APPENDIX B
RESPONSES TO SCOPING COMMENTS

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APPENDIX B
RESPONSES TO SCOPING COMMENTS

B.1 INTRODUCTION

In March 2001, the U.S. Department of Energy (DOE) issued a strategy for completing the 1996 West Valley Demonstration Project (WVDP) Completion and Closure Draft Environmental Impact Statement (EIS) (DOE 1996) and a Notice of Intent (NOI) to prepare a Decontamination and Waste Management EIS (66 Fed. Reg. 16447 (2001)). The Decontamination and Waste Management EIS was originally intended to be a revision of the 1996 Completion and Closure Draft EIS (see Section 1.2 for details). In the NOI, DOE published for comment its position that its decisionmaking process would be facilitated by preparing and issuing for public comment a Revised Draft EIS that focused on DOE's actions to decontaminate the project facilities and manage WVDP wastes controlled by DOE under the West Valley Demonstration Project Act. In the NOI, DOE also announced that it would conduct a public scoping meeting on April 10, 2001.

DOE received nine written and oral comments regarding the proposed scope of the Decontamination and Waste Management EIS from individuals, organizations, and government agencies. These comments were provided in letters and electronic mail messages and at the public scoping meeting. The commenters were:

- George J. Wilberg
- James L. Pickering
- Carol Mongerson
- State of New York Office of the Attorney General
- Coalition on West Valley Nuclear Wastes
- Concerned Citizens of Cattaraugus County, Inc.
- West Valley Citizens Task Force
- Nuclear Information and Resource Service, and Public Citizen/Critical Mass Energy and Environment Program (joint submittal)
- League of Women Voters of Buffalo/Niagara

B.2 SUMMARY OF COMMENTS

The commenters expressed concern regarding or opposition to DOE's rescoping of the *Environmental Impact Statement for Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Service Center* (1996 Completion and Closure Draft EIS). Taken together, the comments suggest that preparing one EIS for near-term decontamination and waste management activities and another EIS to support long-term decommissioning and/or long-term stewardship of the site violates the National Environmental Policy Act (NEPA) and the Stipulation of Compromise (*Coalition on West Valley Nuclear Wastes & Radioactive Waste Campaign*, Civil Action No. 86-1052-C, entered into on May 27, 1987).

B.3 DOE RESPONSE

As stated in the NOI to rescope the 1996 Completion and Closure Draft EIS, this EIS was originally focused on DOE actions to decontaminate West Valley Demonstration Project (WVDP or the Project) facilities and manage WVDP wastes that are controlled by DOE under the West Valley Demonstration Project Act. DOE has modified the scope of this EIS as a result of public comments received during scoping and has decided to eliminate the consideration of decontamination activities at the WVDP in the scope of this EIS. The scope is now limited to onsite waste management and offsite waste transportation activities, and no longer includes decontamination activities as proposed in the NOI. The need for and potential environmental impacts of future decontamination activities will be addressed in the continuation of the 1996 Completion and Closure EIS, now referred to as the Decommissioning and/or Long-Term Stewardship EIS. An Advance NOI for this EIS was issued on November 6, 2001 (66 Fed. Reg. 56090 (2001)).

The proposed waste management activities addressed in this EIS would need to be taken by DOE regardless of the decisions regarding the long-term management of the Western New York Nuclear Service Center (the Center) that would be made at a later date. DOE's proposed waste management activities are independent of eventual site decommissioning and closure decisions.

DOE believes that the proposed waste management activities are not "connected" to future decommissioning and/or long-term stewardship decisions for WVDP or the Center, as that term is defined in the Council on Environmental Quality regulations implementing NEPA (*see* 40 Code of Federal Regulations [CFR] 1508.25(a)). The proposed activities would not automatically trigger other actions that would require the preparation of an EIS, can proceed independently of other actions at the site, and are not dependent upon future decisions regarding long-term plans for the site. Moreover, undertaking these activities in the near term would not limit or prejudge the range of alternatives or the decisions that would be made for eventual decommissioning of WVDP facilities and/or long-term stewardship of the Center. Finally, DOE believes that preparing an EIS for waste management activities would allow the Department to make progress in removing wastes from the site, rather than waiting until site decommissioning and/or long-term stewardship decisions are made some time in the future.

The specific issues that were raised by the commenters and DOE's responses are provided below.

GEORGE J. WILBERG

Wilberg Comment 1. *After reading the recent article about the continuing radioactive cleanup at the West Valley Nuclear Facilities I can only think that this cleanup has taken what seems to me "forever." In weighing the alternatives of a one part or two part plan I can only wonder how much longer the two part plan will take? Although I do not have the exact details of each plan it would appear to the uninformed reader that the two part plan obviously would take longer. Therefore, as a local resident and taxpayer I opt for the one part plan to achieve closure of this facility.*

DOE Response: DOE believes that rescoping the 1996 Completion and Closure Draft EIS into a Waste Management EIS and continuing the evaluations begun in the 1996 Completion and Closure Draft EIS in a future Decommissioning and/or Long-Term Stewardship EIS will allow the Department to begin site cleanup at an earlier time, rather than waiting until all future site closure decisions have been made. This approach will allow DOE to make decisions regarding transportation of waste for offsite disposal and to implement those decisions while undertaking the process of making long-term closure or stewardship decisions with the New York State Energy Research and Development Authority (NYSERDA) and federal and state regulators.

Wilberg Comment 2. *The four day trip* [in reference to spent fuel shipments to Idaho] *seems to be the safest and most secure by using our railways. Truck transportation has too many variables and possibilities of failure – that is unacceptable. The half life of U-235 and 238 is high was well as strontium. Many thousands of years will pass before that radioactivity can decrease to an acceptable level (most sources says 10,000 years!). The best place for storage is in a relatively uninhabited area* *with low earthquake activity. An area that can be relatively easily protected from terrorism is also a needed requirement – Idaho would seem ideal for such a venture.*

DOE Response: The Waste Management EIS analyzes the transportation of low-level radioactive waste (LLW), mixed LLW, transuranic (TRU) waste, and high-level radioactive waste (HLW) by both rail and truck to appropriate storage or disposal facilities. The storage and disposal sites being considered are Envirocare in Utah (disposal of LLW and mixed LLW), the Nevada Test Site in Nevada (disposal of LLW), the Hanford Site in Washington (disposal of LLW and storage of HLW and TRU waste), the Waste Isolation Pilot Plant in New Mexico (storage and disposal of TRU waste), the Savannah River Site in South Carolina (storage of TRU and HLW), Oak Ridge National Laboratory in Tennessee (storage of TRU waste), Idaho National Engineering and Environmental Laboratory (storage of TRU waste), and the proposed Yucca Mountain High-Level Waste Repository (disposal of HLW). All of these sites have waste management facilities that are safe and secure and that provide the appropriate isolation from the human environment for each type of WVDP waste.

JAMES L. PICKERING

Pickering Comment 1 (summarized from comment letter). *The West Valley Demonstration Project Act (Public Law No. 96-368) provides for the removal, preparation for disposal, solidification, and decontamination of facilities at the West Valley Demonstration Project site. The Stipulation of Compromise in Civil Action No. 86-1052-C (U.S. District Court, Western District of New York) calls for one EIS process and one environmental impact statement. Both the Stipulation and the one process/one EIS under Public Law No. 96-368 are binding upon the Department of Energy. The Notice of Intent to rescope the 1966 Draft Completion and Closure EIS is void and unlawful and unconstitutional.*

DOE Response: In DOE's view, neither the West Valley Demonstration Project Act nor the Stipulation of Compromise requires the preparation of only one EIS. DOE has met or will meet all of the commitments included in the Stipulation of Compromise by completing both the Waste Management EIS and the future Decommissioning and/or Long-Term Stewardship EIS. DOE has met or will meet all of the vitrification, waste management, and closure requirements set forth in the West Valley Demonstration Project Act. The Decommissioning and/or Long-Term Stewardship EIS will evaluate alternatives for completing DOE's obligations under the Act.

Pickering Comment 2 (from public meeting). *Our scientists have identified certain black holes in outer space. They have computed that it takes millions and billions of light years before the rays got here to identify those black holes. What those black holes are is a space where all of the rest of its environment is zero. We have developed the technology to get vehicles in outer space. I see no reason why we should not take a test and ship something even if it was not radioactive and see if it would head towards that black hole once we got beyond the gravitational pull of the earth and have a vehicle headed into a black hole, then we give nature the whole of creation back her radioactive waste.*

DOE Response: DOE has studied the environmental impacts that could occur if DOE developed and implemented various technologies for the management and disposal of radioactive waste. It examined several alternatives, including mined geologic disposal, very deep hole disposal, disposal in a mined cavity that resulted from rock melting, island-based geologic disposal, subseabed disposal, ice sheet disposal, well injection disposal, transmutation, and space disposal in a Final Environmental Impact Statement on *Management of Commercially Generated Radioactive Waste* (DOE/EIS-0046F). Space disposal in particular was thought to pose unacceptable health and safety risks. The Record of Decision for that EIS announced the DOE decision to pursue the mined geologic disposal alternative for disposition of radioactive waste (46 Federal Register [FR] 26677 (1981)).

CAROL MONGERSON COMMENTS (FROM PUBLIC MEETING)

Mongerson Comment 1. *If this hearing were legal, which I am not conceding by making these remarks, I would want to say some of the following. I do not really have comments to make on the first EIS proposal. What you are planning to cover sounds reasonable to me. You've done a pretty good job our here so far and I trust you to do the decontamination work pretty well.*

DOE Response: The NOI to revise the strategy for completing the 1996 Completion and Closure Draft EIS, published in the *Federal Register* on March 26, 2001 (66 FR 16447) gave appropriate notice of the public meeting held on April 10, 2001. Notice of the meeting was also provided in local media. For this reason, DOE believes that the public meeting held to discuss the revised strategy and the scope of the Waste Management EIS was in compliance with all applicable laws.

DOE and the WVDP appreciate the confidence in our ability to safely and effectively decontaminate the Project facilities.

Mongerson Comment 2. *So my concerns are about the second one... It appears to me that some decisions – that the two EISs are not really inseparable because some decisions have already been made about which waste to ship. Until this time only Class A waste has been agreed that we would ship Class A waste offsite. Now we are talking about doing higher classes of waste and the transuranic waste. So that decision has already been made and it makes those EISs inseparable and we will already be committed to that.*

DOE Response: As a result of the *Final Waste Management Programmatic Environmental Impact Statement for Managing, Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (WM PEIS) (DOE/EIS-0200-F, May 1997), DOE made programmatic decisions regarding the management (treatment, storage, or disposal) of LLW, mixed LLW, TRU waste, HLW, and non-wastewater hazardous waste. The proposed actions and alternatives assessed in this EIS are consistent with the terms of the Stipulation of Compromise reached with the Coalition on West Valley Nuclear Wastes and Radioactive Waste Campaign. Implementation of theses actions would allow DOE to make progress in meeting its obligations under the Act that pertain to waste management (see Appendix A), and they are consistent with programmatic decisions DOE has made (see Sections 1.6.1.2 and 1.6.1.4) regarding the waste types addressed in this EIS. Those decisions and their respective EISs, as they apply to the WVDP, provide for shipping wastes from the West Valley site to other regional or centralized DOE sites for treatment, storage, and disposal, as appropriate. In particular, DOE is considering a variety of options in this EIS for offsite transportation and disposal of LLW and mixed LLW and offsite storage or disposal of TRU waste and HLW.

Pursuant to the Stipulation of Compromise, DOE is permitted to ship Class A LLW and some mixed LLW. DOE will defer shipment of other types of waste until completion of the Waste Management EIS and the issuance of a Record of Decision (ROD). The shipment of wastes offsite for disposal or storage is an activity that will have to occur regardless of the ultimate decision that is made regarding the disposition of the WVDP and the Center.

Mongerson Comment 3. *The first thing I want to say about the second EIS is … the idea of doing a draft environmental impact statement without knowing what NRC criteria you are going to have to meet has always struck me as being insane and it still has. We must wait for that NRC criteria before we write these drafts.*

DOE Response: This comment refers to criteria that the U.S. Nuclear Regulatory Commission (NRC) has prescribed for the cleanup of the WVDP site. DOE will address these criteria in the future Decommissioning and/or Long-Term Stewardship EIS.

Mongerson Comment 4. *The second thing that disturbs me is what appears to me to be an appearance of a new term. That term in the title – long term management of the facilities. That may mean nothing but is sounds ominous to me and it disturbs me because to me what we were promised was not long-term management. What we were promised was closure and decommission. Long-term management to me implies indefinite institutional control and indefinite institutional control is something that is not realistic. I don't believe that we can count on it. I just don't think it is going to happen.*

DOE Response: Long-term stewardship (or management) does include provisions for institutional control such as continuous monitoring and maintenance of protective barriers to protect the public.

Long-term stewardship was an option in the 1996 Completion and Closure Draft EIS under Alternatives III and IV, although the term "long-term stewardship" was not used in that document. Long-term stewardship (long-term monitoring and maintenance) is a reasonable alternative for site closure, and it will be analyzed in the future Decommissioning and/or Long-Term Stewardship EIS along with other alternatives. An Advance NOI was issued on November 6, 2001 (66 FR 56090) formalizing DOE's commitment to begin work on the Decommissioning and/or Long-Term Stewardship EIS.

Mongerson Comment 5. *Any waste which we ship away from here has to go some place else and that some place else is not going to want it either. This is a fundamental problem that we are simply going to have to deal with. Our society is going to have to deal with this problem and the irony is that we keep on making more waste. All the time we are trying to deal with this problem but nobody wants it. We must stop making more nuclear waste. Yes, we have to deal with what is at West Valley already. We must stop making more. Now, you will say that's neither here nor there with this EIS and in a sense that is true, but the problem is not inseparable. You cannot make the one decision without making the other as a society.*

DOE Response: As the commenter recognizes, whether the nation continues to produce nuclear waste is a decision to be made by the American people and Congress, not by DOE. As a federal agency, DOE is required to follow the dictates of Congress, which has enacted laws directing DOE to engage in activities (such as research and development and national security) that generate nuclear waste. Because a decision to discontinue the production of nuclear waste is not within DOE's purview, that issue will not be analyzed in either the Waste Management EIS or the future Decommissioning and/or Long-Term Stewardship EIS.

STATE OF NEW YORK OFFICE OF THE ATTORNEY GENERAL

Office of the Attorney General Comment 1. *There is no basis for the proposed action other than the conclusory statement in the Notice that "the regulatory and physical nature of the two categories of actions are different." This is no more true now than it was when the NEPA process was initiated in 1988.*

DOE Response: Although DOE attempted to address all issues in the 1996 Completion and Closure Draft EIS, it became apparent, during DOE and NYSERDA discussions on the preferred alternative, that separating waste management from decommissioning would allow DOE to move forward with activities for which it is responsible under the West Valley Demonstration Project Act and for which it would not need NYSERDA's concurrence. For that reason, DOE decided to rescope the 1996 Draft EIS and proceed with the Waste Management EIS that focuses exclusively on activities conducted by DOE.

Office of the Attorney General Comment 2. *The Notice is somewhat misleading in that it announces DOE's and NYSERDA's "intent to revise their strategy for completing the [1996 Completion and Closure Draft EIS] issued for public comment in March 1996." In fact, however, a review of the entire Notice reveals that the agencies seek not to complete the 1996 Completion and Closure Draft EIS but instead to separate the EIS process into two parts.*

DOE Response: DOE apologizes if some readers found the Notice misleading. As described in the Notice, the revised strategy for completing the 1996 Completion and Closure Draft EIS was to separate the original proposed action into two distinct activities: the first being waste management and decontamination; and the second focusing on decommissioning. DOE has modified the scope of this EIS as a result of public comments received during scoping. The scope is now limited to onsite waste management and offsite waste transportation activities, and no longer includes decontamination activities as proposed in the NOI. DOE will prepare an EIS in the future for decisions regarding decommissioning and/or long-term stewardship. An Advance NOI was issued on November 6, 2001 (66 FR 56090), formalizing DOE's commitment to begin work on the Decommissioning and/or Long-Term Stewardship EIS. Upon completion of both of these EISs, the proposed action and alternatives described in the 1996 Completion and Closure Draft EIS will have been fully analyzed and the subject of public review and comment, thus "completing" the 1996 Completion and Closure Draft EIS.

Office of the Attorney General Comment 3. *Pursuant to 40 CFR Section 1508.25(a)(3), actions involving common geography and cumulative environmental impacts such as are present at the WNYNSC and the WVDP should be evaluated in a single EIS.*

DOE Response: The Council on Environmental Quality regulations implementing the procedural provisions of NEPA do encourage federal agencies to consider the extent to which proposed actions that are connected, cumulative, or similar should be addressed in the same EIS (*see* 40 CFR 1508.25(a)). DOE has determined that, while the waste management and decommissioning proposals would both affect the WVDP site and the Center, other considerations (such as timing) favor the separation of the two proposals into two EISs. This is consistent with the Council on Environmental Quality NEPA regulations.

Office of the Attorney General Comment 4. *The first three alternatives for closure of the WNYNSC including the WVDP in the 1996 Draft Completion and Closure EIS are based on varying degrees of waste removal. Given the acknowledged unsuitability of the WNYNSC for the long-term storage or disposal of radioactive waste, waste removal must necessarily be part of future actions regarding decommissioning and/or long-term stewardship. Pursuant to 40 CFR Section 1502.23 an EIS must include a cost-benefit analysis. Separating the same issues now addressed in the 1996 Completion and Closure Draft EIS into two separate Environmental Impact Statements, particularly waste removal, will have a significant impact on the cost-benefit analysis used to evaluate closure options, including monetary costs and qualitative considerations. Economies of scale and the significance of cumulative environmental, social, and economic impacts are unavoidably affected by separating the EIS into two parts.*

DOE Response: The Council on Environmental Quality NEPA regulations state that "[i]f a cost-benefit analysis relevant to the choice among environmentally different alternatives is being considered for the proposed action, it shall be incorporated by reference or appended to the statement as an aid in evaluating the environmental consequences." (40 CFR 1502.23). Neither NEPA nor the Council on Environmental Quality regulations require that a cost-benefit analysis be prepared as part of an EIS.

There could be cumulative environmental impacts associated with the proposed waste management activities and the conduct of future decommissioning and/or long-term stewardship activities. DOE describes the potential for these cumulative impacts in the Waste Management EIS and will take these potential impacts into account in its decisionmaking process.

COALITION ON WEST VALLEY NUCLEAR WASTES (COALITION)

Coalition Comment 1. *The Stipulation of Compromise Settlement (hereinafter "Stipulation") requires that "the closure Environmental Impact Statement process - including the scoping process - shall begin no later than 1988 . . ." This requirement is binding. DOE cannot unilaterally create a new scoping process that supersedes or substantially modifies the scoping process carried out in 1988.*

DOE Response: The Notice of Intent to prepare the Completion and Closure EIS was issued in 1988, beginning the scoping process for that document. DOE has fulfilled this aspect of the Stipulation. Moreover, the Stipulation does not preclude DOE from preparing other EISs or environmental review documentation to analyze proposed activities at the WVDP that must occur regardless of any future decisions regarding site decommissioning, closure, or long-term stewardship.

Coalition Comment 2. *The scoping process begun in 1988 led to issuance of the 1996 Completion and Closure Draft EIS. A Final EIS or Record of Decision has not yet been issued. Thus, the EIS process specified in the Stipulation has not yet been completed. It is not clear from the Notice of Intent published in the Federal Register on March 26, 2001 whether the EIS process specified in the Stipulation has already been, or soon will be, partially discontinued or suspended. It would be violative of the Stipulation of Compromise Settlement for the DOE to unilaterally abandon the current EIS process and begin a new segmented process.*

DOE Response: The EIS process specified in the Stipulation is not being and will not be discontinued or suspended. Rather, DOE will complete its obligations under the Stipulation by a slightly different route than was envisioned in 1988. An Advance NOI was issued on November 6, 2001 (66 FR 56090), formalizing DOE's commitment to begin work on the Decommissioning and/or Long-Term Stewardship EIS. The conditions of the Stipulation of Compromise will be met by the Waste Management EIS and the future Decommissioning and/or Long-Term Stewardship EIS, in combination. Upon completion of both of these EISs, all conditions of the Stipulation will have been met.

Coalition Comment 3. *The provisions of the Stipulation apply to any and all Environmental Impact Statements into which the closure EIS that began in 1988 may be split. Paragraph 3 of the Stipulation defines the scope of the closure EIS very broadly, such that it covers disposal of all "[Class A] [Class B/C] wastes generated as a result of the activities of the West Valley Demonstration Project as mandated by the United States Congress under the West Valley Demonstration Project Act."*

DOE Response: The provisions of the Stipulation apply to an EIS, begun in 1988, to analyze the potential impacts associated with site closure, including onsite waste disposal. This EIS, as rescoped, assesses only the offsite shipment of stored wastes and wastes that will be generated during the next 10 years of operations while decommissioning and/or long-term closure decisions are still ongoing. Pursuant to the Stipulation, DOE retains the ability to dispose of Class A LLW in accordance with applicable law at a site other than the Center. In addition, for waste material containing elements having an atomic number greater than 92 in concentrations greater than 10 nanocuries per gram but less than or equal to 100 nanocuries per gram, the Stipulation provides that "[f]or disposal at locations other than the Center, such disposal will be in accordance with applicable law." The Stipulation does not address transportation and subsequent offsite disposal of TRU (waste material containing elements having an atomic number greater than 92 in concentrations greater than 100 nanocuries per gram) or HLW. Thus, the preparation of an EIS to examine waste management activities, none of which relate to onsite disposal of waste, is consistent with the Stipulation.

Coalition Comment 4. *According to the Notice of Intent published in the Federal Register on March 26, 2001, "DOE intends to issue soon a Notice of Intent for a second EIS, with NYSERDA as a joint lead agency, on decommissioning and/or long-term stewardship of the WVDP and the Western New York Nuclear Service Center . . ." This will violate provisions of the Stipulation. The Stipulation requires that "the closure Environmental Impact Statement process - including the scoping process - shall begin no later than 1988 . ." DOE cannot unilaterally create a new EIS with a new scoping process that supersedes or substantially modifies the scoping process carried out in 1988. As specified in the Stipulation, the EIS is a closure EIS. DOE cannot unilaterally change the purpose of the project and thus the scope of the EIS.*

DOE Response: As noted above, the NOI to prepare the Completion and Closure EIS was issued in 1988, beginning the scoping process for that document. DOE has fulfilled this aspect of the Stipulation. However, the Stipulation does not preclude DOE from completing its obligations under the Stipulation by a slightly different route than was envisioned in 1988, separating the original scope of the Completion and Closure EIS into two EISs, one that analyzes proposed waste management activities and one that addresses future decisions regarding site decommissioning, closure, and/or long-term stewardship. As stated above, DOE believes that this approach is consistent with the Council on Environmental Quality NEPA implementing regulations regarding connected actions (40 CFR 1506.1) and that this approach, upon completion of the future Decommissioning and/or Long-Term Stewardship EIS, will meet all of the conditions of the Stipulation of Compromise. An Advance NOI was issued on November 6, 2001 (66 FR 56090), formalizing DOE's commitment to continue work on the Closure EIS process by beginning work on the Decommissioning and/or Long-Term Stewardship EIS. DOE is anticipating that NYSERDA will participate in the preparation of the Decommissioning and/or Long-Term Stewardship EIS as a joint lead agency, that the Nuclear Regulatory Commission (NRC) will participate as a cooperating agency, and that the New York State Department of Environmental Conservation will participate as an involved agency under the New York State Environmental Quality Review Act (SEQRA).

Coalition Comment 5. *According to the Notice of Intent published in the Federal Register on March 26, 2001, DOE intends to dispose of certain low-level and mixed wastes in either Nevada or Washington prior to completion of the West Valley closure EIS. The Stipulation allows off-site disposal of Class A wastes in accordance with applicable law but does not allow any disposal (offsite or otherwise) of Class B/C wastes until the closure EIS is completed.*

DOE Response: Pursuant to the Stipulation, DOE retains the ability to dispose of Class A LLW in accordance with applicable law at a site other than the Center. In addition, for waste material containing elements having an atomic number greater than 92 in concentrations greater than 10 nanocuries per gram but less than or equal to 100 nanocuries per gram, the Stipulation provides that "[f]or disposal at locations other than the Center, such disposal will be in accordance with applicable law." The Stipulation does not address transportation and subsequent offsite disposal of TRU (waste material containing elements having an atomic number greater than 92 in concentrations greater than 100 nanocuries per gram) or HLW. Further, the Stipulation does not preclude the offsite disposal of any type of radioactive waste in accordance with applicable law prior to the completion of a closure EIS. This Waste Management EIS does not address onsite disposal; however, DOE will not initiate any of the waste shipping proposed under the action alternatives until this EIS is completed and a ROD is issued.

Coalition Comment 6. *According to the Notice of Intent published in the Federal Register on March 26, 2001, DOE intends to provide a 45-day public comment period following the issuance of the draft*

Decontamination and Waste Management EIS. The Stipulation requires a six month public comment period.

DOE Response: DOE provided a 6-month comment period for the 1996 Completion and Closure Draft EIS in compliance with the Stipulation and intends to provide a 6-month comment period for the future Decommissioning and/or Long-Term Stewardship EIS, which will be the continuation of the 1996 Completion and Closure Draft EIS. Thus, DOE has complied with, and will continue to comply with, this provision of the Stipulation. The 6-month comment period noted in the Stipulation does not apply to the Waste Management EIS.

Coalition Comment 7. *DOE asserts in the Notice of Intent published in the Federal Register on March 26, 2001, that the "decontamination and waste management actions will not be connected within the meaning of the regulations to decommissioning and/or long-term stewardship actions because decontamination and waste disposal actions can be implemented without previous or simultaneous actions being taken, are not an interdependent part of a larger action, and do not depend on a larger action for their justification . . ." This assertion is false. The actions of decontamination, decommissioning and/or long term stewardship are clearly interconnected in the context of the West Valley Demonstration Project.*

DOE Response: As originally scoped, DOE agrees that the proposed decontaminations actions could have been linked to decommissioning and/or long-term stewardship decisions and has accordingly eliminated them from the scope of this EIS. However, DOE believes that the waste management actions it proposes would need to occur regardless of any future decisions regarding site decommissioning, closure, and/or long-term stewardship. For this reason, DOE believes that these proposed waste management actions are independent from future site decommissioning and/or long-term stewardship decisions and do not depend on those future actions for their justification.

Coalition Comment 8. *DOE asserts in the Notice of Intent published in the Federal Register on March 26, 2001, that DOE and NYSERDA "may decide to proceed independently." This segmentation of the overall cleanup and closure is inappropriate under federal and state environmental review law.*

DOE Response: DOE noted that DOE and NYSERDA intended to prepare the future Decommissioning and/or Long-Term Stewardship EIS jointly under both NEPA and SEQRA, although either agency could decide to proceed independently in support of its separate mission. Applicable NEPA regulations encourage federal and state agencies to become joint lead agencies where appropriate; there is no requirement to do so, particularly when the agencies have responsibilities under different laws and regulations. It is not unlawful for DOE to prepare an EIS pursuant to NEPA to support its decisionmaking process and for NYSERDA to prepare separate documentation pursuant to SEQRA.

CONCERNED CITIZENS OF CATTARAUGUS COUNTY, INC. (CCCC)

CCCC Comment 1. *The substantive mandate of New York's State Environmental Quality Review Act (SEQRA) is much broader than that of the National Environmental Policy Act (NEPA). In particular, SEQRA disfavors dividing an action for environmental review in such a way that the various segments are addressed as though they were independent and unrelated activities where the earlier part of the action may practically determine a subsequent part of the action. Such an approach impermissibly avoids considering the combined environmental effects of all parts of the action. This mandate does not preclude action in stages; it only requires that cumulative impacts of likely subsequent actions be considered in the initial EIS. Unless DOE/NYSERDA's proposed new decontamination and waste management EIS also considers what standards for protection of health and the environment will be met* *at closure and decommissioning of the site, DOE/NYSERDA's proposal will violate SEQRA's mandate. Isn't the proposal dependent on decisions regarding closure of the West Valley site? Won't decisions regarding closure of the West Valley site depend on decontamination and waste management decisions?*

DOE Response: The proposed action and alternatives to be addressed in the Waste Management EIS are activities that are solely DOE's responsibility under the West Valley Demonstration Project Act. These proposed activities include management of waste for which DOE is responsible. For this reason, the applicable environmental review statute is NEPA, not SEQRA. DOE is not required to comply with SEQRA.

However, NEPA, like the SEQRA, requires that an agency consider connected actions together in the same EIS to avoid segmenting a large project into smaller projects with fewer impacts (*see* Council on Environmental Quality, NEPA Implementing Regulations, 40 CFR 1508.25(a)). NEPA also requires that agencies consider the cumulative impacts of past, present, and reasonably foreseeable future actions, along with the impacts of the proposed action (*see* 40 CFR 1508.7)). Thus, although SEQRA does not apply to DOE actions, NEPA imposes similar segmentation and cumulative impact requirements on federal agencies.

DOE does not believe that the proposed waste management activities in this EIS are connected to future decommissioning and/or long-term stewardship decisions for WVDP or the Center. These proposed waste management activities would not trigger other actions that would require the preparation of an EIS, can proceed independently of other actions at the site, and are not dependent upon future decisions regarding long-term plans for the site.

Rather, the proposed waste management activities are those that DOE would need to take regardless of eventual decisions regarding the long-term management of the Center. Undertaking these activities in the near term would not limit or prejudge the range of alternatives or the decisions to be made for eventual decommissioning of Project facilities and/or long-term stewardship of the Center. Further, DOE believes that preparing an EIS for waste management activities will allow the Department to make progress in removing wastes from the site, rather than waiting until site decommissioning and/or long-term stewardship decisions are made in the future.

CCCC Comment 2. *The West Valley Demonstration Project Act's Section 2(a)(5) requires DOE to "decontaminate and decommission" in accordance with NRC requirements. Under what authority does DOE now propose to decontaminate without considering requirements for decommissioning*?

DOE Response: DOE has modified the scope of this EIS as a result of public comments received during scoping. The scope is now limited to onsite waste management and offsite waste transportation activities, and no longer includes decontamination activities as proposed in the NOI.

CCCC Comment 3. *Current federal regulations require monitoring for radionuclides be performed at entry points to community water distribution systems and impose drinking water limits for radionuclides on such water systems. 65 FR 76707 (Dec. 7, 2000). Will the scope include the impact of DOE/NYSERDA's proposed new approach on the ability of community water systems to comply with current MCLs for radionuclides? If such impacts are considered, will they extend to community water systems that rely on the Cattaraugus Creek Sole Source Aquifer that underlies the WVDP site? See 52 FR 36100 (September 25, 1987).*

DOE Response: Because the proposed activities analyzed in the Waste Management EIS are limited to the shipping of wastes offsite and continued management of the HLW tanks prior to decisions from the Decommissioning and/or Long-Term Stewardship EIS, there would be no change in any site releases that could affect the ability of community water systems to comply with maximum contaminant levels for radionuclides. The EIS that will be prepared to address decommissioning and/or long-term stewardship of the site will address any potential impacts to water quality in general and to the Cattaraugus Creek Sole Source Aquifer in particular.

CCCC Comment 4. *Will the proposed EIS consider the effect of contaminated materials left onsite after decontamination on the collective dose for the population that uses the Cattaraugus Creek Sole Source Aquifer? If so, will this be the population at the time of the final status survey is performed?*

DOE Response: DOE will address the potential environmental impacts of contamination remaining after implementation of a decontamination and decommissioning alternative and disposition of the remaining wastes at the Center in the EIS for site decommissioning and/or long-term stewardship. To that end, DOE will use the most current population data available.

CCCC Comment 5. *Will the scope of the proposed decontamination and waste management EIS include the cumulative impact of releases of radioactive and non-radioactive hazardous or toxic substances into surface waters and groundwater from the West Valley site on the Cattaraugus Creek Sole Source Aquifer and the communities and private well water users who rely on the aquifer?*

DOE Response: The Waste Management EIS evaluates potential releases from the proposed waste management actions to the environment (Chapter 4) and the cumulative impacts (Chapter 5) of such releases for each alternative considered. As shown by the analyses, the proposed waste management actions would not result in adverse impacts to groundwater or surface water. Such impacts will be addressed in the Decommissioning and/or Long-Term Stewardship EIS.

CCCC Comment 6. *Together with the Nuclear Regulatory Commission (NRC), DOE and NYSERDA "have long favored addressing environmental impacts on a site-wide basis. Therefore, the EIS, the [NRC's] decommissioning criteria, and long-term control alternatives discussed in [SECY-98-251] cover both DOE's completion of the project and NYSERDA's closure of the site." NRC, SECY-98-251, note 1 (October 30, 1998). Isn't the proposed new decontamination and waste management EIS part of a long-term plan that includes closure of the West Valley site under NEPA? The EIS should consider impacts of decontamination and waste management activities on future site closure options.*

DOE Response: The proposed waste management activities analyzed in this EIS are those that DOE would need to take regardless of eventual decisions regarding the long-term closure and/or management of the Center. Undertaking these activities in the near term would not limit or prejudge the range of alternatives or the decisions to be made for eventual decommissioning of WVDP facilities and/or long-term stewardship of the Center. The proposed waste management activities addressed in this EIS would not have any impact on future site closure options. The potential environmental impacts of contamination remaining after implementation of a decontamination alternative and disposition of remaining wastes from the Center will be evaluated as part of the future EIS for site decommissioning and/or long-term stewardship.

CCCC Comment 7. *Low level radioactive waste and transuranic waste produced by the solidification of high level radioactive waste under the WVDP may be left in place or be left on the West Valley site following completion of the proposed decontamination and waste management activities. Will the scope of the proposed decontamination and waste management EIS measure, calculate, estimate or otherwise determine the amounts of these low level radioactive wastes and transuranic wastes or the exposure levels to be expected from these wastes?*

DOE Response: DOE has limited this EIS to those waste management actions that would ship wastes that are currently stored and that would be generated over the next 10 years to offsite disposal or interim storage. Information regarding the volume and exposure rates of other wastes left onsite after completion of proposed waste management activities (and the proposed disposition of that waste) will be provided in the future Decommissioning and/or Long-Term Stewardship EIS.

CCCC Comment 8. *Will the scope of the proposed decontamination and waste management EIS include the question whether long-term or perpetual institutional controls are necessary to ensure adequate protectiveness results from any decontamination and waste management activities? If this question of institutional controls is considered within the scope, will impacts of decontamination and waste management activities on resources and staff necessary to support long-term institutional controls also be included within the scope?*

DOE Response: This Waste Management EIS examines the potential environmental impacts of performing certain near-term waste management activities for which DOE is responsible under the West Valley Demonstration Project Act. The need for long-term or perpetual institutional controls will be examined in the future Decommissioning and/or Long-Term Stewardship EIS.

CCCC Comment 9. *Will dose-based criteria that include all pathways and that take into account exposures from the entire site, including the State Disposal Area and NYSERDA's 3300 acres around the WVDP, be used to evaluate potential impacts from decontamination and waste management activities?*

DOE Response: This Waste Management EIS examines the potential environmental impacts of performing certain near-term waste management activities for which DOE is responsible under the West Valley Demonstration Project Act. This EIS analyzes the potential worker and public dose from all pathways that could result from these activities. Cumulative impacts from past, present, and reasonably foreseeable future actions also are also analyzed. The future EIS that will be prepared to address decommissioning and/or long-term stewardship of the site will address potential exposures from the 13-square-kilometer (3,300-acre) Center as a whole, including the State-licensed Disposal Area.

CCCC Comment 10. *Will NYSDEC's technical and administrative guidance memorandum 4003, "Cleanup Guidelines for Soils Contaminated with Radioactive Materials," be adopted by DOE as a currently applicable, relevant and appropriate regulation for purposes of decontaminating areas of soil contamination?*

DOE Response: DOE has modified the scope of this EIS as a result of public comments received during scoping. The scope is now limited to onsite waste management and offsite waste transportation activities, and no longer includes decontamination activities as proposed in the NOI; therefore, the guidance memorandum is not applicable to the proposed actions of this EIS. The future Decommissioning and/or Long-Term Stewardship EIS will consider all relevant regulations and standards in its assessments of impacts.

CCCC Comment 11. *Will the scope of the proposed decontamination and waste management EIS include the question whether new waste disposal cells on the site will be needed to manage hazardous or mixed wastes generated as a result of decontamination activities?*

DOE Response: The activities analyzed in the Waste Management EIS do not include onsite disposal of any waste. For that reason, this EIS does address the need for new onsite waste disposal cells.

CCCC Comment 12. *NRC's decommissioning criteria for the West Valley site, including areas outside the Demonstration Project's 200 acres, NRC "rel[ies] on the DOE/NYSERDA's EIS for [NEPA]* *purpose[s]." 64 FR 67952, at p. 67954 (Dec. 3, 1999) (NRC Draft Policy Statement on West Valley). Will the proposed decontamination and waste management EIS stand in for or otherwise consider impacts on NRC's NEPA responsibilities?*

DOE Response: This Waste Management EIS examines the potential impacts of activities at WVDP for which DOE is responsible, and does not affect the NRC's NEPA responsibilities.

WEST VALLEY CITIZEN TASK FORCE (CTF)

CTF Comment 1. *Concerns about Splitting the EIS: The CTF agrees that we must stay within the requirements of the National Environmental Policy Act (NEPA) and the West Valley Demonstration Project (WVDP) Act, both of which seem to call for one process. We are concerned that some important matters might get lost in the changeover; that segmentation could be an issue, and that the second phase could get bogged down if the DOE/NYSERDA disagreement continues. We are eager to see the wording of the proposal for the second phase to be assured that the emphasis will be on closure rather than long-term stewardship and that the possibility of further decontamination is addressed adequately. We believe arriving at a cost/benefit analysis for waste removal and closure could be substantially more difficult once the EIS is split. We note that the recent DOE budget cut could be an omen of future funding shortages, a disturbing possibility.*

DOE Response: Neither NEPA nor the West Valley Demonstration Project Act requires only one NEPA document for all of the activities that must be undertaken at the site in compliance with the Act. The two-EIS strategy allows DOE to progress while longer term discussions with NYSERDA continue.

The Waste Management EIS will address activities that DOE would need to take regardless of eventual decisions regarding the long-term management of the Center, such as transporting nuclear waste for which DOE is responsible to offsite locations for storage or disposal. Decontamination, decommissioning, and site closure will be addressed in the future Decommissioning and/or Long-Term Stewardship EIS. DOE recognizes the CTF's stated preference for a focus on closure in the upcoming EIS and will consider that in the scoping process for that document. An Advance NOI was issued on November 6, 2001 (66 FR 56090), formalizing DOE's commitment to begin work on the Decommissioning and/or Long-Term Stewardship EIS.

DOE disagrees that the generation of two EISs would have a negative effect on its ability to assess the costs of the various decommissioning and/or closure alternatives available to DOE and NYSERDA. DOE annually reassesses its estimated operating costs and uses this information in its budget submittals. DOE is committed to seeking the funding necessary to meet its obligations under the West Valley Demonstration Project Act in its annual budget submittal to Congress; however, it cannot control Congressional decisionmaking.

CTF Comment 2. *Concerns about Phase One: We support only option two, as it is defined in the Federal Register notice (option three as presented at the scoping meeting), which includes decontaminating the high and low-level waste areas, the main plant, Vitrification facility, 01/14 Building and the waste tank farm. In regard to all cleanup, we would like to see all of EPA's concerns addressed, as expressed in their comment to NRC January 2000, including assurance that both radioactive and hazardous waste will be included in the cleanup, and that groundwater and air emissions standards likewise will be upheld. The CTF also has concerns about the brevity of the 45-day comment period.*

DOE Response: DOE has modified the scope of this EIS as a result of public comments received during scoping. The scope is now limited to onsite waste management and offsite waste transportation activities, and no longer includes decontamination activities as proposed in the NOI. DOE's ability to continue to comply with groundwater and air emission standards during the proposed waste management activities is addressed in the Waste Management EIS (Chapter 4).

With respect to the 45-day comment period, DOE believes that the standard 45-day comment period called for in NEPA implementing regulations will be sufficient given the limited nature of the proposed waste management activities analyzed in this Waste Management EIS. DOE provided a 6-month comment period for the 1996 Completion and Closure Draft EIS in compliance with the Stipulation of Compromise and intends to provide a 6-month comment period for the future Decommissioning and/or Long-Term Stewardship EIS.

CTF Comment 3. *Concerns about Phase Two: Our primary concern about splitting the EIS relates to the impact on phase two. Our concerns include:*

- *DOE's definition of the term "closure or long-term management";*
- *Whether the waste left in the tanks could be reclassified as incidental, as at other sites, yet could still be HLW by other definitions;*
- *Whether and how EPA and NRC criteria will be reconciled;*
- *The impact of the NRC Decontamination and Decommissioning guidelines when they are finally made public; and*
- *Most imminent, the ultimate division of responsibility between DOE and NYSERDA.*

DOE Response: These issues relate to the scope of the future Decommissioning and/or Long-Term Stewardship EIS and the basis for ultimate decisions to be made regarding site closure or future use, and are not addressed in the Waste Management EIS due to its limited scope. However, the issues raised in the comment will be within the scope of the second EIS.

NUCLEAR INFORMATION AND RESOURCE SERVICE AND PUBLIC CITIZEN/CRITICAL MASS ENERGY AND ENVIRONMENT PROGRAM (JOINT SUBMITTAL)

NIRS/PC Comment 1. *[Our organizations] request direct notification of all future comment periods, proposed actions and meetings regarding the long-term management and clean-up at the West Valley site. We believe that the 30-day comment period for this Notice of Intent is inadequate and that a 45-day comment period for the proposed segmented Draft Environmental Impact Statement to be published later this year is inadequate.*

DOE Response: DOE has included both organizations on its mailing list for future notices and copies of the Draft Waste Management EIS when it is issued. While DOE allowed for the usual 30-day public comment period on the scope of this EIS, the Department also stated in the Notice of Intent published in the Federal Register on March 26, 2001, that late comments would be considered to the extent practicable (the last comment letter DOE received was dated May 10, 2001). DOE has received no indication that any party seeking to submit scoping comments was unable to do so because of the length of the formal scoping period. Given the limited nature of the proposed activities to be analyzed in the Waste Management EIS, DOE believes that the standard 45-day comment period called for in NEPA implementing regulations will be sufficient for this EIS.

NIRS/PC Comment 2. *[Our organizations] oppose the splitting or segmenting of the Environmental Impact Statement for the West Valley Demonstration Project and Nuclear Service Center site. Some of us are already on record calling for the inclusion of the entire site in long-term planning so that the entire legacy at the site is evaluated in total, all areas, including the DOE Demonstration Project and the NYS* *areas. Segmenting the property into smaller sub-groups for purposes of long-term management and closure opens the door to leaving greater amounts of contamination and risk. We believe that the decontamination and waste management activities are inextricably linked to the decommissioning and long-term management of the site and should not be severed into two distinct Environmental Impact Statements. The Federal Register Notice of Intent does not fully explain or make the case for revising the strategy for completing the demonstration project and closure/long-term site management.*

DOE Response: DOE is not proposing to split the consideration of decommissioning and/or long-term stewardship of the WVDP facilities from the decommissioning and/or long-term stewardship of the Center. Rather, DOE is proposing to analyze the potential impacts associated with waste management activities such as offsite transportation of waste. DOE has modified the scope of this EIS as a result of public comments received during scoping. The scope is now limited to onsite waste management and offsite waste transportation activities, and no longer includes decontamination activities as proposed in the NOI. The proposed waste management activities are those that DOE would need to take regardless of eventual decisions regarding the long-term management of the Center. The future Decommissioning and/or Long-Term Stewardship EIS will analyze the potential impacts of closure and/or long-term management of the Center as a whole, including the Project facilities. An Advance NOI was issued on November 6, 2001(66 FR 56090), formalizing DOE's commitment to begin work on the Decommissioning and/or Long-Term Stewardship EIS.

NIRS/PC Comment 3. *[Our organizations] support efforts by DOE and NYSERDA to comply with the Agreement (Stipulation of Compromise Settlement) with the local community organization, the Coalition on West Valley Nuclear Wastes, in 1987, which resulted from legal action on the long-term management of the site. We do not support efforts to circumvent or violate the Agreement or NEPA. We support the Coalition in its efforts toward isolation of radioactivity from all of the West Valley nuclear activities.*

DOE Response: DOE is not proposing to take any action that would violate either the Stipulation of Compromise or NEPA. DOE supports the efforts to isolate radioactivity from WVDP nuclear activities and believes that preparing an EIS for waste management activities will allow the Department to make progress in onsite waste management and offsite waste transportation activities, rather than waiting until site decommissioning and/or long-term stewardship decisions are made some time in the future.

NIRS/PC Comment 4. *[Our organizations] consider this notice inadequate as an announcement of Scoping for a new segmented EIS, since we contest the simultaneous announcement splitting the existing process.*

DOE Response: In its NOI, published in the *Federal Register* on March 26, 2001, DOE stated that it welcomed comments on the plan for revising the strategy for completion of the 1996 Completion and Closure Draft EIS as well as on the scope of the anticipated Waste Management EIS. DOE has considered all of the comments it received regarding its plan to rescope the 1996 Draft EIS, and continues to believe that this course of action is appropriate and consistent with NEPA and the Stipulation of Compromise.

NIRS/PC Comment 5. *[Our organizations] support the goal of complete isolation of all of the West Valley wastes, support both short and long term remedial actions and planning that prevent leakage, exposure and loss of control of the radioactivity from all of the West Valley activities.*

DOE Response: DOE also supports the efforts to isolate WVDP wastes and believes that preparing an EIS for waste management activities will allow the Department to make progress in onsite waste management and offsite waste transportation activities, rather than waiting until site decommissioning and/or long-term stewardship decisions are made some time in the future.

THE LEAGUE OF WOMEN VOTERS OF BUFFALO/NIAGARA

LWV Comment 1. *The official time period on this revised strategy was inadequate.*

DOE Response: DOE provided the required 30-day comment period for the proposed rescoping of the 1996 Completion and Closure Draft EIS. In addition, DOE stated that late comments would be considered to the extent practicable. For example, DOE received the League of Women Voters comments on May 11, 2001, and has considered those comments along with comments received by the April 25, 2001 due date.

LWV Comment 2. *We concur with all the comments made by the [Citizens Task Force] in this matter, especially questioning the legality of the proposed change, emphasizing the need for staying within the laws of NEPA and the West Valley Demonstration Project Act, and reiterating the necessity that the Nuclear Regulatory Commission guidelines be available soon, before completion of the draft EIS, and honored therein.*

DOE Response: Please see the DOE responses to the CTF comments above. With respect to NRC guidelines, the West Valley Demonstration Project Act requires DOE to decontaminate and decommission material and hardware used in connection with the project "in accordance with such requirements as the Commission may prescribe." West Valley Demonstration Project Act, Section 2((a)(5)(C). The level to which the Center should be cleaned up will be addressed in the future Decommissioning and/or Long-Term Stewardship EIS.

DOE has modified the scope of the EIS as a result of public comments received during scoping. The scope is now limited to onsite waste management and offsite waste transportation activities, and no longer includes decontamination activities as proposed in the NOI.

LWV Comment 3. *The 1996 Draft Environmental Impact Statement for Completion and Closure called for one project while the strategy change requires two separate NEPA documents. When a coordinated plan is split into two or more phases, the overall plan remains in effect. When the plan itself is split, many unforeseen problems can emerge:*

- *Parts of the original plan could be changed, ignored, or forgotten*
- *Cumulative effects may go unchecked because of the segmentation of various portions*
- *Arriving at a cost benefit analysis for a split project will be difficult, and completion will be more expensive*
- *Considering the uncertainty of Congressional budget allotments (recent cuts in the DOE budget presents a prime example), budget constraints could disallow continuance of the project, thus endangering its completion*
- *Splitting the EIS into two could allow for serious delay in drafting and implementing the final EIS and completion and closure for the entire site.*

DOE Response: The West Valley Demonstration Project Act established a single program with multiple components. DOE has already prepared numerous NEPA documents to carry out its numerous responsibilities under the Act, including the *Final Environmental Impact Statement, Long Term Management of Liquid High-Level Radioactive Wastes Stored at the Western New York Nuclear Service Center* (DOE/EIS-0081, June 1982). Rather than address the waste management activities and decommissioning components in one EIS, as originally planned for the Completion and Closure EIS, DOE decided that addressing the two components separately would facilitate its decisionmaking process. Regardless of the number of NEPA documents prepared, the overall plan required by the West Valley Demonstration Project Act remains in place.

DOE believes that all of the activities that were addressed in the 1996 Completion and Closure Draft EIS will be addressed in either the Waste Management EIS or in the future Decommissioning and/or Long-Term Stewardship EIS. Cumulative impacts will be addressed in both documents.

Because DOE proposes to implement actions that will need to occur regardless of any future decommissioning and/or long-term stewardship scenario, DOE does not expect that significant additional costs would be incurred. Although DOE does not anticipate discontinuance of federal funds for the WVDP, possible future budget constraints are a reason to analyze and implement initial cleanup decisions in the short term.

DOE does not expect that the decision to prepare the Waste Management EIS will delay the final decision on the future of the site. DOE issued an Advance NOI on November 6, 2001, to prepare the Decommissioning and/or Long-Term Stewardship EIS in the near future with NYSERDA, demonstrating its commitment to making final decisions regarding the site. Moreover, the waste management activities addressed in the Waste Management EIS would take several years to implement, allowing sufficient time for DOE and the NYSERDA to resolve their differences and make the necessary decommissioning and/or long-term stewardship decisions.

LWV Comment 4. *The second phase could get bogged down, in light of the fact that the Department of Energy withdrew in January from negotiations with the New York State Energy Research and Development Authority regarding their individual responsibilities. We find it very disturbing that the future of the entire project and the surrounding community is being held hostage to intra-governmental squabbles.*

DOE Response: One of the reasons DOE decided to rescope the 1996 Completion and Closure Draft EIS was to be able to make decisions more quickly regarding its responsibilities for the cleanup of the WVDP site. DOE believes that preparing an EIS for waste management activities will allow the Department to make progress in removing waste from the site, rather than waiting until site decommissioning and/or long-term stewardship decisions are made some time in the future.

LWV Comment 5. *Under the proposed change, the first EIS refers to Decontamination and Waste Management. The proposed second EIS does not mention further decontamination and waste management, including removal, which we assume will be necessary. We all need assurance that waste removal and closure will remain the goal and become the reality at the completion of the entire cleanup process at the West Valley site.*

DOE Response: DOE has modified the scope of this EIS as a result of public comments received during scoping. The scope is now limited to onsite waste management and offsite waste transportation activities, and no longer includes decontamination activities as proposed in the NOI. The proposed actions evaluated in this EIS would remove all stored and newly generated wastes from the site. Further decontamination, and decommissioning actions will be the subject of the Decommissioning and/or Long-Term Stewardship EIS.

B.4 REFERENCES

DOE (U.S. Department of Energy), 1996. *Draft Environmental Impact Statement for Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Service Center - Volumes 1 and 2*, DOE/EIS-0226-D, January.

DOE (U.S. Department of Energy), 1997. *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste (Volumes 1 through 5)*, DOE/EIS-0200, Washington, DC, May.

APPENDIX C
HUMAN HEALTH IMPACTS

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APPENDIX C
HUMAN HEALTH IMPACTS

This appendix contains information in addition to that presented in Chapter 4 on the human health analyses conducted for this environmental impact statement (EIS).

C.1 RADIATION AND HUMAN HEALTH

Radiation is the emission and propagation of energy through space or through a material in the form of waves or bundles of energy called photons, or in the form of high-energy subatomic particles. Radiation generally results from atomic or subatomic processes that occur naturally. The most common kind of radiation is electromagnetic radiation, which is transmitted as photons. Electromagnetic radiation is emitted over a range of wavelengths and energies. We are most commonly aware of visible light, which is part of the spectrum of electromagnetic radiation. Radiation of longer wavelengths and lower energy includes infrared radiation, which heats material when the material and the radiation interact, and radio waves. Electromagnetic radiation of shorter wavelengths and higher energy (which are more penetrating) includes ultraviolet radiation, which causes sunburn, X-rays, and gamma radiation.

Ionizing radiation is radiation that has sufficient energy to displace electrons from atoms or molecules to create ions. It can be electromagnetic (for example, X-rays or gamma radiation) or subatomic particles (for example, alpha and beta radiation). The ions have the ability to interact with other atoms or molecules; in biological systems, this interaction can cause damage in the tissue or organism.

Radioactivity is the property or characteristic of an unstable atom to undergo spontaneous transformation (to disintegrate or decay) with the emission of energy as radiation. Usually the emitted radiation is ionizing radiation. The result of the process, called radioactive decay, is the transformation of an unstable atom (a radionuclide) into a different atom, accompanied by the release of energy (as radiation) as the atom reaches a more stable, lower energy configuration. Radioactive decay produces three main types of ionizing radiation—alpha particles, beta particles, and gamma or X-rays—but our senses cannot detect them. These types of ionizing radiation can have different characteristics and levels of energy and, thus, varying abilities to penetrate and interact with atoms in the human body. Because each type has different characteristics, each requires different amounts of material to stop (shield) the radiation. Alpha particles are the least penetrating and can be stopped by a thin layer of material such as a single sheet of paper. However, if radioactive atoms (called radionuclides) emit alpha particles in the body when they decay, there is a concentrated deposition of energy near the point where the radioactive decay occurs. Shielding for beta particles requires thicker layers of material such as several reams of paper or several inches of wood or water. Shielding from gamma rays, which are highly penetrating, requires very thick material such as several inches to several feet of heavy material (for example, concrete or lead). Deposition of the energy by gamma rays is dispersed across the body in contrast to the local energy deposition by an alpha particle. In fact, some gamma radiation will pass through the body without interacting with it.

Radiation that originates outside of an individual's body is called external or direct radiation. Such radiation can come from an X-ray machine or from radioactive materials (materials or substances that contain radionuclides), such as radioactive waste or radionuclides in soil. Internal radiation originates inside a person's body following intake of radioactive material or radionuclides through ingestion or inhalation. Once in the body, the fate of a radioactive material is determined by its chemical behavior and how it is metabolized. If the material is soluble, it might be dissolved in bodily fluids and transported to and deposited in various body organs; if it is insoluble, it might move rapidly through the gastrointestinal tract or be deposited in the lungs.

Exposure to ionizing radiation is expressed in terms of absorbed dose, which is the amount of energy imparted to matter per unit mass. Often simply called dose, it is a fundamental concept in measuring and quantifying the effects of exposure to radiation. The unit of absorbed dose is the rad. The different types of radiation mentioned above have different effects in damaging the cells of biological systems. Dose equivalent is a concept that considers the absorbed dose and the relative effectiveness of the type of ionizing radiation in damaging biological systems, using a radiation-specific quality factor. The unit of dose equivalent is the rem. In quantifying the effects of radiation on humans, other types of concepts are also used. The concept of effective dose equivalent is used to quantify effects of radionuclides in the body. It involves estimating the susceptibility of the different tissue in the body to radiation to produce a tissue-specific weighting factor. The weighting factor is based on the susceptibility of that tissue to cancer. The sum of the products of each affected tissue's estimated dose equivalent multiplied by its specific weighting factor is the effective dose equivalent. The potential effects from a one-time ingestion or inhalation of radioactive material are calculated over a period of 50 years to account for radionuclides that have long half-lives and long residence time in the body. The result is called the committed effective dose equivalent. The unit of effective dose equivalent is also the rem. Total effective dose equivalent is the sum of the committed effective dose equivalent from radionuclides in the body plus the dose equivalent from radiation sources external to the body (also in rem). All estimates of dose presented in this EIS, unless specifically noted as something else, are total effective dose equivalents, which are quantified in terms of rem or millirem (mrem), which is one one-thousandth of a rem.

More detailed information on the concepts of radiation dose and dose equivalent are presented in publications of the National Council on Radiation Protection and Measurements (NCRP 1993) and the International Commission on Radiological Protection (ICRP 1991).

The factors used to convert estimates of radionuclide intake (by inhalation or ingestion) to dose are called dose conversion factors. The International Commission on Radiological Protection and federal agencies such as the U.S. Environmental Protection Agency (EPA) publish these factors (Eckerman and Ryman 1993; Eckerman et al. 1988). They are based on original recommendations of the International Commission on Radiological Protection (ICRP 1977).

The radiation dose to an individual or to a group of people can be expressed as the total dose received or as a dose rate, which is dose per unit time (usually an hour or a year). Collective dose is the total dose to an exposed population. Person-rem is the unit of collective dose. Collective dose is calculated by summing the individual dose to each member of a population. For example, if 100 workers each received 0.1 rem, the collective dose would be 10 person-rem (100 × 0.1 rem).

Exposures to radiation or radionuclides are often characterized as being acute or chronic. Acute exposures occur over a short period of time, typically 24 hours or less. Chronic exposures occur over longer periods of time (months to years); they are usually assumed to be continuous over a period, even though the dose rate might vary. For a given dose of radiation, chronic radiation exposure is usually less harmful than acute exposure because the dose rate (dose per unit time, such as rem per hour) is lower, providing more opportunity for the body to repair damaged cells.

On average, members of the public nationwide are exposed to approximately 300 mrem per year from natural sources (NCRP 1987). The largest natural sources are radon-222 and its radioactive decay products in homes and buildings, which contribute about 200 mrem per year. Additional natural sources include radioactive material in the earth (primarily the uranium and thorium decay series, and potassium-40) and cosmic rays from space filtered through the atmosphere. With respect to exposures resulting from human activities, the combined doses from weapons testing fallout, consumer and industrial products, and air travel (cosmic radiation) account for the remaining approximate 3 percent of the total annual dose. Nuclear fuel cycle facilities contribute less than 0.1 percent (0.05 mrem per year) of the total dose.

Cancer is the principal potential risk to human health from exposure to low or chronic levels of radiation. This EIS expresses radiological health impacts as the incremental changes in the number of expected fatal cancers (latent cancer fatalities) for populations and as the incremental increases in lifetime probabilities of contracting a fatal cancer for an individual. The estimates are based on the dose received and on dose-to-health effect conversion factors recommended by the International Commission on Radiological Protection (1991). The Commission estimated that, for the general population, a collective dose of 1 person-rem would yield 5×10^{-4} excess latent cancer fatality. For radiation workers, a collective dose of 1 person-rem would yield an estimated 4×10^{-4} excess latent cancer fatality. The higher risk factor for the general population is primarily due to the inclusion of children in the population group, while the radiation worker population includes only people older than 18.

Other health effects such as nonfatal cancers and genetic effects can occur as a result of chronic exposure to radiation. Inclusion of the incidence of nonfatal cancers and severe genetic effects from radiation exposure increases the total detriment by 40 to 50 percent (Table C-1), compared to the change for latent cancer fatalities (ICRP 1991). As is the general practice for any U.S. Department of Energy (DOE) EIS, estimates of the total change have not been included in this EIS.

Table C-1. Risk of Latent Cancer Fatalities and Other Health Effects from Exposure to Radiation

Population	Latent Cancer Fatality (per rem)	Nonfatal Cancer (per rem)	Genetic Effects (per rem)	Total Detriment (per rem)
Workers	4.0×10^{-4}	8.0×10^{-5}	8.0×10^{-5}	5.6×10^{-4}
General Population	5.0×10^{-4}	1.0×10^{-4}	1.3×10^{-4}	7.3×10^{-4}

Source: ICRP 1991.

Exposures to high levels of radiation at high dose rates over a short period (less than 24 hours) can result in acute radiation effects. Minor changes in blood characteristics might be noted at doses in the range of 25 to 50 rad. The external symptoms of radiation sickness begin to appear following acute exposures of about 50 to 100 rad and can include anorexia, nausea, and vomiting. More severe symptoms occur at higher doses and can include death at doses higher than 200 to 300 rad of total body irradiation, depending on the level of medical treatment received. Information on the effects of acute exposures on humans was obtained from studies of the survivors of the Hiroshima and Nagasaki bombings and from studies following a multitude of acute accidental exposures. Factors to relate the level of acute exposure to health effects exist but are not applied in this EIS because expected exposures during normal operations and accidents would be well below 50 rem.

C.2 RADIOLOGICAL ASSESSMENT

When radioactivity is released into the environment, it has the potential to affect persons who come in contact with it. Mechanisms for transporting radiation include air, water, soil and food. The many ways an individual or population can come into contact with radiation are known as pathways. Pathway analysis is useful in quantifying the effective dose equivalent to an individual or population that is affected by the release. If radiation is released into the environment, an individual can come directly into contact with it via the external and inhalation pathways, or indirectly via the ingestion pathway. Submersion in an air or water plume can be directly quantified by dose conversion factors based on the concentration in the medium of interest.

Gaseous effluents released to the atmosphere were modeled with a straight line gaussian plume. The receptors were assumed to be downwind at a location that maximized their dose. The total dose to the individual at that location is the sum of all pathways (external, inhalation, and ingestion). At the location of the receptor, the external dose was calculated by multiplying the time-integrated concentration in air by the length of exposure and then multiplying that product by the appropriate external dose conversion factor for air, for each radionuclide, and then those doses were summed across all radionuclides. Radionuclides deposited on the ground also provide an external dose component and are assessed in a similar manner using the appropriate external ground dose conversion factors.

Internal exposure via inhalation for each radionuclide was quantified at the receptor location by multiplying the estimated concentration of the radionuclide by the intake of air (breathing rate times length of exposure) multiplied by the appropriate inhalation dose conversion factor for all nuclides.

The ingestion pathway is significant for some radionuclides that are released into the air or into water used for irrigation. For those radionuclides in the air, as the plume carrying the radionuclides travels away from the source, the radionuclides are deposited on the ground. Some radionuclides move from the soil into vegetation with water. The outside of plants will also intercept radionuclides from air and water. These plants can be either consumed directly by humans, or ingested by an animal (beef or poultry) that will then be consumed by humans or that will produce milk or eggs. The rates at which radionuclides accumulate in plant and animal product food stuffs are described by radionuclide transfer factors.

The following are pathways for liquid effluents released into surface water. The receptor can come into contact with liquid effluents that are released into surface water through direct external submersion in the contaminated water, boating over contaminated water and by spending time on shorelines where contaminated water is present. These are all external pathways. Internal pathways are primarily from drinking contaminated water, eating fish and wildlife that use the water, and by eating produce and animal products that were irrigated using the contaminated surface water.

C.2.1 Normal Operations

The GENII computer code (Napier et al. 1988) was used to estimate the radiation doses from releases during normal operations. For releases of radioactive material to the atmosphere, two receptors were evaluated: the maximally exposed individual, who was considered to be a nearby resident, and the population within 80 kilometers (50 miles) of the WVDP site. People were assumed to inhale radioactive material and be exposed to external radiation from the radioactive material released during normal operations. People were also assumed to ingest radioactive material through foodstuffs such as leafy vegetables, produce, meat, and milk.

Releases to the atmosphere could be from ground level or from a stack. Annual average atmospheric conditions were used to estimate radiation doses. Site-specific meteorological data from 1994 through 1998 (WVNS 2000a) were used to determine these atmospheric conditions.

The values of parameters used in GENII are listed in Table C-2.

C.2.2 Facility Accidents

The GENII computer code (Napier et al. 1988) was also used to estimate radiation doses from accidents. For accidents where radioactive material would be released to the atmosphere, three receptors were evaluated: (1) a worker at the onsite evaluation point located 640 meters (3,000 feet) from the accident, (2) the maximally exposed individual located at the WVDP site boundary, and (3) the population within

Table C-2. Parameters Used in GENII Radiological Assessments

Parameter	Individual Value	Population Value
Leafy Vegetable Consumption Rate	64 kg/yr	23 kg/yr
Other Produce Consumption Rate	217 kg/yr	80 kg/yr
Fruit Consumption Rate	114 kg/yr	42 kg/yr
Cereal Consumption Rate	125 kg/yr	46 kg/yr
Leafy Vegetable Growing Time	90 d	60 d
Other Produce Growing Time	90 d	60 d
Fruit Growing Time	90 d	60 d
Cereal Growing Time	90 d	60 d
Leafy Vegetable Holdup Time	1 d	14 d
Other Produce Holdup Time	60 d	14 d
Fruit Holdup Time	60 d	14 d
Cereal Holdup Time	90 d	14 d
Leafy Vegetable Yield	2 kg/m^2	2 kg/m^2
Other Produce Yield	2 kg/m^2	2 kg/m^2
Fruit Yield	2 kg/m^2	2 kg/m^2
Cereal Yield	2 kg/m^2	2 kg/m^2
Beef Consumption Rate	73 kg/yr	63 kg/yr
Poultry Consumption Rate	37 kg/yr	31 kg/yr
Milk Consumption Rate	310 L/yr	110 L/yr
Egg Consumption Rate	100 kg/yr	20 kg/yr
Beef Holdup Time	20 d	20 d
Poultry Holdup Time	1 d	1 d
Milk Holdup Time	0 d	4 d
Egg Holdup Time	0 d	3 d
Stored Feed Diet Fraction (beef)	0.25	0.25
Stored Feed Diet Fraction (poultry)	0.25	0.25
Stored Feed Diet Fraction (milk cow)	0.25	0.25
Stored Feed Diet Fraction (laying hen)	0.25	0.25
Stored Feed Grow Time (beef)	90 d	90 d
Stored Feed Grow Time (poultry)	90 d	90 d
Stored Feed Grow Time (milk cow)	45 d	45 d
Stored Feed Grow Time (laying hen)	90 d	90 d
Stored Feed Yield (beef)	2 kg/m^2	1 kg/m^2
Stored Feed Yield (poultry)	2 kg/m^2	2 kg/m^2
Stored Feed Yield (milk cow)	2 kg/m^2	2 kg/m^2
Stored Feed Yield (laying hen)	2 kg/m^2	2 kg/m^2
Stored Feed Storage Time (beef)	90 d	90 d
Stored Feed Storage Time (poultry)	90 d	90 d
Stored Feed Storage Time (milk cow)	90 d	90 d
Stored Feed Storage Time (laying hen)	90 d	90 d
Fresh Forage Diet Fraction (beef)	0.25	0.25
Fresh Forage Diet Fraction (milk cow)	0.75	0.75
Fresh Forage Grow Time (beef)	45 d	45 d
Fresh Forage Grow Time (milk cow)	30 d	30 d
Fresh Forage Yield (beef)	0.70 kg/m^2	2 kg/m^2
Fresh Forage Yield (milk cow)	1 kg/m^2	0.7 kg/m^2
Fresh Forage Storage Time (beef)	90 d	90 d
Fresh Forage Storage Time (milk cow)	0	0
Immersion Exposure Time (Chronic)	8,760 hr/yr	8,760 hr/yr

Table C-2. Parameters Used in GENII Radiological Assessments (cont)

Parameter	Individual Value	Population Value
Inhalation Exposure Time (Chronic)	2,000 hr/yr	2,000 hr/yr
Ground Surface Exposure Time (Chronic)	2,000 hr/yr	2,000 hr/yr
Immersion Exposure Time (Acute)	Duration of plume passage	Duration of plume passage
Inhalation Exposure Time (Acute)	Duration of plume passage	Duration of plume passage
Ground Surface Exposure Time (Acute)	2 hr	2 hr
Mass Loading	1×10^{-4} g/m^3	1×10^{-4} g/m^3
Swimming Time	12 hr/yr	8.3 hr/yr
Boating Time	12 hr/yr	8.3 hr/yr
Other Shoreline Activities Time	12 hr/yr	8.3 hr/yr
Transit Time for aquatic recreation	2.3 hr	0 hr
Irrigation Rate	43 in/yr	36 in/yr
Irrigation Duration	6 mo/yr	6 mo/yr
Fish Consumption Rate	21 kg/yr	0.1 kg/yr
Fish Holdup Time	1 d	10 d
Fish Transit Time	2.3 hr	160 hr
Mixing Ratio	0.125	4×10^{-3}
Average River Flow Rate	13.6 m^3/s	23.1 m^3/s
Transit Time to Irrigation Withdrawal	3.8 hr	0
Drink Water Consumption Rate	0	370 L/yr
Drinking Water Holdup Time	0	1 d
Breathing Rate (Chronic)	270 cm^3/s	270 cm^3/s
Breathing Rate (Acute)	330 cm^3/s	330 cm^3/s

Source: WVNS 2000a.
Acronyms: kg/yr = kilograms per year; d = day; kg/m^2 = kilograms per square meter; L/yr = liters per year; hr/yr = hours per year; g/m^3 = grams per cubic meter; in/yr = inches per year; mo/yr = months per year; m^3/s = cubic meters per second; cm^3/s = cubic centimeters per second

80 kilometers (50 miles) of the WVDP site. The maximally exposed individual was assumed to be at the WVDP site boundary because radiation doses were higher at the boundary than at the actual locations of nearby residents.

People were assumed to inhale radioactive material and be exposed to external radiation from radioactive material released during the accident. This radioactive material could be released from ground level or from a stack, depending on the accident. Two types of atmospheric conditions were used to estimate radiation doses, 50 percent atmospheric conditions and 95 percent atmospheric conditions. Fifty percent atmospheric conditions are conditions that are not exceeded 50 percent of the time and provide a realistic estimate of the likely atmospheric conditions that would exist during an accident. Ninety-five percent atmospheric conditions are conditions that are not exceeded 95 percent of the time and provide an upper bound on the atmospheric conditions that would exist during an accident. Site-specific meteorological data from 1994 through 1998 (WVNS 2000a) were used to determine 50 percent and 95 percent atmospheric conditions.

C.3 RADIONUCLIDE RELEASES FOR NORMAL OPERATIONS

Under all alternatives, it is assumed that current levels of maintenance, surveillance, heating, ventilation, and other routine operations would continue to be required while the actions proposed under each alternative were performed. For this EIS, these actions are called ongoing operations. Because ongoing operations would not vary among the proposed alternatives, the releases from these actions would be the same across all alternatives. These releases are listed in the WVDP Annual Site Environmental Reports for 1995 through 1999 (WVNS 1996, 1997, 1998, 1999a, 2000b).

The No Action Alternative and Alternative A would have no additional airborne or liquid releases. For Alternative B, airborne releases would result from the interim stabilization of high-level waste (HLW) tanks 8D-1 and 8D-2. These releases would emanate from the stack at the Waste Tank Farm (Table C-3). The releases are based on 0.1 percent of the mobile inventory in the tanks becoming airborne during interim stabilization and being released after being filtered through two banks of high-efficiency particulate air (HEPA) filters with efficiencies of 99.97 percent. These releases are listed in Table C-4.

Table C-3. Stack Parameters for Normal Operations Releases

Stack	Height (meters)[a]	Diameter (meters)	Discharge Rate (cubic meters per second)[b]	Exit Velocity (meters per second)
Process Building (ANSTACK)	63.4	1.35	23.6	16.49
Vitrification Facility (ANVITSK)	22.86	0.91	11.8	17.98
Waste Tank Farm (ANSTSK)	10.06	0.47	2.12	12.24
01/14 Building (ANCSSTK)	22.25	0.6	4.58	16.19

Source: WVNS 1999b.
a. To convert meters to feet, multiply by 3.2808.
b. To convert cubic meters to cubic feet, multiply by 0.028317.

Table C-4. Airborne Releases from Interim Stabilization Normal Operations

Nuclide	MAR (curies)[a]	DR	ARF	RF	LPF	ST (curies)[b]
Carbon-14	1.0×10^{-3}	1.0	1.0×10^{-3}	1.0	9.0×10^{-8}	1.8×10^{-13}
Cobalt-60	0.50	1.0	1.0×10^{-3}	1.0	9.0×10^{-8}	9.0×10^{-11}
Nickel-63	4.1	1.0	1.0×10^{-3}	1.0	9.0×10^{-8}	7.4×10^{-10}
Strontium-90	820	1.0	1.0×10^{-3}	1.0	9.0×10^{-8}	1.5×10^{-7}
Technetium-99	0.12	1.0	1.0×10^{-3}	1.0	9.0×10^{-8}	2.2×10^{-11}
Cesium-137	21,000	1.0	1.0×10^{-3}	1.0	9.0×10^{-8}	3.8×10^{-6}
Plutonium-241	6.3	1.0	1.0×10^{-3}	1.0	9.0×10^{-8}	1.1×10^{-9}
Curium-242	0.060	1.0	1.0×10^{-3}	1.0	9.0×10^{-8}	1.1×10^{-11}
Neptunium-237	7.0×10^{-3}	1.0	1.0×10^{-3}	1.0	9.0×10^{-8}	1.3×10^{-12}
Plutonium-238	0.70	1.0	1.0×10^{-3}	1.0	9.0×10^{-8}	1.3×10^{-10}
Plutonium-239	0.30	1.0	1.0×10^{-3}	1.0	9.0×10^{-8}	5.4×10^{-11}
Americium-241	5.4	1.0	1.0×10^{-3}	1.0	9.0×10^{-8}	9.7×10^{-10}
Americium-243	0.090	1.0	1.0×10^{-3}	1.0	9.0×10^{-8}	1.6×10^{-11}
Curium-244	1.1	1.0	1.0×10^{-3}	1.0	9.0×10^{-8}	2.0×10^{-10}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = Airborne Release Fraction; RF = respirable fraction; LPF = leakpath factor; ST = source term
a. MAR is based in the mobile inventory in Tank 8D-2 (WVNS 2001a).
b. ST is based on releases from two tanks, 8D-1 and 8D-2.

C.4 RADIONUCLIDE RELEASES FOR ACCIDENTS

The amount of radioactive material released during an accident is known as the source term. The units of the source term are usually curies. It is the product of several factors, including:

$$\text{Source Term} = \text{MAR} \times \text{DR} \times \text{ARF} \times \text{RF} \times \text{LPF}$$

where:

MAR = Material at risk
DR = Damage ratio
ARF = Airborne release fraction
RF = Respirable fraction
LPF = Leakpath factor

The material at risk is the amount of radioactive material (in grams or curies of radioactivity for each radionuclide) available to be acted on by a given physical stress.

The damage ratio is the fraction of the material at risk impacted by the actual accident-generated conditions under evaluation.

The airborne release fraction is the coefficient used to estimate the amount of a radioactive material that can be suspended in air and made available for airborne transport under a specific set of induced physical stresses. It is applicable to events and situations that are completed during the course of the event.

The respirable fraction is the fraction of airborne radionuclides as particles that can be transported through air and inhaled into the human respiratory system and is commonly assumed to include particulate matter less than or equal to 10 micrometers in diameter.

The leakpath factor is the fraction of airborne materials transported from containment or confinement deposition or filtration mechanism (for example, fraction of airborne material in a glovebox leaving the glovebox under static conditions, fraction of material passing through a HEPA filter).

C.4.1 Class A LLW Drum Puncture

This accident assumed that a drum containing Class A low-level waste (LLW) was punctured during handling by a fork of the forktruck. The accident could take place under the No Action Alternative, Alternative A, or Alternative B.

The material at risk for this accident is based on a Class A LLW drum filled with the intermediate radionuclide mix from Marschke (2001). The values for the damage ratio, airborne release fraction, respirable fraction, and leakpath factor are from WVNS (1993a). The frequency of this accident was estimated to be in the range of 0.1 to 0.01 per year (WVNS 2002a). Table C-5 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-5. Source Term for Class A LLW Drum Puncture

Nuclide	MAR (curies)	DR	ARF	RF	LPF	ST (curies)
Strontium-90	6.7×10^{-4}	0.10	1.0×10^{-3}	1.0	1.0	6.7×10^{-8}
Cesium-137	8.6×10^{-4}	0.10	1.0×10^{-3}	1.0	1.0	8.6×10^{-8}
Plutonium-238	2.7×10^{-4}	0.10	1.0×10^{-3}	1.0	1.0	2.7×10^{-8}
Plutonium-239	3.8×10^{-4}	0.10	1.0×10^{-3}	1.0	1.0	3.8×10^{-8}
Plutonium-240	2.7×10^{-4}	0.10	1.0×10^{-3}	1.0	1.0	2.7×10^{-8}
Plutonium-241	1.1×10^{-2}	0.10	1.0×10^{-3}	1.0	1.0	1.1×10^{-6}
Americium-241	2.8×10^{-5}	0.10	1.0×10^{-3}	1.0	1.0	2.8×10^{-9}
Americium-243	8.3×10^{-7}	0.10	1.0×10^{-3}	1.0	1.0	8.3×10^{-11}
Curium-244	4.0×10^{-7}	0.10	1.0×10^{-3}	1.0	1.0	4.0×10^{-11}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

C.4.2 Class A LLW Pallet Drop

This accident assumed that a pallet containing six Class A LLW drums was dropped during handling and the 6 drums were punctured. The accident could take place under the No Action Alternative, Alternative A, or Alternative B.

The material at risk for this accident is based on a Class A LLW drum filled with the intermediate radionuclide mix from Marschke (2001). The values for the damage ratio, airborne release fraction, respirable fraction, and leakpath factor are from WVNS (1993a). The frequency of this accident was estimated to be in the range of 0.1 to 0.01 per year (WVNS 2002a). Table C-6 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-6. Source Term for Class A LLW Pallet Drop

Nuclide	MAR (curies)	DR	ARF	RF	LPF	ST (curies)
Strontium-90	4.0×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	4.0×10^{-7}
Cesium-137	5.2×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	5.2×10^{-7}
Plutonium-238	1.6×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	1.6×10^{-7}
Plutonium-239	2.3×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	2.3×10^{-7}
Plutonium-240	1.6×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	1.6×10^{-7}
Plutonium-241	0.063	0.10	1.0×10^{-3}	1.0	1.0	6.3×10^{-6}
Americium-241	1.7×10^{-4}	0.10	1.0×10^{-3}	1.0	1.0	1.7×10^{-8}
Americium-243	5.0×10^{-6}	0.10	1.0×10^{-3}	1.0	1.0	5.0×10^{-10}
Curium-244	2.4×10^{-6}	0.10	1.0×10^{-3}	1.0	1.0	2.4×10^{-10}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

C.4.3 Class A LLW Box Puncture

This accident assumed that a B-25 box containing 90 cubic feet of Class A LLW was punctured during handling by a fork of the forktruck. The accident could take place under the No Action Alternative, Alternative A, or Alternative B.

The material at risk for this accident is based on a Class A LLW box filled with the intermediate radionuclide mix from Marschke (2001). The values for the damage ratio, airborne release fraction, respirable fraction, and leakpath factor are from WVNS (1993a). The frequency of this accident was estimated to be in the range of 0.1 to 0.01 per year (WVNS 2002a). Table C-7 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-7. Source Term for Class A LLW Box Puncture

Nuclide	MAR (curies)	DR	ARF	RF	LPF	ST (curies)
Strontium-90	8.3×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	8.3×10^{-7}
Cesium-137	0.011	0.10	1.0×10^{-3}	1.0	1.0	1.1×10^{-6}
Plutonium-238	3.3×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	3.3×10^{-7}
Plutonium-239	4.6×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	4.6×10^{-7}
Plutonium-240	3.3×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	3.3×10^{-7}
Plutonium-241	0.13	0.10	1.0×10^{-3}	1.0	1.0	1.3×10^{-5}
Americium-241	3.4×10^{-4}	0.10	1.0×10^{-3}	1.0	1.0	3.4×10^{-8}
Americium-243	1.0×10^{-5}	0.10	1.0×10^{-3}	1.0	1.0	1.0×10^{-9}
Curium-244	4.9×10^{-6}	0.10	1.0×10^{-3}	1.0	1.0	4.9×10^{-10}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

C.4.4 Collapse of Tank 8D-2 Vault (Wet)

For this accident, it is assumed that the occurrence of a severe earthquake greater than six times the design basis (0.1 g) causes the roof of Tank 8D-2 and its vault to collapse, exposing the tank contents to the atmosphere. In this accident, the contents of the tank were assumed to be wet. The material at risk for Tank 8D-2 was a heel made up of two components, the mobile inventory and the fixed inventory (WVNS 2001a). The mobile inventory consisted of the liquid at the bottom of the tank. This liquid was assumed to have an airborne release fraction of 1×10^{-8}. The fixed inventory was assumed to be scoured from the sides of the tank by debris falling into the tank during the collapse and have an airborne release fraction of 1×10^{-7}. Because of its physical form (particles as opposed to liquid), the zeolite inventory was assumed to not be released during the accident.

This accident could take place under the No Action Alternative or Alternative A, or under Alternative B until tank interim stabilization occurred. The frequency of this accident was estimated to be in the range of 10^{-4} to 10^{-6} per year (WVNS 2002a). Table C-8 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-8. Source Term for Tank 8D-2 Collapse (Wet)

Nuclide	Mobile MAR (curies)	Fixed MAR (curies)	DR	Mobile ARF	Fixed ARF	RF	LPF	ST (curies)
Carbon-14	1.0×10^{-3}	4.0×10^{-3}	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	4.1×10^{-10}
Cobalt-60	0.50	1.2	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	1.3×10^{-7}
Nickel-63	4.1	9.7	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	1.0×10^{-6}
Strontium-90	820	39,000	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	3.9×10^{-3}
Technetium-99	0.12	0.68	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	6.9×10^{-8}
Cesium-137	21,000	4,600	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	6.7×10^{-4}
Plutonium-241	6.3	1,000	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	1.0×10^{-4}
Curium-242	0.060	1.4	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	1.4×10^{-7}
Neptunium-237	7.0×10^{-3}	0.32	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	3.2×10^{-8}
Plutonium-238	0.70	120	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	1.2×10^{-5}
Plutonium-239	0.30	48	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	4.8×10^{-6}
Americium-241	5.4	170	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	1.7×10^{-5}
Americium-243	0.090	2.1	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	2.1×10^{-7}
Curium-244	1.1	25	1.0	1.0×10^{-8}	1.0×10^{-7}	1.0	1.0	2.5×10^{-6}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

C.4.5 Collapse of Tank 8D-2 Vault (Dry)

For this accident, it is assumed that the occurrence of a severe earthquake greater than six times the design basis (0.1 g) causes the roof of Tank 8D-2 and its vault to collapse, exposing the tank contents to the atmosphere. In this accident, the contents of the tank were assumed to be dry. The material at risk for Tank 8D-2 was a heel made up of two components, the mobile and zeolite inventory, and the fixed inventory (WVNS 2001a). The mobile and zeolite inventory was assumed to have dried out at the bottom of the tank. This dry material was assumed to have an airborne release factor of 4×10^{-7}. The fixed inventory was assumed to be scoured from the sides of the tank by debris falling into the tank during the collapse and have an airborne release factor of 1×10^{-7}.

Two phenomena were assumed to control the release of radioactive material following a tank collapse. The impact stresses imposed by the falling debris entrain some of the radioactive material in the air during the collapse. For the material on the walls of the tank, the fraction airborne was estimated using Equation 5-1 in DOE (1994). Using a fall height of 8 meters (27 feet) and a particle density of 2 grams per cubic meter, an airborne release fraction of 3×10^{-5} was estimated.

For the solid debris on the bottom of the tank, Section 4.4.3.3.2 of DOE (1994) summarizes experiments that have been run to estimate the release fractions when debris falls into various powders. According to Volume 2 of DOE (1994), there is only one experiment in which objects were actually dropped on powders; Table A-42 of that document summarizes those results. Based on the values listed in the "< 10 : m Inhal. PMS Probe" column, the average airborne release fraction is 1.4×10^{-4}.

The two airborne release fractions derived above were multiplied by 3×10^{-3} to obtain the final release fractions of 1.0×10^{-7} and 4×10^{-7}. The factor of 3×10^{-3} accounts for the effectiveness of the falling debris to remove entrained respirable particulates. The basis for this removal fraction is a series of experiments performed to determine the release fraction of respirable material following an explosion in a cell used to assemble nuclear weapons. These cells have roofs consisting of several feet of overburden that falls into the cell following an explosion. These experiments show that the falling debris removes 99.7 percent of the respirable particles.

This accident could take place under the No Action Alternative or Alternative A, or under Alternative B until tank interim stabilization occurred. The frequency of this accident was estimated to be in the range of 10^{-4} to 10^{-6} per year (WVNS 2002a). Table C-9 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-9. Source Term for Tank 8D-2 Collapse (Dry)

Nuclide	Dry MAR (curies)	Fixed MAR (curies)	DR	Dry ARF	Fixed ARF	RF	LPF	ST (curies)
Carbon-14	1.0×10^{-3}	4.0×10^{-3}	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	8.0×10^{-10}
Cobalt-60	0.50	1.2	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	3.2×10^{-7}
Nickel-63	4.1	9.7	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	2.6×10^{-6}
Strontium-90	990	39,000	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	4.3×10^{-3}
Technetium-99	0.12	0.68	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	1.2×10^{-7}
Cesium-137	130,000	4,600	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	0.054
Plutonium-241	8.3	1,000	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	1.0×10^{-4}
Curium-242	0.060	1.4	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	1.6×10^{-7}
Neptunium-237	7.0×10^{-3}	0.32	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	3.5×10^{-8}
Plutonium-238	0.93	120	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	1.2×10^{-5}
Plutonium-239	0.40	48	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	5.0×10^{-6}
Americium-241	5.4	170	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	1.9×10^{-5}
Americium-243	0.090	2.1	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	2.4×10^{-7}
Curium-244	1.1	25	1.0	4.0×10^{-7}	1.0×10^{-7}	1.0	1.0	2.9×10^{-6}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

C.4.6 Drum Cell Drop

This accident assumed that two drums containing solidified LLW from the Drum Cell were dropped. The accident could take place under Alternative A or Alternative B.

The material at risk for this accident is based on a 71-gallon drum filled with solidified LLW (WVNS 1993b). The airborne release fraction (DOE 1994) assumed that the cement in the drum was solid with a density of 1.8 grams per cubic centimeter (0.065 pound per cubic inch). The fall height for the drums was assumed to be 200 centimeters (79 inches), which yields an airborne release fraction of 7.1×10^{-6}. The damage ratio, respirable fraction, and leakpath factor were assumed to equal one for this accident. The frequency of this accident was estimated to be in the range of 0.1 to 0.01 per year (WVNS 2002a). Table C-10 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-10. Source Term for Drum Cell Drop

Nuclide	MAR (curies)	DR	ARF	RF	LPF	ST (curies)
Strontium-90	0.30	1.0	7.1×10^{-6}	1.0	1.0	2.1×10^{-6}
Cesium-137	2.0	1.0	7.1×10^{-6}	1.0	1.0	1.4×10^{-5}
Plutonium-238	0.076	1.0	7.1×10^{-6}	1.0	1.0	5.4×10^{-7}
Plutonium-239	0.015	1.0	7.1×10^{-6}	1.0	1.0	1.0×10^{-7}
Plutonium-240	0.011	1.0	7.1×10^{-6}	1.0	1.0	7.8×10^{-8}
Plutonium-241	0.74	1.0	7.1×10^{-6}	1.0	1.0	5.2×10^{-6}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

C.4.7 Class C LLW Drum Puncture

This accident assumed that a drum containing Class C LLW was punctured during handling by a fork of the forktruck. The accident could take place under Alternative A or Alternative B.

The material at risk, damage ratio, airborne release fraction, respirable fraction, and leakpath factor are from WVNS (1993a). The frequency of this accident was estimated to be in the range of 0.1 to 0.01 per year (WVNS 2002a). Table C-11 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-11. Source Term for Class C LLW Drum Puncture

Nuclide	MAR (curies)	DR	ARF	RF	LPF	ST (curies)
Strontium-90	0.14	0.10	1.0×10^{-3}	1.0	1.0	1.4×10^{-5}
Cesium-137	0.15	0.10	1.0×10^{-3}	1.0	1.0	1.5×10^{-5}
Plutonium-238	7.5×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	7.5×10^{-7}
Plutonium-239	2.1×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	2.1×10^{-7}
Plutonium-240	1.5×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	1.5×10^{-7}
Plutonium-241	0.099	0.10	1.0×10^{-3}	1.0	1.0	9.9×10^{-6}
Americium-241	5.7×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	5.7×10^{-7}
Americium-243	5.0×10^{-5}	0.10	1.0×10^{-3}	1.0	1.0	5.0×10^{-9}
Curium-244	6.0×10^{-4}	0.10	1.0×10^{-3}	1.0	1.0	6.0×10^{-8}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

C.4.8 Class C LLW Pallet Drop

This accident assumed that a pallet containing six Class C LLW drums was dropped during handling and the 6 drums were punctured. The accident could take place under Alternative A or Alternative B.

The material at risk, damage ratio, airborne release fraction, respirable fraction, and leakpath factor are from WVNS (1993a). The frequency of this accident was estimated to be in the range of 0.1 to 0.01 per year (WVNS 2002a). Table C-12 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-12. Source Term for Class C LLW Pallet Drop

Nuclide	MAR (curies)	DR	ARF	RF	LPF	ST (curies)
Strontium-90	0.84	0.10	1.0×10^{-3}	1.0	1.0	8.4×10^{-5}
Cesium-137	0.90	0.10	1.0×10^{-3}	1.0	1.0	9.0×10^{-5}
Plutonium-238	0.045	0.10	1.0×10^{-3}	1.0	1.0	4.5×10^{-6}
Plutonium-239	0.013	0.10	1.0×10^{-3}	1.0	1.0	1.3×10^{-6}
Plutonium-240	9.0×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	9.0×10^{-7}
Plutonium-241	0.59	0.10	1.0×10^{-3}	1.0	1.0	5.9×10^{-5}
Americium-241	0.034	0.10	1.0×10^{-3}	1.0	1.0	3.4×10^{-6}
Americium-243	3.0×10^{-4}	0.10	1.0×10^{-3}	1.0	1.0	3.0×10^{-8}
Curium-244	3.6×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	3.6×10^{-7}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

C.4.9 Class C LLW Box Puncture

This accident assumed that a B-25 box containing 90 cubic feet of Class C LLW was punctured during handling by a fork of the forktruck. The accident could take place under Alternative A or Alternative B.

The material at risk, damage ratio, airborne release fraction, respirable fraction, and leakpath factor are from WVNS (1993a). The frequency of this accident was estimated to be in the range of 0.1 to 0.01 per year (WVNS 2002a). Table C-13 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-13. Source Term for Class C LLW Box Puncture

Nuclide	MAR (curies)	DR	ARF	RF	LPF	ST (curies)
Strontium-90	1.4	0.10	1.0×10^{-3}	1.0	1.0	1.4×10^{-4}
Cesium-137	1.5	0.10	1.0×10^{-3}	1.0	1.0	1.5×10^{-4}
Plutonium-238	0.075	0.10	1.0×10^{-3}	1.0	1.0	7.5×10^{-6}
Plutonium-239	0.021	0.10	1.0×10^{-3}	1.0	1.0	2.1×10^{-6}
Plutonium-240	0.015	0.10	1.0×10^{-3}	1.0	1.0	1.5×10^{-6}
Plutonium-241	0.99	0.10	1.0×10^{-3}	1.0	1.0	9.9×10^{-5}
Americium-241	0.057	0.10	1.0×10^{-3}	1.0	1.0	5.7×10^{-6}
Americium-243	5.0×10^{-4}	0.10	1.0×10^{-3}	1.0	1.0	5.0×10^{-8}
Curium-244	6.0×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	6.0×10^{-7}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

C.4.10 High-Integrity Container Drop

This accident assumed that a high-integrity container holding radioactive sludge and resin was dropped during handling, spilling its contents. The accident could take place under Alternative A or Alternative B.

The material at risk, damage ratio, airborne release fraction, respirable fraction, and leakpath factor are from WVNS (2002a). The frequency of this accident was estimated to be in the range of 0.1 to 0.01 per year (WVNS 2002a). Table C-14 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-14. Source Term for High-Integrity Container Drop

Nuclide	MAR (curies)	DR	ARF	RF	LPF	ST (curies)
Americium-241	0.18	1.0	4.0×10^{-5}	1.0	1.0	7.2×10^{-6}
Plutonium-239	0.15	1.0	4.0×10^{-5}	1.0	1.0	6.1×10^{-6}
Plutonium-240	0.12	1.0	4.0×10^{-5}	1.0	1.0	4.6×10^{-6}
Plutonium-241	5.7	1.0	4.0×10^{-5}	1.0	1.0	2.3×10^{-4}
Plutonium-238	0.043	1.0	4.0×10^{-5}	1.0	1.0	1.7×10^{-6}
Cesium-137	210	1.0	4.0×10^{-5}	1.0	1.0	8.4×10^{-3}
Cobalt-60	5.2	1.0	4.0×10^{-5}	1.0	1.0	2.1×10^{-4}
Strontium-90	2.2	1.0	4.0×10^{-5}	1.0	1.0	8.7×10^{-5}
Cesium-134	4.5	1.0	4.0×10^{-5}	1.0	1.0	1.8×10^{-4}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

C.4.11 CH-TRU Drum Puncture

This accident assumed that a drum containing contact-handled transuranic (CH-TRU) waste was punctured during handling by a fork of the forktruck. The accident could take place under Alternative A or Alternative B.

The material at risk for this accident is from WVNS (2002a). The damage ratio, airborne release fraction, respirable fraction, and leakpath factor are from WVNS (1993a). The frequency of this accident was estimated to be in the range of 0.1 to 0.01 per year (WVNS 2002a). Table C-15 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-15. Source Term for CH-TRU Drum Puncture

Nuclide	MAR (curies)	DR	ARF	RF	LPF	ST (curies)
Plutonium-238	3.3	0.10	1.0×10^{-3}	1.0	1.0	3.3×10^{-4}
Strontium-90	520	0.10	1.0×10^{-3}	1.0	1.0	0.052
Plutonium-239	0.85	0.10	1.0×10^{-3}	1.0	1.0	8.5×10^{-5}
Plutonium-240	0.64	0.10	1.0×10^{-3}	1.0	1.0	6.4×10^{-5}
Americium-241	0.62	0.10	1.0×10^{-3}	1.0	1.0	6.2×10^{-5}
Plutonium-241	32	0.10	1.0×10^{-3}	1.0	1.0	3.2×10^{-3}
Curium-244	0.14	0.10	1.0×10^{-3}	1.0	1.0	1.4×10^{-5}
Americium-243	0.045	0.10	1.0×10^{-3}	1.0	1.0	4.5×10^{-6}
Cesium-137	570	0.10	1.0×10^{-3}	1.0	1.0	0.057
Uranium-232	0.015	0.10	1.0×10^{-3}	1.0	1.0	1.5×10^{-6}
Americium-242m	7.6×10^{-3}	0.10	1.0×10^{-3}	1.0	1.0	7.6×10^{-7}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

C.4.12 Fire in Loadout Bay

This accident involved a diesel fuel fire in the Remote-Handled Waste Facility as a result of a leak in the fuel tank or fuel line of a truck. This fire would involve CH-TRU and remote-handled transuranic

(RH-TRU) waste. The frequency of this accident was estimated to be in the range of 10^{-4} to 10^{-6} per year WVNS (2000c). This accident could take place under Alternative A or Alternative B.

The material at risk, damage ratio, airborne release fraction, respirable fraction, and leakpath factor are from WVNS (2000c). Table C-16 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-16. Source Term for Fire in Loadout Bay

Nuclide	MAR (curies)	DR	ARF	RF	LPF	ST (curies)
Plutonium-238	11	1.0	6.0×10^{-3}	0.010	1.0	6.8×10^{-4}
Americium-241	3.9	1.0	6.0×10^{-3}	0.010	1.0	2.3×10^{-4}
Plutonium-239	3.2	1.0	6.0×10^{-3}	0.010	1.0	1.9×10^{-4}
Plutonium-240	2.4	1.0	6.0×10^{-3}	0.010	1.0	1.5×10^{-4}
Plutonium-241	71	1.0	6.0×10^{-3}	0.010	1.0	4.2×10^{-3}
Cesium-137	180	1.0	6.0×10^{-3}	1.0	1.0	11
Strontium-90	170	1.0	6.0×10^{-3}	0.010	1.0	9.9×10^{-3}
Curium-244	0.35	1.0	6.0×10^{-3}	0.010	1.0	2.1×10^{-5}
Americium-243	0.17	1.0	6.0×10^{-3}	0.010	1.0	1.0×10^{-5}
Uranium-232	0.051	1.0	6.0×10^{-3}	0.010	1.0	3.0×10^{-6}
Americium-242	0.027	1.0	6.0×10^{-3}	0.010	1.0	1.6×10^{-6}
Thorium-228	0.051	1.0	6.0×10^{-3}	0.010	1.0	3.1×10^{-6}
Americium-242m	0.027	1.0	6.0×10^{-3}	0.010	1.0	1.6×10^{-6}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

C.4.13 Containment System Failure During Interim Stabilization of Tank 8D-2

This accident involved containment system failure during the interim stabilization of Tank 8D-2. During interim stabilization, Tanks 8D-1 and 8D-2 would be filled with about 102 centimeters (40 inches) of grout. The material at risk for this accident was the mobile inventory contained in Tank 8D-2 (WVNS 2001a).

The airborne release fraction is based on the assumption that 0.1 percent of the mobile inventory would become airborne during stabilization and that stabilization would take place over 40 hours. Normally, this airborne radioactivity would be filtered by HEPA filters. This accident assumed a brief (1-hour) unfiltered release of radioactivity occurred during stabilization because of either a ventilation duct failure before filtration or a filter failure. The 1-hour time limitation assumed that the failure would be detected by either the effluent monitors or the filter differential pressure monitors and that mitigating actions (for example, shutdown of exhaust fans or isolation of ducts) would take place. The airborne release fraction for this 1-hour release would be 2.5×10^{-5}:

$$0.001 \times 1 \text{ hr}/40 \text{ hrs} = 0.000025$$

Interim stabilization would take place under Alternative B. The frequency of this accident was estimated to be in the range of 10^{-6} to 10^{-8} per year and could take place under Alternative B but not under the No Action Alternative or Alternative A. Table C-17 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-17. Source Term for Containment System Failure During Interim Stabilization of Tank 8D-2

Nuclide	MAR[a] (curies)	DR	ARF	RF	LPF	ST (curies)
Carbon-14	1.0×10^{-3}	1.0	2.5×10^{-5}	1.0	1.0	2.5×10^{-8}
Cobalt-60	0.50	1.0	2.5×10^{-5}	1.0	1.0	1.3×10^{-5}
Nickel-63	4.1	1.0	2.5×10^{-5}	1.0	1.0	1.0×10^{-4}
Strontium-90	820	1.0	2.5×10^{-5}	1.0	1.0	0.020
Technetium-99	0.12	1.0	2.5×10^{-5}	1.0	1.0	3.0×10^{-6}
Cesium-137	21,000	1.0	2.5×10^{-5}	1.0	1.0	0.53
Plutonium-241	6.3	1.0	2.5×10^{-5}	1.0	1.0	1.6×10^{-4}
Curium-242	0.060	1.0	2.5×10^{-5}	1.0	1.0	1.5×10^{-6}
Neptunium-237	7.0×10^{-3}	1.0	2.5×10^{-5}	1.0	1.0	1.8×10^{-7}
Plutonium-238	0.70	1.0	2.5×10^{-5}	1.0	1.0	1.8×10^{-5}
Plutonium-239	0.30	1.0	2.5×10^{-5}	1.0	1.0	7.5×10^{-6}
Americium-241	5.4	1.0	2.5×10^{-5}	1.0	1.0	1.4×10^{-4}
Americium-243	0.090	1.0	2.5×10^{-5}	1.0	1.0	2.3×10^{-6}
Curium-244	1.1	1.0	2.5×10^{-5}	1.0	1.0	2.7×10^{-5}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

a. The MAR for this accident is the mobile inventory in Tank 8D-2 (WVNS 2001a).

C.4.14 Collapse of Tank 8D-2 Vault (Grouted)

For this accident, it is assumed that the occurrence of a severe earthquake greater than six times the design basis (0.1 g) causes the roof of Tank 8D-2 and its vault to collapse, exposing the tank contents to the atmosphere. In this accident, the contents of the tank were assumed to be dry. The material at risk for Tank 8D-2 was a heel made up of two components, the mobile and zeolite inventory, and the fixed inventory (WVNS 2001a). The mobile and zeolite inventory was assumed to have been grouted in place at the bottom of the tank and are not available for release (airborne release fraction = 0). The fixed inventory was assumed to be scoured from the sides of the tank by debris falling into the tank during the collapse and have an airborne release fraction of 1×10^{-7}. In addition, the fixed inventory below the level of the grout [1 meter (40 inches)] was assumed to be unavailable for release. The fixed inventory is proportional to the interior tank surface area; because 44 percent of the interior tank surface area would be below 1 meter of grout, the damage ratio for the fixed inventory was 0.56 (1 – 0.44).

This accident could take place only under Alternative B, after tank interim stabilization occurred. The frequency of this accident was estimated to be in the range of 10^{-4} to 10^{-6} per year (WVNS 2002a). Table C-18 lists the material at risk, damage ratio, airborne release fraction, respirable fraction, leakpath factor, and source term for this accident.

Table C-18. Source Term for Tank 8D-2 Collapse (Grouted)

Nuclide	Dry MAR (curies)	Fixed MAR (curies)	DR	Dry ARF	Fixed ARF	RF	LPF	ST (curies)
Carbon-14	1.0×10^{-3}	4.0×10^{-3}	0.56	0	1.0×10^{-7}	1.0	1.0	2.2×10^{-10}
Cobalt-60	0.50	1.2	0.56	0	1.0×10^{-7}	1.0	1.0	6.7×10^{-8}
Nickel-63	4.1	9.7	0.56	0	1.0×10^{-7}	1.0	1.0	5.4×10^{-7}
Strontium-90	990	39,000	0.56	0	1.0×10^{-7}	1.0	1.0	2.2×10^{-3}
Technetium-99	0.12	0.68	0.56	0	1.0×10^{-7}	1.0	1.0	3.8×10^{-8}
Cesium-137	130,000	4,600	0.56	0	1.0×10^{-7}	1.0	1.0	2.6×10^{-4}
Plutonium-241	8.3	1,000	0.56	0	1.0×10^{-7}	1.0	1.0	5.7×10^{-5}
Curium-242	0.060	1.4	0.56	0	1.0×10^{-7}	1.0	1.0	7.8×10^{-8}
Neptunium-237	7.0×10^{-3}	0.32	0.56	0	1.0×10^{-7}	1.0	1.0	1.8×10^{-8}
Plutonium-238	0.93	120	0.56	0	1.0×10^{-7}	1.0	1.0	6.5×10^{-6}
Plutonium-239	0.40	48	0.56	0	1.0×10^{-7}	1.0	1.0	2.7×10^{-6}
Americium-241	5.4	170	0.56	0	1.0×10^{-7}	1.0	1.0	9.5×10^{-6}
Americium-243	0.090	2.1	0.56	0	1.0×10^{-7}	1.0	1.0	1.2×10^{-7}
Curium-244	1.1	25	0.56	0	1.0×10^{-7}	1.0	1.0	1.4×10^{-6}

Acronyms: MAR = material at risk; DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; LPF = leakpath factor; ST = Source Term

C.5 ATMOSPHERIC DATA

Hourly meteorological data collected at West Valley are shown in Tables C-19 and C-20 for 10-meter (33-foot) and 60-meter (197-foot) heights. These data were collected over a 5-year period from 1994 through 1998 (WVNS 2000a). They are arranged according to direction, atmospheric stability class, and wind speed. When the wind was calm (wind speed = 0 meters per second), the data were assigned to stability classes weighted by the frequency of each stability class. The "greater than 12 meters per second" data were included with the "9.0-12.0 meters per second" data.

C.6 LOCATIONS OF RECEPTORS

Locations of receptors near the WVDP site are listed in Table C-21. To provide a realistic estimate of maximally exposed individual radiation doses from airborne releases during normal operations, radiation doses were evaluated at the locations of nearby residences. For releases from the Process Building, the location that yielded the largest radiation dose was at 1,800 meters (5,900 feet) northwest of the WVDP site. For airborne releases from the Vitrification Facility, the Waste Tank Farm, and the 01/14 Building, the location that yielded the largest radiation dose was at 1,900 meters (6,200 feet) north-northwest of the WVDP site. Population radiation doses from airborne releases during normal operations included contributions from all directions for distances from 0 to 80 kilometers (0 to 50 miles) of the WVDP site.

To provide a conservative estimate of maximally exposed individual radiation doses from airborne releases during accidents, radiation doses were evaluated at the WVDP site boundary because radiation doses at the site boundary were slightly larger than at nearby residences. For ground-level releases, the location that yielded the largest radiation dose was at 1,051 meters (3,448 feet) west-northwest of the WVDP site for 95-percent meteorology and at 1,223 meters (4,012 feet) north-northwest for 50-percent meteorology. For elevated releases, the location that yielded the largest radiation dose was at 1,806 meters (5,925 feet) south-southwest of the WVDP site for 95-percent meteorology and 50-percent meteorology.

Table C-19. Hours for Combinations of Direction, Stability Class, and Wind Speed Range at 10-meter (33-foot) Height for 1994-1998 at the WVDP Site[a]

Direction		Stability Class	Wind Speed Range (in meters per second)					
From	To		0.0-1.5	1.5-3.0	3.0-6.0	6.0-9.0	9.0-12.0	> 12.0
S	N	A	4	9	21	1	0	0
SSW	NNE	A	2	11	16	0	0	0
SW	NE	A	1	16	14	0	0	0
WSW	ENE	A	2	10	3	0	0	0
W	E	A	1	11	3	0	0	0
WNW	ESE	A	0	22	40	0	0	0
NW	SE	A	1	46	242	2	0	0
NNW	SSE	A	0	19	67	6	0	0
N	S	A	0	21	20	0	0	0
NNE	SSW	A	0	18	12	0	0	0
NE	SW	A	0	13	10	0	0	0
ENE	WSW	A	0	11	12	0	0	0
E	W	A	0	16	9	0	0	0
ESE	WNW	A	0	7	6	0	0	0
SE	NW	A	0	9	10	0	0	0
SSE	NNW	A	2	6	10	0	0	0
	Calms	A	0					
S	N	B	0	23	42	3	0	0
SSW	NNE	B	2	34	26	0	0	0
SW	NE	B	1	50	27	0	0	0
WSW	ENE	B	0	26	10	0	0	0
W	E	B	1	34	14	0	0	0
WNW	ESE	B	1	67	61	1	0	0
NW	SE	B	0	119	241	1	0	0
NNW	SSE	B	0	34	95	2	0	0
N	S	B	0	24	18	0	0	0
NNE	SSW	B	2	28	15	0	0	0
NE	SW	B	3	22	10	0	0	0
ENE	WSW	B	2	13	4	0	0	0
E	W	B	0	15	7	0	0	0
ESE	WNW	B	0	10	4	0	0	0
SE	NW	B	1	15	16	2	0	0
SSE	NNW	B	2	19	40	0	0	0
	Calms	B	1					
S	N	C	5	68	74	0	0	0
SSW	NNE	C	3	74	29	0	0	0
SW	NE	C	3	102	30	0	0	0
WSW	ENE	C	3	48	19	0	0	0
W	E	C	2	71	21	0	0	0
WNW	ESE	C	8	143	72	2	0	0

Table C-19. Hours for Combinations of Direction, Stability Class, and Wind Speed Range at 10-meter (33-foot) Height for 1994-1998 at the WVDP Site[a] (cont)

Direction		Stability Class	Wind Speed Range (in meters per second)					
From	To		0.0-1.5	1.5-3.0	3.0-6.0	6.0-9.0	9.0-12.0	> 12.0
NW	SE	C	7	203	341	4	0	0
NNW	SSE	C	4	95	118	5	0	0
N	S	C	1	71	30	0	0	0
NNE	SSW	C	9	39	11	0	0	0
NE	SW	C	5	33	11	0	0	0
ENE	WSW	C	3	18	6	0	0	0
E	W	C	2	17	20	4	0	0
ESE	WNW	C	3	22	14	0	0	0
SE	NW	C	5	39	44	2	0	0
SSE	NNW	C	2	39	42	9	0	0
	Calms	C	0					
S	N	D	284	929	615	25	0	0
SSW	NNE	D	294	938	283	1	0	0
SW	NE	D	257	729	181	1	0	0
WSW	ENE	D	251	501	96	0	0	0
W	E	D	340	827	214	0	0	0
WNW	ESE	D	429	1,441	739	1	0	0
NW	SE	D	370	2,575	1,816	8	0	0
NNW	SSE	D	147	630	492	4	0	0
N	S	D	131	421	126	0	0	0
NNE	SSW	D	139	261	46	0	0	0
NE	SW	D	91	170	29	0	0	0
ENE	WSW	D	90	142	117	8	0	0
E	W	D	103	161	128	1	0	0
ESE	WNW	D	140	314	202	2	0	0
SE	NW	D	191	660	698	114	4	0
SSE	NNW	D	180	534	797	270	29	3
	Calms	D	46					
S	N	E	810	895	315	10	0	0
SSW	NNE	E	446	288	39	0	0	0
SW	NE	E	280	59	3	0	0	0
WSW	ENE	E	267	41	3	0	0	0
W	E	E	290	66	3	0	0	0
WNW	ESE	E	317	183	2	0	0	0
NW	SE	E	175	267	28	0	0	0
NNW	SSE	E	60	34	3	0	0	0
N	S	E	38	8	1	0	0	0
NNE	SSW	E	38	8	0	0	0	0
NE	SW	E	32	9	0	0	0	0
ENE	WSW	E	54	8	0	0	0	0

Table C-19. Hours for Combinations of Direction, Stability Class, and Wind Speed Range at 10-meter (33-foot) Height for 1994-1998 at the WVDP Site[a] (cont)

Direction		Stability Class	Wind Speed Range (in meters per second)					
From	To		0.0-1.5	1.5-3.0	3.0-6.0	6.0-9.0	9.0-12.0	> 12.0
E	W	E	95	15	4	0	0	0
ESE	WNW	E	114	73	7	0	0	0
SE	NW	E	275	433	199	3	0	0
SSE	NNW	E	575	692	476	94	11	0
	Calms	E	219					
S	N	F	632	98	0	0	0	0
SSW	NNE	F	276	9	0	0	0	0
SW	NE	F	166	1	0	0	0	0
WSW	ENE	F	111	4	0	0	0	0
W	E	F	68	7	0	0	0	0
WNW	ESE	F	28	2	0	0	0	0
NW	SE	F	20	6	0	0	0	0
NNW	SSE	F	23	4	0	0	0	0
N	S	F	16	0	0	0	0	0
NNE	SSW	F	10	1	0	0	0	0
NE	SW	F	20	0	0	0	0	0
ENE	WSW	F	17	0	0	0	0	0
E	W	F	42	1	0	0	0	0
ESE	WNW	F	96	14	1	0	0	0
SE	NW	F	223	72	3	0	0	0
SSE	NNW	F	711	136	10	0	0	0
	Calms	F	537					
S	N	G	696	22	0	0	0	0
SSW	NNE	G	168	0	0	0	0	0
SW	NE	G	89	0	0	0	0	0
WSW	ENE	G	51	1	0	0	0	0
W	E	G	16	1	0	0	0	0
WNW	ESE	G	4	0	0	0	0	0
NW	SE	G	8	0	0	0	0	0
NNW	SSE	G	9	0	0	0	0	0
N	S	G	5	0	0	0	0	0
NNE	SSW	G	4	0	0	0	0	0
NE	SW	G	6	0	0	0	0	0
ENE	WSW	G	12	0	0	0	0	0
E	W	G	16	0	0	0	0	0
ESE	WNW	G	53	3	0	0	0	0
SE	NW	G	260	27	0	0	0	0
SSE	NNW	G	1,197	85	0	0	0	0
	Calms	G	611					

Source: WVNS 2000a.
a. Total hours recorded (1994-1998) for wind blowing from the direction and at the speed range indicated.

Table C-20. Hours for Combinations of Direction, Stability Class, and Wind Speed Range at 60-meter (197-foot) Height for 1994-1998 at the WVDP Site[a]

Direction		Stability Class	Wind Speed Range (in meters per second)					
From	To		0.0-1.5	1.5-3.0	3.0-6.0	6.0-9.0	9.0-12.0	> 12.0
S	N	A	0	2	15	7	1	0
SSW	NNE	A	0	2	22	5	0	0
SW	NE	A	0	5	21	12	0	0
WSW	ENE	A	0	5	11	5	0	0
W	E	A	1	4	16	4	1	0
WNW	ESE	A	1	7	87	70	2	0
NW	SE	A	0	8	122	59	3	0
NNW	SSE	A	0	9	41	21	1	0
N	S	A	0	7	34	2	0	0
NNE	SSW	A	0	3	26	0	0	0
NE	SW	A	0	3	19	0	0	0
ENE	WSW	A	0	6	17	0	0	0
E	W	A	1	9	19	0	0	0
ESE	WNW	A	0	4	6	0	0	0
SE	NW	A	1	2	13	1	0	0
SSE	NNW	A	1	3	8	1	0	0
	Calms	A	1					
S	N	B	0	8	34	7	2	0
SSW	NNE	B	1	3	45	15	1	0
SW	NE	B	1	5	72	12	0	0
WSW	ENE	B	0	9	42	10	1	0
W	E	B	0	16	38	19	0	0
WNW	ESE	B	0	31	159	55	6	0
NW	SE	B	0	31	168	51	1	0
NNW	SSE	B	0	23	72	7	0	0
N	S	B	3	14	22	0	0	0
NNE	SSW	B	0	21	21	0	0	0
NE	SW	B	1	19	16	0	0	0
ENE	WSW	B	0	8	10	0	0	0
E	W	B	0	7	14	0	0	0
ESE	WNW	B	2	9	4	1	0	0
SE	NW	B	0	7	15	5	0	0
SSE	NNW	B	2	6	29	12	0	0
	Calms	B	0					
S	N	C	4	15	61	11	0	0
SSW	NNE	C	2	28	107	9	0	0
SW	NE	C	2	30	121	17	0	0
WSW	ENE	C	1	29	71	13	0	0
W	E	C	0	35	115	14	2	0
WNW	ESE	C	1	48	266	79	12	0

Table C-20. Hours for Combinations of Direction, Stability Class, and Wind Speed Range at 60-meter (197-foot) Height for 1994-1998 at the WVDP Site[a] (cont)

Direction		Stability Class	Wind Speed Range (in meters per second)					
From	To		0.0-1.5	1.5-3.0	3.0-6.0	6.0-9.0	9.0-12.0	> 12.0
NW	SE	C	3	53	260	41	1	0
NNW	SSE	C	4	53	98	15	0	0
N	S	C	2	52	45	0	0	0
NNE	SSW	C	1	36	22	0	0	0
NE	SW	C	4	28	17	0	0	0
ENE	WSW	C	1	14	14	1	0	0
E	W	C	1	14	21	7	3	0
ESE	WNW	C	3	14	15	4	0	0
SE	NW	C	1	27	40	4	1	1
SSE	NNW	C	0	16	38	14	6	
	Calms	C	0					
S	N	D	42	162	475	278	54	5
SSW	NNE	D	24	242	908	204	6	0
SW	NE	D	29	408	1,334	296	2	0
WSW	ENE	D	46	438	1,066	181	2	0
W	E	D	49	528	1,737	506	24	0
WNW	ESE	D	49	585	2,320	748	32	0
NW	SE	D	70	524	1,425	322	8	0
NNW	SSE	D	67	311	469	46	0	0
N	S	D	82	312	262	14	0	0
NNE	SSW	D	84	234	167	1	0	0
NE	SW	D	74	193	99	6	0	0
ENE	WSW	D	76	105	195	10	3	0
E	W	D	62	126	214	12	1	0
ESE	WNW	D	85	219	281	33	0	0
SE	NW	D	86	371	671	226	53	6
SSE	NNW	D	38	227	685	323	204	45
	Calms	D	24					
S	N	E	65	178	523	226	28	1
SSW	NNE	E	39	174	728	136	0	0
SW	NE	E	38	153	589	69	0	0
WSW	ENE	E	30	200	249	6	0	0
W	E	E	32	184	299	7	0	0
WNW	ESE	E	42	165	286	10	1	0
NW	SE	E	47	134	201	6	0	0
NNW	SSE	E	56	65	62	0	0	0
N	S	E	55	72	10	0	0	0
NNE	SSW	E	43	34	4	0	0	0
NE	SW	E	36	32	7	0	0	0
ENE	WSW	E	40	35	14	0	0	0

Table C-20. Hours for Combinations of Direction, Stability Class, and Wind Speed Range at 60-meter (197-foot) Height for 1994-1998 at the WVDP Site[a] (cont)

Direction		Stability Class	Wind Speed Range (in meters per second)					
From	To		0.0-1.5	1.5-3.0	3.0-6.0	6.0-9.0	9.0-12.0	> 12.0
E	W	E	55	59	14	6	0	0
ESE	WNW	E	111	121	42	1	0	0
SE	NW	E	224	507	455	50	0	0
SSE	NNW	E	166	337	536	207	76	14
	Calms	E	59					
S	N	F	72	100	140	1	0	0
SSW	NNE	F	19	87	115	0	0	0
SW	NE	F	26	46	66	0	0	0
WSW	ENE	F	27	56	30	1	0	0
W	E	F	18	50	22	0	0	0
WNW	ESE	F	26	55	25	0	0	0
NW	SE	F	43	52	35	0	0	0
NNW	SSE	F	44	34	13	0	0	0
N	S	F	42	8	0	0	0	0
NNE	SSW	F	20	4	0	0	0	0
NE	SW	F	28	3	0	0	0	0
ENE	WSW	F	28	3	0	0	0	0
E	W	F	39	7	0	0	0	0
ESE	WNW	F	72	35	6	0	0	0
SE	NW	F	374	390	162	3	0	0
SSE	NNW	F	457	286	134	8	0	0
	Calms	F	77					
S	N	G	99	172	122	1	0	0
SSW	NNE	G	36	114	166	1	0	0
SW	NE	G	25	87	49	0	0	0
WSW	ENE	G	32	68	7	0	0	0
W	E	G	20	37	8	0	0	0
WNW	ESE	G	21	25	6	0	0	0
NW	SE	G	31	44	6	0	0	0
NNW	SSE	G	24	16	1	0	0	0
N	S	G	15	2	0	0	0	0
NNE	SSW	G	19	1	0	0	0	0
NE	SW	G	28	0	0	0	0	0
ENE	WSW	G	17	2	0	0	0	0
E	W	G	27	1	0	0	0	0
ESE	WNW	G	63	12	2	0	0	0
SE	NW	G	317	369	89	0	0	0
SSE	NNW	G	554	511	110	0	0	0
	Calms	G	44					

Source: WVNS 2000a.

a. Total hours recorded (1994-1998) for wind blowing from the direction and at the speed range indicated.

Table C-21. Locations of Receptors at WVDP Site (in meters)[a]

Direction	Site Boundary Distance	Nearest Residence Distance
S	1,958	2,300
SSW	1,806	2,800
SW	1,538	2,100
WSW	1,405	2,200
W	1,051	1,800
WNW	1,051	1,200
NW	1,153	1,300
NNW	1,223	1,900
N	1,598	2,500
NNE	1,604	2,600
NE	1,604	1,900
ENE	1,615	2,000
E	1,856	2,500
ESE	2,430	2,600
SE	2,406	2,900
SSE	2,223	3,100

Sources: WVNS 2000a (site boundary); WVNS 2002b (nearest residence).
a. To convert meters to feet, multiply by 3.2808.

For accidents, radiation doses for workers were also evaluated at an onsite evaluation point located 640 meters (2,100 feet) from the accident. For ground-level releases, the north-northwest direction yielded the largest radiation dose for 95-percent meteorology and 50-percent meteorology. For elevated releases, the southwest direction yielded the largest radiation dose for 95-percent meteorology and 50-percent meteorology.

Population radiation doses from airborne releases during accidents were evaluated for the direction that yielded the largest population radiation dose. For ground-level and elevated releases, the north-northwest direction yielded the largest population radiation dose for 95-percent meteorology and 50-percent meteorology. For distances from 0 to 80 kilometers (0 to 50 miles) of the WVDP site, this direction had a population of about 680,000 people.

C.7 POPULATION DATA

The 2000 population within 80 kilometers (50 miles) of the WVDP site was 1,535,963 (Table C-22). This was an increase of about 15 percent since 1990, with most of the growth being in the southern suburbs of Buffalo, north and north-northwest of the WVDP site. The 2000 population within 10 kilometer (6.2 miles) of the WVDP site was 8,978; this was a decrease of about 2 percent since 1990.

C.8 RADIATION DOSES FROM CONTINUED MANAGEMENT FOR WVDP WORKERS AND THE PUBLIC

Using data from DOE Radiation Exposure Monitoring System (DOE 2001) for 1995 through 1999, the average collective radiation dose to workers at the WVDP site was about 15 person-rem per year (Table C-23). Over this same time period, the average individual radiation dose to workers at the WVDP site was about 59 millirem (mrem) per year. This radiation dose is well below the WVDP site administrative control level of 500 mrem per year (WVNS 2001b).

Table C-22. 2000 Population Distribution Around the WVDP Site

Direction	Distance (in kilometers)[a]										
	0 to 2	2 to 3	3 to 5	5 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 80	Total (0 to 80)
S	3	6	19	140	998	1,849	5,874	1,420	1,7190	6,109	33,608
SSW	4	3	44	205	540	1,957	2,669	691	437	15,236	21,786
SW	9	4	19	166	780	2,163	2,563	4,148	7,935	54,727	72,514
WSW	13	7	32	167	497	674	2,386	2,304	5,201	13,869	25,150
W	14	13	41	105	390	5,710	1,819	4,129	29,437	10,830	52,488
WNW	20	40	203	68	1,276	7,277	6,140	8,614	0	0	23,638
NW	8	32	58	236	915	5,206	19,405	1,407	0	0	27,267
NNW	1	6	40	2,554	1,518	8,536	59,778	106,966	294,784	213,344	687,527
N	5	10	53	2380	1,680	4,329	24,337	80,620	109,284	112,259	334,957
NNE	7	12	69	306	914	3,824	3,940	5,758	10,979	35,272	61,081
NE	8	14	47	160	1,343	1,649	2,155	2,596	10,031	17,803	35,806
ENE	7	16	40	122	4,082	3,586	1,419	2,218	5,687	26,411	43,588
E	7	12	95	171	1,323	1,376	1,752	4,048	1,600	11,020	21,404
ESE	10	23	64	175	1,411	578	1,127	2,668	4,521	17,611	28,188
SE	22	22	105	318	725	2,689	2,432	3,820	4,541	7,076	21,750
SSE	1	19	40	358	353	698	2,427	24,822	6,562	9,931	45,211
Total	139	239	969	7,631	18,745	52,101	140,223	256,229	508,189	551,498	1,535,963

a. To convert kilometers to miles, multiply by 0.62137.

Table C-23. Radiation Doses to WVDP Workers from Continued Management Activities

Year	Number of People Monitored	Number of People with Measurable Doses	Collective Dose (person-rem/yr)	Individual Dose (mrem/yr)
1999	1,064	243	12.5	52
1998	1,115	260	18.2	70
1997	1,206	174	6.9	40
1996	1,365	231	11.2	48
1995	1,518	311	26.9	87
Average	1,254	244	15	59

Source: DOE 2001.

Using data from the West Valley Annual Site Environmental Reports (WVNS 1996, 1997, 1998, 1999a, 2000b) for 1995 through 1999, the collective radiation dose to people living around the WVDP site from airborne releases was about 0.17 person-rem per year (Table C-24). The individual radiation dose from airborne releases was about 0.021 mrem per year.

Table C-24. Radiation Doses to WVDP Members of the Public from Continued Management Activities

Pathway	**Individual Dose (mrem/yr)**	**Collective Dose (person-rem/yr)**
Airborne		
1999	0.011	0.11
1998	0.034	0.26
1997	0.049	0.39
1996	8.7×10^{-3}	0.070
1995	4.3×10^{-4}	8.6×10^{-3}
Annual Average	0.021	0.17
Waterborne[a]		
1999	0.056	0.13
1998	0.031	0.067
1997	0.024	0.038
1996	0.067	0.084
1995	0.028	0.094
Annual Average	0.041	0.083
All-Pathways		
1999	0.068	0.24
1998	0.065	0.33
1997	0.073	0.43
1996	0.076	0.15
1995	0.028	0.10
Annual Average	0.062	0.25
Background		
1999	300	380,000
1998	300	380,000
1997	300	380,000
1996	300	390,000
1995	300	390,000
Annual Average	300	380,000

a. Includes effluents and North Plateau drainage.
Sources: WVNS 1996, 1997, 1998, 1999a, and 2000b

Over this same time period, radiation doses from waterborne releases, including effluents and North Plateau drainage, were estimated to be 0.041 mrem per year for individuals and 0.083 person-rem per year for the population within 80 kilometers (50 miles) of the WVDP site.

The collective radiation dose through all exposure pathways (air and water) to people living around the WVDP site was about 0.25 person-rem per year. The individual radiation dose through all exposure pathways to people living within 80 kilometers (50 miles) of the WVDP site was about 0.062 mrem per year. For perspective, the population radiation dose from background radiation to people living within 80 kilometers (50 miles) of the WVDP site was 380,000 person-rem per year, and the individual radiation dose from background radiation to people living within 80 kilometers of West Valley was about 300 mrem per year.

C.9 AIR QUALITY

New York State is divided into nine regions for assessing state ambient air quality. The WVDP site is located in Region 9, which is comprised of Niagara, Erie, Wyoming, Chatauqua, Cattaraugus, and Allegany counties. The WVDP site and the surrounding area in Cattaraugus County are in attainment with the National Primary and Secondary Ambient Air Quality Standards contained in 40 CFR 50 and

New York State air quality standards contained in 6 NYCRR 257. The city of Buffalo, located about 48 km (30 mi) from the WVDP site, is a marginal nonattainment area for ozone (EPA 2002).

Under all of the proposed alternatives, the primary impacts to air quality would be through the continued emission of four criteria pollutants—nitrogen dioxide, sulfur dioxide, carbon monoxide, and particulate matter—from the two Cleaver Brooks boilers at the WVDP site. These boilers are used to generate steam for heating and other processes at the site, and each have a capacity of 20.2 million British thermal units per hour. Together, these boilers use about 2 million cubic meters (70 million cubic feet) of natural gas and about 24,000 liters (6,300 gallons) of No. 2 fuel oil per year. The other two criteria pollutants, lead and ozone, are produced in insufficient quantities by the boilers for consideration in this analysis.

Emissions from the boilers are presented in Table C-25. These emissions were calculated using the emission factors from *Compilation of Air Pollutant Emission Factors* (EPA 1998) (Chapter 1.3 for fuel oil combustion and Chapter 1.4 for natural gas combustion and are for boilers with a capacity of less than 100 million British thermal units per hour). The particulate matter emissions include both filterable particulate matter and condensable particulate matter, and all particulate matter was assumed to have an aerodynamic diameter of less than 10 micrometers. Back-up generators at the WVDP site do not contribute significantly to these emissions. Other data used in the analysis are listed in Table C-26.

The SCREEN3 computer code (EPA 1995) was used to model the potential impacts to air quality from these emissions. Three analyses were performed: (1) a simple terrain analysis for flat terrain, (2) a simple elevated terrain analysis for terrain lower than the physical stack height, and (3) a complex terrain analysis for terrain higher than the physical stack height. The simple elevated terrain analysis and the complex terrain analysis were performed because of the many hills and valleys around the WVDP site. Many offsite locations were examined in these analyses. The nearest location was at 1,051 meters (3,450 feet) from the boiler stacks, which corresponds to the nearest the WVDP site boundary location. The furthest location was at 50,000 meters (30 miles) from the site. The simple elevated terrain analysis yielded the highest estimates of criteria pollutant concentrations (Table C-27). The highest concentrations occurred at 1,379 meters (4,524 feet) from the WVDP site. As shown in Table C-27, the concentrations of criteria pollutants from the WVDP site emissions are well below the National Primary and Secondary Ambient Air Quality Standards contained in 40 CFR 50 and the New York State air quality standards contained in 6 NYCRR 257. It should be noted that the background concentrations used in Table C-27 were from near Buffalo, New York; actual background concentrations near the WVDP site would be lower. WVDP emissions of nitrogen dioxide and sulfur dioxide are also well below the New York State Department of Environmental Conservation's annual emission cap of 90,700 kilograms (100 tons).

Table C-25. Annual Criteria Pollutant Emissions from WVDP Boilers (in tons)[a]

Criteria Pollutant	Emissions from Natural Gas	Emissions from No. 2 Fuel Oil
Nitrogen Dioxide	3.5	0.063
Sulfur Dioxide	0.021	0.22
Carbon Monoxide	2.9	0.016
Particulate Matter	0.27	0.010

Source: EPA 1998.

a. To convert tons to kilograms, multiply by 907.18.

Note: Emissions are based on using 70 million cubic feet of natural gas and 6,300 gallons of No. 2 fuel oil per year. The boilers were assumed to operate 180 days per year. Emissions were calculated using the emission factors from AP-42, Chapter 1.3 for fuel oil combustion and AP-42, Chapter 1.4 for natural gas combustion, and are for boilers with a capacity of less than 100 million British thermal units per hour.

Table C-26. Data Used to Model Criteria Pollutant Emissions

Parameter	Value
Stack Height	7.62 meters (25 feet)
Stack Diameter	0.6096 meter (24 inches)
Stack Velocity	8 meters per second (26 feet per second)
Stack Temperature	154ºC (427ºK)
Ambient Temperature	20ºC (293ºK)
Boiler Capacity	20.2 million British thermal units per hour
Boiler Operating Time	180 days per year
Minimum site boundary distance	1,051 meters (3,450 feet)
Maximum distance	50,000 meters (30 miles)
Maximum sulfur content of No. 2 fuel oil	0.5 percent
Excess oxygen	3 percent
Fuel factor (natural gas)	8,710 dry standard cubic feet per million British thermal units
1-hour averaging time to 3-hour averaging time multiplying factor	0.9 (a)
1-hour averaging time to 8-hour averaging time multiplying factor	0.7 (a)
1-hour averaging time to 24-hour averaging time multiplying factor	0.4 (a)
1-hour averaging time to annual averaging time multiplying factor	0.08 (a)

Source: EPA 1992.

Table C-27 also shows the regional background concentrations of the criteria pollutants as measured near Buffalo, New York (EPA 2001). When combined with concentrations from WVDP emissions, the resulting total concentrations are also below the National Primary and Secondary Ambient Air Quality Standards contained in 40 CFR 50 and the New York State air quality standards contained in 6 NYCRR 257.

Air emissions of radionuclides from WVDP, are regulated by the EPA under the National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations, 40 CFR Part 61, Subpart H, National Emission Standards for Emissions of Radionuclides other than Radon from Department of Energy Facilities. Annual reporting of the radionuclide emissions for calendar year 2000 was less than 0.1 percent of EPA's standards (WVNS, 2001).

Table C-27. Criteria Pollutant Concentrations from WVDP Boiler Emissions and Regional Background

Criteria Pollutant	Averaging Time	Standard[a,b]	Concentration From WVDP Emissions[b,c]	Background Concentration[b,d]	Total Concentration[b]	Percent of Standard
Nitrogen dioxide	Annual	100[g,h,i] (0.053 ppm)	1.5	41	42	42
Carbon monoxide	1 hour	40,000[g,i] (35 ppm)	15	5,800	5,800	14
Carbon monoxide	8 hours	10,000[g,i] (9 ppm)	11	3,200	3,200	32
Sulfur dioxide	Annual	80[g,i] (0.03 ppm)	0.10	17	17	22
Sulfur dioxide	24 hours	365[g,i] (0.14 ppm)	0.50	63	64	17
Sulfur dioxide	3 hours	1,300[h,i] (0.5 ppm)	1.1	160	160	12
Particulate matter[e]	Annual	50[g,h]	0.11	21	21	42
Particulate matter[f]	24 hours	150[g,h]	0.56	61	61	41
Ozone	1 hour	235[g,h] (0.12 ppm)	(--)	210	210	89
Lead	Quarterly	1.5[g,h]	(--)	0.03	0.03	2

a. Standards from 40 CFR 50, National Primary and Secondary Ambient Air Quality Standards and 6 NYCRR 257, Air Quality Standards. Comparisons to the standards for particulate matter with an aerodynamic diameter less than 2.5 micrometers and the 8-hour ozone standard were not made because these standards have been remanded to the U.S. Environmental Protection Agency by the U.S. Court of Appeals.
b. Units in micrograms per cubic meter. Parts per million not calculated for substances that do not exist as a gas or vapor at normal room temperature and pressure.
c. The maximum criteria pollutant concentrations from WVDP boiler emissions were located 1,379 meters (4,524 feet) from the WVDP site.
d. Source: EPA 2001. Background concentrations were measured near Buffalo, New York.
e. Annual state standard is 45 to 75 micrograms per cubic meter according to level designation.
f. 24-hour state standard is 250 micrograms per cubic meter.
g. National primary ambient air quality standard.
h. National secondary ambient air quality standard.
i. New York State air quality standard.

C.10 OFFSITE IMPACTS

This section describes how the data in Table 2-6 were derived from the *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (DOE 1997a) (WM PEIS), the *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (DOE 1997b) (WIPP SEIS-II), and the *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada* (DOE 2002) (Yucca Mountain Repository EIS).

LLW and Mixed LLW Disposal at Hanford, NTS, or a Commercial Disposal Site such as Envirocare. In the WM PEIS, DOE analyzed the potential environmental impacts of managing (treating, storing, or disposing of) LLW, mixed LLW, TRU waste, HLW, and hazardous waste. For each waste type, DOE considered a Decentralized Alternative (DOE sites where waste was currently generated or stored), one or more Regionalized Alternatives (a few DOE sites at various locations across the nation), and one or more Centralized Alternatives (one DOE site). Of particular relevance to this WVDP Waste

Management EIS, the WM PEIS described human health impacts of disposing of 1.5 million cubic meters (53.5 million cubic feet) of LLW at Hanford (Centralized Alternative 3) or NTS (Centralized Alternative 4) and disposing of 219,000 cubic meters (7.8 million cubic feet) of mixed LLW at Hanford (Centralized Alternative) or NTS (Regionalized Alternative 3) (WM PEIS, Section 1.5 and Table 1-6.2).

For these two waste types, the WVDP waste represents less than 2 percent of the total waste volume from all DOE sites analyzed in the WM PEIS (for Class A waste, the WVDP represents 0.3 percent of the total LLW volume; for LLW, the WVDP waste represents 1.3 percent of the total LLW volume; and for mixed LLW, the WVDP waste represents 0.1 percent of the total mixed LLW volume). Because impacts, particularly human health impacts, are directly related to waste volume, the impacts of managing WVDP LLW and mixed LLW at either Hanford or NTS would be no more than 2 percent of the total impacts at those sites, as described in the WM PEIS. Table 2-6 shows the potential human health impacts of disposing of WVDP LLW and mixed LLW at Hanford or NTS. These impacts are 2 percent of the impacts described in the site data tables for those sites in Volume II of the WM PEIS. The impacts of the disposal of these waste types at Envirocare are assumed to be similar to impacts at Hanford.

TRU Waste Interim Storage at Hanford, INEEL, ORNL, or SRS. The WM PEIS also analyzed the treatment and interim storage of differing volumes of TRU waste from several DOE sites (including WVDP) at Hanford, INEEL, ORNL, or SRS (Regionalized Alternative 3). Table 2-6 shows the potential human health impacts of all TRU waste treatment and interim storage at those sites as stated in the WM PEIS. Because the WVDP TRU waste to be stored at those sites would not be treated and would be a smaller volume than that analyzed in the WM PEIS (and included in Table 2-6), the data in Table 2-6 substantially overstate the potential impacts of storing WVDP TRU waste at those sites.

TRU Waste Interim Storage at WIPP. The WM PEIS analyzed the treatment of TRU waste generated at most DOE sites at WIPP (Centralized Alternative). Table 2-6 shows the potential human health impacts of WVDP TRU waste interim storage at WIPP. These impacts are the impacts described in the WIPP SEIS-II for TRU waste treatment at WIPP. Because the volume of WVDP TRU waste is less than the volume analyzed in the WM PEIS, and because the impacts of interim storage at WIPP would be less than the impacts of TRU waste treatment at that site, the data in Table 2-6 substantially overstate the potential impacts of WVDP TRU waste interim storage at WIPP.

HLW Interim Storage at Hanford or SRS. With respect to HLW storage, the WM PEIS analyzed the interim storage of 340 canisters of WVDP HLW at Hanford (Regionalized Alternative 2) and SRS (Regionalized Alternative 1). Table 2-6 shows the potential human health impacts of WVDP HLW interim storage at these sites as originally reported in the site data tables for Hanford and SRS (Volume II of the WM PEIS). The impacts of interim storage of WVDP HLW would be slightly less because the volume of WVDP HLW (300 canisters) is slightly less than the volume of WVDP HLW analyzed in the WM PEIS (340 canisters).

TRU Waste Disposal at WIPP. The WIPP SEIS-II analyzed the potential environmental impacts of the shipment of all TRU waste to WIPP for treatment prior to disposal. TRU waste generated and stored at WVDP represents less than 1 percent of the total inventory to be disposed of at WIPP (175,580 cubic meters [6.2 million cubic feet]). Table 2-6 shows the expected human health impacts of disposing of WVDP TRU waste at WIPP. These impacts are 1 percent of the impacts reported in the WIPP SEIS-II (WIPP SEIS-II, Section 3.4, Table 3-18).

HLW Disposal at Yucca Mountain. The Yucca Mountain Repository EIS analyzed the potential environmental impacts of the disposal of 70,000 metric tons of heavy metal of HLW and spent nuclear fuel at the Yucca Mountain Repository. The 300 canisters of HLW (approximately 690 metric tons of heavy metal)[1] at WVDP represent approximately 1 percent of the total inventory of HLW and spent nuclear fuel to be disposed of at Yucca Mountain. Table 2-6 shows the expected human health impacts of disposing of WVDP HLW waste at the Yucca Mountain Repository. These impacts are 1 percent of the impacts reported in the Yucca Mountain Repository EIS (Yucca Mountain Repository EIS, Section 2.4.1, Table 2-7).

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[1] DOE estimates that each WVDP HLW canister contains 2.3 metric tons of heavy metal. Thus, 300 canisters would contain 690 metric tons of heavy metal. This volume is 1 percent of the 70,000 metric tons of heavy metal analyzed in the Yucca Mountain Repository EIS.

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APPENDIX D
TRANSPORTATION

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APPENDIX D
TRANSPORTATION

D.1 INTRODUCTION

This appendix summarizes the methods and results of analysis for determining the environmental impacts of radioactive materials transportation on public highways and rail systems. The impacts are presented by alternative and include doses and health effects.

D.2 TRANSPORTATION REGULATIONS

The regulatory standards for packaging and transporting radioactive materials are designed to achieve four primary objectives:

- Protect persons and property from radiation emitted from packages during transportation, by specific limitations on the allowable radiation levels;
- Provide proper containment of the radioactive material in the package (achieved by packaging design requirements based on performance-oriented packaging integrity tests and environmental criteria);
- Prevent nuclear criticality (an unplanned nuclear chain reaction that may occur as a result of concentrating too much fissile material in one place); and
- Provide physical protection against theft and sabotage during transit.

The U.S. Department of Transportation regulates the transportation of hazardous materials in interstate commerce by land, by air, and on navigable water. As outlined in a 1979 Memorandum of Understanding (MOU) with the U.S. Nuclear Regulatory Commission (NRC), the Department of Transportation specifically regulates the carriers of radioactive materials and the conditions of transport such as routing, handling and storage, and vehicle and driver requirements. The Department of Transportation also regulates the labeling, classification, and marking of radioactive material packages.

The NRC regulates the packaging and transport of radioactive material for its licensees, which includes commercial shippers of radioactive materials. Under an agreement with the U.S. Department of Transportation, the NRC sets the standards for packages containing fissile materials and Type B packages. The NRC also establishes safeguards and security regulations to minimize the theft, diversion, or attack on certain shipments.

The U.S. Department of Energy (DOE), through its management directives, orders, and contractual agreements, ensures the protection of public health and safety by imposing standards on its transportation activities that are equivalent to those of the NRC and Department of Transportation. DOE has the authority, granted by a 1973 MOU between the Department of Transportation and the Atomic Energy Commission, to certify DOE-owned packages. DOE may design, procure, and certify its own packages, for use by DOE and its contractors, if the packages provide for a level of safety that is equivalent to that provided in Title 10 of the Code of Federal Regulations (CFR) Part 71.

The U.S. Department of Transportation also has requirements that help reduce transportation impacts. For example, there are requirements for drivers, packaging, labeling, marking, and placarding. There are also requirements that specify the maximum dose rate associated with radioactive material shipments, which help reduce incident-free transportation doses.

The Federal Emergency Management Agency is responsible for establishing policies for, and coordinating civil emergency management, planning, and interaction with, federal executive agencies that have emergency response functions in the event of a transportation incident. The Federal Emergency Management Agency coordinates federal and state participation in developing emergency response plans and is responsible for the development of the interim Federal Radiological Emergency Response Plan. This plan is designed to coordinate federal support to state and local governments, upon request, during the event of a transportation incident.

Other agencies regulating the handling and transport of radioactive materials include the U.S. Postal Service, the Occupational Safety and Health Administration, and the U.S. Environmental Protection Agency.

Radioactive materials are transported in Excepted packages, Industrial packages, Type A packages, or Type B packages. The amount of radioactive material determines which package must be used. Excepted packages are used to transport materials with extremely low levels of radioactivity and must meet only general design requirements. Industrial packages are used to transport materials which present a limited hazard to the public and environment, such as contaminated equipment and radioactive waste solidified in materials such as concrete.

Type A packages are used to transport radioactive materials with higher concentrations of radioactivity such as low-level radioactive waste (LLW). Type A packages are designed to retain their radioactive contents in normal transport. Under normal conditions, a Type A package must withstand:

- Hot (158 degrees Celsius [70 degrees Fahrenheit]) and cold (-40 degrees Celsius [-40 degrees Fahrenheit]) temperatures

- Pressure changes of 3.6 pounds per square inch

- Normal vibration experienced during transportation

- Simulated rainfall of 5 centimeters (2 inches) per hour for 1 hour

- Free drop from 0.3 to 1 meter (1 to 4 feet), depending on the package weight

- Corner drop test

- Compression test

- Impact of a 6-kilogram (13.2-pound) steel cylinder with rounded ends dropped from 1 meter (3 feet) onto the most vulnerable surface of the cask.

Type B packages are used to transport materials with radioactivity levels higher than those allowed for Type A packages. Type B packages are designed to retain their radioactive contents in both normal and accident conditions. In addition to the normal conditions outlined above, under accident conditions a Type B package must withstand:

- Free drop for 9 meters (30 feet) onto an unyielding surface in a way most likely to cause damage to the cask
- For some low-density, light-weight packages, a dynamic crush test consisting of dropping a 500-kilogram (1,100-pound) mass from 9 meters (30 feet) onto the package resting on an unyielding surface
- Free drop from 1 meter (40 inches) onto the end of a 15-centimeter (6-inch) diameter vertical steel bar
- Exposure for not less than 30 minutes to temperatures of 800 degrees Celsius (1,475 degrees Fahrenheit)
- For all packages, immersion in at least 15 meters (50 feet) of water for 8 hours
- For some packages, immersion in at least 0.9 meter (3 feet) of water for 8 hours in an orientation most likely to result in leakage
- For some packages, immersion in at least 200 meters (660 feet) of water for 1 hour.

Compliance with these requirements is demonstrated by using a combination of simple calculational methods, computer modeling techniques, or full-scale or scale-model testing of casks.

D.3 TRANSPORTATION ROUTES

To assess incident-free and transportation accident impacts, route characteristics were determined for shipments from the West Valley Demonstration Project (WVDP) Site to Envirocare in Clive, Utah; the Hanford Site in Richland, Washington; the Idaho National Engineering and Environmental Laboratory; the Nevada Test Site (NTS) in Mercury, Nevada; the Oak Ridge National Laboratory in Tennessee; the Savannah River Site (SRS) in Aiken, South Carolina; and the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico. Representative highway and rail routes were analyzed using the routing computer code WebTRAGIS (Johnson and Michelhaugh 2000). The routes were calculated using current routing practices and applicable routing regulations and guidelines. Route characteristics include total shipment distance between each origin and destination and the fractions of travel in rural, suburban, and urban population density zones. Population densities were determined using data from the 2000 census. Table D-1 shows the truck and rail route distances and the population densities along the proposed routes.

The WebTRAGIS computer code predicts highway routes for transporting radioactive materials within the United States. The WebTRAGIS database is a computerized road atlas that currently describes approximately 386,000 kilometers (240,000 miles) of roads. Complete descriptions of the interstate highway system, U.S. highways, most of the principal state highways, and a number of local and community highways are identified in the database. The WebTRAGIS computer code calculates routes that maximize the use of interstate highways. This feature allows the user to determine routes for shipment of radioactive materials that conform to U.S. Department of Transportation regulations (as specified in 49 CFR Part 397). The calculated routes conform to applicable guidelines and regulations and therefore represent routes that could be used. However, they may not be the actual routes used in the future. The code is updated periodically to reflect current road conditions, and it has been benchmarked against reported mileages and observations of commercial truck firms.

The WebTRAGIS computer code also is designed to simulate the routing of the U.S. rail system. The WebTRAGIS database consists of 94 separate subnetworks and represents various competing rail

Table D-1. Truck and Rail Route Distances and Population Densities

Origin	Destination	Distances (in kilometers)[a]			Population Densities (in person per square kilometer)[b]		
		Rural	Suburban	Urban	Rural	Suburban	Urban
Truck Routes							
WVDP	Envirocare	2,505.2	659.5	81.5	11.6	303.3	2,352.1
	SRS	856.3	583.1	35.4	17.7	309.0	2,197.5
	Hanford	3,222.1	792.0	82.2	11.2	294.5	2,309.8
	WIPP	2,482.8	1,225.0	77.1	15.3	292.1	2,115.7
	NTS/Yucca Mountain	3,055.0	756.7	115.9	11.0	308.9	2,468.1
	INEEL	2,642.9	702.3	70.3	11.8	295.2	2,325.3
	ORNL	716.4	517.1	25.2	19.3	291.5	2,110.5
SRS	WIPP	1,729.6	650.8	64.4	13.2	315.6	2,172.5
	NTS/Yucca Mountain	3,253.7	893.2	137.2	11.0	333.7	2,393.5
INEEL	WIPP	1,952.1	266.0	42.8	6.9	356.2	2,293.6
ORNL	WIPP	1,647.1	538.6	67.8	12.7	328.2	2,263.6
Hanford	WIPP	2,531.3	355.7	54.7	7.2	339.3	2,277.2
	NTS/Yucca Mountain	1,507.7	299.1	75.3	8.6	345.4	2,537.9
Rail Routes							
WVDP	Envirocare	2,778.9	502.5	176.1	8.2	423.4	2,482.9
	SRS	1,284.6	430.1	96.9	15.3	391.4	2,486.0
	Hanford	3,471.5	559.6	176.9	6.3	413.2	2,477.1
	WIPP	2,491.5	372.9	117.3	7.4	437.9	2,448.8
	NTS/Yucca Mountain (rail portion of route)	3,172.5	507.8	176.3	7.4	421.8	2,482.8
	NTS/Yucca Mountain (truck portion of route)	517.71	4.18	0.16	1.08	577.00	1,764.67
	INEEL	2,839.1	490.0	159.9	8.2	414.3	2,487.0
	ORNL	827.6	329.6	97.6	15.2	435.1	2,490.6

Table D-1. Truck and Rail Route Distances and Population Densities (cont)

Origin	Destination	Distances (in kilometers)[a]			Population Densities (in person per square kilometer)[b]		
		Rural	Suburban	Urban	Rural	Suburban	Urban
Rail Routes (cont)							
SRS	WIPP	2,512.2	421.6	78.7	9.9	415.7	2,188.4
	NTS/Yucca Mountain (rail portion of route)	3,479.1	550.9	125.5	7.4	418.6	2,280.7
	NTS/Yucca Mountain (truck portion of route)	517.71	4.18	0.16	1.08	577.00	1,764.67
INEEL	WIPP	2,169.7	162.2	42.5	3.6	421.8	2,292.5
ORNL	WIPP	2,458.6	360.4	63.8	8.0	388.7	2,241.2
Hanford	WIPP	2,986.1	214.0	57.2	3.7	428.8	2,262.3
	NTS/Yucca Mountain (rail portion of route)	1,597.5	124.3	38.0	4.7	400.2	2,370.1
	NTS/Yucca Mountain (truck portion of route)	517.71	4.18	0.16	1.08	577.00	1,764.67

Acronyms: WVDP = West Valley Demonstration Project; SRS= Savannah River Site; WIPP= Waste Isolation Pilot Plant; NTS = Nevada Test Site; INEEL = Idaho National Engineering and Environmental Laboratory; ORNL = Oak Ridge National Laboratory.

a. To convert kilometers to miles, multiply by 0.62137.

b. To convert people per square kilometer to people per square mile, multiply by 2.59.

companies in the United States. The database used by WebTRAGIS was originally based on Federal Railroad Administration data and reflected the U.S. railroad system in 1974. The database has since been expanded and modified over the past two decades. Standard assumptions in the WebTRAGIS computer code were applied to the routes analyzed for this EIS and simulate the selection process railroads used to direct shipments of radioactive material. Currently, there are no specific routing regulations for transporting radioactive material by rail. WebTRAGIS is updated periodically to reflect current track conditions, and it has been benchmarked against reported mileages and observations of commercial rail firms.

Because there is no rail access to the NTS, it was assumed that radioactive waste would be shipped to Nevada by rail to an intermodal transfer facility in Nevada and then shipped from the intermodal transfer facility to NTS by truck.

D.4 SHIPMENTS

Radioactive material shipments associated with the proposed alternatives are assumed to be transported by either truck or rail. At this time, insufficient data exist to determine what fraction of shipments would be shipped by either transport mode. Therefore, the transportation analysis assumed that radioactive materials would be shipped 100 percent by truck and 100 percent by rail to bound potential impacts.

Several types of containers were assumed to be used to transport the radioactive waste evaluated in this environmental impact statement (EIS). The types of containers, their volumes, and the numbers of containers in a shipment are listed in Table D-2. Table D-3 lists the waste volumes, numbers of containers, and numbers of shipments for each alternative evaluated in the EIS. In Tables D-2 and D-3, a shipment is defined as the amount of waste transported on a single truck or a single railcar. There may be multiple railcars per train, but the data used in the transportation analysis and the resulting transportation impacts are based on the number of railcars that are transported. For example, rail accident rates are based on the number of accidents per railcar-mile, not on the number of accidents per train-mile.

The waste volumes used in this EIS were based on current waste volumes and future projections. These volumes were then escalated by about 10 percent to account for the uncertainties in future waste projections, packaging efficiency, and the choice of shipping container. Using this process, contact-handled transuranic (CH-TRU) waste was escalated from 1,019 cubic meters (36,000 cubic feet) to 1,133 cubic meters (40,000 cubic feet); remote-handled transuranic (RH-TRU) waste was escalated from 227 cubic meters (8,000 cubic feet) to 255 cubic meters (9,000 cubic feet); and LLW was escalated from 12,743 cubic meters (450,000 cubic feet) to 14,158 cubic meters (500,000 cubic feet). Drum Cell waste was not escalated because actual container counts are known. The volume of Drum Cell waste was based on 19,877 71-gallon drums and an additional 500 71-gallon drums containing sodium-bearing waste. All Drum Cell waste and sodium-bearing waste was assumed to be Class C LLW. This yields a volume of 5,477 cubic meters (193,405 cubic feet), so the total volume of LLW analyzed was 19,635 cubic meters (693,405 cubic feet). The escalated volume includes 223 cubic meters (7,889 cubic feet) of mixed LLW.

D.5 INCIDENT-FREE TRANSPORTATION

Radiological dose during normal, incident-free transportation of radioactive materials results from exposure to the external radiation field that surrounds the shipping containers. The dose is a function of the number of people exposed, their proximity to the containers, their length of time of exposure, and the intensity of the radiation field surrounding the containers.

Table D-2. Waste Types and Containers

Waste Type	Container	Container Volume (ft^3)[a]	Effective Volume (ft^3)	Number of Containers per Shipment
Class A LLW	B-25 box	90	81	14 (truck) 28 (rail)
Class A LLW	55-gallon drum	7.65	6.885	84 (truck) 168 (rail)
Class B LLW	HIC[b]	100	90	1 (truck) 4 (rail)
Class B LLW	55-gallon drum	7.65	6.885	84 (truck) 168 (rail)
Class C LLW	HIC[b]	100	90	1 (truck) 4 (rail)
Class C LLW	71-gallon drum[c]	9.5	9.5	24 (truck) 96 (rail)
Class C LLW	55-gallon drum[d]	7.65	6.885	10 (truck) 40 (rail)
CH-TRU	55-gallon drum[e]	7.65	6.885	42 (truck) 42 (rail)
RH-TRU	55-gallon drum[f]	7.65	6.885	10 (truck) 40 (rail)
MLLW	55-gallon drum	7.65	6.885	84 (truck) 168 (rail)
HLW	Canister	NA[g]	NA	1 (truck) 5 (rail)

Acronyms: LLW = low-level radioactive waste; HIC = high-integrity container; CH-TRU = contact-handled transuranic waste; RH-TRU = remote-handled transuranic waste; MLLW = mixed low-level waste; HLW = high-level radioactive waste.

a. To convert cubic feet to cubic meters, multiply by 0.028317.

b. High-integrity containers were assumed to be shipped in a Type B shipping container.

c. Solidified waste from the Drum Cell.

d. Class C drums were assumed to be shipped in a Type B shipping container holding 10 drums.

e. CH-TRU waste drums were assumed to be shipped in a Type B TRUPACT-II shipping container, which holds 14 drums. A truck or rail shipment was assumed to hold three TRUPACT-II shipping containers.

f. RH-TRU waste drums were assumed to be shipped in a Type B shipping container holding 10 drums.

g. NA = not applicable.

Radiological impacts were determined for crew workers and the general population during normal, incident-free transportation. For truck shipments, the crew were drivers of the shipment vehicles. For rail shipments, the crew were workers in close proximity to the shipping containers during inspection or classification of railcars. The general population was the individuals within 800 meters (2,625 feet) of the road or railway (off-link), sharing the road or railway (on-link), and at stops. Collective doses for the crew and general population were calculated using the RADTRAN 5 computer code (Neuhauser et al. 2000).

Collective Dose Scenarios

Calculating the collective doses is based on developing unit risk factors. Unit risk factors provide an estimate of the impact from transporting one shipment of radioactive material over a unit distance of travel in a given population density zone. The unit risk factors may be combined with routing information such as the shipment distances in various population density zones to determine the risk for a

Table D-3. Waste Volumes, Containers, and Shipments By Alternative

Waste Type	No Action Alternative			Alternative A			Alternative B		
	Volume (ft^3)[a]	Number of Containers	Number of Shipments	Volume (ft^3)	Number of Containers	Number of Shipments	Volume (ft^3)	Number of Containers	Number of Shipments
Class A LLW (boxes)	97,649	1,206	87 (truck) 44 (rail)	351,586	4,341	311 (truck) 156 (rail)	351,586	4,341	311 (truck) 156 (rail)
Class A LLW (drums)	47,351	6,878	82 (truck) 41 (rail)	83,014	12,508	144 (truck) 72 (rail)	83,014	12,508	144 (truck) 72 (rail)
Class B LLW (HIC)	0	0	0	38,500	428	428 (truck) 107 (rail)	38,500	428	428 (truck) 107 (rail)
Class B LLW (drums)	0	0	0	194	29	1 (truck) 1 (rail)	194	29	1 (truck) 1 (rail)
Class C LLW (HIC)	0	0	0	12,618	141	141 (truck) 36 (rail)	12,618	141	141 (truck) 36 (rail)
Class C LLW (55-gallon drums)	0	0	0	6,198	901	91 (truck) 23 (rail)	6,198	901	91 (truck) 23 (rail)
Class C LLW (71-gallon drums)	0	0	0	193,405	20,377	850 (truck) 213 (rail)	193,405	20,377	850 (truck) 213 (rail)
CH-TRU	0	0	0	40,000	5,810	139 (truck) 139 (rail)	40,000	5,810	278 (truck)[b] 278 (rail)[b]
RH-TRU	0	0	0	9,000	1,308	131 (truck) 33 (rail)	9,000	1,308	262 (truck)[c] 66 (rail)[d]
MLLW	0	0	0	7,889	1,146	14 (truck) 7 (rail)	7,889	1,146	14 (truck) 7 (rail)
HLW		0	0		300	300 (truck) 60 (rail)		300	600 (truck)[e] 120 (rail)[f]
Total	145,000	8,084	169 (truck) 85 (rail)	742,404	46,839	2550 (truck) 847 (rail)	742,404	46,839	3,120 (truck)[g] 1,079 (rail)[h]

Acronyms: LLW = low-level radioactive waste; HIC = high-integrity container; CH-TRU = contact-handled transuranic waste; RH-TRU = remote-handled transuranic waste; MLLW = mixed low-level waste; HLW = high-level radioactive waste.

a. To convert cubic feet to cubic meters, multiply by 0.028317.
b. 139 CH-TRU shipments from WVDP to interim storage, 139 CH-TRU shipments from interim storage to disposal.
c. 131 RH-TRU shipments from WVDP to interim storage, 131 RH-TRU shipments from interim storage to disposal.
d. 33 RH-TRU shipments from WVDP to interim storage, 33 RH-TRU shipments from interim storage to disposal.
e. 300 HLW shipments from WVDP to interim storage, 300 HLW shipments from interim storage to disposal.
f. 60 HLW shipments from WVDP to interim storage, 60 HLW shipments from interim storage to disposal.
g. Includes 270 TRU waste, and 300 HLW, truck shipments from interim storage to disposal. Alternative B would load the same number of truck shipments (2,550) at WVDP for shipment offsite as Alternative A.
h. Includes 172 TRU waste, and 60 HLW, rail shipments from interim storage to disposal. Alternative B would load the same number of rail shipments (847) at WVDP for shipment offsite as Alternative A.

single shipment (a shipment risk factor) between a given origin and destination. Cashwell et al. (1986) contains a detailed explanation of the use of unit risk factors. Table D-4 contains the unit risk factors for truck and rail shipments.

Each waste type was assigned an external radiation dose rate representative of its constituents and shipping container. High-level waste (HLW), Class B LLW, and Class C LLW were assigned a dose rate of 14 millirem (mrem) per hour at 1 meter (3 feet) from their respective vehicles. Using the RADTRAN 5 computer code, this yields the regulatory maximum dose rate at 2 meters (7 feet) from the vehicle, which is 10 mrem per hour. RH-TRU waste was assigned a dose rate of 10 mrem per hour at 1 meter, and CH-TRU waste was assigned a dose rate of 4 mrem per hour at 1 meter (DOE 1997a). Class A LLW and mixed LLW were assigned a dose rate of 1 mrem per hour at 1 meter (DOE 1997b).

Incident-free nonradiological fatalities were also evaluated using unit risk factors. These fatalities would result from exhaust and fugitive dust emissions from highway and rail traffic and are associated with 10-micrometer particles. The nonradiological unit risk factor for truck transport used in this analysis was 1.5×10^{-11} fatalities per kilometer per persons per square kilometer; for train transport, the nonradiological unit risk factor was 2.6×10^{-11} fatalities per kilometer per persons per square kilometer. Escorts for HLW shipments were assumed to be in automobiles, with a unit risk factor of 9.4×10^{-12} fatalities per kilometer per persons per square kilometer. These unit risk factors were estimated from the

Table D-4. Unit Risk Factors for Incident-Free Transportation

Receptor	Type of Zone	Rail	Truck
Public			
Off-link (rem per [persons per square kilometer] per kilometer)	Rural	3.90×10^{-8}	2.89×10^{-8}
	Suburban	6.24×10^{-8}	3.18×10^{-8}
	Urban	1.04×10^{-7}	3.18×10^{-8}
On-link (person-rem per kilometer per vehicle per hour)	Rural	1.21×10^{-7}	9.53×10^{-6}
	Suburban	1.55×10^{-6}	2.75×10^{-5}
	Urban	4.29×10^{-6}	9.88×10^{-5}
Residents near rest/refueling and walk-around stops (person-rem per [persons per square kilometer] per kilometer)	Rural	1.24×10^{-7}	5.50×10^{-9}
	Suburban	1.24×10^{-7}	5.50×10^{-9}
	Urban	1.24×10^{-7}	5.50×10^{-9}
Residents near rail classification stops (person-rem per [persons per square kilometer] per square kilometer)	Suburban	1.59×10^{-5}	NA[a]
Public including workers at rest/refueling stops (person-rem per kilometer)	Rural	NA	7.86×10^{-6}
	Suburban	NA	7.86×10^{-6}
	Urban	NA	7.86×10^{-6}
Workers			
Dose in moving vehicle (person-rem per kilometer)	Rural	NA	4.52×10^{-5}
	Suburban	NA	4.76×10^{-5}
	Urban	NA	4.76×10^{-5}
Classification stops at origin and destination (person-rem)	Suburban	0.0464	0.018
In-transit rail stops (person-rem per kilometer)	Rural	1.45×10^{-5}	NA
	Suburban	1.45×10^{-5}	NA
	Urban	1.45×10^{-5}	NA
Walk-around inspection (person-rem per kilometer)	Rural	NA	1.93×10^{-5}
	Suburban	NA	1.93×10^{-5}
	Urban	NA	1.93×10^{-5}

a. NA = not applicable.

data in Biwer and Butler (1999) and have been adjusted to account for more current diesel exhaust emission factors, a fleet average fugitive dust emission factor for roads, an age-adjusted mortality rate, and an average 10-micrometer particle risk factor. The distances used in the nonradiological analyses were doubled to reflect the round-trip distances, because these impacts could occur whether or not the shipments contain radioactive material.

Maximally Exposed Individual Exposure Scenarios

Maximum individual doses were calculated using the RISKIND computer code (Yuan et al. 1995). The maximum individual doses for the routine transport offsite were estimated for transportation workers and for members of the public. For rail shipments, the three scenarios for members of the public were:

- A railyard worker working at a distance of 10 meters (33 feet) from the shipping container for 2 hours,
- A resident living 30 meters (98 feet) from the rail line where the shipping container was being transported, and
- A resident living 200 meters (656 feet) from a rail stop where the shipping container was sitting for 20 hours.

For train shipments, the maximum exposed transportation worker was an inspector working 1 meter (3 feet) from the shipping container for 1 hour.

For truck shipments, the three scenarios for members of the public were:

- A person caught in traffic and located 1 meter (3 feet) away from the surface of the shipping container for 30 minutes,
- A resident living 30 meters (98 feet) from the highway used to transport the shipping container, and
- A service station worker working at a distance of 20 meters (66 feet) from the shipping container for 1 hour.

The hypothetical maximum exposed individual doses were accumulated for all shipments over 1 year. For workers, it was assumed that they would be exposed to 23 percent of the shipments, based on working 2,000 hours per year. However, for the scenario involving an individual caught in traffic next to a truck, the radiological exposures were calculated for only one event because it was considered unlikely that the same individual would be caught in traffic next to all containers for all shipments. For truck shipments, the maximum exposed transportation worker is the driver who was assumed to drive shipments for up to 1,000 hours per year. In the maximum exposed individual scenarios, the exposure rate for the shipments depended on the type of waste being transported. Also, the maximum exposure rate for the truck driver was 2 mrem per hour (10 CFR 71.47(b)(4)).

D.6 TRANSPORTATION ACCIDENTS

The offsite transportation accident analysis considers the impacts of accidents during the transportation of waste by truck or rail. Under accident conditions, impacts to human health and the environment may result from the release and dispersal of radioactive material. Transportation accident impacts have been assessed using accident analysis methodologies developed by the NRC. This section provides an overview of the methodologies, and the reader can obtain a detailed description from the referenced reports (NRC 1977; Fischer et al. 1987; Sprung et al. 2000). Accidents that could potentially breach the shipping container are represented by a spectrum of accident severities and radioactive release conditions. Historically, most transportation accidents involving radioactive materials have resulted in little or no release of radioactive material from the shipping container. Consequently, the analysis of accident risks takes into account a spectrum of accidents ranging from high-probability accidents of low severity to hypothetical high-severity accidents that have a correspondingly low probability of occurrence. This accident analysis calculates the probabilities and consequences from this spectrum of accidents.

To provide DOE and the public with a reasonable assessment of radioactive waste transportation accident impacts, two types of analyses were performed. First, an accident risk assessment was performed that takes into account the probabilities and consequences of a spectrum of potential accident severities using a methodology developed by the NRC (NRC 1977; Fischer et al. 1987; Sprung et al. 2000). For the spectrum of accidents considered in the analysis, accident consequences in terms of collective dose to the population within 80 kilometers (50 miles) were multiplied by the accident probabilities to yield collective dose risk using the RADTRAN 5 computer code (Neuhauser et al. 2000). Second, to represent the maximum reasonably foreseeable impacts to individuals and populations should an accident occur, radiological consequences were calculated for an accident of maximum credible severity in each population zone. An accident is considered credible if its probability of occurrence is greater than 1×10^{-7} per year (1 in 10 million per year). The accident consequence assessment for maximally exposed individuals and population groups was performed using the RISKIND computer code (Yuan et al. 1995).

The impacts for specific alternatives were calculated in units of dose (rem or person-rem). Impacts are further expressed as health risks in terms of estimated latent cancer fatalities in exposed populations. The health risk conversion factors used were derived from International Commission on Radiological Protection Publication 60 (ICRP 1991). The nonradiological impacts from transportation accidents (traffic fatalities) were also estimated.

D.6.1 Transportation Accident Rates

For calculating accident risks and consequences, state-specific accident rates were taken from data provided in Saricks and Tompkins (1999) for rail and heavy combination trucks. For calculating the nonradiological impacts from transportation accidents, state-specific fatality rates were taken from data provided in Saricks and Tompkins (1999) for rail and heavy combination trucks.

D.6.2 Conditional Probabilities and Release Fractions

Accident severity categories for potential radioactive waste transportation accidents are described in three NRC reports: NUREG-0170 (NRC 1977) for radioactive waste in general; a report commonly referred to as the Modal Study (Fischer et al. 1987); and a reassessment of NUREG-0170 (Sprung et al. 2000). The latter two reports address only spent nuclear fuel. The Modal Study represents a refinement of the NUREG-0170 methodology, and the recent reassessment analysis, which compares more recent results to NUREG-0170, represents a further refinement of both studies. Even though none of the radioactive waste assumed to be shipped in this EIS is classified as spent nuclear fuel, many of the modeling techniques developed in Fischer et al. (1987) and Sprung et al. (2000) can be applied to the types of waste that would be shipped from the WVDP site. Thus, this section presents the results of analyses that extend the results presented in the reexamination of the transport risk to fuel types other than spent nuclear fuel.

Each of the risk analyses considers a spectrum of accidents of varying severity. Each first determines the conditional probability that the accident will be of a specified severity. Then, based on the accident environment associated with each severe accident, each models the behavior of the material being shipped and the response of the packaging. The models estimate the fraction of each species of radioactive material that might be released for each of the severe accidents being considered. Each of the NRC risk assessments has considered a different breakdown of the severe accident environment. The analyses presented in NUREG-0170 divides the accident environment into eight accident severity categories. Fischer et al. (1987) represented the severe accident environment as a matrix, with one dimension being midline temperature of the lead in the cask and the other dimension being cask deformation. The matrix contained a total of 20 cases. The most recent analysis (Sprung et al. 2000) also represented the severe accident environment as a matrix, with one dimension being the temperature of the radioactive material and the other being the velocity of impact onto an unyielding surface. The matrix contained 19 cases for the truck accidents and 21 cases for rail accidents. The unique feature of the most recent analysis is the specification of a fire-only case. The NUREG-0170 analyses did not specify the accident environment associated with each of the eight accident severity categories, whereas the later analyses both based their cases on a matrix of fire durations and mechanical impacts on the cask. The result is ultimately reduced to a conditional probability of occurrence for each accident case or category, and a set of radionuclide release fractions for each accident case or category.

Both the Modal Study and Sprung et al. (2000) distinguished among material types that are present in the waste form. In addition to release fractions for particulates, separate release fractions are specified for noble gases, cesium, ruthenium, and any crud that might be present on the external surfaces of the spent nuclear fuel cladding. Rather than carry between 19 and 21 accident severity cases through the analysis, a simple mathematical technique has been used to reduce the accident categories to 6 when estimating the transport accident risk.

The probability for the severity category was estimated using the following formula:

$$P_{Sci} = \sum_{j} P_{Cj}$$

where:

j represents the cases included in severity category i
P_{Cj} is the case j probability
P_{Sci} is the accident severity i probability

The probability weighting of the release fractions is calculated using the following formula:

$$RF_{Sci,m} = \frac{\sum_{j,m} RF_{Cj} * P_{Cj}}{P_{Sci}}$$

The use of the “i” and “j” subscripts in the above equation are the same as those used for the probability calculation. The additional “m” subscript has been added to represent the various material classes. The term “RF” is the fraction of the material in the cask released for a given material type. The two equations above are general and have been used to reduce the accident severity categories in NUREG-0170 from 8 to 6 and, in the case of the HLW and Class B and Class C shipping container analyses, from the 21 rail and 19 truck accident severity cases described by Sprung et al. (2000) to the 6 accident severity categories carried through this assessment. Use of these two equations reduces the level of detail carried into subsequent calculations without changing the overall risk estimate. Tables D-5 through D-10 show the six accident severity categories used to model the transportation accident risk for all the waste materials that may be shipped from the WVDP site.

Table D-5. Conditional Probabilities and Release Fractions for CH-TRU Waste Shipments

Severity Category	Truck		Rail	
	Conditional Probability	Release Fraction	Conditional Probability	Release Fraction
1	0.91	0	0.80	0
2	0.070	8.0×10^{-9}	0.18	2.0×10^{-8}
3	0.016	2.0×10^{-7}	0.018	7.0×10^{-7}
4	2.8×10^{-3}	8.0×10^{-5}	1.8×10^{-3}	8.0×10^{-5}
5	1.1×10^{-3}	2.0×10^{-4}	1.3×10^{-4}	2.0×10^{-4}
6	1.0×10^{-4}	2.0×10^{-4}	7.0×10^{-5}	2.0×10^{-4}

Source: DOE 1990.

Table D-6. Conditional Probabilities and Release Fractions for RH-TRU Waste Shipments

Severity Category	Truck		Rail	
	Conditional Probability	Release Fraction	Conditional Probability	Release Fraction
1	0.99993	0	0.99991	0
2	6.2×10^{-5}	2.6×10^{-5}	3.9×10^{-5}	2.5×10^{-5}
3	5.6×10^{-6}	2.4×10^{-5}	4.9×10^{-5}	8.8×10^{-5}
4	5.2×10^{-7}	2.6×10^{-5}	5.8×10^{-7}	5.3×10^{-4}
5	7.0×10^{-8}	6.2×10^{-5}	1.1×10^{-7}	1.3×10^{-4}
6	2.2×10^{-10}	6.7×10^{-5}	8.5×10^{-10}	2.9×10^{-4}

Source: DOE 1990.

Table D-7. Conditional Probabilities and Release Fractions for HLW Shipments

Severity Category	Truck		Rail	
	Conditional Probability	Release Fraction	Conditional Probability	Release Fraction
1	0.99993	0	0.99991	0
2	6.2×10^{-5}	3.4×10^{-8}	3.9×10^{-5}	6.2×10^{-8}
3	5.6×10^{-6}	0	4.9×10^{-5}	0
4	5.2×10^{-7}	2.4×10^{-7}	5.8×10^{-7}	7.9×10^{-6}
5	7.0×10^{-8}	9.3×10^{-8}	1.1×10^{-7}	9.3×10^{-8}
6	2.2×10^{-10}	3.0×10^{-7}	8.5×10^{-10}	2.7×10^{-6}

Table D-8. Conditional Probabilities and Release Fractions for Class C LLW Drum Cell Waste Shipments

Severity Category	Truck		Rail	
	Conditional Probability	Release Fraction	Conditional Probability	Release Fraction
1	0.93	0	0.93	0
2	0.071	1.2×10^{-5}	0.069	1.2×10^{-5}
3	2.2×10^{-3}	3.1×10^{-5}	1.0×10^{-3}	3.1×10^{-5}
4	7.5×10^{-5}	8.8×10^{-6}	3.7×10^{-3}	3.3×10^{-5}
5	6.9×10^{-4}	5.0×10^{-5}	3.8×10^{-4}	5.9×10^{-5}
6	6.1×10^{-5}	5.7×10^{-5}	1.3×10^{-4}	7.5×10^{-5}

Table D-9. Conditional Probabilities and Release Fractions for Class A Drum and Box and Class B LLW Drum Waste Shipments

Severity Category	Truck		Rail	
	Conditional Probability	Release Fraction	Conditional Probability	Release Fraction
1	0.81	0	0.82	0
2	0.14	1.2×10^{-5}	0.14	1.2×10^{-5}
3	0.028	9.2×10^{-4}	0.019	9.1×10^{-4}
4	1.9×10^{-4}	5.0×10^{-4}	2.5×10^{-5}	5.0×10^{-4}
5	0.019	7.9×10^{-3}	0.015	7.7×10^{-3}
6	1.2×10^{-4}	0.38	9.7×10^{-4}	0.38

Table D-10. Conditional Probabilities and Release Fractions for Class B LLW High-Integrity Containers and Class C LLW Drum and High-Integrity Container Shipments

Severity Category	Truck		Rail	
	Conditional Probability	Release Fraction	Conditional Probability	Release Fraction
1	0.99993	0	0.99991	0
2	6.2×10^{-5}	2.6×10^{-5}	3.9×10^{-5}	2.5×10^{-5}
3	5.6×10^{-6}	2.4×10^{-5}	4.9×10^{-5}	8.8×10^{-5}
4	5.2×10^{-7}	2.6×10^{-5}	5.8×10^{-7}	5.3×10^{-4}
5	7.0×10^{-8}	6.2×10^{-5}	1.1×10^{-7}	1.3×10^{-4}
6	2.2×10^{-10}	6.7×10^{-5}	8.5×10^{-10}	2.9×10^{-4}

In developing the release fractions for the various waste types, the models developed in Sprung et al. (2000) combined separate responses of the waste form, its cladding, the response of the gases internal to the waste form and shipping container, and the shipping container. Waste form release fractions were estimated for the 21 rail and 19 truck cases. For shipping containers used for HLW and Class B and Class C waste, the response for the various accident environments represented by the 19 and 21 cases was assumed to be the same. To estimate the behavior of materials released from the clad to the internals of the packaging, Sprung et al. (2000) developed a deposition and gas expansion model to estimate the fraction of the material in the gas that might be released to the environment. To demonstrate how these models were adapted to one of the WVDP waste types, the modeling of the HLW canister behavior in the accident environment represented by the 21 rail and 19 truck severe accident cases will be described.

The first step was to make the assumption that because glass and ceramics are both brittle solids, both will have similar particulate release fractions when struck during a severe transportation accident. Because a melt temperature of 1,150 degrees Celsius (2,102 degrees Fahrenheit) is used to pour the HLW into the canister, no noble gases would be present in the waste form. Furthermore, any cesium or ruthenium present would be tightly bound to the boron and silicon in the HLW so they would behave as particulates instead of volatile species. Lastly, there would be no crud.

The second step was to replace the clad failure rate used in Sprung et al. (2000) for spent nuclear fuel with a canister failure model. Based on impact tests on simulated HLW canisters, it was estimated that 20 percent of the canisters would fail if they impacted a surface at between 48 and 97 kilometers (30 and 60 miles) per hour, 70 percent would fail if they impacted the surface at between 97 and 145 kilometers (60 and 90 miles) per hour, and all would fail if they impacted the surface at speeds in excess of 145 kilometers (90 miles) per hour. Furthermore, assuming the canister was sealed at room temperature, a stress analysis performed on the canister showed that it would not fail from pressure buildup when exposed to fires as high as 1,000 degrees Celsius (1,832 degrees Fahrenheit). This was the highest temperature considered in any of the cases modeled by Sprung et al. (2000).

The final two parts of the Sprung et al. (2000) analysis were deposition and gas displacement models. The deposition model estimated the fraction of the material released from the spent nuclear fuel clad that is deposited on the inside surfaces of the cask and clad and therefore not available for immediate release. The gas displacement model considers the pressure buildup inside the cask and the fraction of the gas that must be released to reduce the pressure inside the cask to atmospheric pressure. The model assumes the fraction of the radioactive material released from the cask is the same as the fraction of the internal gases that must be released from the cask to reduce the internal pressure in the cask to atmospheric pressure. In the modeling of the HLW releases, no changes were made to the gas displacement model. The source of the displacement was assumed to be the 1.9 atmosphere pressure internal to the canister during shipment. This pressure is based on the assumption that the canister was sealed at room temperature and operates at 300 degrees Celsius (572 degrees Fahrenheit) during shipment.

Once the 19 truck cases and the 21 rail cases have been modeled for the waste forms, the resultant conditional probabilities and release fractions were reduced to the 6 accident severity categories shown in Tables D-5 to D-10. While different assumptions were made, a similar process was performed to estimate the conditional probabilities and release fractions for the other waste forms. For the Class C drum cell waste shipments, the waste is contained in a grout matrix that is assumed to be have impact properties that are similar to those for the HLW and ceramic fuel. For the thermal behavior, the grout will basically turn back to powder, losing all its bound water, at 600º Celsius (1,112º Fahrenheit). A thermal model of a waste drum was used to estimate the fraction of the grout decomposed as a function of the fire duration. The conditional fire probabilities were the same as those used for the HLW, and the thermal release fraction for the decomposed grout used the release fraction for aggregate taken from DOE (1994). The results for this waste form are shown in Table D-8. For the waste in Type B containers, the HLW canister model was modified in two ways. First, the effect of the canister was removed, placing all of the release limits on the performance of the Type B packaging in the accident environment. This packaging was assumed to perform as the lead cask performed in Sprung et al. (2000). The other change was to use release fractions that are consistent with the type of waste being shipped, a surface-contaminated solid. These release fractions and conditional probabilities are shown in Tables D-6 and D-10. For the Class A waste shipped in drums and boxes, a crush model was used to estimate the fraction of the drums failed at various impact velocities, and the release fractions for combustible solids presented in DOE (1994) were thought to be most representative of these wastes. The release fractions and conditional probabilities for these waste forms are presented in Table D-9.

The RADTRAN 5 computer code was used to estimate accident unit risk factors (units of person-rem per kilometer per person per square kilometer) for each radionuclide in the various waste forms. An Access database was used to combine the unit risk factors with data on conditional probabilities, release fractions, accident rates, population densities, route distances, and radionuclide inventories to calculate the total accident dose risk for each alternative examined in the EIS. For a given alternative, the accident unit risk factors were first multiplied by the number of shipment kilometers through each population zone being traversed by the waste shipments and then by the population density associated with that population zone. By summing over all population zones traversed by the waste form and then over all waste forms being considered, the total accident dose risk for each of the alternatives has been obtained.

D.6.3 Shipment Inventories

The radionuclide inventories in Classes A, B, and C LLW were estimated from the five radionuclide mixes in Table 3-6 of Marschke (2001). The five radionuclide mixes were converted to radionuclide concentrations and scaled to arrive at the maximum radionuclide concentrations that were Class A, B, or

C waste. To determine which of the five mixes for each waste class had the greatest radiological hazard, the radionuclide concentration was divided by the A_2 value for each radionuclide from 10 CFR 71 and summed for each mix. The mix with the largest sum represents the mix with the largest radiological hazard; this mix was then used in the transportation risk assessment. The radionuclide concentrations were then converted to container inventories, which are presented in Table D-11. Radionuclide inventories for Drum Cell waste are presented in Table D-12.

Table D-11. Class A, B, and C Container Inventories[a]

Nuclide	Class A LLW		Class B LLW		Class C LLW	
	Drum[b] Inventory	Box Inventory	Drum Inventory	HIC[c] Inventory	Drum Inventory	HIC[c] Inventory
Hydrogen-3	1.56×10^{-6}	5.50×10^{-8}	6.76×10^{-8}	8.83×10^{-7}	6.76×10^{-7}	8.83×10^{-6}
Carbon-14	6.49×10^{-6}	7.23×10^{-8}	8.88×10^{-8}	1.16×10^{-6}	8.88×10^{-7}	1.16×10^{-5}
Iron-55	0	5.57×10^{-7}	6.84×10^{-7}	8.95×10^{-6}	6.84×10^{-6}	8.95×10^{-5}
Nickel-59	0	1.24×10^{-6}	1.52×10^{-6}	1.99×10^{-5}	1.52×10^{-5}	1.99×10^{-4}
Nickel-63	0	1.66×10^{-4}	2.04×10^{-4}	2.66×10^{-3}	2.04×10^{-3}	0.0266
Cobalt-60	0	1.16×10^{-8}	1.43×10^{-8}	1.87×10^{-7}	1.43×10^{-7}	1.87×10^{-6}
Strontium-90	7.02×10^{-4}	0.070	0.086	1.12	0.86	11.2
Technetium-99	2.49×10^{-7}	6.26×10^{-6}	7.68×10^{-6}	1.00×10^{-4}	7.68×10^{-5}	1.00×10^{-3}
Iodine-129	5.21×10^{-10}	0	0	0	0	0
Cesium-137	8.96×10^{-4}	0.798	0.98	12.8	9.80	128
Europium-154	5.48×10^{-6}	7.32×10^{-4}	8.99×10^{-4}	0.0118	8.99×10^{-3}	0.118
Actinium-227	5.85×10^{-10}	9.44×10^{-12}	1.16×10^{-11}	1.52×10^{-10}	1.16×10^{-10}	1.52×10^{-9}
Radium-228	3.43×10^{-11}	1.57×10^{-17}	1.93×10^{-17}	2.52×10^{-16}	1.93×10^{-16}	2.52×10^{-15}
Protactinium-231	2.21×10^{-9}	4.55×10^{-12}	5.58×10^{-12}	7.30×10^{-11}	5.58×10^{-11}	7.30×10^{-10}
Thorium-232	2.37×10^{-10}	9.25×10^{-17}	1.14×10^{-16}	1.49×10^{-15}	1.14×10^{-15}	1.49×10^{-14}
Uranium-232	4.09×10^{-6}	6.09×10^{-8}	7.48×10^{-8}	9.78×10^{-7}	7.48×10^{-7}	9.78×10^{-6}
Uranium-233	8.75×10^{-6}	1.08×10^{-7}	1.33×10^{-7}	1.74×10^{-6}	1.33×10^{-6}	1.74×10^{-5}
Uranium-234	4.34×10^{-7}	6.27×10^{-8}	7.70×10^{-8}	1.01×10^{-6}	7.70×10^{-7}	1.01×10^{-5}
Uranium-235	8.43×10^{-8}	1.40×10^{-9}	1.71×10^{-9}	2.24×10^{-8}	1.71×10^{-8}	2.24×10^{-7}
Uranium-238	9.49×10^{-7}	1.24×10^{-8}	1.52×10^{-8}	1.99×10^{-7}	1.52×10^{-7}	1.99×10^{-6}
Neptunium-237	3.71×10^{-9}	4.70×10^{-7}	5.77×10^{-7}	7.55×10^{-6}	5.77×10^{-6}	7.55×10^{-5}
Plutonium-238	2.79×10^{-4}	8.80×10^{-5}	1.08×10^{-4}	1.41×10^{-3}	1.08×10^{-3}	0.0141
Plutonium-239	3.92×10^{-4}	2.10×10^{-5}	2.58×10^{-5}	3.38×10^{-4}	2.58×10^{-4}	3.38×10^{-3}
Plutonium-240	2.78×10^{-4}	2.10×10^{-5}	2.58×10^{-5}	3.38×10^{-4}	2.58×10^{-4}	3.38×10^{-3}
Plutonium-241	0.011	7.62×10^{-4}	9.36×10^{-4}	0.0122	9.36×10^{-3}	0.122
Plutonium-242	2.27×10^{-7}	1.08×10^{-7}	1.33×10^{-7}	1.74×10^{-6}	1.33×10^{-6}	1.74×10^{-5}
Americium-241	2.87×10^{-5}	7.33×10^{-4}	9.00×10^{-4}	0.0118	9.00×10^{-3}	0.118
Americium-243	8.70×10^{-7}	8.61×10^{-6}	1.06×10^{-5}	1.38×10^{-4}	1.06×10^{-4}	1.38×10^{-3}
Curium-242	1.05×10^{-16}	5.10×10^{-6}	6.26×10^{-6}	8.19×10^{-5}	6.26×10^{-5}	8.19×10^{-4}
Curium-243	1.54×10^{-8}	7.97×10^{-5}	9.78×10^{-5}	1.28×10^{-3}	9.78×10^{-4}	0.0128
Curium-244	4.21×10^{-7}	7.97×10^{-5}	9.78×10^{-5}	1.28×10^{-3}	9.78×10^{-4}	0.0128

a. All inventories presented in curies.
b. Also used for mixed LLW shipment inventory.
c. HIC = high-integrity container

Table D-12. Drum Cell Waste Container Inventory

Nuclide	Drum Inventory (in curies)
Hydrogen-3	1.3×10^{-4}
Carbon-14	3.6×10^{-4}
Cobalt-60	6.0×10^{-8}
Nickel-63	3.5×10^{-5}
Strontium-90	0.027
Technetium-99	0.11
Antimony-125	1.0×10^{-4}
Iodine-129	1.8×10^{-5}
Cesium-137	0.021
Neptunium-237	4.3×10^{-5}
Plutonium-238	5.9×10^{-3}
Plutonium-239	1.2×10^{-3}
Plutonium-240	9.4×10^{-4}
Plutonium-241	0.067
Americium-241	1.4×10^{-3}
Plutonium-242	1.2×10^{-6}
Curium-242	8.6×10^{-12}

The radionuclide inventories for CH-TRU waste was taken from DOE (1997a) and are listed in Table D-13. The radionuclide inventory for RH-TRU waste was based on the radionuclide distribution for spent nuclear fuel, scaled to 2 curies of plutonium per 55-gallon drum, or 20 curies of plutonium per 10 drums, which is the limit for the shipping container. The radionuclide inventory is listed in Table D-13. The radionuclide inventory for HLW was taken from DOE (2002) and is listed in Table D-14.

Table D-13. TRU Waste Container Inventories[a]

Nuclide	CH-TRU Waste Drum Inventory	RH-TRU Waste Drum Inventory
Cobalt-60	4.6×10^{-5}	0
Strontium-90	7.1×10^{-4}	3.8
Cesium-137	7.1×10^{-4}	4.1
Thorium-228	0	1.2×10^{-3}
Uranium-232	0	1.2×10^{-3}
Uranium-233	0	0
Uranium-235	0	0
Uranium-238	0	0
Plutonium-238	71	0.26
Plutonium-239	1.1	0.073
Plutonium-240	0.30	0.055
Plutonium-241	14	1.6
Plutonium-242	4.9×10^{-5}	0
Americium-241	0.26	0.089
Americium-242	0	6.2×10^{-4}
Americium-242m	0	6.2×10^{-4}
Americium-243	0	3.9×10^{-3}
Curium-244	0	8.1×10^{-3}

a. All inventories presented in curies.

Table D-14. HLW Canister Inventory

Nuclide	Canister Inventory[a]
Actinium-227	0.046
Americium-241	200
Americium-242m	1.0
Americium-243	1.3
Carbon-14	0.53
Curium-242	0.84
Curium-243	0.28
Curium-244	11
Curium-245	3.4×10^{-3}
Curium-246	3.9×10^{-4}
Cesium-134	4.4×10^{-3}
Cesium-135	0.62
Cesium-137	16,000
Hydrogen-3	0.078
Iodine-129	8.1×10^{-4}
Niobium-93m	0.95
Neptunium-237	0.092
Protactinium-231	0.059
Palladium-107	0.042
Plutonium-238	27
Plutonium-239	6.4
Plutonium-240	4.7
Plutonium-241	95
Plutonium-242	6.4×10^{-3}
Radium-228	6.3×10^{-3}
Ruthenium-106	1.9×10^{-9}
Selenium-79	0.23
Samarium-151	270
Tin-126	0.4
Strontium-90	14,000
Technetium-99	6.5
Thorium-229	8.9×10^{-4}
Thorium-230	2.3×10^{-4}
Thorium-232	6.3×10^{-3}
Uranium-232	0.023
Uranium-233	0.037
Uranium-234	0.019
Uranium-235	3.9×10^{-4}
Uranium-236	1.1×10^{-3}
Uranium-238	3.3×10^{-3}
Zirconium-93	1.1
Nickel-59	0.41
Nickel-63	27
Cobalt-60	0.11

Source: DOE 2002.

a. All inventories presented in curies.

D.6.4 Atmospheric Conditions

Because it is impossible to predict the specific location of an offsite transportation accident, generic atmospheric conditions were selected for the risk and consequence assessments. For accident risk assessment, neutral weather conditions (Pasquill Stability Class D) were assumed. Neutral weather conditions are typified by moderate windspeeds, vertical mixing within the atmosphere, and good dispersion of atmospheric contaminants. Because neutral meteorological conditions compose the most frequently occurring atmospheric stability condition in the United States, these conditions are most likely to be present in the event of an accident involving a radioactive waste shipment. On the basis of observations from National Weather Service surface meteorological stations at 177 locations in the United States, on an annual average, neutral conditions (Pasquill Class C and D) occur 59 percent of the time, while stable (Pasquill Class E and F) and unstable (Pasquill Class A and B) conditions occur 33 percent and 8 percent of the time, respectively (CRWMS M&O 1999).

For the accident consequence assessment, doses were assessed under both neutral (Class D with 4.47 meters [14.67 feet] per second windspeed) and stable (Class F with 0.89 meter [2.92 feet] per second windspeed) atmospheric conditions. Stable weather conditions are typified by low windspeeds, very little vertical mixing within the atmosphere, and poor dispersion of atmospheric contaminants. Class F meteorology in combination with windspeeds of 0.89 meter per second generally occur no more than 12 percent of the time. Results calculated for neutral conditions represent the most likely consequences, and results for stable conditions represent a worst-case weather situation.

D.6.5 Population Density Zones

Three population density zones (rural, suburban, and urban) were used for the offsite population risk assessment. These zones respectively correspond to three mean population densities of 6, 719, and 3,861 persons per square kilometer. The actual population densities in the three zones were based on an aggregation of the twelve population density zones provided in the WebTRAGIS output and on data from the 2000 census.

D.6.6 Exposure Pathways

Radiological doses were calculated for an individual located near the scene of the accident and for populations within 80 kilometers (50 miles) of the accident. Rural, suburban, and urban population densities were assessed. Dose calculations considered a variety of exposure pathways, including inhalation and direct exposure (cloudshine) from the passing cloud, ingestion of contaminated crops, direct exposure (groundshine) from radioactivity deposited on the ground, and inhalation of resuspended radioactive particles from the ground.

D.6.7 Health Risk Conversion Factors

The following health risk conversion factors used to estimate latent cancer fatalities from radiological exposures were derived from International Commission on Radiological Protection Publication 60 (ICRP 1991): 5×10^{-4} and 4×10^{-4} latent cancer fatalities per person-rem for members of the public and workers, respectively. Although latent cancer fatalities are the predominant health risk associated with low-level radiation doses (that is, doses below the thresholds for acute effects), they are not the only potential detrimental health effect. Risks of other delayed health effects such as non-fatal cancers and hereditary effects should also be acknowledged. International Commission on Radiological Protection Publication 60 (ICRP 1991) has estimated that the total risk of detrimental health effects are 7.3×10^{-4} and 5.6×10^{-4} total detrimental health effects per person-rem for members of the public and workers, respectively.

D.7 RESULTS

D.7.1 Transportation Impacts

No Action Alternative. Table D-15 lists the transportation impacts under the No Action Alternative. If trucks were used to ship the radioactive waste, an estimated 0.030 to 0.037 fatality would occur. The range of total fatalities is based on the minimum and maximum total fatalities for each waste type. Of that, about 60 percent would be from nonradiological traffic accidents and about 10 percent would be from nonradiological pollutants (diesel exhaust and fugitive dust).

If trains were used, an estimated 0.036 to 0.043 fatality would occur. About 70 percent would be from nonradiological traffic accidents and about 20 percent would be from nonradiological pollutants (diesel exhaust and fugitive dust).

Table D-15. Transportation Impacts Under the No Action Alternative

Waste Type	Destination	Incident-Free		Radiological Accident Dose Risk (person-rem)	Incident-Free		Radiological Accident Risk (LCFs)	Pollution Health Effects	Traffic Fatalities	Total Fatalities
		Public (person-rem)	Worker (person-rem)		Public (LCFs)	Worker (LCFs)				
Truck										
Class A	Envirocare	15	23	0.11	7.7×10^{-3}	9.2×10^{-3}	5.7×10^{-5}	2.1×10^{-3}	0.011	0.030
Class A	Hanford	19	27	0.12	9.3×10^{-3}	0.011	6.2×10^{-5}	2.3×10^{-3}	0.014	0.037
Class A	NTS	19	27	0.14	9.5×10^{-3}	0.011	7.1×10^{-5}	2.8×10^{-3}	0.013	0.036
Total Truck Fatalities: 0.030 – 0.037										
Rail										
Class A	Envirocare	27	24	0.45	0.014	9.7×10^{-3}	2.2×10^{-4}	3.0×10^{-3}	9.8×10^{-3}	0.036
Class A	Hanford	28	26	0.49	0.014	0.010	2.5×10^{-4}	3.1×10^{-3}	0.012	0.040
Class A	NTS	28	32	0.45	0.014	0.013	2.3×10^{-4}	3.0×10^{-3}	0.012	0.043
Total Rail Fatalities: 0.036 – 0.043										

Acronyms: LCFs = latent cancer fatalities; NTS = Nevada Test Site. The range of total fatalities is based on the minimum and maximum total fatalities for each waste type.

Alternative A. Table D-16 lists the transportation impacts under Alternative A. If trucks were used to ship the radioactive waste, an estimated 0.69 to 0.72 fatality would occur. The range of total fatalities is based on the minimum and maximum total fatalities for each waste type. Of that, about 30 percent would be from nonradiological traffic accidents and about 15 percent would be from nonradiological air pollutants.

If trains were used, an estimated 0.52 to 0.59 fatality would occur. Of that, about 30 percent would be from nonradiological traffic accidents and about 20 percent would be from nonradiological air pollutants.

Alternative B. Table D-17 lists the transportation impacts under Alternative B. If trucks were used to ship the radioactive waste, an estimated 0.76 to 0.87 fatality would occur. The range of total fatalities is based on the minimum and maximum total fatalities for each waste type. Of that, about 35 percent would be from nonradiological traffic accidents and about 15 percent would be from nonradiological air pollutants.

If trains were used, an estimated 0.62 to 0.78 fatality would occur. Of that, about 30 percent would be from nonradiological traffic accidents and about 15 percent would be from nonradiological air pollutants.

Table D-16. Transportation Impacts Under Alternative A

Waste Type	Destination	Incident-Free		Radiological Accident Dose Risk (person-rem)	Incident-Free		Radiological Accident Risk (LCFs)	Pollution Health Effects	Traffic Fatalities	Total Fatalities
		Public (person-rem)	Worker (person-rem)		Public (LCFs)	Worker (LCFs)				
Truck										
Class A	Envirocare	41	62	0.23	0.021	0.025	1.1×10^{-4}	5.7×10^{-3}	0.030	0.081
	Hanford Site	50	74	0.24	0.025	0.029	1.2×10^{-4}	6.3×10^{-3}	0.038	0.098
	NTS	51	71	0.28	0.026	0.029	1.4×10^{-4}	7.6×10^{-3}	0.036	0.098
Class B	Hanford Site	47	130	1.4×10^{-3}	0.024	0.052	6.9×10^{-7}	5.9×10^{-3}	0.035	0.12
	NTS	48	120	1.6×10^{-3}	0.024	0.050	7.9×10^{-7}	7.1×10^{-3}	0.034	0.11
Class C	Hanford Site	140	400	9.1×10^{-4}	0.072	0.16	4.6×10^{-7}	0.018	0.11	0.36
	NTS	150	380	1.1×10^{-3}	0.074	0.15	5.4×10^{-7}	0.022	0.10	0.35
CH-TRU	WIPP	14	20	1.2	6.9×10^{-3}	8.0×10^{-3}	6.2×10^{-4}	2.3×10^{-3}	0.012	0.030
RH-TRU	WIPP	11	27	1.2×10^{-5}	5.4×10^{-3}	0.011	6.2×10^{-9}	2.2×10^{-3}	0.011	0.030
MLLW	Envirocare	1.3	1.9	0.017	6.4×10^{-4}	7.6×10^{-4}	8.7×10^{-6}	1.8×10^{-4}	9.2×10^{-4}	2.5×10^{-3}
	Hanford	1.5	2.3	0.019	7.7×10^{-4}	9.1×10^{-4}	9.4×10^{-6}	1.9×10^{-4}	1.2×10^{-3}	3.0×10^{-3}
	NTS	1.6	2.2	0.022	7.9×10^{-4}	8.8×10^{-4}	1.1×10^{-5}	2.3×10^{-4}	1.1×10^{-3}	3.0×10^{-3}
HLW	Repository	34	88	1.6×10^{-3}	0.017	0.035	8.1×10^{-7}	5.8×10^{-3}	0.024	0.082
Total Truck Fatalities: 0.69 – 0.72										
Rail										
Class A	Envirocare	73	65	0.88	0.037	0.026	4.4×10^{-4}	8.0×10^{-3}	0.026	0.097
	Hanford Site	74	70	0.97	0.037	0.028	4.8×10^{-4}	8.2×10^{-3}	0.034	0.11
	NTS	76	87	0.88	0.038	0.035	4.4×10^{-4}	8.1×10^{-3}	0.033	0.11
Class B	Hanford Site	70	66	5.6×10^{-3}	0.035	0.026	2.8×10^{-6}	3.9×10^{-3}	0.016	0.081
	NTS	71	90	5.1×10^{-3}	0.036	0.036	2.5×10^{-6}	3.8×10^{-3}	0.017	0.093
Class C	Hanford Site	220	200	2.0×10^{-3}	0.11	0.081	1.0×10^{-6}	0.012	0.049	0.25
	NTS	220	280	1.8×10^{-3}	0.11	0.11	9.1×10^{-7}	0.012	0.053	0.29
CH-TRU	WIPP	14	16	0.33	6.9×10^{-3}	6.5×10^{-3}	1.6×10^{-4}	3.4×10^{-3}	0.018	0.035
RH-TRU	WIPP	11	13	4.0×10^{-5}	5.5×10^{-3}	5.1×10^{-3}	2.0×10^{-8}	8.0×10^{-4}	4.2×10^{-3}	0.016
MLLW	Envirocare	2.2	2.0	0.068	1.1×10^{-3}	8.0×10^{-4}	3.4×10^{-5}	2.4×10^{-4}	8.1×10^{-4}	3.0×10^{-3}
	Hanford	2.3	2.2	0.075	1.1×10^{-3}	8.6×10^{-4}	3.8×10^{-5}	2.5×10^{-4}	1.0×10^{-3}	3.3×10^{-3}
	NTS	2.3	2.7	0.068	1.2×10^{-3}	1.1×10^{-3}	3.4×10^{-5}	2.5×10^{-4}	1.0×10^{-3}	3.5×10^{-3}
HLW	Repository	13	28	4.9×10^{-4}	6.3×10^{-3}	0.011	2.5×10^{-7}	4.2×10^{-3}	0.019	0.041
Total Rail Fatalities: 0.52 – 0.59										

Acronyms: LCFs = latent cancer fatalities; CH-TRU = contact-handled transuranic waste; RH-TRU = remote-handled transuranic waste; MLLW = mixed low-level waste; HLW = high-level radioactive waste; NTS = Nevada Test Site; WIPP = Waste Isolation Pilot Plant. The range of total fatalities is based on the minimum and maximum total fatalities for each waste type.

Table D-17. Transportation Impacts Under Alternative B

Waste Type	Destination	Incident-Free Public (person-rem)	Incident-Free Worker (person-rem)	Radiological Accident Dose Risk (person-rem)	Incident-Free Public (LCFs)	Incident-Free Worker (LCFs)	Radiological Accident Risk (LCFs)	Pollution Health Effects	Traffic Fatalities	Total Fatalities
Truck										
Class A	Envirocare	41	62	0.23	0.021	0.025	1.1×10^{-4}	5.7×10^{-3}	0.030	0.081
	Hanford Site	50	74	0.24	0.025	0.029	1.2×10^{-4}	6.3×10^{-3}	0.038	0.098
	NTS	51	71	0.28	0.026	0.029	1.4×10^{-4}	7.6×10^{-3}	0.036	0.098
Class B	Hanford Site	47	130	1.4×10^{-3}	0.024	0.052	6.9×10^{-7}	5.9×10^{-3}	0.035	0.12
	NTS	48	120	1.6×10^{-3}	0.024	0.050	7.9×10^{-7}	7.1×10^{-3}	0.034	0.11
Class C	Hanford Site	140	400	9.1×10^{-4}	0.072	0.16	4.6×10^{-7}	0.018	0.11	0.36
	NTS	150	380	1.1×10^{-3}	0.074	0.15	5.4×10^{-7}	0.022	0.10	0.35
CH-TRU	SRS → WIPP	21	35	3.7	0.010	0.014	1.8×10^{-3}	3.8×10^{-3}	0.022	0.052
	INEEL → WIPP	29	50	2.9	0.014	0.020	1.5×10^{-3}	4.2×10^{-3}	0.025	0.065
	ORNL → WIPP	18	33	2.3	8.9×10^{-3}	0.013	1.1×10^{-3}	3.1×10^{-3}	0.017	0.043
	Hanford → WIPP	35	59	3.4	0.017	0.023	1.7×10^{-3}	4.9×10^{-3}	0.032	0.079
RH-TRU	SRS → WIPP	16	43	3.6×10^{-5}	8.1×10^{-3}	0.017	1.8×10^{-8}	3.6×10^{-3}	0.021	0.050
	INEEL → WIPP	23	65	3.4×10^{-5}	0.011	0.026	1.7×10^{-8}	4.0×10^{-3}	0.024	0.065
	ORNL → WIPP	14	40	2.2×10^{-5}	7.0×10^{-3}	0.016	1.1×10^{-8}	2.9×10^{-3}	0.016	0.042
	Hanford → WIPP	27	78	3.9×10^{-5}	0.014	0.031	1.9×10^{-8}	4.6×10^{-3}	0.030	0.080
MLLW	Envirocare	1.3	1.9	0.017	6.4×10^{-4}	7.6×10^{-4}	8.7×10^{-6}	1.8×10^{-4}	9.2×10^{-4}	2.5×10^{-3}
	Hanford Site	1.5	2.3	0.019	7.7×10^{-4}	9.1×10^{-4}	9.4×10^{-6}	1.9×10^{-4}	1.2×10^{-3}	3.0×10^{-3}
	NTS	1.6	2.2	0.022	7.9×10^{-4}	8.8×10^{-4}	1.1×10^{-5}	2.3×10^{-4}	1.1×10^{-3}	3.0×10^{-3}
HLW	SRS → Repository	53	130	4.3×10^{-3}	0.027	0.054	2.2×10^{-6}	9.6×10^{-3}	0.047	0.14
	Hanford → Repository	50	140	2.3×10^{-3}	0.025	0.055	1.2×10^{-6}	8.0×10^{-3}	0.037	0.12
										Total Truck Fatalities: 0.76 – 0.87

Table D-17. Transportation Impacts Under Alternative B (cont)

Waste Type	Destination	Incident-Free		Radiological Accident Dose Risk (person-rem)	Incident-Free		Radiological Accident Risk (LCFs)	Pollution Health Effects	Traffic Fatalities	Total Fatalities
Rail										
Class A	Envirocare	73	65	0.88	0.037	0.026	4.4×10^{-4}	8.0×10^{-3}	0.026	0.097
	Hanford Site	74	70	0.97	0.037	0.028	4.8×10^{-4}	8.2×10^{-3}	0.034	0.11
	NTS	76	87	0.88	0.038	0.035	4.4×10^{-4}	8.1×10^{-3}	0.033	0.11
Class B	Hanford Site	70	66	5.6×10^{-3}	0.035	0.026	2.8×10^{-6}	3.9×10^{-3}	0.016	0.081
	NTS	71	90	5.1×10^{-3}	0.036	0.036	2.5×10^{-6}	3.8×10^{-3}	0.017	0.093
Class C	Hanford Site	220	200	2.0×10^{-3}	0.11	0.081	1.0×10^{-6}	0.012	0.049	0.25
	NTS	220	280	1.8×10^{-3}	0.11	0.11	9.1×10^{-7}	0.012	0.053	0.29
CH-TRU	SRS → WIPP	35	45	1.4	0.018	0.018	6.9×10^{-4}	8.9×10^{-3}	0.057	0.10
	INEEL → WIPP	41	49	2.1	0.020	0.020	1.0×10^{-3}	0.010	0.038	0.089
	ORNL → WIPP	32	42	1.2	0.016	0.017	6.2×10^{-4}	8.0×10^{-3}	0.031	0.073
	Hanford → WIPP	47	53	2.5	0.023	0.021	1.3×10^{-3}	0.012	0.053	0.11
RH-TRU	SRS → WIPP	28	35	1.5×10^{-4}	0.014	0.014	7.3×10^{-8}	2.1×10^{-3}	0.013	0.044
	INEEL → WIPP	32	39	2.5×10^{-4}	0.016	0.015	1.2×10^{-7}	9.7×10^{-3}	0.036	0.077
	ORNL → WIPP	25	33	1.4×10^{-4}	0.013	0.013	6.8×10^{-8}	7.5×10^{-3}	0.030	0.063
	Hanford → WIPP	37	42	2.9×10^{-4}	0.018	0.017	1.5×10^{-7}	0.011	0.050	0.096
MLLW	Envirocare	2.2	2.0	0.068	1.1×10^{-3}	8.0×10^{-4}	3.4×10^{-5}	2.4×10^{-4}	8.1×10^{-4}	3.0×10^{-3}
	Hanford Site	2.3	2.2	0.075	1.1×10^{-3}	8.6×10^{-4}	3.8×10^{-5}	2.5×10^{-4}	1.0×10^{-3}	3.3×10^{-3}
	NTS	2.3	2.7	0.068	1.2×10^{-3}	1.1×10^{-3}	3.4×10^{-5}	2.5×10^{-4}	1.0×10^{-3}	3.5×10^{-3}
HLW	SRS → Repository	20	48	5.1×10^{-4}	9.9×10^{-3}	0.019	2.5×10^{-7}	6.1×10^{-3}	0.038	0.074
	Hanford → Repository	19	47	6.5×10^{-4}	9.4×10^{-3}	0.019	3.3×10^{-7}	5.3×10^{-3}	0.034	0.067
										Total Rail Fatalities: 0.62 – 0.78

Acronyms: LCFs = latent cancer fatalities; CH-TRU = contact-handled transuranic waste; RH-TRU = remote-handled transuranic waste; MLLW = mixed low-level waste; HLW = high-level radioactive waste; SRS = Savannah River Site; HF = Hanford Site; WIPP = Waste Isolation Pilot Plant; NTS = Nevada Test Site; INEEL = Idaho National Engineering and Environmental Laboratory; ORNL = Oak Ridge National Laboratory. The range of total fatalities is based on the minimum and maximum total fatalities for each waste type.

D.7.2 Incident-Free Radiation Doses to Maximally Exposed Individuals

No Action Alternative. Table D-18 lists the incident-free radiation doses for the maximally exposed individual scenarios under the No Action Alternative. If trucks were used to ship the waste, the maximally exposed worker would be a driver who would receive a radiation dose of about 250 mrem per year based on driving a truck carrying Class A LLW for about 700 hours per year. This is equivalent to a probability of a latent cancer fatality of about 1.0×10^{-4}.

Table D-18. Incident-Free Radiation Doses for the Maximally Exposed Individual Scenarios

Scenario	No Action Alternative	Alternative A	Alternative B
Truck			
Service station worker (member of the public)	0.10 mrem/yr (5.0×10^{-8} LCFs)	19 mrem/yr (9.5×10^{-6} LCFs)	19 mrem/yr (9.5×10^{-6} LCFs)
Individual in traffic jam (member of the public)	0.50 mrem (2.5×10^{-7} LCFs)	8.2 mrem (4.1×10^{-6} LCFs)	8.2 mrem (4.1×10^{-6} LCFs)
Nearby resident (member of the public)	1.1×10^{-4} mrem/yr (5.5×10^{-11} LCFs)	0.022 mrem/yr (1.1×10^{-8} LCFs)	0.022 mrem/yr (1.1×10^{-8} LCFs)
Driver (occupational)	250 mrem/yr (1.0×10^{-4} LCFs)	2,000 mrem/yr (8.0×10^{-4} LCFs)	2,000 mrem/yr (8.0×10^{-4} LCFs)
Rail			
Railyard worker (member of the public)	0.35 mrem/yr (1.8×10^{-7} LCFs)	35 mrem/yr (1.8×10^{-5} LCFs)	35 mrem/yr (1.8×10^{-5} LCFs)
Nearby resident (member of the public)	2.9×10^{-4} mrem/yr (1.5×10^{-10} LCFs)	0.055 mrem/yr (2.8×10^{-8} LCFs)	0.055 mrem/yr (2.8×10^{-8} LCFs)
Resident near rail stop (member of the public)	0.042 mrem/yr (2.1×10^{-8} LCFs)	8.0 mrem/yr (4.0×10^{-6} LCFs)	8.0 mrem/yr (4.0×10^{-6} LCFs)
Inspector (occupational)	1.9 mrem/yr (7.6×10^{-7} LCFs)	190 mrem/yr (7.6×10^{-5} LCFs)	190 mrem/yr (7.6×10^{-5} LCFs)

Under the No Action Alternative, the maximally exposed member of the public would be a person working at a service station who would receive a radiation dose of about 0.10 mrem per year. This is equivalent to a probability of a latent cancer fatality of about 5.0×10^{-8}.

If trains were used to ship the waste, the maximally exposed worker would be an inspector. This worker would receive a radiation dose of about 1.9 mrem per year. This is equivalent to a probability of a latent cancer fatality of about 7.6×10^{-7}. The maximally exposed member of the public was a railyard worker who was not directly involved with handling the railcars. This person would receive a radiation dose of about 0.35 mrem per year. This is equivalent to a probability of a latent cancer fatality of about 1.8×10^{-7}.

Alternative A. Table D-18 lists the incident-free radiation doses for the maximally exposed individual scenarios under Alternative A. If trucks were used to ship the waste, the maximally exposed worker would be a driver who would receive a radiation dose of about 2,000 mrem per year based on driving a truck for 1,000 hours per year. This is equivalent to a probability of a latent cancer fatality of about 8.0×10^{-4}.

The maximally exposed member of the public would be a person working at a service station who would receive a radiation dose of about 19 mrem per year. This is equivalent to a probability of a latent cancer fatality of about 9.5×10^{-6}.

If trains were used to ship the waste, the maximally exposed worker would be an inspector. This worker would receive a radiation dose of about 190 mrem per year. This is equivalent to a probability of a latent cancer fatality of about 7.6×10^{-5}. The maximally exposed member of the public was a railyard worker who was not directly involved with handling the railcars. This person would receive a radiation dose of about 35 mrem per year. This is equivalent to a probability of a latent cancer fatality of about 1.8×10^{-5}.

Alternative B. Table D-18 lists the incident-free radiation doses for the maximally exposed individual scenarios under Alternative B. If trucks were used to ship the waste, the maximally exposed worker would be a driver who would receive a radiation dose of about 2,000 mrem per year based on driving a truck for 1,000 hours per year. This is equivalent to a probability of a latent cancer fatality of about 8.0×10^{-4}.

The maximally exposed member of the public would be a person working at a service station who would receive a radiation dose of about 19 mrem per year. This is equivalent to a probability of a latent cancer fatality of about 9.5×10^{-6}.

If trains were used to ship the waste, the maximally exposed worker would be an inspector. This worker would receive a radiation dose of about 190 mrem per year. This is equivalent to a probability of a latent cancer fatality of about 7.6×10^{-5}. The maximally exposed member of the public was a railyard worker who was not directly involved with handling the railcars. This person would receive a radiation dose of about 35 mrem per year. This is equivalent to a probability of a latent cancer fatality of about 1.8×10^{-5}.

D.7.3 Impacts from Severe Transportation Accidents

In addition to analyzing the radiological and nonradiological risks of transporting radioactive waste from West Valley, DOE assessed the consequences of severe transportation accidents, known as maximum reasonably foreseeable transportation accidents. These severe accidents have a probability of about 1×10^{-7} per year. The consequences of these accidents were determined through the inhalation, groundshine, and immersion pathways.

The following assumptions were used to estimate the consequences of maximum reasonably foreseeable accidents:

- The release height of the plume is 10 meters (33 feet) for both fire- and impact-related accidents. Modeling the heat release rate of accident scenarios involving fire would result in lower consequences than modeling all events with a 10-meter release height.
- Breathing rate for individuals is assumed to be 10,400 cubic meters (13,600 cubic yards) per year (Neuhauser and Kanipe 2000).
- Short-term exposure to airborne contaminants is assumed to be 2 hours.
- Long-term exposure to contamination deposited on the ground is assumed to be 24 hours for the maximally exposed individual and 7 days for the population, with no interdiction or cleanup.
- The accident was assumed to occur in an urban area. The consequences for the maximum reasonably foreseeable accidents were estimated using 2000 census population density data from 0 to 80 kilometers (50 miles) for the 20 most populous urbanized areas in the country.

- Impacts were determined using low wind speeds and stable atmospheric conditions (a wind speed of 0.89 meters per second [2.9 feet per second] and Class F stability). The atmospheric concentrations estimated from these conditions would be exceeded only 5 percent of the time.

- The release fractions used in the analysis were for severity category 6 accidents (see Tables D-5 through D-10).

- The container inventories used in the analysis are listed in Tables D-11 through D-14. The number of containers that were assumed to be involved in the maximum reasonably foreseeable accident are listed in Table D-19. In several cases, multiple Type B shipping containers could be transported in a single shipment (see Table D-2). Because it is unlikely that a severe accident would breach multiple Type B shipping containers, a single Type B shipping container was assumed to be breached in the maximum reasonably foreseeable accident.

Table D-19. Number of Containers Involved in the Maximum Reasonably Foreseeable Transportation Accident

Case	Mode	Container Type	Number of Containers Involved
Class A LLW drums	Rail	55-gallon drum	168 55-gallon drums
Class A LLW boxes	Rail	B-25 box	28 B-25 boxes
Class A LLW drums	Truck	55-gallon drum	84 55-gallon drums
Class A LLW boxes	Truck	B-25 box	14 B-25 boxes
Class B LLW drums	Rail	55-gallon drum	168 55-gallon drums
Class B LLW HIC	Rail	High-integrity container	1 high-integrity container in one Type B shipping container
Class B LLW drums	Truck	55-gallon drum	84 55-gallon drums
Class B LLW HIC	Truck	High-integrity container	1 high-integrity container in one Type B shipping container
Class C LLW drums	Rail	55-gallon drum	10 55-gallon drums in one Type B shipping container
Class C LLW HIC	Rail	High-integrity container	1 high-integrity container in one Type B shipping container
Class C LLW drums	Truck	55-gallon drum	10 55-gallon drums in one Type B shipping container
Class C LLW HIC	Truck	High-integrity container	1 high-integrity container in one Type B shipping container
Drum Cell Drums	Rail	71-gallon drum	24 71-gallon drums
Drum Cell Drums	Truck	71-gallon drum	96 71-gallon drums
CH-TRU	Rail	55-gallon drum	14 55-gallon drums in one TRUPACT-II Type B shipping container
CH-TRU	Truck	55-gallon drum	14 55-gallon drums in one TRUPACT-II Type B shipping container
RH-TRU	Rail	55-gallon drum	10 55-gallon drums in one Type B shipping container
RH-TRU	Truck	55-gallon drum	10 55-gallon drums in one Type B shipping container
HLW	Rail	Canister	1 canister in one Type B truck shipping container
HLW	Truck	Canister	5 canisters in one Type B rail shipping container

Acronyms: LLW = low-level waste; HIC = high-integrity container; CH-TRU = contact-handled transuranic waste; RH-TRU = remote-handled transuranic waste; HLW = high-level radioactive waste

No Action Alternative. The maximally exposed individual would receive a radiation dose of 4.6 rem from the maximum reasonably foreseeable transportation accident involving a truck shipment of Class A LLW (Table D-20). This is equivalent to a risk of a latent cancer fatality of about 2.3×10^{-3}. The probability of this accident is about 5×10^{-7} per year. The population would receive a collective radiation dose of about 1,300 person-rem from this truck accident involving Class A LLW. This could result in about 1 latent cancer fatality.

For the maximum reasonably foreseeable transportation rail accident involving Class A LLW, the maximally exposed individual would receive a radiation dose of about 9.2 rem (Table D-20). This is equivalent to a risk of a latent cancer fatality of about 4.6×10^{-3}. The probability of this accident is about 2×10^{-6} per year. The population would receive a collective radiation dose of about 2,600 person-rem from this rail accident involving Class A LLW. This could result in about 1 latent cancer fatality.

Table D-20. Consequences of Severe Transportation Accidents[a]

Case	Mode	Severity Category	Individual Dose (rem)	Individual LCF	Population Dose (person-rem)	Population LCF
Class A LLW drums	Rail	6	9.2	4.6×10^{-3}	2,600	1.3
Class A LLW boxes	Rail	6	2.1	1.0×10^{-3}	580	0.29
Class A LLW drums	Truck	6	4.6	2.3×10^{-3}	1,300	0.65
Class A LLW boxes	Truck	6	1.0	5.2×10^{-4}	290	0.15
Class B LLW drums	Rail	6	15	7.7×10^{-3}	4,300	2.2
Class B LLW HIC	Rail	6	7.3×10^{-6}	3.6×10^{-9}	8.1×10^{-3}	4.1×10^{-6}
Class B LLW drums	Truck	6	7.7	3.8×10^{-3}	2,200	1.1
Class B LLW HIC	Truck	6	1.3×10^{-5}	6.5×10^{-9}	5.0×10^{-3}	2.5×10^{-6}
Class C LLW drums	Rail	6	5.6×10^{-5}	2.8×10^{-8}	0.062	3.1×10^{-5}
Class C LLW HIC	Rail	6	7.3×10^{-5}	3.6×10^{-8}	0.081	4.1×10^{-5}
Class C LLW drums	Truck	6	9.8×10^{-5}	4.9×10^{-8}	0.038	1.9×10^{-5}
Class C LLW HIC	Truck	6	1.3×10^{-4}	6.5×10^{-8}	0.050	2.5×10^{-5}
Drum Cell Drums	Rail	6	6.6×10^{-3}	3.3×10^{-6}	2.7	1.3×10^{-3}
Drum Cell Drums	Truck	6	2.0×10^{-5}	9.9×10^{-9}	0.51	2.6×10^{-4}
CH-TRU	Rail	6	25	0.012	6,600	3.3
CH-TRU	Truck	6	25	0.012	6,600	3.3
RH-TRU	Rail	6	0.14	7.1×10^{-5}	32	0.016
RH-TRU	Truck	6	0.14	7.1×10^{-5}	32	0.016
HLW	Rail	6	1.7×10^{-3}	8.7×10^{-7}	44	0.022
HLW	Truck	6	2.3×10^{-3}	1.1×10^{-6}	0.96	4.8×10^{-4}

Acronyms: LCF = latent cancer fatality; LLW = low-level waste; HIC = high-integrity container; CH-TRU = contact-handled transuranic waste; RH-TRU = remote-handled transuranic waste; HLW = high-level radioactive waste

a. Impacts are for stable meteorological conditions. Population impacts are in an urban area.

Alternative A. For waste shipped under Alternative A, the maximum reasonably foreseeable truck or rail transportation accident with the highest consequences would involve CH-TRU waste. Because one transuranic package transporter (TRUPACT-II) shipping container was assumed to be involved in either the truck or rail accident, the consequences for the truck or rail accident are the same. However, the probabilities of the truck and rail accidents are slightly different. The probability of the truck accident was 6×10^{-7} per year; for rail, the probability of the accident was 1×10^{-7} per year. The maximally exposed individual would receive a radiation dose of about 25 rem from this accident (Table D-20), which is equivalent to a latent cancer fatality risk of 0.012. The population would receive a collective radiation dose of approximately 6,600 person-rem from this accident. This could result in about 3 latent cancer fatalities.

Alternative B. For waste shipped under Alternative B, the maximum reasonably foreseeable truck or rail transportation accident with the highest consequences would involve CH-TRU waste. Because one TRUPACT-II shipping container was assumed to be involved in either the truck or rail accident, the consequences for the truck or rail accident are the same. However, the probabilities of the truck and rail accidents are slightly different. The probability of the truck accident was 1×10^{-6} per year; for rail, the probability of the accident was 5×10^{-7} per year. The maximally exposed individual would receive a radiation dose of about 25 rem from this accident (Table D-20), which is equivalent to a latent cancer fatality risk of 0.012. The population would receive a collective radiation dose of approximately 6,600 person-rem from this accident. This could result in about 3 latent cancer fatalities.

Using the screening procedure in *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE 2000), the sum of fractions of the biota concentration guides for the Class A LLW accidents and the CH-TRU accident were less than 1. Therefore, the radioactive releases from the Class A LLW accidents and the CH-TRU accident are not likely to cause persistent, measurable deleterious changes in populations or communities of terrestrial or aquatic plants or animals.

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