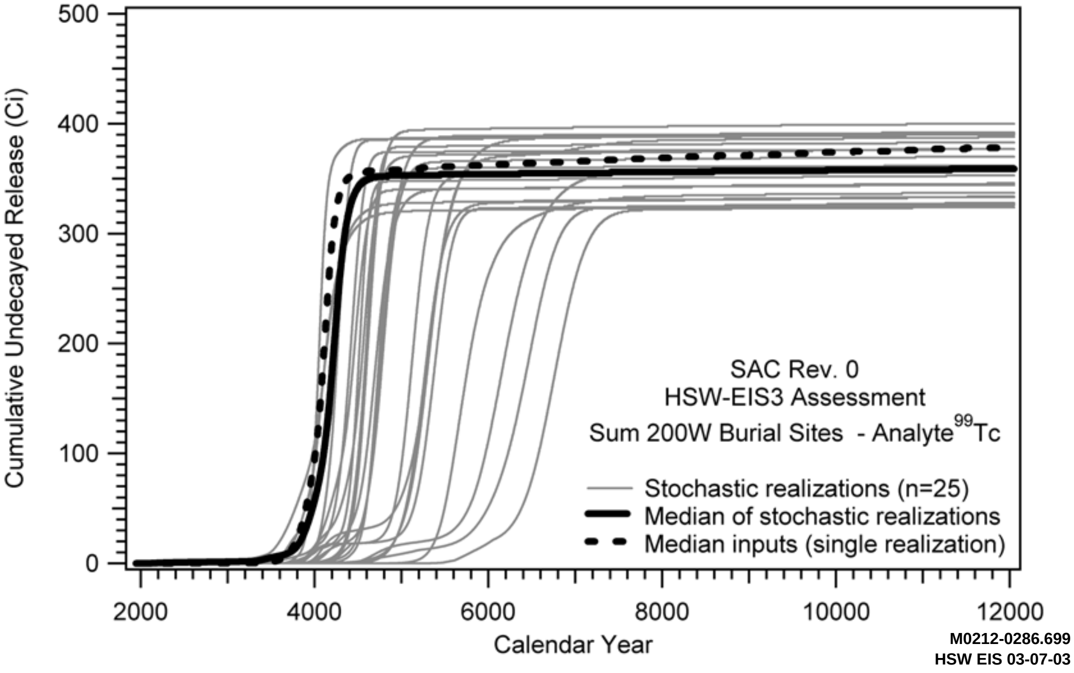

Figure L.6. SAC Results for Cumulative (undecayed) Vadose Zone Release of Technetium-99 from All Solid Waste Disposal Facilities Sites in the 200 West Area (including all “218” sites)

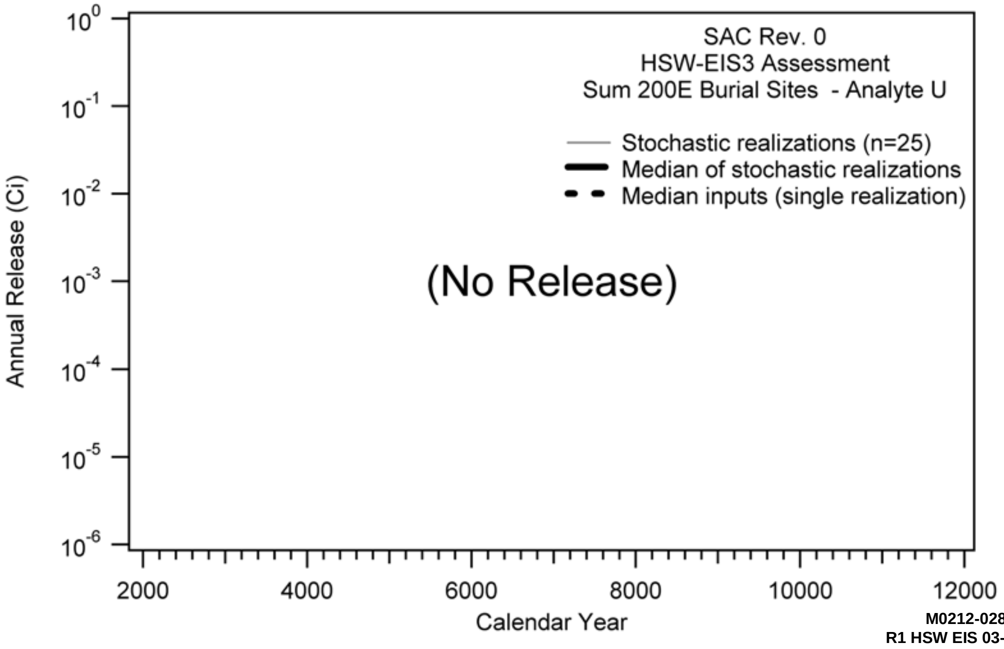

Figure L.7. SAC Results for Annual Vadose Zone Release of Uranium from All Solid Waste Disposal Facilities Sites in the 200 East Area (including all "218" sites except 218-E-14 and 218-E-15, and excluding ILAW)

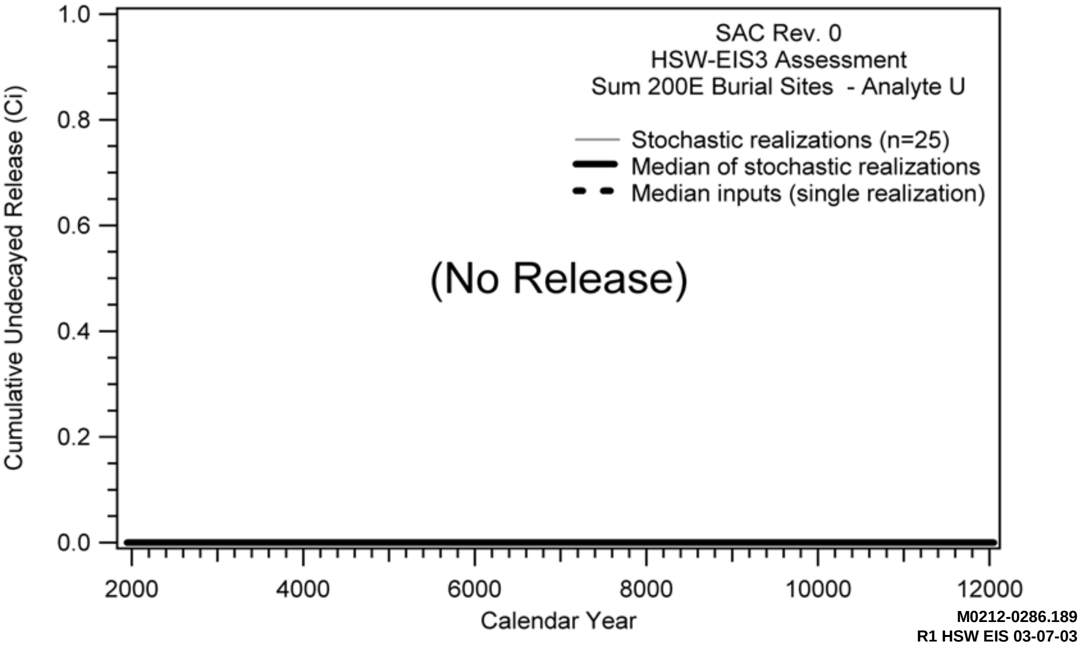

Figure L.8. SAC Results for Cumulative (undecayed) Vadose Zone Release of Uranium from All Solid Waste Disposal Facilities Sites in the 200 East Area (including all "218" sites except 218-E-14 and 218-E-15, and excluding ILAW)

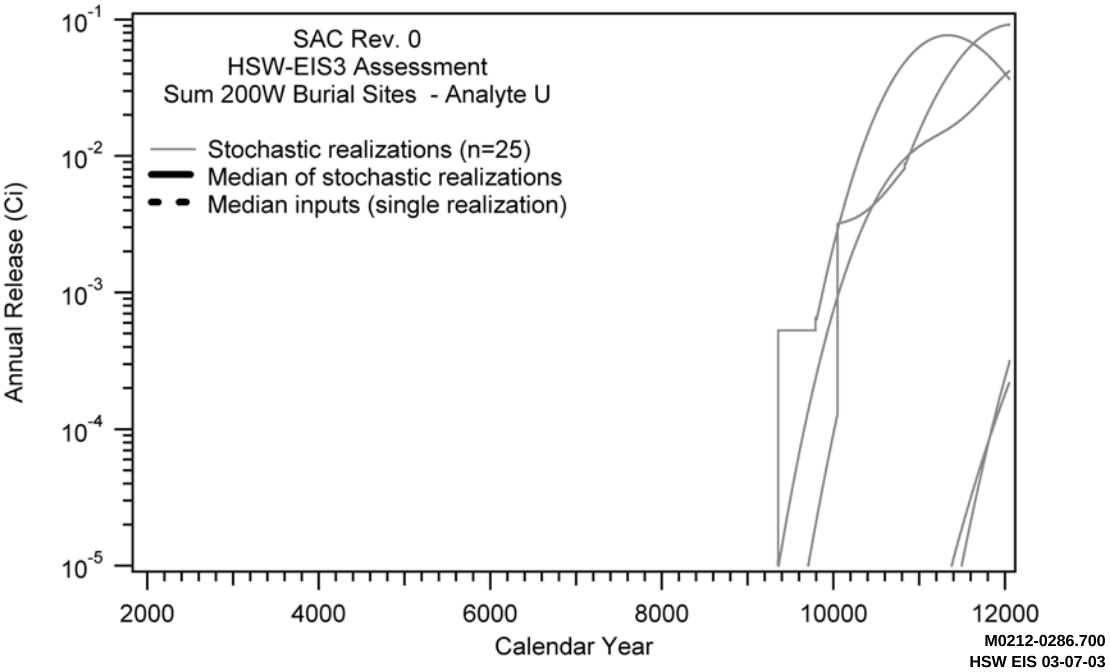

Figure L.9. SAC Results for Annual Vadose Zone Release of Uranium from All Solid Waste Disposal Facilities Sites in the 200 West Area (including all "218" sites)

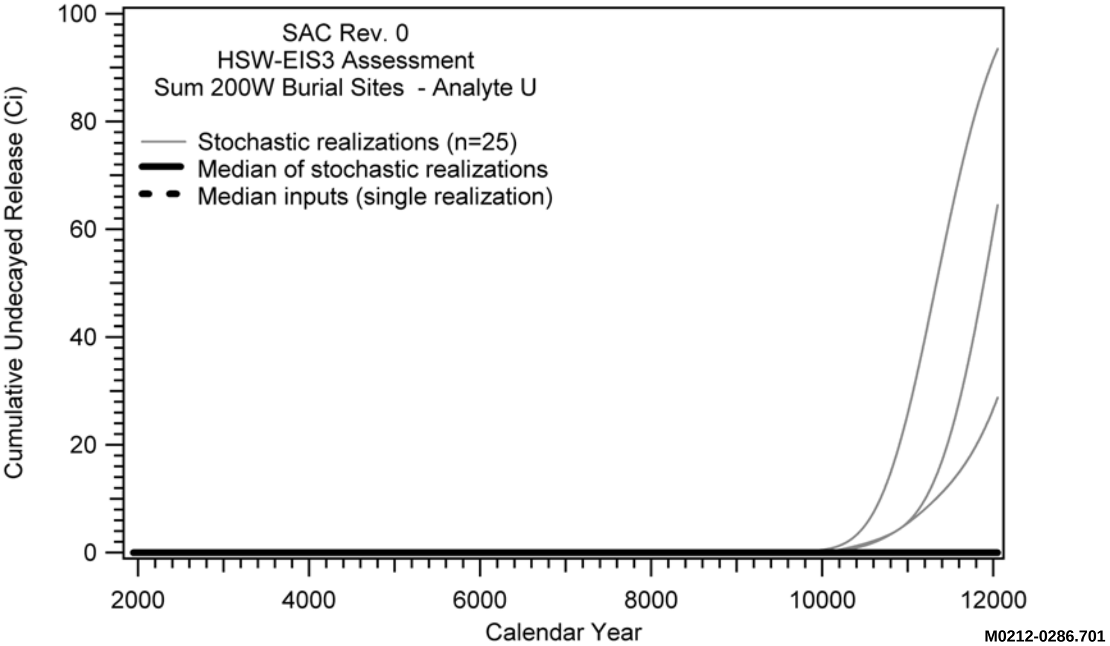

Figure L.10. SAC Results for Cumulative (undecayed) Vadose Zone Release of Uranium from All Solid Waste Disposal Facilities Sites in the 200 West Area (including all "218" sites)

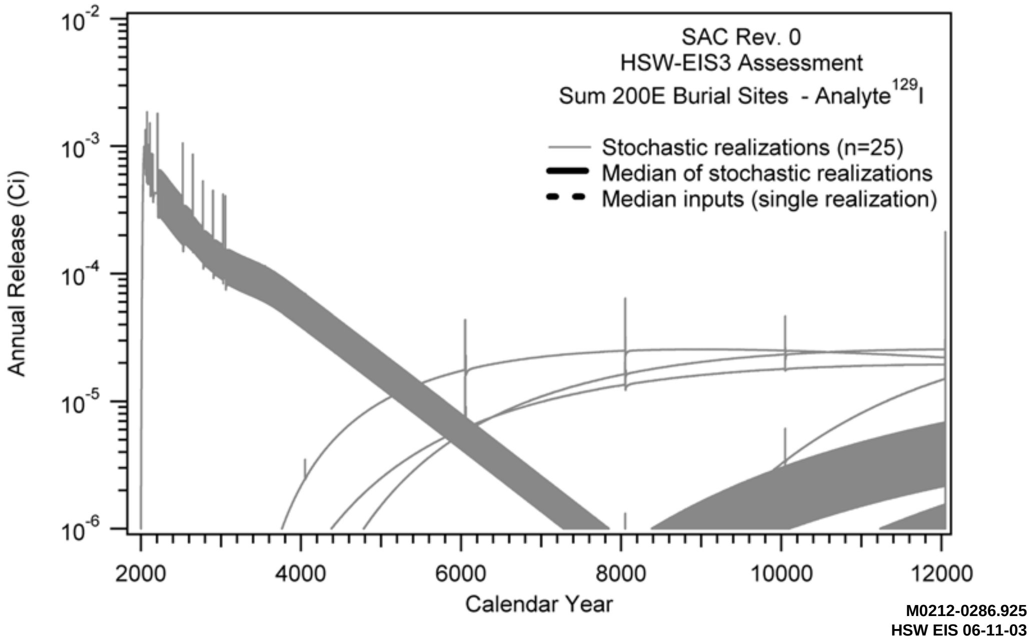

Figure L.11. SAC Results for Annual Vadose Zone Release of Iodine-129 from All Solid Waste Disposal Facility Sites in the 200 East Area (including all "218" sites except 218-E-14, 218-E-15, and excluding ILAW).

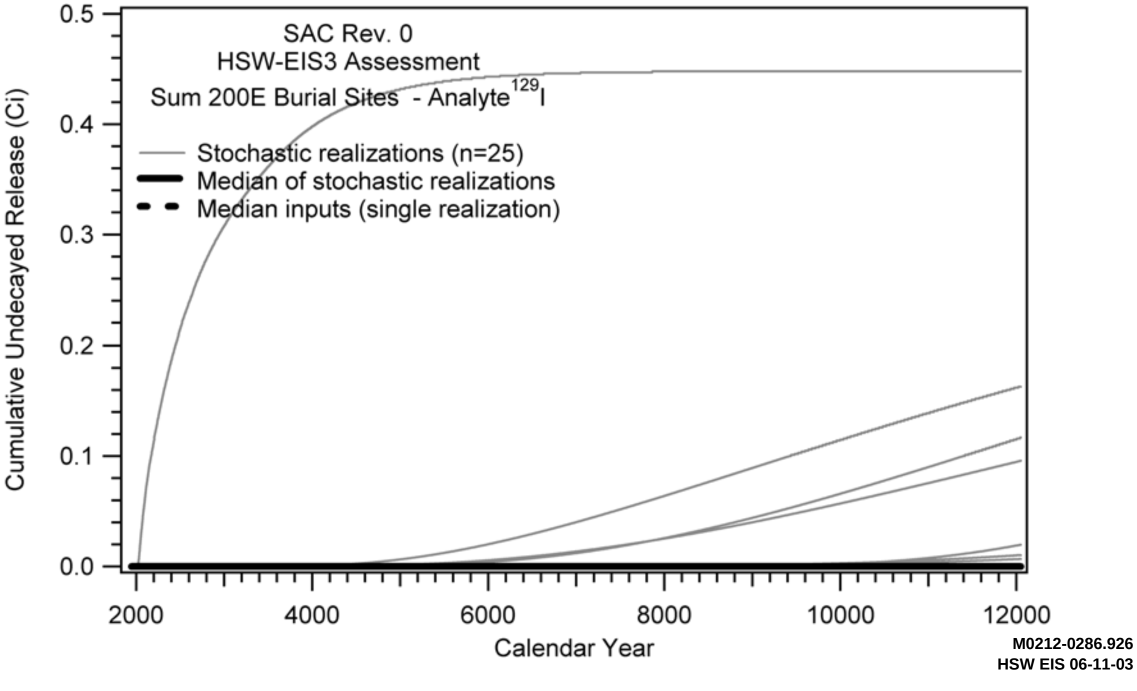

Figure L.12. SAC Results for Cumulative (undecayed) Vadose Zone Release of Iodine-129 from All Solid Waste Disposal Facility Sites in the 200 East Area (including all "218" sites except 218-E-14, 218-E-15, and excluding ILAW).

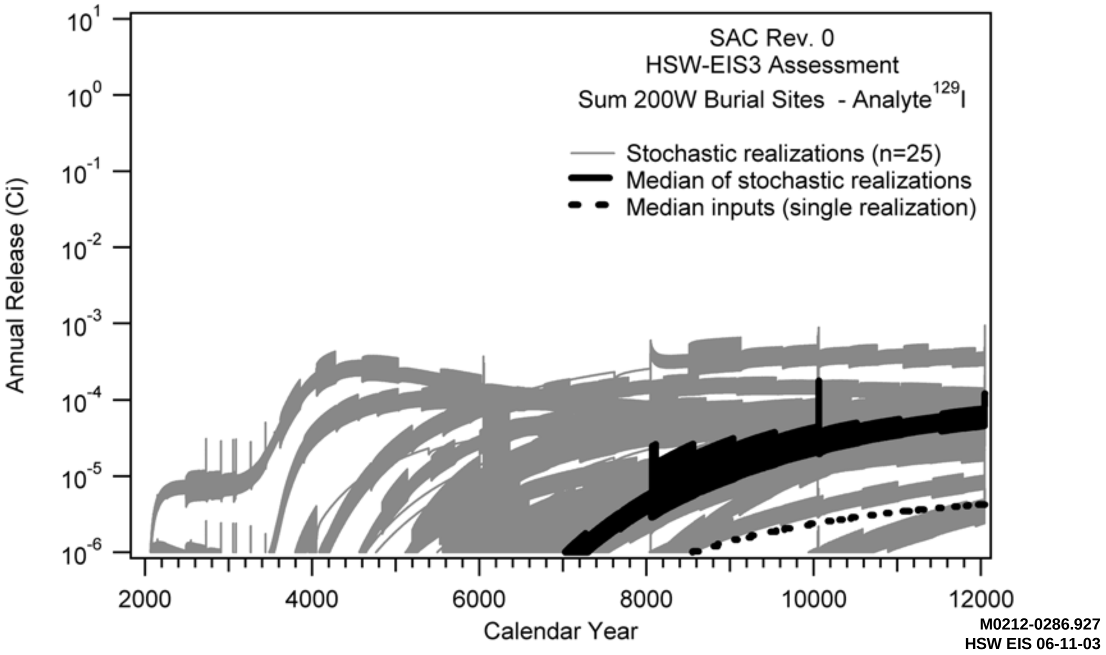

Figure L.13. SAC Results for Annual Vadose Zone Release of Iodine-129 from All Solid Waste Disposal Facility Sites in the 200 West Area (including all "218" sites).

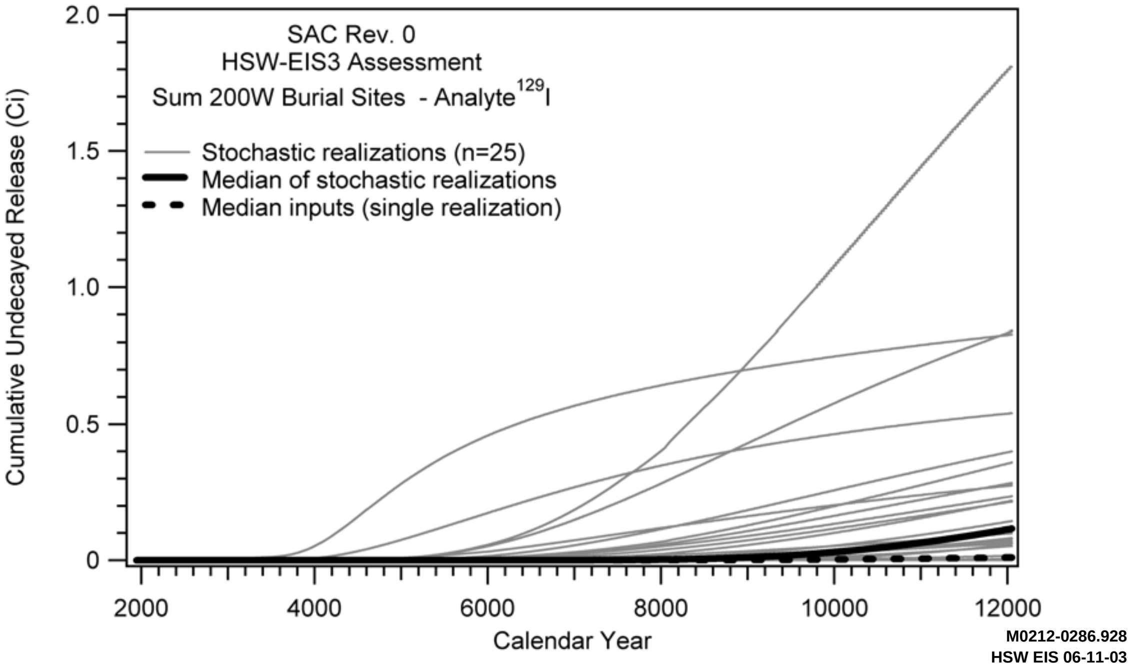

Figure L.14. SAC Results for Cumulative (undecayed) Vadose Zone Release of Iodine-129 from All Solid Waste Disposal Facility Sites in the 200 West Area (including all "218" sites).

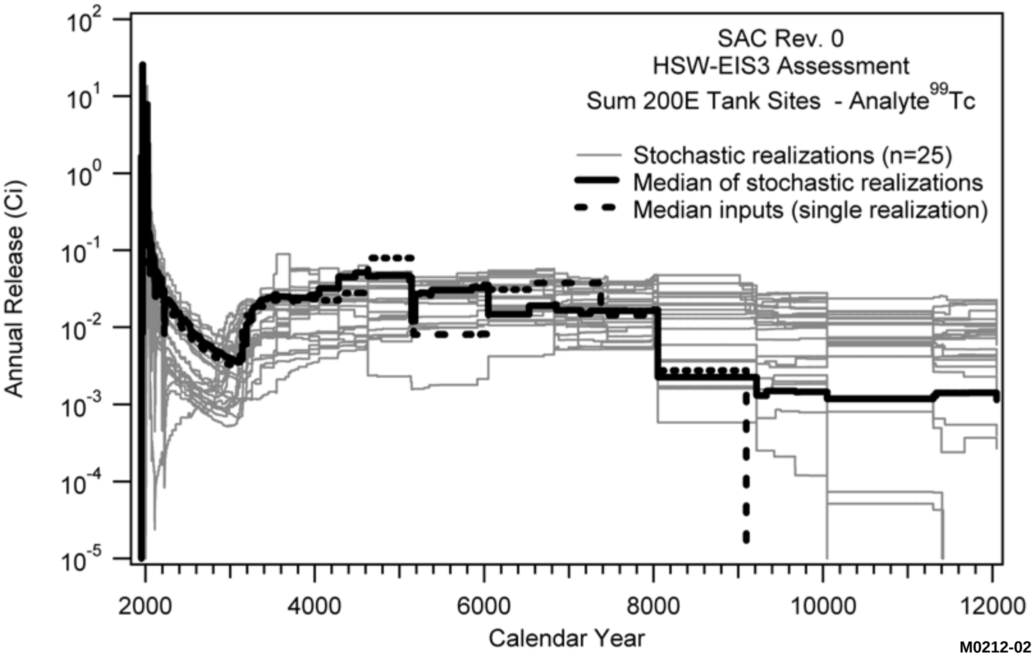

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Figure L.15. SAC Results for Annual Vadose Zone Release of Technetium-99 from All Tank Sites in the 200 East Area

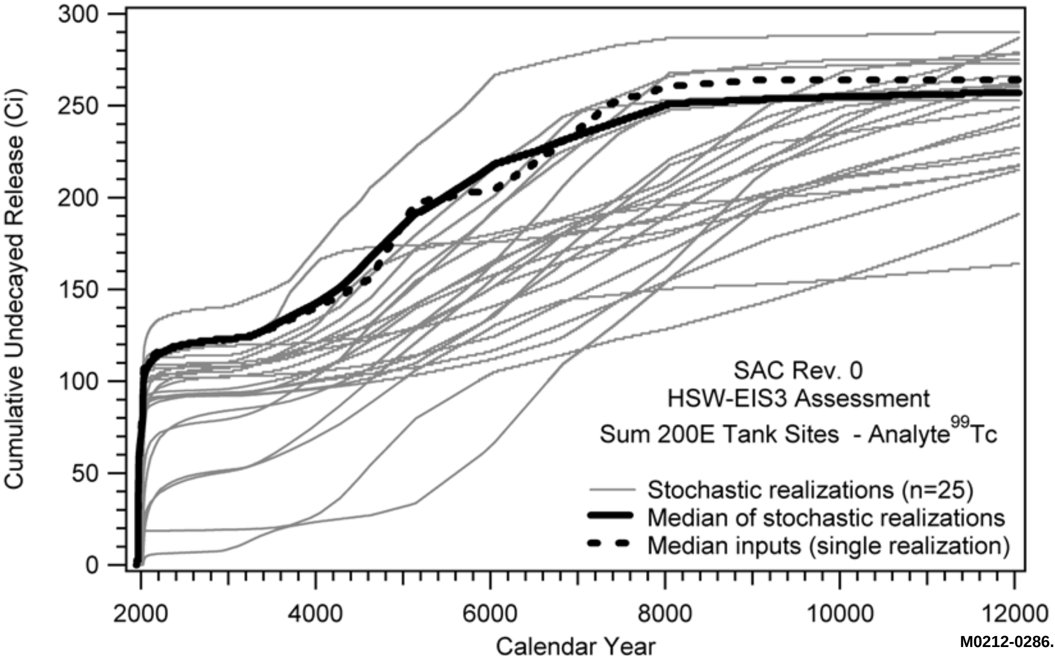

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Figure L.16. SAC Results for Cumulative (undecayed) Vadose Zone Release of Technetium-99 from All Tank Sites in the 200 East Area

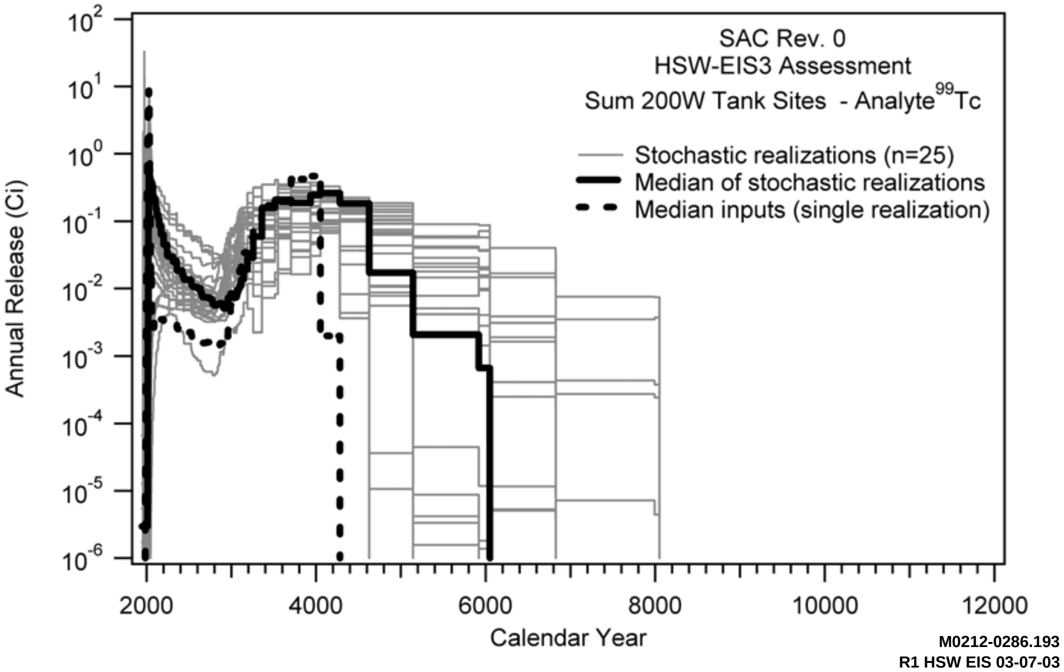

Figure L.17. SAC Results for Annual Vadose Zone Release of Technetium-99 from All Tank Sites in the 200 West Area

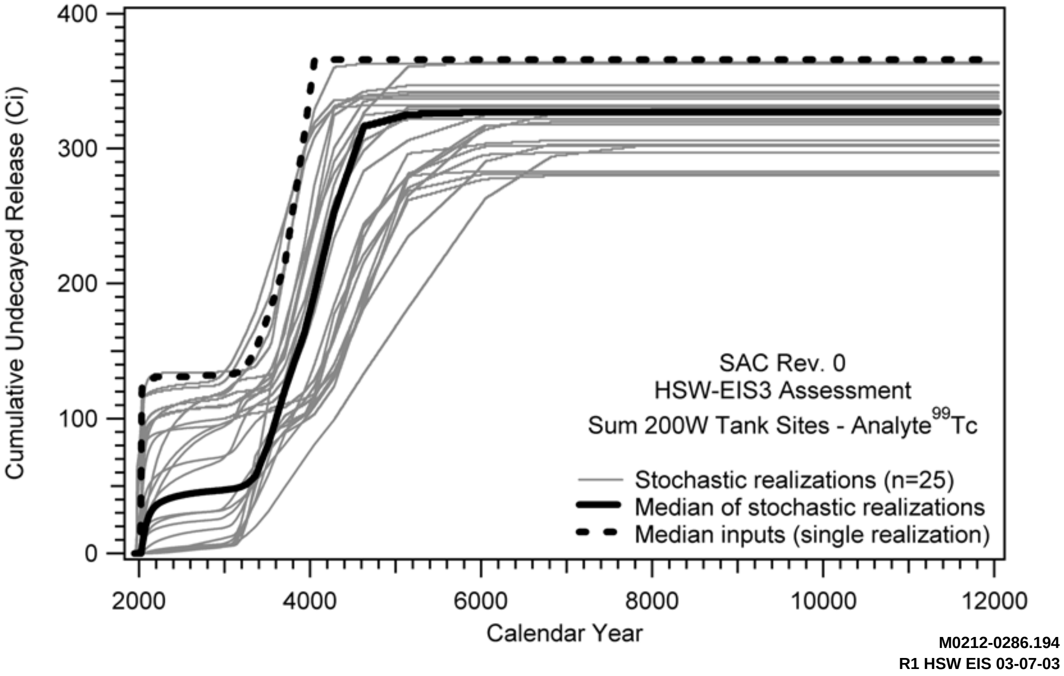

Figure L.18. SAC Results for Cumulative (undecayed) Vadose Zone Release of Technetium-99 from All Tank Sites in the 200 West Area

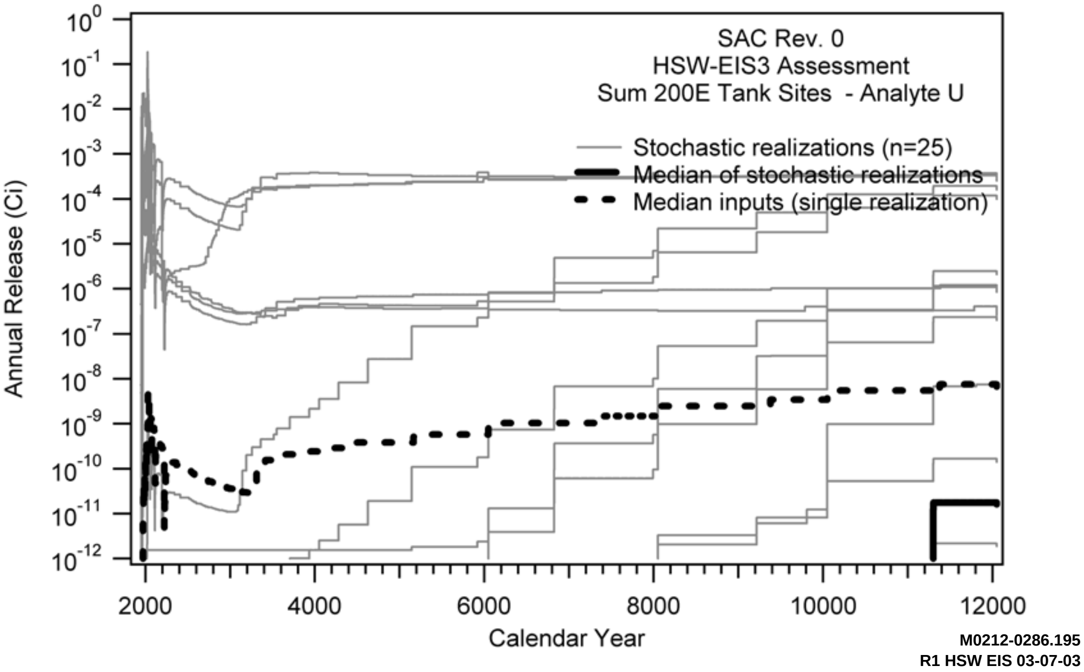

Figure L.19. SAC Results for Annual Vadose Zone Release of Uranium from All Tank Sites in the 200 East Area

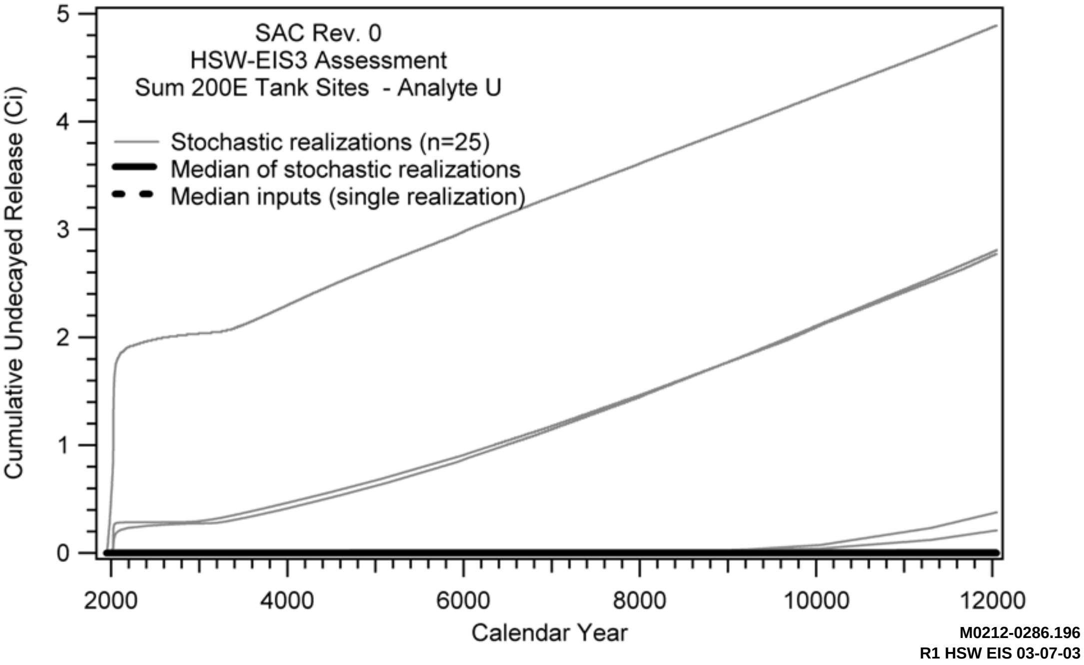

Figure L.20. SAC Results for Cumulative (undecayed) Vadose Zone Release of Uranium from All Tank Sites in the 200 East Area

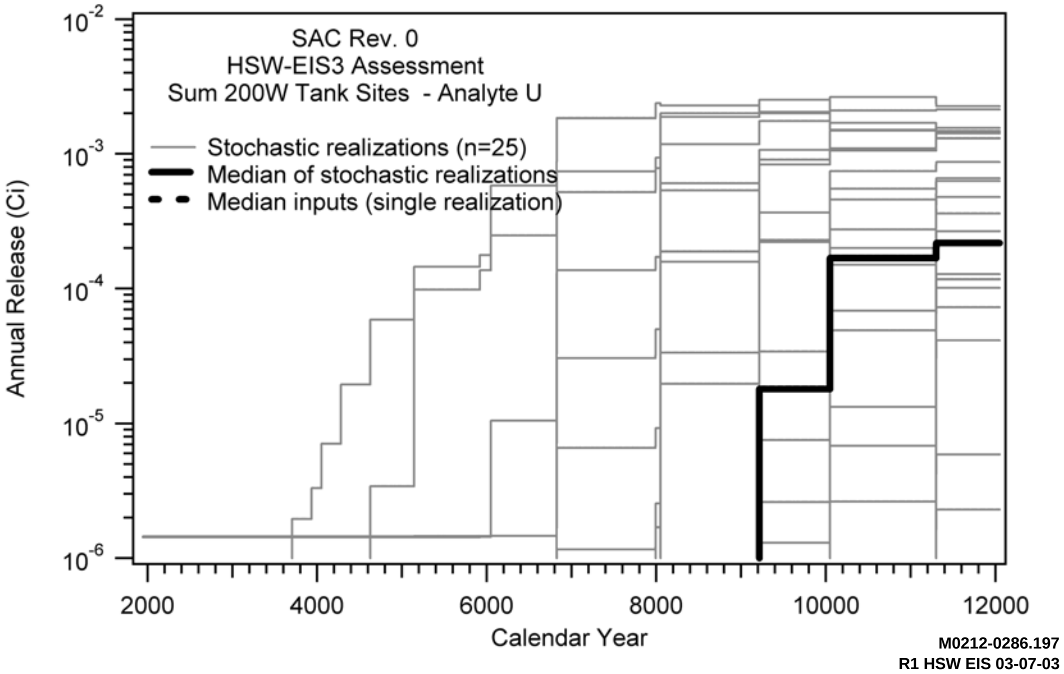

Figure L.21. SAC Results for Annual Vadose Zone Release of Uranium from All Tank Sites in the 200 West Area

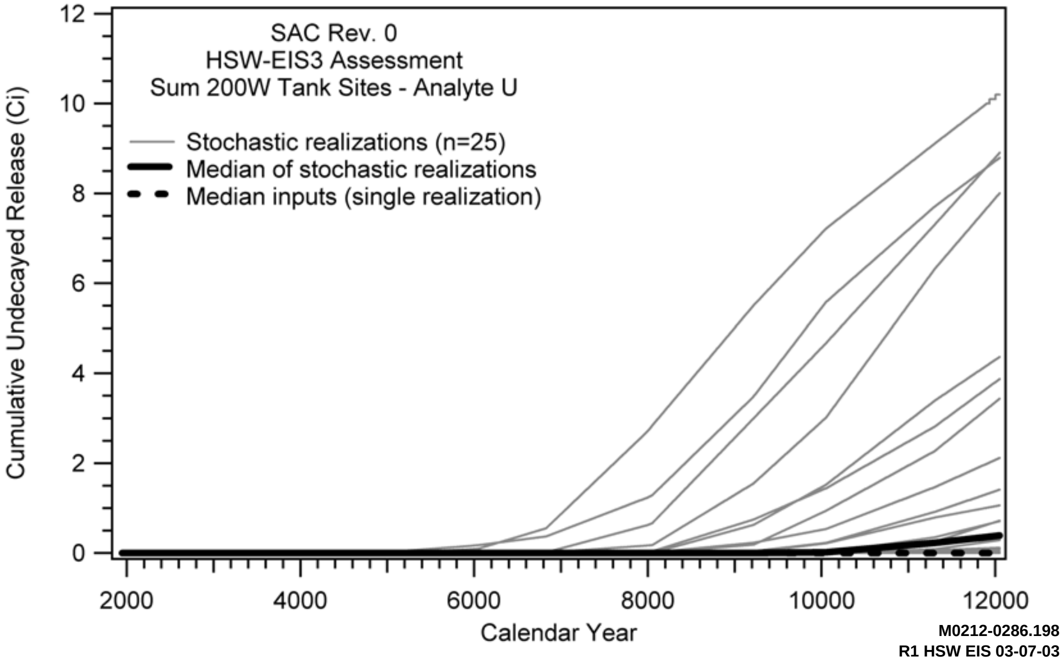

Figure L.22. SAC Results for Cumulative (undecayed) Vadose Zone Release of Uranium from All Tank Sites in the 200 West Area

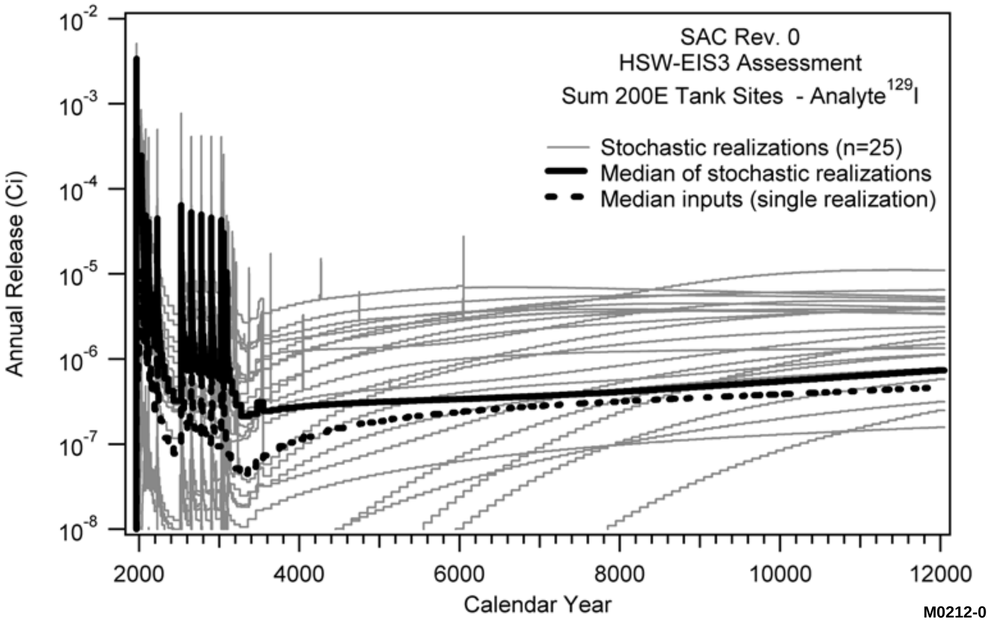

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Figure L.23. SAC Results for Annual Vadose Zone Release of Iodine-129 from All Tank Sites in the 200 East Area

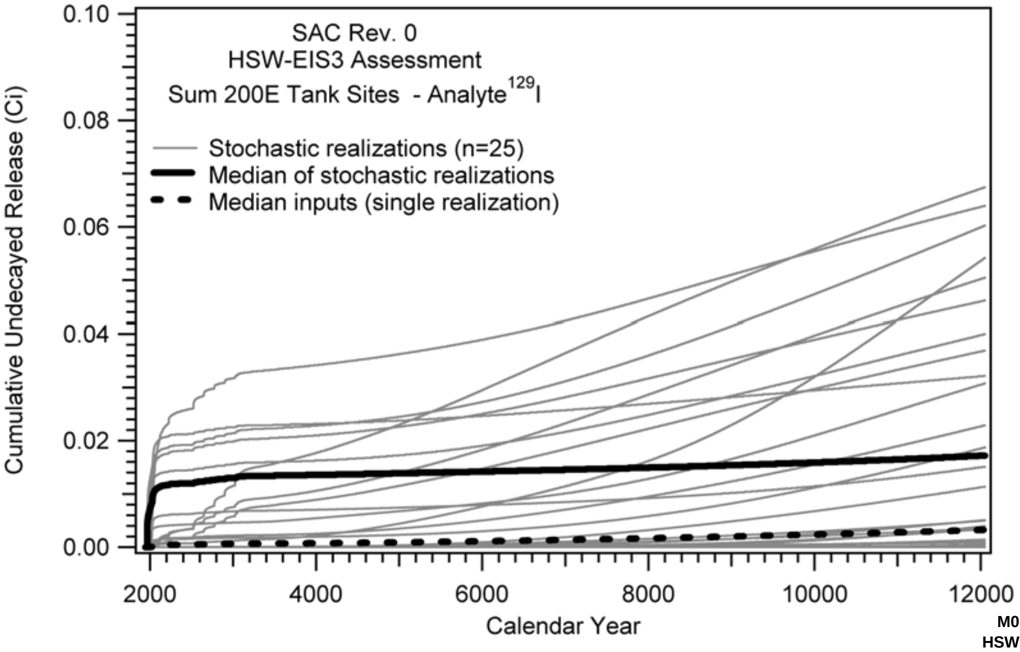

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Figure L.24. SAC Results for Cumulative (undecayed) Vadose Zone Release of Iodine-129 from All Tank Sites in the 200 East Area

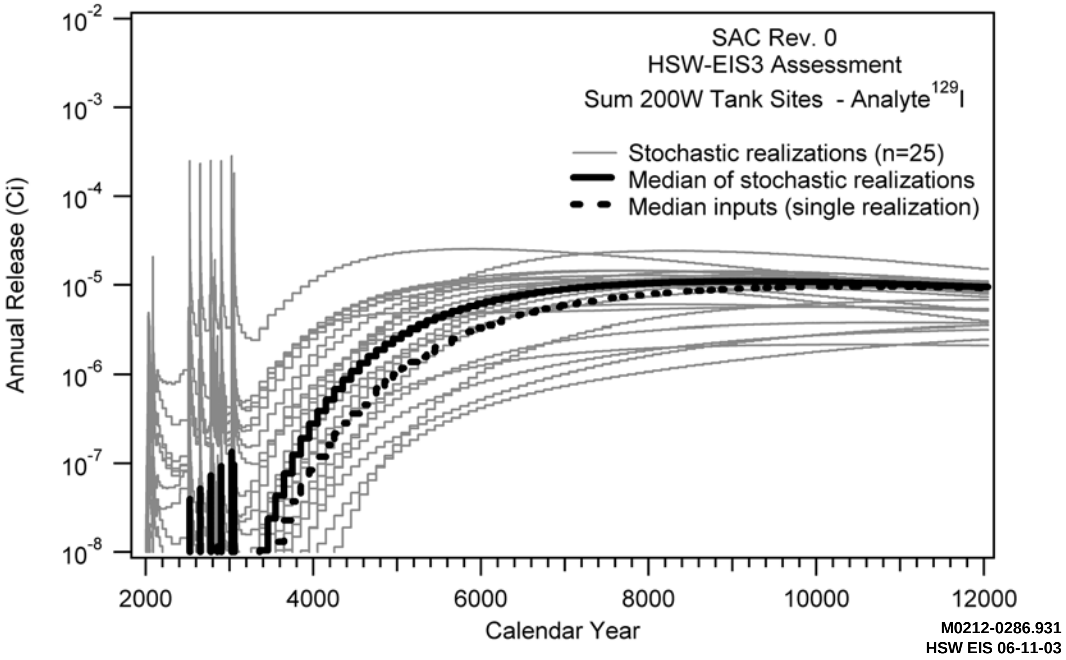

Figure L.25. SAC Results for Annual Vadose Zone Release of Iodine-129 from All Tank Sites in the 200 West Area

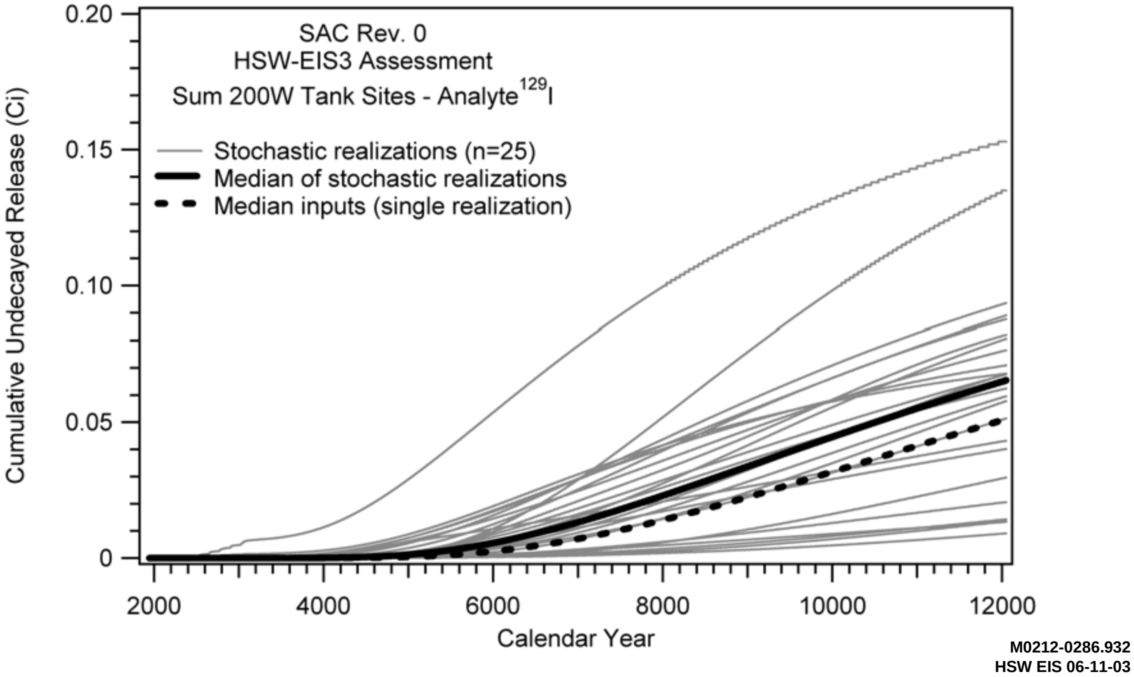

Figure L.26. SAC Results for Cumulative (undecayed) Vadose Zone Release of Iodine-129 from All Tank Sites in the 200 West Area

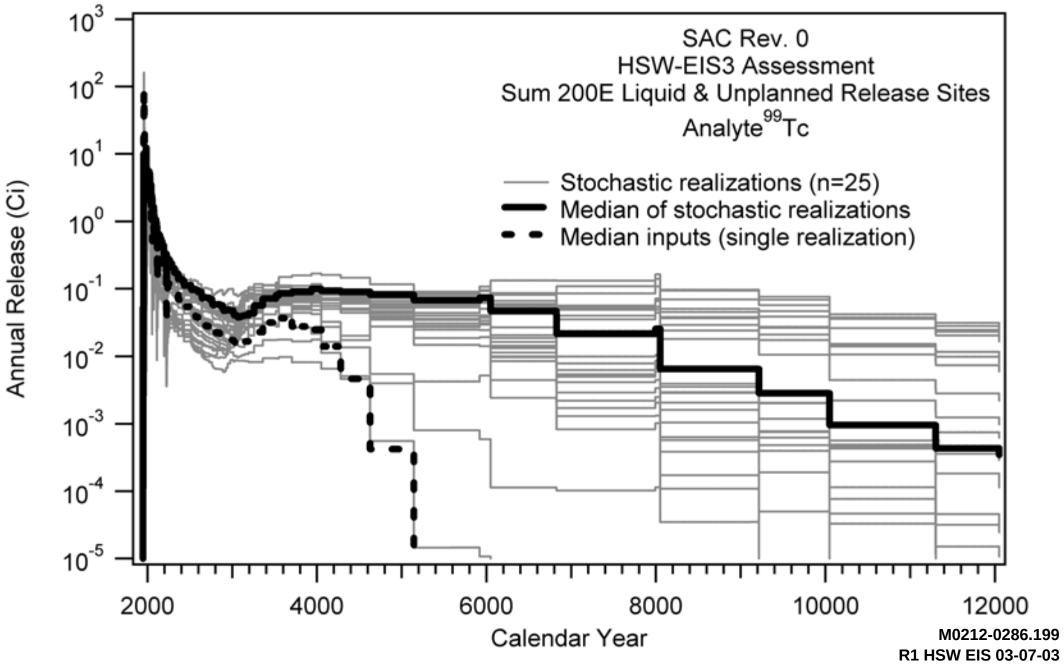

Figure L.27. SAC Results for Annual Vadose Zone Release of Technetium-99 from All Liquid Discharge and Unplanned Release Sites in the 200 East Area

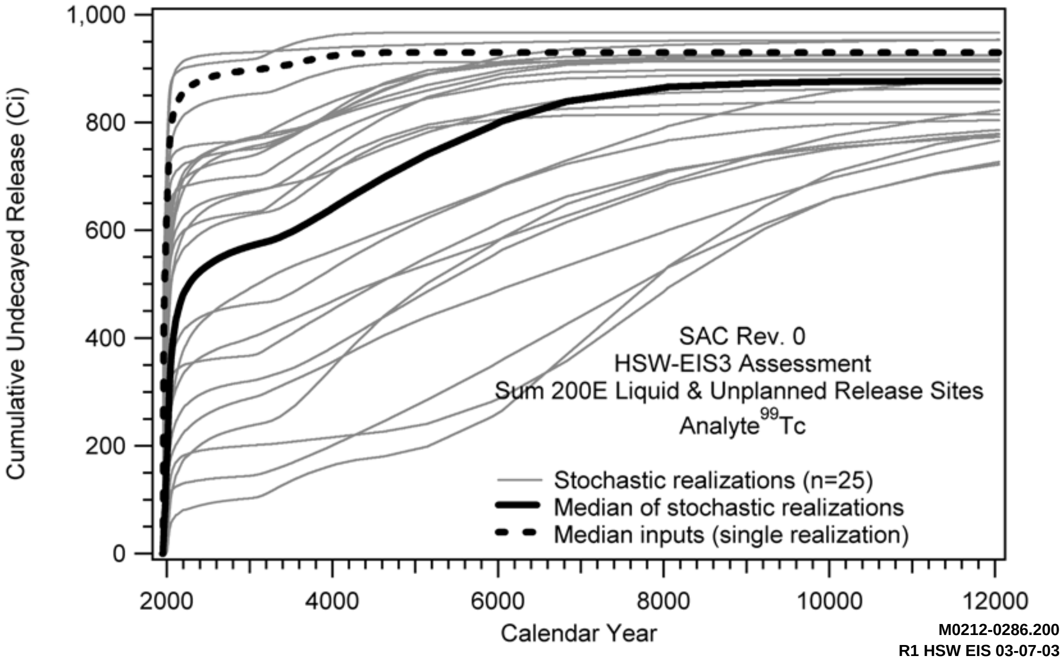

Figure L.28. SAC Results for Cumulative (undecayed) Vadose Zone Release of Technetium-99 from All Liquid Discharge and Unplanned Release Sites in the 200 East Area

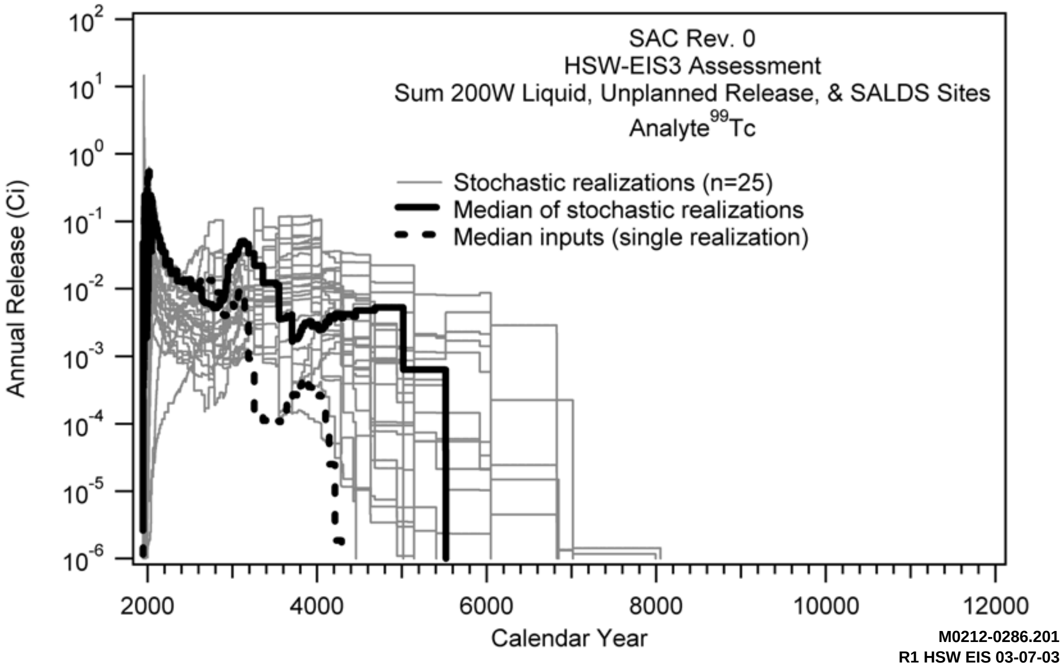

Figure L.29. SAC Results for Annual Vadose Zone Release of Technetium-99 from All Liquid Discharge and Unplanned Release Sites in the 200 West Area Plus SALDS

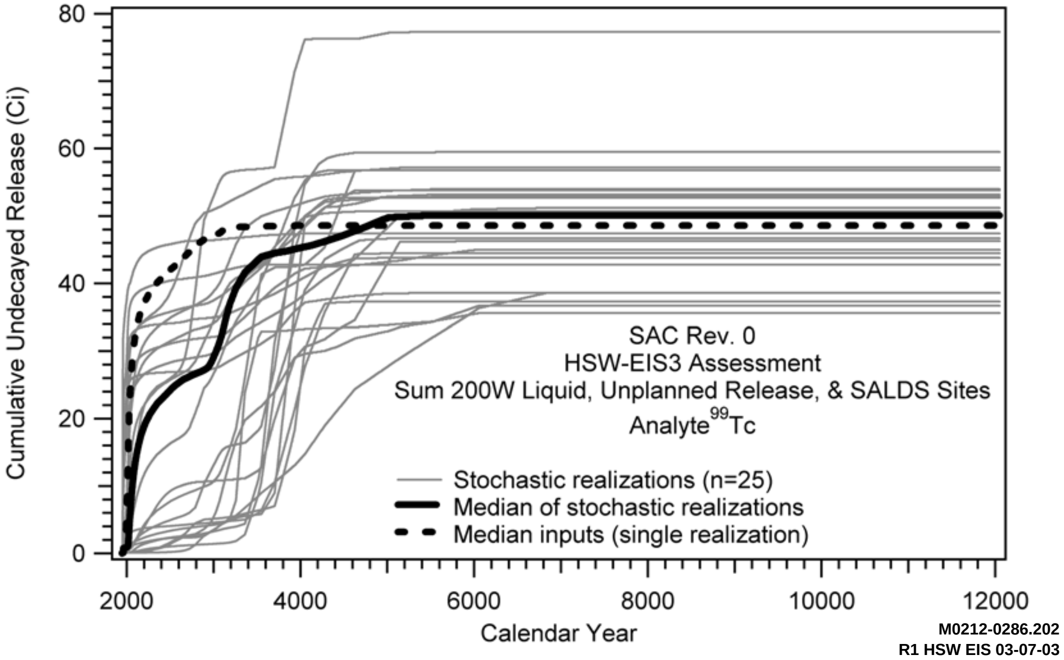

Figure L.30. SAC Results for Cumulative (undecayed) Vadose Zone Release of Technetium-99 from All Liquid Discharge and Unplanned Release Sites in the 200 West Area Plus SALDS

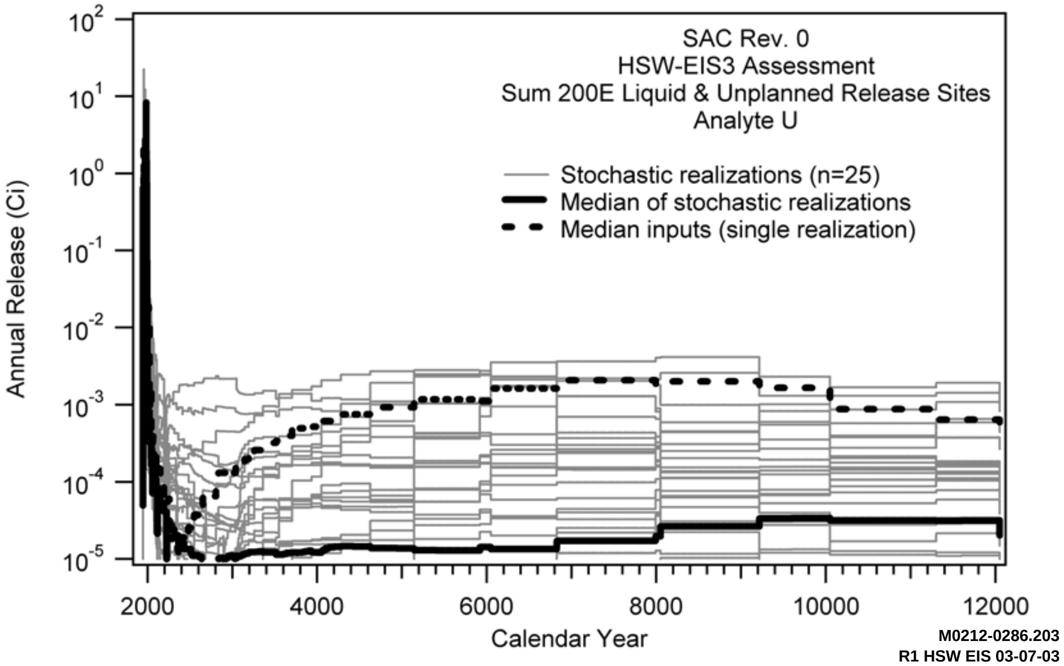

Figure L.31. SAC Results for Annual Vadose Zone Release of Uranium from All Liquid Discharge and Unplanned Release Sites in the 200 East Area

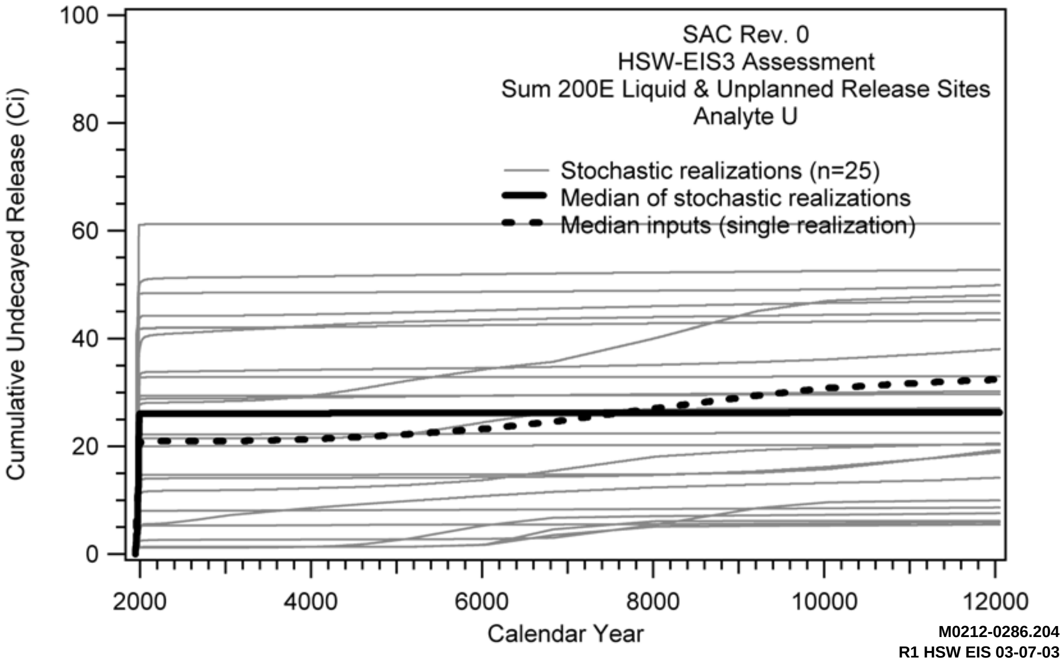

Figure L.32. SAC Results for Cumulative (undecayed) Vadose Zone Release of Uranium from All Liquid Discharge and Unplanned Release Sites in the 200 East Area

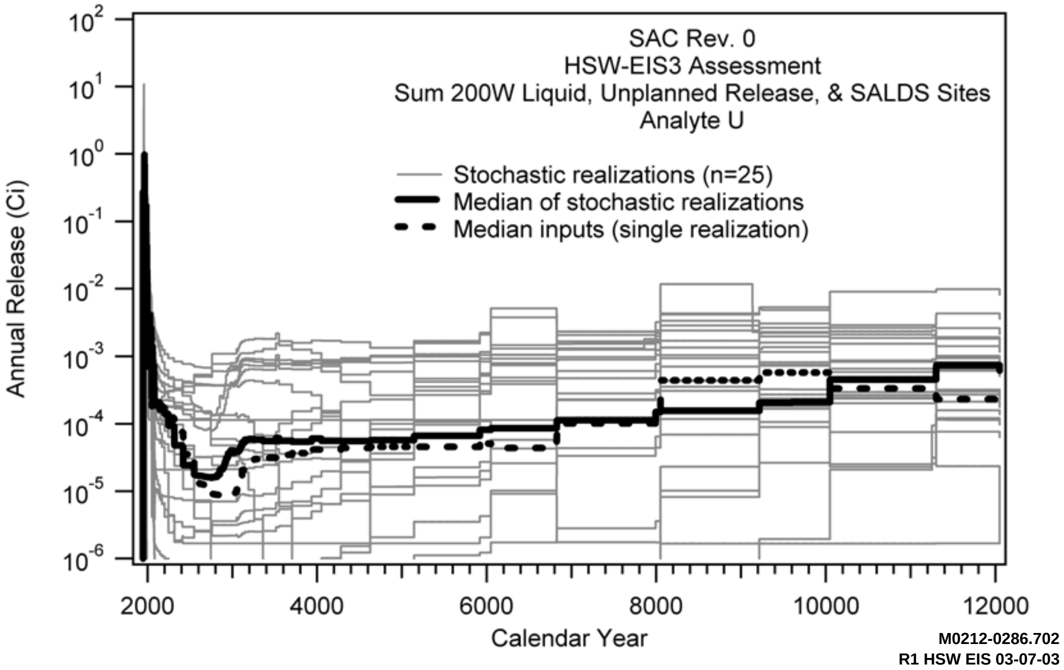

Figure L.33. SAC Results for Annual Vadose Zone Release of Uranium from All Liquid Discharge and Unplanned Release Sites in the 200 West Area Plus SALDS

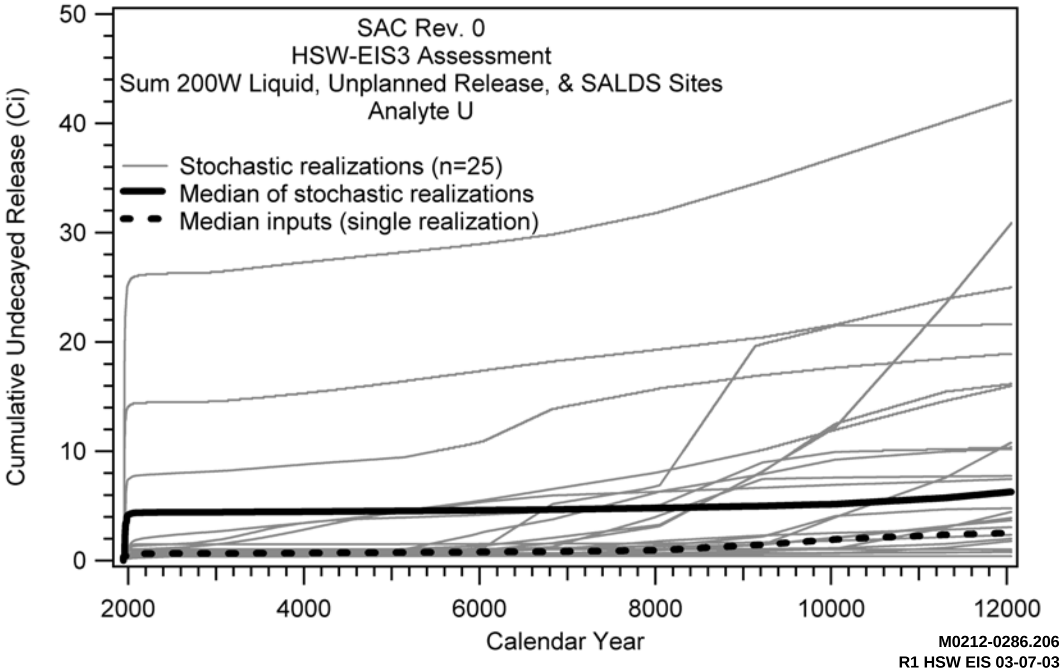

Figure L.34. SAC Results for Cumulative (undecayed) Vadose Zone Release of Uranium from All Liquid Discharge and Unplanned Release Sites in the 200 West Area Plus SALDS

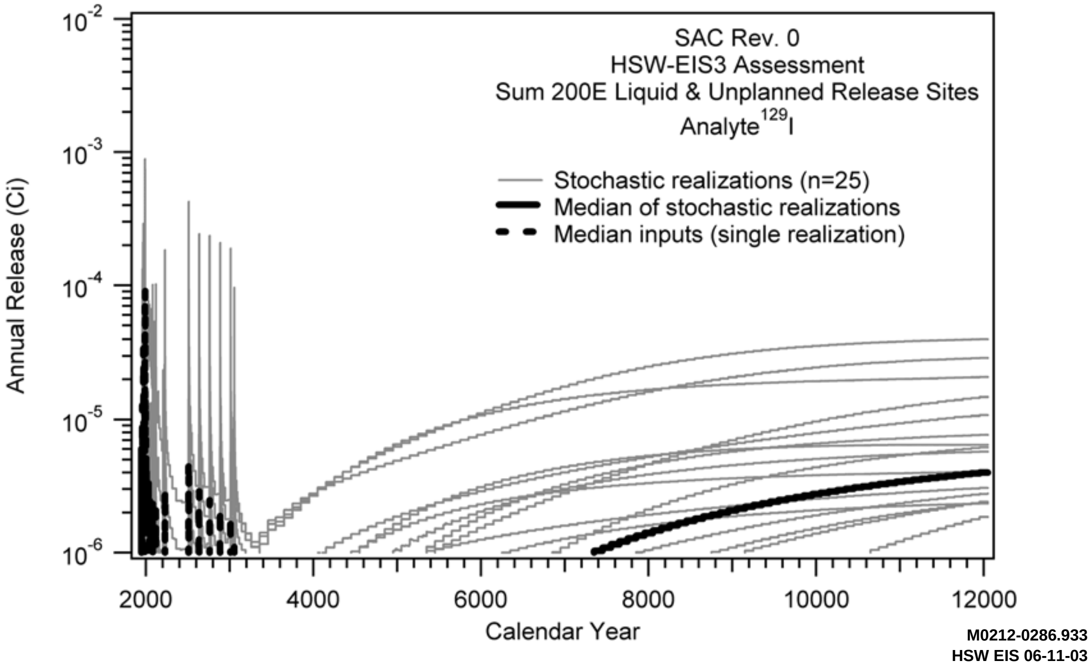

Figure L.35. SAC Results for Annual Vadose Zone Release of Iodine-129 from All Liquid Discharge and Unplanned Release Sites in the 200 East Area

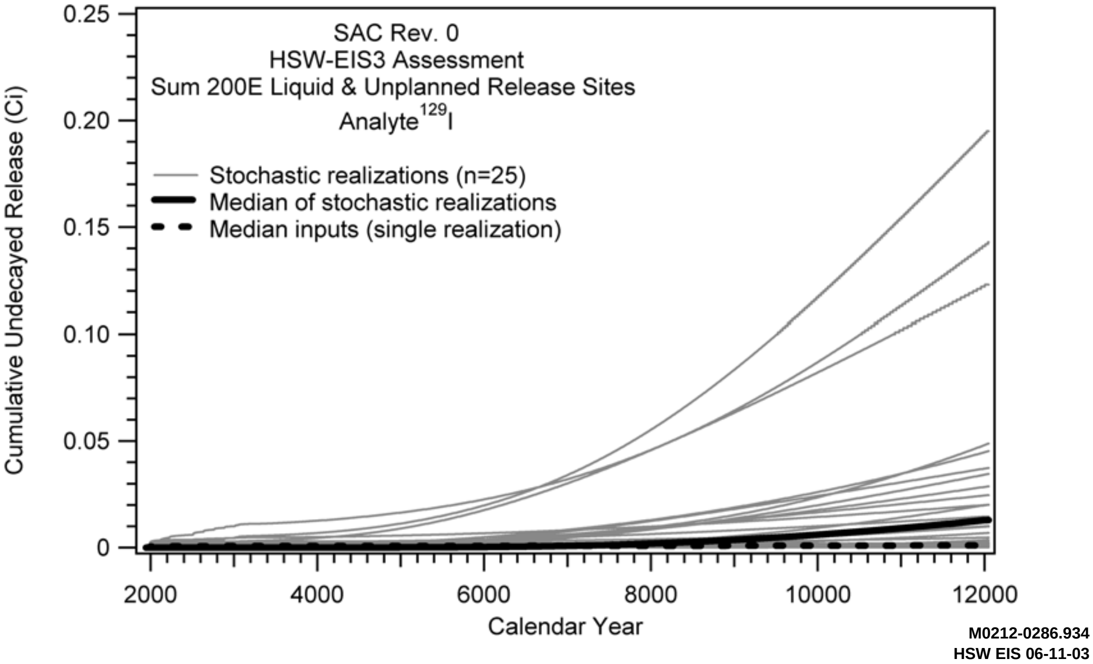

Figure L.36. SAC Results for Cumulative (undecayed) Vadose Zone Release of Iodine-129 from All Liquid Discharge and Unplanned Release Sites in the 200 East Area

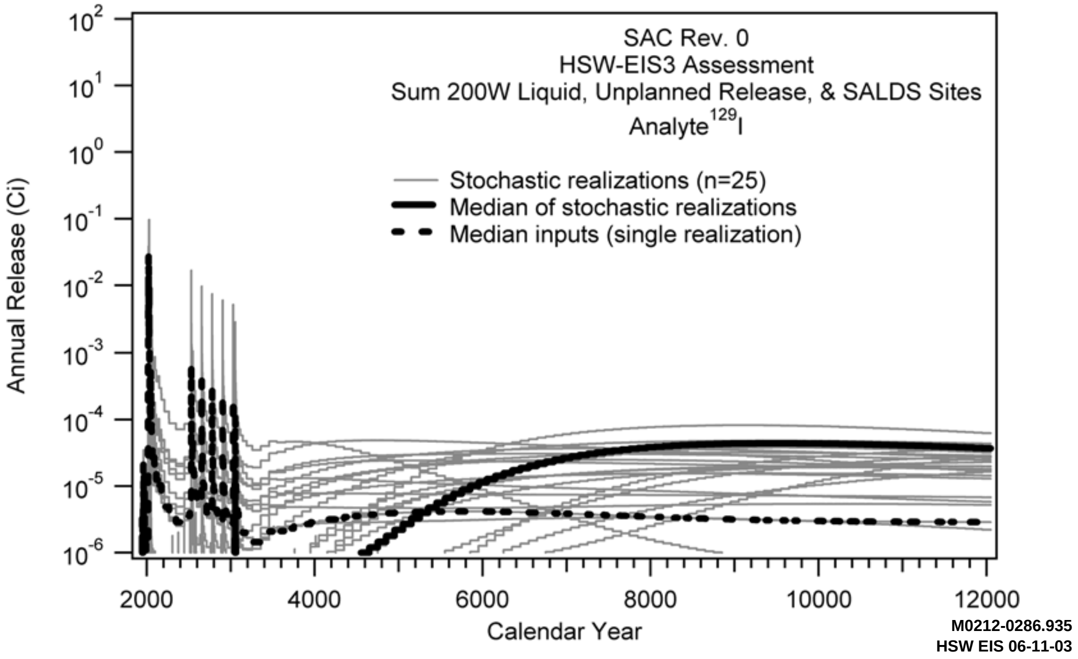

Figure L.37. SAC Results for Annual Vadose Zone Release of Iodine-129 from All Liquid Discharge and Unplanned Release Sites in the 200 West Area plus SALDS

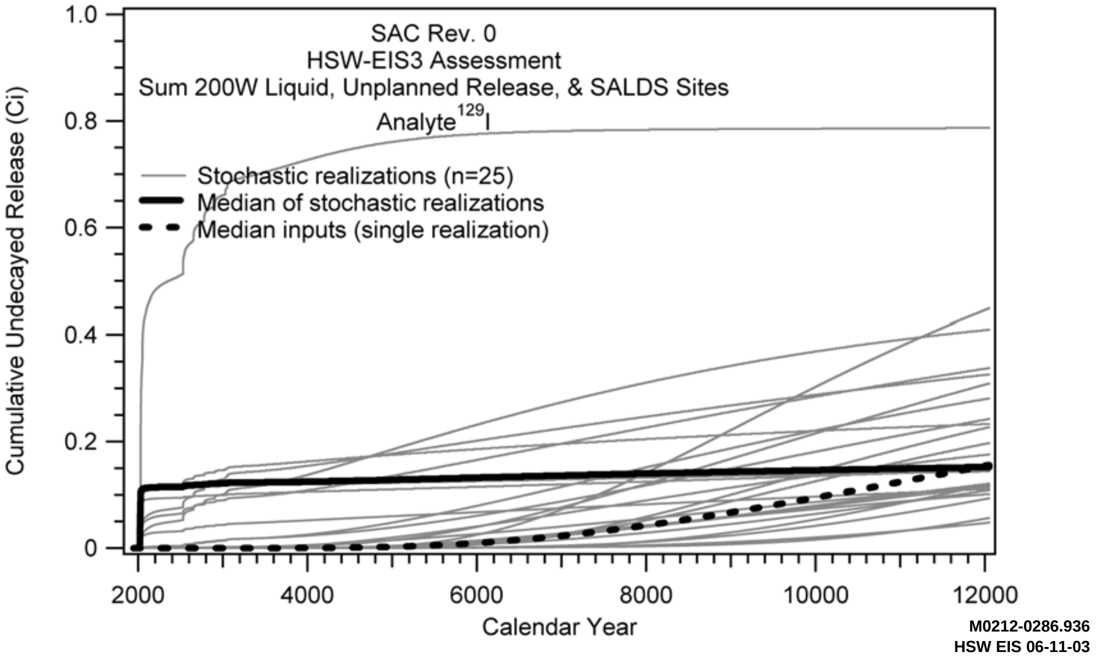

Figure L.38. SAC Results for Cumulative (undecayed) Vadose Zone Release of Iodine-129 from All Liquid Discharge and Unplanned Release Sites in the 200 West Area Plus SALDS

Figures L.39 through L.56 present the results for vadose zone releases to groundwater for the sum of all other sites on the Central Plateau, except for ERDF and the commercial low-level radioactive waste disposal site (that is, sites in 200 East and 200 West Areas, excluding solid waste burial ground, tank, liquid discharge, unplanned release, ERDF, and commercial low-level radioactive waste disposal sites), and for the sum of all sites outside the 200 East and 200 West Areas (that is, the 100, 300, 400, and 600 Area sites). Cumulative releases to groundwater for all other sites (for example, canyons, tunnels) on the Central Plateau range from approximately 15 to approximately 50 Ci for technetium-99 during the 10,000-year analysis period. The majority of this activity is associated with 200 West Area. Negligible releases of uranium occur from these sites. Iodine-129 releases from these sites range from 0 to approximately 0.045 Ci during the analysis period, and have median values of approximately zero for the 200 East Area and less than 0.003 Ci for the 200 West Area. Cumulative releases to groundwater from sites away from the Central Plateau (for example, river corridor sites with residual contamination) range from approximately 17 to approximately 37 Ci for technetium-99 during the 10,000-year analysis period. The release of uranium from these same sites ranges from approximately 5 to approximately 80 Ci. The release of iodine-129 from these sites ranges from approximately 0 to 0.0014 Ci, with a median value of approximately 0.0002 Ci. Note that the river corridor includes several liquid waste disposal trenches that received fuel fabrication waste streams that carried uranium to the vadose zone.

Figures L.57 through L.62 present the results for vadose zone releases to groundwater for ERDF. Cumulative releases to groundwater from ERDF range from 0 to approximately 27 Ci for technetium-99 during the 10,000-year analysis period. As in the case of solid waste, uranium in ERDF does not exhibit significant release during the 10,000-year period. Only 3 of 25 realizations exhibit any release, with no releases exhibited before 7000 years post-closure. Hence, the median case shows no uranium release to groundwater. Releases of iodine-129 to groundwater from ERDF during the 10,000 year analysis period range from approximately 0 to 0.042 Ci, with a median value of approximately 0.013 Ci.

Figures L.63 through L.68 present the results for vadose zone releases to groundwater for the commercial low-level radioactive waste disposal site operated by US Ecology, Inc. Cumulative releases to groundwater from the US Ecology, Inc. site range from 0 to approximately 80 Ci for technetium-99 during the 10,000-year analysis period. The annual release curves (Figure L.63) and the cumulative plots (Figure L.64) exhibit substantial variability in the timing of release; however, the peak annual releases appear to vary between only approximately $2\text{x}10^{-2}$ and approximately $5\text{x}10^{-2}$ Ci/yr after 3000 A.D. As in the case of solid waste and ERDF, uranium in the US Ecology, Inc. site does not exhibit release to groundwater during the 10,000-year period. Releases of iodine-129 from the commercial disposal site to the groundwater range from approximately 0 to 5.3 Ci. However, few of the stochastic realizations exhibit releases to the water table, and the median value release is zero during the 10,000-year analysis period.

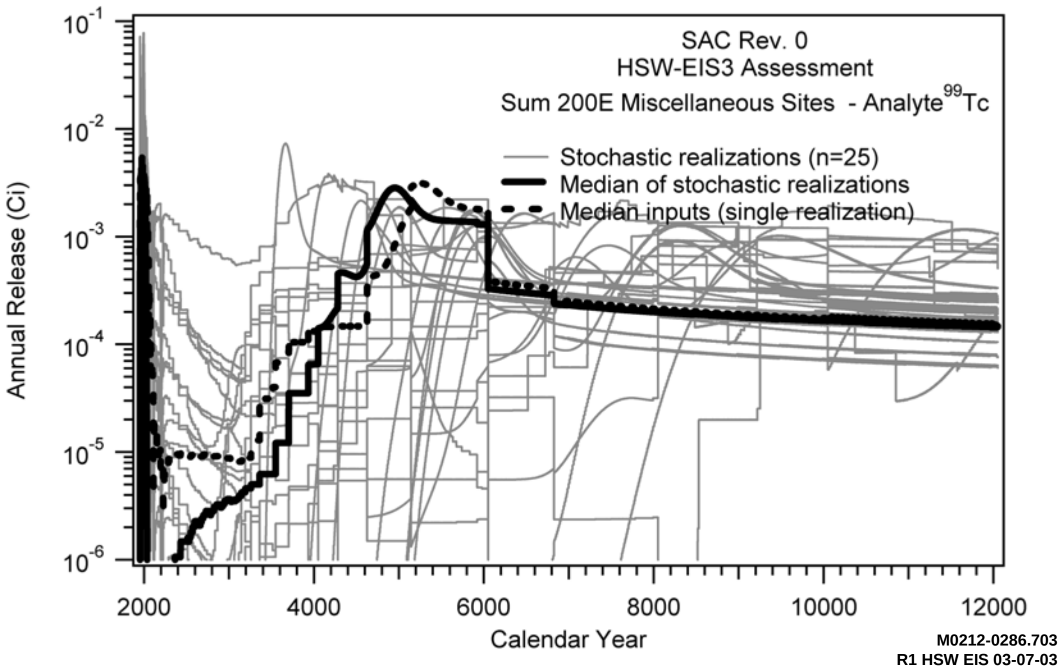

Figure L.39. SAC Results for Annual Vadose Zone Release of Technetium-99 from All Other Sites in the 200 East Area

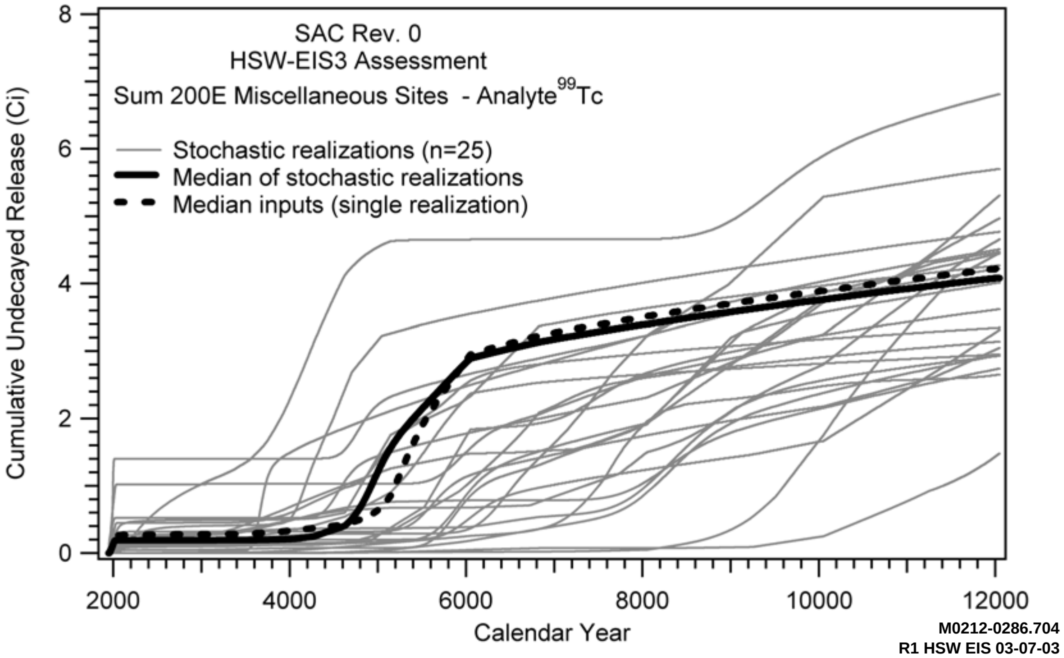

Figure L.40. SAC Results for Cumulative (undecayed) Vadose Zone Release of Technetium-99 from All Other Sites in the 200 East Area

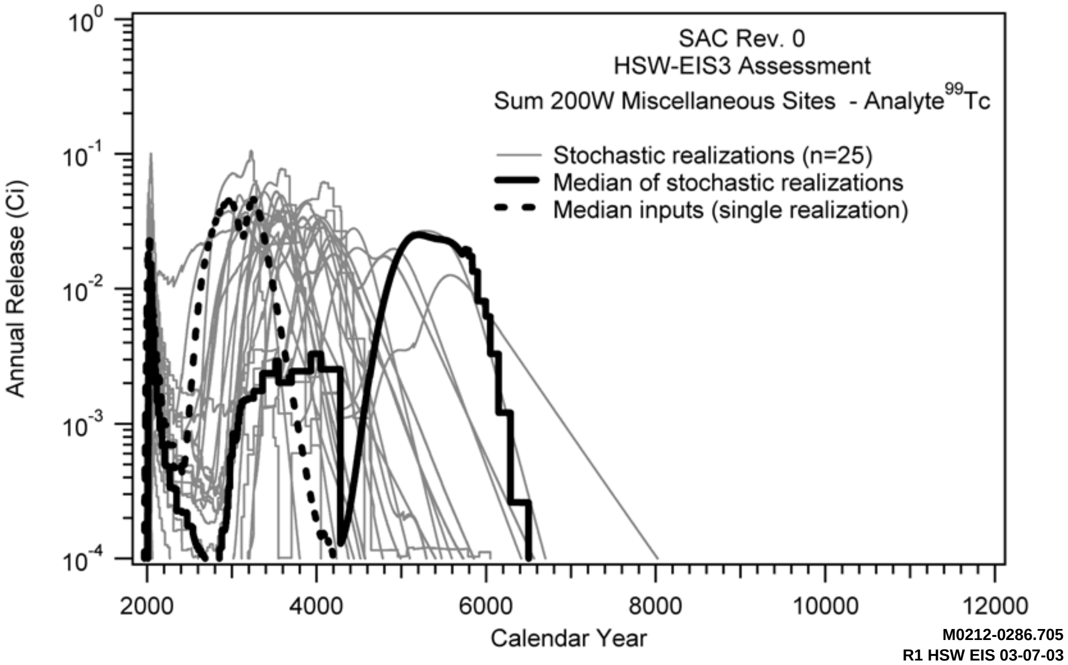

Figure L.41. SAC Results for Annual Vadose Zone Release of Technetium-99 from All Other Sites in the 200 West Area

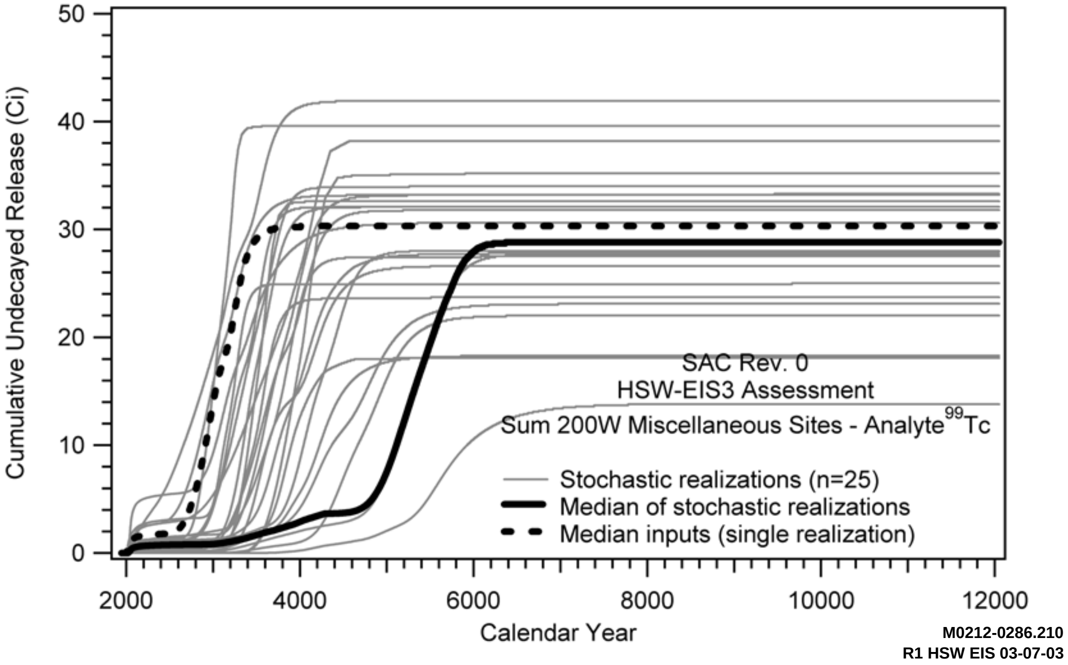

Figure L.42. SAC Results for Cumulative (undecayed) Vadose Zone Release of Technetium-99 from All Other Sites in the 200 West Area

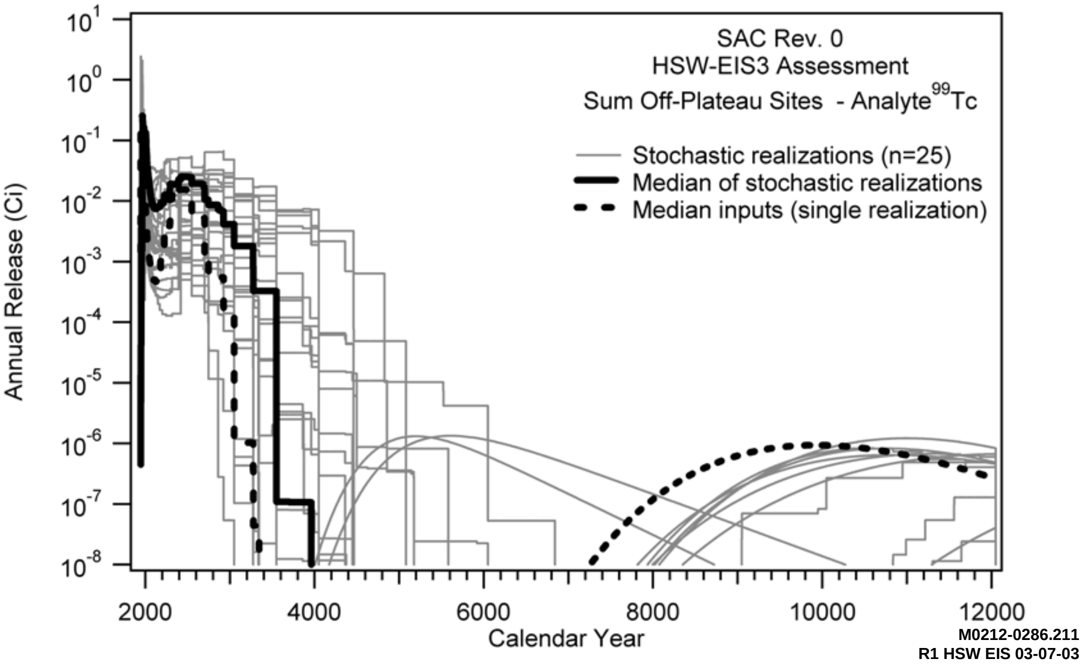

Figure L.43. SAC Results for Annual Vadose Zone Release of Technetium-99 from all Other Sites Outside the 200 East and 200 West Areas

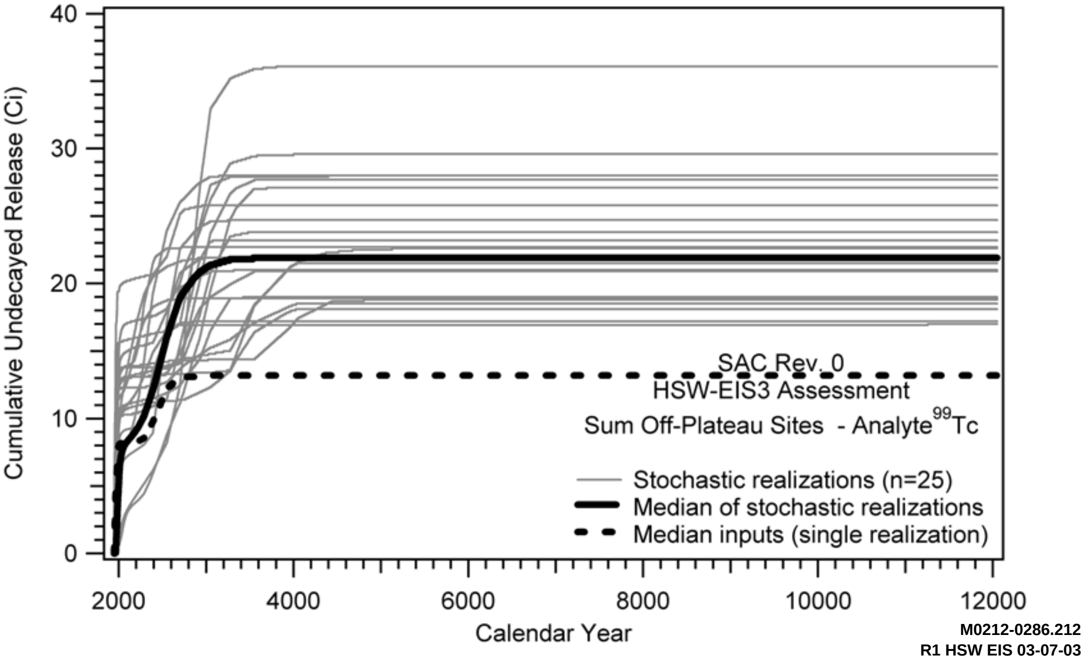

Figure L.44. SAC Results for Cumulative (undecayed) Vadose Zone Release of Technetium-99 from All Other Sites Outside the 200 East and 200 West Areas

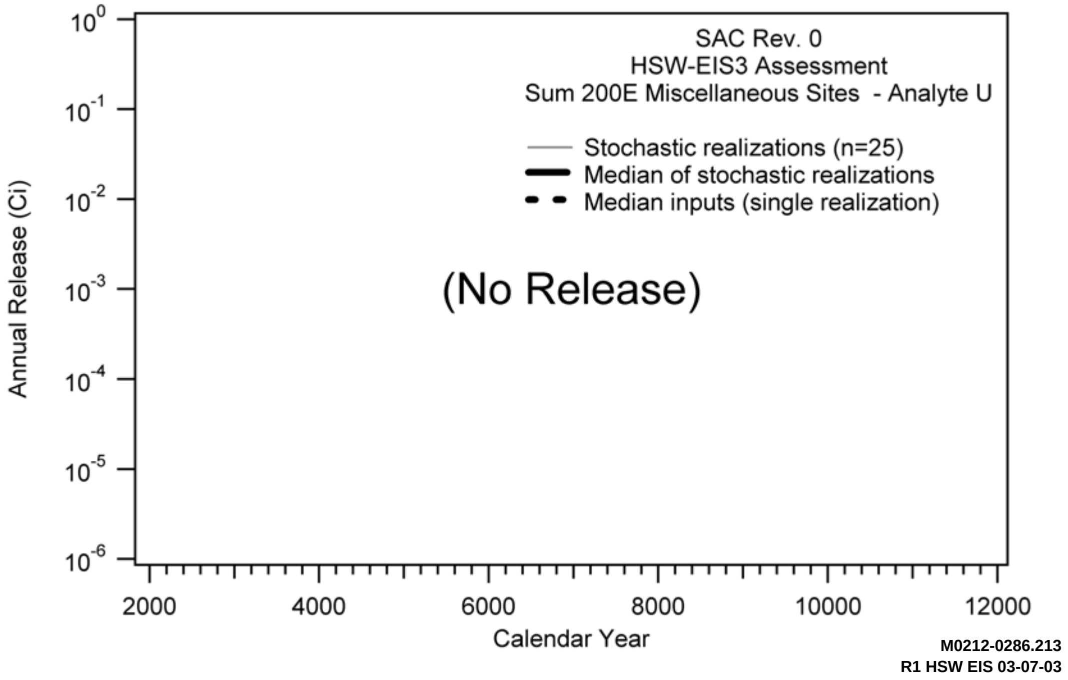

Figure L.45. SAC Results for Annual Vadose Zone Release of Uranium from All Other Sites in the 200 East Area

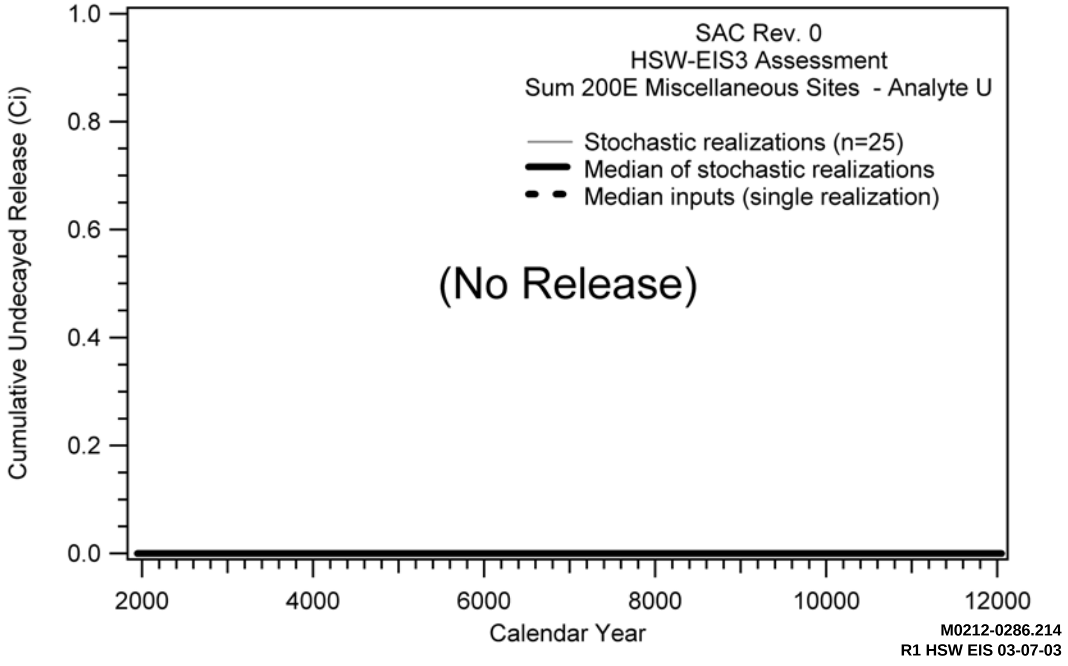

Figure L.46. SAC Results for Cumulative (undecayed) Vadose Zone Release of Uranium from All Other Sites in the 200 East Area

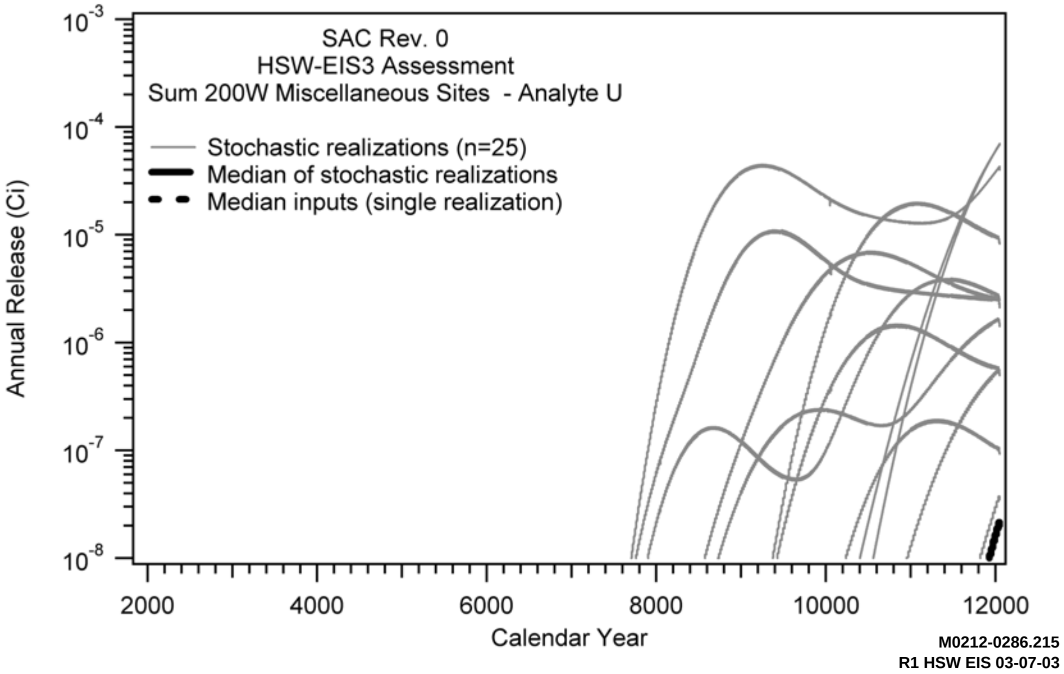

Figure L.47. SAC Results for Annual Vadose Zone Release of Uranium from All Other Sites in the 200 West Area

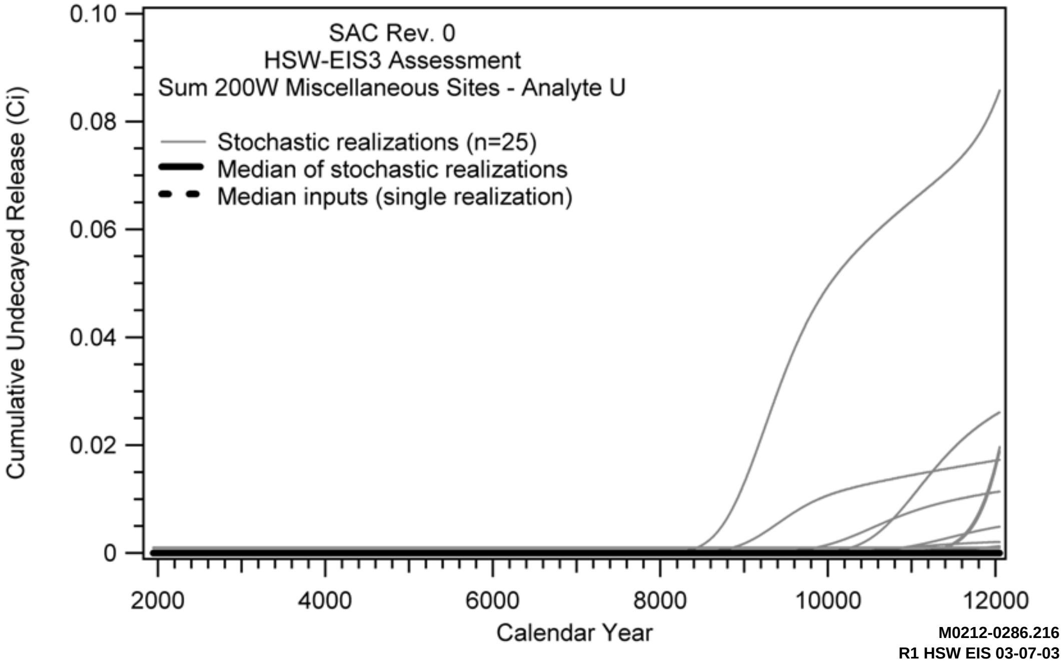

Figure L.48. SAC Results for Cumulative (undecayed) Vadose Zone Release of Uranium from All Other Sites in the 200 West Area

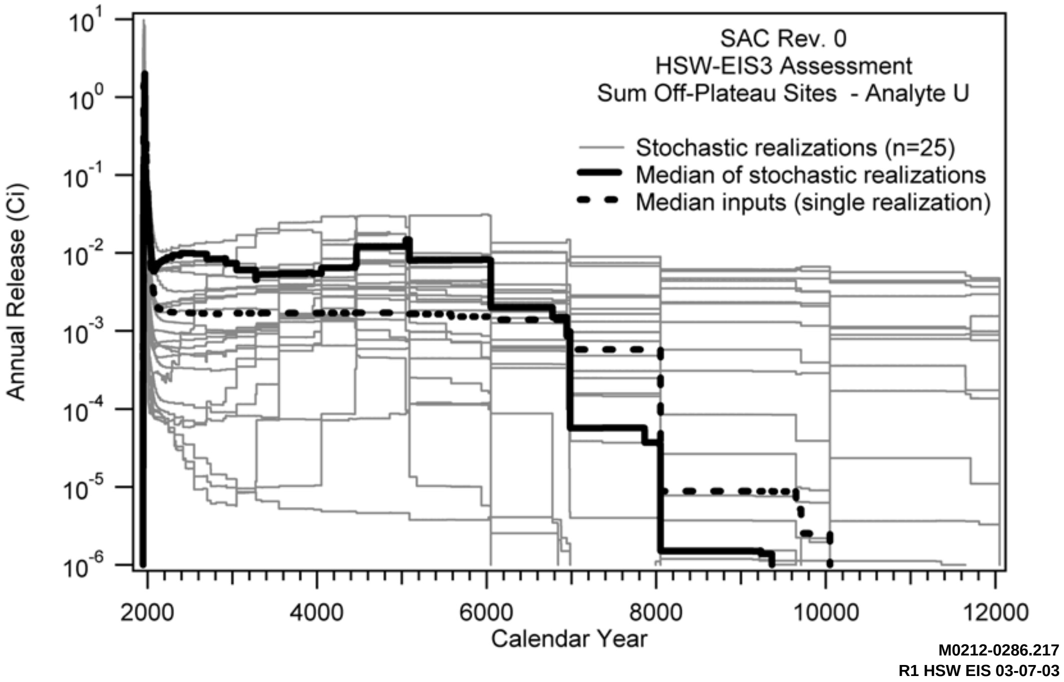

Figure L.49. SAC Results for Annual Vadose Zone Release of Uranium from All Other Sites Outside the 200 East and 200 West Areas

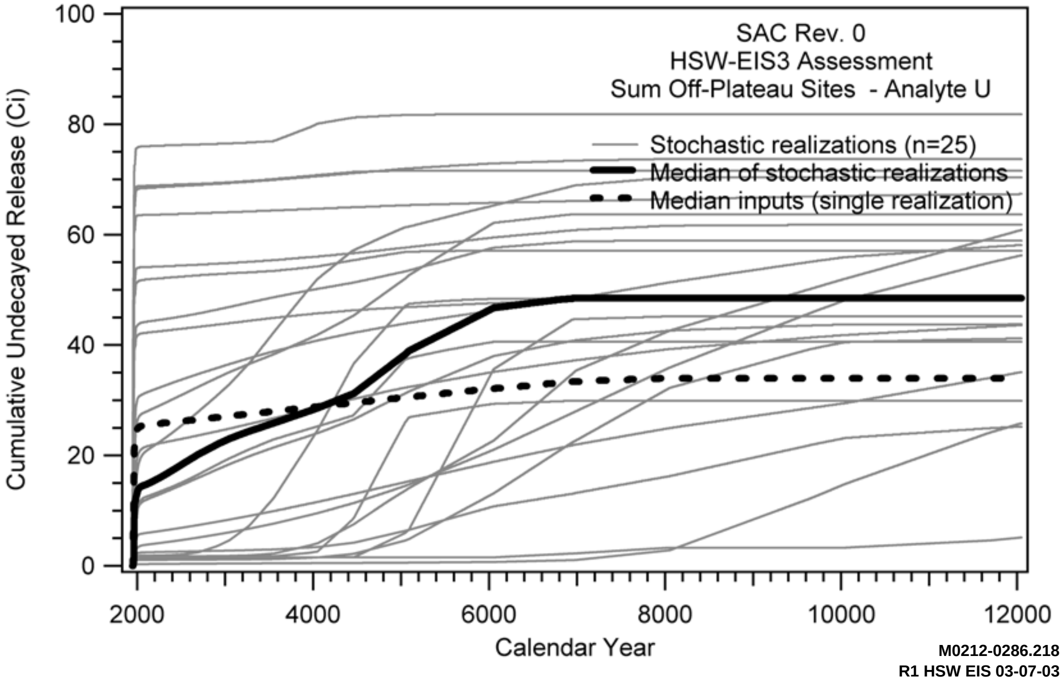

Figure L.50. SAC Results for Cumulative (undecayed) Vadose Zone Release of Uranium from All Other Sites Outside the 200 East and 200 West Areas

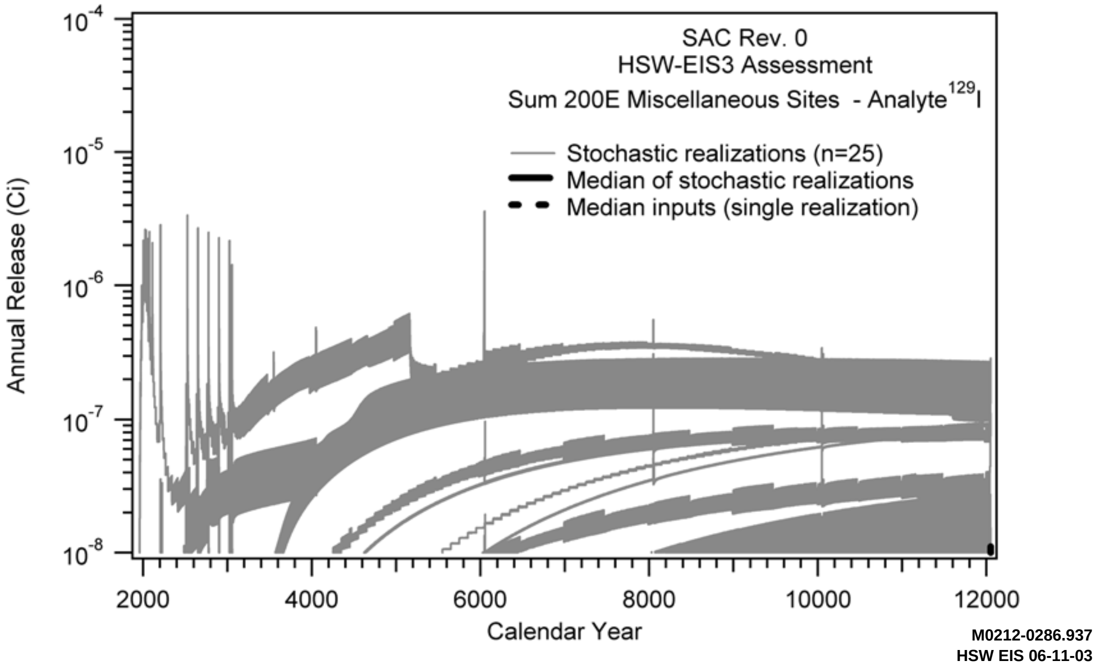

Figure L.51. SAC Results for Annual Vadose Zone Release of Iodine-129 from All Other Sites in the 200 East Area

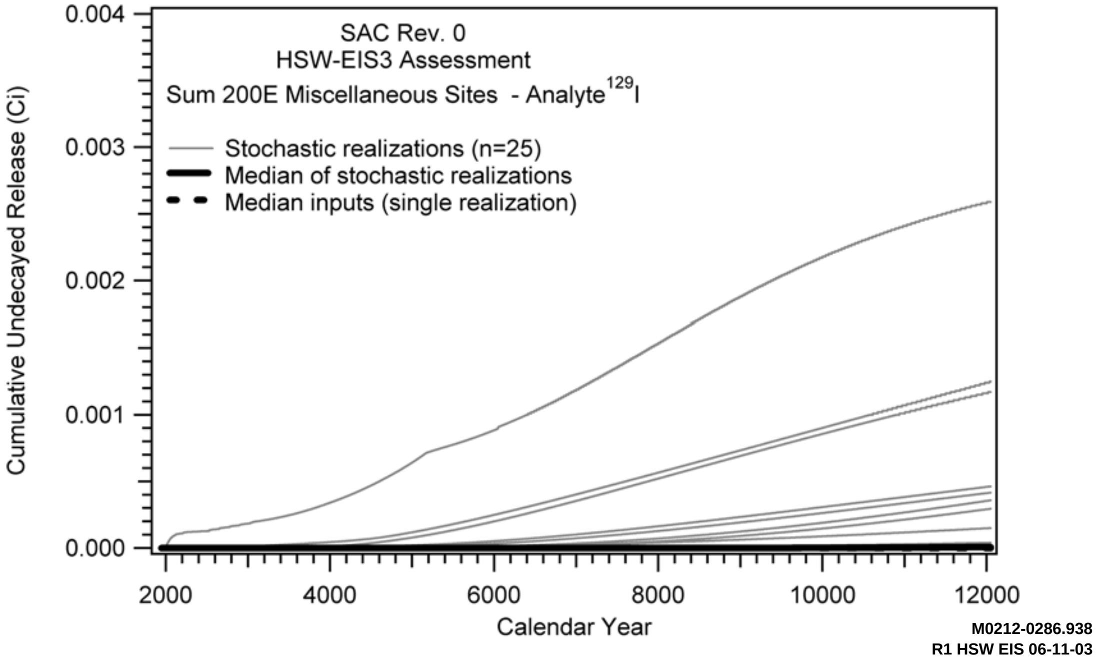

Figure L.52. SAC Results for Cumulative (undecayed) Vadose Zone Release of Iodine-129 from All Other Sites in the 200 East Area

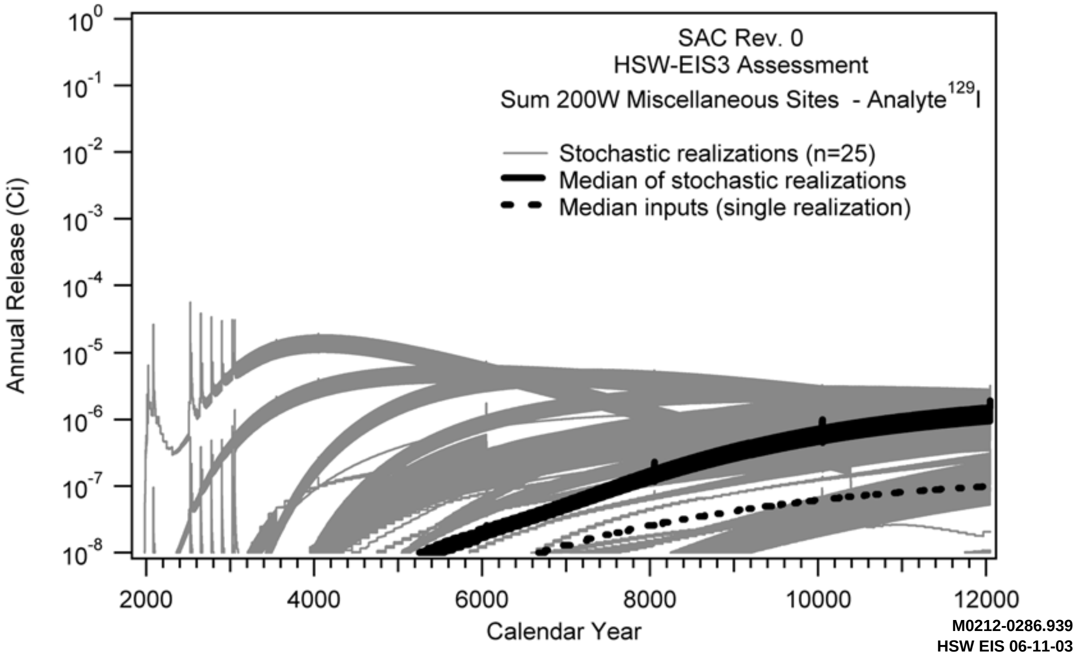

Figure L.53. SAC Results for Annual Vadose Zone Release of Iodine-129 from All Other Sites in the 200 West Area.

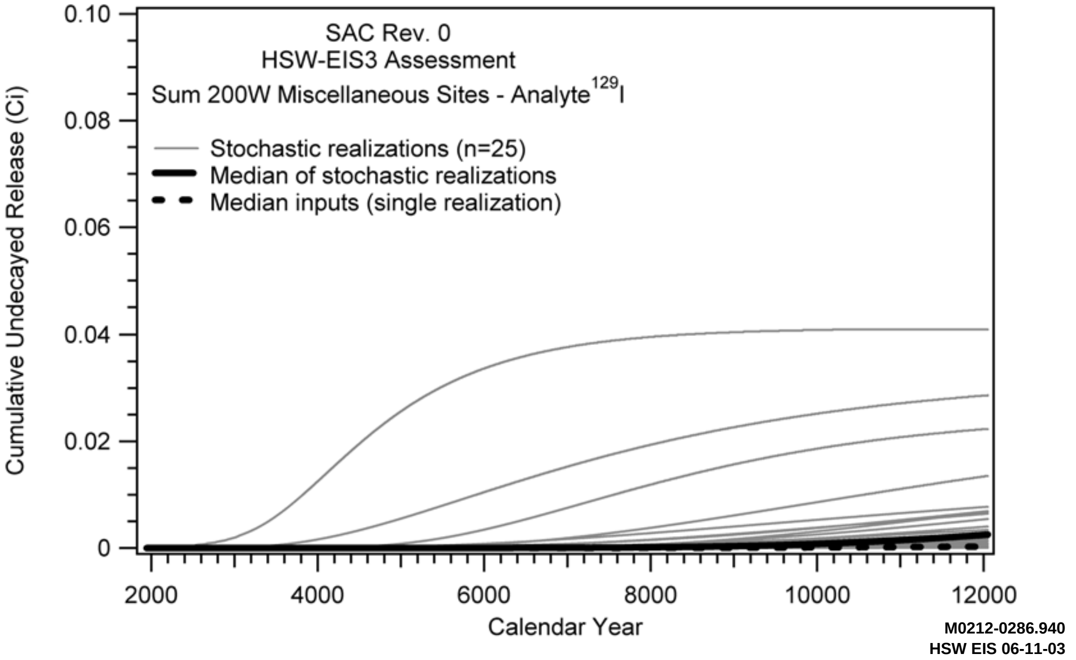

Figure L.54. SAC Results for Cumulative (undecayed) Vadose Zone Release of Iodine-129 from All Other Sites in the 200 West Area.

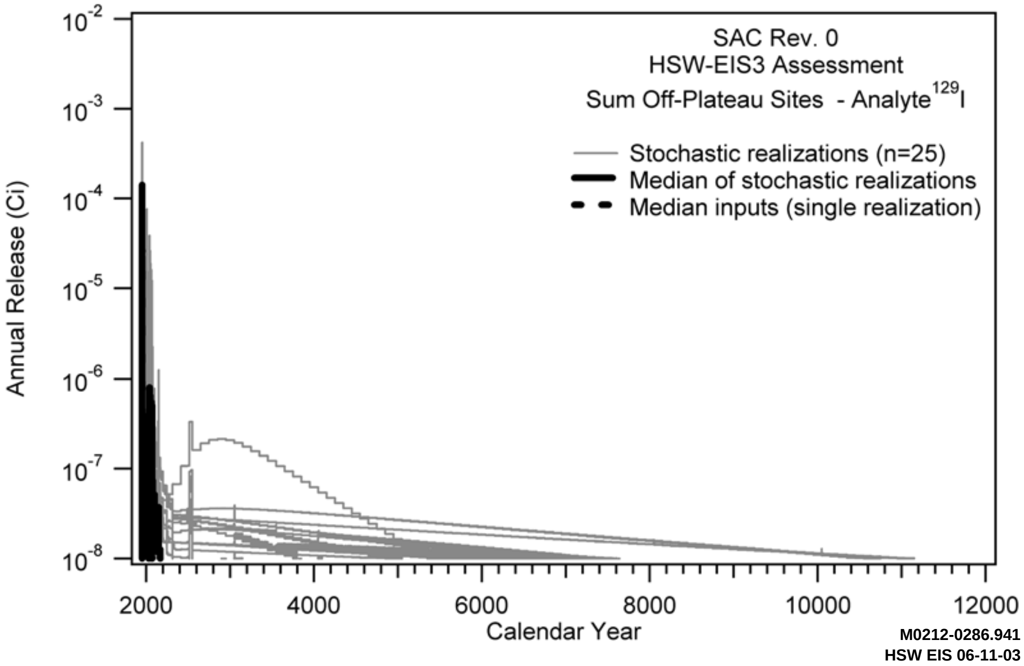

Figure L.55. SAC Results for Annual Vadose Zone Release of Iodine-129 from All Other Sites Outside the 200 East and 200 West Areas.

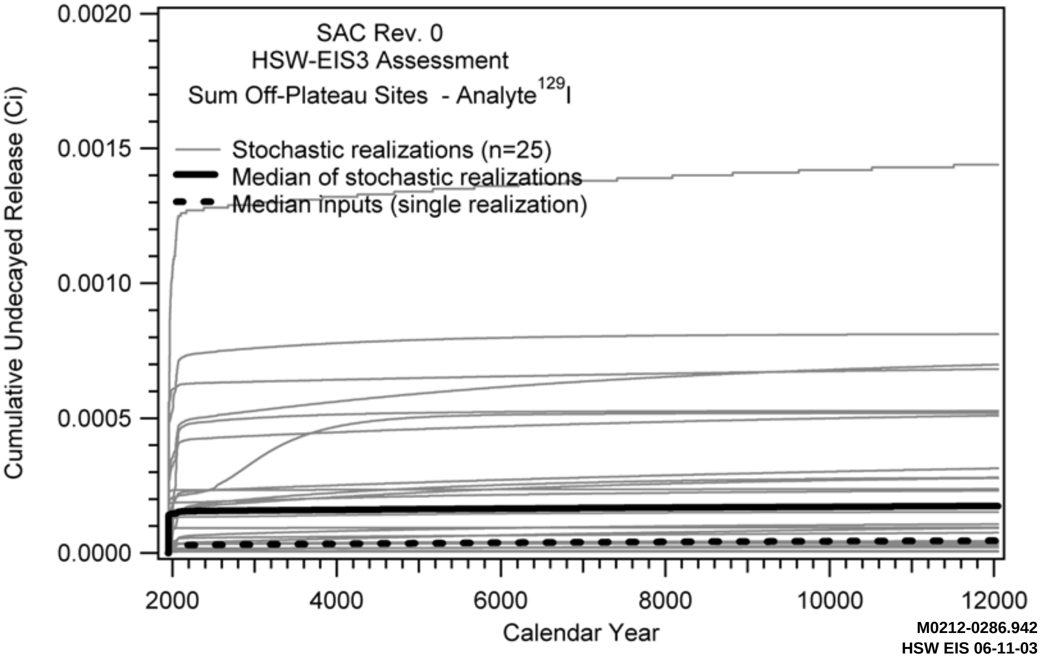

Figure L.56. SAC Results for Cumulative (undecayed) Vadose Zone Release of Iodine-129 from All Other Sites Outside the 200 East and 200 West Areas.

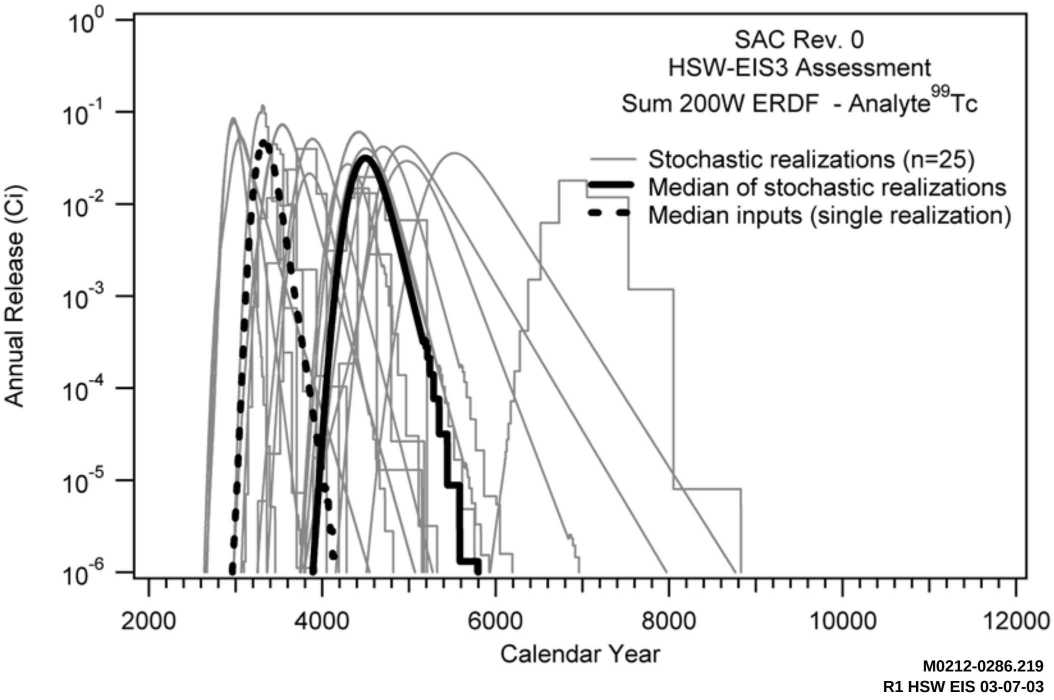

Figure L.57. SAC Results for Annual Vadose Zone Release of Technetium-99 from ERDF

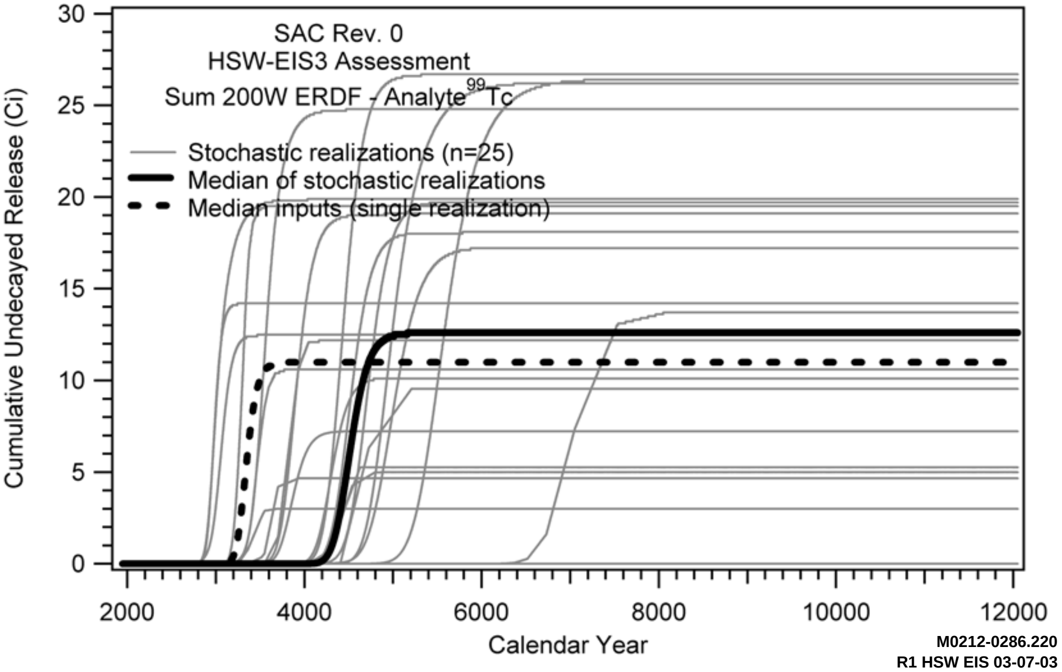

Figure L.58. SAC Results for Cumulative (undecayed) Vadose Zone Release of Technetium-99 from ERDF

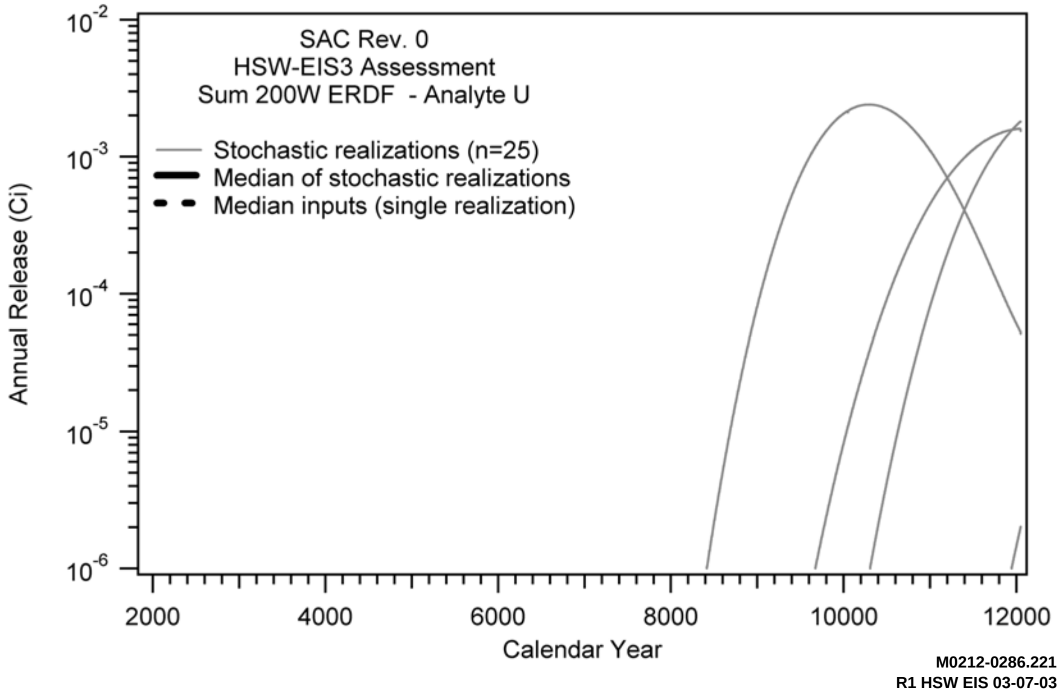

Figure L.59. SAC Results for Annual Vadose Zone Release of Uranium from ERDF

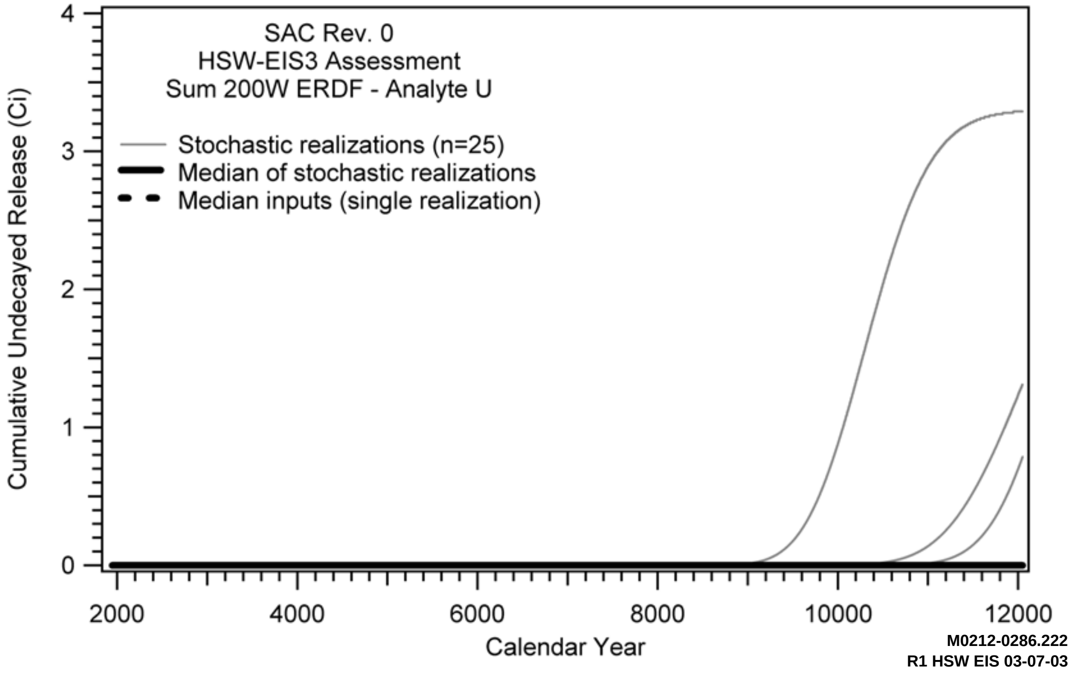

Figure L.60. SAC Results for Cumulative (undecayed) Vadose Zone Release of Uranium from ERDF

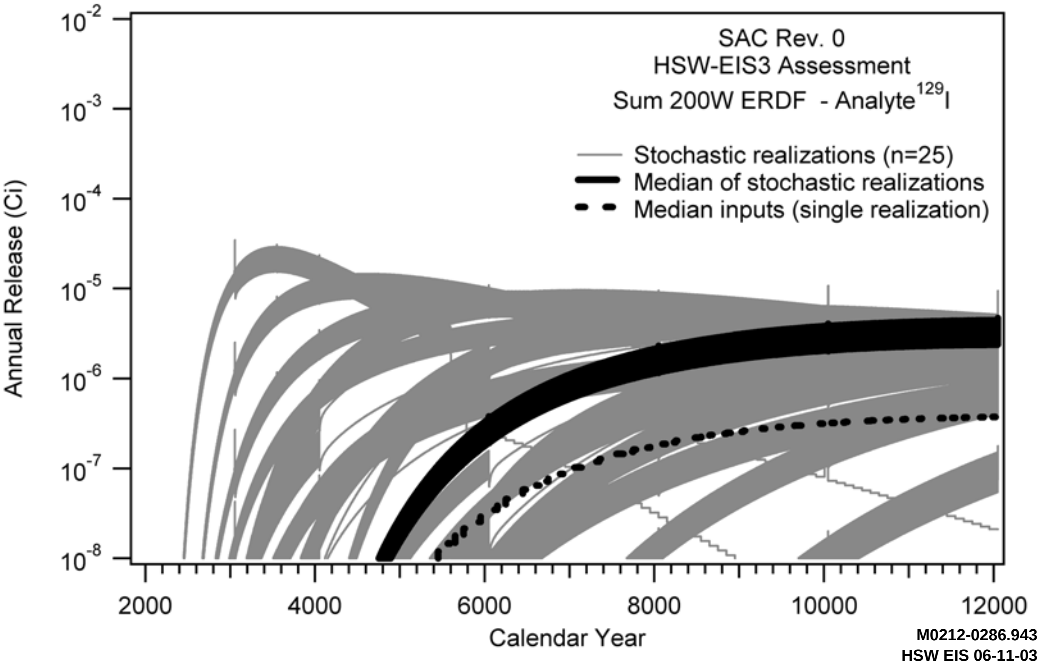

Figure L.61. SAC Results for Annual Vadose Zone Release of Iodine-129 from ERDF

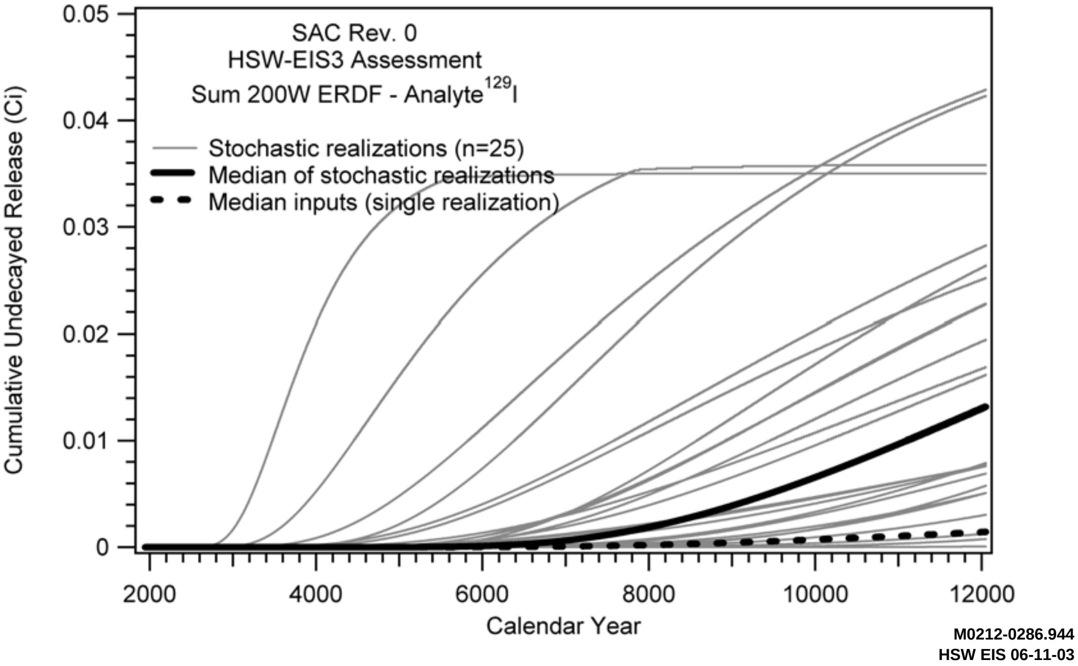

Figure L.62. SAC Results for Cumulative (undecayed) Vadose Zone Release of Iodine-129 from ERDF

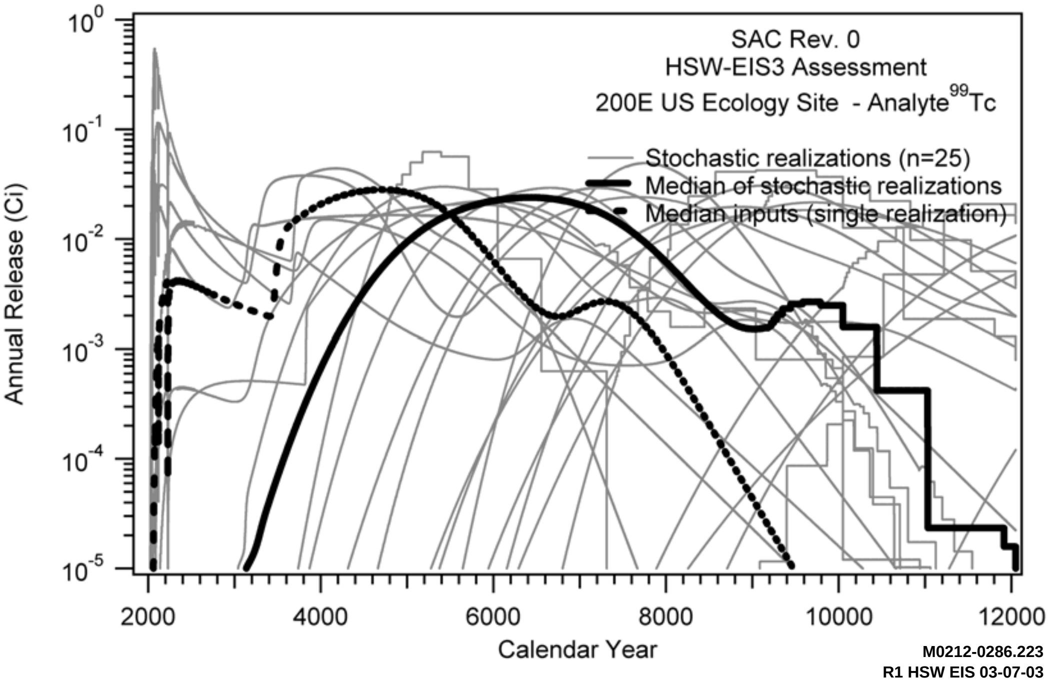

Figure L.63. SAC Results for Annual Vadose Zone Release of Technetium-99 from the Commercial Low-Level Radioactive Waste Disposal (US Ecology, Inc.) Site

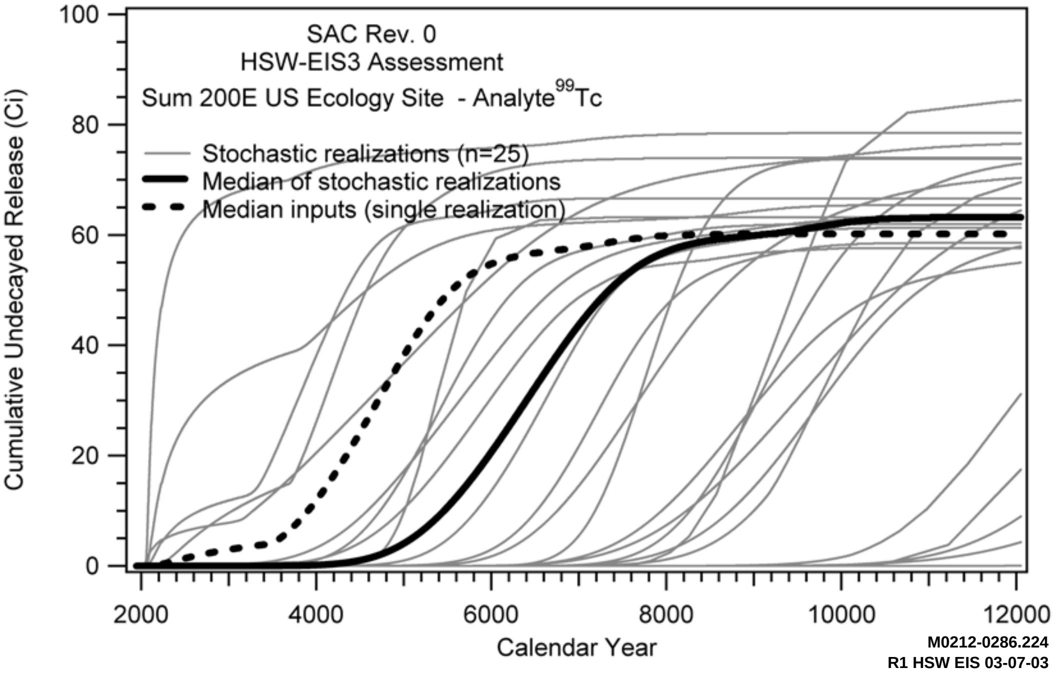

Figure L.64. SAC Results for Cumulative (undecayed) Vadose Zone Release of Technetium-99 from the Commercial Low-Level Radioactive Waste Disposal (US Ecology, Inc.) Site

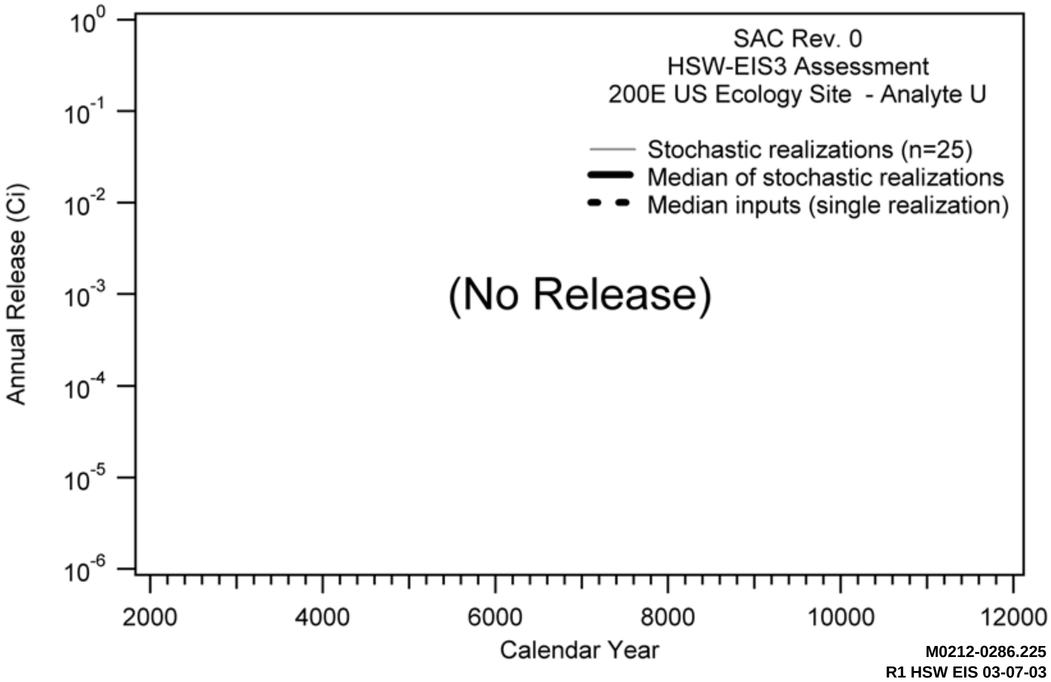

Figure L.65. SAC Results for Annual Vadose Zone Release of Uranium from the Commercial Low-Level Radioactive Waste Disposal (US Ecology, Inc.) Site

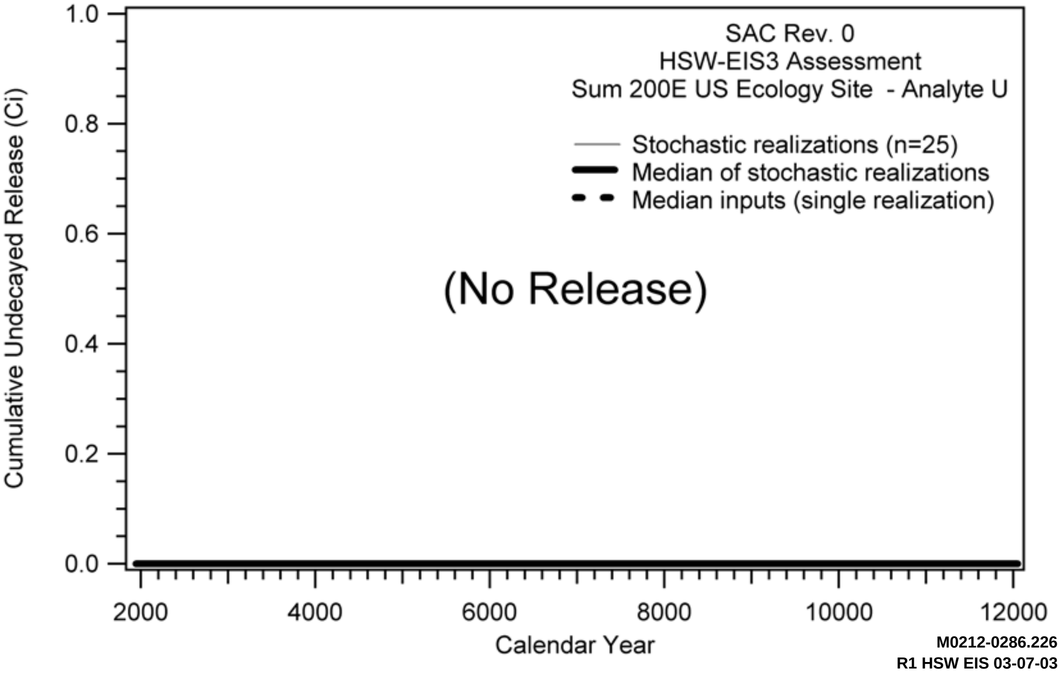

Figure L.66. SAC Results for Cumulative (undecayed) Vadose Zone Release of Uranium from the Commercial Low-Level Radioactive Waste Disposal (US Ecology, Inc.) Site

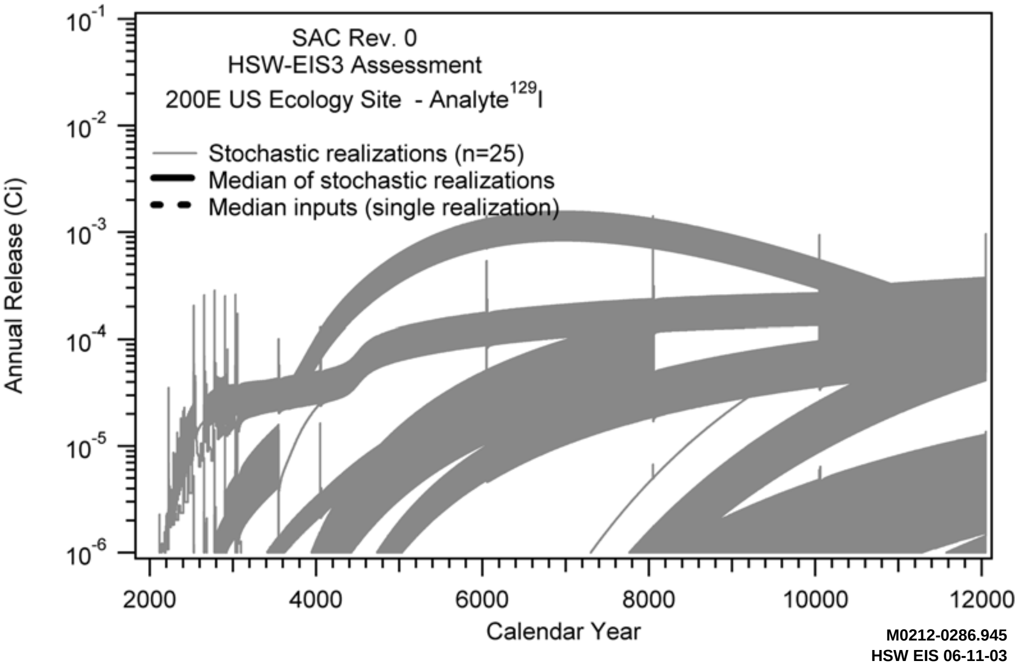

Figure L.67. SAC Results for Annual Vadose Zone Release of Iodine-129 from the Commercial Low-Level Radioactive Waste Disposal (US Ecology, Inc.) Site

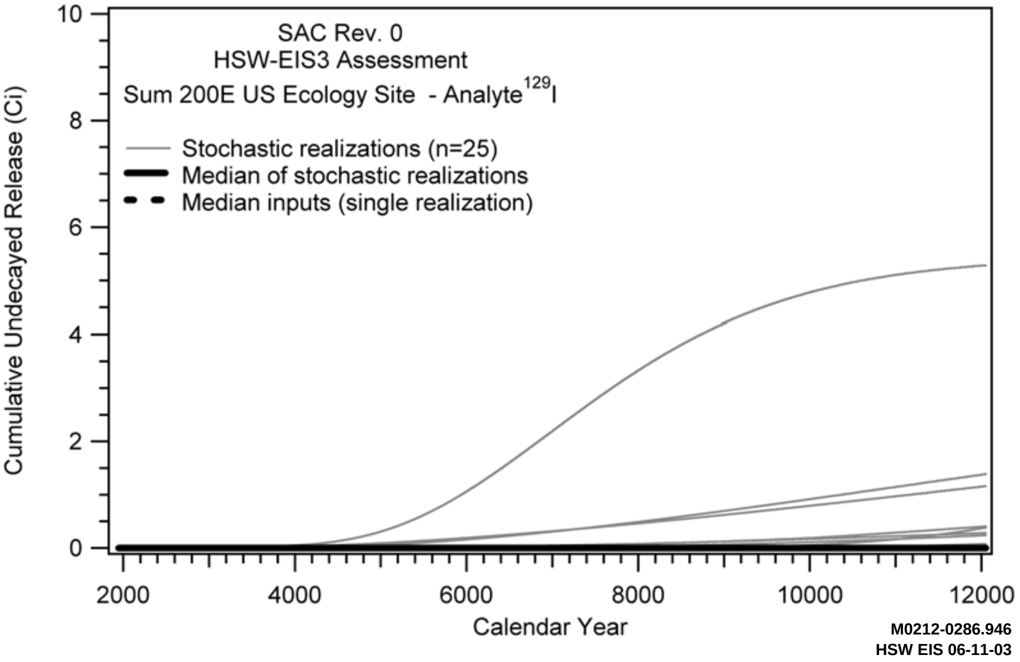

Figure L.68. SAC Results for Cumulative (undecayed) Vadose Zone Release of Iodine-129 from the Commercial Low-Level Radioactive Waste Disposal (US Ecology, Inc.)

These results indicate that technetium-99 releases from the solid waste disposal facilities to groundwater may account for approximately 323 to approximately 445 Ci in 10,000 years. This contrasts with approximately 440 to approximately 645 Ci of technetium-99 from tank sites, approximately 735 to approximately 1030 Ci from liquid releases, approximately 15 to approximately 50 Ci from other sites on the Central Plateau, approximately 17 to approximately 37 Ci from sites away from the plateau, 0 to approximately 27 Ci from ERDF, and 0 to approximately 80 Ci from the US Ecology, Inc. site. Overall, the comparison is approximately 323 to approximately 445 Ci of technetium-99 from solid waste and approximately 1530 to approximately 2310 Ci of technetium-99 released in 10,000 years from all Hanford Site sources. Thus, the contribution from Hanford solid waste would amount to about 20 percent of the cumulative technetium-99 release from all Hanford sources.

The release of uranium to groundwater from Hanford solid waste is much lower. No realizations showed any release of uranium to groundwater from Hanford solid waste in the 200 East Area, and only 5 of 25 realizations exhibit any release of uranium to groundwater from Hanford solid waste in 200 West Area. Thus, in an average, or median, sense, Hanford solid waste deposits would release no uranium to groundwater over the 10,000-year analysis period. This result compares to a median release of approximately 84 Ci and a range of release to groundwater from the 25 realizations of between approximately 10 and approximately 300 Ci of uranium for all Hanford wastes. Of the five realizations of non-zero uranium release from Hanford solid waste in the 200 West Area, the range of cumulative release was 0 to approximately 90 Ci, but the majority of realizations show zero release. As a consequence, the contribution from Hanford solid waste would amount to between 0 and 30 percent of the cumulative release from all Hanford sources. The majority of the technetium-99 and uranium release was forecast to occur from past liquid discharge sites (cribs, ponds, trenches) and unplanned releases on the plateau and from off-plateau or river corridor waste sites.

The inventory of iodine-129 and its release to groundwater from Hanford solid waste are lower than technetium-99 or uranium; however, they are just as substantial given the low production inventory and the potential health impacts of the isotope. Iodine-129 releases from the solid waste disposal facilities to the groundwater may account for approximately 0 to 2.2 Ci in 10,000 years. This amount contrasts with approximately 0.1 Ci to 0.22 Ci released from tank sites, approximately 0 to 1 Ci released from liquid discharge and unplanned release sites, approximately 0 to 0.045 Ci released from other sites on the Central Plateau, approximately 0 to 0.0014 Ci released from sites away from the plateau, approximately 0 to 0.042 Ci released from ERDF, and approximately 0 to 5.3 Ci released from the commercial low-level radioactive waste disposal site operated by US Ecology, Inc. Ci of iodine-129 from solid waste deposits, and approximately 0.1 to 8.8 Ci of iodine-129 released in 10,000 years from all Hanford sources. Using the maximum releases to the water table, the contribution from Hanford solid waste, excluding ILAW, would amount to about 25 percent of the cumulative iodine-129 release from all Hanford sources; however, the commercial disposal site dominates the estimates of maximum release. If the median result is used to estimate the role of solid waste, its role is approximately 27 percent of all releases; however, the commercial disposal site contribution is negligible, tank sites are as important as solid waste, and liquid discharge and unplanned release sites on the plateau dominate.

L.3.2 Drinking Water Dose at Selected 200 East and 200 West Area Locations

Doses to humans calculated using the SAC software and data are summarized in this section. The exposure scenario has an adult human drinking 2 L per day of contaminated groundwater. The doses in this section are presented as total effective dose equivalents, that is, the sum of the dose equivalents to various organs and tissues of the body, each weighted by an organ-specific weighting factor. The total effective dose equivalent includes the committed effective dose equivalent from internal deposition of radionuclides (from inhalation and ingestion) and the dose equivalent from penetrating radiation from sources external to the body. The radionuclide dose conversion factors used in this report were taken from compilations established by the EPA (Eckerman et al. 1988; Eckerman and Ryman 1993). These dose conversion factors are *not* the same as those required to show compliance with the National Primary Drinking Water Regulations (40 CFR 141). However, groundwater concentrations are also shown in Section L.3.4 for comparison with the 40 CFR 141 maximum contaminant levels, or MCLs. The stochastic capability of SAC was employed for these simulations, so the following results are shown in each plot in this section:

- Individual **stochastic results** (25 realizations) are shown in black.

- The **median result** of the 25 realizations—that is, the realization that resulted in the median integrated cumulative dose in the year 12,050 A.D. (at the end of the simulation)—is shown in blue.

- The **median-inputs** simulation—a separate single-realization simulation with SAC using the median value of all stochastic input variables—is shown in red.

The variability in the stochastic results is due to variability in the inventory, release, and transport of technetium-99, iodine-129, and uranium. The human dose calculations use fixed inputs. Because active institutional control cannot be relied on after 100 years, the scenarios using groundwater begin in 2150.

The doses provided in this section are based on all waste at the Hanford Site except the ILAW, melters, and naval reactor compartments. Cumulative releases to groundwater for Hanford solid waste, excluding ILAW disposed of in the Central Plateau, range from approximately 323 to approximately 445 Ci for technetium-99 during the 10,000-year analysis period. This compares with a range of release to groundwater between approximately 1530 and 2310 Ci of technetium-99 for all Hanford wastes except ILAW. The contribution from Hanford solid waste excluding ILAW would amount to about 20 percent of the cumulative release from Hanford sources excluding ILAW. The median release of technetium-99 from Hanford solid waste excluding ILAW was approximately 390 Ci while the median release for all Hanford sources except ILAW was approximately 2000 Ci. The ILAW cumulative release of technetium-99 for the base case (Mann et al. 2001) considering the full technetium-99 inventory was approximately 86 Ci by the end of the 10,000-year post-closure period. Accordingly the contribution from Hanford solid waste including ILAW would amount to about 25 percent of the cumulative release from all Hanford sources after 10,000 years.

For uranium, the cumulative releases to groundwater for Hanford solid waste disposed of in the Central Plateau range from 0 to approximately 94 Ci. However of all realizations simulated, no realizations showed any release to groundwater from Hanford solid waste in the 200 East Area, and only 5 of 25 realizations show any release of uranium to groundwater from Hanford solid waste in the 200 West Area. Thus in an average (or median) sense, Hanford solid waste deposits would release no uranium to groundwater over the 10,000-year period of analysis. This compares with a median release of approximately 84 Ci and a range of release to groundwater from the 25 realizations of between approximately 10 to 300 Ci of uranium for all Hanford wastes except ILAW. Of the five realizations of non-zero uranium release from Hanford solid waste in the 200 West Area, the cumulative release ranged from 0 to approximately 90 Ci. The contribution from uranium in Hanford solid waste lies between 0 and 30 percent of the cumulative release from all Hanford sources. However, the median release of uranium from Hanford solid waste was zero while the median release for all Hanford sources (except ILAW) was approximately 84 Ci. The ILAW cumulative release of uranium for the base case (Mann et al. 2001) was less than 1 Ci by the end of the 10,000-year post-closure period. Accordingly, the contribution from Hanford solid waste including ILAW would amount to less than 1.2 percent of the cumulative median release of uranium from all Hanford sources after 10,000 years.

For iodine-129, the cumulative releases to groundwater for Hanford solid waste disposal of in the Central Plateau range from approximately 0 to 2.2 Ci. The median release to groundwater is 0.1 Ci. This amount compares with a range of release to groundwater from the 25 realizations of between approximately 0.1 and 8.8 Ci of iodine-129 for all Hanford wastes (except ILAW). The median value of iodine-129 releases from all Hanford sources (except ILAW) is approximately 0.36 Ci, all of which is from DOE waste because the median release from the commercial disposal site is approximately 0 Ci. With regard to the maximum values, the contribution from iodine-129 in Hanford solid waste lies between 0 and 25 percent of the cumulative release from all Hanford sources. With regard to the median values, the contribution from solid waste is 27 percent of the total. The ILAW cumulative release of iodine-129 for the base case (Mann et al. 2001) was approximately 0.07 Ci by the end of the 10,000-year post-closure period. This is a nominal amount given the existing iodine-129 plume in groundwater and the forecast releases of other waste forms.

L.3.2.1 Drinking Water Dose at the Northeast Corner of the 200 West Area

The drinking water dose to a human from technetium-99 using groundwater approximately 1 km (0.62 mi) outside the northeast corner of 200 West Area is provided in Figure L.69. The location was chosen to represent the highest doses from the local groundwater plume. The drinking water dose to a human from uranium and iodine-129 at the same location is provided in Figures L.70 and L.71. None of these figures includes the impact of ILAW. However, ILAW disposal occurs in the 200 East Area, and existing and future groundwater flow will conduct plumes from ILAW release away from the 200 West Area location represented in these figures. The data for technetium-99 show peaks that occur early and then again after approximately 3000 years. Figure L.69 exhibits a peak dose from technetium-99 of approximately 3.5 mrem/yr and a median of less than 1 mrem/yr with much lower consequences in the 7000 to 10,000-year time frame (that is, a range of 0.001 to 0.01 mrem/yr and a median less than 0.002 mrem/yr). Figure L.70 exhibits an early peak dose from uranium (that is, a range of less than 0.01 to 0.3 mrem/yr and a median of approximately 0.06 mrem/yr) and considerable variability in later years because of the sorption model for uranium (that is, a range of 0.0001 to 5 mrem/yr and a median of approximately 0.03 mrem/yr). Figure L.71 exhibits a peak dose from iodine-129 in the range of 0.02 to

0.06 mrem/yr and a median of approximately 0.05 mrem/yr. Lower-level consequences occur in the 7000 to 12,000 A.D. time frame when a second peak or plateau in dose occurs with a long-term median value less than 0.02 mrem/yr.

L.3.2.2   Drinking Water Dose at the Southeast Corner of the 200 East Area

The drinking water dose to a human from technetium-99 using groundwater from approximately 1 km (0.62 mi) outside the southeast corner of 200 East Area is provided in Figure L.72. The location was chosen to represent the highest doses from the local groundwater plume. The drinking water dose to a human from uranium and iodine-129 at the same location is provided in Figures L.73 and L.74. None of these figures includes the impact of ILAW. The technetium-99 results show peaks early and again throughout the 10,000-year period. Figure L.72 exhibits a peak median dose from technetium-99 in the range of 1 to 2 mrem/yr during the 10,000-year period. Peaks of individual realizations range to 3 mrem/yr. Figure L.73 exhibits a peak median dose from uranium of less than 1 mrem/yr early with a long-term median value of less than 0.01 mrem/yr. There is considerable variability in later years because of the sorption model for uranium (that is, after 10,000 years there is a range of approximately 0.001 to 1 mrem/yr, but the median is less than 0.01 mrem/yr). Figure L.74 exhibits a peak dose from iodine-129 in the range of 0.2 to 0.25 mrem/yr and a median of approximately 0.2 mrem/yr with lower consequences after 7000 A.D. (that is, a range of 0.07 to 0.003 mrem/yr and a median of less than 0.015 mrem/yr).

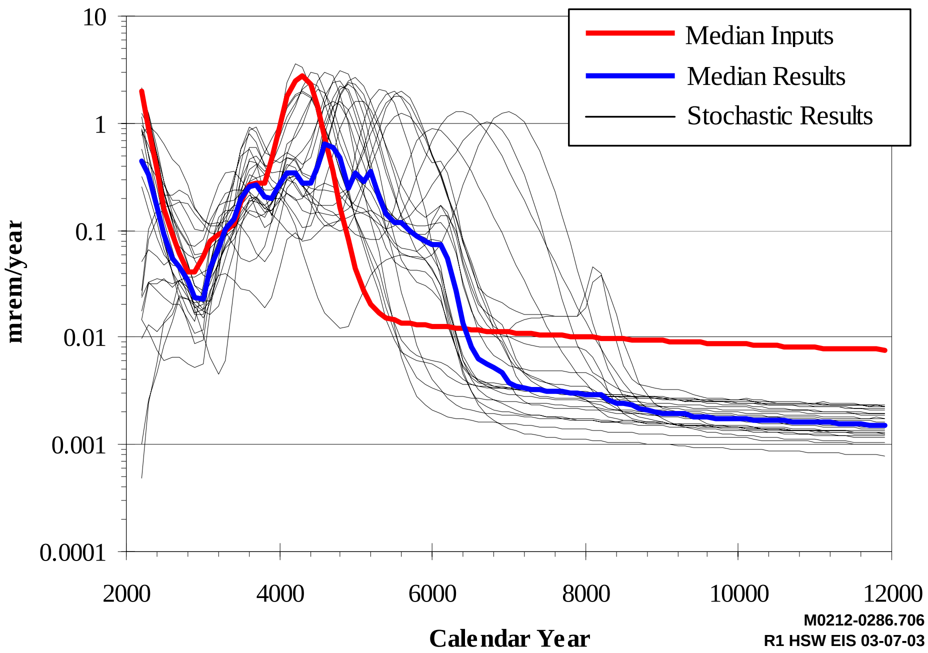

Figure L.69. Hypothetical Drinking Water Dose from Technetium-99 from All Hanford Sources Except ILAW, Melters, and Naval Reactors in Groundwater 1 km Downgradient Northeasterly of the 200 West Area

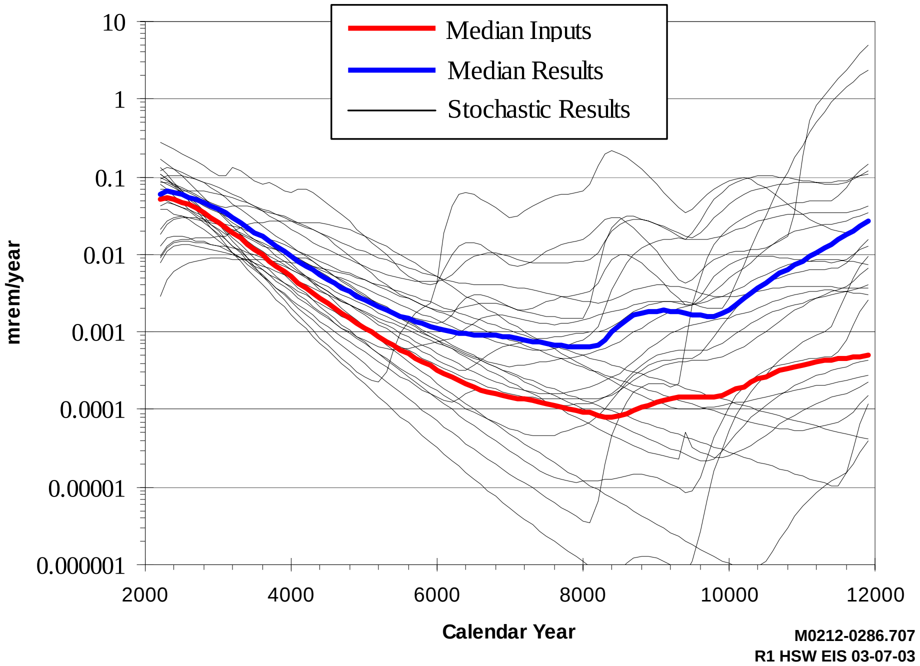

Figure L.70. Hypothetical Drinking Water Dose from Uranium from All Hanford Sources Except ILAW, Melters, and Naval Reactors in Groundwater 1 km Downgradient Northeasterly of the 200 West Area

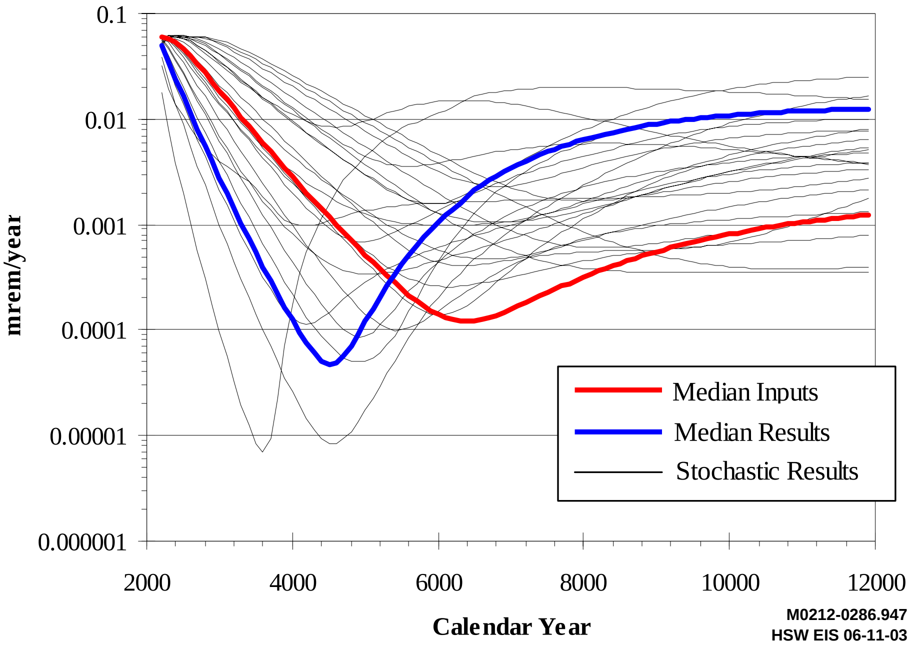

Figure L.71. Hypothetical Drinking Water Dose from Iodine-129 from All Hanford Sources Except ILAW, Melters, and Naval Reactors in Groundwater 1 km Downgradient Northeasterly of the 200 West Area

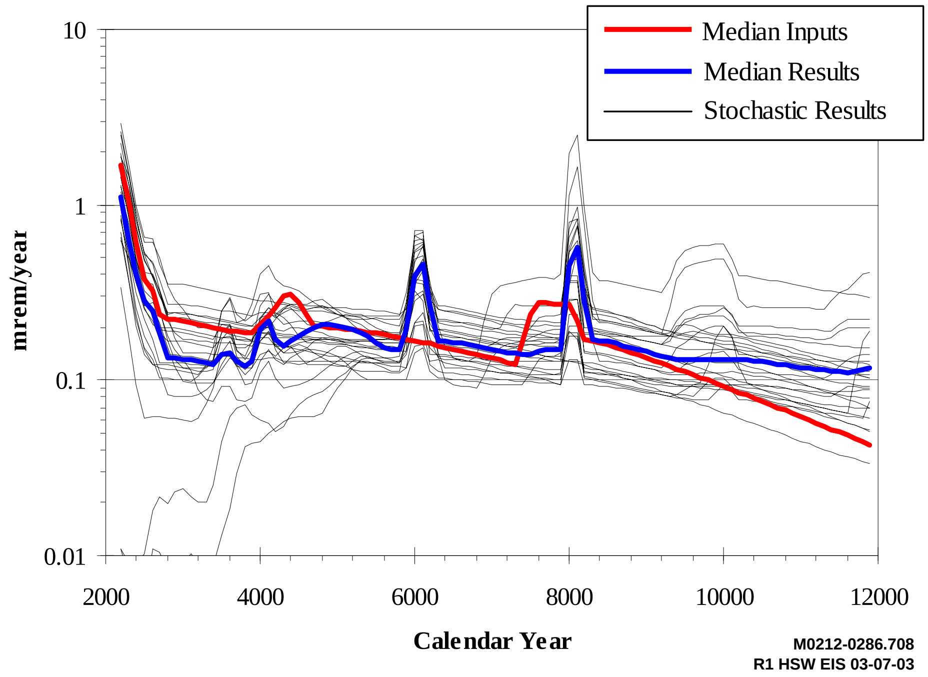

Figure L.72. Hypothetical Drinking Water Dose from Technetium-99 from All Hanford Sources Except ILAW, Melters, and Naval Reactors in Groundwater 1 km Downgradient Southeasterly of the 200 East Area

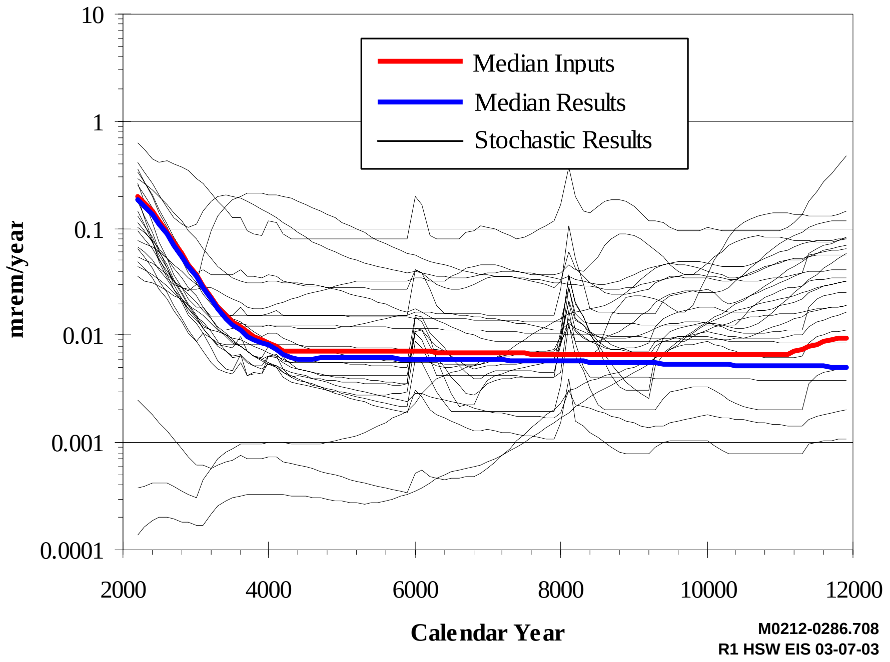

Figure L.73. Hypothetical Drinking Water Dose from Uranium from All Hanford Sources Except ILAW, Melters, and Naval Reactors in Groundwater 1 km Downgradient Southeasterly of the 200 East Area

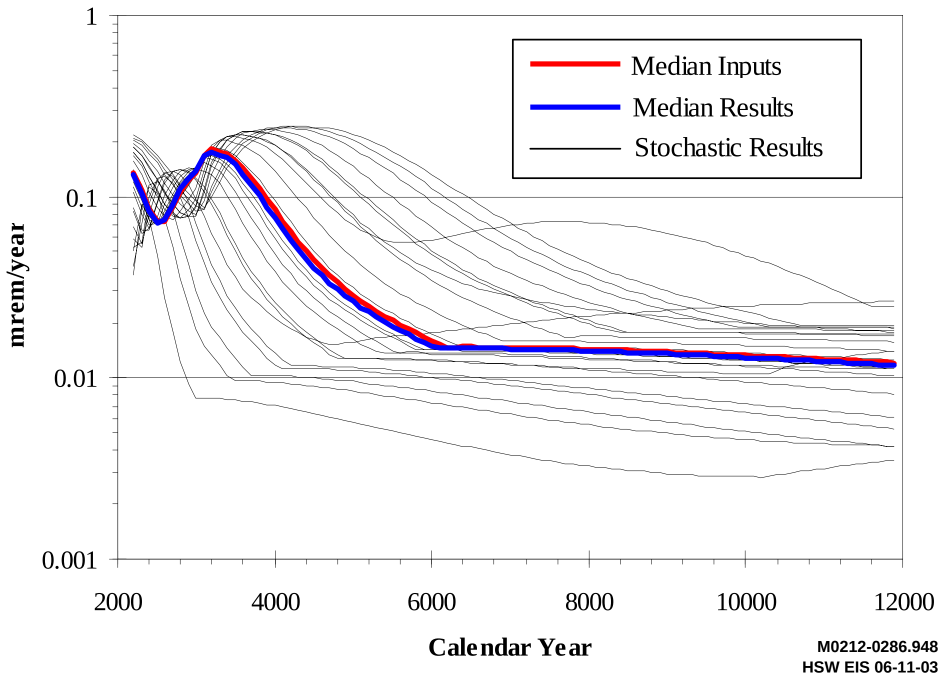

Figure L.74. Hypothetical Drinking Water Dose from Iodine-129 from All Hanford Sources Except ILAW, Melters, and Naval Reactors in Groundwater 1 km Downgradient Southeasterly of the 200 East Area

L.3.2.3 Drinking Water Dose at the Northwest Corner of the 200 East Area

The drinking water dose to a human from technetium-99 using groundwater from approximately 1 km (0.62 mi) outside the northwest corner of 200 East Area is provided in Figure L.75. The location was chosen to represent the highest doses from the local groundwater plume. The drinking water dose to a human from uranium and iodine-129 at the same location is provided in Figures L.76 and L.77. These figures exclude the impacts of ILAW. The technetium-99 results show peaks early and again throughout the 10,000-year analysis period. Figure L.75 exhibits a peak median dose from technetium-99 in the range of 0.2 to 1 mrem/yr during the 10,000-year analysis period. Figure L.76 exhibits a peak median dose from uranium of approximately 0.3 mrem/yr with a long-term median value of less than 0.01 mrem/yr. There is considerable variability in later years because of the sorption model for uranium (that is, after 10,000 years, there is range of approximately 0.001 to 1 mrem/yr, but the median is less than 0.01 mrem/yr). Figure L.77 exhibits a peak median dose from iodine-129 of less than 0.25 mrem/yr with a long-term median value of less than 0.01 mrem/yr.

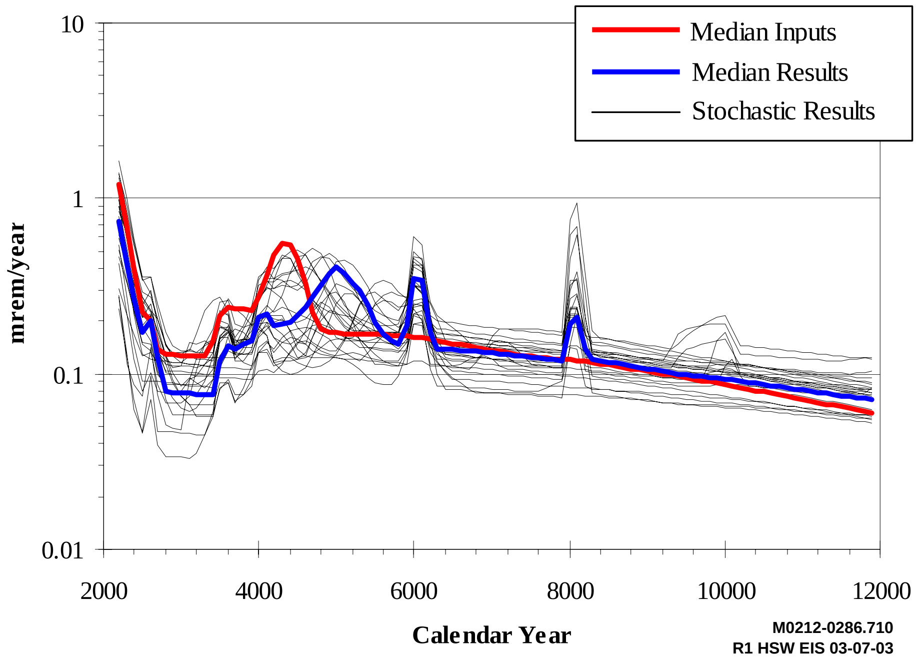

Figure L.75. Hypothetical Drinking Water Dose from Technetium-99 from All Hanford Sources Except ILAW, Melters, and Naval Reactors in Groundwater 1 km Downgradient Northwesterly of the 200 East Area

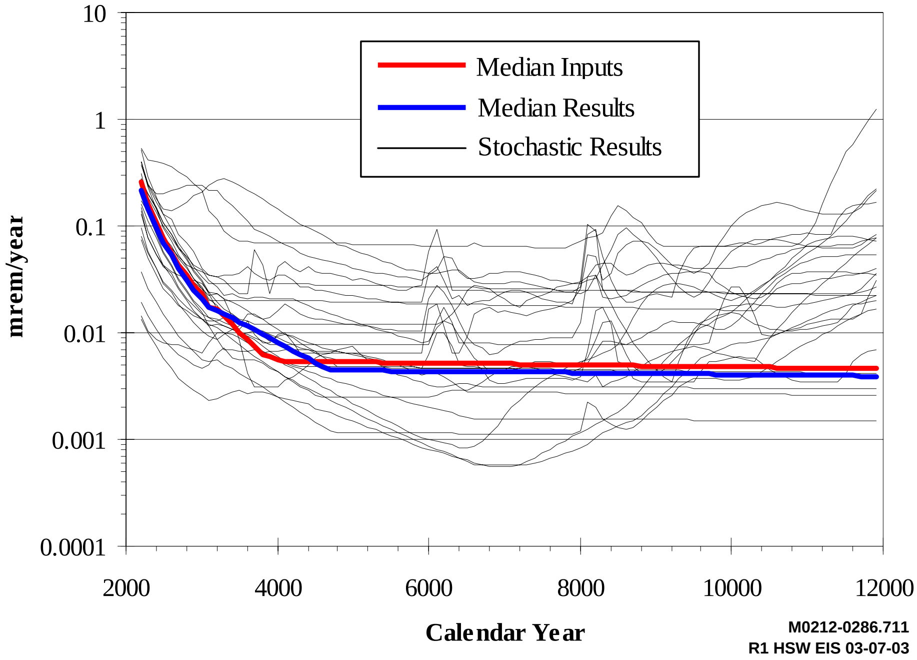

Figure L.76. Hypothetical Drinking Water Dose from Uranium from All Hanford Sources Except ILAW, Melters, and Naval Reactors in Groundwater 1 km Downgradient Northwesterly of the 200 East Area

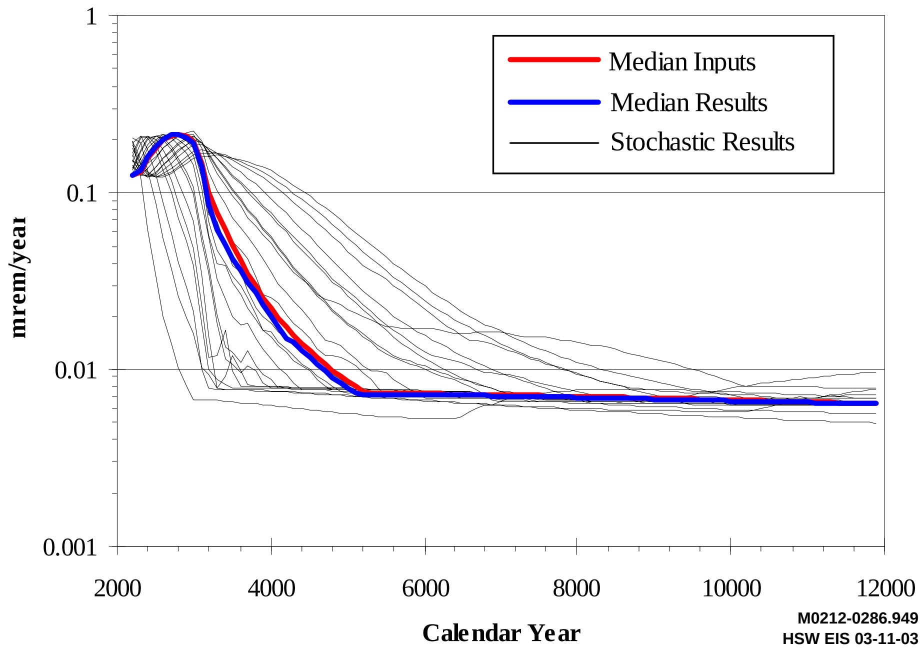

Figure L.77. Hypothetical Drinking Water Dose from Iodine-129 from All Hanford Sources Except ILAW, Melters, and Naval Reactors in Groundwater 1 km Downgradient Northwesterly of the 200 East Area

L.3.3 Dose from Columbia River Water at the City of Richland Pumping Station

Annual dose to humans based on consumption of river water is summarized in this section. The exposure scenario has an adult human drinking 2 L/day of contaminated river water from the modeled near-shore point nearest the City of Richland pumping station. The stochastic capability of SAC was employed for these simulations, so the following results are shown in each plot in this section:

- Individual **stochastic results** (25 realizations) are shown in black.

- The **median result** of the 25 realizations—that is, the realization that resulted in the median integrated cumulative dose in the year 9900 A.D.—is shown in blue. Although the groundwater simulations continued through the year 12,050 A.D., the river simulations were terminated at the year 9900 A.D. due to software design constraints.

- The **median-inputs** simulation—a separate single-realization simulation with SAC using the median value of all stochastic input variables—is shown in red.

The variability in the stochastic results is due to the inventory, release, and transport of technetium-99, iodine-129, and uranium. The human dose model uses fixed inputs in the calculations. The doses provided in this section are based on all waste at the Hanford Site, except ILAW, and do not include background concentrations in the river. Thus, the doses are due entirely to Hanford contaminants, with most of the dose due to waste forms other than solid wastes.

L.3.3.1 Drinking Water Dose at the City of Richland Pumping Station

The drinking water dose to a human from technetium-99, iodine-129, and uranium using water concentrations calculated near the City of Richland pumping station in the Columbia River never gets above 1 x 10^{-4}, or 0.0001, mrem/yr. This location is downriver from all groundwater plumes of Hanford origin. The maximum estimated annual dose from technetium-99 over all realizations shown in Figure L.78 from the year 2000 through 9900 A.D. is less than 4 x 10^{-5}, or 0.00004, mrem/yr, while the peak median dose was approximately 3.5 x 10^{-5}, or 0.000035, mrem/yr. The maximum annual dose from uranium over all realizations shown in Figure L.79 from the year 2000 through 9900 A.D. is less than 2 x 10^{-4}, or 0.0002, mrem/yr, while the peak median dose was approximately 5 x 10^{-5}, or 0.00005, mrem/yr. The maximum annual dose from iodine-129 over all realizations shown in Figure L.80 from the year 2000 through 9900 A.D. is approximately 2 x 10^{-5}, or 0.00002, mrem/yr, while the peak median dose was less than 1.5 x 10^{-5}, or 0.000015, mrem/yr.

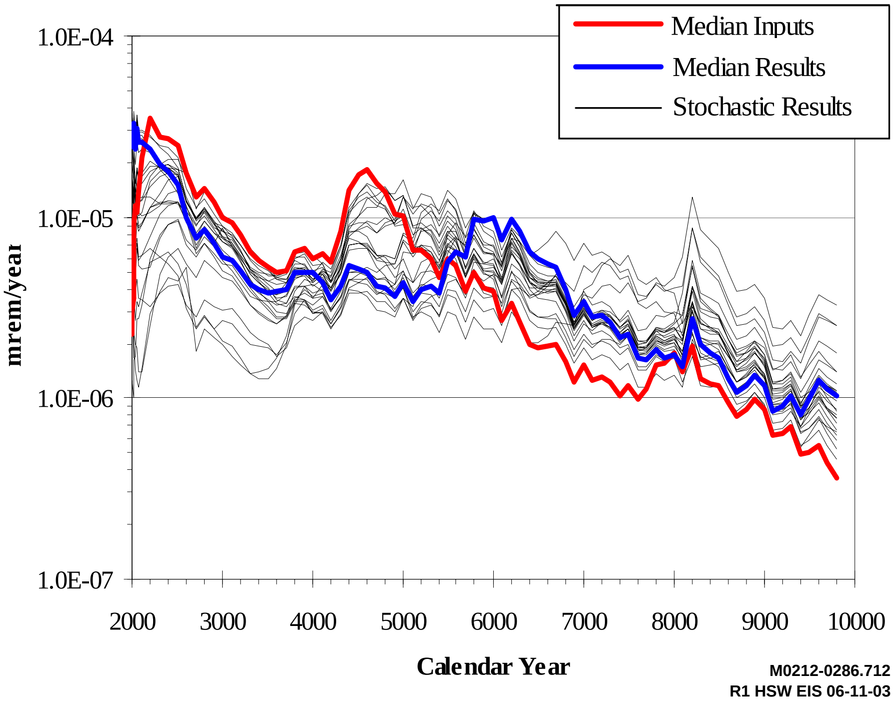

Figure L.78. Drinking Water Dose at the City of Richland Pumping Station from Technetium-99 Due to All Hanford Sources Except ILAW, Melters, and Naval Reactors

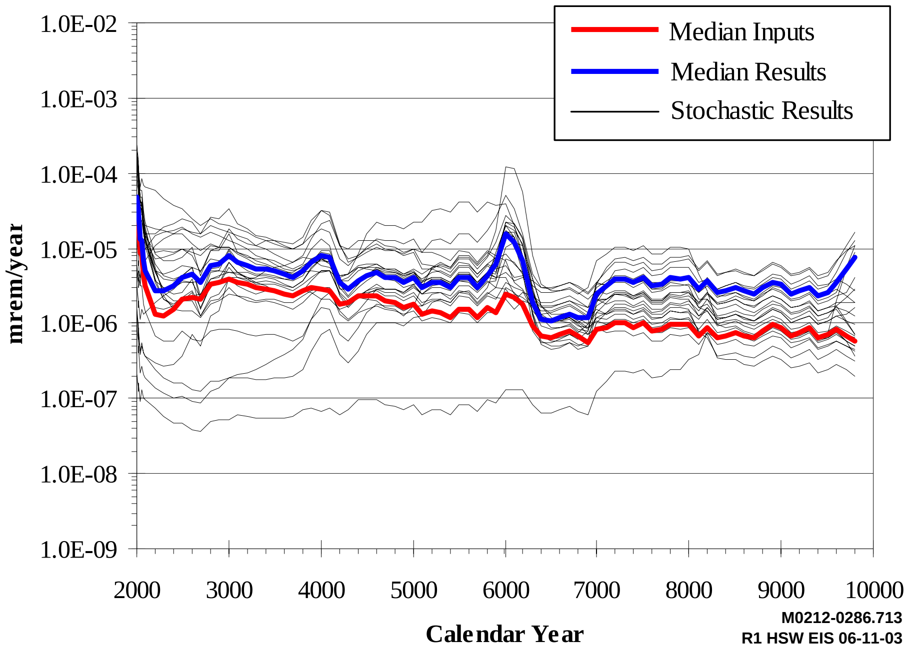

Figure L.79. Drinking Water Dose at the City of Richland Pumping Station from Uranium Due to All Hanford Sources Except ILAW, Melters, and Naval Reactors

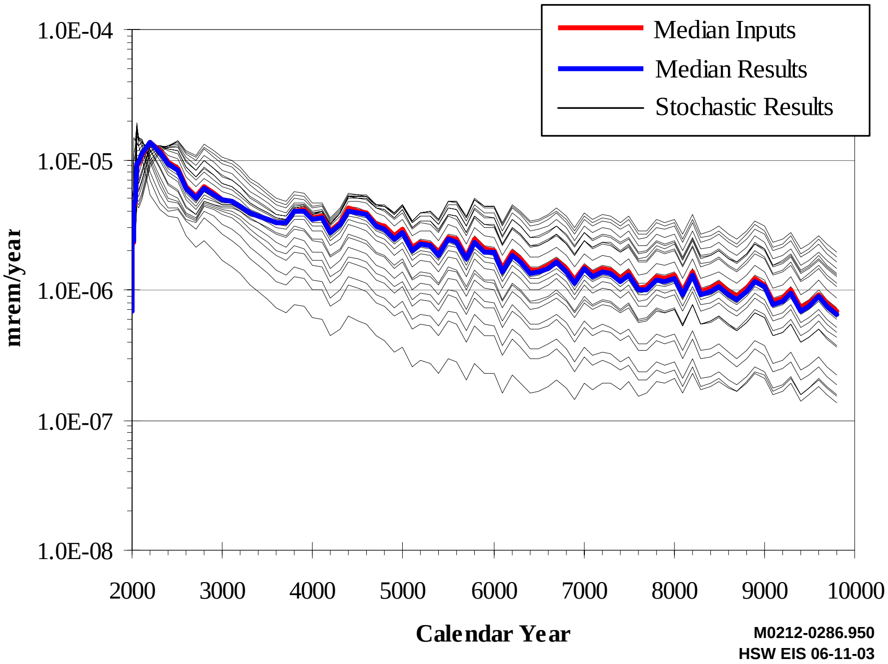

Figure L.80. Drinking Water Dose at the City of Richland Pumping Station from Iodine-129 Due to All Hanford Sources Except ILAW, Melters, and Naval Reactors

L.3.4 Annual Drinking Water Dose at Selected 200 East Area and Columbia River Locations from Hanford Sources Including ILAW

The deterministic capability of SAC was employed with results of the ILAW performance assessment (Mann et al. 2001), which were scaled to current inventory estimates, to provide an initial estimate of the cumulative impact of all Hanford sources including ILAW. These deterministic results portray the median-inputs case of the initial assessment using SAC and the base case of the ILAW performance assessment (Mann et al. 2001). Essentially, the 2-L/d dose impacts from the ILAW inventories of technetium-99, iodine-129, and uranium reported in the ILAW performance assessment (Mann et al. 2001) are superimposed on the SAC median-value simulation. A series of six plots (Figures L.81through L.86) shows combined SAC and ILAW results at a point 1 km southeast of the 200 East Area.

The cumulative impact from technetium-99 for all Hanford sources is provided in Figure L.81. This is the annual drinking water dose from a 2-L/d drinking water scenario for technetium-99 at a point of analysis approximately 1 km (0.62 mi) southeast of the 200 East Area. The curve is a composite of the SAC initial assessment result and the base case ILAW result (Mann et al. 2001). To account for the current estimate of 25,500 Ci of technetium-99 in low-activity waste from the single- and double-shell tanks, the ILAW analysis of a 5790 Ci technetium-99 source has been scaled accordingly.

The cumulative technetium-99 result shown in Figure L.81 exhibits an initial peak in the next two centuries. The peak is approximately 2 mrem/yr and is related to releases from liquid discharge sites in the 200 East Area. Additional but lower peaks of approximately 0.3 mrem/yr, appear in approximately 4400 A.D. and 7600 A.D. Releases from solid waste disposal facilities in the 200 West Area are responsible for the earlier of these two secondary peaks. Tank waste residuals releasing from the 200 East Area, modeled as 1 percent residual tank waste volume in a salt cake waste form, are responsible for the last secondary peak.

By the end of the 10,000-year post-closure period, the cumulative dose from technetium-99 for all Hanford sources is approximately 0.06 mrem/yr, of which approximately 0.02 mrem/yr is from ILAW and 0.04 mrem/yr is from all other Hanford sources. Based on uncertainty in the groundwater conceptual model, the ILAW contribution may be four times larger. Thus, the ILAW contribution may be 0.08 mrem/yr and may be comparable to or larger than that for all other Hanford sources. For this alternate conceptual model, the cumulative 2-L/d dose would be approximately 0.12 mrem/yr at 10,000 years post closure. Note that ILAW release and associated dose impacts play a role in the last several thousand years, and do not substantially alter the secondary peaks described earlier.

The cumulative impact from uranium for all Hanford sources at the line of analysis 1 km (0.6 mi) southeast of 200 East is provided in Figure L.82. The plot of SAC initial assessment and ILAW base-case results shows an early peak drinking-water dose of approximately 0.20 mrem/yr, and the dominance of ILAW uranium by the end of the 10,000-year analysis period. As in the case of technetium-99, uncertainty in the groundwater conceptual model could produce a fourfold increase in ILAW contributions, and the long-term uranium dose of approximately 0.02 mrem/yr could become 0.08 mrem/yr.

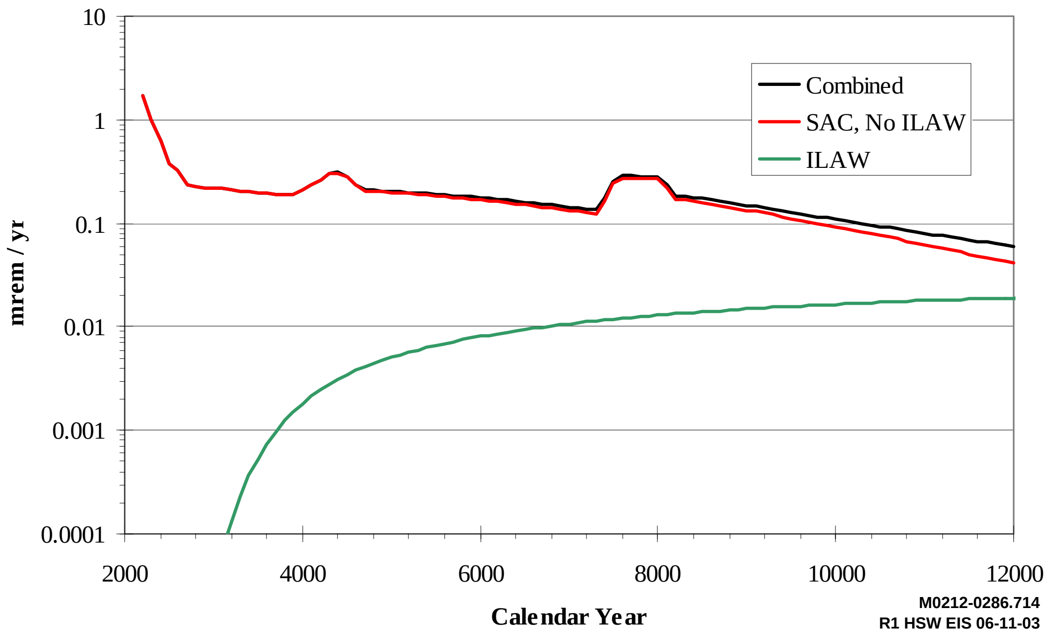

Figure L.81. Hypothetical Drinking Water Dose from Technetium-99 from Hanford Sources Including ILAW in Groundwater 1 km Downgradient Southeasterly of the 200 East Area

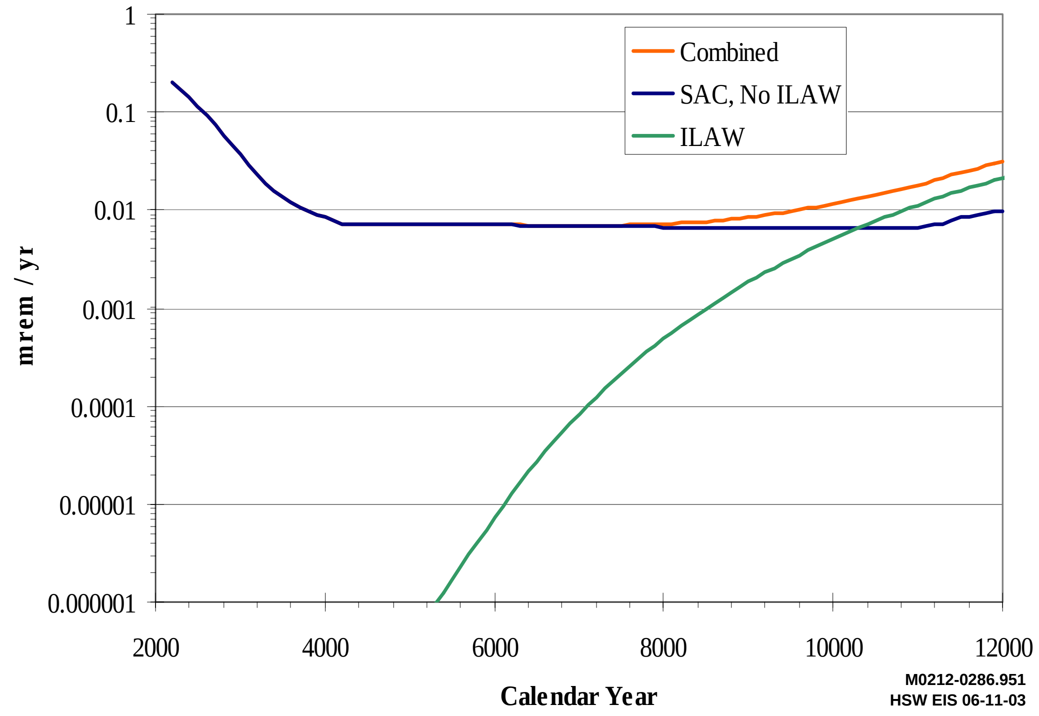

Figure L.82. Hypothetical Drinking Water Dose from Uranium from Hanford Sources Including ILAW in Groundwater 1 km Downgradient Southeasterly of the 200 East Area

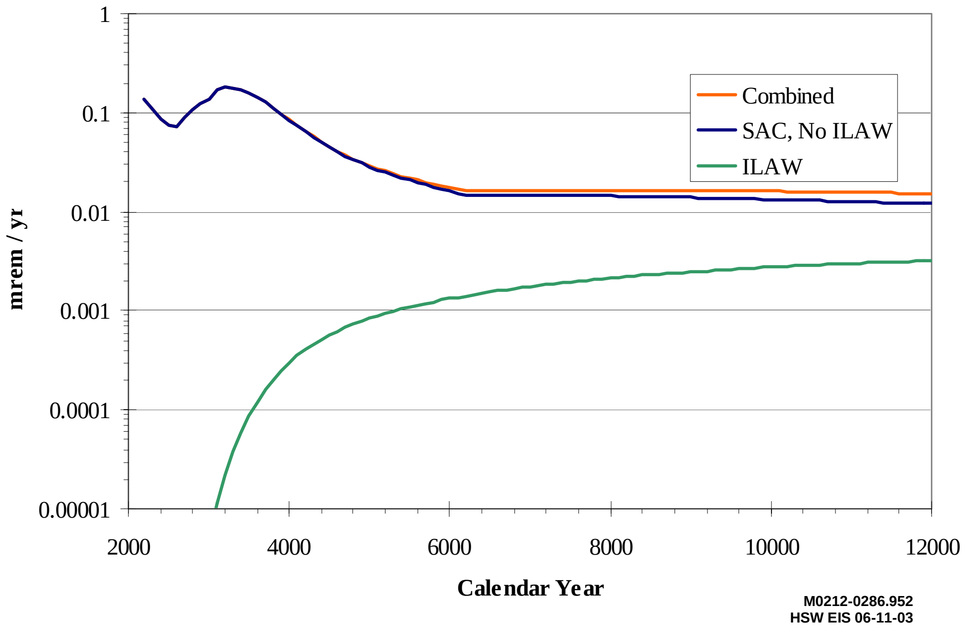

Figure L.83. Hypothetical Drinking Water Dose from Iodine-129 from Hanford Sources Including ILAW in Groundwater 1 km Downgradient Southeasterly of the 200 East Area

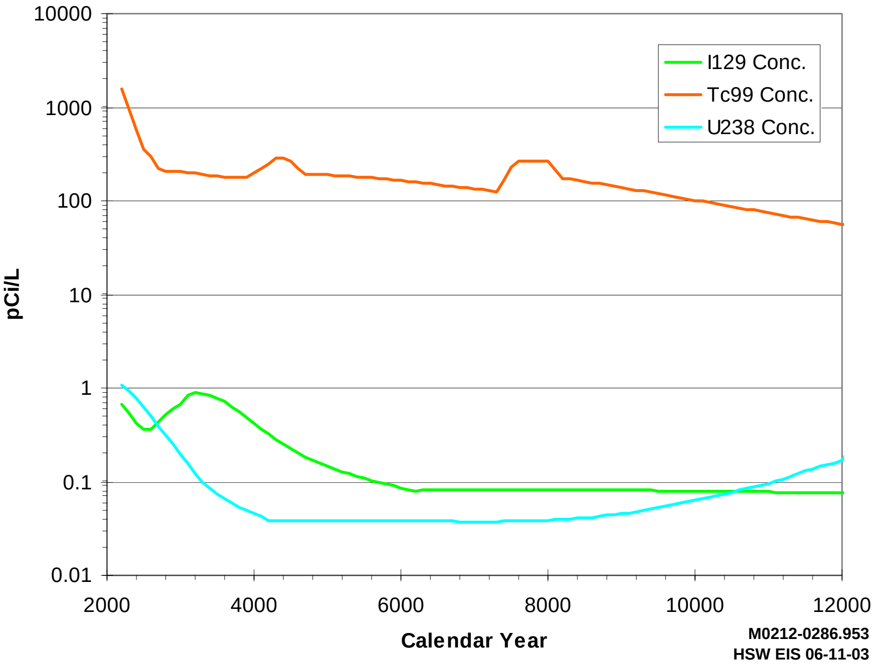

Figure L.84. Concentrations of Technetium-99, Iodine-129, and Uranium from All Hanford Sources in Groundwater 1 km Downgradient Southeasterly of 200 East Area.

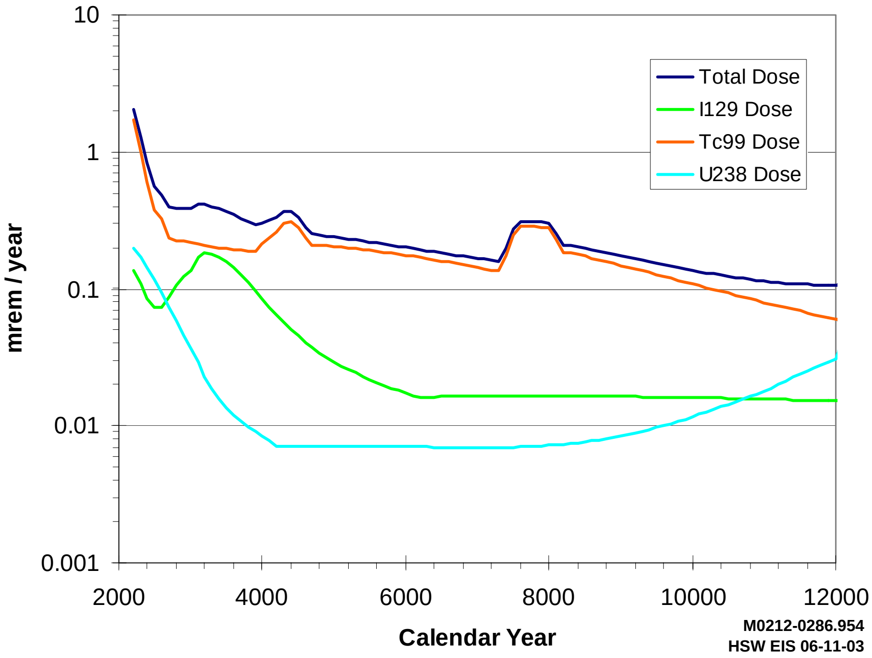

Figure L.85. Hypothetical Drinking Water Dose from Technetium-99, Iodine-129, and Uranium from All Hanford Sources in Groundwater 1 km Downgradient Southeasterly of 200 East Area.

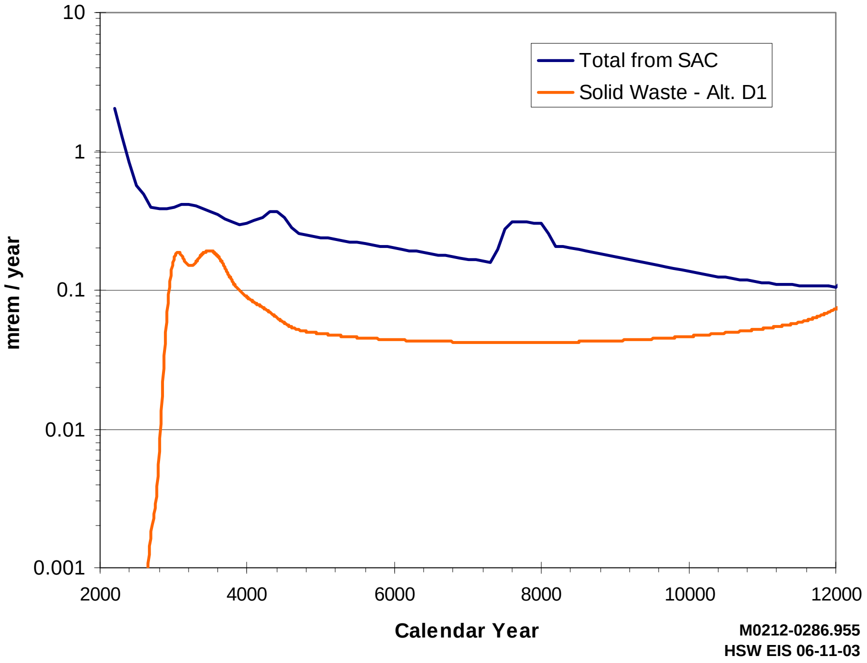

Figure L.86. Hypothetical Total Drinking Water Dose from All Hanford Sources and from Hanford Solid Waste Contributions in Groundwater 1 km Downgradient Southeasterly of 200 East Area.

The cumulative impact from iodine-129 for all Hanford sources at the line of analysis 1 km (0.6 mi) southeast of 200 East is provided in Figure L.83. The plot of SAC initial assessment and ILAW base-case results shows an early peak drinking-water dose of approximately 0.2 mrem/yr, and the increasing but not dominant influence of ILAW iodine-129 later (that is a peak contribution of approximately 0.003 mrem/yr). Groundwater conceptual model uncertainty could yield ILAW contributions four times larger or near 0.01 mrem/yr, hence comparable to the dose associated with other waste releases for iodine-129.

These results for technetium-99, iodine-129, and uranium are an approximation achieved by superimposing the results of two independently conducted analyses. The results indicate that the contribution from ILAW, which represents a substantial fraction of the inventory at Hanford, does not dominate the overall dose prediction made in the initial assessment for all wastes other than ILAW at a line of analysis approximately 1 km (0.6 mi) downgradient from the ILAW disposal facility. Of the three radionuclides, it appears that uranium released from ILAW may dominate uranium released from all other sites; however, the dose from technetium-99 appears to dominate the ILAW and cumulative dose curves discussed below.

Concentration profiles over time for technetium-99, iodine-129, and uranium from all Hanford sources at a line of analysis approximately 1 km (0.6 mi) downgradient southeasterly of the 200 East Area are shown in Figure L.84. Maximum concentrations for each of the radionuclides occur in the near term. Concentrations of technetium-99, iodine-129, and uranium are respectively 1600, 1.1 and, 0.90 pCi/L. The technetium-99 and iodine-129 concentrations are at or above the benchmark drinking water standards of 900 pCi/L and 1 pCi/L, respectively. The uranium concentration, approximately 3.3 μg/L, is below its benchmark drinking water standard of 30 μg/L. The cumulative impact for technetium-99, iodine-129, and uranium from all Hanford sources is provided in Figure L.85. This is the annual dose resulting from a 2 L/d drinking water scenario for each of the radionuclides. The values of maximum dose for technetium-99, iodine-129, and uranium corresponding to the maximum concentrations are 1.7, 0.18, and 0.20 mrem/yr, respectively.

The annual cumulative dose from technetium-99, iodine-129, and uranium exhibits a peak of approximately 2 mrem/yr within the next two centuries. This peak appears to be related to releases from past liquid discharge sites in the 200 East Area. Additional, but lower, peaks of approximately 0.4 mrem/yr appear in approximately years 4400 and 7600. Based on the visualization of groundwater contaminant transport in the unconfined aquifer over 10,000 years, it appears that releases of technetium-99 from Hanford solid waste disposal facilities in the 200 West Area are responsible for the peak in approximately year 4400. Tank waste residuals releasing technetium-99 in the 200 East Area from a 1-percent residual volume and a salt cake waste are responsible for the last peak. The underlying long-term dose declines to 0.1 mrem/yr by 10,000 years post closure. This dose is related to long-term releases from Hanford solid waste and other miscellaneous waste, which, when combined, account for approximately 0.07 mrem/yr, and from ILAW, which accounts for approximately 0.04 mrem/yr.

Based on uncertainty in the groundwater conceptual model, the ILAW contribution to the cumulative result may be approximately four times larger. The resulting cumulative 2 L/d drinking water dose from ILAW for technetium-99, iodine-129, and uranium would be approximately 0.2 mrem/yr at 10,000 years post closure. Somewhat higher contributions than shown here from Hanford solid waste and other sources, (that is, 0.07 mrem/yr) may also occur because of uncertainty in the groundwater conceptual model used in the SAC; however, groundwater-model uncertainty as it relates to the Hanford solid waste contributions is addressed in Section 5.3 (of Volume I of this EIS) and Appendix G. Note that the ILAW release and associated dose impacts play a role in the last several thousand years only and do not substantially influence the peaks that occur earlier.

The cumulative dose from all Hanford sources and the portion attributed to solid waste at the line of analysis 1 km downgradient southeasterly of the 200 East Area are shown in Figure L.86. Differences in the two curves (that is, the slope of the curves) are attributed to somewhat different distribution coefficient values used in the simulation of solid waste disposal alternatives and in the cumulative assessment. The more rapid release and migration of uranium in the evaluation of solid waste disposal alternatives enables uranium to influence the long-term solid waste contribution between 8000 and 12,000 A.D. This uranium influence is not seen in the initial assessment simulated with SAC because of the use of somewhat higher distribution coefficients to represent median or central tendency behavior.

Distribution Coefficients, K_ds, of the Linear Sorption Isotherm Model

The System Assessment Capability (SAC) is designed to simulate a stochastic analysis where parameter distributions are centered around median or best estimate parameter values. For the distribution coefficient K_d, values were drawn from a recent summary of K_d data by Cantrell et al. (2002) and patterned after the K_d model in the 1998 composite analysis (Kincaid et al. 1998). The deterministic case posed and analyzed is based on median values for all stochastic data.

The HSW EIS is designed to execute a series of deterministic analyses where scenarios of waste disposal are varied but model parameters are fixed so as to produce conservative simulations, that is, fixed at lower K_d values to create more rapid and higher concentration contaminant transport. Accordingly, the conservative representation of the HSW EIS produces more rapid migration movement and higher concentrations than the median value representation of the SAC.

Another series of six plots (Figures L.87 through L.92) shows combined results for use of water from the Columbia River at the City of Richland pumping station located downstream of the Hanford Site. This location is downriver from all groundwater plumes of Hanford origin, and reveals the substantial dilution and dispersion that occurs because of the relatively substantial discharge of the Columbia River as compared to that of the unconfined aquifer underlying Hanford. Although groundwater simulations continued through the year 12,050 A.D. (that is, 10,000 years post closure), the river simulations were terminated at 9900 A.D. (that is 8000 years post closure) due to design constraints in the software used for the river model. Thus, river model forecasts are not available for the final 2000 years of the 10,000-year post-closure period. However, as is apparent from the simulation results achieved, trends seen in the

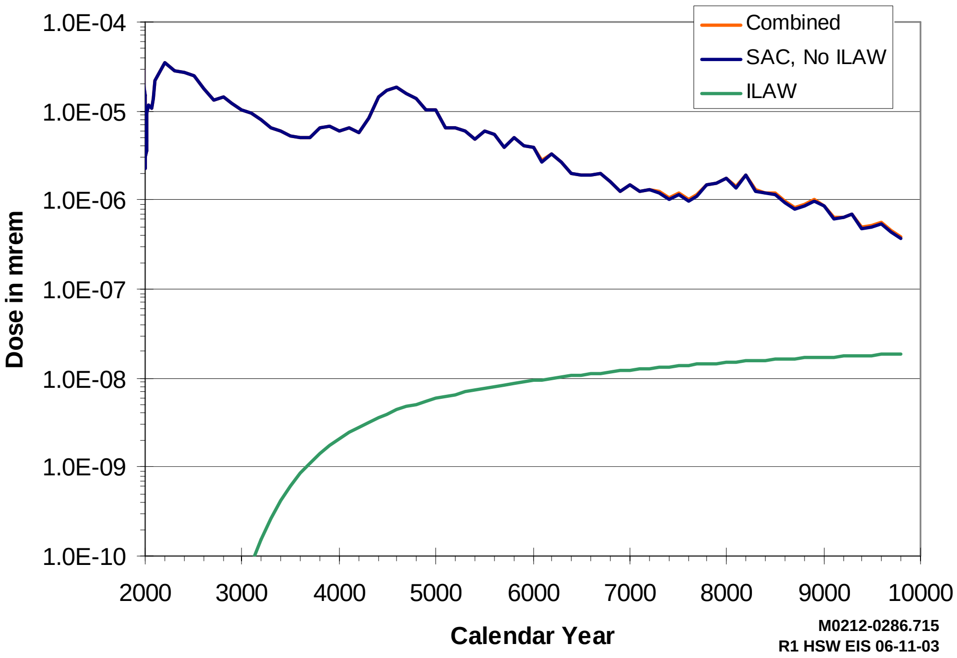

Figure L.87. Annual Drinking Water Dose from Technetium-99 in the Columbia River at the City of Richland Pumping Station from Hanford Sources Including ILAW

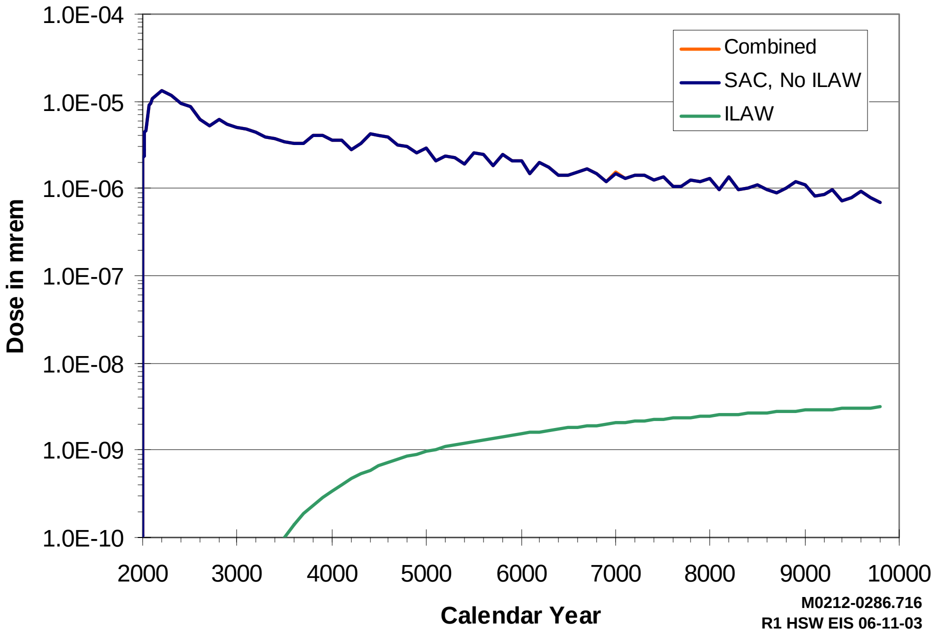

Figure L.88. Annual Drinking Water Dose from Iodine-129 in the Columbia River at the City of Richland Pumping Station from Hanford Sources Including ILAW

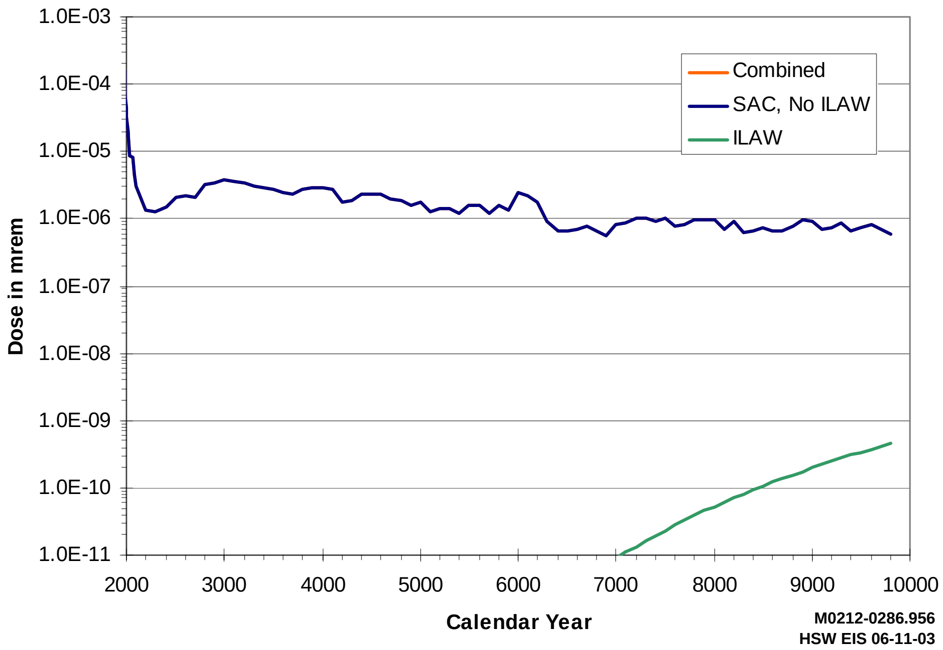

Figure L.89. Annual Drinking Water Dose from Uranium in the Columbia River at the City of Richland Pumping Station from Hanford Sources Including ILAW

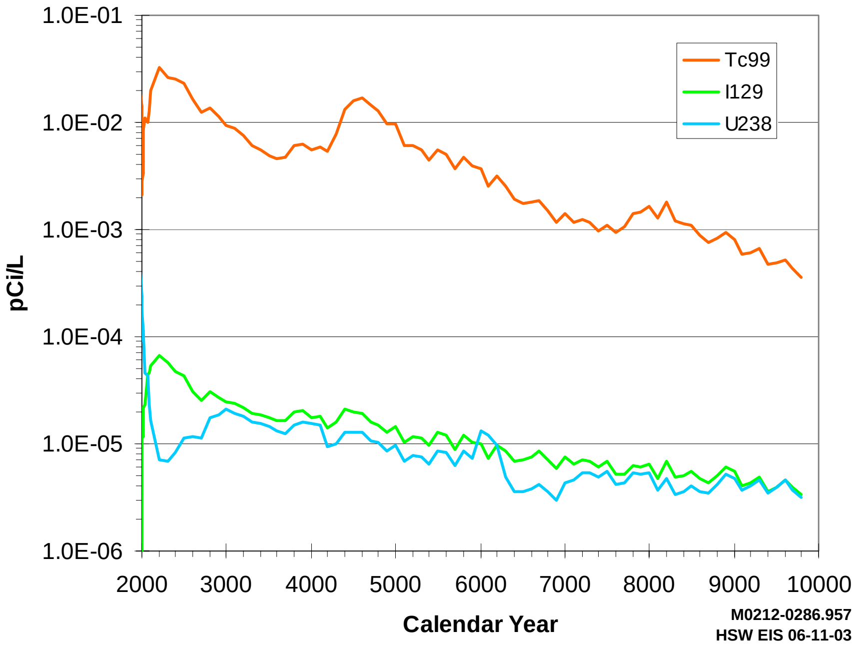

Figure L.90. Concentration of Technetium-99, Iodine-129, and Uranium in the Columbia River at the City of Richland Pumping Station

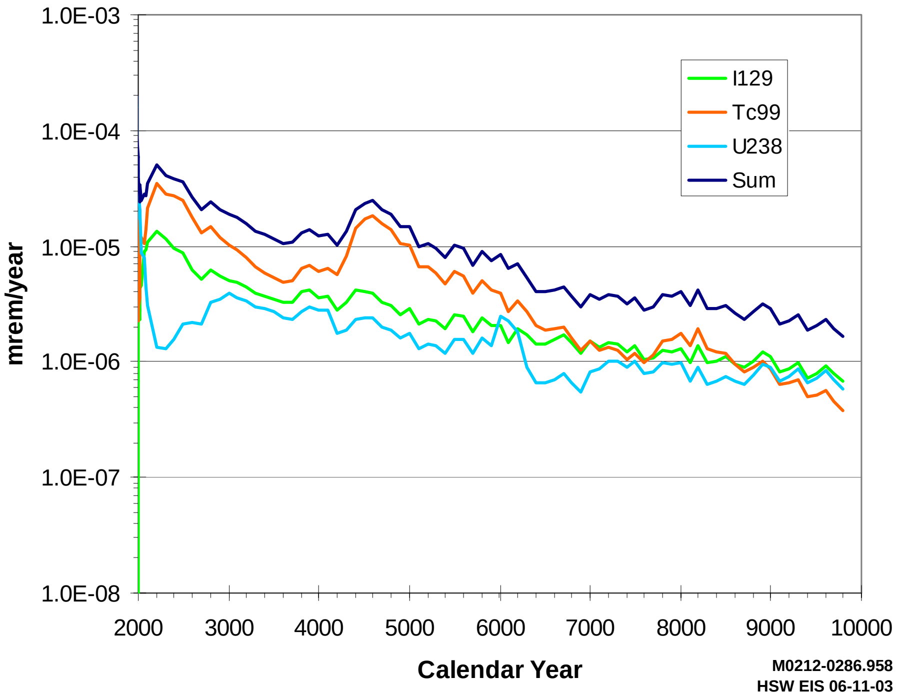

Figure L.91. Drinking Water Dose from Technetium-99, Iodine-129, and Uranium in the Columbia River at the City of Richland Pumping Station

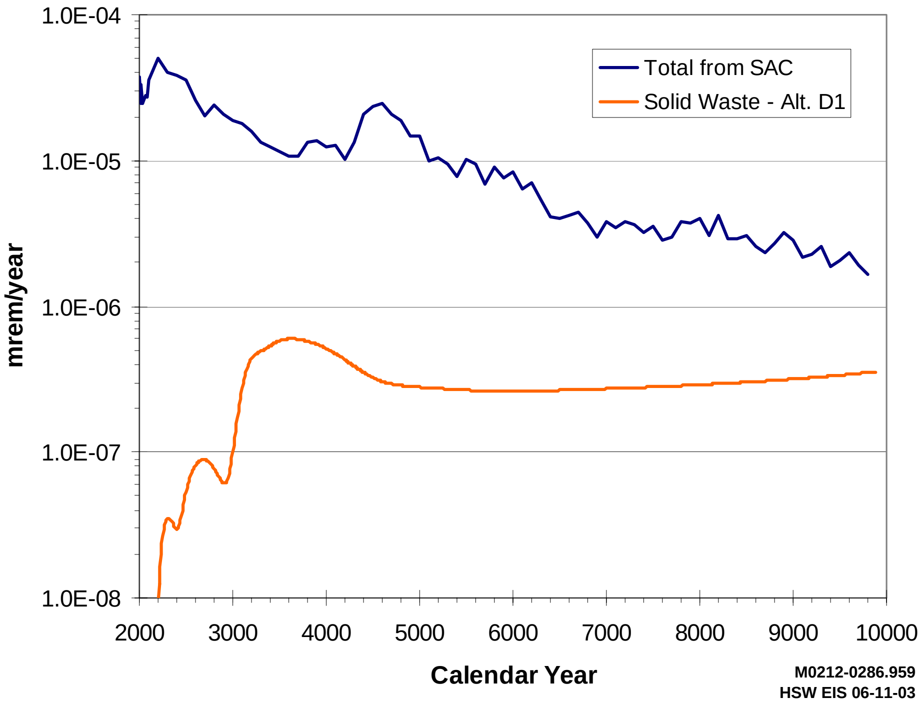

Figure L.92. Total Drinking Water Dose from All Hanford Sources and the Hanford Solid Waste Contribution in the Columbia River at the City of Richland Pumping Station.

groundwater system near the Central Plateau appear somewhat later and at much reduced concentrations in the Columbia River at the City of Richland location. Results of the dose analyses are presented as annual radiation dose.(a)

A comparison of consequences from consuming 2 L/day of river water with and without the ILAW release of technetium-99, iodine-129, and uranium are provided in Figures L.87, L.88, and L.89 for the Columbia River at the City of Richland pumping station. Results from the SAC median-input case of the initial assessment and from the ILAW performance assessment base case are shown on each figure.

Figure L.87 shows that dose originating from the ILAW containing 25,500 Ci of technetium-99 is well below the technetium-99 dose originating from all other Hanford wastes, and the cumulative dose is less than 1.0×10^{-4} mrem/yr. The cumulative dose from technetium-99 is less than 1.0×10^{-6} mrem/yr at 8000 years post closure, and this result is five orders-of-magnitude below the dose predicted at the 200 East Area location.

The comparison graphic of consequences from uranium is provided in Figure L.89. The peak value of uranium consequence occurs in the near term and is less than 1.0×10^{-4} mrem/yr. After 8000 years post closure and at the time of greatest ILAW uranium impact, the dose from uranium is estimated to be approximately three orders-of-magnitude below that of all other Hanford sources. Combined, the estimated dose from uranium is less than 1.0×10^{-6} mrem/yr after approximately 4000 years. The consequences from iodine-129 releases are shown in Figure L.88. The peak dose from iodine-129 also occurs in the near term and is less than 2.0×10^{-5} mrem/yr. After 8000 years post closure and at the time of greatest ILAW iodine-129 impact, the dose from ILAW iodine-129 is estimated to be more than two orders-of-magnitude below that of all other Hanford sources. Combined, the estimated dose from iodine-129 at that time is approximately 1.0×10^{-6} mrem/yr.

These results for technetium-99, iodine-129, and uranium are an approximation achieved by superimposing the results of two independently conducted analyses. Nevertheless, the results indicate that the contribution from ILAW does not substantially influence the overall dose prediction made in the initial assessment for all wastes other than ILAW at the City of Richland.

Figure L.90 shows the concentrations of technetium-99, iodine-129, and uranium from all Hanford sources from Columbia River water at the City of Richland pumping station for the median inputs case. A corresponding plot of the drinking water dose for technetium-99, iodine-129, and uranium is provided in Figure L.91. While having a much more variable appearance caused by river discharge variability, the peaks seen in technetium-99 plots at the 200 East Area location are also present in Figure L.91. Dose from Hanford-origin uranium and iodine-129 also exhibit a temporal variability caused by variability in Columbia River discharge. However, the peaks are subdued and delayed because these elements are

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(a) The National Council on Radiation Protection and Measurements continues to hold that a dose of 1 mrem/yr is a dose “below which efforts to reduce the radiation exposure to the individual are unwarranted (Section 17 of NCRP, 1993)” (NCRP 2002). Regardless, in this EIS doses are reported as calculated, however small they may be. Thus doses will be seen that are several to many orders of magnitude below 1 mrem/yr and, while these may be useful for comparative purposes, they should not be construed as having any physical meaning in terms of detriment to health.

sorbed, and consequently, they migrate more slowly than groundwater and non-sorbed elements such as technetium. Concentration and annual dose values are approximately five orders-of-magnitude lower at the City of Richland compared to those predicted at the 200 East Area. Figure L.91 shows that the maximum doses for the median inputs case representation of technetium-99, iodine-129, and uranium are less than or equal to 3.5×10^{-5}, 1.5×10^{-5}, and 5×10^{-5} mrem/yr, respectively.

These peaks occur at different times based on the sorption of each radionuclide. The drinking water dose from Columbia River water at the City of Richland pumping station never exceeds 1×10^{-4} mrem/yr in the median-inputs analysis.

Figure L.92 shows the cumulative dose from all Hanford sources and the portion attributed to Hanford solid waste at the City of Richland pumping station. By the end of this analysis (8000 years post closure), the contribution from solid waste is increasing slightly while the cumulative dose from all sources is decreasing, and the overall dose from the three radionuclides is estimated to be less than 1×10^{-5} mrem/yr for the median-inputs case.

L.4 References

40 CFR 141. "National Primary Drinking Water Regulations." Code of Federal Regulations. Online at: http://www.access.gpo.gov/nara/cfr/waisidx_01/40cfr141_01.html

42 USC 6901 et seq. Resource Conservation and Recovery Act (RCRA) of 1976. Online at: http://www4.law.cornell.edu

42 USC 9601 et seq. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. Online at: http://www4.law.cornell.edu

Bergeron, M. P., E. J. Freeman, S. K. Wurstner, C. T. Kincaid, F. M. Cooney, D. L. Strenge, R. L Aaberg, and P. W. Eslinger. 2001. *Addendum to Composite Analysis for Low-Level Disposal in the 200 Area Plateau of the Hanford Site*. PNNL-11800-Addendum 1, Pacific Northwest National Laboratory, Richland, Washington. Online at: http://www.pnl.gov/main/publications/external/technical_reports/pnnl-11800-adden-1.pdf

Blanton, M. L., W. W. Gardiner, and R. L. Dirkes. 1995. *Environmental Monitoring of the Columbia River Sediments: Grain-Size Distribution and Contaminant Association.* PNL-10535, Pacific Northwest Laboratory, Richland, Washington.

Bryce, R. W., C. T. Kincaid, P. W. Eslinger, and L. F. Morasch (eds.). 2002. *An Initial Assessment of Hanford Impact Performed with the System Assessment Capability*. PNNL-14027, Pacific Northwest National Laboratory, Richland, Washington. Online at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-14027/PNNL-14027.pdf

Cantrell, K. J., R. J. Serne, and G. V. Last. 2002. *Hanford Contaminant Distribution Coefficient Database and Users Guide*. PNNL-13895, Pacific Northwest National Laboratory, Richland, Washington. Online at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13895.pdf

Cole, C. R., S. K. Wurstner, M. P. Bergeron, M. D. Williams, and P. D. Thorne. 1997. *Three-Dimensional Analysis of Future Groundwater Flow Conditions and Contaminant Plume Transport in the Hanford Site Unconfined Aquifer System: FY 1996 and 1997 Status Report*. PNNL-11801, Pacific Northwest National Laboratory, Richland, Washington.

Cole, C. R., M. P. Bergeron, S. K. Wurstner, P. D. Thorne, S. Orr, and M. McKinley. 2001a. *Transient Inverse Calibration of Hanford Site-Wide Groundwater Model to Hanford Operational Impact–1943-1996*. PNNL-13447, Pacific Northwest National Laboratory, Richland, Washington. Online at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13447.pdf

Cole, C. R., M. P. Bergeron, C. J. Murray, P. D. Thorne, S. K. Wurstner, and P. M. Rogers. 2001b. *Uncertainty Analysis Framework - Hanford Site-Wide Groundwater Flow and Transport Model*. PNNL-13641, Pacific Northwest National Laboratory, Richland, Washington. Online at: http://www.pnl.gov/main/publications/external/technical_reports/pnnl-13641.pdf

Cooney, F. M. 2002. *Groundwater/Vadose Zone Integration Project Methods Used to Assemble Site-Specific Waste Site Inventories for the Initial Assessment*. BHI-01570, Rev 0, Bechtel Hanford, Inc., Richland, Washington.

DOE. 2001. *Radioactive Waste Management Manual*. DOE Manual 435.1-1, U.S. Department of Energy, Washington, D.C. Online at: http://www.directives.doe.gov.

DOE-RL. 1996. *Focused Feasibility Study of Engineered Barriers for Waste Management Units in the 200 Areas*. DOE/RL-93-33, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Online at: http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D197226618

DOE-RL. 1998. *Screening Assessment and Requirements for a Comprehensive Assessment: Columbia River Comprehensive Impact Assessment*. DOE/RL-96-16, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL. 1999. *Groundwater/Vadose Zone Integration Project Background Information and State of Knowledge*. DOE/RL-98-48, Vol. II, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Eckerman, K. F., A. B. Wolbarst, and A. C. B. Richardson. 1988. *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion. Federal Guidance Report No. 11*. EPA-520/1-88-020, U.S. Environmental Protection Agency, Washington, D.C.

Eckerman, K. F. and J. C. Ryman. 1993. *External Exposure to Radionuclides in Air, Water, and Soil, Federal Guidance Report No. 12*. EPA 402-R-93-081, U.S. Environmental Protection Agency, Washington, D.C.

Ecology, EPA, and DOE. 1989. *Hanford Federal Facility Agreement and Consent Order*. 89-10 (As Amended). Washington State Department of Ecology, U.S. Environmental Protection Agency, U.S. Department of Energy, Richland, Washington. Online at: http://www.hanford.gov/tpa/tpahome.htm

Eslinger, P. W., D. W. Engel, L. H. Gerhardstein, C. A. LoPresti, W. E. Nichols, and D. L. Strenge. 2002a. *User Instructions for the Systems Assessment Capability, Rev. 0, Computer Codes; Volume 1: Inventory, Release, and Transport Modules*. PNNL-13932-Volume 1, Pacific Northwest National Laboratory, Richland, Washington. Online at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13932-v.1.pdf

Eslinger, P. W., C. Arimescu, B. A. Kanyid, and T. B. Miley. 2002b. *User Instructions for the Systems Assessment Capability, Rev. 0, Computer Codes. Volume 2: Impact Modules*. PNNL-13932, Volume 2, Pacific Northwest National Laboratory, Richland, Washington. Online at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13932-v.2.pdf

Farris, W. T., B. A. Napier, P. W. Eslinger, T. A. Ikenberry, D. B. Shipler, and J. C. Simpson. 1994. *Atmospheric Pathway Dosimetry Report, 1944-1992*. PNWD-2228 HEDR, Battelle–Pacific Northwest National Division, Richland, Washington.

Fayer, M. J. and T. B. Walters. 1995. *Estimated Recharge Rates at the Hanford Site*. PNL-10285, Pacific Northwest National Laboratory, Richland, Washington.

Fayer, M. J., E. M. Murphy, J. L. Downs, F. O. Kahn, C. W. Lindenmeier, and B. N. Bjornstad. 1999. *Recharge Data Package for the Immobilized Low-Activity Waste 2001 Performance Assessment*. PNNL-13033, Pacific Northwest National Laboratory, Richland, Washington.

Fecht, K. R., G. V. Last, and K. R. Price. 1977a. *Evaluation of Scintillation Probe Profiles from 200 Area Cribs Monitoring Wells*. ARH-ST-156, Vol. II, Atlantic Richfield Hanford Company, Richland, Washington.

Fecht, K. R., G. V. Last, and K. R. Price. 1977b. *Evaluation of Scintillation Probe Profiles from 200 Area Cribs Monitoring Wells*. ARH-ST-156, Vol. III, Atlantic Richfield Hanford Company, Richland, Washington.

Gupta S. K., C. R. Cole, C. T. Kincaid, and A. M. Monti. 1987. *Coupled Fluid, Energy, and Solute Transport (CFEST) Model: Formulation and User's Manual*. BMI/ONWI-660, Battelle Memorial Institute, Columbus, Ohio.

Hajek, B. F. 1966. *Soil Survey: Hanford Project in Benton County, Washington*. BNWL-243, Pacific Northwest Laboratory, Richland, Washington.

Ho, C. K, R. G. Baca, S. H. Conrad, G. A. Smith, L. Shyr, and T. A. Wheeler. 1999. *Stochastic Parameter Development for PORFLOW Simulations of the Hanford AX Tank Farm*. SAND98-2880, Sandia National Laboratories, Albuquerque, New Mexico. Online at: http://infoserve.sandia.gov/sand_doc/1998/982880.pdf

Khaleel, R. 1999. *Far-Field Hydrology Data Package for Immobilized Low-Activity Tank Waste Performance Assessment*. HNF-4769, Fluor Daniel Northwest, Inc., Richland, Washington.

Khaleel, R. and E. J. Freeman. 1995. *Variability and Scaling of Hydraulic Properties for 200 Area Soils, Hanford Site*. WHC-EP-0883, Westinghouse Hanford Company, Richland, Washington.

Khaleel, R., T. E. Jones, A. J. Knepp, F. M. Mann, D. A. Myers, P. M. Rogers, R. J. Serne, and M. I Wood. 2000. *Modeling Data Package for S-SX Field Investigation Report (FIR).* RPP-6296, Rev. 0, CH2M Hill Hanford Group, Inc., Richland, Washington.

Kincaid, C. T., M. P. Bergeron, C. R. Cole, M. D. Freshley, N. L. Hassig, V. G. Johnson, D. I. Kaplan, R. J. Serne, G. P. Streile, D. L. Strenge, P. D. Thorne, L. W. Vail, G. A. Whyatt, and S. K. Wurstner. 1998. *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site.* PNNL-11800, Pacific Northwest National Laboratory, Richland, Washington.

Kincaid, C. T., P. W. Eslinger, W. E. Nichols, A. L. Bunn, R. W. Bryce, T. B. Miley, M. C. Richmond, S. F. Snyder, and R. L. Aaberg. 2000. *Groundwater/Vadoes Zone Integration Project System Assessment Capability (Revision 0) Assessment Description, Requirements, Software Design, and Test Plan.* BHI-01365, Draft A, Bechtel Hanford, Inc., Richland, Washington.

Kipp, K. L. and R. D. Mudd. 1974. *Selected Water Table Contour Maps and Well Hydrographs for the Hanford Reservation, 1944-1973.* BNWL-B-360, Pacific Northwest Laboratories, Richland, Washington.

Kirkbride, R. R., G. K. Allen, B. A, Higley, T. M. Hohl, S. L. Lambert, R. M. Orme, D. E. Place, J. A. Seidl, R. S. Wittman, J. H. Baldwin, J. N. Strode, J. A. Reddick, and L. M. Swanson. 2002. *Tank Farm Contractor Operation and Utilization Plan, Volume I.* HNF-SD-WM-SP-012, Rev. 4, Numatec Hanford Corp., CH2M HILL Hanford Group, Inc., DMJMH&N, Richland, Washington.

Mann, F. M., K. C. Burgard, W. R. Root, R. J. Puigh, S. H. Finfrock, R. Khaleel, D. H. Bacon, E. J. Freeman, B. P. McGrail, S. K. Wurstner, and P. E. LaMont. 2001. *Hanford Immobilized Low-Activity Waste Performance Assessment: 2001 Version.* DOE/ORP-2000-24, Rev. 0, U.S. Department of Energy, Office of River Protection, Richland, Washington.

Mattigod, S. V., G. A. Whyatt, R. J. Serne, P. F. Martin, K. E. Schwab, and M. I. Wood. 2000. *Diffusion and Leaching of Selected Radionuclides (I-129, Tc-99, and U) through Category 3 Waste Encasement Cement Concrete and Soil Fill Material: Progress Report for 2001*. PNNL-13639, Pacific Northwest National Laboratory, Richland, Washington.

Murphy E. M., T. R. Ginn, and J. L. Phillips. 1996. "Geochemical Estimates of Paleorecharge in the Pasco Basin: Evaluation of the Chloride Mass-balance Technique." *Water Resources Research* 32(9): 2853-2868.

NCRP. 2002. *Managing Potentially Radioactive Scrap Metal: Recommendations of the National Council on Radiation Protection and Measurements*. NCRP Report No. 141, National Council on Radiation Protection and Measurements, Bethesda, Maryland.

Poston, T. M., R. W. Hanf, R. L. Dirkes, and L. F. Morasch. 2002. *Hanford Site Environmental Report for Calendar Year 2001*. PNNL-13910, Pacific Northwest National Laboratory, Richland, Washington. Online at http://hanford-site.pnl.gov/envreport/2001/index.htm

Prych E. A. 1998. *Using Chloride and Chlorine-36 as Soil-Water Tracers to Estimate Deep Percolation at Selected Locations on the U.S. Department of Energy Hanford Site, Washington*. W 2481, U.S. Geological Survey, Reston, Virginia.

Richmond, M. C., W. A. Perkins, and Y. Chien. 2000. *Numerical Model Analysis of System-wide Dissolved Gas Abatement Alternatives, Final Report*. PNWD-3245, Prepared by Battelle Pacific Northwest Division for the U.S. Army Corps of Engineers, Walla Walla District, Walla Walla, Washington.

Schroeder, P. R. 1997. *Hydrologic Evaluation of Landfill Performance (HELP) Model, Version 3.07.* Developed by the Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS for the U.S. Environmental Protection Agency Risk Reduction Engineering Laboratory, Cincinnati, OH. Online at: http://www.wes.army.mil/el/elmodels

Serne, R. J., R. O. Lokken, and L. J. Criscenti. 1992. "Characterization of Grouted Low-Level Waste to Support Performance Assessment." *Waste Management* 12: 271-287.

Simpson, B. C., R. A. Corbin, and S. F. Agnew. 2001. *Groundwater/Vadose Zone Integration Project: Hanford Soil Inventory Model.* BHI-01496, Rev 0. Bechtel Hanford Inc., Richland, Washington.

Thorne, P. D. and M. A. Chamness. 1992. *Status Report on the Development of a Three-Dimensional Conceptual Model for the Hanford Site Unconfined Aquifer System*. PNL-8332, Pacific Northwest Laboratory, Richland, Washington.

Thorne, P. D., M. A. Chamness. F. A. Spane Jr., V. R. Vermeul, and W. D. Webber. 1993. *Three-Dimensional Conceptual Model of the Hanford Site Unconfined Aquifer System, FY 1993 Status Report.* PNL-8971, Pacific Northwest Laboratory, Richland, Washington.

Thorne, P. D., M. A. Chamness. V. R. Vermeul, Q. C. MacDonald, and S. E. Schubert. 1994. *Three-Dimensional Conceptual Model for the Hanford Site Unconfined Aquifer System, FY 1994 Status Report.* PNL-10195, Pacific Northwest Laboratory, Richland, Washington.

Thorne, P. D. and D. R. Newcomer. 1992. *Summary and Evaluation of Available Hydraulic Property Data for the Hanford Site Unconfined Aquifer System*. PNL-8337, Pacific Northwest Laboratory, Richland, Washington.

US Ecology, Inc. 1996. *Site Stabilization and Closure Plan for the Low-Level Radioactive Waste Disposal Facility*. US Ecology, Inc., Richland, Washington. Online at: http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D197070070

van Genuchten, M. 1980. "A Closed-Form Equation for Predicting the Hydraulic Conductivity of Unsaturated Soils." *Soil Sci. Am. J*. 44:892-898.

Watrous, R. A. and D.W. Wootan. 1997. *Activity of Fuel Batches Processed Through Hanford Separations Plants, 1944 Through 1989*. HNF-SD-WM-TI-794, Rev. 0, Lockheed Martin Hanford Company and Fluor Daniel Northwest, Richland, Washington.

WDOH and Ecology. 2000. *Draft Environmental Impact Statement. Commercial Low-Level Radioactive Waste Disposal Site, Richland, Washington.* Washington State Department of Health and Washington State Department of Ecology, Olympia, Washington. Online at: http://www.ecy.wa.gov/pubs/0005010.pdf

White, M. D. and M. Oostrom. 1996. *STOMP Subsurface Transport Over Multiple Phases: Theory Guide*. PNNL-11217, Pacific Northwest National Laboratory, Richland, Washington.

Wood, M. I. 1996. *Addendum to the Performance Assessment for Low-Level Waste Disposal in the 200 West Area Active Burial Grounds*. HNF-SD-WM-TI-798, Rev. 0, Rust Federal Services of Hanford, Inc., Richland, Washington.

Wood, M. I., R. Khaleel, P. D. Rittmann, A. H. Liu, S. H. Finfrock, R. J. Serne, K. J. Cantrell, and T. H. DeLorenzo. 1995. *Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds*. WHC-EP-0645, Westinghouse Hanford Company, Richland, Washington.

Wootan, D. W. and S. F. Finfrock. 2002. *Activity of Fuel Batches Processed Through Hanford Separation Plants, 1944 Through 1989*. RPP-13489, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

Appendix M

Long-Term Impacts Associated with Discontinuing Disposal of HSW at the Hanford Site

Appendix M

Long-Term Impacts Associated with Discontinuing Disposal of HSW at the Hanford Site

M.1 Introduction

Consideration was given to a scenario of discontinuing disposal of Hanford solid waste (HSW) at Hanford. This would differ from the No Action Alternative evaluated in this *Hanford Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement* (HSW EIS) in that no future wastes from Hanford or offsite generators would be accepted for disposal under the HSW program after 2007, the point at which the existing disposal capacity is projected to be used. The long-term environmental impacts (extracted from Section 5.3 and Appendix G) of the following waste types were analyzed:

- Pre-1970 through 1995 low-level waste (LLW) in the Low Level Burial Grounds (LLBGs)
- Category (Cat) 1 and Cat 3 LLW disposed of in the period 1996-2007
- Mixed LLW (MLLW) for the period 1996–2007 that could be disposed of in Trenches 31 and 34 in the 200 West Area with any remaining MLLW stored in the Central Waste Complex (CWC).

These waste categories include all waste disposed of in the LLBGs through 2007.

M.2 Impacts on Groundwater

Impacts on groundwater are presented in terms of annual dose to an individual drinking 2 liters of water per day from hypothetical wells located downgradient from the existing waste disposal facilities. The doses, as a function of time for 10,000 years after site closure, are presented in Figures M.1 through M.3 for the well 1 km downgradient from the 200 West Area LLBGs, the northwest well 1 km from the 200 East Area LLBGs, and the near-river well. Dose plots are presented for both capped and uncapped LLBGs (MLLW trenches 31 and 34 are capped in both cases). The plot for the No Action Alternative as provided in Section 3.4 is also shown.

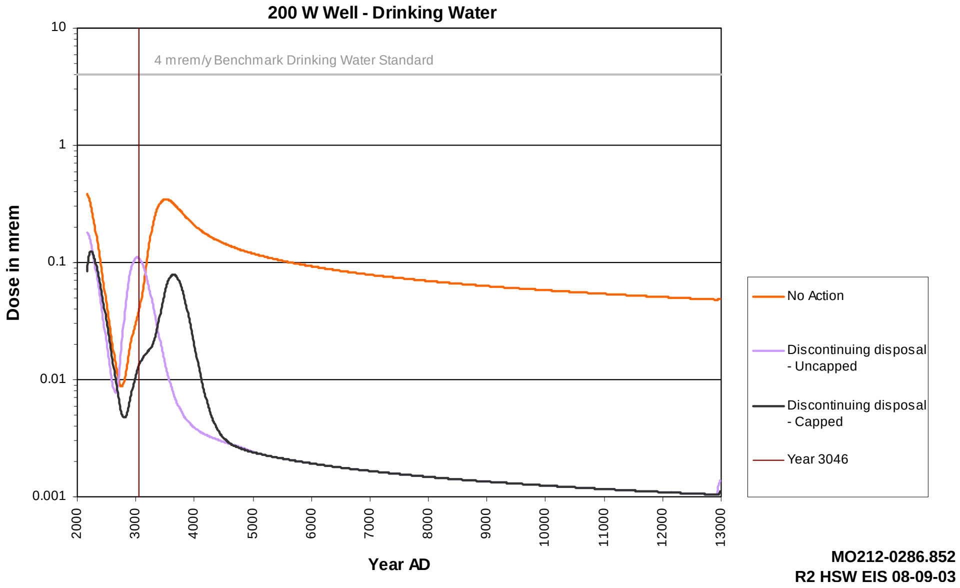


Figure M.1. Hypothetical Annual Dose from Drinking Water Containing Maximum Combined Concentrations of Radionuclides in Groundwater at 1 km Downgradient from the 200 West Area as a Function of Calendar Year

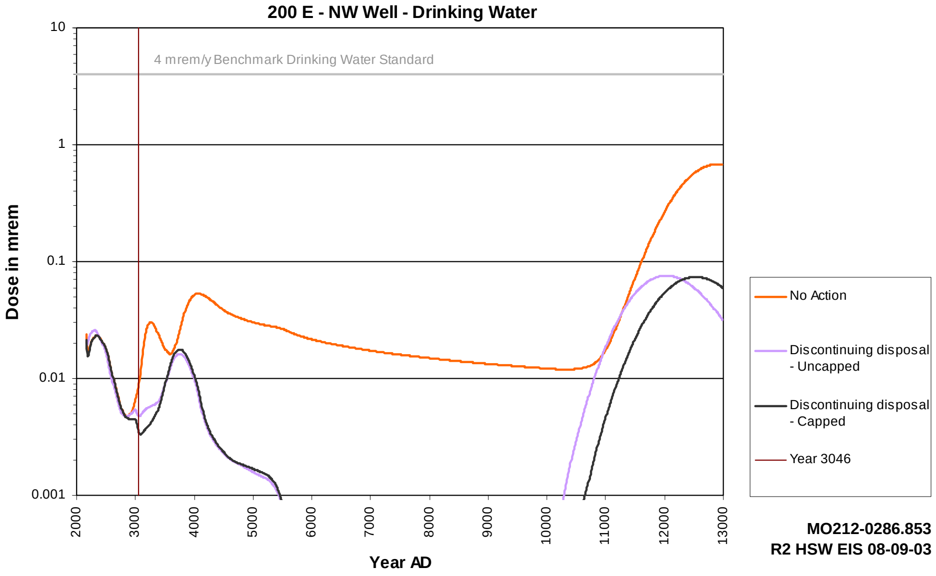


Figure M.2. Hypothetical Annual Dose from Drinking Water Containing Maximum Combined Concentrations of Radionuclides in Groundwater 1 km Downgradient Northwest of the 200 East Area as a Function of Calendar Year

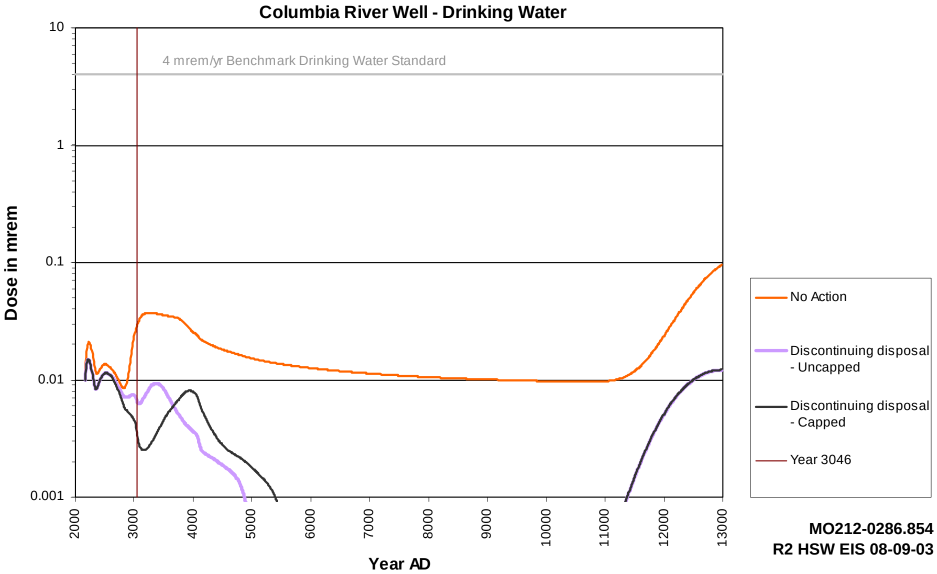


Figure M.3. Hypothetical Annual Dose from Drinking Water Containing Maximum Combined Concentrations of Radionuclides in Groundwater Near the Columbia River as a Function of Calendar Year

As would be expected, the plots for discontinuing disposal show lower doses over most of the period of analysis than do the plots for the No Action Alternative. However, the doses are essentially the same in the earlier part of the period of analysis, as the additional inventories of HSW do not contribute. It may also be noted that capping the wastes provides for only a minimal reduction in doses; however, the presence of barriers shifts the arrival of contaminants and, consequently, the doses by roughly 600 years.

Impacts on groundwater are also presented in terms of annual dose to the hypothetical resident gardener as a function of time in Figures M.4 through M.6, and to the hypothetical resident gardener with a sauna or sweat lodge scenario in Figures M.7 through M.9.

Impacts on groundwater in terms of annual dose to the hypothetical resident gardener are higher than those in terms of drinking water dose, but, in general, follow the same pattern. Again, the pattern is similar in terms of the hypothetical resident gardener with sauna or sweat lodge, but the doses are larger due to the inhalation pathway.

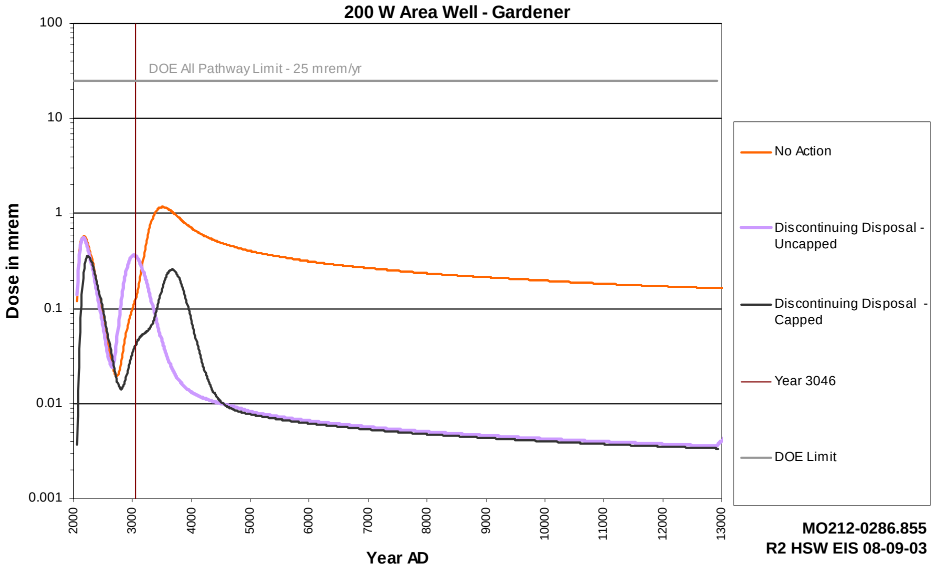


Figure M.4. Annual Dose to a Hypothetical Resident Gardener at Various Times over 10,000 Years Using Water from a Well 1 km Downgradient from 200 West Area

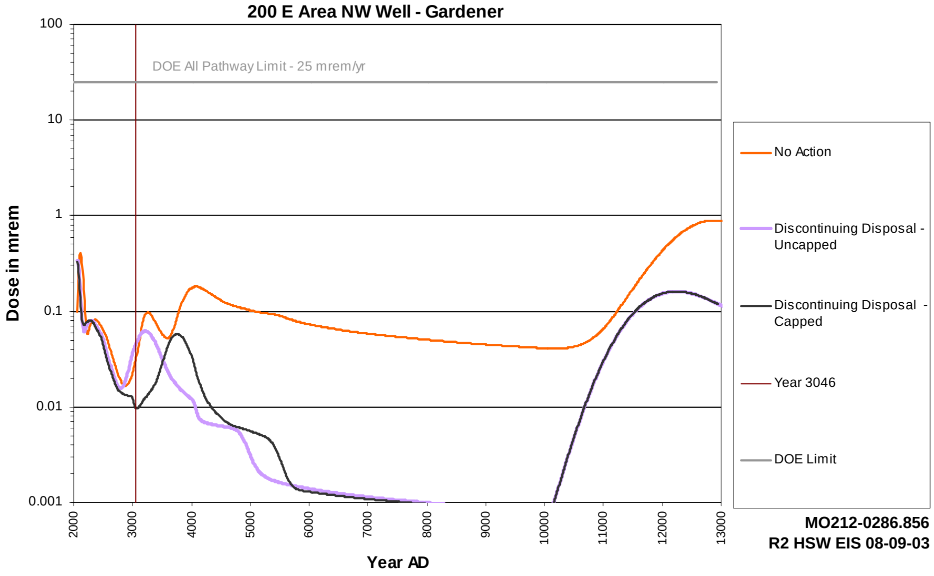


Figure M.5. Annual Dose to a Hypothetical Resident Gardener at Various Times over 10,000 Years Using Water from a Well 1 km Downgradient Northwest of the 200 East Area

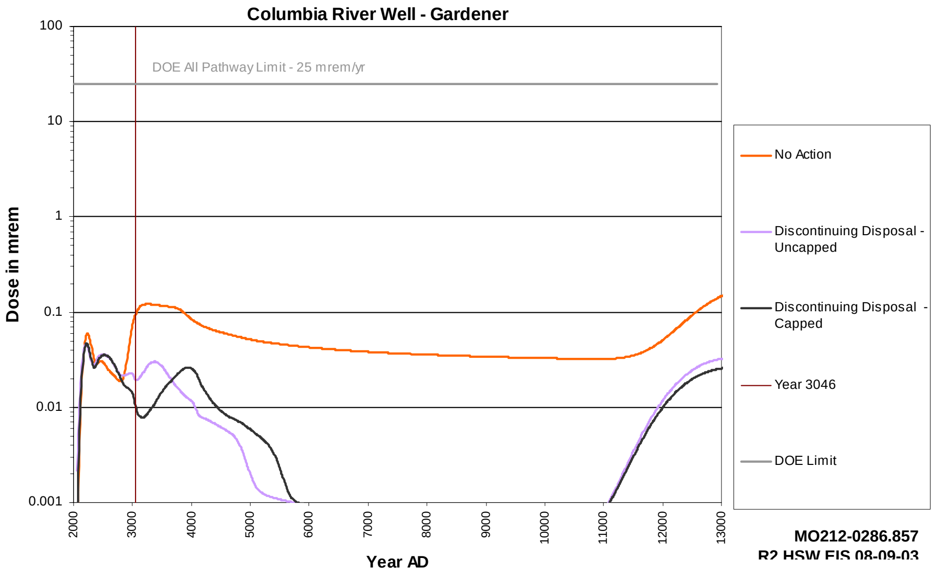


Figure M.6. Annual Dose to a Hypothetical Resident Gardener at Various Times over 10,000 Years Using Water from a Well Adjacent to the Columbia River

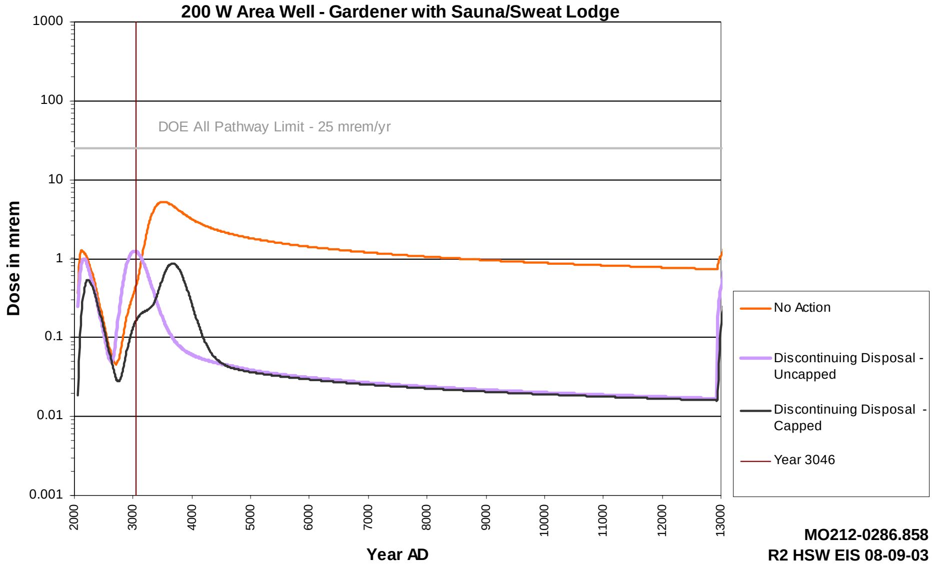


Figure M.7. Annual Dose to a Hypothetical Resident Gardener with a Sauna/Sweat Lodge Scenario at Various Times over 10,000 Years Using Water from a Well 1 km Downgradient from the 200 West Area

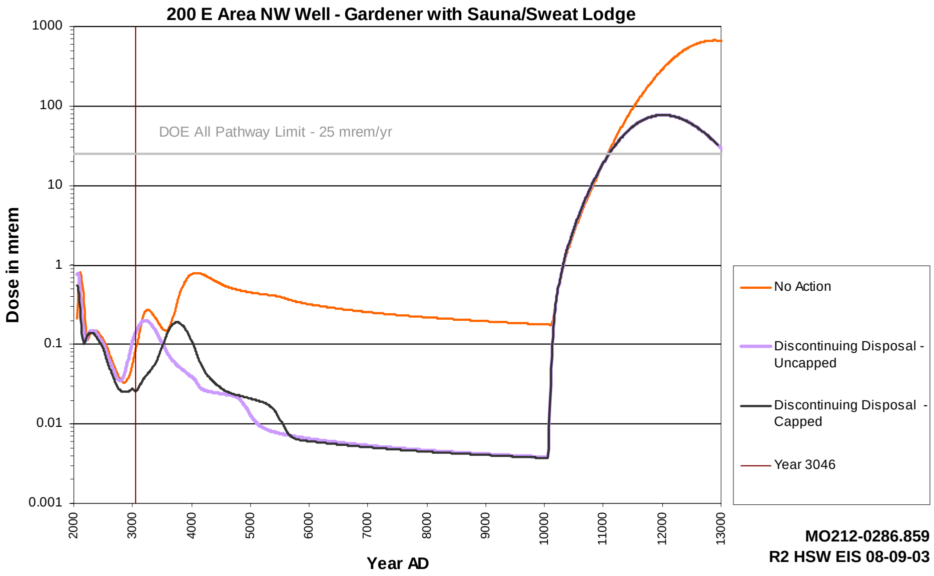


Figure M.8 Annual Dose to a Hypothetical Resident Gardener with a Sauna/Sweat Lodge Scenario at Various Times over 10,000 Years Using Water from a Well 1 km Downgradient Northwest from the 200 East Area

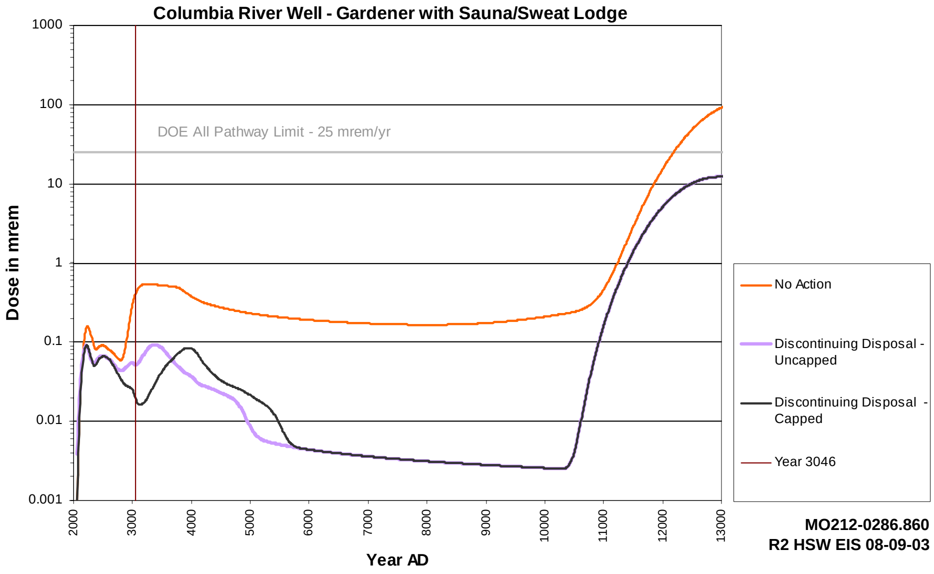


Figure M.9. Annual Dose to a Hypothetical Resident Gardener with a Sauna/Sweat Lodge Scenario at Various Times over 10,000 Years Using Water from a Well Adjacent to the Columbia River

Appendix N

Overview of DOE Nationwide and Hanford Site Waste Management Programs and Initiatives

Appendix N

Overview of DOE Nationwide and Hanford Site Waste Management Programs and Initiatives

The following sections describe the U.S. Department of Energy (DOE) national waste management programs, the implementation of those programs at Hanford, and recent initiatives examining strategies to accelerate cleanup activities.

N.1 DOE Nationwide Waste Management Programs

DOE nationwide waste management programs fall into two general categories: 1) management of operational waste generated during other research and materials production programs, and 2) environmental restoration programs to clean up and close DOE facilities that no longer have active operations. Nationwide management of operational waste has been evaluated in the *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (WM PEIS, DOE 1997a) and the *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (WIPP SEIS2, DOE 1997c), as described in Section 1, in Volume I of this HSW EIS. Environmental restoration activities generally fall under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 (42 USC 9601). Under DOE policy (DOE 1994a), the CERCLA process incorporates values and public involvement procedures comparable to those implemented by the National Environmental Policy Act (NEPA, 42 USC 4321). The following sections describe the DOE nationwide activities to manage both operational and environmental restoration wastes and other nuclear materials.

N.1.1 Environmental Management Top-to-Bottom Review

In 2001, DOE reviewed its efforts to clean up 114 sites nationwide that are managed as part of DOE's Environmental Management (EM) Program (DOE 2002a). Cleanup of 74 of those sites is complete, and cleanup efforts at other sites are well under way. However, costs and schedules for the more extensive cleanup efforts, including Hanford, were expected to increase unless there were major changes in the way cleanup work was being managed. That review, referred as the Top-to-Bottom Review, was intended to identify problems and recommend improvements to accelerate cleanup, reduce risks, and reduce costs.

Twelve major issues were identified during the review:

1. <u>Better use of performance-based contracting is needed</u>. Performance-based contracting is the single best opportunity for improving DOE's cleanup efforts. It is now being employed inconsistently. This

inconsistency reduces the effectiveness of this contracting approach to reduce risks to workers, the public, and the environment. Better use of performance-based contracting requires improvements by both DOE and its contractors.

2. Waste needs to be managed to reduce risks. The current framework and, in some cases, interpretation of DOE Orders and requirements, laws, regulations, and cleanup agreements create obstacles to achieving cleanup that reduces risks to workers, the public, and the environment as quickly as possible. Waste is often managed and treated based on where it comes from and not on what actual risk it presents to workers, the public, and the environment. Funds are not being spent in proportion to the hazards.

3. Cleanup strategies for accelerating site closure need to be based on national needs. There is no single strategy for closure of DOE sites. There is only a collection of closure strategies for individual sites. This fragmented approach results in costly duplication of effort and assignment of priorities based on local concerns rather than on a national basis.

4. Cleanup agreements need to be improved. Regulatory agreements have often failed to achieve expected reductions in risk or accelerated site closures. In some cases, provisions in these agreements have not focused on the highest risk.

5. Safeguard and security threats need to be reduced. Large quantities of special nuclear materials are stored at several facilities that have no need for those materials. A great deal of combustible and dispersible transuranic waste is also stored at many sites awaiting certification and disposal. These scattered storage configurations are difficult to manage, expensive, and present greater safeguards and security concerns.

6. Long-term stewardship needs to be better considered. Long-term stewardship is necessary for the continued protection of the public and the environment after sites are closed. DOE needs to adequately plan for long-term stewardship at these sites.

7. Breakthrough business processes are needed to accelerate risk reduction. DOE's existing business processes are not structured to address cost and schedule growth. As structured today, the cleanup of DOE's EM sites is expected to cost \$220 billion. This cost could increase to over \$300 billion unless significant changes are made. With increased cost come further delays in cleanup.

8. Implementation of NEPA requirements needs to better support decision making. The NEPA process as currently implemented for clean up efforts is often time-consuming and costly without providing the sound analysis and rational alternatives needed to support good decision making by DOE.

9. A single program for accelerating clean up of small sites is needed. DOE's EM Program is responsible for the cleanup of several small sites. Cleanup of those sites could be accelerated and life-cycle costs reduced if a single management approach were used to address those cleanup efforts.

10. Packaging and transportation requirements need to better support accelerated risk reduction. Existing packaging and transportation policies and procedures often result in delays in removing materials from sites. This increases costs and delays reduction of risks.

11. Environmental Management Program needs to focus on cleanup. DOE's EM Program manages several activities that do not support accelerated, risk-based clean up. Both budget resources and staff and management attention are not fully applied to clean up and closure of sites.

12. Science and Technology Program needs to focus on cleanup efforts. DOE's Science and Technology Program is not focused on providing the necessary support to DOE's EM Program to accelerate clean up efforts.

N.1.2 DOE Cost Report

In 2002, DOE prepared a life-cycle cost analysis to address the disposal of DOE's low-level (radioactive) waste (LLW) (DOE 2002c). Life-cycle disposal costs include those related to transportation, disposal, closure, and long-term stewardship. The report discussed facilities for the disposal of LLW from cleanup actions under CERCLA (e.g., the Environmental Restoration Disposal Facility [ERDF]) as well as facilities used for other LLW disposal (e.g., the Low Level Burial Grounds [LLBGs]). The report was prepared to address congressional concerns regarding the cost of LLW disposal, the extent to which DOE fee structures reflect actual life-cycle costs, and the impact of DOE disposal facilities on commercial LLW disposal.

The report concluded the following:

1. Pre-disposal costs offer the greatest opportunity for cost savings.

   Pre-disposal costs are those costs associated with getting LLW ready for disposal, packaging LLW, and transporting LLW to a disposal site. Pre-disposal costs vary greatly by individual waste stream. These pre-disposal costs are strongly influenced by specific radioactive constituents in the waste, the physical form of the waste, where the waste is generated, where it is disposed of, and the volume of the waste.

2. DOE facilities used for the disposal of onsite waste from CERCLA cleanup actions offer the least expensive life-cycle disposal costs.

   LLW and mixed low-level (radioactive) waste (MLLW) from CERCLA cleanup actions tend to be very large volumes of minimally contaminated waste. This waste generally does not require special shielding or packaging to protect people or the environment. Costs can be spread over a greater volume of waste, thereby decreasing the per unit disposal cost of that waste. Disposal typically occurs at the same site as cleanup, thus minimizing transportation costs.

3. Commercial facilities offer the most cost-effective disposal for some DOE waste.

   The report noted that commercial disposal facilities sometimes offer the lowest life-cycle disposal costs. This validates existing DOE practices. Commercial disposal facilities have historically been used for the disposal of some DOE LLW (DOE 1997b). Commercial disposal facilities will continue to be used by DOE where they offer cost-effective disposal of DOE LLW.

   Envirocare of Utah, Inc. is the commercial site that currently receives the largest volume of DOE LLW. More than 20 DOE sites have disposed of large amounts of waste at the Envirocare site. For example, in September 2000, about 4200 m^3 (150,000 ft^3) of LLW from the DOE Savannah River Site were disposed of at Envirocare (Envirocare 2000b). DOE MLLW is also disposed of at Envirocare. For example, over a five-year period ending in 2000, the DOE-Oak Ridge Reservation shipped over 5600 m^3 (200,000 ft^3) of MLLW to Envirocare for disposal (Envirocare 2000a). Since 1993 Envirocare has received over 56,000 m^3 (2,000,000 ft^3) of DOE mixed and low-level waste for treatment and/or disposal (Envirocare 2000c).

4. DOE disposal facilities offer services that are not commercially available.

   Some DOE LLW and MLLW cannot be disposed of at commercial facilities. Commercial disposal facilities operate under State or U.S. Nuclear Regulatory Commission licenses that restrict the sources, quantities, types, and specific characteristics of waste that can be disposed of in those facilities. DOE waste that cannot be disposed of commercially needs to be disposed of in DOE facilities.

5. Comparison of disposal alternatives must consider more than just disposal fees.

   DOE LLW disposal sites charge fees to DOE waste generators for the incremental cost of facility operation and maintenance associated with waste disposal. DOE disposal sites are limited in their ability to charge fees to recover past costs (e.g., initial facility construction) that were funded through congressional appropriations. DOE is also precluded from collecting fees to cover future costs (e.g., closure and long-term stewardship) without specific congressional approval.

The way DOE funds disposal does not preclude life-cycle cost considerations being used to determine the most cost-effective disposal site. Given that pre-disposal costs offer a substantial opportunity for cost savings, the cost report concludes that DOE should continue to make disposal decisions based on life-cycle disposal costs rather than on the fees charged to DOE waste generators by DOE disposal sites. This recommendation reinforces existing DOE requirements for considering life-cycle costs, such as those for waste minimization (DOE 2001a), facility management (DOE 1998), and radioactive waste management (DOE 2001b).

N.2 DOE Office of Environmental Management Programs at the Hanford Site

The following sections describe EM activities at Hanford, and relate those activities to the alternatives described in this HSW EIS.

N.2.1 Spent Nuclear Fuel

As part of the defense materials program, spent nuclear fuel (SNF) from Hanford's production reactors was sent to process facilities, such as the Plutonium-Uranium Extraction (PUREX) Facility, to separate plutonium and uranium from the remaining radionuclides in the fuel. Most of the remaining radionuclides were sent to underground tanks in the Hanford 200 Areas for storage as HLW.

When the last processing plant closed in the late 1980s, about 2100 metric tons of unprocessed production reactor SNF remained at the Hanford Site. This SNF represents about one-eighth (1/8) of the curies of radioactivity that exist at Hanford. The SNF has been stored in the K Basins near the Columbia River. The K Basins are water-filled pools that provide shielding and cooling. Water in the K Basins contains small quantities of radioactive materials, and the basins have leaked water to the surrounding soil in the past.

Because of concerns about possible future contamination of the Columbia River, DOE is moving the SNF away from the river to a storage facility in the central Hanford Site. After the SNF is removed from the K Basins, it is dried in the Cold Vacuum Drying Facility and moved to the Canister Storage Building (CSB) in the 200 East Area. About 30 metric tons of SNF stored at other Hanford Site locations will also be sent to the CSB. The SNF would ultimately be sent to the Yucca Mountain repository for disposal.

After removal of the SNF, sludge (dirt and small debris) from the K Basins will be placed into sealed containers and sent to T Plant for storage. The sludge is classified as transuranic waste, which will be treated at Hanford and disposed of at WIPP. Contaminated water in the K Basins will be treated at the Effluent Treatment Facility (ETF), and the solid residues will be disposed of onsite. After the SNF, sludge and water have been removed, the K Basins will be demolished. The resulting debris and any surrounding contaminated soil will be disposed of at the LLBGs or ERDF.

As of November 2003, 1503 metric tons of the 2100 metric tons of K Basin SNF had been sent to the CSB. Removal of all the SNF is scheduled for completion in 2004. Removal of the water and sludge, treatment of contaminated waste, and demolition of the K Basins is scheduled for completion by 2007.

N.2.2 High-Level Waste

After SNF was processed, the process waste was sent to underground tanks in the Hanford 200 Areas for storage. This process waste is defined as HLW, which consists of a combination of solids, sludges, and liquids. One hundred seventy-seven tanks were constructed at Hanford and currently contain about 53 million gallons of waste.

Twenty-eight of the 177 Hanford tanks are double-shell tanks. The remaining tanks are single-shell tanks, of which 67 may have leaked more than one million gallons of waste. Liquids are being pumped from the single-shell tanks and transferred to double-shell tanks to prevent leaks from reoccurring. About 2.5 million gallons of liquid have been pumped from 131 single-shell tanks, and DOE plans to pump an additional 500,000 gallons out of the single-shell tanks by 2004.

Cesium and strontium were removed from HLW because of the heat generated during decay of those isotopes, and because of their potential for use in various industrial processes. The separated cesium and strontium were sealed in double-walled steel capsules that are currently stored in a water-filled pool at the Waste Encapsulation and Storage Facility (WESF). High-level tank waste and the cesium and strontium capsules, represent more than three-fourths of the curies of radioactivity that exist at the Hanford Site.

A waste treatment plant (WTP) is currently under construction at Hanford to treat and vitrify the tank waste, a process that will convert it to a stable glass for disposal. In the WTP, the tank waste will be separated into HLW and low-activity waste streams. The HLW glass will be placed into canisters and stored onsite before being sent to Yucca Mountain for disposal. DOE initially planned to store vitrified low-activity waste in concrete vaults in the 200 East Area (DOE and Ecology 1996). Other options for onsite disposal of the immobilized low-activity waste (ILAW) are being evaluated as part of this HSW EIS. DOE has also announced plans to prepare an EIS for retrieval of the tank waste and closure of the Hanford tanks (68 FR 1052).

N.2.3 Environmental Restoration Waste

In 1989, portions of the Hanford Site were placed on the National Priorities List as contaminated sites requiring cleanup action under CERCLA. CERCLA provides the regulatory framework for most cleanup of hazardous substances from past-practices sites, such as old buildings, waste cribs, burial grounds, and other sites that are no longer in use. CERCLA provides a process to address sites where a release, or a threat of release, of hazardous substances has occurred. In the context of CERCLA, remediation of a waste site may consist of removing the hazardous substances and other contaminated materials from the waste site, or it could involve a combination of removal and stabilization of the site to minimize migration of residual hazardous substances to the surrounding environment (for example, by placing a barrier over the waste site to reduce water infiltration and migration of the waste constituents to groundwater).

CERCLA and the National Contingency Plan regulations (40 CFR 300) provide authority for conducting two types of response actions: removal actions and remedial actions. Removal actions are applied to cases that do not require extensive, time-consuming, and costly study and analysis. Removal actions can also be taken to respond to emergencies, address entire operable units, or achieve prompt risk reduction prior to a remedial response. In many instances, it may be reasonable to complete the cleanup entirely using only removal authorities. A major goal of DOE removal actions is to contribute to the efficiency of any subsequent longer-term remedial actions. In cases where there has been a release, or threat of release, the factors outlined in 40 CFR 300.415(b) are considered in determining the appropriateness of taking a removal action.

For remedial actions, DOE conducts a remedial investigation/feasibility study to characterize the hazardous substances associated with each site and to consider potential methods for reducing the risk associated with those materials. The process for evaluating remediation alternatives includes comparing each alternative against nine criteria, including overall protection of human health and the environment, long-term effectiveness, and short-term effectiveness. As noted previously, these criteria are consistent with the elements that would be addressed in a NEPA review. Long-term effectiveness considers the magnitude of the residual risk to human health or the environment from untreated waste, or treatment residues, remaining at the conclusion of remediation activities. It also considers the adequacy and reliability of controls needed to manage untreated wastes or treatment residuals. Short-term effectiveness evaluates impacts occurring during remediation, such as risks to the community (for example, from air emissions), risks to workers, and risks to the environment. A public review of the proposed action is included, ultimately leading to a CERCLA Record of Decision (ROD) for completing the remediation process.

Environmental restoration at Hanford involves characterizing and remediating contaminated soil and groundwater; stabilizing contaminated soil; remediating disposal sites; decontaminating, decommissioning, and demolishing former plutonium production buildings, nuclear reactors, and separation plants; maintaining inactive waste sites; transitioning facilities into the Surveillance and Maintenance Program; and mitigating effects to biological and cultural resources from site development and environmental cleanup and restoration activities. Within the Hanford Site, over 1700 waste sites and 500 contaminated facilities have been identified for remediation under CERCLA or a substantially comparable Resource Conservation and Recovery Act (RCRA; 42 USC 6901) process. DOE has prioritized Hanford cleanup to focus on sites near the Columbia River first, including placing the plutonium production reactors into interim safe storage, demolition of other unneeded facilities, removal of contaminated soil, and remediation of inactive disposal facilities that contain potentially hazardous waste.

Nine plutonium production reactors were constructed at Hanford from 1943 through 1963. These reactors are being placed in interim safe storage, which is the process of demolishing all but the shield walls surrounding the reactor core and putting a new roof over the remaining facilities. The reactors will remain in the interim safe storage state for up to 75 years to allow radiation levels in the reactor cores to decay to more manageable levels. Three reactors have been placed in interim safe storage since 1998, work is in progress on two others, and three remain to be started. Alternatives to dismantlement are being considered for B Reactor because of its historic role, including its preservation as a museum.

Most cleanup of the Hanford Central Plateau is planned after completion of the River Corridor activities, although some projects are currently in progress. That phase of the cleanup will include remediation of contaminated soil and inactive disposal facilities and disposition of inactive facilities, including the fuel and plutonium processing buildings. CERCLA sites in the 200 Areas, including burial grounds closed before 1970, are the last sites scheduled for a major characterization effort. DOE has undertaken a project that includes characterization to assess the nature and extent of soil contamination and to select appropriate remedial actions. Decisions regarding remediation would be made as characterization is completed. The framework for the characterization and remediation of 200 Area CERCLA sites is defined in the *200 Areas RI/FS Implementation Plan* (DOE-RL 1999).

The Environmental Restoration Disposal Facility (ERDF) is located in the center of the Hanford Site between the 200 East and 200 West Areas. ERDF is a large-scale disposal facility designed to receive and isolate LLW and MLLW. It is currently authorized by the U.S. Environmental Protection Agency (EPA) to receive only waste from Hanford cleanup activities. ERDF is a RCRA-compliant landfill authorized under CERCLA.

ERDF is designed to provide disposal capacity for projected Hanford cleanup wastes over the next 20 to 30 years. Four disposal cells make up ERDF. The first two cells were constructed beginning in 1995 and began receiving waste in 1996. The cells are each 152 meters (500 feet) square at the bottom, 21 meters (70 feet) deep, and over 304 meters (1,000 feet) wide at the surface. Construction of two additional cells was completed in 2000, and there are plans to construct up to four additional cells. The cells are lined with a RCRA Subtitle C-type liner and have a leachate collection system. An interim cover has been placed over filled portions of the first two cells. After ERDF is filled, a final barrier will be placed over the entire facility to minimize infiltration of rain and release of hazardous constituents from the waste. Capacity of the current four-cell configuration is 10 million tons, which can be expanded as necessary. Currently, ERDF receives about 3,000 tons of waste per day, and is expected to receive about 7 million tons of waste during Hanford cleanup. The facility is monitored regularly and will continue to be monitored after closure to ensure that human health and the environment are protected.

N.2.4 Groundwater Protection

Groundwater beneath the Hanford Site ultimately surfaces at springs near or in the Columbia River, which traverses the northern and eastern parts of the site. Some of the groundwater is contaminated by radionuclides and hazardous chemicals as a result of past liquid disposal practices, leaks, and spills. Past practices that contributed to groundwater contamination have been discontinued, including disposal of untreated liquids to the ground. Programs are under way to clean up and stabilize remaining materials that could present a threat to human health and the environment. The past practice of discharging untreated liquid waste to the ground was reduced in the 1980s and discontinued in 1995. Within the 200 Area plateau, two state-permitted discharge sites still exist: the 200 Area Treated Effluent Disposal Facility and the State-Approved Land Disposal Structure (SALDS). Tritiated water is discharged at the SALDS in accordance with DOE Order 5400.5 (DOE 1993). There is no practicable technology available for removing tritium from dilute liquid waste streams. Currently, DOE uses the long transit time in groundwater from the discharge point to the Columbia River to allow tritium to decay. Allowing the tritium to decay in the groundwater while isolated from public use is an acceptable alternative to direct release to the atmosphere or to surface water.

DOE conducts an extensive program to monitor groundwater contamination (Poston et al. 2003). In 2002, samples were collected from 658 monitoring wells to determine the distribution and movement of existing radiological and chemical constituents in Hanford Site groundwater and to identify and characterize potential and emerging groundwater contamination problems. Samples were analyzed for approximately 25 different radiological constituents and 53 different chemical constituents. The total area of groundwater contaminant plumes with concentrations exceeding drinking water standards was estimated to be about 197 square kilometers (76 square miles) in 2002. This area, which has decreased by about 5% compared to 2001, occupies approximately 13% of the total area of the Hanford Site. Most of the contaminant plume area, represented by tritium, lies southeast of the 200 East Area extending to the Columbia River.

The most widespread groundwater contaminants are tritium, iodine-129, technetium-99, uranium, strontium-90, carbon tetrachloride, nitrate, and trichloroethene. Plumes of carbon-14, cesium-137, cobalt-60, and plutonium occur in isolated parts of the 100 and 200 Areas. For over 10 years, DOE has been treating contaminated groundwater plumes in both the 100 and 200 Areas. Since the pump-and-treat projects began, over 6 billion liters of groundwater have been treated. Nearly 350 kg (760 lb) of chromium, over 7000 kg (15, 594 lb) of carbon tetrachloride, 24,000 kg (53, 255 lb) of nitrate, 165 kg (60.8 lb) of uranium, 95 g (0.21 lb) of technetium-99, and 1.3 Ci of strontium-90 have been removed. An additional 78,000 kg (171,515 lb) of carbon tetrachloride has been removed from the soil by vapor extraction to prevent future groundwater contamination (Poston et al. 2003). Radioactive decay is also reducing the quantities of radionuclides; for example, over the past 10 years in the 100-N Area, 215 Ci of strontium-90 have decayed.

Groundwater monitoring at Hanford is being addressed through milestones established under the Tri Party Agreement independently of this HSW EIS. DOE and a team of contractors have developed, and are implementing, a sitewide program that integrates all assessment and remediation activities that address key groundwater, vadose zone, and related Columbia River issues. This effort is coordinated by the Groundwater Protection Program to support cleanup and closure decisions for the Hanford Site and protection of the Columbia River. General information regarding Hanford's Groundwater Protection Program can be found at http://www.hanford.gov/cp/gpp. Information developed under that program was used to evaluate long-term impacts of LLW and MLLW disposal in this HSW EIS.

N.2.5 Liquid Waste

The 200 Area Liquid Waste Processing Facilities receive, treat, and dispose of liquid effluents from onsite programs and projects. Facilities include the Liquid Effluent Retention Facility (LERF), the 2025E Effluent Treatment Facility (ETF), the 200 Area Treated Effluent Disposal Facility (TEDF), State-Approved Land Disposal Site (SALDS), and the 242-A Evaporator. The 300 Area TEDF processes potentially hazardous wastewater from the 300 Area.

The 242-A Evaporator is a RCRA-permitted facility that concentrates tank waste to reduce the overall volume and storage requirements. The facility has a volume reduction capacity of 270,000 L (70,000 gal) per day. The concentrated waste is returned to the waste tanks, and the process condensate is transferred to the LERF. Since the evaporator was upgraded in 1994 and from its restart through late 2000, its operation has reduced tank waste volume by over 11 million gallons. This treatment activity has provided a savings in tank space equivalent to 12 double-shell tanks.

The LERF is a RCRA-permitted facility that consists of three basins with a usable capacity of about 88 million L (23 million gal). The LERF receives and temporarily stores wastewater from the 242-A

Evaporator, groundwater from the site pump-and-treat projects, leachate from onsite solid waste disposal facilities and a variety of generators (including site cleanup activities). From LERF, the water is routed to the ETF for treatment and disposal.

The ETF is a RCRA-permitted treatment process, has a design capacity 216 million L (56 million gal) per year, and removes hazardous and radioactive contaminants other than tritium. The ETF treatment process includes filtration (removal of suspended solids) ultraviolet light/peroxide (destruction of organics), reverse osmosis (removal of dissolved solids), and ion exchange (radioactivity removal). Storage tanks hold the treated effluent for verification of acceptable discharge levels, before the effluent is transferred to the 200 Area TEDF or SALDS.

The 200 Area TEDF is a collection and disposal system for non-hazardous, non-radioactive waste streams. The TEDF includes more than 19 kilometers (12 miles) of polyvinyl chloride pipe up to 36 centimeters (14 inches) in diameter connecting facilities to a second state-permitted land disposal site. The TEDF has a capacity of 13,000 L (3,400 gal) per minute, equivalent to 6.8 billion L (1.8 billion gal) per year. The final disposition of this waste is the SALDS.

The SALDS receives treated and verified liquid process waste from the 200 Area TEDF. The liquid wastes received at SALDS are not considered dangerous, but may contain tritium. The facility consists of a gravel bed with a geotextile membrane cover.

The 300 Area TEDF receives the combined wastewater collection for the 300 Area. The facility receives processed wastewater and has the ability to perform characteristic waste treatment under Permit-by-Rule provisions. The treated waste water from the 300 Area TEDF is discharged to the Columbia River through an outfall permitted by the National Pollutant Discharge Elimination System or to the city of Richland waste water treatment plant.

N.2.6 Cleanup, Constraints, and Challenges Team (C3T)

In 2001, the DOE, its contractors, the EPA, and the Washington State Department of Ecology started a series of discussions to better identify, characterize, and resolve constraints and barriers to Hanford cleanup (DOE-RL 2002a). Tribal nations were also invited to participate in these discussions. These discussions, referred to as the Cleanup, Constraints, and Challenges Team (C3T) process, are designed to be an informal forum where ideas and concepts could be discussed openly. Ideas are developed and evaluated to determine whether they could accelerate cleanup; reduce costs; or protect workers, the public, and the environment. The C3T process is not intended to replace legal or regulatory requirements, or to change formal commitments such as the Tri-Party Agreement (TPA; Ecology, EPA, and DOE 1989). Some concepts identified during the C3T process might be suitable for implementing immediately. However, most would probably require further planning, changes to existing permits and TPA Milestones, changes to existing contracts, and preparation of additional NEPA reviews.

Seven sub-teams were formed to consider opportunities to accelerate cleanup and reduce cost in the following areas:

1. Cesium/Strontium Capsule Disposition:
    - Develop options that would substitute for continued underwater storage of cesium and strontium capsules.
    - Develop options that would substitute for vitrifying cesium and strontium prior to final disposal.
    - Tank Retrieval and Closure Demonstration Project:
    - Demonstrate waste retrieval technologies.
    - Demonstrate closure of tanks.

2. ORP (DOE Office of River Protection) Baseline Opportunities (Mission Acceleration Initiatives):
    - Enhance design and operations of the waste treatment plant (WTP).
    - Explore alternate waste treatment technologies including sulfate removal, containerized grout, bulk vitrification, and steam reformation.

3. Integrated Groundwater Protection, Monitoring, Assessment, and Remediation:
    - Develop an overall approach for groundwater protection, monitoring, assessment, and remediation.
    - Explore technologies for removing and immobilizing contaminants.
    - Reduce natural and artificial recharge through contaminated areas.
    - Minimize duplication and inconsistencies between regulatory requirements for monitoring and well drilling (RCRA, CERCLA, U.S. Atomic Energy Act [AEA; 42 USC 2011]) and comply with standards for protection of human health and the environment.

4. Central Plateau Vision and Strategy:
    - Develop an overall approach to cleanup of waste sites on the Central Plateau.
    - Develop a strategy for transitioning the Central Plateau to industrial use.

5. Waste Disposal Project Options:
    - Consider combined disposal of LLW, MLLW, and ILAW.
    - Evaluate the use of canyon buildings for waste disposal.
    - Coordinate pre-1970 and post-1970 transuranic waste management activities (retrieval, treatment, and disposal).

6. ORP (DOE-Office of River Protection)/RL (DOE-Richland Operations Office) Baseline Integration and Infrastructure Optimization (Site Infrastructure and Services):
    - Assess site infrastructure needs (e.g., roads, utilities) as cleanup progresses and the Hanford Site “shrinks.”

N.2.7 Hanford Performance Management Plan (HPMP)

Drawing on recommendations contained in the Top-to-Bottom Review and on ideas emerging from the C3T process (DOE-RL 2002a), the Hanford Performance Management Plan (HPMP) was prepared to accelerate cleanup at Hanford (DOE-RL 2002b). The HPMP describes higher-level strategic initiatives as well as specific goals for completing Hanford cleanup by 2035, which is 35 years earlier than previously planned.

A Hanford map showing the River Corridor, the Central Plateau, and some key features on the Hanford Site is shown in Figure N.1.

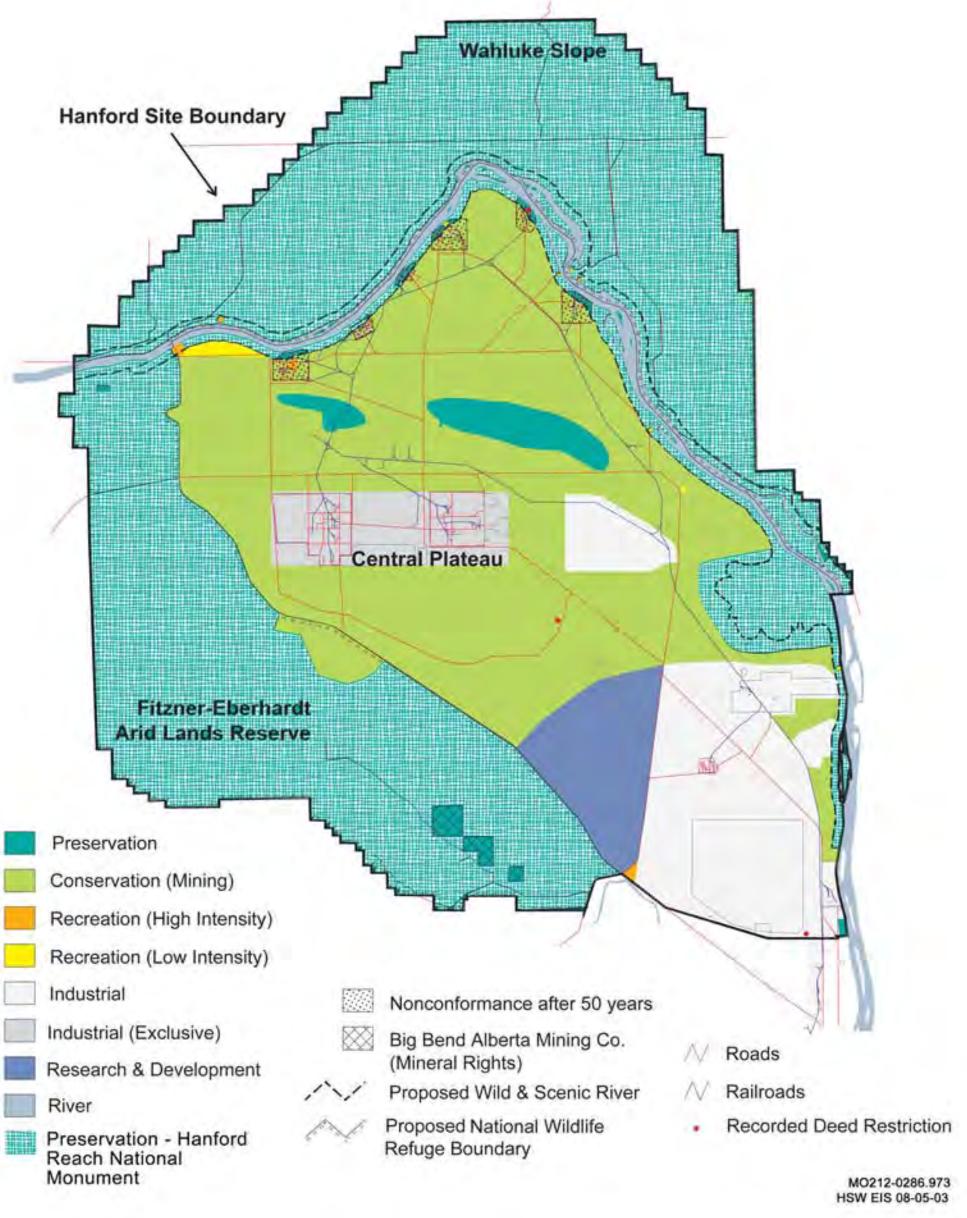


Figure N.1. Hanford's Land-Use Plan

With the help of the EPA and the Washington State Department of Ecology, six strategic initiatives were developed:

1. Accelerate Columbia River Corridor Cleanup. Restore the Columbia River Corridor reducing the risk to the river and shrinking Hanford Site operations. Complete remediation of 50 burial grounds, 579 waste sites, 357 excess facilities, and 7 plutonium production reactors by 2012.

2. Accelerate Tank Waste Treatment. End the tank waste program by 2033. Accelerate tank waste retrieval. Complete tank waste treatment by 2028 by increasing the capacity of the planned waste treatment plant and using supplemental technologies for waste treatment and immobilization. Demonstrate tank closure and start in earnest the process of closing tanks now. Many of the activities related to tank waste are on the "critical path" to site closure, and the site cannot be closed until they are complete.

3. Accelerate Stabilization and De-Inventory of Nuclear Materials. Accelerate the cleanup of Hanford's other urgent risks. Remove K Basins spent nuclear fuel, sludge, debris, and water from the river's edge 10 months early. Stabilize and securely store remaining plutonium nine years sooner. Demolish the Plutonium Finishing Plant (PFP) seven years earlier. Evaluate the benefits of moving 1,936 high-radiation-level cesium and strontium capsules to a secure dry storage facility and seek a path to allow Hanford to directly ship the (unvitrified) capsules to a national geologic repository. This would avoid the risk, time, and cost associated with vitrifying the capsules in the waste treatment plant.

4. Accelerate Waste Disposal. Accelerate treatment and disposal of MLLW and retrieval and shipment of TRU waste five to ten years ahead of current plans. Work with other DOE sites to ensure that disposal capability exists to meet their mission and closure schedules.

5. Accelerate Central Plateau Cleanup. Use regional or other waste site grouping strategies to clean up over 900 excess facilities on the Central Plateau (including the five massive plutonium separation and processing facilities commonly referred to as canyons) and more than 800 non-tank-farm waste sites. Use U Plant to demonstrate the ability to combine disposition canyon facilities in place (the Canyon Disposal Initiative) and remediate associated waste sites. With the exception of T Plant, which is required for final processing, disposition of the canyon facilities is expected 14 years early.

6. Accelerate Cleanup and Protection of Hanford Groundwater. Protect groundwater resources. Remove or isolate contaminant sources on the Central Plateau. Remediate sources of contamination outside the Central Plateau core zone. Reduce the conditions that have the potential to drive contaminants into the groundwater. Integrate all site-monitoring requirements. Accelerate remediation of high-risk sites by five years.

A list of specific goals and how they compare to previous plans can be found in Table N.1.

Under HPMP initiatives, cleanup of 964 km^2 (511 mi^2) of the Hanford Site's 1158 km^2 (586 mi^2) would be complete by 2012. After that time, cleanup activities would be limited to the Central Plateau. Acceleration is expected to reduce the estimated $90 billion cleanup costs by $30-40 billion.

Table N.1. Hanford Performance Management Plan Acceleration Goals

Cleanup Activity	Previous Plan	Acceleration Goal
Complete Cleanup	2070	2035
Start Tank Closure	2012(a)	2002
Initiate Plutonium Finishing Plant (PFP) Plutonium Deinventory	2009	2003
Establish the Site-Wide Integrated Groundwater Protection Program	NA(b)	2003
Complete First Tank Waste Retrieval and Closure Demonstration	2014(a)	2004
Demonstrate Supplemental Tank Waste Technologies	NA	2004
Complete Plutonium Finishing Plant (PFP) Plutonium Deinventory	2014	2005
Retrieve, Assay, and Disposition 15,000 Drums of Buried Suspect Transuranic Waste	2010	2006
Complete Removal of K Basins Spent Nuclear Fuel, Sludge, Debris, and Water	2007(g)	2006
Move Cesium and Strontium Capsules into Dry Storage	NA	2008(c)
Treat 14,000 m^3 of MLLW	2012	2008
Demolish PFP	2016	2009
Achieve Waste Treatment Plant Full Performance	2018	2010
Complete U Plant Regional Closure	2025	2011
Initiate Shipments of Cesium and Strontium Capsules to National Geologic Repository	2040	2012
Complete River Corridor Cleanup	2037	2012(e)
Complete Remediation of High-Risk Sites(e)	2017	2012
Disposition of All Contact-Handled Transuranic Waste(d)	2027	2015
Complete Closure of 60 to 140 Single-Shell Tanks(h)	2024	2018
Complete Tank Waste Treatment	2048(f)	2028

(a) The current Tri-Party Agreement target date.

(b) Agencies have recently agreed to establish a new sitewide Integrated Groundwater Protection Program.

(c) The benefits of dry storage and disposal options will be evaluated in FY 2003.

(d) Remote-handled and non-standard transuranic waste will require processing through a modified T Plant or a new facility, alternatives evaluated in this EIS.

(e) Several discrete projects in the River Corridor will not be completed by 2012. The 618-10 and 618-11 Burial Grounds will be completed in 2018. Several facilities in the 300 Area related to the Pacific Northwest National Laboratory will remain operational. The reactor cores will remain in interim safe storage pending final disposition. Ongoing groundwater cleanup, monitoring, and stewardship activities will be required based on final groundwater remedies. The Fast Flux Test Facility is not yet included.

(f) The current DOE projection is 2048. The Tri-Party Agreement date is 2028.

(g) The current Tri-Party Agreement Milestone is July 31, 2007.

(h) The number of tanks depicted here represents a DOE goal and does not represent agreement with the Washington State Department of Ecology.

While all the strategic initiatives affect Hanford as a whole, activities included in Strategic Initiative 4, Accelerate Waste Disposal, are most relevant to the alternatives analyzed in the HSW EIS. Specific goals within that initiative include the following:

- Initiate construction of lined MLLW/LLW disposal facilities by April 30, 2005.

- Complete characterization, retrieval, storage, and disposal of 15,000 drum-equivalents of suspect transuranic waste by September 30, 2006.

- Complete risk studies and associated environmental documentation to support decisions about how much of the remaining post-1970 and pre-1970 transuranic waste must be retrieved by September 30, 2006.

- Initiate use of lined MLLW/LLW disposal facilities by September 30, 2007.

- Complete treatment and/or disposal of all stored MLLW (about 7000 m^3) and newly generated MLLW (forecasted to be about 7000 m^3) by September 30, 2008.

- Complete retrieval of post-1970 suspect, contact-handled transuranic waste from the Low Level Burial Grounds by September 30, 2010.

- Complete certification and shipment of all legacy, contact-handled transuranic waste (about 7500 m^3) to the Waste Isolation Pilot Plant by September 30, 2013.

Some of the acceleration activities described in the HPMP could be implemented immediately. Others could be implemented as a result of reviews performed under this HSW EIS. Some, however, would require further planning, changes to existing permits and TPA Milestones, and preparation of additional NEPA or CERCLA reviews. Implementation of some of the accelerated cleanup proposals is discussed in Volume I, Section 3 of this EIS. However, the plans and schedules associated with many HPMP proposals were not sufficiently well developed for detailed analysis at the time this EIS was prepared. Therefore, the analyses of environmental impacts presented in Section 5 do not necessarily reflect all activities, or the timing of some activities, as described in the HPMP.

N.2.8 Pollution Prevention/Waste Minimization

Pollution prevention is defined as the use of materials, processes, and practices that reduce or eliminate the generation and release of pollutants, contaminants, hazardous substances, and wastes into land, water, and air. Pollution prevention includes practices that reduce the use of hazardous materials, energy, water, and other resources along with practices that protect natural resources through conservation or more efficient use. Within DOE, pollution prevention includes all aspects of source reduction as defined by the EPA, and incorporates waste minimization by expanding beyond the EPA definition of pollution prevention to include recycling.

DOE’s interpretation of pollution prevention is consistent with the definition in the International Organization of Standardization (ISO) Document 14001, *Environmental Management Systems – Specifications with Guidance for Use* (ANSI/ISO 1996), which includes recycling. DOE’s definition is also consistent with the Council of Environmental Quality’s definition of pollution prevention.

Pollution prevention is achieved through the following:

- equipment or technology selection or modification, process or procedure modification, reformulation or redesign of products, substitution of raw material, waste segregation, and improvements in housekeeping, maintenance, training or inventory control

- increased efficiency in the use of raw materials, energy, water, or other resources

- recycling to reduce the amount of waste and pollutants destined for release, treatment, storage, and disposal.

Pollution prevention is applied to all DOE pollution-generating activities including the following:

- manufacturing and production operations

- facility operations, maintenance, and transportation

- laboratory research

- research, development, and demonstration

- weapons dismantlement

- stabilization, deactivation, and decommissioning

- legacy waste and contaminated site cleanup.

DOE is faced with the challenge of removing and treating wastes already generated from past production and manufacturing operations. Facility and equipment stabilization, deactivation and decommissioning, and weapons dismantlement activities result in significant amounts of wastes that must be handled. Many pollution prevention techniques may not directly apply to wastes that were generated and media that were contaminated by previous practices. However, two techniques, waste segregation and recycling, are used to reduce the amount of such waste that would otherwise require additional treatment and disposal.

Additional waste and pollutants are generated in the process of conducting restoration and dismantlement activities. Pollution prevention is applicable to the generation of secondary waste and is factored into remedial investigations, feasibility studies, design, and execution of all restoration and dismantlement projects. Restoration projects are performed in a manner that reduces or prevents the generation of new waste and pollutants, and reduces the further release and spread of contamination (DOE 1996b).

In 1994, DOE prepared its first pollution prevention plan (DOE 1994b). The latest version of DOE’s Pollution Prevention Program is described in *Pollution Prevention Program Plan* (DOE 1996b). This plan is consistent with the requirements and guidance of the following:

- Pollution Prevention Act of 1990 (42 USC 13101)

- Resource Conservation and Recovery Act (42 USC 6901)

- Executive Order 13101, Greening of Government through Waste Prevention, Recycling, and Federal Acquisition (63 FR 49643, September 14, 1998)

- Executive Order 13123, Greening the Government through Efficient Energy Management (64 FR 30851, June 3, 1999)

- Executive Order 13148, Greening the Government through Leadership in Environmental Management (65 FR 24595, April 21, 2000)

- Executive Order 13149, Greening the Government through Federal Fleet and Transportation Efficiency (65 FR 24607, April 21, 2000)

- DOE Order 5400.1, Change 1, *General Environmental Protection Program* (June 29, 1990) (DOE 1990)

- DOE Order 430.2, *In-House Energy Management* (June 13, 2000) (This Order has been replaced by DOE Order 430.2A, *Departmental Energy and Utilities Management*, April 15, 2002) (DOE 1996a)

- DOE Notice 430.3, *Extension of DOE Order 430.2, In-House Energy Management,* (December 13, 2000) (This notice has been replaced by DOE Order 430.2A, *Departmental Energy and Utilities Management,* April 15, 2002) (DOE 1996a)

- DOE Order 435.1, *Radioactive Waste Management* (July 9, 1999) (This Order was supplemented by DOE Order 435.1, Change 1, August 28, 2001) (DOE 2001a)

- DOE Manual 435.1, *Radioactive Waste Management Manual* (July 9, 1999) (This manual was supplemented by DOE Manual, Change 1, June 19, 2001) (DOE 2001b)

The *Pollution Prevention Program Plan* outlines specific goals issued by the Secretary of Energy for reducing waste generation from routine operations and for reducing the use and release of toxic chemicals. This plan required that individual operations offices, like the Richland Operations Offices that is responsible for Hanford activities, develop its own goals to help achieve the DOE-wide goals set by the Secretary. The *Pollution Prevention Program Plan* set goals through December 31, 1999. Further goals have since been set for fiscal year (FY) 2005 and 2010.

DOE’s generation of all waste types, including LLW, MLLW, and transuranic waste has decreased substantially since 1993. This same trend in the reduction of wastes generated is also occurring at the Hanford Site. The reduction in waste generated by DOE during routine operations and during cleanup/stabilization activities has resulted in cost savings or avoidance of costs amounting to over

$120,000,000 in FY 2001. Of that figure, more than $22,000,000 of cost savings and cost avoidance occurred at Hanford (DOE 2002b).

Some examples of waste minimization activities performed at Hanford during FY 2001 are provided below (extracted from Coenenberg and Stitt 2001).

- Mechanical screening to separate contaminated soil from non-contaminated soil reduced the amount of soil that would have otherwise been sent to ERDF for disposal as LLW by almost 1400 m^3 and saved $192,000.
- Reusing lead from contaminated railcars in the 325 Building reduced the amount of lead that would have otherwise been treated and disposed of as MLLW by 2.1 m^3 and saved about $35,000.
- Upgrading the ion exchange system at the ETF will result in the reduction of the amount of MLLW that will be generated annually by 9.8 m^3 and will save about $38,000 annually.
- Recycling chemicals and gases; fire extinguishers; incandescent, sodium, and mercury vapor lamps; mercury and related equipment; shop towels; and small batteries reduced the amount of material that would have otherwise been treated and disposed of as hazardous waste by 8.5 tons and saved about $190,000.
- Recycling lead acid vehicle batteries reduced the amount of material that would have otherwise been treated and disposed of as hazardous waste by 8.5 tons and saved almost $200,000.
- Replacement of a high-performance liquid chromatograph and other laboratory equipment will result in the reduction of the amount of mixed low-level waste and hazardous waste that will be generated annually by about 0.1 m^3 and will save about $94,000 annually.
- Using slightly contaminated soil for shielding and mixing during remediation activities at the 100-N Crib reduced the amount of soil that would have otherwise been sent to ERDF for disposal as LLW by almost 3600 m^3 and saved about $450,000.

N.2.9 Transuranic Waste Considerations

A recent study by DOE (2002d) to accelerate disposal of TRU waste has considered the creation of a “western hub” to certify TRU waste from small-quantity sites for shipment to WIPP. Hanford is one of the sites being considered as a potential western hub. If Hanford is designated as a western hub, additional TRU waste may be shipped from small-quantity sites to Hanford for certification and temporary storage prior to shipment to WIPP for disposal.

N.3 References

40 CFR 300. “National Oil and Hazardous Substances Pollution Contingency Plan.” Code of Federal Regulations. Online at: http://www.access.gpo.gov/nara/cfr/waisidx_02/40cfr300_02.html

63 FR 49643. Executive Order 13101 of September 14, 1998. “Greening of Government through Waste Prevention, Recycling, and Federal Acquisition.” *Federal Register* (September 16, 1998). Online at: http://www.gpoaccess.gov/fr/index.html

64 FR 30851. “Executive Order 13123 of June 3, 1999. Greening the Government through Efficient Energy Management.” *Federal Register* (June 3, 1999). Online at: http://www.gpoaccess.gov/fr/index.html

65 FR 24595. “Executive Order 13148 of April 21, 2000. Greening the Government through Leadership in Environmental Management.” *Federal Register* (April 26, 2000). Online at: http://www.gpoaccess.gov/fr/index.html

65 FR 24607. “Executive Order 13149 of April 21, 2000. Greening the Government through Federal Fleet and Transportation Efficiency.” *Federal Register* (April 26, 2000). Online at: http://www.gpoaccess.gov/fr/index.html

68 FR 1052. “Notice of Intent to Prepare an Environmental Impact Statement for Retrieval, Treatment, and Disposal of Tank Waste and Closure of Single- Shell Tanks at the Hanford Site, Richland, Washington.” *Federal Register* (January 8, 2003). Online at: http://www.gpoaccess.gov/fr/index.html

42 USC 2011 et seq. Atomic Energy Act (AEA) of 1954. Online at: http://www4.law.cornell.edu

42 USC 4321 et seq. National Environmental Policy Act (NEPA) of 1969, as amended. Online at: http://www4.law.cornell.edu

42 USC 6901 et seq. Resource Conservation and Recovery Act (RCRA) of 1976. Online at: http://www4.law.cornell.edu

42 USC 9601 et seq. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. Online at: http://www4.law.cornell.edu

42 USC 13101. 1990. Pollution Prevention Act. Online at: http://www4.law.cornell.edu

ANSI/ISO. 1996. *Environmental Management Systems˜ Specifications with Guidance for Use*. ANSI/ISO 14001-1996, American Society for Quality Control, Milwaukee.

Coenenberg, J. G. and J. M. Stitt. 2001. *Pollution Prevention Accomplishments, Hanford Site, FY 2001*. DOE/RL-2000-79, Revision 1. U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE. 1990. *General Environmental Protection Program*. DOE Order 5400.1, Change 1, U.S. Department of Energy, Washington, D.C. Online at: http://www.directives.doe.gov/pdfs/doe/doetext/oldord/5400/o54001c1.pdf

DOE. 1993. *Radiation Protection of the Public and the Environment*. DOE Order 5400.5, U.S. Department of Energy, Washington, D.C. Online at: http://www.directives.doe.gov

DOE. 1994a. "Secretarial Policy on the National Environmental Policy Act." U.S. Department of Energy, Washington, D.C. Online at: http://www.directives.doe.gov

DOE. 1994b. *Waste Minimization/Pollution Prevention Crosscut Plan 1994*. DOE/FM-0145, U.S. Department of Energy, Office of the Secretary, Washington, D.C.

DOE. 1996a. *In-House Energy Management*. DOE Order 430.2, U.S. Department of Energy, Washington, D.C. Online at: http://www.directives.doe.gov/pdfs/doe/doetext/neword/430/o4302.pdf

DOE. 1996b. *Pollution Prevention Program Plan*. DOE/S-0118, May 3, 1996. U.S. Department of Energy, Office of the Secretary, Washington, D.C. Online at: http://www.osti.gov/bridge/purl/238516-46Z2Ea/webviewable

DOE. 1997a. *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*. DOE/EIS-0200-F, Vol. 1-5, U.S. Department of Energy, Washington, D.C.

DOE. 1997b. *Integrated Data Base Report – 1996: U.S. Spent Nuclear Fuel and Radioactive Waste Inventories, Projections, and Characteristics*. DOE/RW-0006, Rev. 13, U.S. Department of Energy, Office of Environmental Management, Washington, D.C.

DOE. 1997c. *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement*. DOE/EIS-0026-S-2, U.S. Department of Energy, Carlsbad Area Office, Carlsbad, New Mexico.

DOE. 1998. *Life Cycle Assessment Management*. DOE Order 430.1A, U.S. Department of Energy, Washington, D.C. Online at: http://www.directives.doe.gov/pdfs/doe/doetext/neword/430/o4301a.pdf

DOE. 2001a. *Radioactive Waste Management*. DOE Order 435.1, Change 1, U.S. Department of Energy, Washington, D.C. Online at: http://www.directives.doe.gov

DOE. 2001b. *Radioactive Waste Management Manual*. DOE Manual 435.1-1, U.S. Department of Energy, Washington, D.C. Online at: http://www.directives.doe.gov

DOE. 2002a. *A Review of the Environmental Management Program Presented to the Assistant Secretary for Environmental Management by the Top-to-Bottom Review Team.* U.S. Department of Energy, Office of Environmental Management, Washington, D.C. Online at: http://www.em.doe.gov/ttbr.pdf

DOE. 2002b. *Annual Report of Waste Generation and Pollution Prevention Progress 2001*. DOE/EM-0630, June 2002. U.S. Department of Energy, Office of Environmental Management, Washington, D.C. Online at: http://tis.eh.doe.gov/p2/wastemin/2001ar.pdf

DOE. 2002c. *Report to Congress – The Cost of Waste Disposal: Life Cycle Cost Analysis of Disposal of Department of Energy Low-Level Radioactive Waste at Federal and Commercial Facilities*. U.S. Department of Energy, Office of Environmental Management. Online at: http://www.envirocareutah.com/pages/pdf/Final_LLW_Report_7_08_02.pdf

DOE. 2002d. *Transuranic Waste Performance Management Plan.* U.S. Department of Energy, Carlsbad Field Office, Carlsbad, New Mexico. Online at: http://www.wipp.carlsbad.nm.us/suyw/july2002/FTWPMP.pdf

DOE-RL. 1999. *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program.* DOE/RL-98-28, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL. 2002a. *Cleanup, Constraints, and Challenges (C3T) Team Status Interim Report*. DOE/RL-2002-65, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Online at: http://www.hanford.gov/docs/rl-2002-65/rl-2002-65.pdf

DOE-RL. 2002b. *Performance Management Plan for the Accelerated Cleanup of the Hanford Site*. DOE/RL-2002-47, Rev. D, U.S. Department of Energy, Richland Operations Office and the Office of River Protection, Richland, Washington. Online at: http://www.hanford.gov/docs/rl-2002-47/rl-2002-47.pdf

DOE and Ecology. 1996. *Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement*. DOE/EIS-0189, U.S. Department of Energy, Richland Operations Office, Richland, Washington and Washington State Department of Ecology, Olympia, Washington.

Ecology, EPA, and DOE. 1989. *Hanford Federal Facility Agreement and Consent Order.* 89-10 (As Amended). Washington State Department of Ecology, U.S. Environmental Protection Agency, U.S. Department of Energy, Richland, Washington. Online at: http://www.hanford.gov/tpa/tpahome.htm

Envirocare of Utah, Inc. 2000a. *Envirocare Begins 5th Year of Service on K-25 Pond Project*. (April 2000). Online at: http://www.envirocareutah.com/pages/ecnews/ec_begins_5th.html

Envirocare of Utah, Inc. 2000b. *Envirocare Receives First Shipment from DOE Savannah River Site*. (October 2000). Online at: http://www.envirocareutah.com/pages/ecnews/waste_shipment_sr.html

Envirocare of Utah, Inc. 2000c. *Envirocare Receives High Marks from Department of Energy*. (March 2000). Online at: http://www.envirocareutah.com/pages/ecnews/ec_receives.html

Poston, T. M., R. W. Hanf, R. L. Dirkes, and L. F. Morasch (eds.). 2003. *Hanford Site Environmental Report for Calendar Year 2002*. PNNL-14295, Pacific Northwest National Laboratory, Richland, Washington. Online at: http://hanford-site.pnl.gov/envreport/2002/index.htm

Appendix O

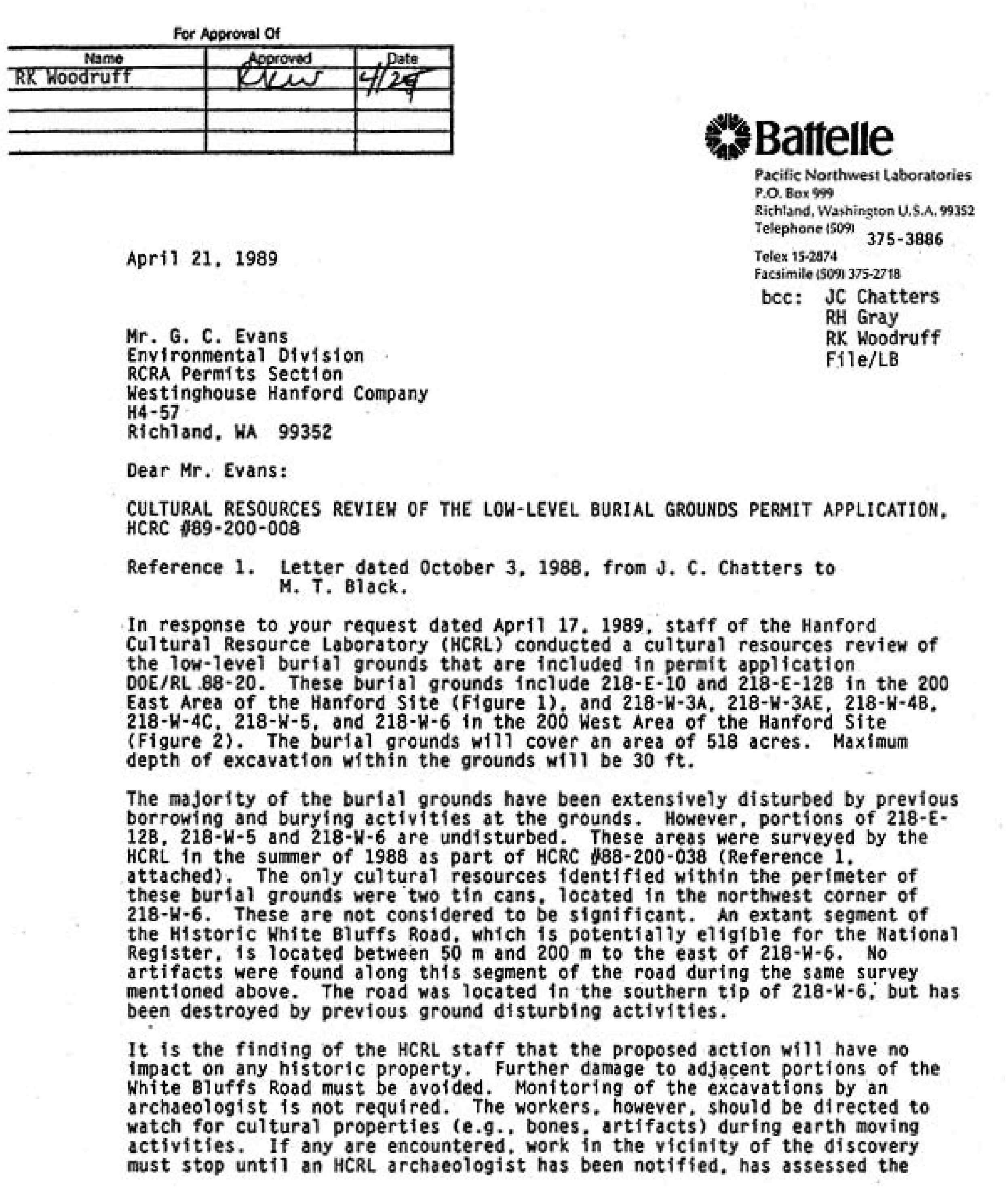
Unpublished Sources Cited in the Hanford Site Solid (Radioactive and Hazardous) Waste Environmental Impact Statement

Appendix O

Unpublished Sources Cited in the Hanford Site Solid (Radioactive and Hazardous) Waste Environmental Impact Statement

This appendix contains sources such as personal communications, memos, and other reference material. These sources are listed in alphabetical order as they were called out in the text of this Hanford Site Solid (Radioactive and Hazardous) Waste Environmental Impact Statement, and each new source starts on a face page.

HCRC# 89-200-008. Cadoret, N. A. and J. C. Chatters. September 1989. Archaeological Survey of the 200 East and 200 West Areas, Hanford Site, Washington. Unpublished report prepared for the U.S. Department of Energy. Copy on file at Pacific Northwest National Laboratory, Richland, Washington.



For Approval Of

Name	Approved	Date
RK Woodruff		4/25

Battelle
Pacific Northwest Laboratories
P.O. Box 999
Richland, Washington U.S.A. 99352
Telephone (509) 375-3886
Telex 15-2874
Facsimile (509) 375-2718

bcc: JC Chatters
RH Gray
RK Woodruff
File/LB

April 21, 1989

Mr. G. C. Evans
Environmental Division
RCRA Permits Section
Westinghouse Hanford Company
H4-57
Richland, WA 99352

Dear Mr. Evans:

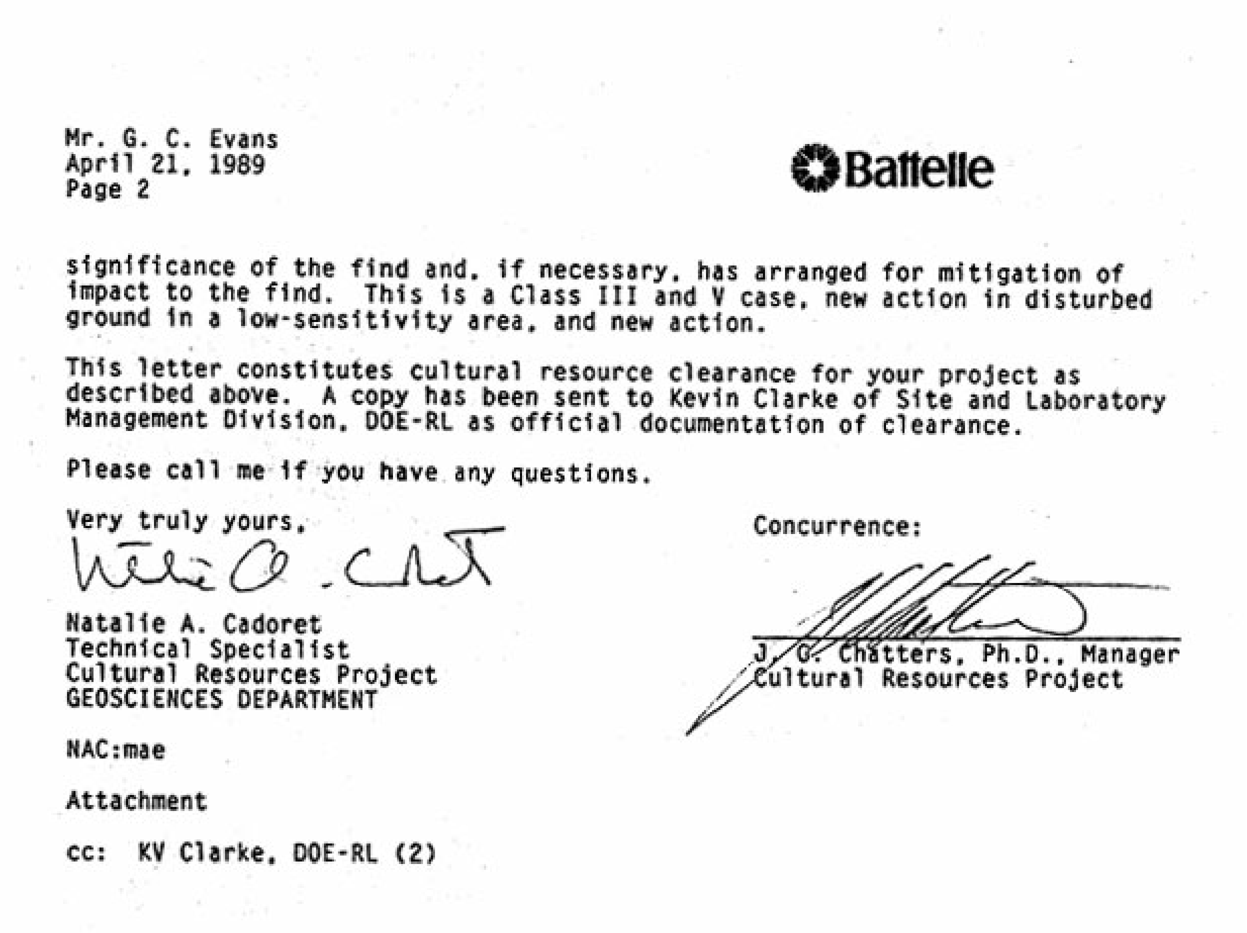
CULTURAL RESOURCES REVIEW OF THE LOW-LEVEL BURIAL GROUNDS PERMIT APPLICATION, HCRC #89-200-008

Reference 1. Letter dated October 3, 1988, from J. C. Chatters to M. T. Black.

In response to your request dated April 17, 1989, staff of the Hanford Cultural Resource Laboratory (HCRL) conducted a cultural resources review of the low-level burial grounds that are included in permit application DOE/RL 88-20. These burial grounds include 218-E-10 and 218-E-12B in the 200 East Area of the Hanford Site (Figure 1), and 218-W-3A, 218-W-3AE, 218-W-4B, 218-W-4C, 218-W-5, and 218-W-6 in the 200 West Area of the Hanford Site (Figure 2). The burial grounds will cover an area of 518 acres. Maximum depth of excavation within the grounds will be 30 ft.

The majority of the burial grounds have been extensively disturbed by previous borrowing and burying activities at the grounds. However, portions of 218-E-12B, 218-W-5 and 218-W-6 are undisturbed. These areas were surveyed by the HCRL in the summer of 1988 as part of HCRC #88-200-038 (Reference 1, attached). The only cultural resources identified within the perimeter of these burial grounds were two tin cans, located in the northwest corner of 218-W-6. These are not considered to be significant. An extant segment of the Historic White Bluffs Road, which is potentially eligible for the National Register, is located between 50 m and 200 m to the east of 218-W-6. No artifacts were found along this segment of the road during the same survey mentioned above. The road was located in the southern tip of 218-W-6, but has been destroyed by previous ground disturbing activities.

It is the finding of the HCRL staff that the proposed action will have no impact on any historic property. Further damage to adjacent portions of the White Bluffs Road must be avoided. Monitoring of the excavations by an archaeologist is not required. The workers, however, should be directed to watch for cultural properties (e.g., bones, artifacts) during earth moving activities. If any are encountered, work in the vicinity of the discovery must stop until an HCRL archaeologist has been notified, has assessed the



Mr. G. C. Evans
April 21, 1989
Page 2

Battelle

significance of the find and, if necessary, has arranged for mitigation of impact to the find. This is a Class III and V case, new action in disturbed ground in a low-sensitivity area, and new action.

This letter constitutes cultural resource clearance for your project as described above. A copy has been sent to Kevin Clarke of Site and Laboratory Management Division, DOE-RL as official documentation of clearance.

Please call me if you have any questions.

Very truly yours,

Natalie A. Cadoret
Technical Specialist
Cultural Resources Project
GEOSCIENCES DEPARTMENT

Concurrence:

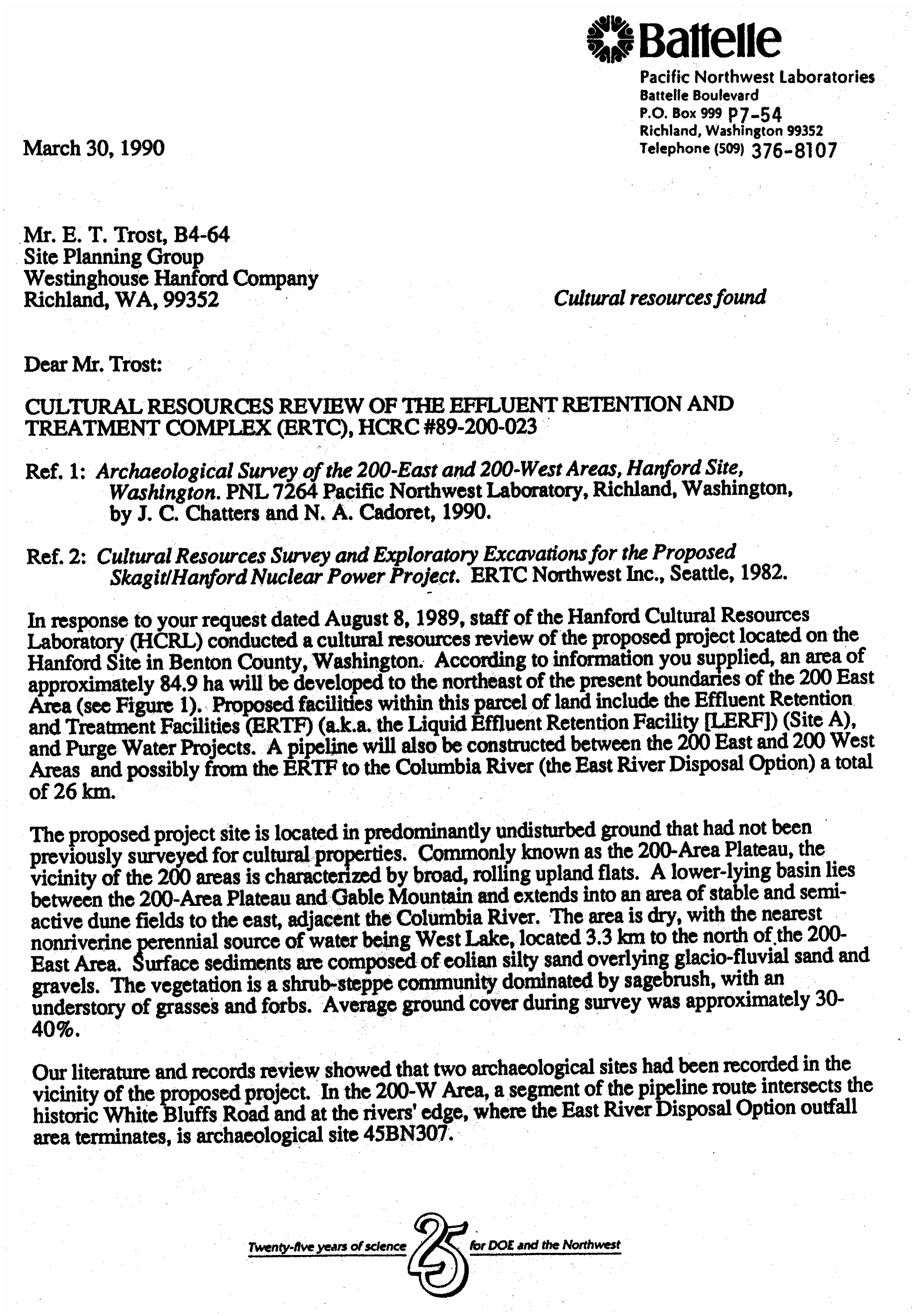
J. C. Chatters, Ph.D., Manager
Cultural Resources Project

NAC:mae

Attachment

cc: KV Clarke, DOE-RL (2)

HCRC #89-200-023. Minthorn, P. E. March 1990. Cultural Resources Review of the Effluent Retention and Treatment Complex (ERTC). Unpublished report prepared for Westinghouse Hanford Company. Copy on file at Pacific Northwest National Laboratory, Richland, Washington.



Battelle
Pacific Northwest Laboratories
Battelle Boulevard
P.O. Box 999 P7-54
Richland, Washington 99352
Telephone (509) 376-8107

March 30, 1990

Mr. E. T. Trost, B4-64
Site Planning Group
Westinghouse Hanford Company
Richland, WA, 99352

Cultural resources found

Dear Mr. Trost:

CULTURAL RESOURCES REVIEW OF THE EFFLUENT RETENTION AND TREATMENT COMPLEX (ERTC), HCRC #89-200-023

Ref. 1: *Archaeological Survey of the 200-East and 200-West Areas, Hanford Site, Washington.* PNL 7264 Pacific Northwest Laboratory, Richland, Washington, by J. C. Chatters and N. A. Cadoret, 1990.

Ref. 2: *Cultural Resources Survey and Exploratory Excavations for the Proposed Skagit/Hanford Nuclear Power Project.* ERTC Northwest Inc., Seattle, 1982.

In response to your request dated August 8, 1989, staff of the Hanford Cultural Resources Laboratory (HCRL) conducted a cultural resources review of the proposed project located on the Hanford Site in Benton County, Washington. According to information you supplied, an area of approximately 84.9 ha will be developed to the northeast of the present boundaries of the 200 East Area (see Figure 1). Proposed facilities within this parcel of land include the Effluent Retention and Treatment Facilities (ERTF) (a.k.a. the Liquid Effluent Retention Facility [LERF]) (Site A), and Purge Water Projects. A pipeline will also be constructed between the 200 East and 200 West Areas and possibly from the ERTF to the Columbia River (the East River Disposal Option) a total of 26 km.

The proposed project site is located in predominantly undisturbed ground that had not been previously surveyed for cultural properties. Commonly known as the 200-Area Plateau, the vicinity of the 200 areas is characterized by broad, rolling upland flats. A lower-lying basin lies between the 200-Area Plateau and Gable Mountain and extends into an area of stable and semi-active dune fields to the east, adjacent the Columbia River. The area is dry, with the nearest nonriverine perennial source of water being West Lake, located 3.3 km to the north of the 200-East Area. Surface sediments are composed of eolian silty sand overlying glacio-fluvial sand and gravels. The vegetation is a shrub-steppe community dominated by sagebrush, with an understory of grasses and forbs. Average ground cover during survey was approximately 30-40%.

Our literature and records review showed that two archaeological sites had been recorded in the vicinity of the proposed project. In the 200-W Area, a segment of the pipeline route intersects the historic White Bluffs Road and at the rivers' edge, where the East River Disposal Option outfall area terminates, is archaeological site 45BN307.

Twenty-five years of science 25 for DOE and the Northwest

P.E. Minthorn and N.A. Cadoret conducted a pedestrian survey of the proposed project area from 11-7-89 to 1-10-90, using a 20-m transect spacing. When archaeological properties were encountered, the survey was intensified to locate the approximate boundaries of each site.

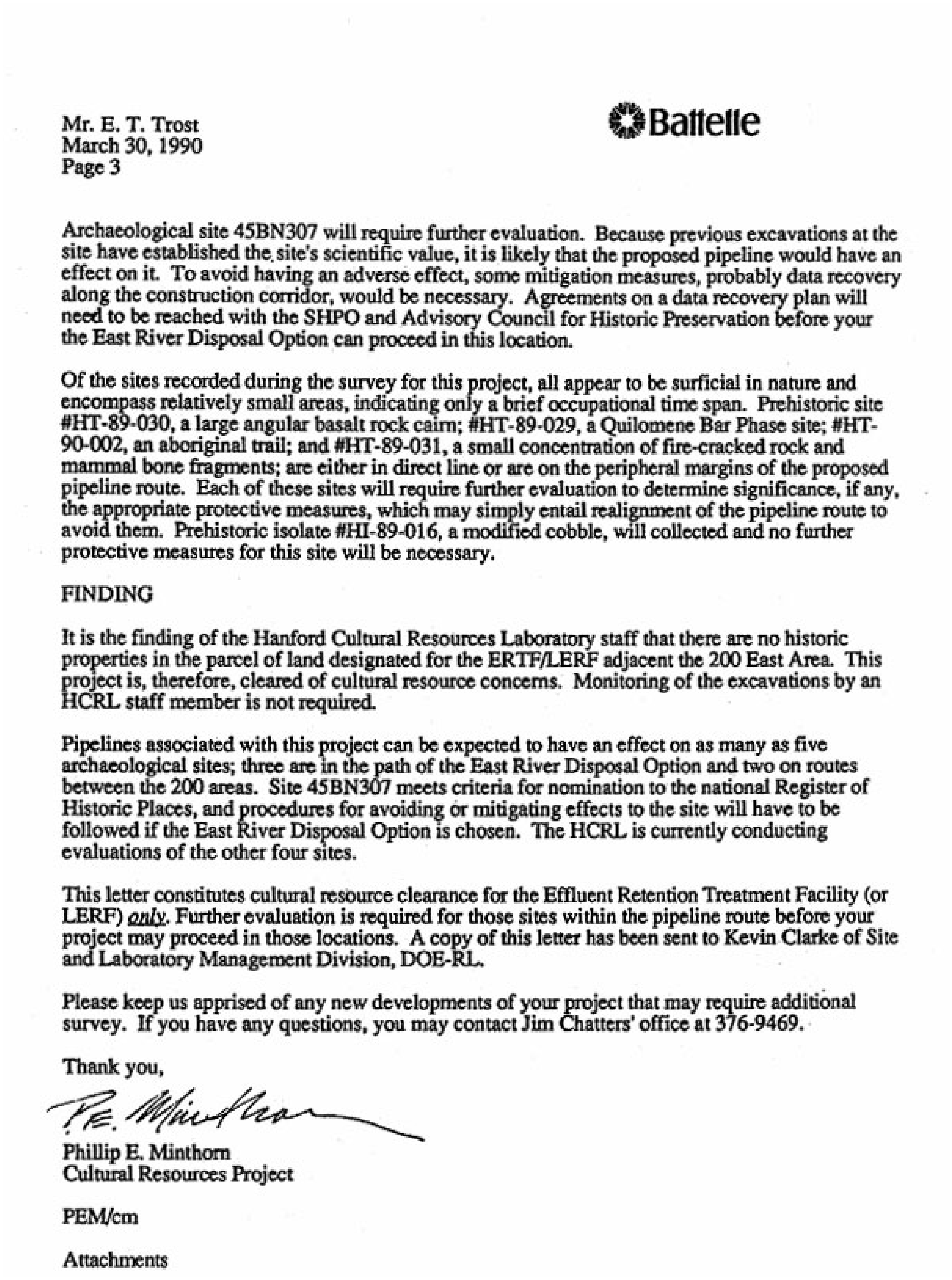
SURVEY RESULTS

No cultural properties were identified in the area designated for the ERTC or the LERF. However, five prehistoric sites were encountered along the proposed pipeline route. In the East River Disposal Option area, two archaeological sites were recorded, temporarily designated HT-89-029 and HT-90-002. HT-89-029 is a Quilomene Bar Phase site with an age range of 2500-1500 yrs. B.P. and includes a scatter of mammal bone fragments, fire cracked rocks, and one diagnostic projectile point. HT-90-002 is an aboriginal trail extending 140m northeast-southwest. Another archaeological site HT-89-030 was recorded in the pipeline route that extends east-west on the northern edge of the 200-West and 200-East areas and consists of a cairn made from large angular basalt cobbles. On the portion of the pipeline connecting the southern edges of the 200-West and 200-East Areas, two archaeological properties, HT-89-031 and HI-89-016, were recorded. HT-89-031 consists of a small concentration of fire-cracked rock and mammal bone fragments and HI-89-016 is an isolated cobble tool.

The two previously recorded sites are intersected by the project's pipelines, the White Bluffs Road by the line between the northern edges of the 200- East and 200-West Areas, and archaeological Site 45BN307 by the East River Disposal Option; both require special consideration. The HCRL has determined that the historic White Bluffs Road meets criteria for eligibility for nomination to the National Register of Historic Places (NRHP) and is, therefore accorded certain protective measures. Archaeological site 45BN307 previously has been found to meet criteria for nomination to the NRHP, based on archaeological materials present their scientific potential for contributing to an understanding of local and regional prehistory (see Reference 2). Exploratory excavations at 45BN307, conducted by ERTEC, Inc. in 1979, revealed a previously undisturbed prehistoric cultural deposit dating from approximately 1500 B.P. to historic times. However, review of the data reported by ERTEC shows that this conclusion is incorrect. Their records show that this site contains late Frenchman Springs Phase ca 3500-2800 B.P. and a Vantage/Cascade Phase ca 8000-4000 B.P. manifestations. Reconnaissance of the site for this project also substantiated this assessment by locating a probable Cascade Phase artifact. This finding only enhances the site's claim to statutory protections.

RECOMMENDATIONS

Recommendations for the historic White Bluffs Road include the road and a culturally sensitive zone 200-m wide. Procedure requires that proposed projects located near the road be designed to minimize any foreseeable impacts upon the road and the area surrounding it. If an impact is unavoidable, we will have to reach an agreement with the Washington State Historic Preservation Officer (SHPO) and Advisory Council for Historic Preservation that would result in a finding of no adverse effect. It appears, however, that the road has already been disturbed in the location where it is intersected by the pipeline, so construction of the pipeline will have no new effects on the road.



Archaeological site 45BN307 will require further evaluation. Because previous excavations at the site have established the site's scientific value, it is likely that the proposed pipeline would have an effect on it. To avoid having an adverse effect, some mitigation measures, probably data recovery along the construction corridor, would be necessary. Agreements on a data recovery plan will need to be reached with the SHPO and Advisory Council for Historic Preservation before your the East River Disposal Option can proceed in this location.

Of the sites recorded during the survey for this project, all appear to be surficial in nature and encompass relatively small areas, indicating only a brief occupational time span. Prehistoric site #HT-89-030, a large angular basalt rock cairn; #HT-89-029, a Quilomene Bar Phase site; #HT-90-002, an aboriginal trail; and #HT-89-031, a small concentration of fire-cracked rock and mammal bone fragments; are either in direct line or are on the peripheral margins of the proposed pipeline route. Each of these sites will require further evaluation to determine significance, if any, the appropriate protective measures, which may simply entail realignment of the pipeline route to avoid them. Prehistoric isolate #HI-89-016, a modified cobble, will collected and no further protective measures for this site will be necessary.

FINDING

It is the finding of the Hanford Cultural Resources Laboratory staff that there are no historic properties in the parcel of land designated for the ERTF/LERF adjacent the 200 East Area. This project is, therefore, cleared of cultural resource concerns. Monitoring of the excavations by an HCRL staff member is not required.

Pipelines associated with this project can be expected to have an effect on as many as five archaeological sites; three are in the path of the East River Disposal Option and two on routes between the 200 areas. Site 45BN307 meets criteria for nomination to the national Register of Historic Places, and procedures for avoiding or mitigating effects to the site will have to be followed if the East River Disposal Option is chosen. The HCRL is currently conducting evaluations of the other four sites.

This letter constitutes cultural resource clearance for the Effluent Retention Treatment Facility (or LERF) *only*. Further evaluation is required for those sites within the pipeline route before your project may proceed in those locations. A copy of this letter has been sent to Kevin Clarke of Site and Laboratory Management Division, DOE-RL.

Please keep us apprised of any new developments of your project that may require additional survey. If you have any questions, you may contact Jim Chatters' office at 376-9469.

Thank you,

Phillip E. Minthorn
Cultural Resources Project

PEM/cm

Attachments

HCRC #93-200-074. Crist, M. E., and M. K. Wright. June 1993. *Cultural Resources Review of the Solid Waste Retrieval Complex, Phase I (W-113) and Enhanced Radioactive and Mixed Waste Storage Facility Project.* Unpublished report prepared for Westinghouse Hanford Company. Copy on file at Pacific Northwest National Laboratory, Richland, Washington.

Battelle
Pacific Northwest Laboratories
Battelle Boulevard
P.O. Box 999
Richland, Washington 99352
Telephone (509)
372-1791

June 28, 1993

Cultural Resources Present

Mr. Ben Floyd
Westinghouse Hanford Company
Solid Waste Disposal
P. O. Box 1970/N3-13
Richland, WA 99352

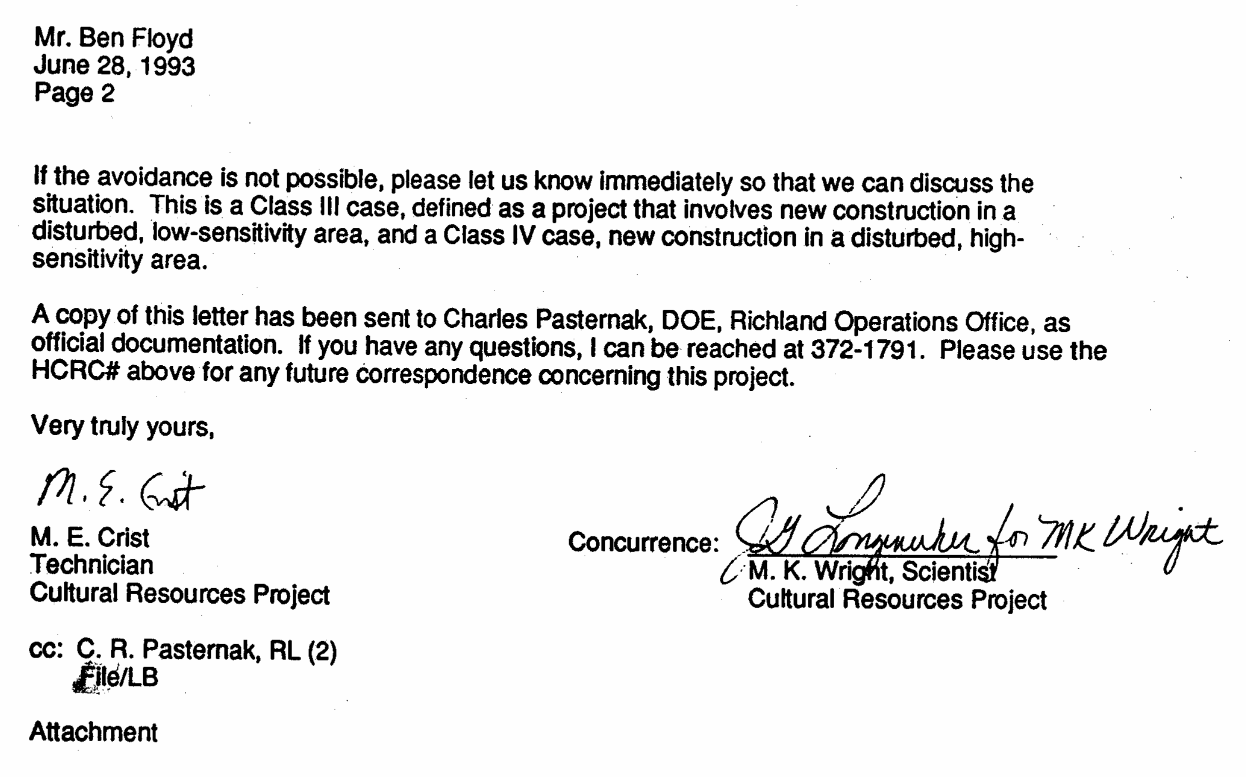
CULTURAL RESOURCES REVIEW OF THE SOLID WASTE RETRIEVAL COMPLEX, PHASE I (W-113) AND ENHANCED RADIOACTIVE AND MIXED WASTE STORAGE FACILITY PROJECT. HCRC #93-200-074.

Dear Ben:

In response to your request received June 25, 1993, staff of the Hanford Cultural Resources Laboratory (HCRL) conducted a cultural resources review of the subject project, located in the 200 Area of the Hanford Site. According to the information that you supplied, the project entails constructing and operating the Phase I Retrieval complex for retrieving transuranic solid waste, which will include several support buildings and facilities. It will also involve the construction and operation of a Phase V Facility for storage of waste containers.

Our literature and records review shows that the project area has been previously surveyed (HCRC #88-200-005). Two isolates and one historic site were located on the survey. The isolates, one .38 caliber cartridge and one broken cryptocrystalline flake, and the site, consisting of one can and blue glass fragments, are not eligible for the National Register of Historic Places (NRHP). However, the historically significant White Bluffs Road will run through the southeast corner of the proposed project area (see attachment). Although the section of road that will pass through the project has been grated and does not appear to be eligible for the NRHP, a report of eligibility needs to be written (currently in progress by our office) and submitted to the State Historic Preservation Officer (SHPO), who then has thirty days to respond to our findings. Until that time, the road needs to be avoided by this and other projects.

It is the finding of the HCRL staff that the White Bluffs Road and a 100 meter buffer zone on both sides of it needs to be avoided by this project if at all possible. If the avoidance is possible, we find that there are no known significant cultural resources in the remaining project area. The workers, however, must be directed to watch for cultural materials (e.g., bones, artifacts) during excavations. If any are encountered, work in the vicinity of the discovery must stop until an HCRL archaeologist has been notified, assessed the significance of the find, and, if necessary, arranged for mitigation of the impacts to the find. If avoidance of the road is possible, please send us a map of the new project boundaries.



Mr. Ben Floyd
June 28, 1993
Page 2

If the avoidance is not possible, please let us know immediately so that we can discuss the situation. This is a Class III case, defined as a project that involves new construction in a disturbed, low-sensitivity area, and a Class IV case, new construction in a disturbed, high-sensitivity area.

A copy of this letter has been sent to Charles Pasternak, DOE, Richland Operations Office, as official documentation. If you have any questions, I can be reached at 372-1791. Please use the HCRC# above for any future correspondence concerning this project.

Very truly yours,

M. E. Crist

M. E. Crist
Technician
Cultural Resources Project

Concurrence: JG Longenecker for MK Wright
M. K. Wright, Scientist
Cultural Resources Project

cc: C. R. Pasternak, RL (2)
File/LB

Attachment

HCRC #95-200-104. Cadoret, N. A., and P. R. Nickens. May 1995. *Cultural Resources Review of the Solid Waste Retrieval Complex, Enhanced Radioactive and Mixed Waste Storage Facility, Infrastructure Upgrades, and Central Waste Support Complex.* Unpublished report prepared for Westinghouse Hanford Company. Copy on file at Pacific Northwest National Laboratory, Richland, Washington.

Battelle
Pacific Northwest Laboratories
Battelle Boulevard
P.O. Box 999
Richland, Washington 99352
Telephone (509) 376-8107

May 15, 1995

No Known Historic Properties

Ms. P. C. Berlin
Westinghouse Hanford Company
P. O. Box 1970/MSIN N3-13
Richland, WA 99352

Dear Ms. Berlin:

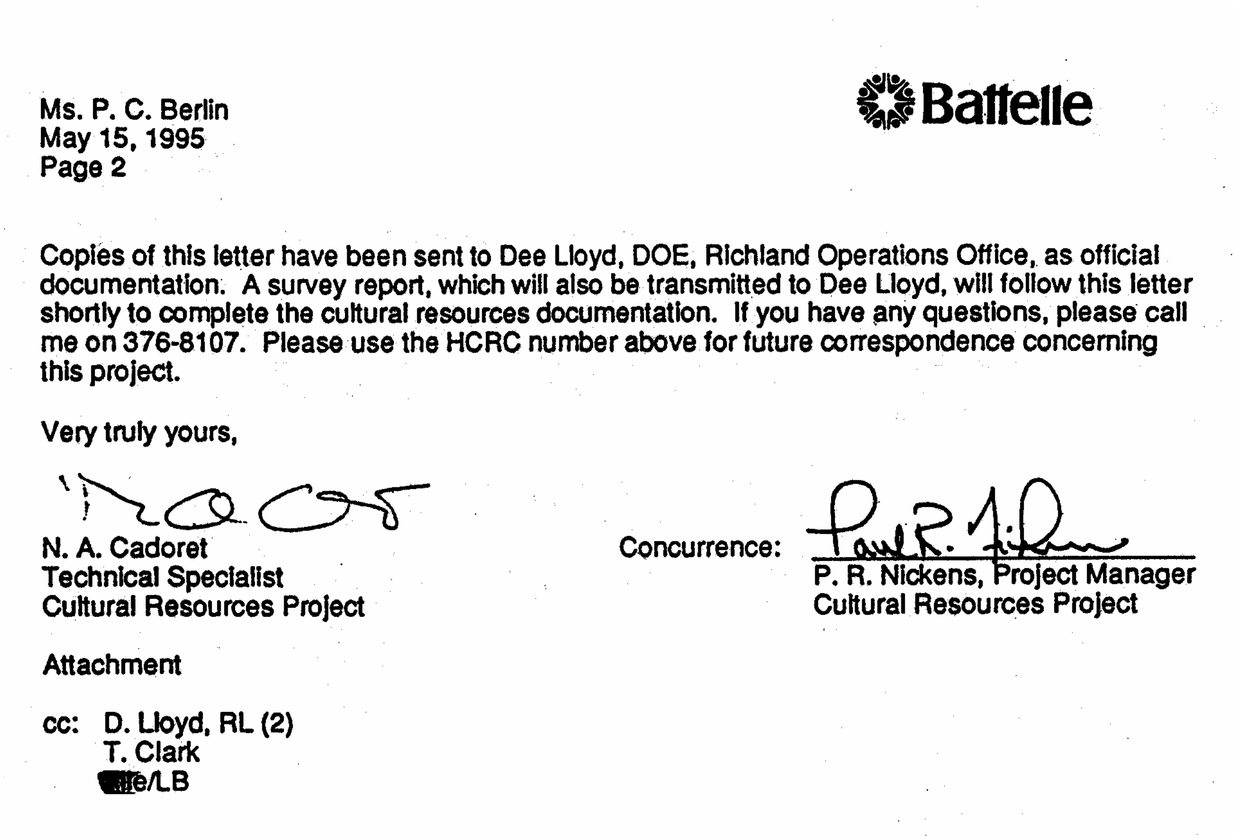
CULTURAL RESOURCES REVIEW OF THE SOLID WASTE RETRIEVAL COMPLEX, ENHANCED RADIOACTIVE AND MIXED WASTE STORAGE FACILITY, INFRASTRUCTURE UPGRADES, AND CENTRAL WASTE SUPPORT COMPLEX. HCRC #95-200-104

In response to your request received May 3, 1995, staff of the Hanford Cultural Resources Laboratory (HCRL) conducted a cultural resources review of the subject project, located in the 200 West Area of the Hanford Site. The entire project area has been previously submitted to the HCRL for review (HCRC #88-200-005, #92-200-001, #93-200-074, #94-200-169, #95-200-039), except for the future sewer drainfield located on the west edge of the project area, west of Eugene Ave and north of 22nd St.

Our literature and records review shows that portions of the project area have been disturbed by previous Hanford Site activities. It is very unlikely that any intact archaeological materials exist in such disturbed ground. Most of the project area located in undeveloped ground, except for the future sewer drainfield, has been surveyed previously by HCRL staff (HCRC #88-200-005 and HCRC #88-200-038). A portion of the historic White Bluffs Road is within the proposed complex. This road has been determined to be eligible for listing on the National Register of Historic Places (Register), however, that section of the road located within the fenced 200 West Area has been found to be a non-contributing element. Therefore, this portion of the road is not considered to be a historic property. One site and two isolated artifacts were also found during the surveys. The two artifacts were collected and the site, a historic trash scatter, is not eligible for listing on the Register.

A survey of the proposed future sewer drainfield was completed by HCRL staff on May 9 and 12, 1995. No archaeological sites or isolates were recorded during this survey. The attached map shows the areas that have been surveyed in the project vicinity.

It is the finding of the HCRL staff that there are no known historic properties within the proposed project area. The workers, however, must be directed to watch for cultural materials (e.g., bones, artifacts) during all work activities. If any are encountered, work in the vicinity of the discovery must stop until an HCRL archaeologist has been notified, assessed the significance of the find, and, if necessary, arranged for mitigation of the impacts to the find. The HCRL must be notified if any changes to project location or scope are anticipated. This is a Class III and V case, defined as a project which involves new construction in a disturbed, low-sensitivity area and in an undisturbed area.



Battelle

Copies of this letter have been sent to Dee Lloyd, DOE, Richland Operations Office, as official documentation. A survey report, which will also be transmitted to Dee Lloyd, will follow this letter shortly to complete the cultural resources documentation. If you have any questions, please call me on 376-8107. Please use the HCRC number above for future correspondence concerning this project.

Very truly yours,

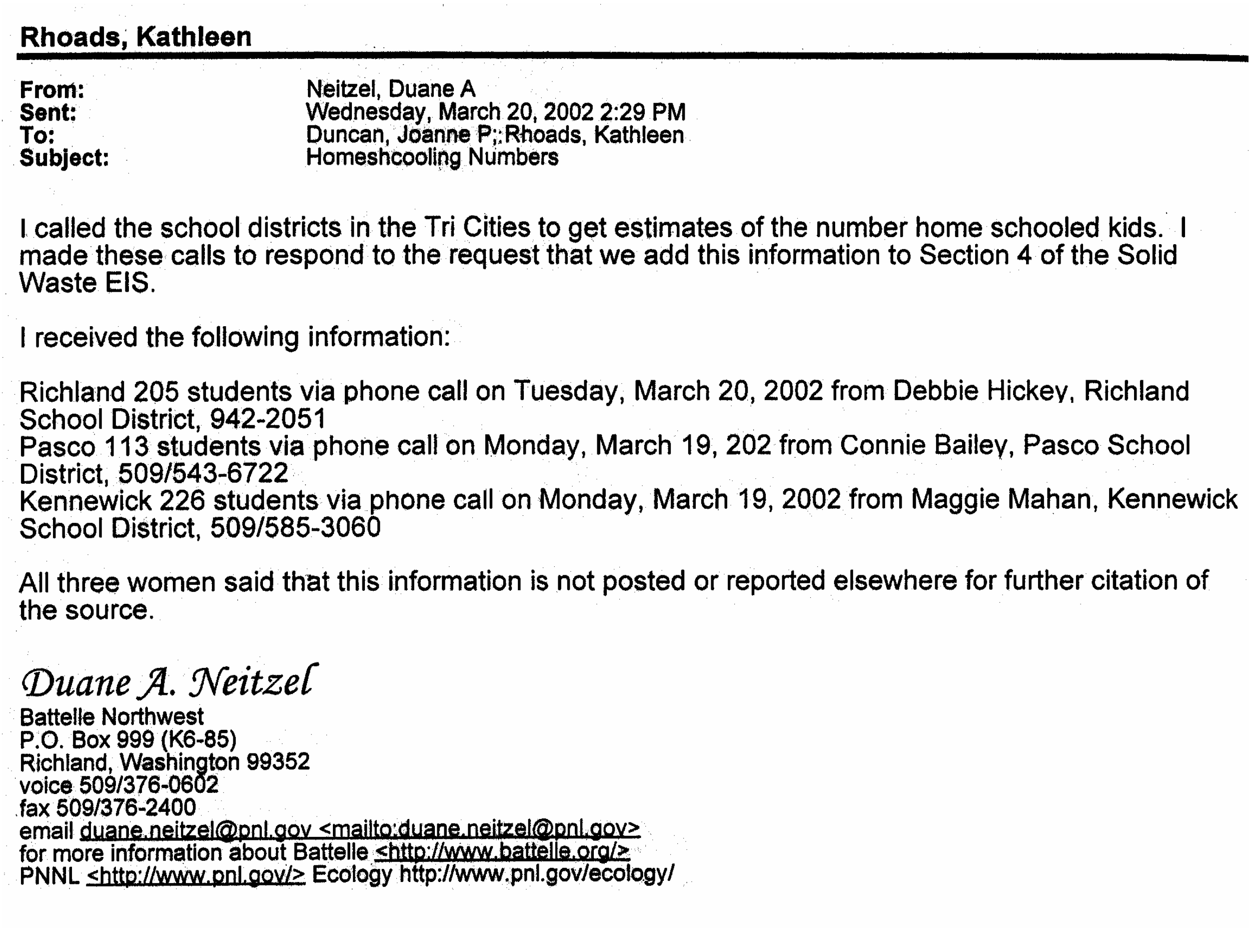
N. A. Cadoret
Technical Specialist
Cultural Resources Project

Concurrence:
P. R. Nickens, Project Manager
Cultural Resources Project

Attachment

cc: D. Lloyd, RL (2)
T. Clark
[redacted]e/LB

Neitzel, D. A. 2002b. Personal communication with Debbie Hickey (Richland School District), Connie Bailey (Pasco School District), and Maggie Mahan (Kennewick School District).



Rhoads, Kathleen

From: Neitzel, Duane A
Sent: Wednesday, March 20, 2002 2:29 PM
To: Duncan, Joanne P;Rhoads, Kathleen
Subject: Homeshcooling Numbers

I called the school districts in the Tri Cities to get estimates of the number home schooled kids. I made these calls to respond to the request that we add this information to Section 4 of the Solid Waste EIS.

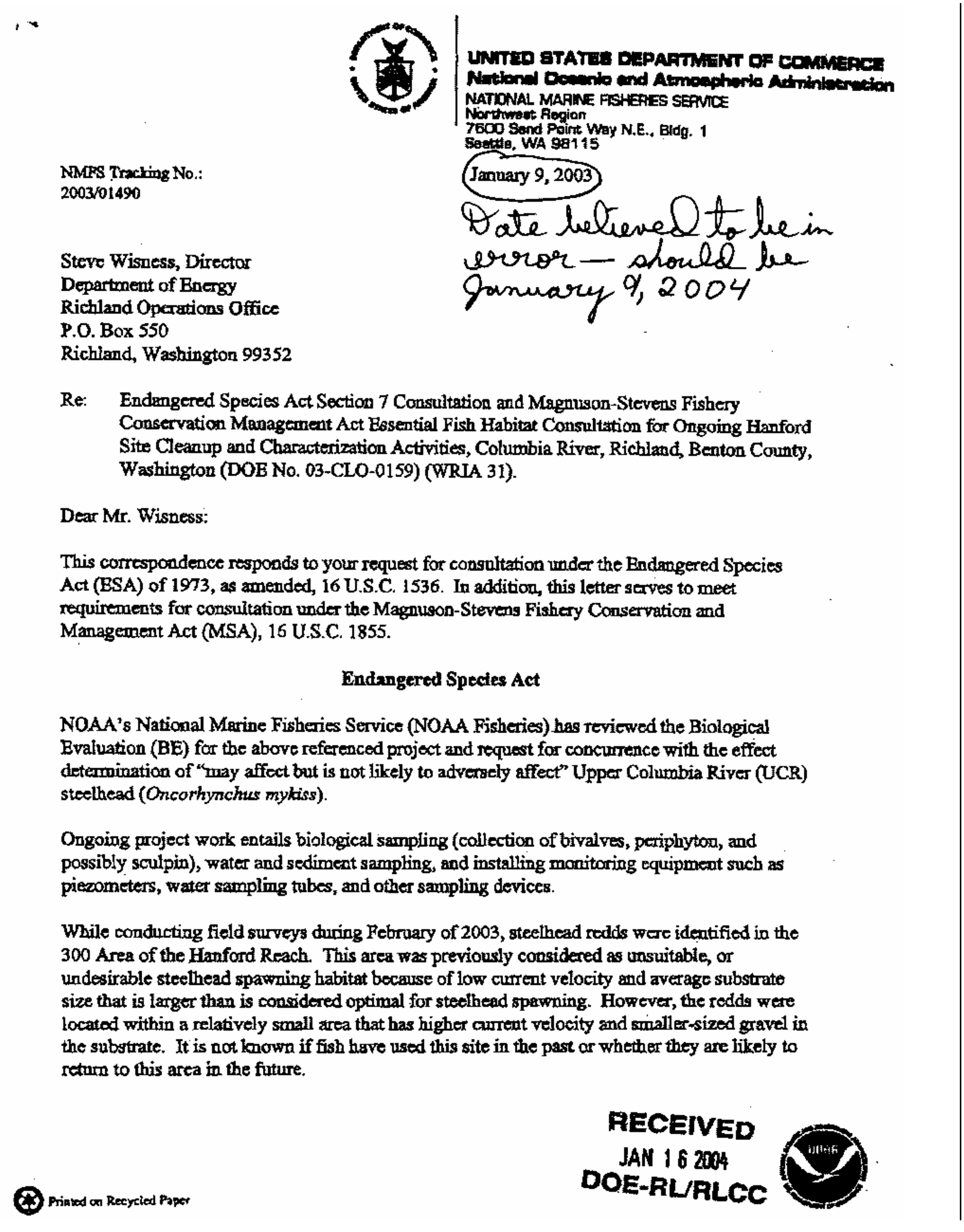
I received the following information:

Richland 205 students via phone call on Tuesday, March 20, 2002 from Debbie Hickey, Richland School District, 942-2051
Pasco 113 students via phone call on Monday, March 19, 202 from Connie Bailey, Pasco School District, 509/543-6722
Kennewick 226 students via phone call on Monday, March 19, 2002 from Maggie Mahan, Kennewick School District, 509/585-3060

All three women said that this information is not posted or reported elsewhere for further citation of the source.

Duane A. Neitzel
Battelle Northwest
P.O. Box 999 (K6-85)
Richland, Washington 99352
voice 509/376-0602
fax 509/376-2400
email duane.neitzel@pnl.gov <mailto:duane.neitzel@pnl.gov>
for more information about Battelle <http://www.battelle.org/>
PNNL <http://www.pnl.gov/> Ecology http://www.pnl.gov/ecology/

Lohn, R.D. January 9, 2004. Letter to S. Wisness, DOE, “Endangered Species Act Section 7 Consultation and Magnuson-Stevens Fishery Conservation Management Act Essential Fish Habitat Consultation for Ongoing Hanford Site Cleanup and Characterization Activities, Columbia River, Richland, Benton County, Washington (DOE No. 03-CLO-0159) (WRIA 31).” NMFS Tracking No. 2003/01490, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, United States Department of Commerce, Seattle, WA.



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northwest Region
7600 Sand Point Way N.E., Bldg. 1
Seattle, WA 98115

NMFS Tracking No.:
2003/01490

January 9, 2003

Date believed to be in error — should be January 9, 2004

Steve Wisness, Director
Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

Re: Endangered Species Act Section 7 Consultation and Magnuson-Stevens Fishery Conservation Management Act Essential Fish Habitat Consultation for Ongoing Hanford Site Cleanup and Characterization Activities, Columbia River, Richland, Benton County, Washington (DOE No. 03-CLO-0159) (WRIA 31).

Dear Mr. Wisness:

This correspondence responds to your request for consultation under the Endangered Species Act (ESA) of 1973, as amended, 16 U.S.C. 1536. In addition, this letter serves to meet requirements for consultation under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), 16 U.S.C. 1855.

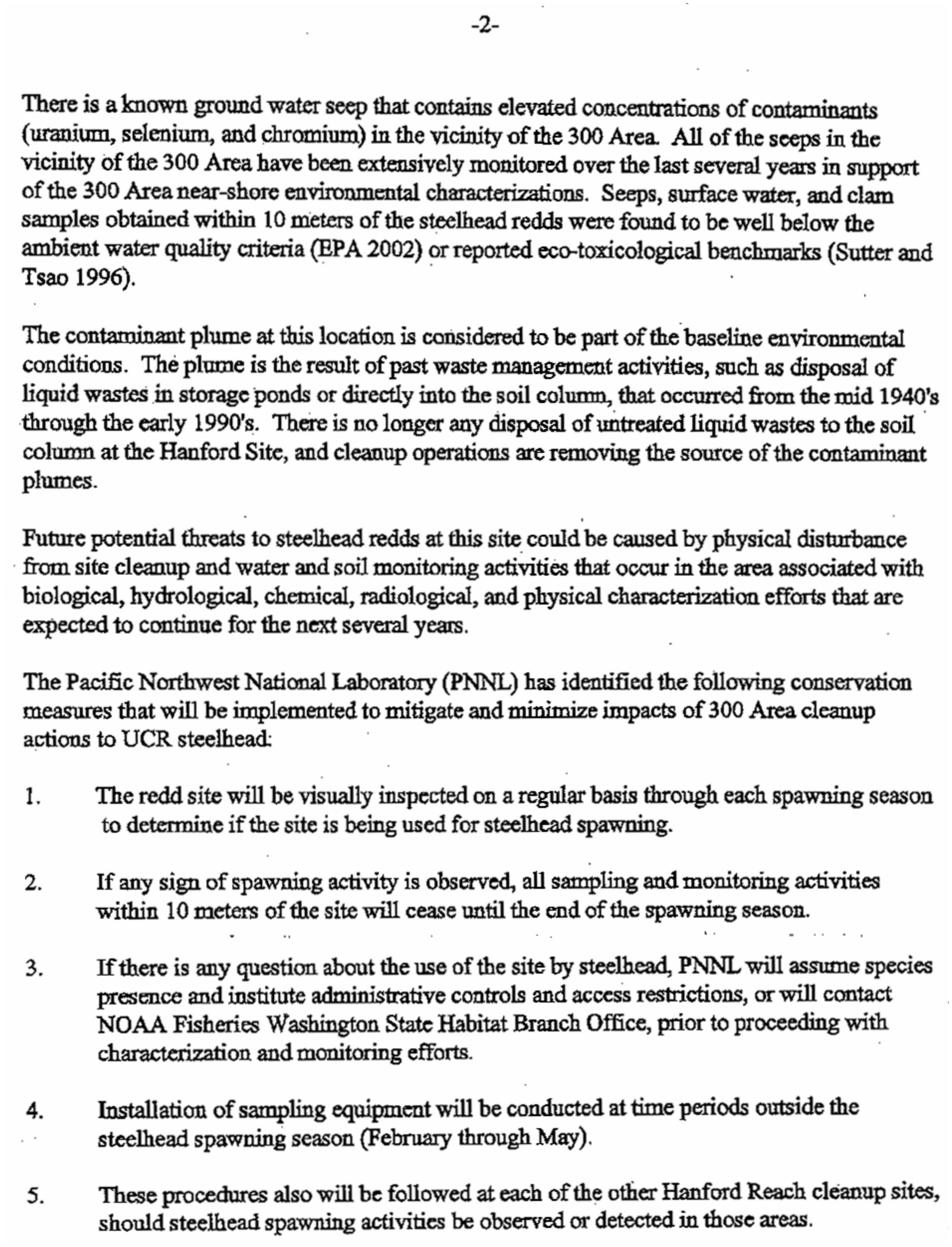
Endangered Species Act

NOAA's National Marine Fisheries Service (NOAA Fisheries) has reviewed the Biological Evaluation (BE) for the above referenced project and request for concurrence with the effect determination of "may affect but is not likely to adversely affect" Upper Columbia River (UCR) steelhead (*Oncorhynchus mykiss*).

Ongoing project work entails biological sampling (collection of bivalves, periphyton, and possibly sculpin), water and sediment sampling, and installing monitoring equipment such as piezometers, water sampling tubes, and other sampling devices.

While conducting field surveys during February of 2003, steelhead redds were identified in the 300 Area of the Hanford Reach. This area was previously considered as unsuitable, or undesirable steelhead spawning habitat because of low current velocity and average substrate size that is larger than is considered optimal for steelhead spawning. However, the redds were located within a relatively small area that has higher current velocity and smaller-sized gravel in the substrate. It is not known if fish have used this site in the past or whether they are likely to return to this area in the future.

RECEIVED
JAN 16 2004
DOE-RL/RLCC



There is a known ground water seep that contains elevated concentrations of contaminants (uranium, selenium, and chromium) in the vicinity of the 300 Area. All of the seeps in the vicinity of the 300 Area have been extensively monitored over the last several years in support of the 300 Area near-shore environmental characterizations. Seeps, surface water, and clam samples obtained within 10 meters of the steelhead redds were found to be well below the ambient water quality criteria (EPA 2002) or reported eco-toxicological benchmarks (Sutter and Tsao 1996).

The contaminant plume at this location is considered to be part of the baseline environmental conditions. The plume is the result of past waste management activities, such as disposal of liquid wastes in storage ponds or directly into the soil column, that occurred from the mid 1940's through the early 1990's. There is no longer any disposal of untreated liquid wastes to the soil column at the Hanford Site, and cleanup operations are removing the source of the contaminant plumes.

Future potential threats to steelhead redds at this site could be caused by physical disturbance from site cleanup and water and soil monitoring activities that occur in the area associated with biological, hydrological, chemical, radiological, and physical characterization efforts that are expected to continue for the next several years.

The Pacific Northwest National Laboratory (PNNL) has identified the following conservation measures that will be implemented to mitigate and minimize impacts of 300 Area cleanup actions to UCR steelhead:

1. The redd site will be visually inspected on a regular basis through each spawning season to determine if the site is being used for steelhead spawning.

2. If any sign of spawning activity is observed, all sampling and monitoring activities within 10 meters of the site will cease until the end of the spawning season.

3. If there is any question about the use of the site by steelhead, PNNL will assume species presence and institute administrative controls and access restrictions, or will contact NOAA Fisheries Washington State Habitat Branch Office, prior to proceeding with characterization and monitoring efforts.

4. Installation of sampling equipment will be conducted at time periods outside the steelhead spawning season (February through May).

5. These procedures also will be followed at each of the other Hanford Reach cleanup sites, should steelhead spawning activities be observed or detected in those areas.

NOAA Fisheries concurs that the proposed action is not likely to adversely affect UCR steelhead. Our concurrence is based on information and conservation measures described in the BE and other supporting documents. This concludes informal consultation on this action in accordance with 50 CFR 402.14(b)(1). The Department of Energy (DOE) must re-analyze this ESA consultation if: (1) new information reveals that the action agency may affect listed species in such a way not previously considered; (2) the action is modified in a manner that causes an affect to the listed species that was not previously considered; or (3) a new species is listed, or critical habitat is designated, that may be affected by the proposed action.

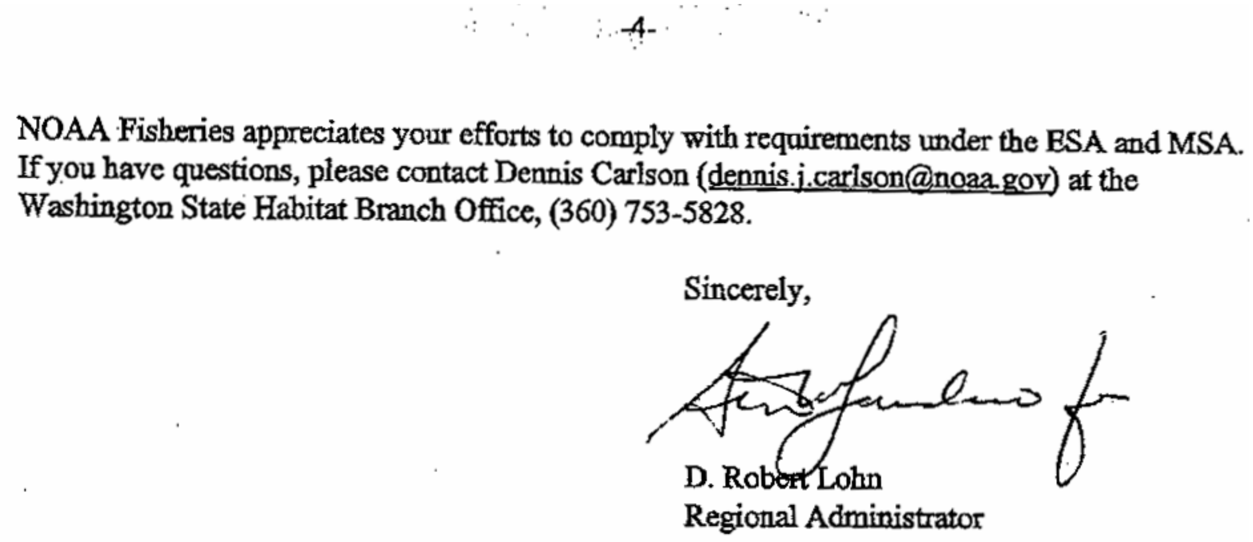
Magnuson-Stevens Fishery Conservation Management Act

Federal agencies are required, under section 305(b)(2) of the MSA and its implementing regulations (50 CFR 600 Subpart K), to consult with NOAA Fisheries regarding actions that are authorized, funded, or undertaken by that agency that may adversely affect Essential Fish Habitat (EFH). The MSA section 3 defines EFH as "those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity." If an action would adversely affect EFH, NOAA Fisheries is required to provide the Federal action agency with EFH conservation recommendations (MSA section 305(b)(4)(A)). This consultation is based, in part, on information provided by the Federal action agency and descriptions of EFH for Pacific salmon contained in Appendix A to Amendment 14 to the Pacific Coast Salmon Plan (August 1999) developed by the Pacific Fishery Management Council and approved by the Secretary of Commerce (September 27, 2000).

The proposed action and action area are described in the BE. The action area includes habitat which has been designated as EFH for various life stages of chinook (*Oncorhynchus tshawytscha*) and coho (*O. kitsutch*) salmon.

EFH Conservation Recommendations: Because the habitat requirements (*i.e.*, EFH) for MSA-managed species in the action area are similar to that of the ESA-listed species, and because the conservation measures the DOE included as part of the proposed actions to address the ESA concerns are also adequate to avoid, minimize, or otherwise offset potential adverse effects to designated EFH, conservation recommendations pursuant to (MSA section 305(b)(4)(A)) are not necessary. Since NOAA Fisheries is not providing conservation recommendations at this time, no 30-day response from DOE is required (MSA section 305(b)(4)(B)).

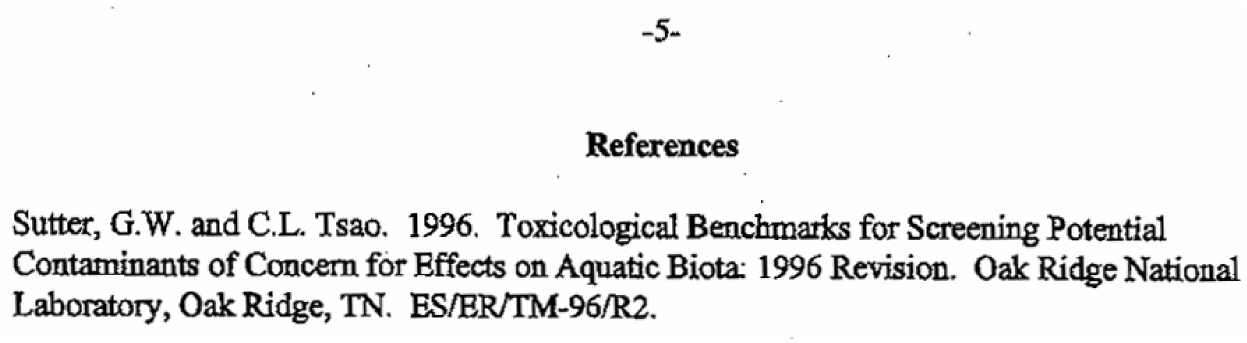
This concludes consultation under the MSA. If the proposed action is modified in a manner that may adversely affect EFH, or if new information becomes available that affects the basis for NOAA Fisheries' EFH conservation recommendations, the DOE will need to reinitiate consultation in accordance with the implementing regulations for EFH at 50 CFR 600.920(1).



NOAA Fisheries appreciates your efforts to comply with requirements under the ESA and MSA. If you have questions, please contact Dennis Carlson (dennis.j.carlson@noaa.gov) at the Washington State Habitat Branch Office, (360) 753-5828.

Sincerely,

D. Robert Lohn
Regional Administrator



References

Sutter, G.W. and C.L. Tsao. 1996. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-96/R2.

Sackschewsky, M. R., T. M. Poston, J. L. Downs, and B. L. Tiller. 2003. Information on Steelhead Redds Found Adjacent to the 300 Area. Unpublished Report. Pacific Northwest National Laboratory, Richland, Washington.

INFORMATION ON STEELHEAD REDDS FOUND ADJACENT TO 300 AREA

M. R. Sackschewsky, T. M. Poston, J. L. Downs, B. L. Tiller

15 August 2003

On February 24, 2003, PNNL biologists working under the Public Safety and Resource Protection Program (PSRPP) identified two areas in the Columbia River along the 300 Area shoreline that appeared to be spawning sites (redds) recently built by one of two possible salmonid species (coho or steelhead). The Washington Department of Fish and Wildlife (WDFW) was contacted about these observations and Mr. Paul Hoffarth (WDFW) subsequently inspected the sites and agreed that the redds in question were recently developed and were likely steelhead (*Onchorhynchus mykiss*). At WDFW's request and under their jurisdiction, PNNL staff collected two eggs from the site on March 20, 2003. The State fish geneticist (Sewell Young) identified DNA from these eggs as steelhead in May, 2003. We have yet to receive a copy of his report.

BACKGROUND

The Hanford Reach falls within the southern-most range of the upper-Columbia River Basin steelhead "ESU" (Ecologically Significant Unit) and steelhead within this ESU are listed as federally-endangered, with the NOAA Fisheries (formerly the National Marine Fisheries Service [NMFS]) as the jurisdictional agency. State and federal agency representatives have speculated that steelhead spawn throughout the Hanford Reach; however, there have been relatively few documented sightings of steelhead redds, with the exception of a few in the vicinity of the Ringold hatchery return (spring creek) during 2002 and 2001. Earlier surveys (1999 – 2000) indicated potential spawning areas near 100-F slough, however a rapid increase in the water level after the aerial surveys made it difficult to verify the potential spawning areas as steelhead redds. Surveys conducted over 30 years ago during exceptionally low water levels identified active redds that were thought to be steelhead near Vernita bar, Coyote Rapids, Locke Island, 100-F islands, and Ringold (DOE/RL 2000). In general, aerial surveys for steelhead redds have been ineffective due to high, turbid spring flows that obscure visibility.

Steelhead are thought to spawn within the Hanford reach starting in early to mid February and continuing through late May or early June; water levels normally increase to the point that visibility through the water column is obscured by mid to late March. Over the past five years, juvenile-emergent steelhead have been captured by both the WDFW and Columbia River Tribal Fish Commission (CRTFC) field crews while surveying for and collecting juvenile salmonids throughout the Hanford Reach. Although juvenile fish may move some distance from where the redd was located, the juvenile steelhead that were captured were relatively small, and likely of local origin.

Therefore, although ample circumstantial evidence of steelhead spawning within the Hanford Reach has accumulated, these observations appear to be the first fully verified steelhead redds other than those located near the Ringold hatchery. The redds at Ringold are located within the primary flow channel of the hatchery return, in a habitat that is not typical of the rest of the Hanford Reach, and the spawning adults were suspected to be returning hatchery fish.

REDD LOCATIONS AND POTENTIAL EXPOSURE

The location of the newly found redds (Figure 1) is of additional interest for two reasons. First, they were located in a portion of the Hanford Reach previously considered as unsuitable, or undesirable steelhead spawning habitat. In general, the area adjacent to the 300 Area is characterized by lower current velocity and larger average substrate size than is considered optimal for steelhead spawning areas (DOE/RL 2000). However, the redds were located within a relatively small area that has higher current velocity and smaller-sized gravel in the substrate. Therefore, the steelhead were able to locate and use suitable micro-habitats within an otherwise unsuitable region. We do not know if fish have used this site in the past or whether they are likely to return to this area in the future.

The second issue with the location of these redds is their proximity to a known ground water seep that has elevated concentrations of several contaminants (uranium, selenium, and chromium) of which uranium is of most potential concern. All of the seeps in the vicinity of the 300 Area have been extensively monitored over the last several years in support of the 300 Area near-shore environmental characterization. Recent results of this characterization are summarized in Patton et al. (2003). The steelhead redds were found near one of the three primary 300-Area seep sites (Location #9; Patton et al. 2003). Previous sampling of that seep found elevated levels of uranium in clams, crayfish, the seep water, and surface water collected from shallow (0.25m) sample locations, as well as in the sediments. Some uranium concentrations at this site were found to be several times greater than the EPA drinking water standard of 30 μg/L (EPA 2002). EPA has not established a ambient water quality criterion for uranium. Uranium concentrations reported in the riverbank spring water at location # 9 were approximately 143 μg/L, and the values collected at a depth of 0.25 m were approximately 85 μg/L. Sediment U concentrations ranged from 3.8 to 11.5 μg/g. These concentrations decreased quickly and significantly in both bivalves and water with increasing depth and distance from the shore; and at 1.5-meter water depths, the water and clam concentrations were similar to the results reported for an upstream reference site. The redds were located at depths of between 0.5 and 1.5 meters and were between 5 and 10 meters from the shoreline during low-flow periods (approximately 45,000 CFS).

Based on the available sampling data and the fact that measurements for all contaminant concentrations decreased with depth and distance from shore, the potential exposure levels experienced by the eggs and juveniles within the redds were probably low. However, a realistic estimate of the true ecological risk to these redds would require a significant amount of additional work because accurate estimates of the uranium concentrations in the cobble or water within the redds are not available, and little is known about the toxicological effects of uranium on embryonic and juvenile steelhead.

Few criteria are available to evaluate the potential toxicological or ecological impacts to juvenile fish or eggs exposed to elevated uranium concentrations in surface water. For many contaminants, EPA has published acute and chronic ambient water quality criteria (NAWQC). The NAWQC are based on at least 5 acute tests and 3 chronic tests for several species of aquatic invertebrates and fish. There is little aquatic toxicity data for uranium and NAWQC have not been established. In their place, other benchmarks have been established from the limited testing results that are available. These are categorized as screening benchmarks for potential toxic effects. Suter and Tsao (1996) list several toxicological screening benchmarks for uranium and freshwater fish (see attachment on toxicological benchmarks). For example, they list a Lowest Chronic Value (CV) of 142 μg/L, based on fathead minnow exposure and response. The CV is defined as the lowest reported chronic exposure level from a single test that caused an effect. This value was calculated based on a single value of an acute test using the formula: $\log CV = 0.73 \log LC_{50} - 0.70$ where the LC_{50} refers to the lethal concentration for 50% of the population. These benchmarks are best compared to the concentration of uranium in Columbia River water that is usually about 0.5 μg/L [Poston et al. 2002]. Although the elevated uranium concentrations reported in water samples collected from the riverbank spring near the location of the redds are greater than some of the published values that are used to screen uranium as a potential contaminant of concern, the comparison with the benchmark values *should not* be construed as evidence of harm or as an estimate or assessment of ecological risk.

In addition to elevated uranium, elevated concentrations (compared to background samples collected at Vernita) of selenium and chromium were found in seeps, surface water, and clam samples obtained within 10 meters of the steelhead redds. However, the concentrations of these analytes in the seeps and surface water collected at location # 9 were well below the ambient water quality criteria (EPA 2002) or reported eco-toxicological benchmarks (Suter and Tsao 1996).

In summary, the primary impact to the steelhead redds found near the 300 Area is not likely to result from chemical, radiological, or toxicological effects. However, the physical disturbance from activities that occur in the area associated with biological, hydrological, chemical, radiological, and physical characterization efforts (i.e., PSRPP and related activities) may need to be restricted either temporally or spatially to avoid negative impacts during the spawning period.

ISSUES: DISCUSSION AND PLANNED ACTIONS

The presence of these steelhead redds in the Hanford Reach and their location near a seep with elevated contaminants gives rise to several issues that can be addressed through ongoing projects under the PSRPP or through integrated efforts of ongoing programs supporting clean up activities at Hanford.

There are four main issues related to the documented presence of this endangered species near the industrial facilities of the Hanford Site.

1. **Appropriate notifications should be made and consultations pursued, if needed, with federal and state agencies responsible for management of the species.**

PNNL has notified both the WDFW and NOAA Fisheries regarding discovery of the redds and will continue to pursue discussion and correspondence with the agencies regarding steelhead spawning in the Reach with respect to DOE activities. This notification may result in reopening the Section 7 consultation that resulted in the salmon and steelhead management plan. The discussions should provide guidance as to any appropriate changes in management and monitoring of the species, and in how the species should be considered in planning and evaluation of cleanup scenarios, especially in the 300 Area.

All interested parties currently work under the assumption that steelhead spawning occurs in the Reach and general management concerns are addressed in the existing management plan (DOE 2000); substantial changes to species management are not expected for DOE.

PNNL will work with NOAA Fisheries to determine whether administrative controls (such as site protection and work restrictions around the redds) are needed to restrict access to spawning areas during critical time periods. This effort will be developed under current PSRPP projects and will be prioritized as needed within the current scope of the program.

Current Status of NOAA Fisheries Consultations:

Mr. Dennis Carlson of NOAA Fisheries was contacted on July 17, 2003 concerning the 300 area steelhead redds. The overall situation was explained, and a simple plan of action was agreed upon. It was agreed that the actions that require consultation are the continued sampling and monitoring in the area, not the exposure to the uranium plume.

PNNL will prepare a letter that will constitute a Biological Evaluation (he said it does not need to be a formal Biological Assessment) of the proposed activities. This will include a summary of the background information, details about the redds, descriptions of proposed sampling and monitoring activities in the vicinity of the redds, the mitigation measures that we propose (i.e., avoidance at critical periods), and our overall assessment of impacts to the steelhead. Ideally, he will then provide us with a concurrence letter that would close out the consultation.

PNNL will include a discussion of the uranium plume as part of the background information, such as where it came from, how long it has been there (these will establish that the plume is part of the baseline condition - i.e., it pre-exists at least the 1997 listing of the steelhead, and possibly the 1972 passage of the ESA). We will also include the recently measured concentrations, discuss the dilution factors at the site, and we can provide whatever rudimentary toxicological information that is available. Again, he definitely understood that the consultation issue is the continued physical activities near the redds and that in the long term, DOE is working toward reduction and elimination of the contaminant threats.

2. **The distribution and abundance of steelhead spawning in the Hanford Reach are not well known or mapped.**

Survey and characterization information is needed to determine whether redds are established in proximity to Hanford industrial areas, groundwater seeps on the Hanford shoreline or in areas scheduled for characterization as part of Hanford clean up activities. We do not know if steelhead are likely to reuse this site near the 300 Area in the future, or the importance of this spawning site to the overall population of steelhead in the Hanford Reach. Aerial surveys should be conducted in late February or early March, before the start of the spring freshet, when water levels are relatively low and visibility is good. Boat surveys should be scheduled to occur in conjunction with, or immediately following the aerial surveys so that confirmation can be obtained before the river rises. Previous aerial surveys were performed during April or May when visibility is greatly obscured. Early season aerial surveys might miss some of the later, and possibly peak-season, spawning, but would provide an indication of the number and distribution of spawning sites. The Ecological Monitoring and Compliance Project (EMC) will prioritize this survey and inventory within the planned project dollars and scope for FY 2004. Survey data and locations of any spawning sites would be maintained in the EMC geographic data base for the Hanford Site. Information on the presence or absence of federally listed species is required for reaching a record of decision under CERCLA cleanup activities.

3. **Little information is available to characterize potential contaminant exposures or potential effects on juvenile or adult steelhead.**

The current Salmon and Steelhead Management Plan does not address potential contaminant exposures or potential effects on juvenile or adult steelhead. The only discussion is in regard to ground water treatment activities that could alter the properties of the groundwater entering the river. Consultation with NOAA Fisheries indicates that exposure to elevated uranium for the spawning site near the 300 Area is not an immediate or priority concern at this time.

Response to this issue depends partially on whether additional survey data provide continued or new evidence of spawning sites in the Hanford Reach. PNNL will evaluate avenues to acquire additional data to help assess the potential uranium exposure level within and adjacent to known redd locations. Characterization and monitoring work accomplished under the PSRPP Surface Environmental Surveillance Project (SESP) and EMC will continue at the 300 Area and will increase over the next several years in the 100 Areas. Increased survey and monitoring for steelhead redds in areas where contaminated groundwater plumes intersect the river may be initiated under EMC. This monitoring should, at a minimum, entail an increased effort in the near shore areas of the 100 Areas and 300 Area where characterization work is being conducted. Increased survey efforts for steelhead will be considered during the annual internal design review for sampling under the PSRPP.

Characterization of steelhead spawning distribution and abundance will also be identified by the PSRPP as a data need to the Ground Water Protection Program through the Characterization of Systems efforts. EMC will prioritize this survey and inventory within the planned project dollars and scope for FY 2004. Increased monitoring may be done in conjunction with other characterization efforts already planned at each of the areas, but specific surveys for spawning sites should be planned early for each of the 100 Areas to minimize potential impacts of survey activities on juvenile steelhead. PNNL will confer with NOAA Fisheries to determine if the use of an existing Section 10 (scientific collection) permit is appropriate, or negotiate a new Section 10 permit before monitoring if any disruptive sampling (such as egg collection) is anticipated.

The SESP has plans to continue sampling and measurement of water and sediment concentrations and biota tissue residues adjacent to the 300 Area spawning site. These efforts may include collecting sediment / pore water samples at various substrate depths from the redd locations. This sampling would need to be performed off season (i.e., between July and September and may require consultation with NOAA Fisheries. Currently, several water sampling instruments are set a various depths into the substrate and are located within a meter of one of the steelhead redds. Work involving measurements of water concentrations of uranium in the benthic community is currently underway as part of SESP/EMC integration effort. It may be possible to use water sample results obtained from these sites to estimate actual ambient exposure levels in the redds. PSRPP will assure that the field activities conducted in support of EMC, SESP, and GPP are integrated and coordinated.

Ongoing work under the PSRPP should provide additional data to help clarify the potential exposure of redds in the Reach. However, some data collection activities included in the characterization, such as sediment sampling, have the potential to adversely affect near-shore steelhead redds via direct physical disruption or through siltation or other disturbances. These physical impacts are probably a greater potential threat to the redds than any potential eco-toxicological impacts. Mitigation of these physical impacts is likely to be the primary concern of NOAA Fisheries.

Information developed through GPP groundwater monitoring and characterization of system work and under GPP science and technology tasks may provide data and predictive tools that could be used to provide additional information and insights in assessing potential contaminant exposure of steelhead redds in the Hanford Reach. Planned local-scale groundwater transport model development and application in FY 04 and 05 within the 300 area will evaluate specific relevant technical issues that include:

- Arrival of contaminants at the groundwater/river interface
- Mixing of groundwater and surface water in vicinity of the river interface
- The effect of seasonal fluctuations in river stage and bank storage on contaminant transport and potential exposure

We anticipate that the broader comprehensive site evaluations using the System Assessment Capability modeling efforts will describe relative ecological risk for juvenile salmonids at a coarse scale for the river system; however, this would not provide detailed information on exposure and risk for specific spawning sites.

4. **Relatively little information exists to document the toxicological effects of uranium on embryonic or juvenile salmonids.**

At the reported concentrations for the seep sampled at seep location 9, the uranium might present a toxicological hazard, but is well below the levels that could be considered to be a radiological hazard. Existing Hanford projects are scheduled to provide additional data concerning the toxicological effects of uranium on eggs of young juvenile fish. Plans have been submitted to address uranium toxicity in juvenile rainbow trout during FY05 under the Groundwater Protection Program (GPP). Current plans are to initiate periphyton tests with uranium in 2004, followed by tests using rainbow trout in 2005. The order of investigation might be changed if deemed necessary by DOE and NOAA Fisheries. Current estimate to perform the rainbow trout toxicological work (including both feeding and immersion studies) under the GPP is approximately $300 K.

The laboratory-based studies mentioned above will provide information for deducing toxicological properties of uranium in juvenile steelhead. Determining ecological impacts to individuals and populations of the species would likely require additional field work to assess the uptake in natural settings. A study similar to that recently performed to examine chromium uptake by juvenile fall Chinook salmon in the 100 Areas could be appropriate depending on locations of spawning sites and the data gathered through increased monitoring and characterization of both contaminants and steelhead spawning in the Reach. Such a study will be considered in the annual PSRPP design review process.

REFERENCES

Patton, G. W., B. L. Tiller, E. J. Antonio, T. M. Poston, and S. P. Van Verst. 2003. *Survey of Radiological and Chemical Contaminants in the Near-Shore Environment at the Hanford Site 300 Area*. PNNL-13692, Rev. 1. Pacific Northwest National Laboratory, Richland, WA.

Poston, T. M., R. W. Hanf, R. L. Dirkes, and L. F. Morasch. 2002. *Hanford Site Environmental Report for Calendar Year 2001*. PNNL-13910. Pacific Northwest National Laboratory. Richland, WA.

Suter, G.W. and C. L. Tsao. 1996. *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision*. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-96/R2.

U.S. Department of Energy. 2000. *Threatened and Endangered Species Management Plan, Salmon and Steelhead.* DOE/RL-2000-27. April 2000.

U.S. Environmental Protection Agency. 2002. *2002 Edition of the Drinking Water standards and health Advisories*. EPA 822-R-02-038. Office of Water. Summer 2002.

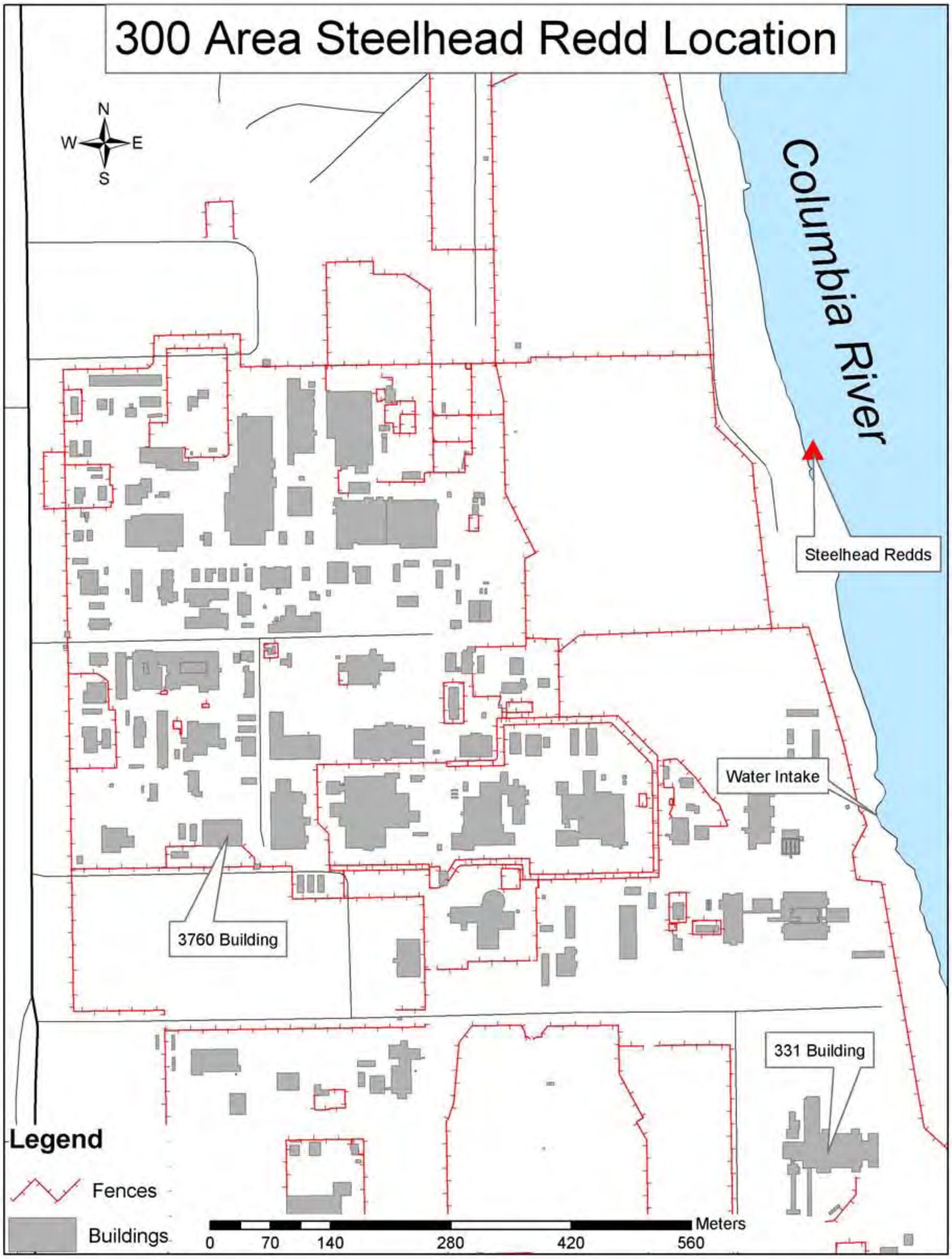


Figure O.1. Location of the Steelhead Redds near the 300 Area

Attachment 1. Published Toxicological Benchmarks for Uranium Exposures of Fish

For many contaminants, EPA has published acute and chronic ambient water quality criteria (NAWQC). The NAWQC are based on at least 5 acute tests and 3 chronic tests for several species of aquatic invertebrates and fish. There is little aquatic toxicity data for uranium and NAWQC have not been established. In their place, other benchmarks have been established from the limited number of testing results that are available. These are categorized as screening benchmarks for potential toxic effects. Suter and Tsao (1996) list several toxicological screening benchmarks for uranium and freshwater fish. These benchmarks can be compared to the concentration of uranium in Columbia River water that is usually about 0.5 μg/L [Poston et al. 2002]:

- Lowest Chronic Value (CV) - 142 μg/L, based on fathead minnow, this is defined as the lowest reported chronic exposure level from a single test. It was based on a single value of an acute test and was calculated based on the formula:
  $\log CV = 0.73 \log LC_{50}-0.70$

- Lowest EC_{20} (Effective Concentration) – 455 μg/L, based on fathead minnow, this is the lowest calculated acute EC_{20} taken from the fathead minnow test. In absolute terms, exposure of fathead minnow to this concentration would result in a loss of mobility in the exposed population

- Population EC_{20} - 27μg/L, based on a calculated result from the single fathead minnow test. It represents a concentration that would hypothetically produce a 20% reduction (mobility) in fish populations from long term exposure.

- Secondary Acute Value (SAV) – 46 μg/L, based on two brook trout acute tests where the LC_{50} was 11,250 μg U/L. The SAV was extrapolated from this data for the level not expected to have an adverse effect following an acute (short term or 96 hour) exposure.

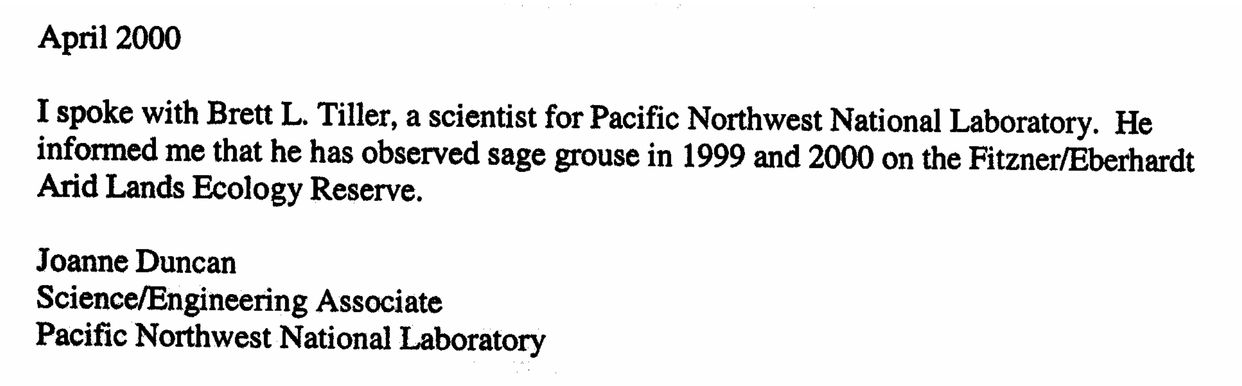
- Secondary Chronic Value – 2.6 μg/L, based on two brook trout acute tests where the LC_{50} was 11,250 μg U/L. This chronic benchmark was further extrapolated from the acute tests and has a high degree of uncertainty.

The secondary acute and secondary chronic values are based on a single study performed with brook trout and accordingly have a great deal of uncertainty associated with the predicted benchmarks. The other set of values were based on acute studies using fathead minnows. There applicability to exposure of steelhead embryos is open to debate, however, the benchmarks based on brook trout, as a member of the family Salmonidae, is more representative of the steelhead exposure scenario, than the data for fathead minnow.

The uncertainty associated with the toxicity benchmarks is very high for several reasons. The toxicity tests were based on exposure to juvenile fish, where as the susceptibility of steelhead eggs and alevins (sac fry) to uranium exposure is unknown. Uranium has complex chemistry in freshwater that may influence its propensity for accumulation and toxicity in fish. Differences in water quality (e.g., carbonate concentration, pH etc.) may profoundly affect the response of aquatic organisms living in water containing elevated concentrations of uranium.

The secondary toxicity benchmarks are calculated when there is insufficient data to generate National Ambient Water Quality Criterion. They represent concentrations of uranium in water that are not expected to have an adverse impact on the species in question. A review of the toxicity data in Suter and Tsao (1996) has revealed inconsistencies and contradictions in the analysis and reporting of uranium benchmarks. These benchmarks are under further review. As an inherently conservative process, there is a reasonable possibility that higher concentrations of U may not have an adverse effect on steelhead.

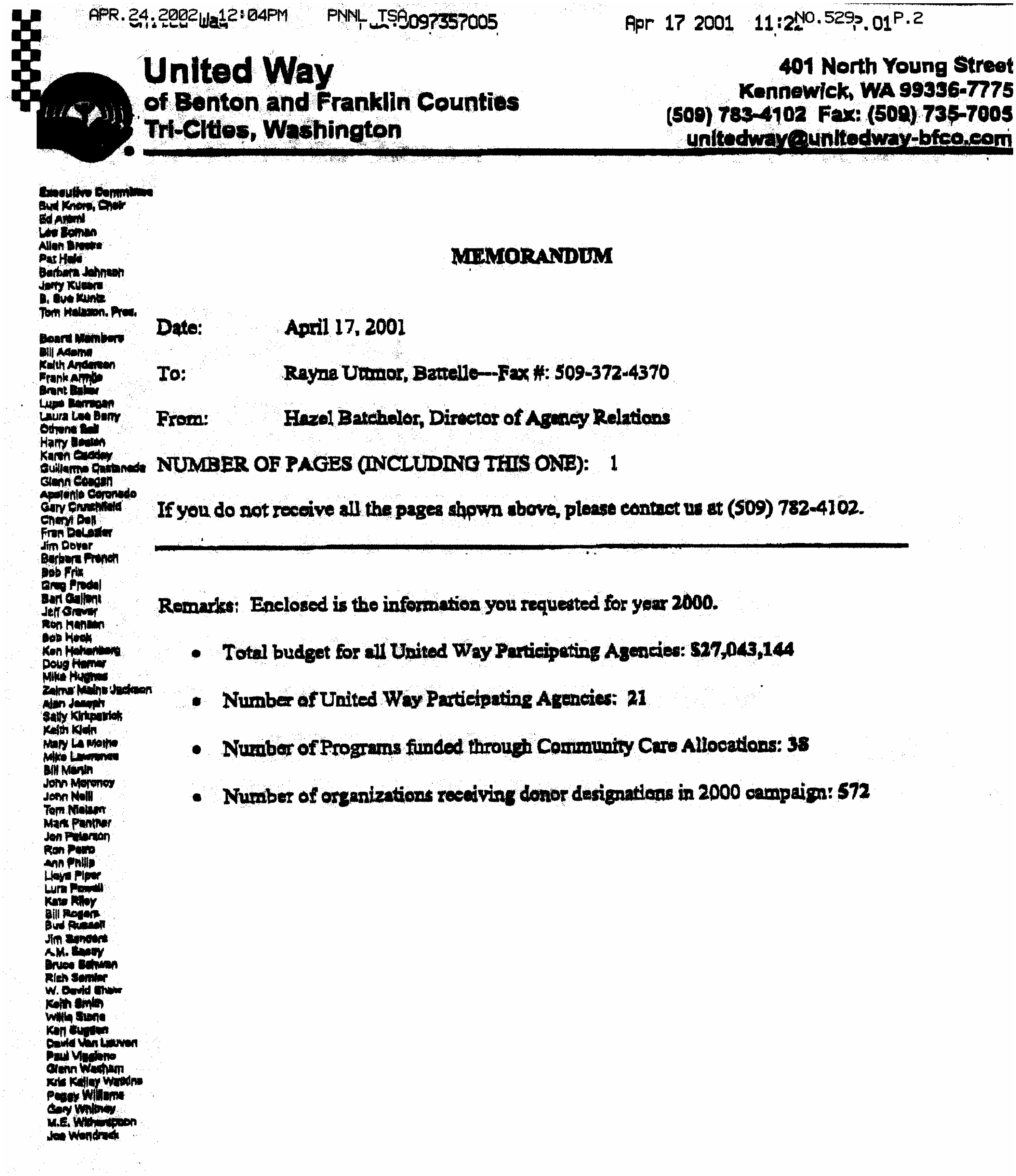
Tiller, B. L. 2000. Personal communication regarding wildlife on the Fitzner/Eberhardt Arid Lands Ecology Reserve.



April 2000

I spoke with Brett L. Tiller, a scientist for Pacific Northwest National Laboratory. He informed me that he has observed sage grouse in 1999 and 2000 on the Fitzner/Eberhardt Arid Lands Ecology Reserve.

Joanne Duncan
Science/Engineering Associate
Pacific Northwest National Laboratory



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United Way
of Benton and Franklin Counties
Tri-Cities, Washington

401 North Young Street
Kennewick, WA 99336-7775
(509) 783-4102 Fax: (509) 735-7005
unitedway@unitedway-bfco.com

MEMORANDUM

Date: April 17, 2001

To: Rayna Ummor, Battelle—Fax #: 509-372-4370

From: Hazel Batchelor, Director of Agency Relations

NUMBER OF PAGES (INCLUDING THIS ONE): 1

If you do not receive all the pages shown above, please contact us at (509) 782-4102.

Remarks: Enclosed is the information you requested for year 2000.

- Total budget for all United Way Participating Agencies: $27,043,144
- Number of United Way Participating Agencies: 21
- Number of Programs funded through Community Care Allocations: 38
- Number of organizations receiving donor designations in 2000 campaign: 572