AR TARGET SHEET

The following document was too large to scan as one unit, therefore, it has been broken down into sections.

EDMC#: 0000003
SECTION: 7 OF 11

DOCUMENT #: DOE/EIS-0113

TITLE: Final EIS Disposal of Hanford Defense High-Level, Transuranic and Tank Wastes

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VOLUME 4
PUBLIC COMMENTS
AND RESPONSES

FINAL ENVIRONMENTAL
IMPACT STATEMENT

DISPOSAL OF HANFORD DEFENSE HIGH-LEVEL, TRANSURANIC AND TANK WASTES

Hanford Site
Richland, Washington

DECEMBER 1987

U.S. DEPARTMENT OF ENERGY

COVER SHEET

RESPONSIBLE AGENCY: U.S. Department of Energy

TITLE: Final Environmental Impact Statement, Disposal of Hanford Defense High-Level, Transuranic and Tank Wastes, Hanford Site, Richland, Washington

CONTACTS: Additional copies or information concerning this statement can be obtained from: Mr. Tom Bauman, Communications Division, U.S. Department of Energy, Richland Operations Office, Richland, WA 99352. Telephone: (509) 376-7378.

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ABSTRACT: The purpose of this Environmental Impact Statement (EIS) is to provide environmental input into the selection and implementation of final disposal actions for high-level, transuranic and tank wastes located at the Hanford Site, Richland, Washington, and into the construction, operation and decommissioning of waste treatment facilities that may be required in implementing waste disposal alternatives. Specifically evaluated are a Hanford Waste Vitrification Plant, Transportable Grout Facility, and a Waste Receiving and Packaging Facility. Also an evaluation is presented to assist in determining whether any additional action should be taken in terms of long-term environmental protection for waste that was disposed of at Hanford prior to 1970 as low-level waste (before the transuranic waste category was established by the Atomic Energy Commission but which might fall into that category if generated today).

The following alternatives are considered in this EIS: 1) in-place stabilization and disposal, where waste is left in place but is isolated by protective and natural barriers; 2) geologic disposal, where most of the waste (by activity and to the extent practicable) is exhumed, treated, segregated, packaged and disposed of in a deep geologic repository; waste classified as high-level would be disposed of in a commercial repository developed pursuant to the Nuclear Waste Policy Act; transuranic waste would be disposed of in the Waste Isolation Pilot Plant near Carlsbad, New Mexico; 3) a reference alternative, where some classes of waste are disposed of in geologic repositories and other classes of waste are disposed of by in-place stabilization and disposal; 4) the preferred alternative, in which double-shell tank wastes, strontium and cesium capsules, and retrievably stored TRU wastes are disposed of according to the reference alternative, and in which decisions are deferred on disposal of single-shell tank wastes and on further remedial action for TRU-contaminated soil sites and pre-1970 buried suspect TRU-contaminated solid wastes (except the 618-11 site) until additional information is obtained on waste characterization, retrieval methods, and performance of near-surface disposal systems; and 5) a no disposal action alternative (continued storage).

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DOE/EIS-0113 (VOL. 4 of 5)
PUBLIC COMMENTS
AND RESPONSES

FINAL ENVIRONMENTAL IMPACT STATEMENT

DISPOSAL OF HANFORD DEFENSE HIGH-LEVEL, TRANSURANIC AND TANK WASTES

Hanford Site
Richland, Washington

DECEMBER 1987

U.S. DEPARTMENT OF ENERGY
ASSISTANT SECRETARY FOR DEFENSE PROGRAMS
WASHINGTON, D.C. 20545

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FOREWORD

This environmental impact statement (EIS) provides analyses of environmental impacts for the selection and implementation of final disposal strategies for the high-level (HLW), transuranic (TRU) and tank wastes generated during national defense activities and stored at the Hanford Site near Richland, Washington. Also an evaluation is presented to assist in determining whether any additional action should be taken in terms of long-term environmental protection for waste that was disposed of at Hanford prior to 1970 as low-level waste (before the transuranic waste category was established by the Atomic Energy Commission (AEC) but which might fall into that category if generated today). This document also addresses environmental impacts associated with the construction, operation and decommissioning of waste treatment facilities that may be required to implement the waste disposal alternatives.

Several previous documents have addressed environmental aspects of the management of defense waste at the Hanford Site. The first comprehensive one, The Final Environmental Statement for Hanford Waste Management Operations (ERDA-1538), was issued in 1975. In that statement, waste management practices at Hanford were shown to protect the public health and safety and the environment on an interim basis. Those practices, however, were not and are not intended as final solutions for long-term isolation and disposal of high-level, TRU and tank wastes.

In 1977, the Energy Research and Development Administration (ERDA) issued the report Alternatives for Long-Term Management of Defense High-Level Radioactive Waste (ERDA-77-44), which included preliminary cost estimates and analyses of near-term risks associated with alternatives considered. That document examined 27 variations on four options for the processing and disposal of Hanford HLW, encompassing numerous final waste forms and storage and disposal modes.

In 1978, the National Research Council of the National Academies of Science and Engineering issued a report entitled Radioactive Wastes at the Hanford Reservation: A Technical Review, concluding that there has not been in the past, and is not at the present, any significant radiation hazard to public health and safety from waste management operations at Hanford. The Council recommended that long-term isolation and disposal of Hanford high-level waste become the main focus of waste management research and development.

The need to include retrievably stored TRU waste within the scope of wastes to be disposed of, and concerns about potential environmental impacts of wastes disposed of before 1970 as low-level wastes (before the Atomic Energy Commission established the TRU waste category but which might be classed as TRU if generated today), led to enlarging the earlier plan that was to issue an EIS covering high-level waste only. Accordingly, on April 1, 1983, the Department of Energy (DOE) published in the Federal Register (48 FR 14029) a Notice of Intent (NOI) to prepare an EIS on Disposal of Radioactive Defense High-Level and Transuranic Wastes at Hanford.

Eighteen comment letters were received in response to the Notice of Intent to prepare this EIS. Ten of the letters only requested copies of the draft EIS when issued; eight contained comments regarding its preparation. The draft EIS was published during March 1986, and its availability was published in the Federal Register on April 11 (51 FR 12547). During the 120-day agency and public comment period on the draft EIS, which began on April 11, 1986, 243 letters were received that provided about 2000 substantive comments on the draft EIS. In addition, oral testimony was heard on the draft EIS in public hearings held during July 1986, in Richland, Washington; Portland, Oregon; Seattle, Washington; and Spokane, Washington.

Excluded from consideration in this EIS are low-level radioactive wastes in liquid and solid disposal sites at Hanford (see ERDA 1538). These waste sites are presently being reviewed under hazardous-waste regulations. Also excluded are wastes generated by decontamination and decommissioning of surplus or retired facilities after the year 1983 (other than for those facilities directly associated with waste disposal). Those operations will be the subject of other National Environmental Policy Act (NEPA) reviews.

The Defense Waste Management Plan (DOE/DP 0015) states of the Hanford wastes: "Immobilization of new and readily retrievable high-level waste will begin about 1990 after sufficient experience is available from Savannah River's vitrification process. Other waste will be stabilized in place in the 1985-2015 time frame if, after the requisite environmental documentation, it is determined that the short-term risks and costs of retrieval and transportation outweigh the environmental benefits of disposal in a geologic mined repository."

It is necessary to understand the major differences between civilian and defense wastes and the programs to effect their disposal. Both types of waste include fission products and transuranic waste elements. On the other hand, the quantities of these elements, the physical and chemical forms of the wastes, and the technically sound alternatives for their disposal are markedly different. In all cases, for both civilian and defense, the final methods selected will have to meet the Environmental Protection Agency (EPA) standards (40 CFR 191) for the disposal of spent fuel and high-level and TRU wastes. The Nuclear Waste Policy Act of 1982 mandates a procedure to select the potential repository sites for detailed characterization.

A comparison of the Hanford waste inventory resulting from chemical processing of about 100,000 metric tons of nuclear reactor fuel with that of a commercial repository containing 70,000 metric tons of spent fuel elements is enlightening. In this comparison, the waste inventory from 100,000 metric tons of Hanford reactor fuel contains about 4% as much of the readily transportable (geohydrologically) isotopes ^{14}C, ^{99}Tc, and ^{129}I as is contained in 70,000 metric tons of commercial spent fuel. It contains only 1% as much ^{90}Sr and ^{137}Cs and about 0.1% as much of the primary transuranics ^{239}Pu, ^{240}Pu, and ^{241}Am. The volume of the Hanford wastes is markedly larger than the civilian wastes cited above--410,000 m^3 of Hanford wastes as compared to 29,000 m^3 of commercial spent fuel.

The physical and chemical characteristics of existing and potential waste forms considered in this EIS are highly diverse: liquid waste in double-shell tanks, vitrified/canistered wastes (from processed double-shell tank wastes); sludge and salts in the single-shell tanks; strontium and cesium capsules that are further protected with a handling container; previously disposed of pre-1970 wastes in various forms and containers; and finally, low-level waste products, from the processing of double-shell-tank waste, in the form of grout.

In accordance with the requirements of NEPA, as amended, and implementing regulations of the Council on Environmental Quality (CEQ) published in the Code of Federal Regulations as 40 CFR 1500, this EIS was written early in the decision-making process to ensure that environmental values and alternatives are fully considered before any decisions are made that might lead to adverse environmental impacts or limit the choice of reasonable alternatives. This process will also help ensure that the public is fully informed and is involved in the decision-making process.

To comply with the NEPA's requirement for early preparation of environmental documentation, this EIS has been prepared early in the disposal decision process. As with any major action, it is expected that once a disposal decision is made, subsequent detailed engineering may enhance specific waste retrieval, treatment, handling, immobilization and/or disposal processes evaluated in the EIS. However, the processes evaluated in this document have been chosen such that, when finally implemented for any of the options, the processes would not be expected to result in environmental impacts that significantly exceed those described here. The DOE believes that bounding analyses performed in this EIS meet the requirements of CEQ regulations for analysis of all reasonably forseeable significant adverse impacts.

Implementation of defense waste disposal under the alternatives described in this EIS will be done in compliance with the letter and spirit of applicable federal and state environmental statutes, regulations and standards. To ensure that impacts of specific processes used during disposal implementation do not differ significantly from the results of the analyses set forth in this document, DOE will conduct environmental reviews of the specific processes as finally proposed. On the basis of these reviews, DOE will determine in accord with agency guidelines what additional NEPA documentation is required. The DOE anticipates that a supplemental EIS will be prepared prior to a decision on a disposal option for single-shell tank waste.

This document is not intended to provide the environmental input necessary for siting or constructing a geologic repository. For analysis of environmental impacts of alternatives involving geologic disposal, generic designs for either an offsite or onsite repository were used. Detailed environmental documentation required by the Nuclear Waste Policy Act of 1982 will be prepared before a geologic repository is sited, constructed and operated. A future EIS to address site selection is expected to include a discussion of cumulative impacts of the repository program at all candidate sites, including Hanford.

Other NEPA documentation relevant to this EIS includes the supplement to ERDA-1538, Double-Shell Tanks for Defense High-Level Radioactive Waste Storage at the Hanford Site (DOE/EIS-0063), and the Final Environmental Impact Statement--Operation of PUREX and Uranium Oxide Plant Facilities (DOE/EIS-0089). (The draft PUREX EIS with an addendum constituted the final PUREX EIS.)

Environmental considerations regarding disposal of Hanford's retrievably stored TRU waste at the Waste Isolation Pilot Plant (WIPP) (except for retrieval, processing, packaging, certification and transportation of waste from Hanford to WIPP, which are discussed in this EIS) are based on the Final Environmental Impact Statement--Waste Isolation Pilot Plant (DOE/EIS-0026). Environmental considerations associated with waste disposal in geologic repositories are based on information from the Final Environmental Impact Statement--Management of Commercially Generated Radioactive Waste (DOE/EIS-0046F). Alternatives to disposal of high-level waste in geologic repositories were described in that document.

Environmental considerations associated with borosilicate glass as a waste form for repository disposal of waste and with the construction and operation of a plant to provide vitrified waste are based in part on information developed in three previous DOE documents: Final Environmental Impact Statement--Defense Waste Processing Facility Savannah River Plant, Aiken, South Carolina (DOE/EIS-0082); Environmental Assessment--Waste Form Selection for SRP High-Level Waste (DOE/EA-0179); and Analyses of the Terminal Waste Form Selection for the West Valley Demonstration Project (WVDP-100 DOE).

The EIS has been structured to conform as closely as possible to the format described in CEQ Regulation 40 CFR Parts 1502.1 through 1502.18. To provide more information for the reader than can be reported within the text of Volume 1, more detailed information is included in 22 appendices (Volumes 2 and 3). Figure 1 in the Introduction to the Appendices (Volume 2, p. xxiv) shows the purpose of each appendix and how appendices relate to each other and to the text of Volume 1. Lines in the margins of Volumes 1, 2 and 3 indicate the areas where revisions were made. Volume 4 contains agency and public comments received and responses to them as well as the indication of location where revisions were made to the draft EIS. Volume 5 contains a reproduction of all of the comment letters received.

The final EIS is being transmitted to commenting agencies, made available to members of the public, and filed with the EPA. The EPA will publish a notice in the Federal Register indicating that the DOE has filed the final EIS. A DOE decision on proposed actions will not be made earlier than 30 days after the EPA has published the Federal Register notice for the final EIS. The DOE will record its decision in a publicly available Record of Decision (ROD) document published in the Federal Register.

CONTENTS

Volume 1 contains:

Volume 2 contains:

Volume 3 contains:

APPENDIX U--PRELIMINARY ANALYSIS OF THE FUTURE GROUNDWATER TRANSPORT OF CHEMICALS RELEASED

APPENDIX V--SITE-MONITORING EXPERIENCE

Volume 5 contains:

PUBLIC COMMENTS

1.0 INTRODUCTION

This comment volume has been prepared in compliance with Council of Environmental Quality (CEQ) regulations that provide for the consideration of comments received during the agency and public comment period (40 CFR 1503.4 & 1506.6). This volume contains responses by the Department of Energy (DOE) to approximately 2000 written comments included in 243 letters that were received by the DOE during the public comment period and to comments received during four public hearings conducted in July 1986.

Notice of availability of the draft Environmental Impact Statement for Disposal of Hanford Defense High-Level, Transuranic and Tank Waste, hereafter referred to as the draft EIS, appeared in the Federal Register on April 11, 1986. The Federal Register notice invited comment on the draft EIS within the 120-day comment period, which began April 11, 1986, and ended August 9, 1986. Four public hearing were held, as follows:

Richland, Washington:	July 8, 1986
Portland, Oregon:	July 10, 1986
Seattle, Washington:	July 15, 1986
Spokane, Washington:	July 17, 1986.

Open houses, designed to provide general information on Hanford defense waste management and to encourage public review of the draft EIS, were also held in seven cities in the Northwest before publication of the draft EIS. These open-house style meetings were held in Kennewick, Yakima, Spokane, Olympia, and Seattle, Washington; and in The Dalles and Portland, Oregon. The open houses were followed by information workshops held between May 20 and June 11 in Richland, Yakima, Spokane, Olympia, and Seattle, Washington; and in Portland and Pendleton, Oregon. At both the open houses and the workshops, technical staff were present to address questions and concerns voiced by the attending public. The DOE estimates that some 20,000 members of the public were reached through this information-sharing effort.

Over 1,600 copies of the draft EIS were distributed to individuals and groups including reviewers of the April 1, 1983, Notice of Intent; state and federal agencies; legislators; public libraries and the media. In addition, over 6,000 summaries of the draft EIS were distributed throughout the Northwest.

1.1 PROCESSING OF WRITTEN COMMENTS

At the beginning of the public comment period, a process was established to receive, document, and prepare responses to written public comments. Each letter, upon receipt, was assigned an identification number. Letters were reviewed and specific comments within each letter were identified. Each comment was assigned a number and categorized by topic. Over 100 topics that addressed DOE policy, technical and editorial issues were identified and compiled into 10 major groups:

1. Commercial repository
2. Defense waste program
3. EIS scope and preparation

4. Applicable laws and regulations
5. Data base and facilities
6. Affected environment
7. Disposal alternatives and technologies
8. Short-term impacts
9. Long-term impacts
10. Organization and presentation.

Some of the letters focused on one topic and contained only one or two comments. Other letters, however, addressed a broad range of issues. With the exception of some editorial comments (which were simply incorporated into the text of the final EIS), every comment received has been addressed in this volume. Frequently, a particular issue was raised in a number of different letters. In these instances a single paraphrased comment has been developed to represent the common concern of these letters and a single response has been provided.

Figure 1 shows how the comments were handled from receipt to inclusion in the final EIS Volumes 1, 2, and 3, or this Volume 4.

All comment letters were photostatically reproduced and are included as Volume 5 of the final EIS. A numerical index has been provided in the front of Volume 5 to identify the individual or organization who submitted each comment letter.

This volume first presents policy comments (Section 2), followed by technical comments (Section 3), in turn followed by comments on organization and presentation of the draft EIS (Section 4). The identification numbers of the letters from which each comment was derived are cited in parentheses after each comment.

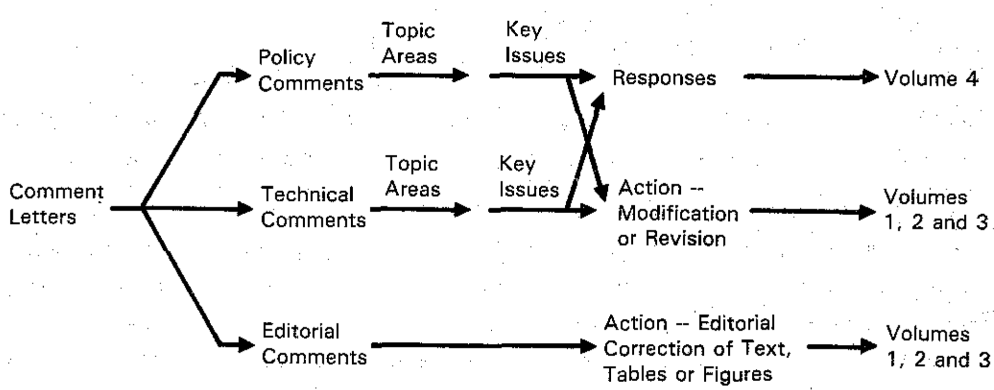

FIGURE 1. Flow Diagram for Treatment of Public Comment Letters

The form of the response to each comment is as follows:

Policy Comments. Responses to policy comments are either a direct response to the comment or a statement identifying why the comment is not considered to be within the scope of this EIS. In some cases, policy comments resulted in changes to the EIS; such changes are noted.

Technical Comments. When responses to technical comments include changes to the EIS, where possible, the response identifies where in the final EIS the change was made. If a technical comment was judged to be incorrect, the response in this volume provides an explanation. When technical comments addressed concerns outside the scope of the document, a statement is made to that effect.

Editorial Comments. Responses to comments on organization and presentation indicate that a change was made, or contain a statement explaining why no change was made. Editorial comments addressing typographical and grammatical errors were handled as part of the preparation of the final EIS and are not discussed specifically in this volume.

1.2 PROCESSING OF PUBLIC HEARING COMMENTS

Public hearings were held in mid-July 1986 to receive public testimony on the draft EIS. Public testimony was recorded in hearing transcripts. These transcripts were reviewed, and comments were identified and coded in the same manner as written comments received during the draft EIS review period. Public hearing comments were sorted by topic area, assigned a number, and included in this volume along with responses.

1.3 FINDING RESPONSES TO COMMENTS

A tracking system has been devised to facilitate determination of how a particular passage in a comment letter was responded to in Volume 4. Each paraphrased comment in Volume 4 is assigned a number; these numbers appear in the margins of the Volume 5 letters to identify the passage or passages corresponding to particular comments in Volume 4. In this way, every comment contained in the letters can be traced to at least one (and sometimes more than one) paraphrased comment in Volume 4.

Two appendices are included in this volume. Appendix A lists each written comment letter by the individuals, organizations and agencies who submitted them. The number assigned to each letter by the DOE is then listed. Also listed are the comment numbers for the paraphrased comments in this volume where issues raised by each letter are addressed.

Appendix B provides a list, by hearing location and in alphabetical order, of individuals, organizations and agencies who provided public testimony. Associated with each listing is the number assigned to each presenter. Also noted are the comment numbers in this volume under which the specific comments raised during the testimony are addressed.

1.4 REFERENCES

U.S. Code of Federal Regulations (CFR). 1985. Government Printing Office, Washington, D.C.

40 CFR 1503 (Council on Environmental Quality), Commenting.

40 CFR 1506 (Council on Environmental Quality), Other Requirements of NEPA.

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2.0 POLICY COMMENTS AND RESPONSES

The following comments address approaches or positions regarding the commercial repository, defense waste programs, EIS scope and legal issues.

2.1 COMMERCIAL REPOSITORY

2.1.1 Comment:

A number of individuals and representatives of organizations expressed reservation or opposition to the possibility of Hanford's selection as the site for the nation's first commercial nuclear waste repository. Opposition was based on many contentions, including: the area is unstable geologically, the Site is proximal to the Columbia River, the porous and layered nature of the basalt rock is unsuitable, the salt formations would be superior as host rock for the waste, transportation of wastes from other sites to Hanford would increase the risk of public exposure, saleability of produce may be impacted, and political expediency may have been the major factor in choosing this site. The EPA recognized that siting a commercial repository at Hanford is a separate decision making process and did not consider the acceptability of Hanford as a repository site in their review (Letter Numbers: 9, 16, 17, 19, 21, 25, 26, 27, 30, 31, 32, 33, 34, 35, 38, 41, 44, 45, 48, 51, 53, 56, 59, 62, 63, 66, 69, 72, 75, 78, 86, 88, 90, 92, 95, 96, 97, 100, 102, 104, 107, 108, 109, 112, 114, 115, 117, 121, 122, 123, 124, 125, 130, 131, 133, 135, 137, 139, 140, 142, 144, 145, 146, 155, 158, 159, 162, 164, 165, 168, 173, 176, 179, 181, 186, 188, 189, 200, 202, 205, 207, 210, 211, 213, 214, 217, 218, 219, 220, 222, 223, 224, 225, 226, 235, 237, 243-EPA. Hearing Numbers: 322, 331, 332, 334, 339, 341, 402, 410, 413, 418, 419, 427, 428, 438, 439, 442, 443, 448, 451, 455, 456, 458, 461, 469, 473, 476, 508, 533, 542, 552, 561, 562, 564, 566, 604, 616, 619, 620, 627, 629, 638, 639, 640, 641, 645, 648, 650, 653, 654, 655, 659).

Response:

The siting of the first commercial nuclear waste repository is beyond the scope of this EIS. Repository siting has undergone, and will continue to undergo, a separate public and agency review process (DOE 1986b). The concerns expressed in letters and in oral testimony about the potential commercial repository at Hanford have been passed on to the Office of Civilian Radioactive Waste Management in the Department of Energy.

2.1.2 Comment:

One reviewer stated that, "though not the purpose of this EIS, the subject of deep geologic disposal is raised as an alternative throughout the document. The fact that it is not the purpose of the EIS to discuss this alternative (as mentioned throughout) coupled with the fact that it is a viable disposal alternative illustrates that the two projects are interrelated, resulting in an incomplete EIS. Points not specifically covered in this document at least need to be referred to the repository EIS so it will be clear that all concerns will eventually be addressed" (Letter Number: 223).

Response:

As stated in the Foreword to the draft EIS, "This document is not intended to provide environmental input necessary for siting or constructing a geologic repository. It is, however, the purpose of the HDW-EIS to evaluate impacts associated with disposal of defense wastes in a geologic repository. For analysis of environmental impacts involving geologic disposal, generic designs for either an offsite or onsite repository are used. Detailed environmental documentation required by the Nuclear Waste Policy Act of 1982 will be prepared before a geologic repository is sited, constructed and operated."

2.1.3 Comment:

Several reviewers discussed the possible mingling of commercial and defense wastes in a repository. Some reviewers were concerned that failure to discuss the mandate of Chapter 8 of the Nuclear Waste Policy Act (NWPA) regarding the need for a Presidential decision on mingling of defense and commercial wastes was a critical omission of the EIS. Moreover, there was a concern that DOE plans for processing commercial nuclear wastes for plutonium had not been declared (Letter Numbers: 10, 56, 67, 69, 70, 84, 121, 140, 144, 147, 164, 171, 186, 211, 215, 216, 217, 223, 231, 234).

Response:

The President's decision to mingle defense waste with commercial waste is cited on page 2.1 of the draft EIS. Discussion of impacts associated with mingling of defense wastes in a commercial repository will be included in an EIS associated with the final selection of a repository site. Processing commercial wastes for plutonium extraction is not being considered and is therefore not discussed in this EIS.

2.1.4 Comment:

One reviewer commented on the statement in Chapter 6 that to the extent that any decision based on a final commercial repository Environmental Impact Statement requires defense high-level waste (HLW) to be placed in a repository constructed under the Nuclear Waste Policy Act, or placed in other facilities, which are authorized for subsequent long-term storage of such waste, and that such a repository or other facilities would comply with subsequent applicable licensing requirements of the Nuclear Regulatory Commission. However, the reviewer noted that Section 202 of the Energy Reorganization Act applies solely to a defense-only geologic repository, which President Reagan has removed from consideration. The DOE should explain what the cryptic term "other facilities" means in the above statement. If DOE is considering the development of facilities other than a repository, for the "long-term storage" of HLW, the Department should so state and provide details (Letter Number: 240).

Response:

The "other facilities" mentioned in Section 202 of the Energy Reorganization Act which would be applicable to defense wastes are: (a) facilities used primarily for the receipt and storage of high-level radioactive wastes resulting from activities licensed under the Atomic Energy Act of 1954 as amended, and (b) retrievable surface storage facilities and other facilities authorized for the express purpose of subsequent long-term storage of high-level radioactive waste generated by the Administration, which are not part of or used for development and evaluation activities.

2.1.5 Comment:

It was contended that not one or two repository sites, but ten, twenty, or thirty are needed, preferably close to the sites of nuclear waste production so that wastes do not have to be transported (Hearing Numbers: 323, 523, 619, 646).

Response:

The siting or number of geologic repositories is being conducted in accordance with the Nuclear Waste Policy Act and is beyond the scope of this EIS.

2.1.6 Comment:

Concern was raised that the commercial repository site characterization, especially the exploratory shaft, might result in increased airborne contamination from defense waste and might impact defense waste sites. It was also felt that the present waste may affect the repository site characterization work, pre- and post-closure activities, and performance. Defense wastes themselves may affect repository performance regardless of where the repository may be located (Letter Numbers: (193, 215, 219, 217, 223).

Response:

The proposed Basalt Waste Isolation Project (BWIP) repository site characterization efforts will be focused outside of the 200 Areas fences. Periodic monitoring of the exploratory shaft work is planned to confirm that no defense waste contamination is present. If contamination is detected, it will be contained and appropriate remedial actions will be taken. Some of the smaller exploratory drill holes that will be located inside the 200 Area fences will be carefully located to avoid defense waste sites. It is recognized that the presence of some soil and groundwater contamination from early defense operations would make repository monitoring at Hanford more difficult. Monitoring plans to be utilized by the repository program will be sensitive to contamination from the defense waste and from the commercial spent fuel or processed waste.

The performance of the repository will be a function of the multilayer barrier design and not the type of wastes disposed within it. Both the commercial spent fuel and processed wastes and the defense wastes will be isolated within several man-made containers and a natural rock barrier; defense waste operations will not impact repository performance. If, however, a repository were proposed to be located at Hanford, the cumulative impacts of defense waste disposal and repository impacts would be considered. This would be documented in an EIS addressing final selection of a repository site.

2.1.7 Comment:

Reviewers questioned how the defense waste disposal alternatives might interfere with monitoring of a commercial repository, especially in the earlier post-closure years, or of the nearby commercial low-level waste disposal facility (Letter Numbers: 12, 56, 69, 217, 223).

Response:

Monitoring specific to the repository program is beyond the scope of this EIS. Should the DOE choose to propose construction of a commercial waste repository at Hanford, the DOE's licensing analysis would include details concerning a repository-specific monitoring program and the possible relationship between the program and other Hanford site activities. Additional details on how to distinguish between defense and commercial high-level and low-level waste releases would be provided at that time. (See also comment 2.1.10.)

2.1.8 Comment:

Reviewers felt that DOE should not have tabled the search for a second repository (Letter Numbers: 61, 71, 107, 111, 172, 174, 184, 197, 208, 217, 223, 224, 225, 226).

Response:

DOE's Office of Civilian Radioactive Waste Management has only delayed its search for a second repository. Questions concerning the revised schedule should be addressed to the DOE's Office of Civilian Radioactive Waste Management in Washington, D.C. Hanford high-level waste disposal decisions will not depend on the existence of a second commercial repository; therefore, second repository siting decisions will not influence Hanford high-level waste disposal.

2.1.9 Comment:

Several reviewers felt that using the Hanford Site for disposal of commercial nuclear wastes would risk the contamination of groundwater, including upward seepage of waste through fractured basalt (Letter Numbers: 24, 27, 90, 155, 219).

Response:

Determination of the suitability of the Hanford Site as a repository site is the purpose of the Basalt Waste Isolation Project (BWIP), not this EIS.

2.1.10 Comment:

A reviewer stated: "The DOE's proposals for permanent disposal of defense wastes at Hanford pose special problems with respect to the NRC's current and future reviews and licensing decisions involving the Basalt Waste Isolation Program (BWIP) site as a candidate for the high-level waste geologic repository. For example, the DOE is required to develop a Performance Confirmation Program for BWIP to provide data that indicate, where practicable, whether subsurface conditions encountered and changes resulting from construction and waste emplacement are within limits assumed in the licensing review and that natural and engineered systems and components are functioning as intended."

"Some of the actions proposed in this DEIS could potentially make a BWIP Performance Confirmation Program more difficult to design and carry out. For example, the barriers proposed for in-place stabilization of wastes may reduce infiltration to the unconfined aquifer system, potentially altering groundwater flow conditions. The final EIS should include, in the discussion of impacts, possible effects of the proposed alternatives on licensability of a high-level waste repository at the BWIP site." Reviewers expressed the concern that the decisions made about the commercial waste repository may constrain options considered in the draft EIS (Letter Numbers: 10, 70, 217, 220, 223, 239-NRC).

Response:

The issue of commercial repository licensing is beyond the scope of this EIS. However, there is the possibility that DOE's proposals for permanent disposal of defense wastes at Hanford could make BWIP's Performance Confirmation Program more difficult. One example is the ability of BWIP's groundwater program to differentiate between possible contaminant excursions from the BWIP facility and the defense-waste facilities. As asserted in the response to comment 2.1.7, the DOE's licensing analysis would include details on cross-contamination potential.

Concerning the potential of the defense-waste alternatives to alter groundwater flow conditions, it is felt that negligible effects would be experienced.

2.1.11 Comment:

Two classes of waste are considered for disposal at the Hanford site: the defense wastes and the civilian wastes. These two classes of waste share the same "affected environment." The criteria stipulated in 40 CFR 191 must therefore be applied to the "total" radionuclide release from both the defense and civilian wastes (Letter Number: 215).

Response:

If the Hanford site is chosen for the first geologic repository, specific details on compliance to 40 CFR 191 will be addressed in future documents. The treatment of cumulative release from defense and civilian wastes will be worked out with key regulatory agencies.

2.2 DEFENSE WASTE PROGRAM

2.2.1 Comment:

Many reviewers supported DOE's intent to address disposal of Hanford defense waste. Most said that something should be done now, based on safety, health, environmental and sound scientific considerations, not on political or cost considerations. Several reviewers included in their comments the concern that current waste practices on the Hanford Site should be discontinued (Letter Numbers: 4, 5-DOI, 8, 12, 22, 35, 41, 43, 44, 46, 51, 52, 55, 60, 61, 64, 70, 78, 83, 92, 107, 108, 110, 111, 116, 119, 128, 136, 144, 147, 159, 162, 163, 164, 166, 169, 170, 174, 192, 200, 202, 205, 207, 211, 216, 217, 223, 224, 232, 243-EPA. Hearing Numbers: 601, 651).

Response:

The purpose of the proposed action in this EIS is to take a major step away from continued storage of Hanford defense high-level, transuranic and tank wastes and move toward permanent waste disposal. DOE's policy is to dispose of waste in a safe, environmentally acceptable and cost-effective manner, consistent with applicable regulations and standards. This policy and recognition of the need for additional development and evaluation in certain areas were major considerations in the development of the preferred alternative (Volume 1, Chapters 3 and 5, of the final EIS).

2.2.2 Comment:

Reviewers commented that Congress should establish and enforce a demanding schedule of compliance (Letter Numbers: 53, 171, 217, 219).

Response:

This comment should be addressed to the reviewers' congressional representatives; the DOE receives its authority and direction from Congress.

2.2.3 Comment:

Several reviewers took the position that long-term public health and safety should be the driving force behind the choice of alternatives; some contended that cost should not be a factor in achieving complete public health and safety (Letter Numbers: 12, 61, 67, 70, 78, 83, 116, 141, 152, 174, 180, 208, 217, 223).

Response:

Public health and safety is the driving force behind the defense waste program. All alternatives for defense waste disposal involve some risk. The objective of the EIS is to analyze and compare the impacts associated with the alternatives so that responsible decisions can be made. The costs associated with defense waste disposal are going to be significant regardless of the alternative selected for implementation; therefore, costs must be considered. However, the DOE policy is to proceed with disposal in a manner that protects the public and worker health and safety, complies with applicable regulations, and is cost effective in the best interest of public welfare.

2.2.4 Comment:

Some reviewers advocated consideration of cost effectiveness and limited taxpayer resources. One reviewer favored the in-place stabilization alternative, pointing out that there are many ways in which taxpayer funds could be spent to far greater advantage in protecting health and safety. Another reviewer suggested that funding for the geologic repository site study would be better spent on research to improve nuclear waste storage technology. Other reviewers commented on the reason behind leaking tanks; noting that deficiencies had been corrected, they contended that the concerns of downwind exposures were highly exaggerated and expressed confidence in safety of operations at Hanford (Letter Numbers: 13, 58, 64, 126, 202. Hearing Numbers: 413, 417, 428, 433, 438, 446, 634).

Response:

Costs versus potential benefits must be considered in making defense waste disposal decisions. The preferred alternative presented in the final EIS (Section 5.6) provides for the possibility of in-place stabilization of some defense wastes, but does not preclude choices among other alternatives based on the results of additional development and evaluation.

The comment that suggests that funding would be better spent on waste storage technology rather than on geologic repository site studies presumably refers to the Commercial Radioactive Waste Management Program which is outside the scope of this EIS.

Comments supportive of the Hanford mission and confidence in its safe operation are also acknowledged.

2.2.5 Comment:

A reviewer felt that if the disposal plan must secure the waste for 10,000 years, the question of how it is to be maintained for that period has not been addressed (Letter Number: 243-EPA).

Response:

The aim of disposal is to provide for a system that does not require active maintenance. Moreover, EPA standards do not permit reliance on active institutional controls for more than 100 years and are therefore designed to promote isolation integrity of a waste site for up to 10,000 years without the need for maintenance. That is, the disposal system must be designed to operate safely on its own.

2.2.6 Comment:

A reviewer felt that, if DOE were truly looking for a safe solution, there would not be "time constraints" for waste disposal action. The waste could be kept on site in such a way that it could be monitored until a method is found to ensure future safety (Letter Number: 80).

Response:

The DOE believes that technology exists with which to dispose of waste and to ensure future safety. This is more certain for some wastes and disposal methods than it is for others, particularly in the area of cost/benefit. As a consequence DOE's preferred alternative would propose to proceed with disposal of some waste classes and defer disposal decisions for others until completion of further development and evaluation.

2.2.7 Comment:

Concerns were expressed about an apparent "double standard" of disposal between defense and commercial wastes. Many reviewers referred specifically to DOE's disposal of defense wastes within 10 m of the surface while at the same location characterization was taking place for disposal of comparably hazardous commercial radioactive wastes at depths of 1000 m (Letter Numbers: 4, 43, 45, 46, 57, 120, 121, 143, 144, 189, 208, 215, 219, 223, 233, 240. Hearing Numbers: 534, 542).

Response:

While a cursory examination of disposal strategies may suggest a double standard, the DOE judges there is no double standard. There are two distinct and separate issues and decision processes associated with commercial radioactive waste disposal and defense waste disposal at Hanford. Significant differences in the levels of radioactivity, waste form, and volume of material distinguish the commercial wastes from the Hanford defense wastes. Although defense wastes are hazardous, the assumption that they are "comparably hazardous" to commercial wastes is incorrect. As noted on page 1.7 of the draft EIS, "In the year 2000, the cumulative volume of high-level waste stored at Hanford is expected to be about 10 times greater than the cumulative volume of spent fuel removed from commercial power reactors. However, the radioactivity in Hanford's high-level waste is projected to be about 80 times lower than the commercial waste produced through the year 2000." In addition, the defense wastes are already at Hanford in various forms, while commercial wastes, primarily in the form of spent fuel, are temporarily located at approximately 70 sites within the U.S. and will eventually be relocated.

The Council on Environmental Quality (CEQ) regulations for implementing the National Environmental Policy Act (NEPA) are among the required steps for decision making regarding defense waste. The CEQ regulations, 40 CFR 1500, call for an examination of reasonable alternatives. In-place stabilization and disposal is one of the alternatives being considered; its merits are compared against the possible reduced long-term risk offered by geologic disposal, as balanced against the short-term risk to workers in retrieving, processing and transporting the waste and the costs associated with the additional steps incurred in geologic disposal. In the final analysis, any disposal of high-level or transuranic waste near surface at Hanford would have to meet the same stringent performance standards (40 CFR 191) that a commercial radioactive waste repository would have to meet, regardless of location.

2.2.8 Comment:

Referring to page 2.1 of the draft EIS, a reviewer questioned whether the Waste Management Plan had somehow negated the NEPA process represented by the EIS; i.e., because the decisions outlined in the EIS have already been made (Letter Number: 233).

Response:

As stated in Chapter 2, Volume 1 of this EIS, the Defense Waste Management Plan was prepared to comply with Public Law 97-90, the Energy Security and Military Applications of Nuclear Energy Authorization Act of 1982. Neither the Defense Waste Management Plan (DOE 1983a) nor the more detailed Interim Hanford Waste Management Plan (DOE 1986d) negates the NEPA process. These plans were prepared to form a basis for preliminary waste disposal planning and budgeting. The Interim Hanford Waste Management Plan, which provides detailed plans for Hanford, is updated approximately once a year. The Record of Decision (ROD) on this EIS, once it is issued, will be reflected in this plan. The DOE intends to reissue the Interim Hanford Waste Management Plan on the basis of the preferred alternative presented in the final EIS, and again to reflect the Record of Decision.

2.2.9 Comment:

Several reviewers were concerned that there was no DOE plan for obtaining the needed funds to proceed with any of the plans for disposal, and that Congress should establish a "trust" fund to ensure that money would be available to accomplish disposal. Reviewers felt that funding for waste disposal should be a Congressional priority. Moreover, a "pay as you go" policy was called for that amounts to a tax on production to pay for disposal. A reviewer suggested that funding should come from the federal defense budget. Some reviewers wanted the final EIS to specify a funding "mechanism or structure" (Letter Numbers: 4, 46, 53, 60, 71, 72, 78, 103, 112, 128, 129, 135, 141, 147, 156, 171, 172, 174, 183, 186, 192, 197, 214, 216, 217, 219, 223. Hearing Number: 414).

Response:

Congress provides funding for DOE activities. The proposal to establish a "trust fund" for disposal of Hanford defense waste requires a legislative action that is beyond DOE authority, and the issue is outside the scope of this EIS. However, these concerns have been forwarded to appropriate DOE staff.

2.2.10 Comment:

Objection was expressed to the practice of "dumping radioactive and chemical waste" directly into the ground. One reviewer recommended that a plan for ceasing this practice and developing alternative disposal methods be instituted (Letter Numbers: 25, 41, 43, 46, 55, 69, 71, 103, 107, 129, 154, 164, 169, 171, 174, 193, 197, 201, 217, 219, 242. Hearing Number: 550).

Response:

The disposal of low-level liquid waste is outside the scope of this EIS. Past and present practice permits discharge of low-level liquid wastes to soil columns, provided that the radionuclide in concentrations do not exceed those listed in DOE Order 5480.1B (DOE 1986c) for uncontrolled areas (Table II). However, DOE agrees with the reviewers' position and, consistent with DOE policy, is moving to cease this practice. It is DOE's intent, as stated in DOE Order 5820.2, "Radioactive Waste Management" (DOE 1984), that "Disposal operations involving discharge of liquid low-level waste directly to the environment or on natural soil columns shall be replaced by other techniques, such as solidification prior to disposal or in-place immobilization...." A plan addressing this issue was submitted to Congress in April 1987. The plan outlined alternatives, including discontinuation of soil column disposal, and provided recommendations for plant improvements that reduce liquid discharges to soil columns. Actions have already been taken to ensure that routine releases are compliant with RCRA requirements.

2.2.11 Comment:

A number of reviewers urged that thorough or total cleanup of the Hanford Site should be considered. Some reviewers requested cleanup regardless of the cost. Others commented that converting the site back to a "pristine" condition was technically and economically unreasonable (Letter Numbers: 4, 8, 14, 21, 55, 58, 68, 78, 129, 164, 166, 200, 201, 203, 215, 219, 223. Hearing Numbers: 412, 421, 544, 506, 618, 619, 633).

Response:

A total Hanford Site cleanup, including low-level waste and decommissioned facilities, is beyond the scope of this EIS, which focuses on the evaluation of alternative methods for disposal of Hanford defense high-level, transuranic, and tank wastes. This EIS addresses reasonable alternatives for disposal of these wastes in a manner that will provide effective long-term protection of public health and welfare. However, for these wastes a "retrieve all" alternative was briefly described in Section 3.3.7. Other wastes, including retired mixed waste disposal sites and decommissioning wastes, will be addressed under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the surplus facilities programs.

2.2.12 Comment:

Reviewers questioned the grounds on which the DOE based its contention that waste management practices at Hanford were shown to safely and effectively isolate the waste on an interim basis, considering, as one reviewer put it, the presence of "uranium in the groundwater; plumes of contaminated groundwater from soil dumping heading towards the Columbia River; 500,000 gallons of high-level nuclear wastes leaked from single-shell tanks; soil heavily contaminated around the tanks; plutonium from Hanford in the air and soil of downwind communities" (Letter Numbers: 57, 66, 78, 115, 151, 155, 157, 164, 193, 214, 217, 242).

Response:

The DOE believes that waste management practices at Hanford have been effective, that they have improved, and that they will continue to improve.

The final EIS on Waste Management Operations for the Hanford Reservation, (ERDA 1975) concluded that the population dose from waste management operations was a very small fraction (0.0001) of the dose from natural background and that the waste management practices were effective. In addition, the National Research Council of the National Academy of Sciences, in its report Radioactive Wastes at the Hanford Reservation (NAS 1978), concluded that "there has not been in the past, and is not at present, any significant radiation hazard to public health and safety from waste management operations at Hanford."

The Hanford Site was selected in part because it afforded a large buffer zone between the operations and the accessible environment in the event of transport of nuclides via water pathways. Groundwater was not seen as a part of the accessible environment, although it was recognized as a transport mechanism to convey nuclides to the Columbia River, which is a sink for that groundwater.

The total amount that leaked from single-shell tanks was less than one percent of the total tank waste managed. The releases of waste from leaking tanks were reduced by pumping as much liquid as possible from leaking or suspected leaking tanks and by changing tank design to double-shell. Leaks have been carefully monitored, and the resulting data indicates that the contamination below the tanks has not moved to any great extent.

Currently, liquid releases are limited to maximum permissible concentration values at the point of release. Moreover, the operational goal is to limit radioactive material in liquid effluent streams to concentrations that lead to doses not exceeding those permitted by EPA drinking water standards. Cumulative atmospheric releases from operations at the Hanford site are a small fraction of the EPA limit of 25 mrem (whole body) and are controlled at the point of discharge (at the stack) of any specific facility.

2.2.13 Comment:

Reviewers requested that an ongoing independent audit of DOE waste management work be done (Letter Numbers: 22, 43, 44, 67, 88, 103, 110, 121, 129, 147, 151, 154, 171, 174, 178, 186, 189, 216, 217, 219, 233).

Response:

The National Academy of Sciences (NAS) reviewed waste disposal practices in detail and published its report in 1978 (NAS 1978). The NAS has also been requested to review disposal alternatives for single-shell tank wastes, and is now in the process of that review.

2.2.14 Comment:

One reviewer stated that the announcement that Hanford was one of the finalists in the selection of the first repository almost completely obscured DOE's statement on military nuclear waste. Reviewers expressed concern that Hanford was the least suitable of the sites under consideration, and that its selection as a finalist despite this has damaged the integrity of the process. Reviewers were concerned that Hanford's selection for the commercial repository would provide a strong bias toward defense waste disposal at Hanford as well (Letter Numbers: 41, 109, 110, 111, 112, 129, 141, 144, 151, 164, 171, 202, 215, 217, 220, 224, 225, 226).

Response:

The DOE's activities in support of the commercial repository are guided by the Office of Civilian Radioactive Waste Management, which is independent of the DOE's defense activities. While the timing of the repository announcement may have been unfortunate, both activities are subject to the NWPA and other requirements to protect public health and safety.

2.2.15 Comment:

A reviewer cited Resolution 86-2 passed by the State of Washington Nuclear Waste Board in April 1986 to establish criteria for reviewing the draft EIS. According to the reviewer the resolution recommended that each alternative should minimize environmental and health effects; be consistent with appropriate state and federal regulations including NEPA, the

Atomic Energy Act, the NWPA, the RCRA, the CERCLA, the Clean Water and Clean Air Acts, 10 CFR 960 and 40 CFR 191; use proven state-of-the-art technologies; minimize future releases and consider but not be driven by economics (Letter Number: 223).

Response:

Fundamentally, the criteria cited also formed the basis for DOE's approach to waste disposal. In addition DOE feels compelled to arrive at a balance between the degree of environmental protection provided and the cost to the taxpayer. Thus, the goal is a level of protection that would result in risks that are small in comparison to other everyday risks and yet is achievable in a reasonable time with realistic funding levels. It would be expected that DOE's compliance with all applicable federal and state regulations for protection of the environment would enable that goal to be reached. State-of-the-art technologies will be used when proven safer, superior and cost effective relative to other established technologies.

2.2.16 Comment:

Reviewers remarked that DOE's decision to regulate radioactive and toxic emissions at the boundary rather than close to the facilities is nonconservative and underscores DOE's intention to use the Hanford Site like a "giant sponge" (Letter Numbers: 55, 242).

Response:

The DOE has no intention of "using the Hanford Site like a giant sponge." Emissions from Hanford operations result in doses to the public that are well within the limits prescribed by standards established by the EPA, either for airborne pathways or in drinking water of downstream users of the Columbia River.

2.2.17 Comment:

The NRC noted that licensing of Hanford waste tanks for HLW would be procedurally complex because of the need to develop appropriate standards and procedures, the existing fait accompli status of the waste tanks, and the difficulty in reasonably evaluating alternatives (e.g., alternative sites) as required by the NEPA. Other statutes would also need to be considered, including one provision (42 U.S.C. para. 7272) which could be read to bar the expenditure of funds for purposes related to licensing of defense waste management activities such as those that might be undertaken at Hanford (Letter Number: 239-NRC).

Response:

The NRC concerns with respect to licensing are acknowledged.

2.2.18 Comment:

The NRC noted that while they did not prejudge disposal of HLW in situ, in the Hanford tanks, they believed establishing the feasibility of such disposal as technically adequate to protect the public health and environment will be exceedingly difficult and may not be achievable. Consequently, nothing in their comments were to be taken as NRC agreement or endorsement of such disposal and that comments made thus far should not be construed as restricting NRC from making additional comments in the future, when or as appropriate (Letter Number: 239-NRC).

Response:

The NRC concerns and reservations are acknowledged.

2.3 EIS SCOPE AND PREPARATION

Comments concerning the scope of the EIS and the way in which it was prepared are addressed in this section.

2.3.1 EIS Scope

2.3.1.1 Comment:

Some reviewers felt that the absence of scoping hearings seemed to preclude considering the question of whether to continue to produce plutonium (and, thus, waste) at Hanford and caused public concern that all defense wastes are not included in the EIS (Letter Numbers: 71, 175, 186, 193, 216, 217).

Response:

The Notice of Intent (NOI) to prepare the draft EIS, 48 FR 14029, April 1, 1983, invited comments on the scope of the draft EIS. Eighteen comment letters were received in response to the NOI. Of these letters, ten requested copies of the draft EIS; eight contained comments regarding preparation of the EIS. Based on the response to the NOI, it was not judged necessary to have a public scoping meeting.

The central theme of the EIS is the evaluation of waste management alternatives for the high-level, transuranic and tank wastes that already exist at Hanford. The issue of whether to produce special nuclear materials, such as plutonium at the Hanford Site, is beyond the scope of this EIS. The need for special nuclear materials is established by the Nuclear Weapons Stockpile Memorandum, which is issued by the President of the United States with subsequent authorization and appropriation of funding from Congress. For purposes of analyzing the impacts of disposal of high-level, transuranic and tank wastes generated at the Hanford Site, assumptions were made concerning the potential future waste that may be generated from continued production operations.

2.3.1.2 Comment:

Reviewers pointed to several NEPA elements which they felt had not been addressed in the draft EIS: 1) The draft EIS assumes that no other options are available, and that no other use for the site is possible. 2) The draft EIS evaluates only the Hanford Site itself, not the aquifer or total drainage system. 3) There is no discussion of alternate site, site use, in-place or offsite disposal options or options for cleanup of existing spills. 4) The draft EIS does not identify the long-term or major environmental values, nor address any "irreversible and irretrievable commitment of resources" (Letter Numbers: 44, 54, 59, 78, 214, 217).

Response:

1) In Chapter 4 of the EIS, "Affected Environment," the status of the Hanford Site as dedicated to nuclear-related work is described. The present position of the federal government is that Hanford will remain a dedicated site for government use. Evaluation of other uses for the Site is beyond the scope of this EIS; however, in its evaluation of long-term impacts, the EIS addresses the possibility that agricultural or other activities could occur on some areas of the Hanford Site in the future.

2) Potential effects on the unconfined aquifer have been considered because it would be a potential path for transport of contamination and public exposure. Figures 4.8 and 4.9 graphically show the extent and configuration of the unconfined groundwater system. The "drainage system" that could be impacted via transport of contaminants through the unconfined aquifer consists of the Columbia River and is covered in the assessment of impacts in Chapter 5 of the EIS.

3) All reasonable alternatives were examined in detail and reported in the draft EIS. These alternatives were selected from a larger number of alternatives that were considered but rejected (see Section 3.3.7 of the final EIS). Alternative sites were considered only for deep geologic disposal. There is no clear benefit from retrieval of the defense wastes under discussion for disposal in another surface site.

4) The irreversible and irretrievable commitment of resources was considered for each alternative; see Sections 5.2.5, 5.3.5, 5.4.5, 5.5.6 and 5.6.5 of the final EIS.

2.3.1.3 Comment:

The concern was raised that, because the geologic repository was cited so many times in the EIS and because of the President's decision to mingle defense and commercial waste, details of the commercial program including design, schedule acceptance, operation, storage, and transportation should have been addressed. One reviewer stated that the repository issue is more important than the defense waste issue; another expressed the opposite opinion (Letter Numbers: 22, 44, 147, 163, 217, 219, 223).

Response:

This EIS tiers upon (incorporates by reference) the EIS for Management of Commercial Waste Management Statement-Generic Environmental Impact Statement (DOE 1980a), which addressed alternative disposal options for commercial high-level and transuranic wastes. Based on the data presented in that document, it was determined that geologic repositories would be the focus of national development and evaluation. When the actual site has been selected, details of the design, schedule for waste acceptance (including the storage of wastes), operation, transportation and other aspects will be addressed in its EIS.

2.3.1.4 Comment:

Reviewers stressed the importance of alleviating public perception of risk; otherwise, decisions made by democratic process will be misguided. In extreme cases, the reviewers felt, actual ill-health could be induced by apprehension (Letter Numbers: 14, 217, 223).

Response:

The DOE is concerned with health and safety, and continues to seek to improve and convey understanding of the risks to the health and safety of the worker and general public and to dispose of waste in a safe, environmentally acceptable and cost-effective manner, consistent with applicable regulations and standards. To help convey understanding and alleviate public apprehension in order that the best decisions are made by the democratic process, the DOE has been conducting and will continue to conduct public outreach programs to address concern about the risks associated with Hanford defense wastes.

It is noted that the relative importance of perceived risk may depend on the participants. Perceived risk, is hard to quantify; however, it becomes more meaningful when transmitted to behavior in reaction to perceived or actual risks. There is a body of literature on perceived risks from the incidents at Three-Mile Island and Chernobyl, including projected economic effects. Psychological reactions might influence behavior in both economic and health patterns. In the case of Three-Mile Island, the psychological impact on and actual behavior of the populace has been the subject of litigation; see Metropolitan-Edison Company versus People Against Nuclear Energy (1983).

There are at least two points to be considered in addressing perceived risk in this EIS. One is that, although an important issue, perceived risks are not traditionally considered under the National Environment Policy Act (NEPA). Another is that quantifying the impact of perceived risk is a developing methodology which includes some subjectivity. Because of factors including NEPA, the subjectivity in the methodology and varying personal attitudes, the DOE has chosen not to address perceived risk in this EIS.

2.3.1.5 Comment:

One reviewer stated: "DOE impermissibly restricts the scope of the EIS by excluding assessments of technologies essential to the implementation of the final disposal strategy. DOE also fails to explain why it does not expect decontamination and decommissioning of existing waste sites and surplus facilities at Hanford after 1983 to affect the environmental impacts evaluated in the DEIS."

"DOE states that engineering decisions about waste retrieval, treatment, and handling have been postponed until the final disposal decision has been made. DOE promises to determine whether the environmental effects of these processes are within the limits described in this EIS. However, reviewing these processes after disposal decisions have been made will occur too late to be meaningful. Waste retrieval, treatment, and handling are crucial to an informed final disposal decision. By excluding them from this EIS, DOE has improperly segmented the EIS process."

"With respect to decontamination and decommissioning, DOE should explain whether these actions will affect the volume of high-level waste (HLW) at Hanford and implementation of the permanent HLW disposal plan chosen based on the EIS. It is not enough that DOE has committed to perform a separate NEPA review of decontamination and decommissioning at some unspecified point in the future" (Letter Number: 240).

Response:

The DOE has provided assessments of the technologies needed to implement the various alternatives presented. As was stated on p. vii of the draft EIS, to comply with the National Environmental Policy Act (NEPA) requirement for early preparation of environmental documentation, the EIS was prepared before final, optimized designs were available for all processes. Once disposal decisions are made, detailed engineering design will be undertaken as required to enhance the processing and retrieval methods. The processes that were evaluated in the EIS were chosen such that, when finally implemented for any of the options, they would be expected to result in environmental impacts that are not significantly greater than those described in the EIS. To confirm this, analyses of the final process designs will be conducted before implementation. Waiting until all designs were finalized before submitting this document for public review would not have met the intent of the NEPA.

With regard to decontamination and decommissioning of old facilities, such activities will not result in the generation of any high-level waste. An EIS covering decommissioning options for eight retired reactor facilities at Hanford is in preparation. All waste associated with these old reactors is classified as low-level waste. There are no immediate plans for decommissioning any of the processing or laboratory buildings, nor is any high-level waste associated with the decommissioning of these facilities. The volumes of low-level or TRU waste that might result would be speculative and will depend on the level of decontamination required before decommissioning. Environmental impacts of future decommissioning activities will be addressed when such actions are at the appropriate stage.

2.3.1.6 Comment:

One reviewer suggested that, since the draft EIS contends that defense waste will continue to be produced for 12 more years at the Hanford Site, the EIS should provide contingencies for waste production and examine a range of production scenarios. What if waste production ceases in 6 years? 20 years? 50 years? The uncertainty surrounding future defense waste production should be recognized and planned for with realistic options (Letter Number: 70).

Response:

The need to dispose of wastes that currently exist is independent of future waste production. If future waste production were cut in half (from about 20% to about 10% of the total by volume), impacts associated with future tank waste and with newly generated transuranic waste would be roughly halved; however, the total waste for which disposal is required would not change significantly. A basis for estimating impacts associated with additional future waste production is presented in Section 3.4.3 of the final EIS. There, impacts among the alternatives are presented separately in units of 12,000 tonnes of fuel reprocessed.

2.3.1.7 Comment:

Reviewers commented that, given the general uncertainties in the technologies proposed, the long-term duration of the wastes involved and inability to accurately predict the potential impacts, the EIS should include a "worst-case" analysis as required under

40 CFR 1502.22. A reviewer pointed to the statement in the EIS that "because of the low residual hazard index of the wastes and the low concentrations of plutonium, the radiological consequences of a glacial flood would not appear important in contrast to the effects of the flood itself.... Current technology is believed capable of controlling the buildup of water behind ice dams, thus precluding the catastrophic floods just described" (draft EIS, p. 3.48). The reviewer felt that this statement seems to imply that present technology or institutional controls would mitigate or prevent effects from catastrophic ice floods in the future, and that such a statement implicitly constitutes reliance on active institutional controls for more than 100 years after disposal (Letter Numbers: 171, 219, 223, 240. Hearing Number: 474).

Response:

The use of "worst-case" type analyses to bound impact estimates has been included in the EIS. Because the President's Council on Environmental Quality (CEQ) has revised 40 CFR 1502.22 by eliminating the title "worst-case" analysis but not the need for such calculations, these analyses have not been called out specifically in the EIS. It is believed that the "bounding" impact analyses in the EIS have met the requirement for including "worst-case" kinds of impact estimations. Bounding impacts are defined as conservative impact estimates that will always be greater than the actual impacts realized.

Concerning institutional controls, there was no intended implication in the draft EIS that current technology for preventing future glacial floods assumes that reliance is being placed on active institutional controls for more than 100 years after disposal. It is just as reasonable to assume that technology would be capable of preventing the catastrophic floods by relieving the impounded water as it is to assume that present technology is lost. However, no reliance on that technology was made in addressing the impacts, as a review of the discussion of the scenario leading to the statement will show.

See also comments 3.5.6.8 and 3.5.6.53.

2.3.1.8 Comment:

Reviewers felt that the draft EIS did not address the State of Washington's role in monitoring the research and analysis that will be required, and that independent research will be needed to prove the design of the engineered barrier, to analyze features of hydrology, safety of the waste form, characterization of wastes (especially the tank wastes), and retrieval of the wastes, and to research means of waste reduction, among other projects. The reviewers saw this role as comparable to the state's efforts in monitoring the site characterization of the Basalt Waste Isolation Project (BWIP) program for commercial and military wastes. Since those efforts are supported by federal grants under the Nuclear Waste Policy Act, the reviewers suggested that the final EIS should indicate how funding of the state's monitoring responsibility will be guaranteed (Letter Numbers: 156, 223).

Response:

Plans for additional development and evaluation of various aspects of disposal (see Section 3.3.5 of this volume) are described in the Interim Hanford Waste Management Plan (DOE 1986d) and the Interim Hanford Waste Management Technology Plan (DOE 1986e). Independent reviews of available research and evaluation results are under way by a National Academy of Sciences panel and other consultants. The role of Washington State in monitoring research activities at Hanford and funding for the State to monitor disposal activities are subjects beyond the scope of this EIS.

2.3.1.9 Comment:

Reviewers noted that active institutional control can only be relied upon for the first 100 years after disposal, and that the draft EIS did not report on monitoring or mitigation plans following the cessation of active controls (Letter Numbers: 215, 223).

Response:

In the event that active institutional control were lost, there would be no further monitoring or mitigation. The loss of active institutional control is only an assumption, however, used for purposes of analysis. In the actual disposal process, monitoring and mitigation activities would continue indefinitely, as required by DOE Order 5480.1B (DOE 1986c).

2.3.1.10 Comment:

Reviewers noted that the draft EIS did not address the impact of each alternative on the ability to monitor post-closure performance of a deep geologic repository. The reviewer also stated that the draft EIS did not discuss a monitoring program specific to defense wastes or related to those wastes that may go to the repository (Letter Number: 223. Hearing Number: 538).

Response:

The monitoring program for post-closure performance of a deep geologic repository is not within the scope of this EIS. It is described as part of the NRC licensing process (10 CFR 60.51) for a commercial repository. Monitoring programs on the Hanford Site have been discussed in Chapter 4 and Appendix V, and in references cited therein.

2.3.1.11 Comment:

Several reviewers asked about cleanup verification plans, criteria, procedures, monitoring (including location of contaminated areas and low-level waste sites), overview and remedial action plans (Letter Numbers: 161, 223. Hearing Number: 441).

Response:

The specifics requested in these comments are not relevant to the comparison of alternatives presented in the EIS. These would be part of the detailed planning to be done before disposal implementation. All DOE operations on the Hanford Site are currently monitored. This monitoring program would be appropriately revised or supplemented, if necessary, to cover permanently disposed wastes. Overview would be performed as applicable by federal and state regulatory agencies and by the DOE Office of Environment, Safety and Health. The bounding assumptions that were used in the impact analysis encompassed reasonable failure scenarios that would require remedial action.

2.3.1.12 Comment:

Reviewers felt that the EIS allows for no alternate site selection, no alternate "in-place" disposal plan for low-level waste, no identification of the speed of movement of existing radioactive pollution to the Columbia River, and no information on the radiotoxicity of existing pollution. The reviewers were concerned that the EIS totally neglects the economic and public health effects on the city of Portland. Other reviewers felt that, even though the draft EIS involved only defense wastes, there would be considerable pressure to locate a commercial repository at the Hanford Site as well (Letter Numbers: 8, 21, 44, 59, 223. Hearing Number: 441).

Response:

This EIS focused on activities within the scope of the proposed action, that is the disposal of high-level, transuranic, and tank wastes. Low-level waste, except for that generated in the course of processing the aforementioned wastes, was not included within the scope of the EIS.

"Existing radioactive pollution" was discussed in Chapter 4 and Appendix V. Additional information on "existing pollution," to the extent that it contributes to cumulative impacts, is included in Section 5.1.4 of the final EIS. The effects of "existing pollution" are discussed in annual reports, the most recent of which is Environmental Monitoring at Hanford for 1985 (Price 1986). Operational environmental monitoring considers the potential for impacts on downstream users, including the city of Portland.

In the analysis of the health and safety impacts of disposal in the various alternatives, the present and forecasted downstream populations including that of Portland were taken into account. The major pathway is the Columbia River and the analysis indicates there will be no significant doses via river water use.

2.3.1.13 Comment:

A number of reviewers expressed concern regarding facility process waste and low-level wastes, and insisted that low-level wastes be addressed in the final EIS. One reviewer was concerned that some TRU-contaminated solid waste burial sites may have been excluded from the wastes considered. Other reviewers saw no objection to disposing of low-level wastes in place at Hanford (Letter Numbers: 53, 137, 147, 157, 171, 192, 215, 217, 219, 223, 232, 233, 239-NRC, 243-EPA).

Response:

Impacts from low-level wastes, i.e., routed low-activity fractions from the double-shell tanks, were evaluated and are included in all alternatives. Impacts to ground and cribs from previous and continued disposal of low-level liquid wastes, and impacts from low-level waste disposed of in near-surface burial grounds are included in the Cumulative Impacts section

(Section 5.1.4) of the final EIS. The need for any remedial action to ensure safe long-term disposal of Hanford's low-level wastes also is being addressed as part of DOE's actions for compliance with CERCLA, RCRA, and DOE Order 5820. The TRU-contaminated solid waste sites containing more than 100 nCi TRU isotopes/g averaged over the volume of potentially contaminated soil, as well as sites where 80 g Pu had been released per 100 m^3 of soil area, are considered in the final EIS.

As shown in Table 5.2 of the final EIS, long-term impacts associated with low-level waste disposal are larger than those from high-level, transuranic and tank wastes disposed of according to the alternatives presented in the final EIS. Low-level waste disposal impacts, however, are smaller than those associated with the no disposal action (the principal reason for large impacts in the no disposal action alternative is the assumption of tank waste remaining in liquid form).

Inventory data for pre-1970 TRU waste sites are based on the best records available. When discrepancies existed between inventory and data, engineering judgement was applied and the higher inventory was usually used. As part of the process to verify data in the Waste Information Data System (WIDS), discrepancies of pre-1970 TRU waste site inventory data have been corrected with the data given in the EIS. Because of the conservatism applied, it is more likely that there are sites in the EIS that are not TRU sites than that TRU sites have been left out, as suggested by one reviewer.

2.3.1.14 Comment:

Many comments were received about consideration of the cumulative impacts of the full range of nuclear activities on the Hanford Site. One group of reviewers commented that the scope of wastes considered for disposal actions was too narrow and urged that DOE increase the EIS scope to cover other wastes beyond the high-level, transuranic and tank wastes, such as the surplus reactors and other wastes from decontamination and decommissioning. One reviewer stated that the scope of the EIS should include the nuclear naval vessel spent reactor cores disposed at Hanford. The Nuclear Regulatory Commission specifically mentioned their concern about the disposal of wastes with TRU concentrations below the 100 nCi/g level. Other reviewers commented that the draft EIS cumulative impacts section was not complete enough to satisfy the CEQ requirement. Some reviewers specifically mentioned the chemical content of the waste relative to cumulative impacts and possible synergistic effects (Letter Numbers: 14, 39, 41, 53, 54, 55, 57, 71, 78, 90, 103, 147, 154, 157, 171, 174, 175, 178, 193, 199, 208, 216, 217, 219, 223, 230, 231, 233, 234, 239-NRC, 240, 242. Hearing Number: 518).

Response:

The scope of the final EIS has been limited to high-level, transuranic and tank wastes that need disposal action. The DOE is addressing hazardous waste low-level wastes that have been disposed of as part of the Hanford Site's compliance activities required by CERCLA. This is discussed in Chapter 6 of the final EIS.

In response to the comments, the cumulative impacts section of this EIS (Section 5.1.4) has been revised to include additional available information. A preliminary impact assessment was performed for groundwater transport of radioactivity from existing low-level waste sites, and this assessment has been addressed in the cumulative impacts in Section 5.1.4. It is also noted that the decontamination and decommissioning of eight surplus production reactors is being addressed in a separate EIS, currently in preparation.

Chemical characteristics of all waste sites are inadequately known to permit a complete assessment of potential impacts from chemicals. As discussed under the preferred alternative, DOE will perform additional development and evaluation, including characterization of the wastes and waste sites for chemicals. Additional environmental documentation will be provided based on the results of this work.

Concerning the nuclear naval vessel spent fuel, no submarine cores (high-level waste) have been or are planned to be sent to Hanford for disposal. This high-level waste is being sent to the Idaho National Engineering Laboratory for processing. However, submarine hull sections that once contained the reactor cores are being sent to Hanford for disposal. The hull sections, including some nonfuel-bearing hardware, are classified as low-level waste. A separate EIS, prepared in 1984 by the U.S. Navy, addressed the alternative disposal options for the decommissioned nuclear submarines. The inventories for the submarine low-level waste scheduled for disposal at Hanford is included under the defense low-level waste shown in the expanded cumulative impact Section 5.1.4 of the final EIS.

2.3.1.15 Comment:

One reviewer commented that DOE should provide a discussion of whether or not the dissemination of knowledge regarding the volume, discharge rate or characteristics of any individual tank waste stream poses a threat to national security (Letter Number: 223).

Response:

The wastes to be disposed of and that are considered in this EIS have been quantified sufficiently to permit estimation of environmental impacts both in the operational and long term phases. The DOE fails to see the need to address in this EIS whether any of this information or additional information might pose a threat to national security.

2.3.2 EIS Preparation

2.3.2.1 Comment:

Several reviewers felt that data were not available to support the analysis provided in the EIS, that the EIS was premature, and that decisions regarding implementation should not be made until additional information becomes available. A discussion of the timing of the draft EIS and the final environmental assessments for characterization of the first commercial high-level waste repository was suggested (Letter Numbers: 52, 70, 71, 171, 215, 217, 219, 239-NRC).

Response:

The Council on Environmental Quality's regulations implementing the National Environmental Policy Act (NEPA) call for preparation of an EIS early in the decision process. The draft EIS has accomplished its purpose of early public involvement and obviated expenditure of money along paths that ultimately would not be taken. The DOE agrees that in some cases the data are not yet adequate to support making final decisions regarding certain waste classes. Hence, the preferred alternative in the final EIS states that certain disposal decisions will not be made until additional research and analyses have been completed.

Although the release of the draft EIS and the final site characterization environmental assessment for potential Nuclear Waste Policy Act repository sites occurred essentially at the same time, there was no connection between the two activities. The EIS assumes that a geologic repository sited in accordance with requirements of the Nuclear Waste Policy Act will receive those Hanford defense high-level wastes for which geologic disposal is selected.

2.3.2.2 Comment:

Several reviewers noted that the draft EIS did not satisfy the requirement to discuss reasonable alternatives and did not include a preferred alternative. Another reviewer indicated that the favorable treatment of the reference alternative in the draft EIS implies DOE's preference of that alternative. A reviewer noted that insufficient research had been completed to determine a preferred alternative (Letter Numbers: 55, 56, 69, 71, 171, 216, 217, 223).

Response:

The National Environmental Policy Act requires the identification of a preferred alternative in the draft EIS, if one exists. At the draft stage, DOE had not chosen a preferred alternative. The purpose of the draft EIS was to present the alternatives and to allow public comments to influence the formulation of the preferred alternative. With the benefit of the views expressed by federal and state agencies and the public during the review process, DOE has developed and described a preferred disposal alternative for some of the wastes in Chapter 3 of the final EIS. Additional development and evaluation will be necessary before a final disposal alternative is established for single-shell tank wastes and pre-1970 TRU wastes.

2.3.2.3 Comment:

Concern was expressed that, because there were a number of aspects that would require additional research before enough information was available upon which to make decisions, a supplemental EIS or other NEPA documentation would be required at a later time to ensure public involvement when the needed data become available. The EPA also recommended preparation of appropriate NEPA documents to support construction of the Hanford Waste Vitrification Plant (HWVP) and the Waste Receiving and Processing Facility (WRAP) (Letter Numbers: 4, 71, 78, 103, 170, 171, 208, 216, 217, 219, 223, 230, 239-NRC, 243-EPA).

Response:

The preferred alternative, described in Chapters 1 and 3 of the final EIS, proposes to proceed with certain disposal actions and conduct additional development and evaluation to provide the data needed for other disposal actions. Supplemental environmental documentation and compliance analysis will be prepared. Public involvement will continue. At this time, DOE intends that this EIS will provide the NEPA documentation for HWVP and WRAP.

2.3.2.4 Comment:

Because there is no firm statistical basis for several of the key parameters, it is expected that DOE will proceed with further data collection and research and that such data and analyses will be available for public comment before any future plans are determined. (Letter Number: 243-EPA).

Response:

As described under the preferred alternative, DOE will be performing additional development and evaluation before implementation of disposal action for some wastes. Opportunity will be given for public comment as required under the National Environmental Policy Act.

2.3.2.5 Comment:

Several reviewers indicated that it was inappropriate for the DOE to have prepared the draft EIS, citing DOE's self interest as a basis for their objection (Letter Numbers: 18, 125, 127, 143. Hearing Numbers: 311, 319, 320, 606).

Response:

The President's Council on Environmental Quality requires that the agency proposing a major federal action is responsible for preparation of the EIS. Not only is the DOE fulfilling this requirement, the DOE feels that the preparation of the EIS is an important part of its planning process, which includes the incorporation of public opinion.

2.3.2.6 Comment:

One reviewer noted that only one of the individuals in the list of authors has health credentials. The reviewer questioned whether a single individual was qualified to be the sole health authority (Letter Number: 175).

Response:

Dr. Gilbert was not the only qualified health-effects scientist involved in preparing the EIS. Protection of health and safety of workers and the public and protection of the environment at Hanford are also supported by a large number of professional health physicists, many of whom are certified by the American Board of Health Physics. A number of these health physicists were involved in the preparation of the draft EIS.

2.3.2.7 Comment:

Some reviewers felt that there was inadequate time to review the draft EIS, that the closing time for comments was not properly noticed, and that citizens groups were not properly notified (Letter Numbers: 107, 140, 147, 171, 217, 218, 223).

Response:

The minimum time for draft EIS review called for by the Council on Environmental Quality is 45 days from the time that the notice of availability is published by the Environmental Protection Agency in the Federal Register. A comment period of 120 days after such publication was provided for this draft EIS. In addition to the request for written comment, public hearings on the draft EIS were held in Richland, Spokane and Seattle, Washington and in Portland, Oregon. The comment period was announced publicly and specified on the draft EIS cover sheet. The four-month review and comment period provided for the draft EIS went well beyond the minimum requirement and is believed adequate for a document of that size. The draft EIS was sent to those who responded to the Notice of Intent, to individuals requesting the draft EIS, to federal agencies, elected officials at the city, county, state and federal level, and to known interested individuals and organizations. Over 1600 copies of the draft EIS were initially distributed. The DOE also conducted an extensive public information program before and during the comment review period.

2.3.2.8 Comment:

It was contended that there were too few hearings held for public comment on the draft EIS, that public forums should be held before the final EIS is issued and before any record of decision is completed, and that a state vote should be provided for on decisions concerning nuclear wastes. Reviewers also voiced the need for more public education as well as more opportunity for public participation in other issues pertaining to waste disposal at Hanford. One reviewer urged the DOE to make available to the public "all current and historical documents pertaining to the handling of defense wastes at Hanford." Reviewers felt that DOE's public education programs have been minimal and too small, too centralized and often too technical. While public hearings play a role in the public information process, DOE should develop a balanced general public education program to help foster public understanding among citizens whose knowledge of the issues may be limited to media reports. A reviewer expressed concern that DOE properly notify citizens groups and affected Indian tribes about hearings and decisions. Two reviewers suggested that notices of Hanford-related hearings should appear in the Walla Walla newspaper also. Other reviewers felt that the public hearings were merely a public-relations forum for the DOE, and were therefore "a sham and a farce" (Letter Numbers: 9, 12, 22, 23, 33, 49, 55, 78, 84, 116, 118, 124, 128, 137, 141, 146, 147, 152, 156, 163, 171, 172, 175, 197, 199, 200, 204, 216, 217, 223, 242. Hearing Numbers: 327, 344, 563, 604, 614, 624, 640).

Response:

Implementing regulations for the National Environmental Policy Act requires the agency to encourage public input on the draft EIS but does not require the agency to conduct public hearings. However, the DOE concluded that public hearings were appropriate. Four public hearings on the draft EIS were held in Richland, Washington; Portland, Oregon; Seattle, Washington; and Spokane, Washington. The number and location of hearings were decided in part by public response to earlier information meetings and public workshops on waste management at the Hanford Site; these earlier meetings were held in Richland, Kennewick, Yakima, Olympia, Seattle, and Spokane, Washington, and in Portland, Pendleton, and The Dalles, Oregon. DOE's public information and education effort included open houses providing general information on Hanford defense waste management disposal alternatives. These open houses were held in seven cities in the Pacific Northwest. Open houses were followed by informational workshops on the draft EIS. The information workshops were held in eight cities in the Pacific Northwest.

It is DOE policy to make information available to the public regarding Hanford Site activities. The Walla Walla Union Bulletin will be added to the list of newspapers in which notices of hearings are placed.

A state vote on disposal of Hanford defense wastes is beyond the scope of the EIS process called for by the National Environmental Policy Act.

2.3.2.9 Comment:

Several reviewers called for full and independent technical review of the EIS; one requested copies of the evaluations made by these independent agencies (Letter Numbers: 44, 45, 59, 68, 120, 121, 143, 144, 147, 152, 162, 177, 193, 199, 214, 216, 217, 219. Hearing Number: 559).

Response:

Full and independent technical review of the draft EIS was provided by Environmental Protection Agency (EPA), NRC and U.S. Geological Survey (USGS) review at the federal level; the Washington Nuclear Waste Board, the Washington Department of Ecology and the Oregon Department of Energy at the state level; and by several Indian organizations and the Northwest Citizens Forum as well as other interested individuals and organizations. Volume 5 of the final EIS contains facsimilies of all the written comments, including those of agencies technically reviewing the EIS, that the DOE has received on the draft EIS. An index is provided in the front of Volume 5 that lists the names and addresses of the federal and state agencies, organizations, and members of the general public who submitted letters.

2.3.2.10 Comment:

Two reviewers suggested that DOE dissolve the current draft EIS process and incorporate public comments, ideas and suggestions rather than continue with what one reviewer described as a "farcical procedure the DOE is cramming down the throats of Washington State citizens." A few reviewers commented that the document was "incomprehensible, defective, inadequate, alienating, elitist, ill-researched, presumptuous, and ludicrous." Reviewers stated that assumptions in the EIS were "clearly unfounded," that valid scientific studies by independent groups have been ignored and that the EIS was defective in scope and analytical content (Letter Numbers: 52, 56, 59, 68, 69, 82, 151, 206, 209, 216, 223. Hearing Number: 531).

Response:

The National Environmental Policy Act (NEPA) requires federal agencies considering major federal actions to prepare an EIS to provide environmental input into the decision. This process includes providing for meaningful consideration of public comment in finalizing the EIS and developing a decision on the action considered.

The draft EIS was reviewed by and commented on by technical experts in the EPA, NRC, USGS, Washington and Oregon States, and by several Indian organizations. Although these reviews generated abundant comments, the EIS was viewed as a meaningful and technically sound document.

2.3.2.11 Comment:

One reviewer stated that the DEIS was "full of ... inept statements, assumptions and conclusions" and used the following statement as an example: "Wastes in repositories approach zero risk in terms of drilling and near-surface excavation, whereas there might be two fatalities over 10,000 years for the in-place stabilization and disposal alternative and 18 fatalities where no monuments, records or markers warn of potential hazard" (p. 3.65) (Letter Number: 216).

Response:

The draft EIS was incorrect in the number of fatalities and the final EIS provides the correct number of fatalities.

2.3.2.12 Comment:

A number of reviewers were supportive and/or had no objection to the content of the draft EIS and/or the process and objectives of Hanford defense waste disposal, expressing appreciation for the opportunity to participate. Some reviewers requested continuing participation in the process. Several reviewers asked or expressed skepticism about what happens to the public's written comments and oral testimony (Letter Numbers: 2-DOI, 4, 13, 15, 37, 39, 56, 58, 69, 70, 72, 101, 110, 124, 128, 171, 172, 184, 215, 217, 221).

Response:

There will be additional opportunities for public participation after the Record of Decision (ROD) is published. The ROD will summarize the decision the DOE will make regarding the potential actions described in the final EIS. If the preferred alternative is selected, decisions for disposal of single-shell tank wastes, pre-1970 buried suspect TRU-contaminated solid waste and TRU-contaminated soil sites will be deferred until further development and evaluation can be performed. In this event, subsequent NEPA documentation would be prepared and public comment would be sought. Processing of public input is discussed in Chapter 1 of this volume.

2.4 APPLICABLE LAWS AND REGULATIONS

This section addresses comments received concerning state and federal laws, regulations and standards and Indian rights.

2.4.1 State and Federal Laws, Regulations and Standards

2.4.1.1 Comment:

Reviewers stated that the DOE should comply with all appropriate state and federal regulations and laws, especially RCRA, CERCLA, and 40 CFR 191, to protect public health and the environment (Letter Numbers: 12, 41, 43, 44, 46, 55, 59, 64, 71, 78, 107, 111, 112, 116, 154, 162, 164, 174, 214, 216, 217, 219, 223, 231, 234, 243-EPA. Hearing Number: 466).

Response:

The DOE policy is to comply with all applicable state and federal laws and regulations for the protection and enhancement of the environment. In accordance with 40 CFR Part 1502.25, Chapter 6 of the EIS lists currently identified federal permits, licenses, and other entitlements that would be required before waste disposal actions would be implemented at the Hanford site. In addition, other major regulations that might govern implementation activities, depending on the strategy chosen and standards of performance for disposal systems, are briefly described. While Chapter 6 of the EIS is primarily intended to discuss currently identified federal permits and other entitlements which may be necessary, the discussion has been revised and expanded to more fully address regulations and to more clearly reflect the DOE's intent to comply with applicable laws and regulations. Compliance with 40 CFR 191 and other regulations will be addressed in a regulatory compliance assessment to be done before implementation of a waste disposal alternative. See also comment 2.4.1.9.

2.4.1.2 Comment:

One reviewer noted that on page 1.8, the draft EIS states that it may not be justifiable to solidify wastes from the Hanford Site and send those wastes to a repository. The reviewer wanted to see included at this point a comparison with the requirements of the 1982 Nuclear Waste Policy Act (NWPA) for high-level wastes, and an analogous comparison with the former requirements of AEC 0511. The reviewer also asked for a discussion of whether it is advisable to change the public law to accommodate the possibility that DOE may leave high-level waste in the soil. Another reviewer also questioned whether the DOE's disregard of NWPA requirements is "politics as usual" (Letter Numbers: 57, 233).

Response:

The NWPA sets forth a process and approach for the establishment of a geologic repository. It requires that disposal of high-level waste in a geologic repository comply with requirements established by the Nuclear Regulatory Commission and the Environmental Protection Agency. It does not prohibit consideration of other disposal alternatives for high-level waste. In fact, in Section 222 of the NWPA, DOE is directed to continue and accelerate a program of research, development and investigation of alternative means and techniques for disposal of high-level radioactive wastes. Since Manual Chapter 0511 is no longer in effect, comparison with the NWPA is not appropriate.

Changes to public law are issues that are beyond the scope of this EIS, which focuses on the selection of a strategy for disposal of Hanford defense, high-level, transuranic and tank wastes.

2.4.1.3 Comment:

One reviewer commented that, contrary to the suggestions in the draft EIS, neither the separation of high-level waste in the failed tanks into two fractions nor the permanent fixing of high-level waste in place should be considered as alternatives until the 1982 Nuclear Waste Policy Act (NWPA) is changed to allow either of these actions (Letter Number: 233).

Response:

The NWPA applies to all high-level wastes that are to be disposed of in a commercial geologic repository. The NWPA does not, however, prohibit the consideration of other disposal alternatives. Thus, no change to the NWPA would be required. Implementation of any high-level and TRU waste disposal option must comply with the requirements set forth in 40 CFR 191.

2.4.1.4 Comment:

Several reviewers noted that the NWPA applies to all defense high-level waste, including tank waste. Reference was made to the decision to mingle wastes as the link between defense waste and the NWPA. The reviewers indicated that because the NWPA applies, all the defense high-level waste and tank waste must be disposed of in a repository (Letter Numbers: 57, 70, 107, 163, 223, 240).

Response:

As noted above, the NWPA applies to all defense high-level wastes that would be disposed of in a commercial repository. Neither the decision to mingle commercial with defense wastes nor the NWPA, however, requires all defense high-level waste to be disposed of in a geologic repository. The President's decision was based in part on a determination by the DOE that those high-level defense wastes which should be disposed of in a geologic repository should be placed in the same repository as that used for the commercial waste, thus obviating the need for a separate repository for disposing of defense high-level waste.

2.4.1.5 Comment:

Reviewers felt that the State of Oregon should be provided with affected state status under the NWPA, and suggested that DOE undertake a national site screening program for repository site selection. Other reviewers commented that Oregon should be given more opportunity to express its concerns (Letter Numbers: 17, 25, 49, 50, 59, 152).

Response:

The repository program and establishment of affected state status under the repository program is beyond the scope of this EIS. These comments have been referred to the Office of Civilian Radioactive Waste Management in the Department of Energy.

2.4.1.6 Comment:

Reviewers were concerned that in-place stabilization and disposal would not be possible on a legal basis, because 1) licensing of waste tanks will be procedurally complex, and

2) the NWPA states that high-level waste must be disposed of in a defense repository or mixed in a commercial repository (Letter Numbers: 57, 215, 217, 219, 233, 240).

Response:

In-place stabilization and disposal was deemed to be a reasonable alternative based on performance analysis (e.g., exhibited a lower cost and occupational exposure risk) and was therefore considered in the draft EIS.

If the in-place stabilization and disposal alternative is selected, the DOE, in consultation with the NRC, will review Section 202 of the Energy Reorganization Act of 1974 to determine the need for licensing. DOE intends to conduct further development and evaluation before making decisions on disposal of single-shell tank wastes, pre-1970 buried suspect TRU-contaminated solid waste and TRU-contaminated soil sites. (Also refer to Comment No. 2.4.1.3.)

2.4.1.7 Comment:

One reviewer asked, "Does not the gravel strategy create 149 high-level nuclear waste repositories, all of which should be legally licensed by the Nuclear Regulatory Commission as required under the Nuclear Waste Policy Act (NWPA) of 1982?" Another reviewer said that the final EIS should state that high-level wastes stabilized in place in single-shell tanks will meet the regulatory requirements for a repository (Letter Numbers: 110, 147, 217).

Response:

If a decision is made to proceed with in-place stabilization and disposal of single-shell tank wastes, DOE, in consultation with the NRC, would review Section 202 of the Energy Reorganization Act of 1974 to determine the need for licensing (refer to Chapter 6 of the final EIS). However, DOE's preferred alternative is to defer disposal decisions regarding the single-shell tank wastes until further development and evaluation can be performed.

2.4.1.8 Comment:

Several reviewers expressed concern about the definition of TRU wastes, and the fact that the definition was changed from 10 nanocuries (nCi) of TRU per gram of waste to 100 nCi TRU/g (Letter Numbers: 57, 76, 101, 107, 110, 164, 171, 174, 182, 187, 193, 215, 216, 217, 219, 223, 233, 242, 243-EPA).

Response:

As footnoted on p. 3.8 of the draft (and final) EIS, the basis for classification of waste as TRU waste was changed in 1982 from 10 nCi/g to 100 nCi/g. The original criterion of 10 nCi/g was established in 1970 by the Atomic Energy Commission in Manual Chapter 0511 as a level above which waste would be stored for future sorting and disposal. This value was based on an equivalent concentration of radium in areas with elevated concentrations of naturally occurring uranium. It was intended to be a very conservative number to be used for sorting wastes only until a number could be established on a firm technical basis.

Studies conducted by the EPA, the NRC, and the DOE on the potential impact of disposal of TRU waste have shown that a higher limit would be appropriate for near-surface disposal of radioactive waste. In 1982, a workshop involving the previously mentioned agencies and technical support organizations was held to discuss these studies (Moghissi et al. 1983). Some participants suggested values higher than the 100 nCi/g, but there was a general consensus that the 100 nCi/g was a safe and conservative level, even though higher levels might be supportable for specific disposal systems and locations. The EPA and NRC have adopted the 100 nCi/g criterion for use as the definition of TRU waste. The DOE also adopted the 100 nCi/g definition in DOE Order 5820.1, which has now been superseded by DOE Order 5820.2 (DOE 1984).

At least ten countries are involved in operations that produce this class of waste. No international consensus has been reached on a numerical definition; 1983 definitions varied from >0.03 to >1000 nCi TRU/g waste. The definitions are presently used to separate wastes going to a sea dumping or shallow-land burial from those requiring greater isolation.

2.4.1.9 Comment:

Reviewers generally felt that the Resource Conservation and Recovery Act (RCRA) applies to Hanford defense wastes and expressed concern that DOE 1) considers the defense waste as byproduct material and not subject to RCRA; 2) does not adequately define the nature of the defense tank waste and thus does not really know whether RCRA applies, although the EPA has recently published a notice that the hazardous components of "mixed wastes" are subject to RCRA; and 3) does not provide the reviewer with an adequate understanding of the consequences of RCRA application and does not provide a "worst-case analysis" to the defense waste disposal alternatives. One reviewer also pointed out that all materials in storage tanks are subject to Subtitle I of RCRA. The reviewer also noted that DOE, EPA and the Washington Department of Ecology were expected to settle an Administrative Order, dated February 5, 1986, concerning the compliance with RCRA (Letter Numbers: 46, 215, 217, 219, 223, 231, 233, 234, 239-NRC, 240, 243-EPA).

Response:

The draft EIS discussed the application of RCRA to the radioactive wastes addressed in the draft EIS in accordance with the DOE's proposed rulemaking published in 50 FR 45936, November 1, 1985, to clarify the term "byproduct materials" for purposes of determining applicability of RCRA to radioactive waste. At that time, the DOE believed that the radioactive wastes addressed in the draft EIS constituted "byproduct materials" which were excluded from the definition of waste regulated pursuant to RCRA.

On May 1, 1987 the DOE published final rules addressing the applicability of RCRA to radioactive wastes. This rule, codified as 10 CFR 962 (52 FR 15937), provides that for purposes of determining the DOE's obligations under RCRA the term byproduct material is limited to the actual radionuclides dispersed or suspended in the waste substance. The nonradioactive, hazardous component of the waste substance will be subject to regulation under RCRA. The effect of this rule is that all DOE radioactive waste which is hazardous under RCRA will be subject to regulation under both RCRA and the Atomic Energy Act.

The final EIS has been revised to reflect this final rule. The DOE will work closely with the EPA and the State of Washington in determining the applicable requirements of RCRA. After the applicable requirements of RCRA are determined, the DOE will review the disposal alternative to determine whether compliance with RCRA requirements would result in substantial changes to the proposed action or to the environmental impacts of that action.

Regarding a "worst-case analysis," the DOE believes that bounding analyses performed in this EIS meet the CEQ requirements for analysis of all reasonably foreseeable significant adverse impacts.

2.4.1.10 Comment:

Reviewers commented on liability implications, including restitution. In particular, reviewers expressed concern that the final EIS should include the impacts of CERCLA and other pertinent statutes on proposed disposal activities and that the specific waste inventories, disposal sites and locations should be included (Letter Numbers: 157, 203, 223, 231).

Response:

The CERCLA is implemented by DOE through DOE Order 5480.1B (DOE 1986c). The DOE has issued a report (DOE 1986a) concerning CERCLA implementation at Hanford. The report provides the preliminary results of the Phase I investigation of inactive waste-disposal sites on the Hanford Site. Section 6.8 has been revised to include a statement on DOE's CERCLA compliance program.

At this time the following observations are made with respect to impacts of laws and regulations on the implementation of defense waste management alternatives.

- There is not enough information presently available with which to prepare a post disposal compliance analysis in accordance with the EPA's 40 CFR 191 "Environmental Standards for the Management and Disposal of Spent Nuclear Fuels, High-Level and Transuranic Radioactive Waste." An indication of how such an analysis would be developed is presented in Appendix S; however, the results are based on preliminary data and selected distributions of important parameters and should not be relied upon as a definitive discriminator of the alternatives (except to the extent that any disposal alternative is superior in the long term to the no disposal action alternative). The management portion of the standard would not be expected to impact any of the alternatives since the estimated doses from operations were shown to be substantially less than the specified limits (Section 3.4.1.1). It appears that assurance requirements would be met for all disposal alternatives and waste classes with the possible exception of the multiple barrier requirement with respect to retrievably stored and newly generated TRU waste in the in-place stabilization and disposal alternative.

- Application of the Resource Conservation and Recovery Act, as amended, and the Comprehensive Environmental Response, Compensation, and Liability Act, as amended, to Hanford wastes is in its beginning stages. While these Acts are not seen as precluding any of the alternatives, anticipation of RCRA requirements would involve including certain design features in the waste vitrification facilities such that the requirements could more easily be met.

- It is expected that compliance with other laws and regulations noted in Chapter 6 of Volume 1 would not preclude implementation of any alternative and would require roughly the same precautions, efforts, and resources regardless of alternative and therefore would have no appreciable impact on selection of an alternative.

2.4.1.11 Comment:

One reviewer felt that more specific reference should be made to the Clean Air Act (40 U.S.C. 7401 et seq.) in the draft EIS p. 5.4, Section 5.1.4, para. 3, specifically, that applicable concentration guides should be referenced and explanations as to what guides are applicable to Hanford should be provided (Letter Number: 223).

Response:

Section 118 of the Clean Air Act, as amended, provides for the control of air pollution by federal facilities. Subpart H of 40 CFR 61 specifically regulates site-specific radionuclide emissions from DOE facilities under the Clean Air Act, and prescribes dose limits for maximally exposed members of the public. Authority for establishing air quality standards and regulation of air emissions in southeastern Washington rests with the Environmental Protection Agency and with the Washington State Department of Ecology, which in turn has approved the Benton-Franklin-Walla Walla Air Pollution Control Authority as a cognizant local air pollution control authority. The DOE will comply with emission limits established by the State of Washington after General Regulation 80-7 of the Authority and will provide Notification of Construction of New Facilities in accordance with requirements of Regulation 80-7. DOE will also comply with other applicable requirements of the Clean Air Act including applicable EPA and state regulations relating to air emissions of radionuclides. While it is not expected that any emission associated with waste disposal will exceed the thresholds requiring Prevention of Significant Deterioration (PSD) permits, the DOE will evaluate activities conducted pursuant to the course of action finally implemented and will apply for and obtain any necessary PSD permits.

An expanded discussion of the Clean Air Act and other applicable standards is given in Section 6.3 of the final EIS.

2.4.1.12 Comment:

Reviewers asserted that no water rights now exist under federal or state laws to provide water to carry out the disposal alternatives (Letter Number: 223).

Response:

No new water withdrawal capacity will be required to support any of the waste disposal alternatives addressed in this EIS. Waste disposal operations would be supplied with water from the existing 200 Area Export Water System. The United States Government has a reserved water right at Hanford for such uses, based on the establishment of the Hanford Nuclear Reservation by the Federal Government for nuclear materials production and associated activities, and for development and evaluation activities.

2.4.1.13 Comment:

Specific reference was made by a reviewer to compliance with the Federal Water Pollution Control Act (33 U.S.C. 1251, et seq.) and 33 U.S.C.A. @ 1323 (Letter Number: 223).

Response:

The Federal Water Pollution Control Act (33 U.S.C. 1251 et seq.) requires all branches of the federal government involved in activities that may result in a point source discharge or runoff of pollutants to waters of the United States (excluding materials regulated under the Atomic Energy Act of 1954) to comply with federal, state, interstate, and local requirements. The objective of the Act is to restore and maintain the integrity of the nation's water. The State of Washington Department of Ecology has promulgated water quality standards and issues National Pollutant Discharge Elimination System (NPDES) permits to non-federal facilities. The EPA's Region X is the permitting agency for federal facilities within Washington State.

The DOE does not anticipate that activities evaluated in this EIS will result in discharges of pollutants regulated under the Clean Water Act. However, in the event that final designs would lead to any such regulated discharges, the DOE would obtain all necessary permits before implementation.

2.4.1.14 Comment:

Reviewers pointed out that the federal Safe Drinking Water Act includes standards for inorganic and organic chemicals, gross alpha particle activity, beta and gamma radioactivity, and radium-226 and radium-228, among other contaminants. The states may be delegated primary enforcement authority for the Act. One reviewer expressed concern that the disposal activities at Hanford might result in violation of the Act, and thought that the DOE needs to identify the full range of standards that must be complied with. Reviewers pointed out that in response to changes in the Act, the State of Washington implemented an underground injection control (UIC) program that prohibits the injection of waste waters into, above or below underground sources of drinking water (Letter Numbers: 223, 243-EPA).

Response:

The purpose of the Safe Drinking Water Act (SDWA), 42 U.S.C. 300f, et seq., as amended by SDWA amendments of 1986 (Public Law 99-339; 40 CFR 124, 141-147), is to set primary drinking water standards for owners/operators of public water systems and to prevent underground injection that can contaminate drinking water sources. The National Primary Drinking Water Regulations, 40 CFR 141, apply to maximum contamination levels in public water systems. The regulations set maximum contaminant levels for radionuclides that may be contained in the water supplied to ultimate users by community water systems. There is no community water system on the Hanford Site; the first such system downstream from the Site is the municipal water plant for Richland, Washington, that draws water from the Columbia River and therefore could be affected by radionuclides originating on the Hanford Site.

Excerpts from 40 CFR 141 that are applicable to public water systems are given in Chapter 6.0, "Applicable Regulations." The contaminant limits described in 40 CFR 141 are substantially the same as those of the Washington State Board of Health Regarding Public Water Systems (WAC 1985).

2.4.1.15 Comment:

Reviewers felt that the draft EIS should have stated that no waste form will be diluted so that it may fall under less stringent disposal requirements (Letter Number: 171, 219).

Response:

It would be unreasonable to commit to never diluting a stream such that disposal could not be performed under alternative means. Where "stringent disposal" refers to appropriate protection of public health and safety, there is no cause for concern. The objective of DOE's disposal program is protection of public health and safety, and that will be assured by appropriate disposal whether the waste is high-level, TRU, low-level or below regulatory concern.

2.4.1.16 Comment:

One reviewer noted that the draft EIS did not include a comparison with the assurance requirements of 40 CFR 191.14 for any of the alternatives.

The reviewer noted that compliance with 40 CFR 191 assurance requirements d, e and f (Sections 3.3.2 and 3.3.3) may not be achieved for the in-place stabilization and disposal alternative and that further analyses are necessary to evaluate the appropriate alternative for these wastes, including the finalization of the protective barrier design and assessments of its performance.

Another reviewer noted that the analysis conducted in the draft EIS was based on many unsubstantiated assumptions and was not sufficient to allow determination of compliance with 40 CFR 191.

The reviewer noted that, with present knowledge, it appears unlikely that EPA standards under 40 CFR 191 could be met by either the in-place stabilization or reference alternative, given reasonably conservative assumptions and analyses of contaminant release to the accessible environment. Another reviewer stated that current concentrations in certain areas of the Hanford Site already exceed these guidelines (Letter Numbers: 215, 223, 243-EPA).

Response:

Based on the preliminary concepts and probabilistic and deterministic analyses presented in the EIS, the DOE believes that the disposal alternatives can be made to meet applicable regulations.

Disposal systems for high-level or TRU radioactive wastes must meet containment requirements listed in 40 CFR 191.13. To provide confidence that these containment requirements will be met, six assurance requirements are listed in 40 CFR 191.14. The assurance requirements address controls, barriers, and retrievability.

The assurance requirements and their implications for the various alternatives are discussed in Volume 1, Section 6.5. (See also response to comment 2.4.1.10.)

2.4.1.17 Comment:

Reviewers noted that the EIS must identify the impacts as required by NEPA and stated that the use of "bounding assumptions" to cover a wide range of impacts is not acceptable. The need to provide for additional public input in the event of delayed Records of Decision was also noted (Letter Numbers: 12, 116, 223).

Response:

The DOE believes that bounding analyses performed in the EIS meet CEQ requirements for analysis of all reasonably foreseeable significant adverse impacts.

See also comments 2.3.2.2 and 2.3.2.3.

2.4.1.18 Comment:

A reviewer stated that the sections on unavoidable adverse impacts should include 1) dedicating the Site to disposal activities for 10,000 years and 2) precluding any further processing of wastes if the geologic disposal alternative were adopted (Letter Number: 223).

Response:

In accordance with 40 CFR 1502.16, "adverse environmental effects which cannot be avoided" were addressed in Chapter 5. Assuming that an appropriate level of safety can reasonably be predicted, dedication of the Site to disposal activities is seen as beneficial rather than adverse. Most of the foreseeable resource value of Hanford waste has already been removed; the resource loss of that sent to a repository would be negligible.

2.4.1.19 Comment:

Reviewers felt that the draft EIS does not clearly indicate the effect of DOE Order 5480.1A Chapter XI [subsequently 5480.1B (DOE 1986c)] on the defense wastes. Clarification of the reference and tables on p. 6.3 was also requested, as was the inclusion of the scope and an anticipated time frame for implementing DOE Order 5820.2 (DOE 1984) (Letter Numbers: 147, 217, 223).

Response:

DOE Order 5480.1B was cited to indicate the levels of protection provided for by DOE regulations. These are constraints within which all activities must be carried out. Table 6.2 has been replaced to reflect a recent change in the primary DOE radiation standards; equivalent concentration guides have been issued for comment and are expected to be finalized shortly. The new DOE orders, as well as NRC revisions to its radiation standards for licensees (10 CFR 20), implement the more recent international guidance.

In regard to DOE Order 5820.2, use of cribs and ponds for disposal of low-level waste is outside the scope of the EIS. However, DOE Order 5820.2 documents DOE's intent to reduce liquid waste discharge to the ground. A plan describing DOE's approach to implementing DOE Order 5820.2 was submitted to Congress in April, 1987.

2.4.1.20 Comment:

One reviewer noted that, of the three disposal options, the reference alternative may be the most reasonable, pending the results of continued research as well as collection of site-specific data; however, there are scenarios in which the potential exists for both the reference and in-place stabilization alternatives to exceed the limits in 40 CFR 191.15. Also, analyses for comparing the action with 40 CFR 191.03, 40 CFR 191.14, and 40 CFR 191.16 have not been presented (Letter Number: 243-EPA).

Response:

An assessment of compliance is premature but will be performed before implementation, when the engineered disposal system designs are optimized. However, based on the analyses in the draft EIS, DOE believes the reference and in-place stabilization alternatives would comply with the limits described in 40 CFR 191.15, specifically those for drinking water associated with a "significant" source of groundwater for undisturbed performance during the first 1000 years after disposal. Additional information has been provided in Section 6.8 of the final EIS regarding the assurance requirements of 40 CFR 191.14. A statement has also been added (Section 3.4.1.1) with respect to offsite dose during disposal operations (40 CFR 191.03). The DOE does not believe that 40 CFR 191.16 requirements for protection of "special" sources of groundwater are applicable to disposal at the Hanford Site, since the groundwater of the Site does not fall within the definition of "special sources of groundwater" set forth in 40 CFR 191.12.

2.4.1.21 Comment:

One reviewer noted that, based on the draft EIS, all options meet the probabilistic standards in Subpart B of 40 CFR 191 except for the no disposal alternative and one scenario of the geological disposal alternative. The reviewer concluded that the draft EIS constituted a preliminary analysis with many unsubstantiated assumptions and that it was not sufficient to allow a determination of compliance with 40 CFR 191 (Letter Number: 243-EPA).

Response:

The analysis provided in Appendix S was to indicate the approach to a probabilistic analysis required by 40 CFR 191 and was not meant to imply compliance or the lack thereof. Additional information will be collected as the planned development and evaluation continues. Before a disposal plan is implemented, a compliance analysis would be performed according to 40 CFR 191 and with the data available at that time and would then be circulated for review.

2.4.1.22 Comment:

Reviewers requested a discussion of monitoring (both effluent and environmental) that would ensure that the potential releases projected for the various alternatives would fall within standards and are as low as reasonably achievable. One reviewer further suggested that it would be appropriate to compare all projected releases to the most restrictive standards that now apply or are expected to apply in the near future. Another reviewer suggested that the current monitoring includes naturally occurring radionuclides (Letter Numbers: 217, 223).

Response:

The short-term operational releases projected for the waste management operations would continue to be monitored under the existing Hanford Environmental Monitoring Program as long as active institutional control is maintained. For releases projected far into the future from hypothetical disruptive events, no reasonable mechanism can be postulated to ensure the continuation of monitoring beyond the required assumption of loss of active institutional control of the site. The intent of the draft EIS is to present the range of potential impacts in the absence of continued monitoring.

For the long-term dose projections, the most restrictive existing or proposed standard is the EPA (40 CFR 141) 4 mrem/year drinking water standard. Note, however, that this standard does not by definition apply to Hanford groundwater, which is not a source for a community water system. This standard is used in the long-term impact assessment comparisons for downstream users of the Columbia River. Before a disposal option is implemented, a regulatory compliance analysis will be performed to determine compliance with applicable standards.

2.4.1.23 Comment:

One reviewer, the NRC, agreed with the position stated in the draft EIS (p. 6.11) that to the extent that any decision based on the EIS (and subsequent final environmental statement) requires defense high-level waste to be placed in a facility which is authorized for the express purpose of long-term storage, such a facility would have to comply with any applicable licensing requirements of the NRC. Notwithstanding any comments presented in the EIS, the NRC may: 1) incorporate into any license that may be issued at a later date conditions that may reflect a more restrictive position than that taken in the EIS, or 2) deny a license for activities at a proposed facility (Letter Number: 239-NRC).

Response:

The DOE acknowledges NRC's position.

2.4.1.24 Comment:

One reviewer noted that Appendix V refers to disposal activities in terms of cribs, trenches, French drains, and reverse wells. The ramifications of the Underground Injection Control (UIC) Regulations (40 CFR 144 and 40 CFR 146) should be discussed in the final EIS (Chapter 6), especially since those regulations prohibit the disposal of hazardous waste or radioactive waste into, or above, underground sources of drinking water. The state program should be discussed also, since the primary enforcement responsibility was designated to the Washington Department of Ecology (Letter Number: 223).

Response:

Under the Safe Drinking Water Act, any planned disposals of fluids by well injection, with the potential to contaminate groundwater that supplies or that can reasonably be expected to supply any public water system, requires a specific rule by EPA or a UIC permit. All activities would be in compliance with applicable provisions of the Safe Drinking Water Act.

2.4.2 Indian Rights

2.4.2.1 Comment:

Several reviewers contended that more attention must be paid to Yakima Indian land claims. "In fact, agreements made for access to sacred Indian lands have not been honored, nor ever can be because of the terrible pollution of the area" (Letter Numbers: 41, 64, 152, 216).

Response:

A description of Indian land claims has been added in Section 4.8.4 of the final EIS, and the discussion of potential impacts on nearby Indians including the Yakimas (Section 3.4.4) has been provided.

About 5% of the Hanford Site land area is occupied by nuclear facilities. Restricted access to areas at the Hanford Site that are held as sacred by the Indian tribes is dictated by national security requirements. See, however, Section 6.10

2.4.2.2 Comment:

A number of reviewers expressed concern that Indians residing in the vicinity of Hanford were not recognized as having certain treaty-granted usage rights on land now occupied by the Hanford Site, nor was any analysis made of possible health, economic or cultural impacts on the Indians as a result of waste disposal. Reviewers noted that no mention is given to the fact that the Hanford Reservation is included in the ceded lands of the Yakima Indian Nation. That particular subject needs to be addressed in significant detail, since the reservation is an important part of the Yakima Indian Nation's heritage. Future impact on the Indians through the prohibition of their use as promised in the 1855 treaty would have significant socioeconomic impacts on the Yakima, Umatilla and the Nez Perce Tribes. Furthermore, one reviewer felt that the discussion of socioeconomics should have included the affected Indian tribes (Letter Numbers: 57, 178, 215, 223, 231, 234. Hearing Number: 559).

Response:

The EIS has been revised in Section 4.8.4 to add recognition of rights and privileges of Indians as provided in the 1855 treaties. Also addressed is the relationship of the Hanford Site to the Yakima and Umatilla Indian reservations. Environmental impacts as they may specifically apply to Indians are discussed in Section 3.4.4, where impacts are contrasted among the alternatives. See also Section 4.8.5, "Archaeological, Cultural and Historical Resources."

In the EIS, the "affected environment" is the focus of environmental impact analysis, and includes all of the lands that could be significantly impacted by airborne pollutants, as well as the Columbia River downstream of the Hanford Site and the ocean into which it flows. This broad definition of "affected environment" includes any usual Indian fishing grounds on the Columbia River and the lands of the Indian reservations.

2.4.2.3 Comment:

Reviewers expressed concern for the Confederated Tribes of the Umatilla Indian Reservation because they are located southeast (prevailing wind direction) of the Hanford Site. The viability of future hunting and gathering on contaminated lands within the Hanford reservation is also of concern to the tribes (Letter Number: 231, 234).

Response:

Offsite measurements of radiation, including locations to the southeast of the Hanford Site show near background levels of radiation and do not pose a health hazard to people in the surrounding areas.

The alternatives presented in the EIS for disposal of defense wastes would be expected to reduce rather than increase the potential for land contamination. Moreover, there are no plans to release any portion of the Hanford Site for hunting and gathering.

2.5 GENERAL COMMENTS

This section addresses policy-related comments of a more general nature.

2.5.1 Comment:

Some reviewers agreed with the EIS statement that "there is no intention of the federal government to ever leave the site." Some reviewers questioned this statement, noting that no government, much less civilization, has ever lasted the length of time the wastes will remain hazardous. It was noted that the draft EIS assumes loss of active institutional control by the year 2150--only a fraction of the time that the wastes will be hazardous. The reviewers were concerned about the ability of any waste disposal option to outlast climate changes, ice ages, geological upheavals, and human populations whose understandings, languages, values and purposes may be very different from our own (Letter Numbers: 101, 110, 219, 243-EPA).

Response:

The initial portion of the comment accurately states the DOE's intention to maintain institutional control of the Site. The EPA, in its standards for environmental protection from disposal of high-level and transuranic wastes, states that active institutional control may be relied on for no more than 100 years following disposal. It is on that basis that DOE has analyzed impacts assuming absence of active institutional control in 100 years after disposal. By conducting an environmental analysis that assumes active institutional controls do not continue indefinitely, the concerns noted by the reviewer are addressed.

Regarding the assumed date for loss of active institutional control, the year 2150 is based on the assumption that waste disposal will be completed by the year 2050. One hundred years of active institutional control then leads to the year 2150 for assumed loss of active institutional control. No disposal concept can boast 100% assurance against disruption for 10,000 years. However, the DOE judges that near-surface disposal facilities at Hanford, if marked carefully and designed to keep contents sufficiently dry, can provide the required isolation from the affected environment. Additional rationale on the lasting nature and value of the protective barrier can be found in the response to comment 3.5.1.30. Discussion of the marker system and its value can be found in Appendix M of the final EIS. Analysis of the ability of the deep geologic repository to ward off natural and human-induced disruptions can be found in DOE's commercial nuclear waste management environmental impact statement (DOE 1980a).

2.5.2 Comment:

Rather than viewing any of the decisions as "permanent disposal actions" (10,000 years or longer), some reviewers feel that they should be viewed as the next logical steps in waste disposal at Hanford. In other words, actions should be taken only if they can meet two key tests:

(1) The draft EIS analysis and documentation are sufficient to give a high degree of confidence that the proposed disposal action is demonstrated to work.

(2) The proposed actions taken will not foreclose potential options for decisions that will not be made until after further studies have been completed (Letter Numbers: 217, 239-NRC).

Response:

The preferred alternative, described in Chapter 3 of the final EIS, is in accord with the position expressed in the above comments. Also, because active institutional controls cannot be guaranteed over the time period of interest, the waste disposal system must be designed to protect public health and safety even if unattended. Natural geologic analogs suggest that waste disposal systems can be designed to be effective for thousands of years.

2.5.3 Comment:

One reviewer suggested an approach to waste disposal that in his view differs from the one implicit in the EIS process in three respects. First, implementation would begin without a final decision on the remedial option to be chosen, so that experience can influence future decisions. Second, those future decisions would be subject to public review at decision points, the first of which would be specified in the final EIS. Third, an important objective of remedial action in this initial stage is to improve our understanding of the best available technology for cleanup, rather than to proceed as if that technology were known (Letter Number: 4).

Response:

The draft EIS noted that additional development and evaluation may be required before final decisions can be made regarding disposal of some waste categories. This comment appears to be an amplification of that position. The preferred alternative, described in Chapter 3 of the final EIS, provides a proposed course of action consistent with this comment.

2.5.4 Comment:

Several reviewers noted that the authors of the EIS seem to be directly or indirectly in the pay of the Department of Energy or its contractors, all of whom have a vested interest in proceeding with one or another disposal scheme and none of whom has the main responsibility for community health (Letter Numbers: 175, 193).

Response:

In accordance with the regulations of the Council of Environmental Quality, the DOE is responsible for preparation of this EIS. A large number of individuals of varying disciplines and employing organizations contributed to the analysis and preparation of the draft and final EIS (see Chapter 7 of the EIS). These professionals were hired by the DOE and its contractors for their expertise and experience in the applicable technical areas. Furthermore, extensive review by independent technical peers of other federal and state agencies provides an effective check and balance against inadvertent bias.

2.5.5 Comment:

Several reviewers were concerned that a conflict of interest exists between DOE producing the nuclear material, setting their own radiation protection standards for release of radioactive material and classification of waste, self monitoring, waste storage and disposal and protection of the environment and public health and safety.

Several reviewers expressed their opposition to the DOE's mission at Hanford, and the way DOE and its predecessor agencies have managed the wastes, and expressed (or implied) lack of confidence that the DOE could be relied upon to effectively dispose of wastes in a manner that would protect public health and safety in the long term. Independent reviews of Hanford activities were called for (Letter Numbers: 4, 11, 14, 16, 17, 18, 21, 23, 30, 39, 43, 44, 51, 54, 55, 59, 61, 62, 64, 67, 68, 70, 73, 75, 76, 77, 78, 82, 83, 84, 104, 106, 107, 110, 115, 117, 119, 121, 123, 125, 127, 129, 130, 136, 142, 144, 146, 151, 152, 155, 162, 171, 174, 175, 186, 187, 189, 193, 198, 201, 202, 204, 208, 211, 212, 214, 216, 219, 230, 242. Hearing Numbers: 319, 320, 408, 435, 447, 468, 543, 556, 557, 604, 606, 607, 619, 622, 623, 624, 632, 636, 643, 644, 647).

Response:

The DOE's activities at the Hanford Site are conducted in accordance with and authorized by the Atomic Energy Act (AEA) of 1954 as amended (Public Law 83-703) and other authorizing legislation, including the Energy Reorganization Act of 1974 and Department of Energy Organization Act. These Acts specifically provide for nuclear materials production and related activities, development and evaluation of military applications of atomic energy and operation of its production and waste management facilities.

The DOE's predecessor agency, the Atomic Energy Commission, initially set radiation protection standards for occupational and environmental exposures. By and large these standards followed the recommendations of the National Council on Radiation Protection and Measurements (NCRP) and were in concert with recommendations of the International Committee on Radiological Protection (ICRP). In 1960, the Federal Radiation Council, formed by Public Law 86-373, provided guidelines for occupational and environmental exposure that were adopted by the AEC and its successor agencies. Those standards remain in effect until the Environmental Protection Agency, the successor agency to the Federal Radiation Council, has a final rulemaking on standards for radiation exposure. Some standards have been promulgated by EPA, such as a 25 mrem/yr limit for maximally exposed members of the public where the exposure path is from airborne radioactive material (40 CFR 61 Subpart H, National Emission Standard for Radionuclide Emissions from Department of Energy Facilities). More comprehensive standards applicable to DOE operations have been incorporated into DOE Orders for protection of public health and the environment and continue to reflect current ICRP and NCRP recommendations. Thus, DOE limits are in accord with applicable limits promulgated by the EPA or other authoritative bodies.

The DOE and its predecessor agencies have requested independent review by such entities as the National Academy of Sciences (NAS 1978). An NAS review of single-shell tank waste disposal alternatives is ongoing.

2.5.6 Comment:

A number of individuals representing themselves or groups expressed opposition to the production of nuclear weapons and/or nuclear energy with its attendant production of nuclear waste, contending that there was no demonstrated need, or that a demonstration of the need was required, for more/any nuclear weapons. Opposition was also expressed to transportation of nuclear waste and the contention was made that there is no place on earth for safe disposal of nuclear waste. The shutdown of N Reactor and of PUREX was also called for. It was mentioned that the final EIS should address the need for more plutonium and highly enriched uranium, contending that their production contributes to the probability of nuclear war (Letter Numbers: 7, 9, 12, 18, 24, 25, 27, 31, 36, 38, 44, 47, 51, 54, 57, 59, 62, 63, 65, 66, 67, 72, 73, 75, 82, 84, 86, 88, 89, 90, 93, 103, 104, 107, 108, 110, 115, 116, 117, 119, 120, 121, 122, 123, 125, 127, 130, 135, 136, 143, 146, 151, 152, 153, 156, 167, 170, 171, 174, 175, 179, 181, 185, 186, 187, 188, 191, 194, 196, 197, 203, 204, 207, 208, 209, 212, 216, 217, 218, 219, 220, 222, 223, 225, 226, 227, 228, 229, 230, 236. Hearing Numbers: 332, 406, 409, 410, 411, 417, 419, 421, 422, 424, 428, 430, 431, 432, 436, 443, 444, 447, 449, 452, 455, 457, 459, 460, 462, 464, 469, 471, 472, 473, 474, 511, 518, 520, 522, 523, 532, 534, 535, 536, 537, 540, 541, 543, 544, 545, 546, 548, 549, 551, 553, 559, 565, 618, 622, 630, 631, 635, 637, 642, 644, 645, 649, 652, 656, 658, 660).

Response:

The issue of nuclear power production and the production of special nuclear materials, such as plutonium, is beyond the scope of this EIS. The need for special nuclear material is addressed in the Nuclear Weapons Stockpile Memorandum, which is a document issued by the President. Subsequent authorization and appropriation of funding for production of the required materials is provided by Congress.

2.5.7 Comment:

Reviewers questioned why all of the land area in the 32-square-mile disposal area needed to be kept from public access. Reviewers felt that only the land area that was irretrievably contaminated by dangerous materials should be restricted. On the other hand, one reviewer noted that the remaining 98% of the radioactive waste will still require the Hanford Site to remain a controlled area. Choosing a repository elsewhere would only contaminate another area (Letter Numbers: 12, 101, 116, 216, 223).

Response:

The Hanford Site comprises an area of approximately 570 square miles that was withdrawn in 1942 for use in the national defense effort. Following World War II it was decided by the United States Government that the Site was required for continuing national nuclear-related activities. The Hanford Site remains under federal control and is expected to remain so indefinitely. The consolidation of waste disposal into a 32-square-mile area was proposed to make the use of boundary markers economically reasonable, to meet the spirit of the controlled zone as per 40 CFR 191, and to accommodate future disposal as may be appropriate in the designated disposal area. It is planned that the remaining area will be retained in "restricted" status for purposes of public safety and national security.

2.5.8 Comment:

Reviewers pointed out that there are potentially valuable and beneficial uses for the radioactive waste which might be cause to consider retrievable storage rather than permanent disposal. Several potential uses were cited: medical sterilization, food preservation, vermin and insect control, industrial irradiators and security fences or barriers. One reviewer advocated research, education, and extensive public relations efforts to promote the benefits of the radioactive properties of the waste and open up world markets (Letter Numbers: 13, 81, 113, 172, 173. Hearing Numbers: 324, 325).

Response:

The DOE agrees that there are possible beneficial uses for some waste constituents. However, the only wastes that currently provide reasonable opportunities for reuse are strontium and cesium capsules. Cesium capsules are presently being used as irradiators and some strontium has been used for power sources. The disposal alternatives are intended to be permanent and are not designed to provide for retrieval. While future retrieval is not precluded, the final waste forms, i.e., glass and grout, probably would make retrieval impractical. Furthermore, the current costs of recovering these byproducts from wastes are higher than their market prices and therefore would not warrant their recovery.

2.5.9 Comment:

Reviewers felt that the EIS needs to discuss what information is still needed to resolve waste issues (Letter Numbers: 70, 161).

Response:

The draft EIS was prepared early in the decision-making process, as required by NEPA, with the knowledge that additional data would be required in certain areas to support an exhaustive analysis. The timing of the release allowed public and agency comment early in the decision process. In the discussion of the preferred alternative in Section 3.3.5 of the final EIS, a general list is provided for development and evaluation items that are required to make a decision on each waste class. In addition, the Interim Hanford Waste Management

Technology Plan (HWMTP) (DOE 1986e) that is cited throughout the EIS provides detailed information on the technology and data required before any of the alternatives can be implemented. The HWMTP is being revised to be consistent with the final EIS (and later the Record of Decision).

2.6 REFERENCES

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3.0 TECHNICAL COMMENTS AND RESPONSES

The comments dealing with technical issues are categorized in this section as pertaining to one of the following areas: data base and facilities, affected environment, disposal alternatives and technologies, short-term impacts, and long-term impacts.

3.1 DATA BASE AND FACILITIES

Comments summarized here are centered on data associated with waste inventories, waste characteristics, and waste definitions.

3.1.1 Data Base

3.1.1.1 Comment:

A number of reviewers expressed concern that data bases for waste inventory, waste characteristics and waste definitions are not adequately known (Letter Numbers: 5-DOI, 46, 78, 171, 178, 189, 215, 216, 217, 230, 242).

Response:

The DOE believes that sufficient information is available to begin disposal operations for several categories of waste discussed in this EIS (see the discussion of the preferred alternative, in Section 3.3.5 of the final EIS). However, characterization before disposal will continue for all waste classes, as discussed in the Interim Hanford Waste Management Technology Plan (DOE 1986e). The characterization planning for the single-shell tank (SST) waste and pre-1970 TRU sites is included. The SST waste characterization effort has been started and six tanks in the TY tank farm have been sampled and analyzed; the data were reported by Weiss (1986). Also, nine additional single-shell tanks have been sampled and analyzed and the data have been documented in RHO-RE-EV-89 P, Preliminary Assessment of the TRAC Model as a Predictor of Key Radionuclide Inventories (Adams, Jensen and Schulz 1986).

3.1.1.2 Comment:

A reviewer noted that the draft EIS does not provide a means of comparison between the volumes and concentrations of the wastes (Letter Number: 215).

Response:

Summary tables in the EIS (Appendix A) show total volumes and total radioactivity in curies. Data from these tables can be used to calculate average concentrations, thus allowing comparison among the six waste categories discussed.

3.1.1.3 Comment:

Some reviewers felt that the locations of the different types of waste sites and their contents are not adequately shown in the draft EIS (Letter Numbers: 171, 215, 239-NRC).

Response:

The draft EIS has presented total waste inventories for the several waste classes and representative content descriptions for specific waste sites, Appendix A. The DOE believes that the data presented on waste sites are sufficient to assess the impacts of the various disposal alternatives and that additional details about site locations would not assist in the impact analyses presented in this EIS.

Where waste site contents are not sufficiently known, additional development and evaluation are recommended; i.e., a deferred decision is recommended on these sites (see a discussion of the preferred alternative in Volume 1, Section 3.3.5).

3.1.1.4 Comment:

A reviewer noted that the draft EIS stated that, by comparison with wastes disposed of on the 200 Areas plateau, the 300 Area waste sites contain "minor" quantities of TRU waste. "Minor" should be defined, or actual figures should have been given (Letter Number: 171).

Response:

Section 5.3.4.1 presented only an overview. The inventories of the sites in question are given in Table A.11 in Appendix A. Note that 618-1 and 618-2 have been reclassified as low-level waste sites as a result of determining (after the draft EIS was published) that the amount of plutonium in each of those sites was one gram and not one kilogram.

3.1.1.5 Comment:

A reviewer noted that the draft EIS presents defense waste as considerably less radioactive than commercial spent fuel but expressed concern that from a public health standpoint, the critical parameter is not specific activity, but potential source term. The solubility and dispersability of single-shell tank wastes more than make up for their lower specific activity. Thus, if national policy favors deep geologic disposal for high-level waste, defense wastes should be considered in the same light (Letter Number: 171).

Response:

Even if one accepts a ratio in specific activity between commercial and defense wastes of 1000:1, there is certainly enough activity in defense waste to warrant great care in its disposal. On the other hand, there is an important distinction to be made regarding specific activity and total source term. Total activity (source term) is important in determining the total integrated impact, whereas the specific activity is important as well in determining the maximum impact on individuals. Solubility and dispersability of wastes if infiltration of water is not prevented is a valid consideration. It was not intended in the draft EIS to favor any alternative for disposal of single-shell tank waste. Also see Comment 2.2.7.

3.1.1.6 Comment:

A reviewer wanted to know whether the soil added by interim stabilization had been included in Tables A.11 and A.12, and how it had been possible to include the actual amount of plutonium if some of the contents of the trenches were classified or unknown (Letter Number: 223).

Response:

The overburden volume added by interim stabilization is included in the tables. Records show the mass in grams of plutonium contained in each site. However, this information was not always recorded for each trench in a site. Values in Table A.11 were derived from records for amount of plutonium and an average value for isotopic composition. The data presented are conservative in order to provide a bounding analysis for the EIS.

3.1.1.7 Comment:

A reviewer noted that while tables in the draft EIS show the estimated inventories of key radionuclides, no indication is given as to the accuracy of these values; therefore, a range should be given for each radionuclide to show the amount of uncertainty.

The reviewer also noted that, on p. xxvii of Volume 2 of the draft EIS, it is stated that inventory values have an uncertainty of +50%/-30%. This uncertainty is very large and should be explicitly stated in any table that uses these values (Letter Number: 215).

Response:

The basis for all inventories was the report by Rockwell (1985), wherein the rough, overall estimate of data accuracy is +50% to -30%. These values would apply to all tables in the draft EIS that employed those inventories. The requested detail may be needed for some implementation, but is not needed to decide among alternatives. The same inventory is used as the basis for each alternative. Even if the inventory were doubled (or halved) for each alternative consistently, the relative comparison would remain unchanged. Rather than specifying uncertainty in each table, accuracy is addressed in the review draft EIS early in Section 3.2, Appendix A, and Appendix B. In Section 3.2 and Appendix B the following is indicated:

- The numerical information on waste inventories are the most accurate data available based on historical records, and are believed to be adequate for generic waste descriptions.
- Future characterization of wastes will be necessary to provide more detail, and in some cases is already under way (Rockwell 1987).

In Appendix A (A.1.3) it is indicated that:

- Single-shell tank waste characterization includes the development of a plan to assemble existing characterization data and to acquire additional data as required. The waste characterization data will be used to form a data base for the single-shell tank wastes.
- Two methods are currently being pursued to characterize wastes in single-shell tanks: 1) simulation modeling and 2) sampling and analysis. Development work is required to calibrate the computer model used to estimate the total waste inventory and the distribution of waste components among tanks. Core-sampling equipment, which takes waste samples from the tanks while maintaining the waste layers, has been demonstrated. Wastes in nine tanks have now been sampled and analyzed

for comparison with computer model predictions. The tanks chosen for sampling were predicted to contain significant amounts of key radionuclides (carbon-14, iodine-129, technetium-99, plutonium-239, plutonium-240, and americium-241). Computer predictions for carbon-14 were about 1,000 times higher than the amount actually found, and may be highly conservative for this radionuclide. Predictions for plutonium were low by a factor of 3. Agreement was much better for the other radionuclides, with the computer predictions being within the 95% confidence interval of analyses for at least half of the tanks (Rockwell 1987).

3.1.1.8 Comment:

Reviewers wanted to know how the impacts from the various forms of waste could be assessed if the contents of the various tanks cannot be adequately characterized (Letter Numbers: 215).

Response:

Values for total quantities of materials in waste tanks as a group are known well enough to permit a selection from among the proposed alternatives. Distribution among waste tanks is less well known, and will be determined, before actual disposal, to the extent required for whatever alternative is selected. Where uncertainties exist, conservative estimates were used to ensure that a bounding analysis was performed (i.e., estimated impacts would be larger than those estimated with better characterization data or actually experienced).

3.1.1.9 Comment:

Reviewers commented that "confusion" exists regarding which wastes are high-level and which are not. The reviewers stated that for some of the defense waste, certain disposal requirements were bypassed by simply reclassifying the waste; waste volumes were lowered by changing definitions. It was suggested that waste types need definition (Letter Numbers: 76, 103, 171, 217, 240).

Response:

Definitions for high-level waste (HLW), transuranic (TRU) waste, and low-level waste (LLW) are provided in Chapter 8 of the draft EIS. These definitions are similar to those in Nuclear Regulatory Commission (NRC) and Environmental Protection Agency (EPA) regulations. With the exception of transuranic wastes, none of the definitions refers to intrinsic properties, such as radionuclide concentrations. The "confusion" mentioned in the comment may refer to the category of tank waste, because tanks have received all classes of liquid waste: HLW, TRU waste and LLW. In addition, substantial amounts of fission products have been removed from tank wastes. Thus these wastes have not been classified in this EIS, they are called "tank waste."

The EPA already has the authority for independent oversight of impacts from DOE operations including disposal practices. The EPA rule 40 CFR 191 regulates disposal of HLW and TRU waste, EPA Rule 40 CFR 61 regulates airborne levels of radionuclides, and EPA 40 CFR 141 regulates community drinking water. Rule 40 CFR 193, when issued, will regulate disposal of LLW. All these rules will guide DOE disposal activities.

A decision to change the definition of TRU waste from 10 to 100 nCi/g was made in 1982. Changing the definition of TRU affects the volume of material to be processed in the geologic alternative; i.e., 35,000 m^3 to 32,000 m^3 for TRU-contaminated soil sites and 360,000 m^3 to 110,000 m^3 for pre-1970 buried suspect TRU-contaminated solid wastes.

See also comment 3.1.1.10.

3.1.1.10 Comment:

Reviewers commented on what they perceived to be a problem created by the DOE in its "shifting and expedient" definitions of high-level, low-level, and transuranic defense wastes. It was suggested that, in order to obtain an accurate picture of the quantities and hazards of Hanford defense wastes, a set of definitions of high-level, low-level and transuranic wastes consistent with those employed by other agencies should be provided (Letter Numbers: 193, 201, 223. Hearing Numbers: 302, 627).

Response:

DOE definitions are consistent with those used by EPA and NRC. The only major change in recent years relates to the definition of transuranic waste. The transuranic waste definition was changed from 10 nCi/g to 100 nCi/g. This change is consistent with both EPA and NRC limits.

For this EIS, the environmental impacts were determined on quantities of the various radionuclides in six classes of waste without regard to whether they were or were not high level. Regardless of the quantitative definition of high-level waste, the environmental impacts derived from the analysis of the disposal options would not change.

The definition of the class of waste called "transuranic waste" grew from a 1970 recommendation of an AEC working group that provided for segregating plutonium-contaminated solid waste at a level of 10 nanocuries per gram of waste. The basis for selecting 10 nanocuries of plutonium-239 as the segregation limit was based on a comparison with the toxicity and natural occurrence of radium-226 (Appendix B to DOE 1974). The stated advantage to the rationale for that limit was that it was environmentally derived. The disadvantage was that at the time of its recommendation, external radiation measurements on waste packages could not detect the presence of plutonium at such a low concentrations.

The DOE changed its definition of transuranic waste to 100 nCi/g in its Order 5820.1 (DOE 1982b). Although the NRC did not call them out as transuranic waste, in its final rule for Licensing Requirements for Land Disposal of Radioactive Waste in 10 CFR 61 (47 FR 57446) the NRC concluded that alpha-emitting radionuclides in concentrations greater than 100 nCi/g were not generally suitable for near-surface disposal. The EPA in its final rule for Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Wastes, 40 CFR 191 (50 FR 38084) defines "transuranic radioactive waste" as waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes with half-lives greater than 20 years, per gram of waste. Thus, the several agencies are in essential agreement on the definition of transuranic waste.

3.1.1.11 Comment:

Reviewers requested the following information: 1) clarification of key terms: "high-level waste," "tank waste" and "defense waste," and their relationships; 2) waste definitions; 3) waste streams to tanks; 4) whether Hanford Site decontamination and decommissioning wastes have been disposed of within Hanford tanks; 5) a concise listing of all wastes routed to tanks, including volumes, origin, and chemical composition; 6) tank waste generated outside the 200 Areas; and 7) a description of past, present, and future characterization efforts. Other reviewers stated that Hanford tank wastes are high-level wastes, and that if subsequent processing of these wastes may have altered the classification, more detailed characterization would be required to support that view; otherwise, some reviewers felt, these wastes should be disposed of in a repository. A tabular listing of all nonradioactive and radioactive waste streams expected to be generated under each disposal alternative was also requested (Letter Numbers: 215, 223, 233, 239-NRC).

Response:

1) Presently, wastes generated from the operation of the first cycle solvent extraction process are considered high-level wastes, and, according to EPA, NRC, and DOE definitions, high-level wastes are characterized as having concentrations of radionuclides such that they require permanent isolation. No approved numerical value or values exist at this time to define the concentrations at which isolation would be necessary. Deliberations among agencies are under way to establish numerical limits; NRC is the lead agency. Until such limits are established, this definition is limited by the first-cycle solvent extraction definition. Therefore, until further waste characterization and identification of tank-waste sources are complete, it is inappropriate to describe single-shell tank waste as high-level waste. Because of the inability to identify single-shell tank wastes by their source, and because the analysis of impacts does not depend on which category the tank wastes come under, they were referred to simply as "tank wastes."

All wastes discussed in this EIS are classified as "defense waste." They all were generated to support specific United States defense programs, as opposed to radioactive waste generated to support commercial power generation or medical treatments. "Defense" defines a category by origin of wastes and is not intended to be a regulatory classification.

2) Again, all wastes covered in the EIS are defense wastes. Defense wastes exist in all forms (HLW, LLW, TRU, hazardous, etc.). Transuranic wastes are defined as those wastes, other than high-level waste, having greater than 100 nanocuries per gram of transuranic elements. Some of the wastes stored in underground tanks at Hanford are TRU wastes. Until the planned characterization of the tank wastes is complete, the specific tanks that will meet or exceed TRU limits are not fully identified. This will be determined before disposal. See comment 3.1.1.10 for a discussion of the definition of TRU waste.

3) As indicated on page x of Volume 1, tank wastes can be subdivided into 1) existing tank waste and 2) newly generated and future tank wastes. Waste streams to tanks are discussed in responses 5 through 6 below. As indicated in response 5, waste data are broken down into individual streams and/or tank transfer information. Also, the major streams are

described in the indicated sections. As indicated in response 6, wastes generated outside the 200 Areas ("Customer Wastes") are discussed in the indicated sections.

As indicated in Chapter 6 of the final EIS, the DOE will comply with all applicable regulations promulgated pursuant to RCRA to the extent that such regulation are not inconsistent with Atomic Energy Act (AEA) requirements. At the time this EIS was first drafted, all tank waste was designated as byproduct waste by DOE. DOE issued a final interpretative rule on byproduct material on May 1, 1987, 52 FR 15937. See Chapter 6 in the final EIS for a discussion of this rule; see also comment 2.4.1.9.

4) Small amounts of decontamination waste were routed to tanks for interim storage. Wastes from decommissioning old facilities are generally solid waste and are sent to either the LLW or the TRU burial ground, depending on the level and type of contamination.

5) Estimated inventories in tanks are provided in Sections A.1 and A.2 of Volume 2 of the EIS and in somewhat more detail on pp. 2.1 through 2.21 of RHO-RE-ST-30 P (Rockwell 1985). These data are not broken down into individual streams and/or tank transfer information. The major streams (complex concentrate, neutralized current acid waste, etc.) are described in the sections indicated. A significant characterization effort for single-shell tank wastes has been started to provide information on chemical and radionuclide contents on a tank-by-tank basis. As these tanks are not receiving wastes now and have not been since November 1980, the original source information does not aid in determining disposal alternatives. Sampling of streams going to double-shell tanks is routine but is normally used to evaluate process efficiencies and to verify that double-shell tank operating specifications are being met. The sampling is not for disposal activities, as the waste is currently being stored pending disposal at a later date.

6) Wastes generated outside the 200 Areas and presently stored in tanks are called "customer wastes" and are described in Sections A.2.2.3 and A.2.3 of Volume 2 of this EIS. These customer wastes consist of about 22% by volume of waste received <u>before</u> concentration, as discussed in the EIS. This waste is generally LLW, which is concentrated by a factor of about 10 in an evaporator facility.

7) The document RHO-WM-TI-1P, <u>TY Tank Farm Waste Characterization Data</u>, (Weiss 1986) details recent characterization work. The Interim Hanford Waste Management Plan (DOE 1986d) and Hanford Waste Management Technology Plan (DOE 1986d) also outline future characterization work for both single-shell and double-shell tank wastes. The "Analytical Methodology" section in Volume 2 of the EIS includes a description of the approach used to bound the uncertainties in present tank inventory assessments. The details of specific analytical efforts are outside the scope of this document. See also comment 3.1.4.4.

3.1.1.12 Comment:

One reviewer, commenting on Section 3.3.2.1, asked whether the land area associated with tank farm disposal (34 hectares) includes tanks under construction or in the planning stages (Letter Number: 223).

Response:

Tank farms within the scope of this EIS are described in Sections 3.2.1 and 3.2.2, and in Appendix A (e.g., Table A.1). Land area specified does not include that for other tanks that may be planned.

3.1.2 Capsule Waste

3.1.2.1 Comment:

A reviewer commented on Appendix B and noted that there is not sufficient discussion on the technical feasibility or legal authority for the disposal of capsule waste. The reviewer requested information regarding the guidelines presented in the draft EIS, p. B.19. The reviewer questioned what conditions (e.g., temperature), as indicated by facility monitoring, would require mitigative measures (Letter Number: 215).

Response:

The technical feasibility for disposal of capsule waste has been investigated (Kaser 1979; Campbell 1981).

Monitoring of temperature and pressure of strontium and cesium drywells would be to assure that the disposal criteria, which were developed to ensure capsule integrity, would not be exceeded under field conditions. In the unlikely event that these criteria would be exceeded, the capsules in question could be removed for mitigating action.

The potential for environmental contamination from encapsulated strontium and cesium disposed of in near surface drywells is believed to be very small. The capsules are in multiple containers and placed at given distances apart to maintain the capsule temperatures within design criteria (to control corrosion rates). It is unlikely that the strontium and cesium containers would be breached in the 800 or so years before the strontium-90 and cesium-137 has all essentially decayed away (for the case of breach by drilling see Section 3.4.2.3).

3.1.2.2 Comment:

Reviewers saw the permanent disposal of cesium and strontium capsules as economically disadvantageous because of their potential usefulness in medicine, agriculture, and the like.

Response:

In accord with the comment, encapsulated waste is being used for or planned for beneficial purposes. It is at the end of that use that disposal is planned.

3.1.2.3 Comment:

One reviewer commented on Section 3.2.3 and noted that the rationale for only removing cesium from future waste in the in-place stabilization and disposal alternative is not explained. Also, it was noted that storage temperatures above 300°C could result in potential explosive reactions, and that the effects of the high temperatures on tanks are not known (Letter Number: 215).

Response:

All of the future double shell tank waste would be processed into grout (except for cesium) in the in-place stabilization and disposal alternative. If neither cesium nor strontium is removed before incorporating the waste into grout, heat removal would preclude a reasonable grout-slab thickness. Cesium removal was selected because of process simplicity. See Section 3.1.2.2, Volume 1, for additional discussions of future tank waste. Temperature limits in waste tanks can be controlled by limiting the amounts of heat producers (like cesium and strontium) in any waste tanks, as well as by using cooling coils and ventilation systems. Tanks that would receive high-heat waste are double-shell, heat-relieved tanks, designed especially for the expected temperatures, and are therefore capable of storing the waste safely.

3.1.2.4 Comment:

One reviewer asked how the separation of cesium from the single-shell tanks would be accomplished (Letter Number: 223).

Response:

Cesium is not preferentially separated from single-shell tank waste in any of the alternatives.

3.1.2.5 Comment:

Reviewers noted that the capsule waste should continue to be stored in water basins until a repository is available for its disposal, and agreed that capsules should be disposed of in a deep geologic repository (Letter Numbers: 53, 57, 71, 141, 217).

Response:

The preferred alternative, which is described in Volume 1, Section 3.3.5 of the final EIS, is consistent with the reviewers' comments.

3.1.2.6 Comment:

One reviewer expressed concern regarding material relating to strontium and cesium capsules. The reviewer noted that in one place (I.2.1), the draft EIS stated that the capsules are to remain in the water basins until 1995. On the other hand, capsules are to remain in water basins until the repository is built (Letter Number: 209).

Response:

Section I.2.1 of the EIS (p. I.6, para. 2) has been revised to state explicitly that the cesium and strontium inventories and radionuclide data for the year 1995 were used in the transportation impact analysis. The DOE's preferred alternative is to continue storage or utilization of capsules for beneficial purposes. When a repository becomes available, capsules that are no longer useful will be disposed of in a repository.

3.1.2.7 Comment:

A reviewer stated that the radioactivities of the decay daughters must be considered in estimating the Hazard Index of the parent plutonium and americium (Letter Number: 101).

Response:

The potential impact of decay products are included in the Hazard Index for each radionuclide.

3.1.2.8 Comment:

Reviewers wanted to know when the practice of leasing and shipping of cesium and strontium began, and requested explicit information regarding such shipments, as well as information regarding returned capsules (Letter Numbers: 174, 209, 210, 243-EPA).

Response:

The actual shipments of cesium and strontium capsules to commercial irradiators began in February 1985. For more information see comment 3.4.2.14.

3.1.3 Transuranic Waste

3.1.3.1 Comment:

Several reviewers have expressed concern about the definition of TRU wastes, and the fact that the definition was changed from 10 nanocuries (nCi) of TRU per gram of waste to 100 nCi TRU/g.

Response:

See comments 2.4.1.8 and 3.1.1.10.

3.1.3.2 Comment:

Reviewers expressed concern about the content, handling, and disposal of waste containing between 10 and 100 nCi TRU/g (Letter Numbers: 101, 171, 174, 233, 239-NRC, 243-EPA).

Response:

The EPA and NRC define TRU waste as waste that contains more than 100 nCi TRU/g waste. The limiting factor includes not only plutonium, but other transuranic isotopes (e.g., americium-241) as well. Waste that contains less than 100 nCi TRU/g is treated as either low-level or high-level waste, even though the waste may not contain plutonium. Low-level waste is outside the scope of this EIS; however, see also response at 3.1.3.33.

3.1.3.3 Comment:

Reviewers questioned how sites were determined to be TRU sites, including inventory determination and uncertainties. One reviewer noted that it should be mentioned that the area included in the 218-E-12B burial ground is only the inactive portion and does not include the portion that is active at this time (Letter Numbers: 215, 223).

Response:

The TRU-contaminated soil sites were selected based on a minimum of 100 nCi TRU isotopes/g averaged over the potentially contaminated soil volume or on an indication that 80 g of plutonium had been released per 100 m^2 of soil area. Portions of the 216-U-10 pond site and three feed ditches--216-Z-1, -11, and -19--showed high TRU concentrations at the outfall to the pond and were also categorized as TRU sites. Because of uncertainties in inventories, sites that might fit the definition were included along with those known to fit the definition.

A pre-1970 burial ground is defined as a buried suspect transuranic-contaminated solid waste site if the concentration of some containers is estimated to exceed 100 nCi/g TRU (based on a soil density of 1.8 g/cm^3 and a peak-to-average concentration of 10:1). On this basis, nine pre-1970 buried suspect transuranic-contaminated solid waste sites have currently been identified on the Hanford Site.

The existing waste inventories are based on historical records. Future characterization of wastes is planned to provide more detail. Assumptions necessary to project future waste inventories are provided in appendices of RHO-RE-ST-30 P (Rockwell 1985). A rough, overall estimate for data accuracy is +50 to -30 percent.

The inactive portion of the 218-E-12B site is a pre-1970 buried suspect TRU-contaminated solid waste site. No additional TRU waste is placed in that site; TRU waste is packaged for 20-year retrievable storage.

3.1.3.4 Comment:

A reviewer stated that the DOE does not consider cleanup of the transuranic soil sites identified in the draft EIS because, according to the draft EIS (p. 3.9), pre-1970 buried suspect transuranic-contaminated solid wastes and transuranic-contaminated soil sites are considered to have been disposed of. Another reviewer stated that leaving more than 100 kg (of plutonium) in Hanford soils is unacceptable; 10 kg might be acceptable. Another reviewer commented that all contaminated soil sites, whether near surface or not, should be excavated to reduce the radioactivity to a "safe" level (Letter Numbers: 103, 161, 217, 219, 230).

Response:

The reviewers misinterpret the DOE's intent, which is further stated in the referenced paragraphs (Sections 3.2.5 and 3.2.6). The reference notes that these sites "... are being reviewed to determine whether further action is warranted in terms of environmental protection." These wastes were considered for additional cleanup under the geologic disposal alternative (Sections 3.3.1.5 and 3.3.1.6) or additional environmental protection actions under the other disposal alternatives. Further evaluation of the wastes prior to disposal is also included in the preferred alternative.

The sum of amounts of plutonium cited by Soehnlein (1972, 1974) amounts to about 290 kg discharged to the ground in the 200 Areas through 1971. Remedial actions removed 58 kg from the Z-9 trench between 1976 and 1978. That action, 58 kg, plus removal of 190 kg covered by this EIS, equals 248 kg, leaving 42 kg rather than 100 kg. Most of this plutonium (about 30 kg) is believed to be in low-level waste sites, which are not included in the scope of this EIS.

3.1.3.5 Comment:

A reviewer questioned the information on volumes and inventories of TRU waste that would remain in place at the Hanford Site for each disposal alternative (Letter Number: 174).

Response:

The requested data may be found in both this EIS and RHO-RE-ST-30 P (support data for the EIS, Rockwell 1985). The inventory and location of eight selected radionuclides for the disposal alternatives are given in the EIS (see Appendix P). Volume data may be found in Appendices A and B (EIS) as well as in RHO-RE-ST-30 P (Rockwell 1985, Chapter 2).

3.1.3.6 Comment:

One reviewer noted that a 1972 report states that 110 Mg of uranium were dumped into soil, whereas the draft EIS only discusses a few curies of uranium. The reference document also lists 591 Mg of uranium and 373 kg of plutonium in pre-1972 solid waste in the 200 Area; the draft EIS only accounts for about 100 Ci of uranium and 100,000 Ci of plutonium in pre-1970 solid waste (Letter Number: 230. Hearing Number: 518).

Response:

The difference in uranium to soil cited is due to an ERDA-1538 citation of total uranium to soil in the 200 Areas whereas the uranium inventory cited in the EIS is that for TRU-contaminated soil sites. Similarly the amount cited in ERDA-1538 is for all buried solid waste whereas that cited in the EIS is for pre-1970 buried suspect TRU-contaminated solid waste only. When given in the same units, the plutonium cited in the comment and that in the EIS are essentially in agreement. The reviewer's statement that the EIS accounts for about 100 Ci of uranium and 100,000 Ci of plutonium in pre-1970 solid waste is in error.

3.1.3.7 Comment:

Reviewers pointed out a discrepancy between a General Accounting Office (GAO) report and the EIS. The GAO report on Defense TRU waste states that the DOE has not fully addressed 81% of the defense TRU waste (Letter Numbers: 71, 217).

Response:

The GAO report, Nuclear Waste: Department of Energy's Transuranic Waste Disposal Plan Needs Revision (GAO 1986), prepared for the House of Representatives Subcommittee on Environment, Energy, and Natural Resources Committee on Government Operations, specifically addressed the DOE's Defense Waste Management Plan (DWMP) (DOE 1983) relative to permanent disposal of defense TRU waste at all DOE sites. The DOE recognized that the inventory data in the DWMP were outdated and provided the GAO with updated inventory estimates through December 1985. For the Hanford Site, the TRU inventories provided to the GAO are consistent with the TRU inventory data in this EIS. Nation-wide DOE TRU inventories (through 1985) were categorized as "stored" (19% by volume), "buried" (40% by volume) and "contaminated soil" (41% by volume). The GAO report states that the DWMP inadequately addresses the disposal of the buried and contaminated soil categories. This EIS does present disposal alternatives for 100% of all three categories of TRU waste at the Hanford Site.

3.1.3.8 Comment:

A reviewer requested more information regarding the "TRU burial grounds," both pre-1970 and retrievably stored, including 1) active and inactive solid waste burial grounds at Hanford; 2) the radioactive inventory (decayed through January 1, 1986) at each burial ground and the chemical (as hazardous waste or mixed waste) inventory at each site, including volumes of contaminated solvents in storage; and 3) a summary of existing monitoring practices and other safeguards employed at these sites, a comparison of these practices with provisions for solid radioactive waste burial in 10 CFR Part 61, and regulations promulgated under the Resource Conservation and Recovery Act (RCRA) as amended (Letter Number: 174).

Response:

1) The active and inactive burial grounds at the Hanford Site are defined in the draft EIS as "land specifically designated to receive contaminated waste packages and equipment, usually in trenches covered with overburden." See also Appendix A of Volume 2.

2) The "TRU burial grounds" discussed in the draft EIS contain retrievably stored TRU and pre-1970 suspected TRU buried solid wastes. The radioisotopic inventory (decayed through 1995) for those sites is discussed in Appendix A. Before 1986, no chemical inventory was maintained for specific burial grounds. Characterization and documentation are currently under way to outline the known chemical data on specific burial grounds.

3) All practices regarding current solid waste burial are aimed at conformance to DOE Order 5820.2, "Radioactive Waste Management" (DOE 1984). A phased plan for RCRA compliance is presently being negotiated with the EPA and the Washington State Department of Ecology. Present monitoring and safeguards practices are part of ongoing operations and are outside the scope of this EIS.

3.1.3.9 Comment:

Reviewers questioned the radionuclide inventories used throughout the draft EIS. The reviewers requested a more detailed discussion of inventory estimates and the criteria for establishing TRU sites (Letter Numbers: 156, 215, 223).

Response:

Inventory data for pre-1970 transuranic waste sites are based on the best records available. When inventory discrepancies existed, engineering judgment was applied and a conservative (higher) inventory was used. As a consequence, instead of existing transuranic sites being left out of the EIS, the more likely case is that there are sites considered in the EIS that are not transuranic sites. Concentrations of transuranic elements were determined by estimating the volume of contamination. For contaminated soil sites, the depth of migration and corresponding contaminated soil volume were modeled from characterization of sites having known inventories of transuranic elements. For buried solid waste sites, the volume is based on the dimensions of each trench or caisson. The volume of contamination includes contaminated soil in the zone of the buried waste, but it does not include the overburden soil above the zone of buried waste. If the concentration of some containers in a site was estimated to equal or exceed 100 nCi/g TRU, that site was identified as a suspect TRU waste site.

3.1.3.10 Comment:

A reviewer expressed concern about predicted groundwater contamination due to waste in the 618 burial ground. Data presented in Appendix Q of the draft EIS for the 618 sites (Table Q.16) are for a no-barrier situation. The reviewer felt that the discussion and presentation of the results of the 618 burial ground sites was inadequate since only the results of the no-barrier situation were presented (Table Q.16); results should have been produced for the case of an operative barrier if that is planned for these sites. It is apparent that the predicted ground water contamination without a barrier is well above EPA water quality standards (40 CFR 141.16--e.g., the strontium standard is exceeded by a factor of 300) (Letter Number: 215).

Response:

The reviewer is correct that data with an operative barrier over the 618 sites were not included. The reason no data were offered was that the particular analysis indicated virtually zero migration of radionuclides with the barrier. (Subsequently, two of the three 618 sites (618-1 and 618-2) have been found to be low-level sites.) The peak concentration of strontium-90 in groundwater was calculated to be 2,100 pCi/L; substantially in excess of the numerical value of 8 pCi/L given in 40 CFR 141.16. The standard in 40 CFR 141.16 applies to community drinking water systems. Groundwater at Hanford does not supply any community drinking water systems. The first community downstream from Hanford is Richland, Washington for which the concentration of strontium-90 in drinking water in this case would be about 10^{-5} pCi/L which is far below the limit specified in 40 CFR 141.16.

3.1.3.11 Comment:

Reviewers commented on the discussion of types of containers used in the shallow land burial trenches in Section 3.2.6 of the draft EIS, "Pre-1970 TRU Buried Solid Waste." It was felt that wooden boxes should have been called out separately, and in addition to the other types of containers mentioned. Reviewers were concerned about subsidence resulting from failed containers. One individual requested that 50-gallon barrels containing radioactive waste be lined with cadmium (Letter Numbers: 215, 223. Hearing Number: 611).

Response:

Further description is contained in Appendix A as referenced in Section 3.2 (see especially Section A.5). Any unprotected container, even metal, could deteriorate with time and cause subsidence. Control of subsidence is described specifically in Section 3.3.2.4 and 3.3.2.6 and in Appendix B (Section B.1.4.2). There would be no advantage to lining barrels with cadmium.

3.1.3.12 Comment:

Reviewers expressed concern regarding subsidence control of buried TRU waste sites and TRU-contaminated soil sites, and asked the following questions: 1) What alternatives to the pile-driving method of subsidence control for TRU burial grounds have been considered? 2) How do the assurances of complete compaction compare to those of the pile-driving method? 3) How do their estimated costs compare to the costs associated with the pile-driving method?

4) How will the effectiveness of the proposed densification procedure be evaluated? One reviewer thought that grout should be used to prevent subsidence; another questioned the prudence of the vibratory compaction technique (Letter Numbers: 215, 223, 231, 234, 239-NRC).

Response:

Significant subsidence is possible in liquid disposal sites with underground cavities that could collapse upon decay of the structure supporting the void space. Records describe the engineering features of void spaces in settling tanks and the concrete of wood-lined caverns of crib systems; other liquid disposal sites did not contain significant voids. Records would be supplemented with field examinations to select injection points for subsidence control. If no suitable openings exist into an underground cavity a pipe would be installed. A cementitious grout (see Appendix A) would be injected into the cavity and allowed to harden. The quantity of grout injected would be monitored, and additional surveys would be conducted if the amount of grout were significantly less than the expected volume of the cavity.

1) Several alternatives to pile driving have been considered for reduction of subsidence. These include: vibratory compaction, explosive compaction, falling mass impact compaction, and grouting.

2) Complete compaction/collapse of all waste containers in TRU burial grounds is not feasible. However, substantial compaction of wooden and cardboard boxes, steel drums, and related materials has been demonstrated in field tests on simulated disposal trenches. Results of pile-driving and in-situ grouting tests have shown that nearly complete waste package consolidation and encapsulation is feasible.

3) Vibratory compaction was not technically feasible due to insufficient energy transfer to required depths. The costs associated with application of the remaining alternatives considered are somewhat site and condition dependent. However, their relative cost (in increasing order) is: falling mass, explosives, pile driving, and grouting.

4) The effectiveness of compaction methods can be determined by: a) measurement of the change of ground elevation, b) calculation of radial ground displacement, c) evaluation of methods at simulated waste disposal sites, and d) destructively examining treated sites.

3.1.3.13 Comment:

Three pre-1970 TRU-contaminated waste burial sites are very near the Columbia River, and Richland, in an area subject to flooding (the 300 Area). In the reference alternative and the geologic alternative, these wastes are to be removed. A reviewer reasoned that, since the EIS describes the criteria used to determine that these wastes are to be removed, it should also clearly identify other sites that may fit the criteria for removal of wastes similar to the criteria used to remove these (Letter Number: 217).

Response:

Because 618-1 and -2, as well as 618-11 (all suspected TRU solid waste sites) are located near the Columbia River and closer to areas of human habitation, it was reasoned that the wastes in these sites should be removed to the 200 Areas plateau. No technical analysis drove the decision, merely the recognition that prudence is advisable. Because all other TRU sites are located on the 200 Areas plateau, movement of the waste in those sites was not considered.

3.1.3.14 Comment:

One reviewer requested information regarding TRU material that has been received at the Hanford Site since 1983 (Letter Number: 217).

Response:

The information pertinent to disposal decisions for newly generated TRU waste is presented in this EIS under the category "retrievably stored and newly generated TRU." Only a small fraction of this waste is generated off site (Bihl, Aldrich and Stanfield 1985).

3.1.3.15 Comment:

One reviewer, commenting on Table A.9 of the draft EIS, noted that when the 216-Z-19 ditch was originally excavated to replace the old 216-Z-11 ditch, the old Z-1 ditch was inadvertently contacted. The reviewer inquired whether that site, which is now listed as the 216-W-20 unplanned release site, should also be included in the TRU sites (Letter Number: 223).

Response:

Site 216-W-20 is not classed as a TRU-contaminated soil site by the definition stated in Section 3.2.5 of the final EIS.

3.1.3.16 Comment:

On page 3.9 the EIS says there are 20,000 Ci of TRU waste in the soil. Yet Table A.10 shows over 30,000 Ci in one site (Hearing Number: 627).

Response:

Table A.10 gives inventories of the site having the highest TRU content and the highest fission product content, as well as the total inventories of all TRU soil sites. The total inventory of the crib is about 30,000 Ci for total fission product plus TRU waste, but only 18,000 Ci of TRU waste.

3.1.3.17 Comment:

Reviewers asked several questions based on Volume 1 of the draft EIS: 1) Are there "hot" landfills not included in the scope of the draft EIS? 2) What is the volume of contaminated soil as a result of tank leaks that would remain in place? 3) Why was the definition of transuranic (TRU) waste changed and how did the change affect cost estimates? 4) Are extraction decisions based on economics and politics and are they technical impossibilities? and 5) What is the procedure for determining radioactive contamination and disposal of equipment used to handle high-level waste? (Letter Numbers: 171, 182, 219).

Response:

1) Contaminated soil sites and solid waste sites discussed in this EIS are only those that are categorized as transuranic (TRU). TRU-contaminated soil sites that are estimated to contain TRU-nuclides at concentrations greater than 100 nCi/g are listed in Table A.9. The pre-1970 TRU solid waste burial grounds (where some containers are estimated to exceed 100 nCi/g) are listed in Table A.11. Retrievably stored TRU solid waste site inventories are shown in Table A.14. All low-level contaminated sites are outside the scope of the EIS.

2) As noted in Section 3.3.5 (p. 3.33) of the draft EIS, approximately 100,000 m^3 of contaminated soil resulting from tank leaks occurs around the tanks.

3) The decision to change the definition of TRU waste from 10 to 100 nCi/g was made in 1982 following the rule making by the Environmental Protection Agency and Nuclear Regulatory Commission. Background information for this change is provided in the response to comment 2.4.1.8 of this volume.

4) "Extraction decisions," or retrieval methods, are based on economically achievable technology that incorporates a high level of safety. Evaluation of retrieval technologies will be assessed, and the optimal method will be chosen before implementation takes place.

5) Equipment that is accessible to the environment used to handle high-level waste is routinely monitored to ensure that no contamination spreads through the environment. Radiation protection personnel survey the equipment to determine the level of contamination.

Radiological protection procedures are in place during the operational use of the equipment. Idle, contaminated equipment is appropriately packaged and placed in suitable storage to prevent inadvertent contact with or spread of contamination. Failed equipment (e.g., pumps) is packaged and disposed of in solid waste burial grounds in accordance with standard radiological operating procedures.

3.1.3.18 Comment:

A reviewer noted that the draft EIS states that TRU-contaminated soil sites consist of French drains and reverse wells. The reviewer felt that the nature of radioactive material pumped into wells, the levels of contamination and intentions for further use should have been described. Also, the probable action if more environmental protection is needed should have been stated (Letter Number: 171).

Response:

As stated in Appendix A, twenty-four sites (including French drains and reverse wells) have been identified as TRU-contaminated soil sites. These sites received TRU-contaminated solutions, in sufficient quantity, such that the sites are estimated to contain TRU nuclides at concentrations greater than 100 nCi TRU/g of material. The practice of discharging TRU-contaminated solutions to the soil column was discontinued in 1970 (reverse wells have not been used for discharge of TRU-contaminated waste since 1957). There were no additional discharge of TRU-contaminated solutions to the twenty-four sites nor will there be any in the future. The preferred alternative (Chapter 3, Volume 1) outlines the development and evaluation anticipated for those sites, including environmental protection requirements. In the interim, ongoing surveillance and monitoring are being conducted as current environmental protection practices.

3.1.3.19 Comment:

Reviewers commented that Z-Plant waste did contain "low concentrations" of plutonium and other TRU and was high in metallic nitrates. This waste was discharged via cribs to "soil columns." The reviewers felt that definitions of "low concentrations" or the actual data should have been provided in the draft EIS (Letter Numbers: 171, 219).

Response:

The material presented in Section 3.1.6 was intended to give an overview of one of the plants producing the waste under consideration. The inventory of wastes sites associated with Z Plant is given in Table A.9 of Appendix A.

3.1.3.20 Comment:

A reviewer expressed concern that sites which received fairly high concentrations of acid waste would have deeper plutonium penetration and subsequently higher volumes of contaminated TRU soil. The reviewer also addressed the "question of diversion boxes and underground waste transfer lines" (Letter Number: 223).

Response:

The TRU liquid disposal sites were not approved for acid disposal. Sites characterized so far show a similar pattern of very limited plutonium migration. There has been one known case in which acid waste was disposed of to the ground near a TRU-contaminated soil site. This appears to have caused a rapid movement of uranium to the groundwater, though there were other circumstances that also may have aggravated the situation. This groundwater was subsequently pumped to reduce the level of uranium. Regarding diversion boxes and transfer lines, underground structural components are described in Section A.4, and remedial actions are described in Appendix B and elsewhere in Chapter 3 of this EIS.

3.1.3.21 Comment:

A reviewer expressed concern about details and planning, specifically questioning what other waste forms for pre-1970 TRU and TRU soil sites were referred to in Section 3.3.1 of the draft EIS (Letter Number: 170).

Response:

The text (Section 3.3.1 of the final EIS) has been changed to also cite the possibility of a cement-based grout waste form. More detailed plans will be developed once a decision on basic alternatives is made.

3.1.3.22 Comment:

One reviewer stated that application to the DOE program of the EPA interim draft TRU guidance is somewhat ambiguous in view of the fact that the guidance would specifically not apply to contaminated soils within the boundaries of a controlled area. If the disposal is intended to eventually permit unrestricted release to the public without further actions, then an evaluation and limitation in terms of projected dose rates of the guidance would be required (Letter Number: 243-EPA).

Response:

As stated on p. 1.12 of the draft EIS, "DOE has no intention of abandoning the Hanford Site." Also, on p. 3.11 the EIS states, "Federal ownership and presence on the Hanford Site is planned in perpetuity." The disposal strategy does not include the intention of eventual unrestricted site release to the public.

3.1.3.23 Comment:

One reviewer expressed interest in mechanical retrieval of TRU-contaminated soil and solid waste sites. Specific details were requested concerning retrieval and transportation of larger items and effluent monitoring during retrieval operations (Letter Number: 223).

Response:

Information in Section B.1.1.3 describes processes in general terms that are believed to be sufficient to select from among the proposed alternatives. Transportation is addressed in the last sentence of that paragraph. Additional development and evaluation is addressed in Section 3.3.5. Monitoring equipment (Section B.1.1.3) will be specified as part of the detailed design if the geologic disposal alternative is selected for implementation.

3.1.3.24 Comment:

A reviewer requested information on dust suppression during retrieval operations. Details on chemical constituents of the suppressant as well as the estimated volume to be used during retrieval were requested (Letter Number: 215).

Response:

It was assumed that water would generally be used as a dust suppressant. Minimal volumes would be used; although these volumes have not been quantified, they certainly will not be sufficient to affect consideration of a disposal alternative.

3.1.3.25 Comment:

Reviewers commented that TRU waste should go to a repository, and specifically mentioned the Waste Isolation Pilot Plant (WIPP) (Letter Numbers: 3, 53, 57, 141, 171, 192, 217, 219).

Response:

The WIPP is a defense-only proposed repository in New Mexico. Transuranic wastes will be packaged to meet the WIPP-Waste Acceptance Criteria (WIPP-WAC) and transported to the WIPP site in compliance with applicable transportation regulations. In the preferred alternative, all retrievably stored and newly generated TRU waste is to be disposed of in WIPP.

3.1.3.26 Comment:

Reviewers indicated that it would be proper to consider disposal of TRU-contaminated soil sites and pre-1970 buried suspect TRU-contaminated solid waste on a site-by-site basis.

Sites found to be too hazardous, even with additional protection, after further review should be reclaimed and the retrieved wastes should be processed for geologic disposal (Letter Numbers: 147, 149, 217).

Response:

The comment has been incorporated into the preferred alternative as described in the final EIS (Section 3.3.5).

3.1.3.27 Comment:

A reviewer inferred that current concentration limits as applied now are, or may be, exceeded in the water table below TRU disposal sites. The concern arose because the use of each TRU disposal site was discontinued before any radionuclide penetrated to the water table at a concentration exceeding the then-applicable concentration limits. The reviewer would like to see a comparison between the old and new concentration limits (Letter Number: 223).

Response:

No comparison can be offered at this time, as Derived Concentration Guidelines (DCGs) are presently in draft form; however, current DOE limits are generally more stringent than previous guidelines. The most recent data regarding Hanford Site groundwater monitoring may be found in PNL-5817 (Price 1986).

3.1.3.28 Comment:

A reviewer pointed out that, although the draft EIS states that radionuclides observed in foodstuff samples collected in 1984 from farms around Hanford are attributable to worldwide fallout, no comparison studies are cited to show similar levels of radionuclides in other areas. The reviewer also wanted to know what the consequences of past deliberate releases have been (Letter Number: 219).

Reviewers also noted that waste discharges have occurred at Hanford for many years and the draft EIS concludes that TRU wastes are absorbed near the discharge point. Reviewers sought evidence/data to support this conclusion (Letter Numbers: 171, 219).

Response:

Appendix V of the final EIS provides data and discussion regarding waste discharges at the Hanford site since the early 1940s. Over 2,900 wells have been constructed (about 1,100 of which go to the groundwater table) on the Hanford Site from pre-Hanford operations to the present. Data from these wells provide a means for monitoring waste disposal sites both within the vadose zone (unsaturated zone) and below the water table and for monitoring groundwater quality away from the disposal sites. Well sampling has indicated that plutonium is adsorbed near the discharge point. See for example Figures V.16 and V.17 and the supporting references.

The basis for the statement regarding fallout and foodstuff is supported in the annual monitoring reports (Price 1985).

3.1.3.29 Comment

A reviewer commented that from the brief statement concerning site 216-B-5 on page B.8 it is not clear that adequate consideration has been given to the possibility that contamination might have spread horizontally over a large area after contacting the water table (Letter Number: 223).

Response:

As stated in section 3.3.1.5 of the draft EIS, contaminated soil would be retrieved until the concentration in the residual soil became less than 100 nCi/g. The residual soil would be monitored during retrieval to determine when sufficient soil had been removed to meet the criterion. Specifically addressing site 216-B-5, if more soil than anticipated required removal, the retrieval operation would be continued until the criterion was met.

3.1.3.30 Comment:

One reviewer questioned whether the HLW and TRU wastes from other facilities referred to in Section 3.2.2 have been included in the analysis of those TRU wastes which may exceed 100 nCi/g after concentration (Letter Number: 243-EPA).

Response:

The wastes in question, discussed in Section 3.2.2, are included throughout the EIS even though it is below 100 nCi/g as generated.

3.1.3.31 Comment:

With respect to TRU wastes disposed of previously, the EPA encouraged further action for their stabilization. The EPA also recommended that, in the course of determining an appropriate action, the resulting risks of all the considered alternatives should be compared in a cost-effectiveness analysis using the requirements of 40 CFR 191 as a baseline (Letter Number: 243-EPA).

Response:

Support for further stabilization of previously disposed of wastes is acknowledged. Even though the pre-1970 TRU wastes have been disposed of, their impacts were analyzed in the EIS to assess the need for remedial action. Until adequate data are available to perform a compliance analysis with respect to 40 CFR 191, attempting a cost-effectivness analysis using the standards as a baseline seems premature.

3.1.3.32 Comment:

The EPA stated that the "transuranic waste" definition is unclear in the draft EIS and in particular questioned why the waste activity was to be measured at the "end of the institutional control periods." The EPA found no reason to refer to any institutional control period and felt that the determination of what is TRU waste should be made at or before the time the decision is made to dispose of it. They also questioned the meaning of the final sentence regarding WIPP (Letter Number: 243-EPA).

Response:

This comment refers to the definition provided in the Glossary of Volume 1, Chapter 8. The definition of transuranic waste utilized is taken from DOE Order 5820.2. The reference to institutional control is included within the definition to suggest that as long as the material is under the control of the institution; i.e., DOE, it may be diluted or concentrated such that the activity "as produced" is not controlling on whether the material is TRU waste or not. However, once the decision has been made to dispose of material containing TRU, the 100 nCi/g specific activity is the deciding factor. The statement regarding WIPP reinforced that WIPP is not to receive commercial high-level waste or spent fuel. The definition of TRU in the final EIS excludes the statement regarding WIPP.

3.1.3.33 Comment:

The NRC noted a concern for the disposal of wastes containing between 10 and 100 nCi TRU/g. They felt that such waste must be disposed of using a stable waste form and that the disposal facility must either permit emplacement at least 5 meters below ground surface or include an engineered intruder barrier. They also encouraged the DOE to consider the results of the 10 CFR 61 supporting analyses when developing disposal concepts for such wastes (Letter Number: 239-NRC).

Response:

Within the context of the EIS, wastes with less than 100 nCi TRU/g are considered as low-level waste; however, NRC's concerns and recommendations will be taken into account in developing disposal options for wastes between 10 and 100 nCi TRU/g.

3.1.4 Tank Waste

3.1.4.1 Comment:

Reviewers stated that additional characterization of single-shell tank (SST) waste is needed before the disposal decision is made. Other reviewers pointed to the need to include the soil surrounding the tanks and underground pipelines in this characterization. One reviewer recommended that wastes be characterized, to the extent practicable, by their sources in fuel-reprocessing operations. This characterization could then be used as one factor in making tank-by-tank leave/retrieve decisions and in determining what fraction of the waste is truly high-level. Another reviewer felt that single-shell tanks should be removed (Letter Numbers: 5-DOI, 78, 147, 211, 215, 217, 223, 239-NRC. Hearing Number: 475).

Response:

As is noted in Chapter 3 and elsewhere in this EIS, the DOE recognizes the need for more detailed waste tank characterization, especially in the area of hazardous chemicals and organics and associated geochemical data. The waste in single-shell tanks has been mixed enough in the last 40 years of operations such that it cannot be characterized simply by its source in the fuel reprocessing cycle. A program currently under way provides for sampling and characterizing the SST waste. See the Interim Hanford Waste Management Technology Plan

(DOE 1986e) for details of the plan and RHO-RE-ST-30 (Rockwell 1987 and Weiss 1986) for preliminary results. Tank contents will certainly be one of the considerations of any tank-by-tank retrieval decision. See Section 3.3.5 of the final EIS for more information on preliminary work in this area.

3.1.4.2 Comment:

A reviewer asked if the potential adverse impacts of soil corrosion of the single-shell tanks had been taken into consideration (Letter Number: 223).

Response:

The single-shell tanks are carbon-steel-lined concrete tanks. Since the carbon-steel liners are not in contact with the soil, no adverse effects on the liners should occur. There is no evidence of surface deterioration of the concrete due to exposure to Hanford soils.

3.1.4.3 Comment:

One reviewer noted that "double accounting" of strontium-90 yields 80 million curies instead of 120 million curies as one would get from multiplying 60 million curies by 2 (Hearing Number: 627).

Response:

The total in tanks was given as 60 million curies. It was known with some certainty that 40 million curies were contained in single-shell tanks. It was not certain whether the other 20 million curies were contained in single-shell or double-shell tanks. Therefore, impact calculations were done assuming that 20 million curies was contained both in single-shell and double-shell tanks; hence, the uncertain activities have been "double accounted."

3.1.4.4 Comment:

Reviewers commented that from the information presented in the draft EIS it appears that the waste in single-shell tanks should be described as high-level waste (Letter Numbers: 233, 239-NRC).

Response:

The DOE believes that it is inappropriate at this time to describe the single-shell tank waste as high-level waste as defined in the Nuclear Waste Policy Act of 1982 (NWPA). At present there is no approved numerical value or values of radioactivity level that would lead DOE to the conclusion that wastes in the single-shell tank would be classified as highly radioactive. As concluded in the draft EIS, the final fate of the single-shell tank waste will be decided pending additional tank characterization and evaluation.

A public rulemaking is in process and is directed at implementing the NWPA definition of HLW. For example, in a recent Advanced Notice of Proposed Rulemaking (52 FR 5992; February 27, 1987), the NRC indicated its intent to modify the 10 CFR 60 definition of HLW to follow more closely the definition in the NWPA.

3.1.4.5 Comment:

A number of reviewers questioned both the cost and the technique presented in the draft EIS to remove wastes from the single-shell tanks in the geologic alternative. Specifically, costs were felt to be unrealistically high, leading to a bias against retrieval of the tank wastes and thus the geologic disposal alternative. Several reviewers mentioned hydraulic sluicing or hydraulic "cavitation." Full-scale testing of retrieval before proceeding with decisions on waste disposal was also recommended by many. Another general concern in this area was related to whether the integrity of the single-shell tanks would affect retrieval and whether loss of integrity would result in additional "leaks" to the ground (Letter Numbers: 57, 71, 171, 184, 192, 215, 217, 223, 239-NRC, 240, 242).

Response:

A preliminary study of relative costs and general design details for standard water sluicing, modified water sluicing, and "hydraulic cavitation" was prepared for the final EIS (see Volume 2, Section B.1.1.1). These and other methods are being studied in greater depth, and will be reviewed by groups such as an independent National Academy of Sciences panel. Present plans are to narrow down the alternative methods. A full-scale demonstration will be conducted before implementation. The eventual selective retrieval of single-shell tank waste is a possibility.

About 2% to 3% of the cost for SST disposal in the geologic alternative is due to retrieval. The large part of the cost is in preparing the waste for geologic disposal. The costs for the several retrieval alternatives were again reviewed by technical staff, and the EIS costs reasonably bound these. For tanks known to leak, introduction of water would increase the chance of renewed tank leaking. Future studies will evaluate alternative retrieval methods and will compare safety, total cost, and potential for environmental impacts.

3.1.4.6 Comment:

A reviewer commented that short-term risks and costs of retrieval of single-shell tank waste should be described (Letter Number: 171).

Response:

Short-term occupational risks and associated costs of all existing tank waste (double- and single-shell tanks) are provided in Section 5.2 of the final EIS. This impact analysis is considered adequate to evaluate tank retrieval risks for the geologic-disposal alternative. Specific data regarding waste retrieval analysis for the single-shell tanks can be found in Rockwell Hanford report RHO-RE-ST-30P.

3.1.4.7 Comment:

Reviewers requested extensive additional data for active and inactive liquid waste disposal sites and single-shell and double-shell tanks. The requests included site locations, monitoring-well locations, well logs, well design specifications, groundwater elevations, monitoring and effluent discharge data, sampling frequency, dates and results (radioactivity, Resource Conservation and Recovery Act chemicals and water quality) of the most recent samples, comparison of results to Environmental Protection Agency drinking water standards, etc. (Letter Numbers: 174, 233).

Response:

The data presented in this EIS are believed to be sufficient for the purpose of evaluating, understanding and comparing the environmental impacts of the defense waste disposal alternatives. Additional data regarding groundwater, drinking water monitoring, waste site monitoring and liquid releases may be found in annual monitoring reports (see reference list in Chapter 4, Volume 1 of this EIS) and other documents, including Law and Schatz (1986).

3.1.4.8 Comment:

A reviewer stated that the amounts of radionuclides or radioactivity remaining in residual wastes and tanks have not been discussed in the draft EIS. The reviewer advocated application of "consistent disposal measures" for tanks, tank residuals and TRU solid waste sites (Letter Number: 215).

Response:

The quantity of radionuclides remaining in tank residuals can be determined by multiplying the tank inventories in Appendix A by 0.05 for single-shell tanks or 0.0005 for double-shell tanks. As stated in the EIS, TRU wastes will be left in place if the concentration does not exceed 100 nCi/g. Inventories of wastes disposed of to the geologic repository, or disposed of on site, near surface with barriers (if applicable) are presented in Tables 5.10, 5.19, 5.29 and 5.47 for each disposal alternative. The disposal alternative selected as specified in the Record of Decision will determine the "disposal measures" to be applied to each waste class within the scope of the EIS.

3.1.4.9 Comment:

In general, reviewers questioned the long-term integrity of the single-shell tanks, specifically as related to the arbitrary date of 2150, after which the tanks are assumed to provide no barrier to waste migration (Letter Numbers: 123, 178, 239-NRC, 242, 243-EPA. Hearing Number: 414).

Response:

There is no precedent by which to judge the life of the single-shell tanks to contain solid chemical salt wastes. Releases that have occurred in the past were at a time when the tanks contained significant quantities of liquid. Following removal of the liquids the tanks may remain stable for centuries.

The assumption that single-shell tanks do not provide a barrier to release after the year 2150 is related directly to the assumed period of active institutional control. In accordance with EPA's standards for disposal, 40 CFR 191, loss of active institutional control cannot be assumed for more than 100 years after disposal. Up to that time corrective actions could be taken.

The most conservative assumption would require the tank structure to be neglected immediately. Data do not suggest that any significant releases from the solid waste are occurring. With the removal of liquids, the single-shell steel and concrete tanks will remain significant if not absolute confining structures for well over one hundred years. To assume the tanks provide no barrier to movement of the solid waste at the present time is not justified.

3.1.4.10 Comment:

A reviewer commented that it is not clear how the supernatant liquid pumped from the single-shell tanks is to be disposed of. Also there is no description of the levels of radioactivity in this liquid (Letter Number: 171).

Response:

The supernatant pumped from single-shell tanks is transferred to double-shell tanks, and will be disposed of as described (Chapter 3, Volume 1) in the preferred alternative for disposal of existing double-shell tank waste. A description of the "level" of radioactivity in the liquid is included in the discussion of existing double-shell tank waste, because the supernatant becomes part of the inventory described for existing double-shell tank waste as given in Appendix A (Table A.4).

3.1.4.11 Comment:

A reviewer commented that details were given of the number of single-shell tanks which may be leakers, but that more information on these tanks is lacking, including the curie content of the tanks and whether the tanks continue to corrode after the supernatant liquid has been removed (Letter Number: 171).

Response:

The tanks may continue to corrode after the supernatant liquid is removed, but the potential for leakage has been markedly reduced with removal of the pumpable liquid. Inventories of individual tanks were not used in the analysis performed for the draft EIS. Inventories by tank farm for single-shell tank waste are given by Rockwell (1985a).

3.1.4.12 Comment:

A reviewer felt that no details were given on the overall condition of the wastes in single-shell tanks. This would include how many tanks have not been dehydrated (Letter Number: 171).

Response:

Single-shell tank waste consists mostly of damp sludge and salt cake. Although none of the tanks has been "dehydrated," an ongoing tank stabilization program includes removing as much liquid as technically practical from the single-shell tanks. To date, 95 of the 149 single-shell tanks have been "interim stabilized."

3.1.4.13 Comment:

Reviewers inquired about disposal of supernatant and sludge washes (Letter Numbers: 171, 215).

Response:

As noted in Section B.2.1 of Appendix B, the supernatant liquid would be processed to remove cesium, strontium, technetium and TRU elements so that they could be disposed of in a geologic repository. Residual supernatant liquid, which would contain small amounts of a few radionuclides, would be assigned to grout disposal. Parallel treatment would be expected for sludge washes.

3.1.4.14 Comment:

Reviewers noted that the proposed grouting process and WRAP facility are also only conceptualized as yet; the WRAP process needs to be tested to some extent. Different grout formulas need testing for consistency, setup time, drying rate, etc., before any decision can be made on grouting (Letter Numbers: 71, 217).

Response:

The grout process would require considerable testing of formulation, leachability and other characteristics before it would be implemented. The concept is, however, believed to be sufficiently established that programmatic direction of waste disposal can be given. The WRAP is a relatively straightforward concept and should require little testing to demonstrate its ability to receive, segregate and process transuranic waste acceptable for disposal in WIPP.

3.1.4.15 Comment:

A reviewer asked how internal drains or pipe openings will be sealed in a way that will ensure tank integrity (Letter Number: 223).

Response:

Proposed concepts for the disposal system do not rely on integrity of the tank. After the tank dome is filled with gravel or crushed basalt, the current concept is to fill those tank penetrations that are accessible from the surface (or from pump or valve pits) with concrete or grout. Inaccessible piping connections between tanks would not be filled.

A text revision was made to the final EIS (as was requested by the reviewer) to indicate that filling the accessible pipes and risers will not guarantee that the concrete tank shell is an impervious barrier.

3.1.4.16 Comment:

A reviewer asked what action the Department of Energy-Richland Operations took in response to the 1980 discovery at the Savannah River Plant of corrosive pitting in double-shell tanks under construction (Letter Number: 174).

Response:

The Department of Energy-Richland Operations and its contractors at that time, Rockwell Hanford Operations and Kaiser Engineers Hanford, sent representatives to the Savannah River Plant (SRP) shortly after the corrosive pitting was discovered in the tanks under construction. Contact between the two sites was maintained throughout the investigation. It was determined that because of the differences in tank steel, the same situation was unlikely to occur at Hanford. No underground tank constructed at Hanford has shown signs of pitting in the steel during construction.

3.1.4.17 Comment:

A reviewer noted that the general corrosion rate (6 mil/yr) used to estimate the time of failure of a steel tank liner is not the most severe rate as stated on p. 12 of Appendix P. Corrosion rates may be three times this rate (NBS 1957) (Letter Number: 223).

Response:

The corrosion rate of 6 mil/yr used and reported in the draft EIS was determined by laboratory studies of materials and solutions specific to Hanford facilities. Identification of the 6-mil/yr value as "the most severe general corrosion rate" is made in the context of the laboratory work performed to define a Hanford-specific value and was not done with reference to all known corrosion rates. Appendix P has been revised to clarify this point.

3.1.4.18 Comment:

A reviewer noted that Section A.1.1 of the draft EIS (p. A.3) does not provide an adequate technical basis for statements of present single-shell tank (SST) integrity with respect to dome collapse. Specifically, the impacts of "potentially corrosive soils and tank leaks on tank integrity" should be addressed (Letter Number: 223).

Response:

Additional references, which summarize an intensive 7-year effort to evaluate the structural integrity of the SST waste concrete tanks, have been added to the final EIS, Appendix A.

These evaluations concluded that the tanks have adequately large margins of safety to continue interim storage of solids (not liquids) beyond their original design life. Laboratory work reported in these studies analyzed the effects of the chemical solution that leaked out of the tanks and determined that it would not adversely impact the concrete or reinforcing steel. Forty-year-old tank concrete exposed to Hanford soil has shown no sign of degradation from soil exposure. The carbon steel liners are not exposed to soil.

3.1.4.19 Comment:

A reviewer commented on Appendix A and noted that nothing was found in the reference document to support the statement in the EIS that "concrete in the single-shell tanks has maintained its integrity preventing tank collapse, during many years of service." The reference document does, however, state that, beginning in 1958, problems were experienced with liquid leaking from some of the tanks (Letter Number: 223).

Response:

Concrete provides the load-bearing support for the earth cover over the tank, and page A.8 of the reference describes the integrity of this support. No tank-dome failure has been observed at Hanford and there has been no indication of reduced structural integrity in the tank domes (ERDA 1977). The steel liner was intended to contain liquids, and this liner has failed for a number of single-shell tanks, causing the leaks mentioned by the reviewer.

3.1.4.20 Comment:

A reviewer, commenting on Section B.1.1.1, noted that the draft EIS does not mention that 31 tanks are suspected of having poor integrity. The implications of the contents of these tanks being retrieved should be noted in the final EIS (Letter Number: 215).

Response:

The section referenced above already states that the integrity of some of the tanks is suspect. All single-shell tanks are (or have been) incorporated in the saltwell pumping program, where liquids are removed from the tanks. The preferred alternative (Section 3.3.5 of the final EIS) proposes further evaluation of disposal alternatives of waste stored in single-shell tanks.

3.1.4.21 Comment:

Questions were received regarding what treatment would be used to destroy organic complexants in double-shell tank (DST) waste and what criteria would be used to determine when it is necessary. The reviewers questioned why organic complexants are not an issue with single-shell tank (SST) wastes, as SSTs are known to contain organic compounds. Reviewers wanted to know whether the presence of organics increases the mobility of wastes in soil (Letter Number: 215).

Response:

In the geologic disposal alternative, both the SST waste and DST wastes were treated as necessary to reduce organic concentrations to acceptable levels for disposal. The process assumed for cost estimation analyses was ozonization (adding ozone to feed streams to destroy organics). Other alternatives such as uses of hydrogen peroxide or heat and pressure will also be investigated, should the geologic disposal alternative be selected. See Section A.2.0 of RHO-RE-ST-30 P (Rockwell 1985) for details.

In the reference alternative, only DST waste was assumed treated, again by ozonization (for cost estimation analyses). For SST wastes in the reference and in-place disposal options, organics were assumed to adversely affect the movement of radionuclides in the soil (i.e., lower K_d values were assumed) and were considered in the modeling.

The criterion governing when to destroy organics has been identified as a technical issue in the Interim Hanford Waste Management Technology Plan (DOE 1986d). It will be based on laboratory determinations relative to the amount of organics that can be allowed in grout (left near surface) and glass. Selection of the best method for destroying organic compounds is to be determined as identified in the plan.

3.1.4.22 Comment:

Reviewers requested the total number of double-shell tanks available and planned and whether inventories provided in Appendix P included those for tanks already built or planned. There were also questions about the 14 tanks assigned to existing DST waste and the 14 assigned to future DST waste. More explanation of the need to transfer from old to new tanks every 50 years in the "Continued Action" alternative was requested, especially as to disposition of old tanks, number of new tanks, etc. The AQ and AT tank farms that apparently are in the planning stage should be discussed (Letter Numbers: 215, 223).

Response:

The 14 tanks of existing waste and 14 tanks of future waste refer to total tank volumes, not specific tanks. Double-shell tanks may contain both existing and "future" (post-1983) waste. Also, spare tank space is reserved in the event that a tank liner started leaking into the annulus.

There are currently 28 active DSTs. At the time of the preparation of the draft EIS, there were only 20 active DSTs with 8 new DSTs (AP tank farm) under construction. Proposed new tank farms (AQ and AT), which would each contain four tanks, are being planned. Construction of these is contingent on whether the current EIS results in a decision to proceed with disposal of grout, as well as continued production facility operations. The planned waste projections through 1996 are addressed in the inventory tables.

New DSTs have an assumed minimum design life of 50 years. Under the no disposal action alternative, two complete retanking campaigns would be necessary each century. This requirement is accounted for in the cost estimate and operational exposures for that alternative. DSTs past 50 years of age would be deactivated and isolated. This is discussed briefly in Appendix B and in more detail (as concerns costs and impacts) in RHO-RE-ST-30 P (Rockwell 1985a).

3.1.4.23 Comment:

A reviewer requested the basis for the decision that only 12 tanks for existing tank waste required passive heat removal pipes in the in-place stabilization and disposal alternative. Also, as there is no plan to separate out strontium and cesium from future tank wastes, concern was raised about management of heat to prevent potential accidents during interim storage (Letter Number: 215).

Response:

Only 12 single-shell tanks contain enough heat-producing cesium or strontium to require delaying installation of barriers in order to keep tank concrete temperatures at an acceptable level. This level is set to prevent rapid degradation of the tanks. Deferral of barrier installation until the year 2030 would allow time for enough radioactive decay so that only one tank would require heat dissipation pipes. This tank would be an obvious candidate for retrieval in partial-leave/partial-retrieve options for SST wastes because of its high heat content. This possibility will be evaluated in future studies. See A.3.1.2 of RHO-RE-ST-30 P (Rockwell 1985) for further discussion.

The interim (short-term) management of high-heat waste from future processing is a site-operations rather than a waste disposal issue.

3.1.4.24 Comment:

A reviewer requested information on the tanks, dates of "liquid intrusion" episodes, and volumes of "liquid intrusion" into single-shell tanks at the Hanford Site, as discussed by Catlin (1980, p. 68), and also wanted to know whether this resulted in leaching of waste (Letter Number: 174).

Response:

Catlin (1980) contains information regarding total volumes and number of tanks. Specific records of intrusion episodes are available in the public reading room of the Federal Building in Richland, Washington. Those episodes are documented as Occurrence Reports and Deviation Reports. The incidents did not involve large volumes of liquid (often only a couple of gallons), so no additional leaching of waste from SSTs is expected.

3.1.4.25 Comment:

Reviewers wanted to know how DOE determined that adding gravel to single-shell tanks with the remaining tank solids will be a suitable method to limit future subsidence. The reviewers felt that consideration should be given to in situ stabilization techniques that meet or exceed the requirements for Class C wastes. One reviewer suggested that clay or gravel should be tested as well as rock fill (Letter Numbers: 71, 110, 223).

Response:

The suitability of gravels as dome fill material is the subject of a dome fill technology development program. The physical and chemical stability of fill will be tested using synthetic and actual wastes to provide assurance that subsidence would not lead to barrier failure. The NRC requirement for a free-standing monolithic fill does not mean that such fills will necessarily be suitable for single-shell tank fill. As the waste will still be near surface, it could be removed, if necessary, by a remote mechanical system (similar to the equipment discussed for removing hard saltcake).

The plans for dome-fill technology development include testing of several materials, among them various igneous and metamorphic rocks. Testing of clays and sand has been considered in the past. Testing of igneous and metamorphic sands is planned. The dome-fill technical issue is addressed in the September 1986 Interim Hanford Waste Management Technology Plan, Section SST-6, "Dome Fill" (DOE 1986e).

3.1.4.26 Comment:

A number of reviewers were concerned about contaminated soil resulting from earlier single-shell tank (SST) leaks. Such soil would be left near surface in all alternatives. The effectiveness of the proposed barrier to prevent migration of the contaminants in this soil was one concern. Laboratory data were requested, to confirm that the contaminated soil under the SSTs was not transuranic waste as stated in Section 3.2.5 of this EIS and that it was non-hazardous. More recent data concerning volume of projected leaks, actual field data and assumed accuracy were requested, as was information about the presence of organics in the material that leaked, the potential explosiveness of the leaked material, and the amount of leaked material that reached groundwater (Letter Numbers: 41, 171, 174, 189, 215, 223. Hearing Number: 542).

Response:

Removal of the concrete tanks and underlying contaminated soil is discussed in Section 3.3.6 of the draft EIS. Major increases in cost and worker exposure would be incurred for a very small increase in total protection to the environment and public. An extensive barrier-testing program (Adams and Wing 1987) is under way to determine the effectiveness of the barriers in preventing nuclide and chemical migration. This work will be completed and released to the public before final decisions are made relating to disposal of any single-shell tank waste.

In Appendix V, Section V.7, Figures V.21 through V.23 present 1973 and 1978 data for 241-T-106 tank leak, which was the largest single tank leak at the Hanford Site. In addition, evaluation of the contaminated soils under the tanks has been initiated under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980 and will take into account that organic compounds were most likely present in some leaks. Results of this evaluation should confirm whether or not any of the contaminated soil may exceed 100 nCi TRU/g.

The material that has leaked out has no explosive potential. Environmental monitoring has not provided evidence to indicate that any leaked material from single-shell tanks has reached groundwater.

3.1.4.27 Comment:

With reference to Isaacson and Gasper (1981), a reviewer suggested that the unreliable tank leak assessment methods utilized for single-shell tanks do not provide conclusive evidence to support that draft EIS statement that there are no data to suggest that significant releases from the solid waste form are currently occurring (Letter Number: 215).

Response:

Isaacson and Gasper (1981) proposed adding extra drywells to the present drywell system to improve the sensitivity of the system. The present monitoring methods have detected leaks in the liquid-filled single-shell tanks and also have detected one or more leaks of residual liquid from isolated tanks. The modeling assumption that the vapor cycle will provide a constant supply of water to the solid wastes in the SSTs is deemed to be a very conservative assumption.

3.1.4.28 Comment:

Reviewers wanted to know whether any double-shell tank leaks have been discovered. Another reviewer cautioned against reliance on the fact that none have leaked, since single-shell tanks did not leak initially either (Letter Numbers: 151, 223. Hearing Numbers: 557, 621).

Response:

To date, no leaks from double-shell tanks at the Hanford Site have been found. Constant monitoring and surveillance of the tanks have not detected any release of radioactive material to any double-shell tank annulus or to the environment.

3.1.4.29 Comment:

Reviewers requested information on the inactive single-shell tanks and active or inactive double-shell tanks, specifically: 1) the date each tank was constructed; 2) the dates each tank received wastes; 3) the facilities from which the wastes discharged to each tank originated; 4) the inventory of organic and inorganic chemicals in each tank; 5) the inventory of heavy metals in each tank; 6) the inventory of radionuclides in each tank; 7) whether the tank is known to have leaked or is suspected of having leaked; 8) whether or not the tank has been "blanked off" so that pumping or sluicing is no longer possible without retrofitting; 9) whether the waste in the tank has been reclassified as anything other than "high-level" and, if so, the reasons for such reclassification; 10) the waste types, by volume, in each tank (i.e., drainable fluid versus salt cake and sludge); 11) whether the tank currently receives self-boiling wastes (Letter Numbers: 174, 233).

Response:

The inactive single-shell tanks are underground storage tanks which are reinforced concrete with carbon steel liners on the bottoms and sides. The 149 SSTs, ranging in capacity from 210 to 3,800 m^3, were constructed between 1944 and 1964. The tanks received waste from 1944 until 1980. The waste streams originated from processing facilities, as well as tank-to-tank transfers. Inventories of waste components by tank farm are found in RHO-RE-ST-30 P (Rockwell 1985, pp. 2-15 through 2-16). A tank characterization program has been implemented to characterize the radionuclide and hazardous waste constituents stored in SSTs. Some SSTs that have leaked are discussed by ERDA (1975, III.2-2 through III.2-7). More detailed information is given by Catlin (1980). Numerous SSTs (approximately 80 to date) have been "interim isolated," which means that the the work required to minimize the addition of liquids into an inactive storage tank, process vault, sump, catch tank or diversion box (such as "blanking off" lines leading to the tanks) is completed. The waste classification issue is discussed earlier in this section.

There are presently no inactive DSTs on the Hanford Site. Twenty-eight DSTs, each with a volume of 3,800 m^3 to 4,300 m^3, were constructed between 1970 and 1986. Wastes from operating facilities, N Reactor, and tank-to-tank transfers have been received since 1971. Chemical and radionuclide inventories of waste types stored in DSTs are discussed in both RHO-RE-ST-30 P (Rockwell 1985, pp. 2-12, 2-17, 2-19) and this EIS (Appendices A and P). Specific inventories are calculated on a tank-by-tank basis as needed for technology development, such as determining feed composition for the vitrification facility. Presently, the DSTs in the AZ tank farm are receiving the "self-boiling" wastes.

3.1.4.30 Comment:

Several reviewers supported geologic disposal over in-place disposal of single-shell and double-shell tank (SST and DST) wastes. Licensing of the disposal of all tank wastes by the Nuclear Regulatory Commission (whether it is disposed of in place or in a repository) was felt necessary to ensure safety. Several of the reviewers recognized that decisions specific to single-shell tank waste cannot be made at this time as more research and development and characterization is needed first. Some reviewers did not wish to see this take longer than 5 to 7 years to close these issues, however (Letter Numbers: 4, 174, 192, 215, 217, 219).

Response:

These specific comments were considered in the development of the preferred alternative. The DOE proposes that geologic disposal of the high-level waste fraction of DST waste should proceed and agrees that additional development and evaluation is needed before a final decision on SST waste is made. The development and evaluation program is being expanded to include examination of alternatives for retrieving and processing SST wastes. Although the DOE views this activity as having high priority, the length of time necessary to close on the SST waste issue will depend on funding and results as they develop.

3.1.4.31 Comment:

One reviewer noted that the draft EIS states that the contents of single-shell tanks (metal compounds) reduce the efficiency of waste loading in borosilicate glass. However, the reviewer felt that there is no justification for this statement, that references are lacking, and that the EIS should state the specifics regarding quantification of "reduced" efficiency and costs involved (Letter Number: 215).

Response:

Much of the single-shell tank waste was generated from earlier processing methods (bismuth phosphate, REDOX[a]) that were less efficient than the present Plutonium and URanium EXtraction (PUREX) process. Thus, there are more tons of inert chemicals per ton of radionuclides. Some of these chemicals affect the quality of glass, so they must be kept at low concentrations. This necessitates a lower-concentration feed to the glass melter, thus requiring more glass canisters per unit volume of waste. As the cost per canister going to a repository is now about $200,000 (and is likely to go higher), every effort will be made in the pre-processing steps to ensure maximum waste-loading efficiency.

3.1.4.32 Comment:

Reviewers were concerned about the existence of toxic chemicals and possible explosions. One requested further description concerning the postulated presence of ferrocyanide precipitates. Another reviewer inquired about possible explosions occurring during tank-drying activities in tanks containing organic compounds and certain heat-sensitive inorganic salts (Letter Numbers: 103, 157, 215, 223, 242).

(a) REDuction/OXidation process, with solvent extraction.

Response:

The DOE recognizes the need for chemical characterization of single-shell tank waste, and has preliminary data regarding that issue (Adams, Jensen, and Schulz 1986). Ferrocyanide compounds were used during earlier processing campaigns and therefore do exist in some of the SSTs. Although a Pacific Northwest Laboratory study concluded that the concentrations are such that an explosion would be very unlikely, it was evaluated as an upper-bound accident.

The presence of organics and other chemicals sensitive to heat will be evaluated in any studies of techniques to be used for drying tanks before disposal action is implemented.

3.1.4.33 Comment:

One reviewer noted the need for clarification regarding disposition of single-shell tanks; would the tanks themselves, or just the tank contents, be retrieved for permanent disposal? Another reviewer asked what would be done with the single-shell and double-shell tanks after they had been emptied. Reviewers also expressed concern about the in-place permanent disposal of wastes in double-shell tanks. One reviewer noted that although DOE also suggests that it may use these tanks for disposal of grouted high-level waste, DOE does not address any potential long-term outcomes of tank failure, decay, or leakage, which "is of particular concern should the DOE decide to reuse the tanks for permanent disposal" (Letter Numbers: 147, 171, 178, 217, 219).

Response:

Emptied tanks will be back-filled with gravel, or possibly used to dispose of low-level waste grout, and barriers will be placed over them. The EIS has been revised to avoid the confusion regarding "retrieval of certain high-activity tanks."

In any disposal alternative waste left in tanks would not be in liquid form and hence would not leak in the usual sense. The tanks themselves are not considered to function in the analyses; therefore, the residuals (0.05% of contents for double-shell tank waste and 5% maximum for single-shell tank waste) are assumed to migrate. Both the cases with an effective barrier and those without a barrier are analyzed; therefore, the risks are presented in this EIS. (Also see Comment 3.1.4.8.)

3.1.4.34 Comment:

A reviewer wanted to know what program of in-tank immobilization is referred to in Section 3.1.7 of the draft EIS: past, present or future (Letter Number: 243-EPA).

Response:

The immobilization refers to ongoing saltwell pumping and conversion of single-shell tank waste to solidified sludge and salt cake (see Appendix A of the EIS).

3.1.4.35 Comment:

There are data which show that releases have occurred from the single-shell tanks and that proper backfilling of these tanks will provide for structural stability only. Backfilling will not significantly inhibit water infiltration or radionuclide release (Letter Numbers: 71, 217, 239-NRC).

Response:

The main purpose of the backfill material is to provide for structural stability to inhibit subsidence and is not intended to significantly inhibit infiltration of water or radionuclide release. A saltwell pumping program is ongoing to remove liquid from the single-shell-tank to mitigate future possible radionuclide releases. The Barrier Development Program (Adams and Wing 1987) includes a design of a protective barrier which will inhibit water infiltration into the waste. A part of future development and evaluation activities for disposal of single-shell-tank waste will involve evaluation of fill material to enhance immobilization of residual waste.

3.1.4.36 Comment:

One reviewer noted that Section 3.3.4.1 mentions the potential for release of radioactive particulate matter as a result of the collapse of tank domes. The reviewer asked what effect dome collapse would have on settlement and failure of the protective barrier (Letter Number: 223).

Response:

Section 3.3.4.1 deals with the no disposal action alternative in which there are no barriers placed over wastes. In the other alternatives the tanks are filled with gravel or other material to prevent tank dome collapse.

3.1.4.37 Comment:

Reviewers expressed that it is apparent that more emphasis is placed on the protection of the SSTs than on their contents. This violates the NWPA, which places primary containment focus on the geologic surroundings and assumes that containers will be compromised or lost after some conservative time period (Letter Numbers: 217, 223).

Response:

If it appeared that more emphasis was placed on protection of the SSTs than on their contents, it was inadvertent; the need, in any of the alternatives, is to protect the waste contents rather than the tanks themselves. On the other hand, that which would protect the tanks was taken as also preventing the loss of contents from the tanks.

Regarding the comparison between deep geologic disposal and near-surface disposal with barriers, the intent was to present the impacts that might arise during and following disposal by these means. Thus, the EIS presented the deep geologic case for SST wastes and also presented the near-surface disposal case which must be evaluated, since it is a reasonable alternative, particularly in light of the potential impacts of retrieving and processing SST waste. Most would share the view that "deeper is safer."

The purpose of grout is to contain the nuclides while being put in place. That grout has resistance to leaching is an added advantage; however, this aspect requires further development and evaluation. In the presence of a fully functioning protective barrier there would be little or no water available with which to leach nuclides and less reliance would be placed on the grout form.

Also, a tank filled with grout (or other material, initially in a liquid or slurry form, that would set-up without significant shrinkage) would probably represent the optimum in subsidence protection, since the maximum fill could be achieved. The use of grout or grout-gravel mixes to fill empty tanks is also due for further development, evaluation, and documentation.

3.1.4.38 Comment:

Additional characterization of wastes in the single-shell tanks will be necessary to provide more detailed information about waste inventories. The reviewer also recommended that the wastes also be characterized to the extent practicable, by their sources in fuel reprocessing operations (Letter Number: 239-NRC).

Response:

The DOE agrees; further characterization of the tank wastes is planned. However, identifying the single-shell tank wastes by their source in the reprocessing operation cannot be done, due to the extensive mixing in the past. The DOE will compare tank characterization data to the applicable high-level waste definition prior to disposal decisions.

3.1.5 Low-Level Waste

3.1.5.1 Comment:

A number of reviewers expressed concern regarding low-level wastes, and often specifically insisted that low-level wastes be addressed in the final EIS. Another reviewer saw no objection to the burial of low-level waste at Hanford.

Response:

See comment 2.3.1.13.

3.1.5.2 Comment:

Reviewers expressed concern about the practice of using cribs for radioactive liquid waste disposal.

Response:

See comment 2.2.10.

3.1.5.3 Comment:

Reviewers requested information regarding the removal and/or stabilization of low-level contaminated soil (Letter Number: 223).

Response:

There is currently no plan to remove any low-level contaminated soil. The action plan for management of these contaminated soil sites is discussed in the Interim Hanford Waste Management Plan (DOE 1986d). (Also see Comments 2.2.10 and 2.3.13.)

3.1.5.4 Comment:

A reviewer requested information on active liquid waste disposal sites (Letter Number: 174).

Response:

The active liquid waste disposal sites are all low-level waste sites, and as such are outside the scope of the draft EIS. Data regarding liquid low-level wastes may be found in the documents RHO-HS-SR-84-10 4Q P and RHO-HS-SR-85-3 4Q Liq P (Aldrich 1985, 1986).

3.1.5.5 Comment:

Reviewers expressed concern regarding the amount of plutonium that would remain on site because low-level waste sites would not be reclaimed (Letter Numbers: 103, 230).

Response:

Approximately 30 kg of plutonium are estimated to be in low-level waste sites at the Hanford Site. The sum of the quantities cited in BNWL-1701 and BNWL-1779 (Soehnlein 1972, 1974) is about 290 kg of plutonium discharged to ground in the 200 areas through 1971. Concern for the amount of plutonium in one trench prompted mining and removal of about 58 kg plutonium from that site between 1976 and 1978. The 190 kg cited in Appendix A, plus 58 kg removed in 1976 through 1978, plus the 30 kg that may remain in low-level waste sites, is then in rough agreement with the 290 kg cited above.

3.1.5.6 Comment:

A reviewer requested the following information on active and inactive liquid disposal sites: 1) the depth to the water table beneath each site, 2) the proximity of the nearest monitoring well, 3) the frequency with which the well is monitored, 4) whether the well is co-monitored with the State of Washington, and 5) whether the well meets Environmental Protection Agency (EPA) and State of Washington specifications.

The reviewer also requested: 6) the date of the most recent sample from each monitoring well, 7) a comparison of the sample results of specific radionuclides present to the applicable EPA drinking-water standards, 8) a comparison of sample results for specific chemicals present to EPA drinking-water standards, 9) whether the well has been sampled for potentially hazardous organic constituents and, if so, a comparison of results to the applicable EPA drinking-water standard (Letter Number: 174).

Response:

1) As stated on p. 4.16 of the draft EIS, "The water table, representing the upper limit of the unconfined aquifer, ranges from 56 to 100 m beneath the ground surface in the 200 Areas...." A generalized east-west cross section of sediments beneath the Hanford Site

(draft EIS, p. 4.7, Figure 4.3) allows an estimate of the general depth to the water table across the Site. Depths to groundwater for the tank farms are given in Table A.2. 2) The monitoring wells and general locations are described in Law and Schatz (1986). 3) Rockwell (1986c) provides the latest analytical data from the sampling of monitoring wells, which are sampled monthly, quarterly, or semi-annually, depending upon the history of the site. 4) The wells are not co-monitored with the State of Washington, although the information is accessible to the State. 5) All wells drilled after 1976 conform to applicable standards. An ongoing program is modifying any existing wells that do not conform. 6) Available monitoring data may be found in Law and Schatz (1986). Existing documentation does not directly compare analytical results with EPA standards. 7-9) Since groundwater at Hanford is not a community drinking water system to which the EPA standards apply and since groundwater monitoring results are not a forecast of environmental impacts associated with permanent disposal, including such comparisons in this EIS is believed to be unwarranted.

3.1.5.7 Comment:

A reviewer suggested that the total number of cribs and French drains and a map showing their location should be provided in Appendix V (Letter Number: 243-EPA).

Response:

Appendix V was intended to present monitoring experience and used specific facilities and events to that end. Additional information on cribs and French drains and their location may be found in Table II.1-C-3 and Figures II.1-C-1,2 of the final EIS on Waste Management Operations, Hanford Reservation (ERDA 1975).

3.1.5.8 Comment:

One reviewer noted that the use of cardboard boxes for disposal of LLW should be discontinued (Letter Number: 233).

Response:

Disposal of low-level waste is outside the scope of this EIS. However, the use of cardboard boxes is practical for disposal of wastes such as slightly contaminated laboratory glassware for which no container is prescribed or necessary. The cardboard box is merely something in which to contain the waste in transit. Although useful for such wastes, the potential for subsidence of a burial ground must be taken into account in the event of decay of partially filled boxes of compressible waste.

3.1.6 Hazardous Chemicals

3.1.6.1 Comment:

A number of reviewers commented that the draft EIS inadequately addressed hazardous chemical constituents of the defense waste. Some of the reviewers felt that DOE should comply with hazardous waste regulations. They asked for additional information about the chemical inventories, about the fate of chemicals in the disposed-of wastes, about potential risks and health effects, and about the effect of chemicals on the transport of radioactivity through the environment. One reviewer commented that the impact of spills or improper disposal of solvents and petroleum products should be assessed and groundwater samples should be analyzed for such compounds, and also requested a discussion of the fate of contaminants in lab wastes (Letter Numbers: 5-DOI, 12, 13, 44, 53, 57, 71, 103, 111, 116, 141, 147, 155, 170, 171, 177, 184, 187, 192, 201, 208, 214, 215, 217, 219, 223, 231, 233, 234, 240, 243-EPA. Hearing Numbers: 412, 440).

Response:

An analysis of health effects parallel to that for radionuclides but for toxic chemicals was not done. The impact of several selected chemicals in the form of comparisons of their concentrations in groundwater to drinking water standards was presented in Section 3.4.2.

Heretofore, the principal emphasis on environmental impacts at the Hanford Site has been on radioactive components of waste. Emphasis has recently shifted to recognize the potential for impacts from chemicals as a whole. The DOE recognizes that additional discussion of hazardous chemical wastes will be necessary for determining compliance with applicable provisions of the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and other applicable regulations. While there are relatively accurate data on the total amount of organic and inorganic chemicals used in fuel reprocessing, data on the present distribution of these inventories in specific tanks and transuranic waste sites are limited. Also, there are few specific data on the transport of chemicals in Hanford soils or their ability to change the transport of radionuclides in the environment. On the basis of available data, impacts from principal sources of chemicals, notably single-shell tanks, are addressed briefly in Section 3.4.6. The DOE will be conducting additional waste characterization, waste site sampling and chemical transport research to permit improved assessment of potential environmental impacts of hazardous chemicals.

The DOE will continue to work with EPA and appropriate state agencies to establish a mutually acceptable method of disposing of hazardous chemical wastes. Hanford defense wastes that are sent to a geologic repository for disposal will be subject to the applicable repository acceptance criteria (either at the Waste Isolation Pilot Plant, WIPP, for the TRU waste or the NRC-licensed commercial repository) and repository performance standards of EPA (40 CFR 191). Grouted low-activity waste fractions from high-level waste processing and non-TRU wastes resulting from sorting stored TRU waste will meet the applicable requirements of RCRA (see Chapter 6). The DOE has initiated an evaluation of waste disposal sites which were inactive before November 1980 as required by CERCLA (see Chapter 6).

In 1985 and 1986, DOE initiated additional groundwater monitoring for hazardous chemicals around active hazardous chemical waste disposal sites and elsewhere on the Hanford Site. Additionally, detailed characterization of the defense wastes is under way. Preliminary data regarding organics, radionuclides, and hazardous chemicals are available in RHO-RE-ST-30 ADD P (Rockwell 1987). Spent solvents, petroleum products and lab wastes are not associated with high-level, transuranic and tank wastes and are outside the scope of the EIS.

3.1.6.2 Comment:

Regarding Appendix U, a reviewer stated that the cadmium and fluoride equilibrium concentrations could not be verified with the references cited (Letter Number: 223).

Response:

Incorrect references were provided. They have been revised in the final EIS text in response to the comment.

3.1.6.3 Comment:

A reviewer noted that on Page 3.5 of the draft EIS it was stated that among other things chemicals of interest were listed in Table 3.1; however, no chemicals were listed in Table 3.1. In addition the reviewer asked the following:

What are the total number of sites, area, volume, mass and quantities of radioactive materials and chemicals of interest for low-level waste at the Hanford Site? What are the chemicals of interest and their quantities for the six waste classes described in the draft EIS? What are the health concerns associated with each chemical of interest? (Letter Number: 223).

Response:

Chemicals are not presented in Table 3.1 but are included in Appendix A. The reference to chemicals of interest has been removed from the description of Table 3.1.

As stated in the draft EIS low-level wastes are outside the scope of this EIS. Names and quantities of the principal chemicals of interest for existing and future tank waste were given in Appendix A. The encapsulated waste consists of strontium fluoride and cesium chloride. The chemical forms of waste in the several TRU categories are presently not well defined; additional characterization is required. An indication of possible movement of selected chemicals to groundwater and their relationship to drinking water standards was presented in Section 3.4.2 of the draft EIS.

Additional characterization of the potential impact of chemicals requires improved knowledge of chemical inventories, leach rates from various waste forms, and transport in the vadose zone to groundwater which information is expected to be obtained during the development and evaluation period. Absence of detailed information on chemicals is not seen as an impediment to selection of strategies for waste disposal.

3.1.7 Future Waste

3.1.7.1 Comment:

Most of the reviewers that addressed disposal of future waste and many testifying at the public hearings urged that no future waste be generated. Some said that the best way to ensure that was to shut down the N Reactor and other processing facilities.

Response:

See comment number 2.5.6.

3.1.7.2 Comment:

One reviewer pointed to the need to identify future wastes and associated impacts from these wastes. Another reviewer noted that the startup time for the Process Facility Modification (PFM) was scheduled for 1993, with a 20-year operating lifetime that extended PUREX/PFM operations to the year 2013. The reviewer felt that there was a discrepancy between the schedule reported in the draft EIS and the actual schedule. The final EIS should address impacts from future wastes (Letter Numbers: 215, 216, 217).

Response:

The draft and final EIS both address anticipated impacts from future wastes. See the final EIS, Section 3.2.2, for the expected operating schedule. See also Section 3.4.3, "Comparison Among Alternatives of Key Impacts from Future Tank Waste and Newly Generated TRU Waste."

3.1.7.3 Comment:

A reviewer noted that 12,000 t of N Reactor fuel are expected to be produced by the year 1995, and that an additional 20,000 t are estimated beyond 1995 for potential defense needs. The reviewer felt that impacts from the possible range of future defense waste need to be addressed in the final EIS, including the potential use of the current or recycled stockpile of plutonium, because the total volume of defense and commercial waste is expected to determine the need for the second geologic repository (Letter Number: 223).

Response:

The impacts of additional 20,000-t PUREX processing campaigns can be determined from material provided in Section 3.4.3 of the draft EIS. Since the additional campaigns are not fixed, they are not included in the amount that would be disposed of in a commercial repository. It is also likely that a second repository will be readdressed before the end of this century. Nevertheless, each 12,000-t campaign, because of lower reactor exposure and removal of uranium and plutonium, is equivalent to less than about 500 t of commercial spent fuel. Hence a 20,000 t PUREX processing campaign would amount to less than 1000 t commercial equivalent and could thus likely be accommodated in the first 70,000-t repository as well.

3.1.7.4 Comment:

A reviewer inquired whether the process of removing additional transuranics from cladding waste before neutralization had already begun, since the draft EIS indicated that this was to begin in 1985 (Letter Number: 223).

Response:

Additional TRU is presently being removed from newly generated cladding waste. A change in the RHO-RE-ST-30 P engineering support document, Section 2.6.3.1, para. 5 (Rockwell 1985), resulted in the revision shown in the final EIS, Section 3.2.2.

3.1.7.5 Comment:

A reviewer observed that there is not enough space in the double-shell tanks to contain the projected waste. Although the draft EIS indicated that there would be a reduction in waste volume, there was no description of how this would be accomplished or what the impacts would be. It was noted that waste is not addressed beyond the year 1995 (Letter Number: 230).

Response:

Future tank wastes and their treatment for processing through 1995 are discussed in detail in Appendix A (Section A.2). Enough volume in tank storage will be available, as discussed in Section A.2.3. Tank storage for campaigns beyond 1995, if required, has not been addressed; the amount needed would depend on whether final disposal actions had begun. However, Section 3.2.2 of both the draft and final EIS addresses extended operations of production activities.

3.1.7.6 Comment:

Two reviewers requested that the final EIS discuss impact of the proposed process change on future waste disposal programs (Letter Numbers: 215, 217).

Response:

The comments refer to the Process Facility Modifications (PFM) project which, if instituted, would eliminate some of the cladding removal waste discussed in the draft EIS. A reduction in waste volume maintains the bounding analyses provided in the draft EIS. Additional documentation, the draft PFM-EIS (DOE 1986a), discusses impacts related to the PFM, all of which are bounded by the EIS. No adverse impacts related to the environment are anticipated should the PFM project be instituted.

3.1.8 Facilities and Processes

3.1.8.1 Comment:

Reviewers expressed concern regarding the level of grout technology for disposal of wastes. Comments covered performance, formulation development, actual testing, relevant documentation and regulatory compliance (Letter Numbers: 46, 71, 110, 170, 223, 231, 234, 242).

Response:

Before implementation of grout in the disposal of waste, extensive development and evaluation efforts will be conducted to verify the suitability of the grout as a disposal medium. Studies will include formulation development, leachability studies, durability (physical and mechanical testing) and long-term performance assessment, including regulatory compliance analyses for all constituents. Documentation supporting the acceptability of any grouted waste form will be published before the disposal of any waste stream within the scope of this EIS. The DOE will also continue to work with the State of Washington and the EPA to ensure that disposal of the grouted waste is in compliance with applicable state and federal regulations.

3.1.8.2 Comment:

A reviewer suggested that grout and vitrification technologies be discussed in the EIS (Letter Number: 57).

Response:

The technologies are discussed in Chapter 3 of the EIS, with specific appendices dedicated to discussions of both grout (Appendix D) and the vitrification facility (Appendix C). Waste forms resulting from these processes were assessed in the EIS regarding their capability to protect the environment.

3.1.8.3 Comment:

A reviewer noted that performance testing on grout should have been described in the draft EIS (Letter Number: 171).

Response:

Performance testing on grout formulations to be used in implementing the waste disposal alternatives has not been done. Before implementation of grout in the disposal of waste, extensive development and evaluation efforts will be conducted to verify the suitability of the grout as a disposal medium.

3.1.8.4 Comment:

A reviewer pointed out that in Appendix D, a cited reference did not delineate contents of a "typical" grout mixture (Letter Number: 223).

Response:

"Typical" was meant to indicate materials utilized in the normal grout formulation such as fly ash, cement, etc. It was not intended that this reference would cover "typical" grout mixes containing radioactive waste. References regarding radioactive grout have been added to Appendix D (Schulz et al. 1980; Tallent et al. 1986).

3.1.8.5 Comment:

A reviewer questioned the stability of grout when subjected to high temperatures and the ability of the grout to incorporate the waste. The reviewer also wondered about the inaccessible horizontal connections between tanks which would not be filled with grout in the in-place stabilization and disposal alternative (Letter Number: 215).

Response:

Technology and formulation development for grouted wastes are ongoing, and a proven, acceptable waste formulation(s) will be documented before disposal. Long-term temperature limits for grout are presently set at less than 90°C based on laboratory tests of grout durability at elevated temperatures; grout formulations will be established so that this value is not exceeded. Residual contamination in transfer lines will be minimized by flushing after use, leaving low-potential doses and impacts from the transfer lines themselves.

3.1.8.6 Comment:

Reviewers commented on the proposed immobilization of complexed concentrate waste in grout. If, for any reason, strontium and/or cesium are not fully removed, the lifetime of the grout will decrease greatly. Additional problems arise with the release of strontium-90 to the environment (Letter Numbers: 171, 177).

Response:

No specific, published data are currently available concerning formulation, pretreatment, or disposal of complexed concentrate waste. The grout program is cognizant of the potential adverse effects of high temperatures on the curing and long-term integrity of a grout monolith. As a result, the development and evaluation program will include studies to demonstrate and qualify effects on long-term performance of chemical and/or radionuclide loading for each type of grouted waste before disposal. These studies will ultimately generate waste stream specifications detailing the maximum permissible chemical and/or radionuclide loading concentrations.

3.1.8.7 Comment:

A reviewer expressed concern regarding safety of grout immobilization if the climate becomes 10% wetter (Letter Number: 177).

Response:

Grouted waste was analyzed in parallel with all other wastes. The climate was modeled to vary such that recharge of precipitation increased by a factor of 10. The level of climate change would be required to cause such additional recharge is not known because of competing influence from increased vegetation with additional precipitation.

3.1.8.8 Comment:

A reviewer commented that under any of the three waste disposal options, at least some wastes will be stabilized in place in the old tanks, but there is no mention of studies of either in-place transformation of the wastes to a more stable form, or to any physical method (i.e., grouting) of isolating or further stabilizing the wastes in the tanks. The reviewer asked whether any such studies were done and whether such techniques would be safer (Letter Number: 171).

Response:

It is not intended that waste would be stabilized in place in single-shell tanks in the geologic alternative. There, it is intended that all waste would be retrieved, but there is a practical limit to how much can be removed. In order to assess impacts of the alternative, it was assumed that up to 5% of the single-shell tank waste would probably not be removed. In practice, if more could be removed it would be. Changing waste form of the residual waste in the tanks was not considered. In the in-place stabilization and disposal alternative, double-shell tank waste is removed and grouted; and it could be returned, at least partially, to tanks. It might be possible to use the technique of in situ vitrification of some tank wastes to change the waste form. Only in the latter case would one expect a significant improvement in the potential for reduction in waste releases.

3.1.8.9 Comment:

Several reviewers commented that the waste should be vitrified, or "solidified" or "glassified." However, one reviewer commented about the lack of experience with the proposed grouting and vitrification plants, and noted that the kinds of accidents that could occur in the operation of the plants have not been adequately considered. Reviewers also noted that it was inappropriate to develop a "preconceptual" design based on the design technology of the West Valley Demonstration Project (New York) and the Defense Waste Processing Facility (Savannah River, South Carolina). Another reviewer also pointed to the need for the grouting and vitrification plants to receive prompt funding (Letter Numbers: 10, 29, 46, 53, 71, 113, 128, 148, 157, 167, 170, 171, 190, 192, 217, 242. Hearing Number: 627).

Response:

As part of the actions anticipated under the preferred alternative and dependent upon the final Record of Decision, the DOE expects to complete the design and construction of the Hanford Waste Vitrification Plant, to finalize the glass and grout formulation and to determine leach rates to ensure that they will meet appropriate waste acceptance criteria. The design, construction, and operation of waste management facilities will be in compliance with all applicable regulations.

3.1.8.10 Comment:

Reviewers also noted that France has applied vitrification of waste, but the reviewers disagreed on the success of the reported results, citing documentation that indicated that glass was not a suitable waste form (Letter Numbers: 75, 110, 170).

Response:

An English translation of the "Rapport du Groupe de Trava Sur la Geshon de Combustibles Irradies," commonly known as the "Castaing Report" (Counseil Superieur de la Surete' Nucleaire 1981) was again reviewed, but the statement alluded to by the reviewers was not located in the report. A more complete reference would be needed to locate the stated conclusion. The following, however, was located:

> "Thus the Group felt that final proof has not yet been offered that the three types c. package, glass, cement and bitumen, considered in the definitive storage plans, can henceforth be considered as of now irrevocably qualified for this purpose" (page 25).

This statement simply reflects the lack of qualification tests on waste products in geologic environments and is also consistent with the need for additional testing of potential systems.

Taken as a whole, the "Castaing Report" is understood to support the selection of glass (vitrification) for solidification of radioactive wastes. The following excerpts reflect this view:

> "Vitrification, which is successfully developed in France for more than twenty years, represents a good alternative for the management of high-level solutions in the short and medium term, with the best safety guarantees (reduced volume, simplified monitoring, among others). The qualification of the glasses for final storage, which appears to be guaranteed for fission products, remains to be established for long half-life emitters" (page 31).

> "To the maximum possible extent, consideration should be given in the future installations to the constant improvements made in the vitrification ... technique, aimed at the maximum long-term stability of the glasses" (page 31).

> "Development work should be continued on a method to concentrate the effluents followed by vitrification of the alpha residues thus obtained" (page 44).

3.1.8.11 Comment:

A reviewer noted that borosilicate glass was chosen over crystalline ceramic as the preferred waste form not because it is more stable, but because "process complexity, development requirements, and programmatic costs would be less for borosilicate glass than crystalline ceramic." Another reviewer thought that further study of borosilicate glass properties was warranted (Letter Numbers: 170, 215).

Response:

Borosilicate glass was selected in part because of the reasons given by the reviewers; it was also selected because it was considered to have adequate stability for the solidification of the wastes. There are always better methods and techniques that can be imagined and possibly developed; however, adequate materials need to be selected to allow the work to go forward. This has been the position of the French as noted above, and they now have many years of experience in the solidification of high-level wastes.

3.1.8.12 Comment:

A reviewer commented that, on page 3.13 of the draft EIS, although the text states that glass leachability is low and thermal stability high, the reference (DOE 1982a) refers to them as "acceptable" (Letter Number: 223).

Response:

Page B.1 of the reference describes desired properties for a waste form. For a product to be "acceptable" it must exhibit all of the important properties to an acceptable degree. This EIS (Appendix C) lists some of these properties to provide more information than simply the word "acceptable."

3.1.8.13 Comment:

Reviewers expressed pessimism about DOE's capability to vitrify waste in large quantities and to retrieve the waste after it is "buried in the proposed repository" (Letter Numbers: 3, 110).

Response:

Vitrification is a proven technology, as demonstrated by the French (see comment number 3.1.8.10). The assumption that DOE intends to retrieve waste that has been disposed of is incorrect; there is no such intent. However, there is a "retrievable" requirement (for 50 years after closure) in the NRC licensing standard to ensure repository performance.

3.1.8.14 Comment:

A reviewer was concerned about the concentration of radionuclides that will be released to the environment during the feed concentration, off gassing from the melter, and canister cooling steps of the vitrification process (Letter Number: 170).

Response:

Off gas from the melter is routed to a process off-gas treatment system. The process off-gas system will remove condensibles, particulates, volatile radionuclides, and chemicals from the melter off gas before the off gas is released to the facility ventilation exhaust system. The system will decontaminate the melter off gas so that component concentrations at the stack, following filtration in the facility exhaust system, will meet release requirements specified in DOE Order 5480.1B (DOE 1981a) for onsite and offsite releases. Condensate collected from the process off-gas system will be recycled to the waste feed concentration system and blended with incoming waste feed. Exhaust air in the pretreatment stage area and in the canister storage area is also filtered through one or more sets of high-efficiency particulate air (HEPA) filters before being released to the atmosphere.

Estimated annual radiological emissions during the operational period are shown in Table C.9 of this EIS. Radiological emissions will not exceed guidelines established by the DOE in DOE Order 5480.1B for release to uncontrolled areas.

Dose commitments to the maximally exposed individual in the general population from routine operations of the Hanford Waste Vitrification Plant (HWVP) are presented in Tables C.6 through C.8. All doses are within EPA limits given in 40 CFR 61.

3.1.8.15 Comment:

A reviewer wanted to know whether radiolytically produced gas causes problems in vitrified waste (Letter Number: 171).

Response:

No problems with radiolytically produced gas are anticipated in vitrified waste. Materials in glass that could radiolytically produce gas, such as water, are in the parts-per-billion range; and, as a consequence, the amount of gas that might be generated would cause no pressure problems.

3.1.8.16 Comment:

Reviewers requested that the final EIS include a statement as to whether the final waste package design for geologic disposal will need to be site-specific depending on the geochemical (and other) conditions of the selected repository (Letter Number: 147, 217).

Response:

The final waste package design will be site specific (as it will be for commercial fuel) in that the design will meet the NRC's 10 CFR 60 and EPA's 40 CFR 191 requirements. The following statement has been added to Section 3.3.1 of the final EIS: "All defense waste to be disposed of in a commercial repository will satisfy the same requirements as commercial waste, including 10 CFR Part 60, 'Disposal of High-Level Wastes in Geologic Repositories,' and 40 CFR Part 191, 'Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes.'"

3.1.8.17 Comment:

A reviewer questioned the conclusion that projected annual releases from the Waste Receiving and Processing (WRAP) facility were well below the limits established by the DOE for release in uncontrolled areas (Letter Number: 223).

Response:

As with all facilities discussed in the draft EIS, routine annual radiological releases are given in Ci/year. Those data are coupled in calculations using facility ventilation rates and volumes, decontamination factors, and dilution/travel distance to the Site boundary, providing radionuclide concentrations at the Site boundary attributed to the facility. Calculations utilizing those factors for the WRAP facility resulted in concentrations well below the limits established in DOE Order 5480.1B (DOE 1981).

3.1.8.18 Comment:

A reviewer noted that there is no vitrification project for stabilizing contaminated soil sites. Another reviewer wanted to know why in situ vitrification was not considered in the EIS (Letter Numbers: 71, 217).

Response:

In situ vitrification at present holds some promise in the area of producing enhanced waste forms. It is expected to be particularly useful for unconsolidated wastes such as the TRU-contaminated soil sites. It is still in experimental stages and for that reason was not included in the draft EIS.

3.1.8.19 Comment:

A reviewer noted that on page 1.13 the draft EIS states "There would be very little ... treatment of waste ..." The reviewer stated that "In-situ vitrification is treatment and has been proposed for TRU sites" and asked for clarification or definition of "treatment" (Letter Number: 223).

Response:

The statement on page 1.13 refers to the in-place stabilization and disposal alternative. Although in situ vitrification holds some promise for additional stabilization of defense waste sites if needed, this EIS has not proposed or assessed the benefits or impacts of this process or "treatment." "Very little treatment of waste" was meant to be in comparison to retrieval and processing into high-activity fractions that would be vitrified and a low-activity fraction that would be disposed of in grout, as in the geologic disposal alternative. The preferred alternative provides for consideration, under development and evaluation, of additional treatment for the waste classes for which final disposal decisions are being postponed.

3.1.8.20 Comment:

A reviewer recommended the following actions: a) fund vitrification and grout facilities, b) systematically clean single-shell tanks, c) remove all nuclear waste (may require 5 years' additional research), d) fill empty single-shell tanks with gravel and cover with barrier, e) vitrify remaining waste, f) similarly process double-shell tank waste, g) monitor waste movement and periodically (25 years) publicly evaluate situation, h) put all waste on 200 Area plateau, i) package waste such that it could be retrieved from geologic disposal, j) similarly handle TRU waste, and k) do not rely on the Columbia River for dilution (Letter Number: 217).

Response:

The comment is basically supportive for geologic alternative. In the geologic alternative, waste would be removed from single-shell tanks, except for a small "heel" which would remain in the tank and be disposed of in place. The preferred alternative calls for no immediate decision on single-shell tank waste. These wastes will be further characterized and evaluated before a disposal option is selected. Not all nuclear waste will be removed from the Hanford Site under any alternative. This is discussed in Section 3.3.7, "Disposal Alternatives Considered but Dismissed from Detailed Consideration." Waste sent to a geologic repository will be packaged to meet the repository criteria. The intent behind a geologic repository is permanent disposal, not waste storage; however, there is a period of time that a repository would be monitored before closure to provide for unforeseen problems. In the geologic disposal alternative, TRU waste is processed and sent to the Waste Isolation Pilot Plant. The Columbia River will not be relied on for dilution of nuclear waste disposed of at the Hanford Site. The purpose of the engineered barrier and other engineered systems is to keep the waste that is left in place stationary in the ground for as long as possible.

3.1.8.21 Comment:

Reviewers recommended actual testing, on some scale, of the Transportable Grout Facility (TGF), the Waste Receiving and Processing facility, and in situ vitrification of TRU-contaminated soils (Letter Numbers: 71, 217).

Response:

The Interim Hanford Waste Management Technology Plan (DOE 1986e) discusses plans for testing the transportable grout equipment (Technical Issue DST-7), Waste Receiving And Processing facility (Technical Issue TRU-4), and in situ vitrification of transuranic-contaminated soils (Technical Issue CSS-4). Those tests would be conducted before final disposal operations.

3.1.8.22 Comment:

A reviewer commented on Section B.1.2.1, Radionuclide Concentration for Geologic Disposal, which discusses the building of a radionuclide concentration facility. The draft EIS states that concentrations of liquids released to surface ponds would be lower than the maximum permissible concentration for releases to uncontrolled areas, except for tritium, which would be within the limit for release to controlled areas. The reviewer felt that this is in conflict with current written goals by Rockwell Hanford Operations to reduce all liquid effluent releases to the drinking water standards (Letter Number: 223).

Response:

Presently there is no practicable alternative to the release of tritium to ground. Three other processes are conceivable: isotopic separation, dilution and evaporation (gaseous release). The method proposed was considered to be the most reasonable choice, but further review would be given during detailed design if this alternative were selected for implementation.

3.1.8.23 Comment:

The draft EIS lists physical and mechanical properties upon which the grout's durability depends and cites Young et al. (1982). The cited reference, in contrast, addresses environmental factors affecting long-term stabilization of soil layers used as radon suppression covers for uranium mill tailings (Letter Number: 223).

Response:

Although the subject of the cited document is radon suppression covers, the analysis of factors is closely related; grout is one of the materials that has been suggested for use and as a consequence long-term performance of grout has been evaluated and the required characteristics described in the document.

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3.2 AFFECTED ENVIRONMENT

This section deals with comments relating to the geology, seismicity, air quality, ecology, cultural resources and socioeconomics of the Hanford area and the surrounding region.

3.2.1 Geology

3.2.1.1 Comment:

A reviewer asked for elaboration on the draft EIS statement (page O.5) concerning the "structural complexity" of the surficial (unconfined) aquifer and vadose zone. Noting that modeling of such "complexities" is not simple, the reviewer asked what evidence there was of the complexity and how it affects contaminant transport (Letter Number: 243-EPA).

Response:

The description of structural complexity on Page O.5 (Appendix O) is derived from evaluation of data from more than 2900 test/observation wells drilled on the Hanford Site. The complexity contributes to the present observed pattern and distribution of contaminants in the groundwater, and it will affect the occurrence and movement of contaminants from the wastes defined in the EIS scenarios. Existing conceptual and numerical models of the hydrologic systems cannot account for each detail and nuance of the system. However, the numerical hydrologic models have been calibrated and verified using the available field and test data sets. The models provide better simulation and prediction of system performance than intuitive or analytical approaches. See comment 3.5.3.6.

3.2.1.2 Comment:

A reviewer referred to a citation presented in Appendix R, which stated that the Pasco Basin is believed to have been cooler and wetter 10,000 to 13,000 years ago than it is today, and to have changed to a warmer, drier climate about 8,000 years ago (Nickmann and Leopold 1985). The reviewer felt that the statement is not in agreement with the observation made in the above reference that stated that there was a change to a wetter climate about 8,000 years ago (Letter Number: 223).

Response:

Nickmann and Leopold (1985) stated that there was a relatively cool and moist interval recorded at Goose Lake, where their studies were conducted, from 6,700 to 8,000 years ago. They also point out that this climatic change was not observed at other previously studied sites. This may be due to 1) nonconformity at the other sites during this time, or 2) the Goose Lake site, which is located in a narrow ecotonal region and has been especially sensitive to paleoclimatic changes. Except for this thousand-year interval, the trend toward a warmer, drier climate has prevailed from about 3,000 to 8,000 years ago.

3.2.1.3 Comment:

Reviewers stated that past climatic changes do not necessarily bound the extreme conditions expected over the next 10,000 years. One reviewer suggested that increased concentrations of CO_2 in the atmosphere could result in a "super-interglacial" period with a mean global temperature of about 63°F (compared to the present 61°F). The reviewer further suggested that the EIS include this possible "super-interglacial" period in its discussion of climate (Letter Numbers: 217, 219, 239-NRC).

Response:

Future warming (i.e., "super-interglacial" through man-induced increases in atmospheric carbon dioxide) was not considered in the draft EIS per se. Rather than attempt to forecast actual climate changes that might lead to increased infiltration of precipitation, leaching of wastes and transport to the environment, a scenario was assumed wherein an amount of recharge about ten times that expected under the present climatic conditions occurred and the consequences thereof analyzed. Moreover, from the results of the disruptive barrier failure scenario one could infer impacts from up to 30 times present expected recharge. The potential for climate change and impacts on the barrier system is also considered in the Barrier Development Program (Adams and Wing 1987).

3.2.1.4 Comment:

A reviewer stated that stratigraphic complexities, which had been ignored for the interpretation of plutonium and americium distributions in Appendix V can greatly alter anticipated effects (Letter Number: 243-EPA).

Response:

The distributions of plutonium-239 and americium-241 in Figures V.12 and V.13 are in the top 10 m of sediment. Note that the scale on Figure V.9 is to a depth of 100 m. The stratigraphic complexities that the reviewer says were ignored are not present to the same degree in the top 10 m of sediment as they are at greater depths (Figure V.9).

3.2.1.5 Comment:

A reviewer disagreed with the draft EIS statement (page 4.5) that the "200 Areas plateau has undergone minimal erosion since formation by floodwaters about 13,000 years ago," stating that "the plateau was not formed but was eroded by flood waters." The reviewer also said that the term "floodwaters" is vague and that the EIS should elaborate on the event (Letter Number: 215).

Response:

The 200 Areas plateau was formed from sediments laid down during late Pleistocene (approximately 13,000 years ago) flooding episodes. Geomorphic units in the area include the Umtanum bar, 200 Areas bar, central Hanford sand plain and Cold Creek alluvial plain. The Umtanum bar is classified as an eddy bar that developed behind the east end of Umtanum Ridge. The 200 Areas bar represents an extension bar that formed as a result of decelerating flow of floodwaters. The central Hanford sand plain was formed during flooding by the deposition of fine-grained sediments on the lee of the Umtanum bar. Holocene alluvium deposited along Cold Creek is superimposed on the western portion of the central Hanford sand plain. Judging by the undissected nature of these units (with the exception of the Cold Creek alluvial plain), minimal erosion has occurred since formation by floodwaters (DOE 1986c). Chapter 4 of the final EIS has been revised to clarify.

3.2.1.6 Comment:

Reviewers inquired about the presence of mineral resources on the site, particularly as their presence might affect the suitability of the site for nuclear waste disposal relative to the requirements of 40 CFR 191.14 or 10 CFR 61 (Letter Numbers: 5-DOI, 239-NRC, 243-EPA).

Response:

In the vicinity of the defense waste disposal sites on the 200 Areas plateau, there are no known mineral or hydrocarbon resources that have a value great enough to be considered commercially extractable. Natural gas (methane) was produced from wells in the Rattlesnake Hills and commercially distributed to the lower Yakima Valley from about 1920 to 1940, at which time the gas had been depleted to the point where production was not economically practical. Additional exploratory wells have been drilled in search of natural gas and oil in the vicinity of the Hanford Site. The deepest of these wells (more than 5180 m) was drilled in the Saddle Mountains, about 26 km north of the Site. These wells were deemed noncommercial by the exploring oil companies. With the exception of small gold placers, no valuable metallic mineral resources are known or believed likely to exist on or near the Site. Relatively low-unit-value industrial rocks and minerals such as diatomaceous earth, sand and gravel, and crushed rock are presently being recovered by surface mining within 100 km of the Site.

3.2.1.7 Comment:

A reviewer noted that the draft EIS states that most structures "generally die out" near the center of the Columbia Plateau (i.e., Pasco Basin). However, the reviewer objected by noting that gravity and aeromagnetic surveys indicate that structures continue eastward through the Pasco Basin to the Columbia River where they appear to be refracted southward (Deju and Richard 1975); thus, structures do not "die out" in the center of the Columbia Plateau (Letter Number: 215).

Response:

The Columbia River and the Pasco Basin are located in the west-central portion of the Columbia Plateau. The fact that structures trend eastward across the Pasco Basin to the Columbia River is consistent with the statement in question.

3.2.1.8 Comment:

One reviewer commented that the Ellensburg formation is not considered in the EIS. Another reviewer felt that the thickness and regional extent of Ellensburg formation interbeds [confined aquifer(s)] should be described in Appendix O (Letter Numbers: 219, 243-EPA).

Response:

Myers et al. (1979), cited in Chapter 4 of the EIS, should be consulted for detailed information on the Ellensburg formation. The Ellensburg formation has little or no relevance to issues under consideration in this EIS.

3.2.1.9 Comment:

One reviewer inquired about the general nature of fracture systems below the Hanford Site, and expressed that the descriptions of stratigraphy in the draft EIS were too general, and asserted that the discussion of geologic information in the draft EIS was "not impressive" (Letter Number: 219).

Response:

Stratigraphy of the Hanford Site was described in general terms. For all waste that might be disposed of near surface, the surficial sediments dominate in importance. If wastes were to be disposed of in a geologic repository at Hanford, the deep stratigraphy would be more important and is discussed in more detail in the Basalt Waste Isolation Project Environmental Assessment (DOE 1986c).

3.2.2 Seismicity

3.2.2.1 Comment:

A reviewer agreed with the draft EIS statement that seismic activity and related phenomena are not believed to be plausible events that might directly release waste but contended that seismic factors must be taken into account in the protective barrier design and performance evaluation (Letter Number: 223).

Response:

Seismic factors are being considered in development of the protective barrier design and evaluation and testing of the barrier performance.

3.2.2.2 Comment:

Reviewers commented that faulting and possible fault reactivation should be discussed further (Letter Numbers: 171, 219, 239-NRC).

Response:

Although present data are too preliminary to permit any specific predictions of continued tectonic activity and effects, these data along with the thickness and nature of the suprabasalt sediments suggest that isolation of waste will not be compromised by faulting or other earthquake-related phenomena. For more information see Appendix R of this EIS.

The DOE (1986c) considered several lines of evidence that suggest possible faults in the vicinity of the 200 Areas. The DOE also examined the age of nearby faults and the potential for future fault activity. A northwest-trending, steeply dipping fault, mapped on Rattlesnake Mountain, is considered part of the Rattlesnake-Wallula alignment. This alignment or splays from this alignment might be present in or near the 200 Areas. However, assuming such an extension at this time seems premature. The NRC agreed that only that portion of the

Cle Elum-Wallula alignment extending from the Blue Mountains to the north end of Rattlesnake Mountain constituted a part of the Rattlesnake-Wallula alignment.

Tectonic breccia has been reported in some deep boreholes near 200 West Area. Such breccias might be easily predicted in synclinal areas indicating local shearing of basalt during deformation. To make predictions of major structures purely on the basis of limited occurrences of breccia in core is speculation. Such breccias merely suggest that structures of unknown extent, geometry and dimensions may be present.

Seismic reflection anomalies and aeromagnetic linears are suggestive of the presence of fault structures near the 200 Areas. Microearthquakes are another type of evidence of the possible presence of faults in or near the 200 Areas. Rupture and slip that produce microearthquakes occur on very small faults or very limited parts of larger faults. If these microearthquakes were occurring on limited segments of larger faults, other evidence of the existence of such major faults should be present. Because major faults have not been detected, it seems reasonable to conclude that the fractures that produce such events are really limited. The existence of small fractures is suggested by different focal mechanisms for several small events in a swarm, as well as seismic moments of such events (DOE 1986c).

The central fault on Gable Mountain has been interpreted to be a capable tear fault (PSPL 1982; NRC 1982). This northeast-trending fault plane continues into overlying glaciofluvial sediments that correlate with 12,000-year-old catastrophic flood deposits, indicating that the fault has been active during the Quaternary period. No earthquakes, however, have been recorded along this fault during the 15 years of instrumental monitoring. Long-term average slip rates calculated for this fault are very low; however, slip rates for this structure and recurrence rate for earthquakes generated by such slip remain to be determined. Based on the low average slip rate and the relationship to the Gable Mountain anticline, the central fault on Gable Mountain has been provisionally assigned a maximum credible earthquake of approximately magnitude 5 to 5.5 (Slemmons and Chung 1982).

The Rattlesnake-Wallula alignment has also been assumed to be a capable fault, primarily due to lack of evidence to the contrary. It is assumed to be a continuous, 120-km-long, right-lateral strike-slip or right-oblique slip fault. Slemmons and Chung (1982) have assumed that because of very low slip rates, recurrence intervals for events as large as magnitude 6.5 may be 50,000 years or longer. Relative inactivity of this feature is suggested by the general absence of microearthquakes along the length during 15 years of instrumental monitoring, and by the absence of any fault scarps suggesting displacement since the latest catastrophic flood some 12,000 years ago.

Clear evidence of late Quaternary, tectonically produced surface faulting has not been found, but deformation has been ongoing, at least episodically, during the Quaternary period. Long-term average low rates of deformation appear to have been in the central Columbia Plateau since the Miocene period, but the episodic nature of this deformation, including slip and recurrence rates, requires further study.

3.2.2.3 Comment:

One reviewer stated that during the past 90 years, several earthquakes with intensities ranging from 5 to 7 (Richter scale) have originated within 50 miles of the Hanford Site, and that an earthquake with an intensity of 8 is entirely possible within 50 miles of the Site. The reviewer termed Washington State "seismically active and unstable." Another reviewer noted that the NRC claims that it is entirely possible for an earthquake to attain a Richter value of 6.5 in the Hanford area. (Letter Numbers: 38, 176).

Response:

The 1936 Milton-Freewater, Oregon event is the largest earthquake recorded on the Columbia Plateau (magnitude 5.75 Richter scale) and was located on the Blue Mountains front (WPPSS 1981). The average recurrence interval for a large earthquake (magnitude 6.5) on a 20-km (12 mi) segment of the Rattlesnake-Wallula alignment is estimated to be greater than 50,000 years (Slemmons and Chung 1982); however, no earthquake of this magnitude has ever been known to occur along the Rattlesnake-Wallula alignment. Seismic activity within the Columbia Plateau occurs less frequently and at lower magnitudes than in other areas of the Pacific Northwest (Myers et al. 1979). Liquefaction, fault rupture, and other ground disturbance phenomena that might affect the integrity of the waste sites have not been found to be plausible events. For a further discussion of seismicity and earthquakes at the Hanford Site, the Basalt Waste Isolation Project Environmental Assessment (DOE 1986c) should be consulted.

3.2.2.4 Comment:

A reviewer noted that earthquake swarm activity has occurred within the Hanford Site, particularly in the Wooded Island portion of the Columbia River (Letter Number: 215).

Response:

Section 4.3 of the final EIS has been revised in response to the comment.

3.2.2.5 Comment:

Referring to a statement on page 4.10 of the draft EIS, a reviewer noted that models do not all agree that faulting and folding in the Pasco Basin took place concurrently, so the EIS should be revised to state this uncertainty (Letter Number: 215).

Response:

Section 4.3 of the final EIS has been revised in response to the comment.

3.2.2.6 Comment:

Reviewers noted that the La Grande-Chewaukin fault structures traverse the Hanford Site and should be shown in Figure 4.5 (Letter Numbers: 44, 214, 217).

Response:

Although some topographical features can be aligned between La Grande and the Chewaukin Graben area, no through-going fault associated with this alignment can be identified on the Hanford Site. The final EIS (Figure 4.5) has been modified to show the thrust faults on the Hanford Site.

3.2.2.7 Comment:

One reviewer noted that subvertical clastic dikes have been observed in the trench walls at the commercial low-level waste disposal area near the 200 East Area (operated by U.S. Ecology). The clastic dikes are indicative of fissuring, which may recur with implications for disruption of shallow-land buried wastes (Letter Number: 239-NRC).

Response:

Clastic dikes are known to exist in the 200 Areas, and have been observed in pond bottoms, waste burial trenches and tank farm excavations. Although the reviewer suggests a seismic origin of the dikes, these features may have developed soon after deposition of the sediments and are not likely to occur without further deposition of sediments. However, the existence of clastic dikes could influence the migration rates of moisture or contaminants to the groundwater.

3.2.2.8 Comment:

A reviewer objected to "vague" wording in the draft EIS Section 4.3 relative to Pasco Basin deformation rates and the lack of quantitative definitions. The reviewer also asked what depths were referred to in the statement in Section R.10: "underground motion will be one-half to two-thirds that of the surface in an undisturbed medium" (Letter Number: 215).

Response:

Section 4.3 of the final EIS has been revised to clarify the deformation rates. The underground motions referred to in R.10 are not relevant to the EIS considerations and the sentences have been deleted from the text.

3.2.3 Air Quality

3.2.3.1 Comment:

Regarding Section 4.5.5, a reviewer commented that no criteria, data or quantitative definitions were presented in support of the statement that air quality in the vicinity of the Hanford Site is generally classified as "quite good." Another reviewer requested a summary table of air quality measurements, including comparison to standards (Letter Numbers: 215, 239-NRC).

Response:

Sections 4.5.4 and 4.5.5 of the final EIS has been revised in response to the comments.

3.2.3.2 Comment:

Reviewers asked for additional information about NO_2 and SO_2 levels and sources including maximum-minimum levels of NO_2, the number of days PUREX was shut down, sources of SO_2, horizontal dimensions of volume sources for SO_2 and information to validate the source characterizations for the air quality model (Letter Numbers: 215, 243-EPA).

Response:

Pollutants, including NO_2 and SO_2, that are governed by the Ambient Air Quality Standards (AAQS) are examined in Appendix T.

The air quality standard for nitrogen oxides is the 100 $\mu g/m^3$ limit for the annual average. During 1984, PUREX was operating about 75% of the time. Increasing the maximum measured NO_2 concentration to reflect 100% operations still results in a maximum NO_2 concentration that is an order of magnitude less than 100 $\mu g/m^3$.

All sources of information, including emission rates, were presented in Appendix T. For the purposes of air quality modeling, the 200 East Area (Figure 4.1) was chosen to represent the source of the emissions, and a volume source was specified to encompass this area.

3.2.3.3 Comment:

A reviewer asked for an explanation of several aspects of atmospheric mixing including: 1) the use of urban instead of rural mixing heights, 2) the fact that EPA does not recommend ($\Delta T/\Delta Z$) lapse rate to estimate stability class, 3) failure to use Hanford Doppler sounder data for mixing heights (Letter Number: 243-EPA).

Response:

Because only two reports per day of mixing height are available from Spokane, an industrial source complex (ISC) preprocessor was used to prepare interpolated values of mixing height for each hour of the model simulation. Two sets of mixing height data were produced by the preprocessor; one set reflected so-called "urban" conditions, while the second set represented "rural" conditions.

The urban mixing height data for Spokane were more consistent with conditions anticipated for the Hanford Site. Based on examination of the data, urban mixing heights were selected for use in the model runs. Although urban mixing heights were used, the model was executed in the rural mode, thus allowing the use of stabilities E and F in diffusion computations.

For this study, mixing height data and hourly surface meteorological observations were obtained for Spokane from the National Climatic Center (NCC) for the years 1960 through 1964. Before 1965, hourly surface observations were archived and are available from the NCC; however, starting in 1965, only 8 rather than 24 hours of surface observations per day were archived. Because there has been no detectable change in the region's climate over the past several decades, data from 1960 through 1964 are assumed to be as climatologically representative of the Hanford region's meteorology as the data from any other recent 5-year period.

All hourly wind directions used to compute atmospheric transport in this study were obtained from the Hanford Meteorology Station and were originally recorded to the nearest 10 degrees or arc. Because of considerable spatial and temporal variations in atmospheric transport directions encountered during a typical hour, transport wind directions were categorized into one of 16 direction sectors for dispersion modeling. The specification of wind direction to the nearest degree or even 10 degrees in model input downplays the importance of spatial and temporal variations in the wind field and implies a much greater precision than could possibly achieved by a straight-line plume model using hourly wind data.

Atmospheric stability at Hanford is computed using the NRC's temperature lapse rate method. The Hanford meteorological staff have had the choice of using the NRC method or the EPA's Pasquill-Gifford wind speed/sky cover procedure for determining atmospheric stability at Hanford. On the basis of numerous diffusion experiments conducted at Hanford in the 1950s and 1960s, the NRC method was judged superior for the Hanford Site. Although measurements of sigma, theta, sigma phi, or sigma w data would be superior to either the NRC's or the EPA's methods for determining atmospheric stability, these measurements are not made on a routine basis.

Although a Doppler acoustic sounder is currently operating at the Hanford Meteorology Station, this equipment was not operational at the time the air quality analysis in Appendix T of the draft EIS was prepared.

3.2.3.4 Comment:

Reviewers noted that, according to Appendix B, airborne emissions of radioactive materials would occur with all classes of waste, and asked how these airborne emissions are to be monitored (Letter Numbers: 217, 223).

Response:

Airborne emissions will be monitored by equipment specified from among proven systems as part of the detailed design for the defense waste disposal alternative selected, so that compliance with applicable federal, state and local regulations for air quality can be ensured. Presentation of monitoring details would not add materially to the decision process.

3.2.3.5 Comment:

Reviewers suggested that the EIS should include airborne radionuclide data reported in current annual monitoring reports. One reviewer also said that the EIS should mention that the concentrations are likely to increase if the Process Facility Modification (PFM) is made to PUREX (Letter Numbers: 215, 233).

Response:

The air concentrations for hydrogen-3, krypton-85, iodine-129, plutonium-239 and plutonium-240 for samples collected near the PUREX facility, located in the 200 East Area, are compared below:

Nuclide	Concentration, pCi/m^3 ESE of 200 E Area	Other Onsite Locations	DOE Radionuclide Concentration Guides, pCi/m^3
^{3}H	3.4	2.3	200,000
^{85}Kr	1500	130	300,000
^{129}I	0.00097	--	20
$^{239,240}Pu$	0.00001	0.000006	0.06 (^{239}Pu)

As can be seen, the air concentrations are orders of magnitude below the Concentration Guide limits. The EIS has been revised in response to the comment.

With the addition of the PFM project to the PUREX facility, the air emission of radionuclides will increase for some isotopes. The largest increments will be for ruthenium-106 (22%), cesium-137 (37%), and plutonium-241 (90%). The additional gaseous discharge of radionuclides from the PFM is not expected to cause an increase in the estimated dose to workers or to the public (DOE 1986a).

3.2.3.6 Comment:

One reviewer expressed concern that he did not know where the aquifers from Hanford go and that there is no reason to doubt that they might connect with Portland's wells (Letter Number: 50).

Response:

The areal extent configuration and surfaces of the aquifers underlying the Hanford site have been extensively investigated and there is no evidence that such a connection exists (RHO-BWI-ST-5 Hydrologic Studies Within the Columbia Plateau - Washington and Integration of Current Knowledge, October 1979).

3.2.4 Ecology

3.2.4.1 Comment:

Reviewers commented that the DOE failed to consider, or urged the DOE to consider, the Columbia River as a resource, the contamination of which would have dire consequences not only for wildlife and habitat, but for human and environmental concerns downstream. Another reviewer requested a thorough study of all impacts of waste disposal on the Columbia River (Letter Numbers: 25, 26, 42, 43, 44, 45, 46, 49, 50, 55, 57, 59, 129, 133, 147, 150, 155, 164, 171, 187, 190, 200, 202, 205, 208, 214, 219, 238/241-DOC. Hearing Number: 408).

Response:

There has never been a lack of consideration of the Columbia River in assessing past or current impacts of the Hanford Site operation, nor is the river neglected now in DOE's plans for permanent disposal of wastes. The EIS specifically recognizes the Columbia River as the chief potential pathway for radioactive material to pass to the biosphere and to man; in fact, this is a major issue around which the disposal effort centers: protection of the Columbia River and its users over the long term.

Beginning in 1960, reports on environmental conditions were prepared by Hanford staff and were made available to Oregon public health groups. On January 23, 1975, a public hearing was held in Portland, Oregon to receive testimony on a draft EIS on Waste Management Operations on the Hanford Reservation (ERDA 1975). As previously discussed, the impacts on the Columbia River of the alternatives for disposing of Hanford defense wastes are minimal. Compliance would be achieved, even for reasonably credible failure scenarios, well within applicable standards (such as drinking water and water quality). It seems reasonable that if the applicable regulations are met, which consider the protection of the environment and use (reuse) of the water, the river-based economy is in no real danger. The impact assessment, therefore, would suggest there is no reason to assume impacts on agricultural, transportation, recreational or commercial uses of the Columbia River. See also comments 3.2.6.1, 3.5.4.3 and 3.5.4.4.

3.2.4.2 Comment:

A number of reviewers were concerned about the short-term and long-term effects of radioactive contamination on plants and animals, including aquatic biota, and the lack of detailed radiation dose assessment for nonhuman species (Letter Numbers: 5-DOI, 145, 171, 178, 187, 219, 223, 231, 234, 238/241-DOC, 239-NRC).

Response:

There has been no observable decline in the populations of wild plants and animals on the Hanford Site apart from the changes in distribution that would be expected from the kinds of physical changes in the natural environment associated with the construction and operation of a large industrial facility that affects less than 5% of the Hanford Site. These changes included the construction of roads, buildings and other facilities (e.g., waste storage) on the Site; creation of surface waters where none previously existed; continuing presence of people on parts of the Site, and restricted human use of other parts (about 95% of the Site). The evaluation of the well-being of the natural system is based, for the most part, on assessment at the population level. Much less is known of the long-term effects of low-level radiation on communities and ecosystems, or the impacts of radiation-produced genetic aberrations on natural systems as compared to intensively managed systems (crops).

Based on past experience, however, there is no evidence to show that present or future radiation levels from high-level waste disposal will have a detrimental impact on the biota of the Site.

The numbers of animals such as deer, jackrabbit, and coyotes have remained fairly stable on the Site or have increased over time. This is partly due to the sanctuary for wildlife provided by restricting human access to the Hanford Site and the absence of livestock grazing. The recent elimination of some of the wastewater ponds will reduce the use of the 200 Areas by migratory waterfowl and shorebirds. The establishment of the more permanent storage of high-level wastes would further isolate radioactive pollutants from the environment.

Radiological doses to humans downstream of Hanford, even under conditions of containment failure and increased groundwater recharge (Appendix R), are substantially lower than normal background exposure. Under 100% barrier failure, at worst the calculated contamination level in the Columbia River would be about 3% of safe drinking water standards. Since it is generally accepted that radiation limits established for nonoccupational human exposure are also protective of other living things (Auerbach 1971; BEIR Report 1972; EPA 53 FR 8181, March 16, 1987), no estimates were made of radiation dose to organisms other than humans for the several waste management alternatives.

Past estimates of the radiation dose to the Hanford Site biota are low. Calculated doses to muskrat, waterfowl, fish, invertebrates and plants living in, on, or near the Columbia River or the wastewater ponds on the 200 Areas plateau were less than 1 rad/yr in 1972; an exception was a dose of about 3 rad/yr to plants in Gable Mountain Pond, which has been removed from service (ERDA 1975). The estimated dose rate to salmon in the Columbia was 4×10^{-4} rad/yr. Estimated lifetime maximum doses to herons and coyotes from consuming goldfish from U-Pond (now decommissioned) was 0.2 rad (Emery et al. 1981). Over a period of more than one generation, chinook salmon (the species of greatest commercial value in the Hanford Reach) that were exposed to 33 to 40 R at the rate of 0.5 R/day in the laboratory, from egg fertilization to the start of feeding showed no significant differences from the control populations in terms of survival to maturity, or in terms of abnormal larvae production (Donaldson and Bonham 1964, 1966, cited in NAS 1971). A very slight depression in the immune response to a bacterial infection was reported for rainbow trout exposed to total dose of 0.4 rads from tritium for 20 days during embryogenesis (Strand 1975). These levels of radiation exposure, in which little or no effects were observed, are many orders of magnitude greater than that estimated for offsite human populations, even under postulated conditions of waste containment failure (Appendix R).

The runs of fall chinook salmon continue to find the Hanford Reach of the Columbia River an acceptable spawning area. Numbers of spawning adult salmon in the Hanford section of the Columbia have greatly increased since annual spawning surveys were started in 1947. This is partly due to improved fish management practices, but it also indicates the suitability of the Hanford Reach as salmon spawning habitat. The Reach is the last significant area of mainstream river salmon spawning. In 1986, more than 50% of the adult fall chinook salmon that passed upstream over McNary Dam, the nearest downstream dam, were estimated to have spawned in the Hanford Reach.

The levels of long-lived radionuclides in the river sediments downstream of the Hanford Site are very low. The estimated total amount of radionuclides in the entire downstream sediments was about 530 Ci in 1977 through 1978 (Beasley and Jennings 1984), which is exceedingly small compared to former annual releases on the order of 300,000 Ci before the closure of the once-through-cooled plutonium reactors. The greatest radionuclide burdens were in the sediments upstream from McNary Dam, but even at this location, the natural radioactivity was 10 times greater than the combined contributions of radioactivity from Hanford and from global fallout.

3.2.4.3 Comment:

Reviewers noted a contradiction between Table 4.12 that lists plant species as endangered and threatened and a statement in Section 4.6.3 that there are no endangered species or threatened plant species on the site. A reviewer also pointed out that Washington-State-listed threatened or endangered species had been ignored. One reviewer requested that "candidate" endangered or threatened species be protected from adverse impacts. The effect on bald eagles of consuming prey containing radioactivity was questioned (Letter Numbers: 5-DOI, 187, 223).

Response:

The draft EIS text has been revised and clarified in response to the reviewers' comments. Consumption of contaminated prey by bald eagles would not be expected to produce any measurable effects on these birds because of the low concentrations of radionuclides in the 200 Areas plateau and the limited use of the plateau by bald eagles. Moreover, once disposal is implemented there would be no source of high-level, transuranic or tank waste materal from which eagle's prey could become contaminated.

3.2.4.4 Comment:

A reviewer stated that if threatened or endangered birds have been sighted at the Hanford Site, the EIS should not state that the species "do not occur" at the Site. The reviewer suggested that the EIS could indicate that as far as it is known, neither species nests on site (Letter Number: 239-NRC).

Response:

The final EIS is consistent with the reviewer's suggestion.

3.2.4.5 Comment:

One reviewer suggested that species lists (including populations) be provided in the draft EIS, that the fall migrating species and numbers frequenting the ponds be identified, and that radioactivity acquired by migrating species would be transferred off site to other ecosystems (Letter Number: 187).

Response:

Species lists for the Hanford Site and the 200 Areas plateau are given by ERDA (1975) and also by Rogers and Rickard (1977). The repetition of detailed species lists would not be a useful addition to the EIS since none of the waste disposal alternatives is expected to have a marked effect on the overall plant and animal populations of the Site.

The number of species and numbers of birds using the wastewater ponds in the 200 Areas plateau have not been documented on an annual basis. Some of the larger ponds (e.g., U-Pond and Gable Mountain Pond) have been or will be decommissioned and stabilized; nevertheless, the bird species using the ponds are, in general, the same as those that use similar ponds in the Saddle Mountain Refuge and the McNary Wildlife Refuge in Washington and the Cold Springs and Umatilla Wildlife Refuges in Oregon (Rickard, Fitzner and Cushing 1981). In a 30-month period in the mid-1970s, Canada geese, American coots, ring-necked ducks, goldeneyes, American widgeons, common mergansers, mallards, scaups and pintails were the most abundant waterfowl on Gable Mountain Pond, the largest of the evaporative cooling water waste ponds. Peak counts were about 800 for Canada geese, 300 to 400 for American coots and ring-necked ducks, and 100 to 200 for the rest of the ducks previously mentioned (Rickard, Fitzner and Cushing 1981). Peak counts of California gulls were about 100.

Birds and other animals that migrate from the Hanford Site to other areas could transport the radionuclides that they may have acquired at Hanford to other areas. Trace amounts of phosphorus-32 and zinc-65 were measured in waterfowl killed in local hunting areas within 80 km of the Site (Hanson and Case 1963), and in fish upstream of the Site and in the Yakima River, a tributary to the Columbia River just downstream of the Site (Cushing and Watson 1966). Several Hanford-produced radionuclides were also found in the marine organisms along the Oregon and Washington coasts near the mouth of the Columbia River (Watson, Davis and Hanson 1963). Much of the radioactivity measured in these animals was discharged to the Columbia River in the cooling water effluents from the now closed once-through-cooling plutonium production reactors. Mule deer and elk that reside on the Site may be shot by hunters if these animals leave the Site during the hunting season (Rickard, Hedlund and Schreckhise 1974). Recent measurements of radionuclides in Hanford biota are shown in Table 4.4.

3.2.4.6 Comment:

Reclamation of the borrow area used as a source of backfill and barrier construction soil was of concern to one reviewer (Letter Number: 5-DOI).

Response:

The borrow area for barrier construction soil will be rehabilitated, following removal of material, using state-of-the-art revegetation practices. These include site-specific soil cultural practices (e.g., tilling, inocculation, etc.) and seeding with native and other species of grasses.

3.2.4.7 Comment:

A reviewer requested analysis of noise impacts on wildlife (Letter Number: 239-NRC).

Response:

Chapter 6 has been revised to include the Noise Control Act of 1972. Noise impacts on wildlife are currently not quantifiable. However, it can be expected that temporary habitat abandonment would occur in the vicinity of elevated noise (most likely restricted to areas where materials for barriers would be obtained).

3.2.5 Cultural Resources

3.2.5.1 Comment:

Several reviewers submitted comments indicating concern for cultural resources (archaeological and historical), especially in the Gable Butte area. One reviewer said professional archaeological resource surveys should be conducted. One reviewer asked for clarification of the scope of the Rice survey of 1968 and stated that the EIS should document the opinion of the State Historical Preservation Officer regarding whether a survey of the project area is needed in accord with the requirements of 36 CFR 800, "Protection of Historic and Cultural Resources." Clarification (i.e., maps) of the location of cultural resources sites relative to construction, excavation, quarrying/mining or new access road sites was requested (Letter Numbers: 5-DOI, 215, 223, 231, 234, 239-NRC).

Response:

Several sites are being considered as alternatives to the Gable Butte area sites as sources of rock needed for possible defense waste disposal actions. A preliminary report (Adams, Jensen and Schulz 1986) identifies two potential alternate sites, West Haven Butte and Gable Mountain quarry. Additional cultural resource surveys of these sites will be performed.

All cultural resource surveys for DOE are conducted by qualified professional archaeologists. The survey conducted by Rice (1968) was concentrated in areas of known or suspected cultural significance along the Columbia River, Gable Mountain, Gable Butte, Rattlesnake Springs, and other portions of the Site.

A qualified archaeologist will perform surveys of all sites potentially affected by the defense waste disposal actions before any such action is taken. The results of these surveys will be used to preserve cultural resources as required by the Archaeological Resource Preservation Act (16 USC 470) and the American Antiquities Act (16 USC 433). The opinion of the Washington State Office of Archaeology and Historic Preservation is cited in Section 6.10 of the final EIS as suggested. Sections on archaeological, cultural and historical resources have been added to the final EIS (Sections 4.8.5 and 6.10).

3.2.6 Socioeconomics

3.2.6.1 Comment:

One reviewer commented that the potential health and socioeconomic effects of an accident at Hanford, or one occurring enroute to Hanford, or one that might result in the Columbia River becoming "more contaminated," would be significant and are wholly ignored in the EIS. The reviewer was concerned about these impacts with respect to Oregon and Washington populations along the Columbia River. Other reviewers also expressed concern that continued waste storage at Hanford is a threat to local economies of communities downstream and one reviewer stated that "high level waste storage and defense wastes would do so to a greater extent." This reviewer also stated that nuclear waste had already contaminated fisheries, and expressed concern that the potential for pollution of the Columbia River could discourage the sport of wind surfing, which is an economic boon to the communities of the Columbia River Gorge. A reviewer raised the question of whether Portland and the surrounding region would remain economically viable if the Columbia River were to become contaminated from activities at Hanford. Other reviewers argued that the EIS should have included a detailed discussion of regional economic costs, in light of the example provided by Chernobyl, of the "very bad economic consequences of widespread radioactive contamination" (Letter Numbers: 9, 38, 52, 59, 75, 95, 119, 129, 165, 171, 178, 181, 201, 214. Hearing Numbers: 408, 420).

Response:

Accidents were examined in detail, were determined to be low-probability events, and even if they were to occur, they would not be expected to have significant consequences to the environment, the Columbia River, or the health and safety of individuals, or direct or indirect adverse socioeconomic consequences to nearby or downstream communities. As far as exposure to offsite populations is concerned, this EIS concludes that all potential radiation doses, both from routine operations and postulated upper-bound accidents, will be very low relative to those occurring from natural background radiation. The maximally exposed individual could potentially receive a dose from postulated accidents of 0.2 rem for the three alternatives with the greatest exposure potential.

The storage of defense wastes at Hanford since the early 1940s has represented a small risk of adverse impacts to the environment of the area. DOE is now seeking the best alternative by which to manage the disposal of these wastes to isolate them permanently from the environment and thereby remove the hazards involved. The selection of any of these alternatives, other than the no action alternative, represents, over the long run, a substantial reduction of risk to the environment and an improvement in future public health and safety. The preferred alternative would provide for the removal of much of the waste for placement in a deep geologic repository. Some of this waste would go to the Waste Isolation Pilot Plant (WIPP) in New Mexico. The rest would go to the commercial repository. There is, of course, a chance that these wastes could be placed in a commercial repository at the Hanford Site. Regardless, they would be isolated far from the environment and therefore would represent a much smaller risk to the public than they do in their current form.

There is no evidence that the Columbia River fisheries have been adversely affected by Hanford defense wastes to date, nor are they likely to be. As has already been pointed out, a decision to permanently dispose of these wastes substantially reduces the risk that the fisheries would be affected. The EIS concludes that there is no reasonable chance that there would be a significant impact on the Columbia River and its fisheries.

The Chernobyl event does not appear to be to be analogous to possible scenarios at Hanford. There is virtually no chance of an event similar to the explosion of the Chernobyl reactor, and the EIS analysis indicates that environmental impacts, under normal operations as well as under accident scenarios, are not expected to be significant. Therefore, a major regional economic cost study would not seem to be warranted in this EIS.

For the reasons indicated above, it would not be reasonable or cost effective to engage in a detailed, regional economic assessment of impacts that are so remote and unlikely. The EIS has already determined that localized economic impacts, due both to growth-related effects of the project and to perceived risks associated with the project, would not be significant. Regional economic impacts would seem even less likely to occur or to be significant if they did occur.

3.2.6.2 Comment:

A reviewer asked about the value and cost of the loss of purity of the Columbia River and the loss of potential agricultural productivity of the defense waste disposal site, and requested a projection of cost for land lost for each alternative (Letter Number: 44).

Response:

The values and costs to be used in an EIS should be those pertinent to the decision being made. Since farmland is not being withdrawn from production, that issue is not germane. However, the value of the potential farmland would have to be greater than $100,000 per acre (in 1987 dollars) to justify the cost of recovery. The value of water is important if it is to be consumed, or if it becomes contaminated to the point that it is lost as a resource. This is not the case with the Columbia River. The purity of the Columbia River is not significantly impacted by the defense waste disposal alternatives, as shown in the impact analysis presented in Chapters 3 and 5 and Appendix R of the final EIS.

Each alternative would require a land commitment of less than 90 km^2, including the defense waste-allocated portion of land under a repository. In comparison, the already-committed Hanford Site is approximately 1500 km^2.

3.2.6.3 Comment:

Several reviewers raised the issue of the potential for negative effects on the region's agriculture, recreation and tourist industries, or economic growth that might come about because of the plutonium production project or other nuclear projects at the Hanford Site. Reviewers alluded to concern that the project could add to the potential for Washington state to become stigmatized because of the nuclear-related activities at Hanford. The reviewers argued that this could in turn cause consumers to reject agricultural products, or cause tourists and new industries to shy away from the area. Hanford was described as a social and economic blight in Eastern Washington, and the statement was made that most people do not want to live, work and raise families near nuclear facilities. One reviewer remarked that activities at Hanford were marked by ongoing examples of failed technology, accidents, cover-ups, and disregard for the Nuclear Waste Policy Act on the question of a second repository. Another reviewer suggested that the discussion of socioeconomic impacts should include a discussion of the economic effects from an erosion of confidence on the part of consumers about the safety of Washington apples. It was suggested that the analysis address the question of how a consumer in California, New York or Japan would relate to apples grown near a site with an increasing accumulation of high-level nuclear waste. Also, the EIS was described as useless for making rational decisions because of the omission of attention to the potential effects of the project on regional agribusiness. That reviewer stated that the value of a year's worth of "Pacific Northwest agribusiness" is $7 billion (Letter Numbers: 59, 68, 110, 164, 214, 219, 223. Hearing Numbers: 311, 313, 437, 605).

Response:

The implementation of one of the disposal alternatives (other than the no action alternative) will improve conditions and reduce environmental and health and safety risks. Because the implementation of any defense waste disposal alternative is projected to result in reduced impacts on the environment and population of the region, adverse social impacts are also expected to be insignificant. The prospect of improved environmental and radiological conditions is expected to have positive social consequences. The defense waste program is expected to have no adverse effects on industrial and economic development decisions in the region, on the marketability of Washington agricultural products, on perceptions of the Tri-Cities as a good place to live and raise a family, on the attractiveness of the area for recreation or tourism, or on beliefs about the general quality of life of the local area, the region or the state.

Most of the agricultural products from areas surrounding the Hanford Site are exported to western Washington, to other states, or abroad, and it is not clear how closely the exported products are identified with the Hanford Site region in the minds of consumers. In addition, radioactive materials have been managed at Hanford for the past 40 years with no apparent adverse impact on agricultural markets, fisheries or tourism, even though there have been several well-publicized radioactive releases to the environment over this period. Similarly, waste management activities at the Hanford Site have had no identifiable effects on real estate values in the region. Effective monitoring programs at the Site are expected to provide convincing evidence to the public that there will not be any adverse impacts on the environment or on regional economic conditions.

Previous research indicates that the presence of nuclear power plants has had no adverse effects on the overall growth rates of the host or nearby communities, nor any significant adverse effects on the price of housing near such plants. In fact, such research shows a significant positive effect on the host region's economy.

It is recognized that public confidence in the DOE's ability to effectively and safely manage these waste materials is an important issue. The presentation of the set of alternative disposal strategies discussed in this EIS is one step in the direction of better management of these wastes, and represents an improvement in the public involvement process. The EIS offers the public an opportunity to judge the weaknesses and strengths and to influence the selection of an alternative disposal strategy. The public's ability to influence this decision process is expected to help reduce perceived risk and increase confidence in the process.

3.2.6.4 Comment:

Reviewers stated that the scope of the socioeconomic impact analysis is deficient with respect to the scope of the socioeconomic parameters, geographic scope and historical perspective. The reviewers considered the treatment of impacts on social and fiscal conditions, infrastructure, and community services to be too superficial. The reviewers felt that the descriptions of socioeconomic conditions should include several elements: composition of the regional work force and population in terms of age profiles, ethnic composition, wage and salary rates by major employer category, and educational levels; a description of cultural, aesthetic, recreational and other attributes of the community; and county and community fiscal data, traffic volumes, traffic accident frequency, and related infrastructure descriptions. Reviewers also felt that socioeconomic impacts would be felt far beyond the immediate vicinity of Hanford; as one example, recent improvements in highway facilities will attract commuting workers from beyond the Benton-Franklin County area (Letter Numbers: 59, 178, 231, 234).

Response:

The question concerning the scope of the socioeconomic parameters can refer to the number of socioeconomic factors included in the assessment versus those excluded or to the depth with which the included factors are addressed. Under either definition, the scope was considered adequate given an assessment of those parameters thought likely to sustain significant impact and given the relatively successful history in the study area of dealing with such impacts under the even more extreme growth conditions associated with the Washington Public Power Supply System.

Several different recent studies that include extensive background information on socioeconomic baseline conditions in the study area are cited in Section 4.8 of the EIS. The objective in preparing Appendix K and the other socioeconomic sections in the body of the EIS is not to provide a complete socioeconomic profile of the study area; rather this EIS is a decision assisting document, designed to solicit public input to aid in the selection of an alternative waste management strategy that will keep potential impacts low. A "bounding analysis" approach was used to set forth the potential scope of impacts, ranging from no action taken beyond maintaining the current storage facilities (up to the point where continued governmental control can no longer be ensured), through mixed-mode alternatives, to placing all the wastes in a geologic repository. The amount of detail provided in the EIS was considered adequate for identifying potentially significant socioeconomic impacts in the context of the "bounding analysis."

With respect to geographic scope, the cited support document by Cluett et al. (1984) contained a detailed discussion of the definition of the study area (Section 2.2) that reviewed historical experience with regard to residential location and commuting patterns of Hanford Site workers. The geographic scope for the discussion in this EIS was established on the basis of these studies, an understanding of the nature of the work required for the construction and operation of the alternative facilities for Hanford defense wastes, estimates of the type and number of incoming workers, and housing and transportation in the region.

These studies had determined that Benton and Franklin Counties sustain the substantial majority of the growth-related impacts that are caused or are likely to be caused by these projects. While there is evidence of some worker residence in outlying areas, the numbers of these commuters is small relative to the base populations involved. Given that the alternative work force configurations for operations related to Hanford defense wastes are expected to be smaller than, for example, the Supply System work force, and, given the ramp-down experience since 1981 in which approximately 10,000 workers lost their jobs on the Hanford Site, the study area definition as presented in the EIS is considered appropriate.

Social impacts that are not primarily growth related (e.g., quality of life, organizational or cultural impacts, perceptions of risk) may be experienced potentially beyond the boundaries of the study area defined for this EIS. Impacts of this type are discussed in the EIS, including Appendix K, in the sections on social conditions. The potential for cultural impacts is covered in Sections 3.4.4 and 3.4.5 of Volume 1.

With respect to the scope of the historical analysis, DOE believes that sufficient information was provided to allow the reader to understand the logic of the analysis and to justify the conclusions drawn. Appendix K of the EIS limits its presentation to summary statistics because, with data available at the time of the study, significant adverse impacts were determined to be unlikely. Also, a much more detailed treatment of baseline conditions in the study area was developed by Cluett et al. (1984). Their document contains a detailed historical review of the relationship between economic and demographic activities in the study area from 1965 through the present (1982 data were the most current available at the time this study was undertaken). This supporting document classified employment and population trends into three distinct time periods: namely, the pre-Supply System period from 1965 to 1973, the Supply System period from 1973 to 1981, and the post-Supply System period after 1981. Employment and population multipliers were derived from observed experience during these periods and used in the with-and-without-project forecasts. It was not considered necessary to examine these relationships earlier than 1965.

Baseline characterization of socioeconomic conditions in this study area has been represented in previous socioeconomic analyses, but adding those details to this EIS would not alter the conclusions or interpretations presented. Because the alternative waste management strategies for Hanford defense wastes represent improvements over current operating practice and conditions at the Hanford Site, it was judged unnecessary to present substantial additional baseline detail that would not contribute to the understanding or interpretation of the assessment.

The addition of the suggested level of detail on the composition of the regional work force and population would not add to an ability to discern significant adverse impacts not already identified. The level of detail provided in the EIS is appropriate for a decision document such as this and is consistent with the "bounding analysis" provided. Further detail in demographic information also is not warranted given the lack of detailed information available with regard to the characteristics of the work force called for under the various disposal alternatives. The assessment in Appendix K is not intended to provide a complete socioeconomic profile of the study area but rather to focus on that subset of information considered necessary to assess potentially significant impacts.

Significant adverse aesthetic or recreational impacts are not expected to result from any of the action alternatives. For the purposes of this EIS, therefore, these impacts were not analyzed in detail. However, as noted earlier, the discussion of social impacts, including cultural, aesthetic and recreational impacts, has been expanded in Chapter 4 and Appendix K of the final EIS.

Detailed data on revenues and expenditures for the operating and capital funds of Benton and Franklin Counties and the Tri-Cities were presented by Cluett et al. (1984). Traffic volume data had also been reviewed in connection with that supporting study. Again, this level of detail is not included in the EIS because it would not have altered the document's conclusions.

3.2.6.5 Comment:

Reviewers stated that the cumulative socioeconomic impacts of other nuclear energy activities at the Hanford federal reservation (federal, state and private sector) are inadequately considered. One reviewer acknowledges that the possible resumption of Washington Public Power Supply System construction and the Basalt Waste Isolation Project are mentioned, but commented that very little statistical data are provided. The reviewer also stated that no mention was made of ongoing DOE defense materials production activities, proposed land burial of irradiated submarine reactor components, or the decommissioning and disposal of activation products from currently "moth-balled" production reactors (Letter Numbers: 216, 231, 234).

Response:

Cumulative impacts are addressed in two places in the EIS. There is a separate section of the EIS that discusses cumulative impacts (Section 5.1.4). The socioeconomic section also incorporates the potential for cumulative impacts (see Appendix K) by developing two alternative baseline scenarios, one of which assumes the restart of WNP-1 in 1988 with completion in 1993, and another that does not make that assumption. A moderate growth in DOE Hanford Site activities is also assumed in the development of baseline conditions. Even under a scenario that includes the WNP-1 restart, the projected new population attracted to the study area at the peak of employment represents less than 6% of the baseline population.

While this kind of analysis accounts for an upper bound on near-term projected cumulative Hanford Site project activities, it is not the same as attempting to address the actual additive (or cumulative) impacts of Hanford defense waste treatment alternatives combined with all other likely DOE and non-DOE Hanford Site activities in terms of a single socioeconomic impact assessment of those activities combined. Such an analysis is considered to be beyond the scope of this EIS.

In part this limitation occurs because project activities are sequenced over time. During preparation of the EIS, for example, precise data on the probable impacts of the Basalt Waste Isolation Project (BWIP) were not available. The socioeconomic analysis takes one activity (the Hanford defense waste disposal alternative) and assesses its probable impacts against a background of all other economic activities, including Hanford Site activities. This type of analysis accounts for competition for scarce resources, including labor and materials, and addresses the marginal effect of the defense waste activity in question.

Furthermore, the EIS (Section 5.1.4) points out that uncertain future DOE development activities on the Hanford Site will be covered under future National Environmental Policy Act assessments.

Other DOE activities are subject to separate assessments to determine potential impacts. Such environmental impact statements or assessments that are prepared after this EIS will need to incorporate the effects, if any, of the Hanford defense waste program in their assessment. In this way, the cumulative impacts of projects are addressed in a sequential fashion over time.

3.2.6.6 Comment:

Reviewers stated that a distinction should be made between construction employees and permanent operations workers for the alternatives presented in this EIS. The reviewer observed that a multiplier of 1.2 is used to calculate secondary employment, but that it is unclear if this factor is used for both construction and operations work forces. The reviewer stated that if distinctions are made in the final EIS between construction and operations work forces, appropriate secondary (or total) employment multipliers should be identified for each type of work force data (Letter Numbers: 231, 234).

Response:

Based on the architect-engineer's data on estimated work force requirements for conducting all of the activities under each of the Hanford defense waste alternatives, the split between construction and operations, particularly with regard to scheduling of activities, is not clearly made. In fact, a nuclear waste repository is not like many large-scale projects in the sense of having a discrete construction phase followed by a discrete operations phase. These activities tend to overlap substantially, because the construction of a disposal facility is in part driven by the rate at which waste materials become available to emplace. Although temporary construction workers tend to have associated with them different socioeconomic effects than do permanent operations workers, these distinctions are likely to be blurred for the reasons mentioned and because construction craft workers in the Tri-Cities area tend to reside permanently in the area. While this distinction traditionally is made and is useful in socioeconomic analyses, it is neither easy to make in this case nor likely to be instructive if it could be made.

Another point in this regard relates to the nature of the "bounding analysis" that is presented. This EIS is not attempting to assess a precise configuration for the waste alternatives; the final alternative will almost certainly be different from any one of the alternatives presented here. Most likely it will be some combination of the alternatives. Also, the use of alternative socioeconomic baseline scenarios is a further attempt to "bound" the analysis. Any differences that might be due to a misspecification of the employment multiplier would be "lost in the noise" and would fall within the range of potential effects represented by these "likely" and "maximum" scenarios. Significant impacts are not expected to occur within this range. When a specific alternative is selected, more precise detail of this sort may be available and appropriate for an assessment. It is agreed that where it is worthwhile to make such a distinction, appropriate secondary multipliers should be identified.

3.2.6.7 Comment:

Several reviewers suggested that the draft EIS had not considered all pertinent factors in the cost analysis and comparisons, including the costs of monitoring, emergencies, accidents and land use loss (Letter Numbers: 44, 59, 71, 216, 217).

Response:

The cost analysis in the draft EIS is believed to be adequate for purposes of making comparisons among the alternatives. The factors suggested would not change the relative costs of the alternatives considered.

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3.3 DISPOSAL ALTERNATIVES AND TECHNOLOGIES

The following comments and responses pertain to the individual disposal alternatives discussed in the draft EIS--geologic, in-place stabilization, reference, and no action. At the end of this section are grouped the comments that are more generally concerned with disposal procedures and policies.

3.3.1 Geologic Disposal

3.3.1.1 Comment:

A number of reviewers expressed their preferences regarding geologic disposal. Some are in favor of geologic disposal despite the cost, and some are in favor of geologic disposal but not at Hanford. Other reviewers are against geologic disposal (Letter Numbers: 3, 8, 10, 18, 29, 41, 42, 44, 46, 53, 57, 60, 61, 63, 78, 90, 101, 103, 106, 110, 120, 121, 122, 128, 137, 141, 142, 143, 144, 146, 148, 158, 163, 165, 171, 175, 180, 187, 189, 192, 195, 201, 204, 207, 216, 217, 218, 219, 223, 224. Hearing Numbers: 315, 321, 322, 340, 343, 344, 345, 394, 405, 412, 414, 415, 416, 424, 428, 435, 523, 560, 612, 615).

Response:

In the final EIS, a preferred alternative is described that would result in geologic disposal of three waste forms: the high-level component of double-shell tank waste, capsule waste, and retrievably stored transuranic waste. The low-activity fraction of double-shell tank waste would be disposed of in grout in near-surface vaults. Additional analyses would be performed and National Environmental Policy Act (NEPA) documentation as appropriate would be prepared to assess the disposal of the other three waste forms. Selection of the commercial repository site is beyond the scope of this EIS. See also comments 2.1.1 and 2.1.2.

3.3.1.2 Comment:

Reviewers felt that the language of the draft EIS appears to be biased against the geologic disposal alternative. Geologic disposal is presented as the most expensive option. Readers are led to believe that Congress will not approve enough money for this option. Reviewers stated that more cost-effective ways to remove single-shell tank waste should be explored before deciding what to do with the waste (Letter Numbers: 46, 64, 129, 171, 184, 219, 233).

Response:

There was no intent to bias the presentation of alternatives against the geologic alternative nor to lead reviewers to believe that Congress would not approve funding for this option. Because of more operations, treatment and disposal, geologic disposal would inevitably incur higher costs. While more cost/worker-dose effective ways of retrieving single-shell tanks will be sought, the high cost is associated with the treatment of the retrieved waste. See comment 3.1.4.5 for discussion of waste retrieval from single-shell tanks.

3.3.1.3 Comment:

Reviewers felt that the geologic disposal cost comparison is no longer valid because the "granite" repository used for offsite cost comparison was dropped from consideration by DOE, causing a bias in the cost comparison that was "unrealistically favorable" toward the reference option (Letter Numbers: 231, 234).

Response:

The granite or crystalline rock repository site has not been dropped from consideration by DOE, only delayed. The method for calculating repository costs is described in Appendix J. Cost projections for repository disposal include repository construction costs via the per-canister disposal fee. The actual cost of transporting waste to a repository is a small fraction of the total cost of the geologic alternative.

3.3.1.4 Comment:

Reviewers felt that the possibility of geologic disposal in horizontal tunnels in the side of a mountain, in this case the Rattlesnake Hills, has been omitted. Several advantages of this disposal method were cited: the waste would be situated above the regional water table at essentially zero head, the tunnels would be easier to construct and operate and hence less costly, these tunnels could be operated at atmospheric pressure, and the path length to the Columbia River would be about doubled (Letter Numbers: 3, 215).

Response:

Selection of a geologic repository in accordance with the Nuclear Waste Policy Act is outside the scope of this EIS.

3.3.1.5 Comment:

Reviewers commented on Section 3.3.5 and noted that the DOE apparently eliminated from detailed consideration the disposal of entire tank contents on the basis of costs and additional risk. Another reviewer suggested that the disposal of single-shell tank wastes be done selectively, on the basis of each tank inventory.

Response:

See comments 3.1.4.1 and 3.1.4.5.

3.3.1.6 Comment:

Reviewers expressed the preference for more repositories so that wastes do not have to be transported from area to area (Hearing Numbers: 323, 523, 619, 646).

Response:

See comment 2.1.5.

3.3.1.7 Comment:

Rather than placing reliance for safe containment on natural rocks surrounding waste that has been encased in glass, as DOE outlines, Sweden plans to use lead, titanium and copper overpacks. A reviewer felt that the DOE should evaluate these options in the final EIS (Hearing Number: 433).

Response:

The form in which waste is to be placed in geologic repositories is being determined under the repository program, and will ultimately be licensed by the NRC before disposal implementation.

3.3.1.8 Comment:

Reviewers were concerned that the geologic disposal alternative could not be reasonably discussed until a site has been selected for a repository (Letter Number: 171. Hearing Number: 543).

Response:

In the draft EIS the existence of a geologic repository somewhere in the continental U.S. was assumed; it was not the purpose of that document to consider repository siting or assess repository impacts.

It was assumed that a repository, regardless of its actual location, would comply with the NRC's 10 CFR 60 and the EPA's 40 CFR 191. Thus, the only site-specific variable would be transportation impacts, which were discussed in the draft EIS.

3.3.1.9 Comment:

Reviewers commented on Section 3.3.1 and Table 4.3 of the draft EIS, which states that the geologic disposal alternative will "remove from surface or near-surface storage or disposal on the Hanford Site essentially all (98% by activity) of high-activity/low-volume and TRU waste (to the extent practicable)," and does not clearly define such terminology as "to the extent practicable" (Letter Numbers: 161, 170, 215).

Response:

The expressions "surface" and "near surface" were meant to include waste in storage facilities such as the water basin storage for encapsulated waste, the underground tanks (near surface) and buried waste and transuranic (TRU) soil sites (both of which are thought of as near surface).

The information given in Table 4.3 is not a practical basis for levels of activity requiring removal from soils, if for no other reason than that soils naturally contain uranium in higher concentrations than those listed in Table 4.3. A more appropriate approach would be to begin with predetermined safe levels of radiation exposure and use radionuclide transport modeling to arrive at permissible concentrations of radionuclides in soil.

The percentage given for the waste retrieved in the geologic disposal alternative was developed from an estimate of 95% removal of single-shell tank waste, 99.95% removal of double-shell tank waste and 100% removal of packaged or solid waste. Packaged or solid wastes include encapsulated wastes, TRU-contaminated soil sites, pre-1970 buried TRU solid wastes and newly generated wastes. In all likelihood, removal of waste from single-shell tanks would be better than 95%, but that value was used to provide a conservative (or pessimistic) estimate of impacts which in aggregate amounted to about 98% by activity.

3.3.1.10 Comment:

One reviewer disagreed with the impact assessment (in the General Summary of the draft EIS) of the short-term radiological impacts of the geologic disposal versus the reference alternative, contending that if the high-level double-shell liquid wastes can be handled within a safety range of 0 to 4, then so can the single-shell tank sludge (Letter Number: 29).

Response:

The processes for removal of the two types of waste are markedly different, as described in Appendix B of the EIS.

3.3.1.11 Comment:

Reviewers expressed concern that technical and geological problems with emplacement of defense high-level waste in a repository need further discussion in the EIS (Letter Numbers: 78, 171).

Response:

Technical and geological problems were addressed in the Commercial Waste Management Statement--Generic Environmental Impact Statement (GEIS) (DOE 1980). With respect to this EIS, the only particulars to be determined, for waste classes destined for repository disposal, are the waste form that would be acceptable to the NRC in terms of licensing a commercial repository, fee and repository loading schedules, and transportation. Consideration of disposal of waste in borosilicate glass in geologic repositories was discussed in detail in the GEIS.

3.3.1.12 Comment

One reviewer noted that cost estimates for the offsite (granite) repository are believed to be higher than basalt because the vertical emplacement scheme is inappropriately assumed (Letter Number: 215).

Response:

The offsite repository was chosen to maximize the transport distance as an alternative. Possible locations farthest from Hanford were in granite. In the final EIS the repository costs for non-TRU wastes have been based on a cost-per-canister and are not influenced by repository media.

3.3.2 In-Place Stabilization and Disposal

3.3.2.1 Comment:

Some reviewers favored in-place stabilization and disposal, or regarded it as an interim measure until a permanent means of disposal could be developed. Other reviewers did not want defense waste stabilized and disposed of on the Hanford Site. Still others indicated that the draft EIS expressed a bias toward in-place stabilization and disposal, and noted that "elimination of the second repository" added further pressure to stabilize and dispose of waste in place (Letter Numbers: 1, 12, 13, 15, 40, 42, 55, 56, 57, 64, 69, 70, 78, 98, 101, 106, 111, 116, 120, 121, 122, 128, 129, 143, 144, 154, 157, 161, 163, 164, 171, 172, 174, 208, 217, 223, 240, 242, 243-EPA. Hearing Numbers: 335, 336, 433, 606).

Response:

The in-place stabilization and disposal alternative was analyzed as one possible option for disposal of Hanford defense waste--one that would not require retrieval, processing, and transportation of most of the waste. It was seen as a viable option because it offers reduced occupational exposure, transportation of wastes, and costs.

There was no relationship between analysis of this alternative and the suspension of the search for the second repository site. For discussion of the delaying of the second repository, see comment 2.1.8.

3.3.2.2 Comment:

One reviewer indicated that the draft EIS did not sufficiently emphasize the stabilization of existing waste, which should be given priority. Calcining was suggested by several reviewers, one of whom felt that the situation at Hanford requires "emergency" measures (Letter Numbers: 46, 216, 230, 242).

Response:

Present storage of defense waste at the Hanford Site does not pose a danger to the public that might require emergency actions. Waste management operations were evaluated in an EIS published in 1975 (ERDA 1975) and by the National Academy of Sciences of the National Research Council in 1978. The conclusions of these studies were that the public health and safety were not threatened by present waste management operations at Hanford.

3.3.2.3 Comment:

Reviewers noted that the proposed process of dissolving waste in glass is better than glass production from calcine (as is done in Idaho) (Letter Numbers: 71, 217).

Response:

It is not required that the draft EIS evaluate a variety of waste vitrification processes. The draft EIS assumes a preconceptual vitrification plant design to support vitrification of retrieved liquid waste in the reference disposal alternative and, with additions, the geologic alternative.

3.3.2.4 Comment:

Reviewers requested additional technical, material, cost, comparative risk, and NEPA information and noted that the discussion in the draft EIS pointed to the need for further experimental/technical development of the disposal technology for in-place stabilization. Appendices A, B, D, J, M, and K were cited as appropriate places to include that detail (Letter Numbers: 70, 71, 217, 223. Hearing Number: 543).

Response:

The DOE agrees that before the final decision to select the in-place stabilization and disposal alternative for any waste class, additional development and evaluation including performance assessment (risk) will be required. This development and evaluation is outlined as part of the preferred alternative described in Section 3.3.5 of the final EIS, and includes such areas as waste characterization, barrier performance studies and analysis, and compliance with EPA standard 40 CFR 191 where applicable.

3.3.2.5 Comment:

Several reviewers noted that Section 3.3.2 of the draft EIS describes operations for which there is no current technology, and that the use of "preconceptual technology" is not acceptable.

One reviewer questioned the DOE's plan to leave most of the single-shell tank waste on site because it is not "readily retrievable" (in other words, retrieval would be too hazardous or too costly). The DOE provides no support for this fundamental assumption in the draft EIS, except that liquefying waste would cause the tanks to leak (Letter Numbers: 5-DOI, 161, 171, 189, 201, 215, 217, 219, 240. Hearing Number: 512).

Response:

The National Environmental Policy Act requires that all reasonable alternatives be addressed at an early stage in the decision-making process. Some aspects of the alternatives have not been thoroughly tested; nevertheless, they are sufficiently reasonable to warrant discussion. The impacts that may result were described in the draft EIS. However, DOE's preferred alternative defines further development and evaluation before making a decision on the disposal of single-shell tanks and buried transuranic wastes.

For additional discussion on retrieval of single-shell tank wastes, see comment 3.1.4.5.

3.3.2.6 Comment:

A reviewer noted that the in-place stabilization of single-shell tank waste conflicts with requirements of the commercial industry for the disposal of high-level wastes, and expressed concern that the heavy metals in the sludge would contaminate the shallow aquifer (Letter Number: 171).

Response:

The EIS presents the in-place stabilization and disposal of single-shell tanks as acceptable because the impacts that were shown to result from such disposal were small and because there was a reasonable expectation that EPA limits on impacts could be met. With an effective barrier in place over the single-shell tanks, as left in the tanks, it was shown that the concentrations of elements and nitrates in groundwater or the Columbia River would not exceed EPA limits. However, chemicals and associated metals would be further investigated as outlined in the preferred alternative.

3.3.2.7 Comment:

Reviewers noted that the Resource Conservation and Recovery Act (RCRA) standards require the use of a liner. This requirement is not included in the description of any option. One reviewer felt that if the DOE intends to meet RCRA standards, the final EIS should show how the standards can be met without the use of liners (Letter Numbers: 171, 219).

Response:

The DOE commitment to comply with RCRA may be found, as revised, in Chapter 6 of the final EIS. There are matters of interpretation and questions of application that will be addressed with the regulatory agencies on a case-by-case basis as well. For example, does the concrete surrounding the single-shell tanks constitute a liner; does the second steel shell of double-shell tanks constitute a liner? Would a short-lived (30-year) liner be more acceptable than a long-lived cap that prevents entry of water? The DOE is dedicated not only to the shorter-term RCRA requirements, but also to the long-term (10,000-year) isolation requirements of any permanent disposal site.

3.3.2.8 Comment:

A reviewer noted that suggestions made in 1960 by the Atomic Energy Commission (predecessor to DOE) to dispose of waste at a surface disposal site by relying on engineered barriers and warning systems had been rejected by the public and the scientific community (Letter Number: 5-DOI).

Response:

The reviewer subsequently referred the DOE to four references, which are summarized below:

(1) The National Academy of Sciences (NAS 1957) favored disposal in cavities mined in salt beds and salt domes, but pointed out that "the next most promising seems to be stabilization of the waste in a slag or ceramic material forming a relatively insoluble product. This could be placed in dry mines, surface sheds or large cavities in salt." Some abandoned mines might be suitable for the disposal of solid wastes. "Shallow mines are similar to caverns in that most are wet and even the dry ones would probably leak if filled with liquid wastes. Evaporated solids in cans could be stored in shallow dry mines." The NAS document

concluded that "continuing disposal of certain [large volume] low level waste in the vadose zone, above the water table, is of limited application and probably involves unacceptable long term risks."

(2) The Second Conference on Ground Disposal of Radioactive Wastes (Morgan, Jamison and Stevenson 1962) reported on some successful lysimeter analysis of engineered barriers at Savannah River. It was reported by a British author that ground disposal is not practiced: "This is not because it is an unsatisfactory process; on the contrary, if carried out under controlled conditions, in a suitable area, it is believed to be a promising method of disposal." There is, however, "...no district in England, where the conditions resemble those found, for example, at Hanford."

Although there was some discussion of the difficulty of constructing an entirely impermeable cover, another example of the efficacy of such multilayered barriers was cited. A natural barrier system was discovered by the USGS near Kachamak Bay in Alaska. Skeletal material from a sand bed topped by a shell heap and then silt and clay was taken to Dr. Alex Herdlichka of the National Museum, "a very competent physical anthropologist" (Morgan, Jamison and Stevenson 1962). He concluded that the bones were not over 20 years old. Archeologists and geologists who studied the site concluded "that the minimum age for this material was one thousand years, and more likely two thousand years."

(3) The General Accounting Office (GAO) (GAO 1977) discussed ERDA alternatives for the disposal of defense waste, pointing out that "Questions have been raised about the two sites (Savannah River and Hanford) for geological disposal." The GAO also noted that "the key issues facing ERDA in the long term management of its existing and future high level wastes are whether or not it can demonstrate technologies to safely remove it from storage tanks, process it into suitable long term storage or disposal forms, and transport it to storage or disposal sites." The GAO discussed the possibility that "the 20 cracked tanks[a] at Hanford may not be susceptible to sluicing due to the danger of dissolving salt crystals that plug the leaks and cause new leakage."

The GAO concluded: "At Hanford ERDA may not be able to remove all of the high level waste from many of the tanks. Thus, entombment in the tanks is one of ERDA's preferred long term storage (if not its disposal) option. Again, ERDA is fortunate because the Hanford site, with the dry desert climate and deep water table (average about 250 feet below the subsurface), appears to be more suitable for long term storage or disposal. ERDA still must do additional site hydrogeological investigations before selecting this option."

(4) The USGS (DOE 1979) pointed out that "disposal of nuclear wastes in a geologic repository has received greater attention than have other disposal alternatives from the technical community since the early 1950's." The USGS further commented that, even in a geologic repository, "total containment in the immediate waste repository probably cannot be guaranteed, and the recognition that a series of independent barriers--both engineered and

(a) Currently there are 60 known or suspected leakers.

natural--to waste migration could offer the redundancy needed to compensate for the uncertainties in predicting long-term waste isolation."

Throughout these references there is a distinct preference for geologic disposal of wastes. There is an intuitively pleasing conclusion that "deeper is better." Even though there are numerous published studies both pro and con with respect to the effectiveness of protective barriers, none of these studies provides an analysis of specific Hanford conditions and the risk/cost benefit of alternatives. When such a trade-off analysis is made, as has been done in this EIS, the conclusion is far from clear that near-surface disposal with engineered barriers should be rejected.

3.3.2.9 Comment:

Reviewers noted that under the in-place stabilization option, cesium and strontium capsules will be disposed of in drywells. Potential environmental contamination from these sources is not mentioned. What risks does this method of disposal have? How mobile are these ions under various environmental conditions? (Letter Numbers: 171, 219).

Response:

The risk from strontium and cesium in drywells is seen as small. The capsules are doubly encapsulated and are placed in disposal canisters. Because of their containment and their relatively short half-lives and because they would not be readily transported in the vadose zone if released from their containers, it is unlikely that encapsulated strontium and cesium would ever reach groundwater. The only real risk would be from drilling into cesium capsules within about 400 years of emplacement.

3.3.3 Reference Alternative

3.3.3.1 Comment:

Several reviewers commented favorably (however, with reservations) on the reference alternative. The EPA gave the reference alternative an EC-2 (Environment Concerns--Insufficient Information).

Other reviewers were opposed to choosing the reference alternative, which was considered as a "cosmetic" effort; as providing no radiological reasons for its preference over other alternatives; as being described in the EIS in positive terms, compared to the other alternatives. Other reviewers noted that the reference alternative does not combine the best of all alternatives, considering that a significant quantity of high-level waste would be left in place. Some reviewers felt that the "reference" alternative was just the DOE's way to avoid naming a "preferred" alternative (Letter Numbers: 8, 58, 60, 101, 120, 122, 138, 143, 149, 170, 190, 201, 215, 223, 231, 234, 243-EPA. Hearing Number: 425).

Response:

The geologic and in-place stabilization and disposal alternatives permit the assessments to bound the range of impacts represented by potential disposal alternatives. The reference alternative provides an example of a middle-ground disposal alternative. It was intended that no preferred alternative would be considered until agency and public input had been received. The preferred alternative (see comments 3.3.5.3) is believed to be responsive to the EPA's observation of the need for further information before implementing a disposal strategy for some waste classes.

3.3.3.2 Comment:

A reviewer commented that the draft EIS states that most ecological impacts from in-place stabilization and disposal of all waste classes would be minimal because much of the area under consideration already has been disturbed; however, it does not explain what additional impacts are predicted. The reviewer felt that although the word "minimal" was used, its meaning was not clear, and wondered what group of biota would be affected most--plants, wildlife, or birds (Letter Number: 171).

Response:

The surface areas involved are existing waste storage or disposal sites. In areas where tanks are stored, the soil surface is covered with gravel. Retrievably stored TRU waste sites are currently large trenches holding the barrels of waste. Sites for wastes previously disposed of are mostly covered by revegetated soils. In the in-place stabilization and disposal alternative, these sites would be covered with the protective barrier. There would be a small ecological impact; ant hills would be buried, scorpions and beetles and other insects would be destroyed and small animals would be displaced.

3.3.4 No Disposal Action (Continued Storage)

3.3.4.1 Comment:

Several reviewers commented that the no disposal action alternative is not an environmentally viable option. Other reviewers cautioned against acting before proven technology has been developed, but encouraged cleaning up the waste at the Hanford Site and mounting a vigorous research and development program (Letter Numbers: 4, 14, 46, 82, 101, 110, 122, 171, 174, 208, 217, 219, 231, 234, 243-EPA).

Response:

On the basis of the analysis performed, DOE continues to contend that the no disposal action alternative is not an acceptable alternative for the long term. The no disposal action alternative serves only as a basis for comparison and to meet the requirement of NEPA for consideration of such an option. Nevertheless, development, evaluation and field testing for this alternative will continue at some sites in order to gain additional experience in disposal technology and to evaluate and develop further predictive models.

3.3.4.2 Comment:

Several reviewers suggested that the defense waste not be disposed of, but rather that it be placed into a monitored retrievable storage facility or some interim form of storage at the Hanford Site (some reviewers requested above-ground storage) or other locations. The concern is that the waste should remain accessible for continued monitoring and for possible retrieval at some future time. Reviewers generally felt that a solution for disposing of the waste permanently is not available at this time, and concern was expressed that nothing irreversible should be done with the waste before truly safe and effective disposal technologies have been developed and proven. Some reviewers felt that resource values in the wastes were being neglected. One reviewer pointed out that the molten glass products that are to be transferred into canisters will require temporary storage at the Hanford Waste Vitrification Plant (HWVP) before shipment to a geologic repository, and that the EIS needs to include the impacts from the temporary storage from the vitrified waste. A reviewer also wondered whether the Monitored Retrievable Storage (MRS) facility planned for commercial waste will be used to extend the beginning of the operational date of the repository. (Letter Numbers: 15, 18, 22, 27, 41, 67, 72, 75, 79, 90, 91, 105, 113, 120, 121, 127, 140, 143, 144, 147, 153, 158, 171, 182, 186, 192, 204, 208, 211, 216, 217, 232. Hearing Numbers: 456, 514, 516, 517, 530, 538, 567, 617, 619, 633, 646, 650).

Response:

The DOE has no plan for a special MRS-type facility to store defense wastes. For vitrified defense waste, the proposed HWVP will provide storage for approximately 750 canisters, representing about 5 years of canister production. The HWVP storage area is expandable if a longer storage period is necessary before the waste can be shipped to the geologic repository. The vitrified waste form is of high integrity and is encased in high-integrity stainless steel canisters that can be safely stored in a monitored, filtered storage facility for a significant length of time if necessary.

Capsule wastes are also presently stored and will continue to be stored in monitored water basins. Other wastes are also stored at the Hanford Site in a safe, monitored situation (e.g., double-shell tanks).

The DOE believes that technology is available to move forward with final disposal, e.g., vitrification, of the classes of wastes described in the preferred alternative, and that it is in the best interest of public and environmental concerns not to delay any longer in areas where technology has been proven.

3.3.5 General

3.3.5.1 Comment:

Reviewers felt that the draft EIS did not discuss the alternatives sufficiently and that they were not technologically proven. Some reviewers expressed the belief that there is no safe method or place for disposal of radioactive waste (Letter Numbers: 31, 57, 80, 86, 99, 100, 102, 124, 155, 171, 186, 187, 191, 194, 196, 215, 216, 227, 228, 229, 236).

Response:

Additional discussion on alternatives has been provided in the final EIS. Technologies relating to waste retrieval and barrier performance will be subject to further development and evaluation according to the preferred alternative. The DOE disagrees with the opinion that no safe disposal method exists, noting the vast quantity of technical work that indicates wastes can be safely disposed of.

See also comment 3.3.5.4.

3.3.5.2 Comment:

Some reviewers felt that the EIS lacks a description of all reasonable alternatives and that more alternatives should have been analyzed. Some questioned why the 27 alternatives referred to in the draft EIS were not included in the EIS, or a reason for their dismissal provided. Reviewers felt that disposal alternatives such as space disposal, sea bed disposal, island disposal, ice sheet disposal, water containment, and subduction under geologic plates should have been discussed. A number of reviewers found disposal at the Hanford Site unacceptable and suggested alternative locations, such as the State of Nevada, the Arctic, in 10 to 30 other locations ("wherever the waste was generated"), on another planet, in the sun, in space, "in the void prior to its creation," in underwater cities, and in "works of sculpture" (Letter Numbers: 9, 20, 28, 33, 41, 44, 45, 47, 64, 66, 73, 79, 89, 91, 92, 93, 94, 99, 115, 132, 133, 135, 171, 178, 183, 187, 214, 215, 216, 217, 223, 230. Hearing Numbers: 463, 547, 611).

Response:

Alternatives such as the sea bed and outer-space were analyzed in the Commercial Waste Management Statement--Generic Environmental Impact Statement (DOE 1980a). In the Record of Decision for that EIS, it was announced that DOE was emphasizing research efforts on geologic disposal. There appeared to be no need to revisit these alternatives in the EIS.

The 27 alternatives cited in the Foreword of the draft EIS actually represented a number of variations on four disposal options for high-level waste. Those options were in-place disposal in existing tanks, onsite geologic disposal, offsite geologic disposal and onsite engineered surface facilities. The variations principally concerned alternative waste forms.

The DOE in DOE (1981b) concluded that while the emphasis of disposal should be on geologic disposal, the alternative of seabed disposal should continue to be investigated. For the reason stated by the reviewer, isolation for millions of years, disposal of waste in the subduction zone (of the seabed) warrants further consideration.

3.3.5.3 Comment:

Several reviewers expressed their support for the disposal of capsule waste, double-shell tank waste, and retrievably stored transuranic waste in a geologic repository. The disposal of other waste should wait for additional studies, including waste characterization and site characterization research. Also, the interrelationships among separate existing programs for the different types of wastes should be coordinated.

Reviewers recommended that the final EIS identify decisions that will be postponed pending further research and development, a timeline for completion of these activities, costs involved, and the type of NEPA review that is anticipated.

Reviewers requested expedition of research and procedure development that leads to the timely cleanup of those wastes posing the greatest risk. Since certain facilities described in the draft EIS are common to several categories of waste, early design would be appropriate. Included here would be a vitrification plant with sufficient capacity for the single-shell tank waste. Studies on the grout concept should also be pursued, with special emphasis on the demonstration of structural integrity and resistance to leaching of the waste form. One reviewer advocated using the best current technology to dispose of waste now while continuing research to improve the waste form. One reviewer expressed concern that the scientific community and the public should be involved in future decisions pertaining to these disposal technologies (Letter Numbers: 3, 12, 53, 116, 120, 126, 141, 143, 147, 161, 171, 172, 192, 215, 217, 223, 239-NRC, 243-EPA).

Response:

The views expressed have been taken into consideration by the DOE in the development of the preferred alternative, as described in Section 3.3.5 of the final EIS. The preferred alternative would result in geologic disposal for capsule waste, high-level, double-shell tank waste, and retrievably stored transuranic waste, grout disposal of low-activity double-shell tank waste, and performance of further development and evaluation for other classes of wastes. The Hanford Waste Vitrification Plant (HWVP) will be large enough to allow future modification if it is decided at a later date to vitrify some or all of the single-shell tank waste. Development of separation processes is also ongoing to reduce the volume of waste requiring repository disposal. Disposal of the other waste classes would await additional studies and technology development.

In addition to the information provided in the preferred alternative, plans for additional development and evaluation of various aspects of disposal (see Section 3.3.5) are described in the Interim Hanford Waste Management Plan (DOE 1986e) and the Interim Hanford Waste Management Technology Plan (DOE 1986d). To forecast the completion and results of the development and evaluation and the type of NEPA documentation required would be premature. State and federal agencies and the public will be involved at the appropriate time, according to the NEPA process.

3.3.5.4 Comment:

Many individuals and organizations expressed interest and concern about the level of technology development set forth in the draft EIS for many processes and facilities described therein. Specific comments included use of the best available technology to get the disposal job accomplished now, additional research and development requirements, independent reviews of technologies and results, funding, contingency plans, and large-scale testing of final design process and/or facility before final disposal. Several reviewers expressed the concern that nothing irreversible be done before disposal technologies are proven. (Letter Numbers: 3, 5-DOI, 12, 19, 22, 29, 53, 70, 78, 83, 87, 103, 106, 116, 120, 121, 126, 128, 143, 144, 147, 170, 171, 185, 215, 217, 223, 239-NRC, 243-EPA. Hearing Number: 412).

Response:

To comply with the National Environmental Protection Act (NEPA) requirements for early preparation of environmental documentation, the draft EIS was prepared before final optimized designs were available for all processes/facilities necessary to complete the disposal options. Once a disposal decision has been made, detailed engineering studies, both pilot-scale and plant-scale, may enhance the specific waste retrieval, treatment, handling, immobilization and/or disposal processes evaluated in the draft EIS. The processes evaluated in the draft EIS were chosen so that, if implemented for any disposal alternative, they would be expected to be bounding in the environmental impacts described in the draft EIS. Independent, outside consultants will continue to provide input for the processes/technologies selected for evaluation.

The DOE's goal is to move toward final disposal of defense wastes. The disposal operations will be conducted in a safe and cost-effective manner, using the best available technologies and complying with applicable regulations. The DOE feels that adequate technology is currently available for disposal of double-shell tank waste, retrievably stored TRU wastes, and strontium and cesium capsules. Additional development and evaluation are required before disposal of single-shell tank waste, pre-1970 buried TRU solid waste, and the TRU-contaminated soil sites. Continued dialogue with various federal and state agencies is planned to ensure adequate programs to close issues. Key parts of the DOE program will continue to be reviewed by reputable outside technical experts, such as the National Academy of Sciences. More detailed waste management plans for the reference alternative are found in the Interim Hanford Waste Management Plan (DOE 1986d) and the Interim Hanford Waste Management Technology Plan (DOE 1986e). These plans are updated periodically and will be updated again after the Record of Decision on the final EIS is issued.

3.3.5.5 Comment:

A reviewer noted that there are several statements in the draft EIS indicating that defense waste will be processed and ready for geologic disposal before the operational date of the repository, raising the question as to whether there is need for interim storage. The anticipated environmental impacts resulting from this temporary storage were not addressed in the draft EIS. A timeline for the processing of defense waste in relation to the acceptance schedule for the geologic repository was requested (Letter Numbers: 147, 217).

Response:

Interim storage of waste glass in canisters is provided for at the HWVP for nominal 5-year canister production. Such storage is in modular configuration for ready increase in capacity, if required. As the schedule for realization of a repository develops, it may be necessary to enlarge the storage area. Impacts of storage considered in the EIS were included in discussions of the HWVP (Appendix C). Those associated with an expansion would be expected to be minor by comparison.

3.3.5.6 Comment:

Reviewers questioned why, if the slagging pyrolysis incinerator is planned for use under the geologic disposal alternative to reduce waste volume, it is not planned for use under the reference alternative (Letter Numbers: 147, 217).

Response:

The volume of TRU waste going to a repository in the reference alternative is sufficiently small that use of a slagging pyrolysis incinerator would be unwarranted.

3.3.5.7 Comment:

Several reviewers commented that single-shell tank waste and possibly other wastes were going to have to be disposed of in place because there would not be enough room in a 70,000-metric tons heavy metal (MTHM) repository (Letter Numbers: 56, 61, 69, 70, 71, 78, 111, 147, 156, 163, 217, 219, 223. Hearing Numbers: 538, 550, 606).

Response:

The DOE is committed to geologic disposal of all waste that is designated in the Record of Decision to go to a geologic repository. If it is determined that additional repository space is required for defense waste, then that space will be made available.

The first commercial repository is presently limited to a receipt of 70,000-MTHM (metric tons of heavy metal) or its equivalent (amount of heavy metal) until the second repository is receiving waste. As the uranium at Hanford was irradiated to much lower burnups than commercial reactor fuel (average burnup less than 1,000 MWd/t compared to 30,000 MWd/t), the units of defense waste quantity must be converted to a commercial-equivalent mass of heavy metal to permit comparison with capacity limits for a commercial repository. This is accomplished by using the process described in DOE (1986), which estimates that there is about 3,000 MTHM commercial equivalent for all Hanford waste. This estimate includes about 1,000 MTHM commercial equivalent for single shell tank waste. [It is noted that larger equivalent metric tons of heavy metal (eMTHM) are used in Appendix S, page S.5. In this case release limits in curies are calculated for each radionuclide based on Table 1 of EPA standard 40 CFR 191 (see Chapter 6, page 6.12, Volume 1 of the Hanford draft EIS), Note 3. Note 3 indicates that "...a value of 5,000 MWd/MTHM may be used when the average fuel burnup is below 5,000 MWd/MTHM...."]

3.3.5.8 Comment:

Reviewers suggested the need for a systems approach to an integrated disposal strategy that would apply to both radioactive and chemical wastes (Letter Numbers: 56, 69, 217).

Response:

Historically, radiological aspects of Hanford wastes have dominated consideration of the environmental impacts of operations and now those of disposal. In that regard, a systems approach was taken and integrated strategies, as far as differences in waste class characteristics would permit, have been followed.

Although research is planned that will place knowledge of the potential for transport of chemicals more on a par with that of radioactive species, it is believed that the completion of this research is not necessary to begin making choices for disposal of Hanford defense wastes. The preferred alternative described in Chapter 3 takes these various aspects into account. Aspects of chemical wastes that involve regulation by the Resource Conservation and Recovery Act or by the Comprehensive Environmental Response, Compensation and Liability Act are discussed in Chapter 6.

See also comment 3.1.6.1.

3.3.5.9 Comment:

One reviewer claimed that cost estimates were generally inadequate. Other reviewers commented particularly that in Appendix J, "Method for Calculating Repository Costs Used in the Hanford Defense Waste EIS," no mention was made of important parameters in the computation of life-cycle costs such as capitalization and amortization charge rates, costs of ultimate decommissioning of geologic repositories (assuming mingling of defense high-level waste and spent fuel from commercial nuclear power plants), and perpetual monitoring following repository closure. The following comments were made: 1) "Total" costs were ostensibly summarized in Appendix L (Tables L.6, L.10, L.14, and L.18); however, only the no disposal action (Table L.18) specified costs for monitoring, surveillance, vegetation control, and subsidence maintenance. A reviewer requested inclusion of similar costs for other disposal alternatives. 2) It was unclear whether land values or costs are included in the calculations, and requested inclusion of "marginal" and "real" costs of land. 3) A reviewer commented on the statement on page J.2 (last paragraph, first sentence), "the design basis modeled was for a 47,000 MTHM repository containing equal amounts of spent fuel and high-level waste," and requested the basis for choosing this capacity. 4) A reviewer requested a sensitivity analysis indicating computed costs at several defense waste and spent fuel capacity levels. One reviewer felt that the draft EIS misleadingly shows the environmental impacts as equal, thereby causing cost, rather than "good science," to be the chief distinction among them (Letter Numbers: 71, 187, 217, 231, 234).

Response:

All of the cost estimates reported for the waste disposal alternatives in the EIS are made on a comparable basis. The only component in the capitalization charge rates that is not included in this analysis is federal financing charges, if any. Including financing charges on all cost estimates would slightly increase the cost difference between the geologic and other disposal options.

Amortization charge rates noted by the reviewer were interpreted to refer to amortization (recovery) of capital. These costs are identical to the costs for capital expenditures used in this analysis. Decommissioning of surface facilities, backfilling and sealing of the repository, and an annuity fund for long-term surveillance are all included in this cost analysis.

Costs of monitoring and surveillance are included in costs of the geologic disposal alternatives.

The geologic disposal alternatives for which a repository is located on federal land do not include a land purchase cost, because the land is owned by the federal government. So-called "opportunity" costs for other federal land uses are subjective at best and are not clearly quantifiable.

The commercial repository design used in the analyses was intended to contain 23,500 MTHM of spent fuel and 23,500 MTHM equivalent of commercial high-level waste. [The 47,000 MTHM total for the repository was that used in the final EIS on Management of

Commercially Generated Radioactive Waste (DOE 1980)]. The capacity of this repository design was increased to dispose of defense high-level wastes described in this EIS. The commercial repository capacity has no effect on the costs of defense waste co-emplacement and so does not affect the estimates in Appendix J.

3.3.5.10 Comment:

A reviewer commented that there was no apparent basis for the assumption that decommissioning would require 20% of the cost used for assembly of the TRU-contaminated soil and solid waste site recovery facility (Letter Number: 223).

Response:

Decontamination and decommissioning (D&D) costs were estimated at a conservative 20% of capital costs for new facilities only. Past experience with facility D&D costs, when corrected for inflation, shows amounts in the 10% to 20% range. It is expected that future facilities will be designed with consideration of eventual D&D which should lower D&D costs.

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3.4. SHORT-TERM IMPACTS

This section addresses comments pertaining to radiological and nonradiological impacts from operations, transportation, and onsite accidents.

3.4.1. Operational Impacts

3.4.1.1 Comment:

Reviewers suggested omitting occupational dose calculations, since these doses are voluntarily received by workers. It was noted that in calculating occupational doses, the draft EIS uses a historical average annual dose for radiation workers. The reviewers felt that this tends to mask operations with high exposure by averaging them in with operations of negligible exposure, and that a more informative approach would be to provide both a description of the projected cumulative frequency distribution of dose and an upper bound on those exposures, including accidents. Another asked if protective methods for the workers were taken into account in arriving at occupational exposure (Letter Numbers: 4, 180, 215, 223).

Response:

Occupational dose was included as one measure of impacts of the disposal alternatives and of the no disposal action. These doses were called out separately so that individual readers could weigh them as they chose. To some, such doses have low weight because they are received voluntarily by workers. To others, occupational dose is a relevant impact regardless of whether voluntarily received. The National Environmental Policy Act and guidelines from the Council of Environmental Quality specify that all impacts be presented.

The facilities projected for the waste management operations described in the draft EIS are not currently at a stage of design that allows a detailed description of dose rates to individual workers. However, through administrative controls and radiation work procedures, including protective methods, the existing individual occupational dose limits can and will be met. Projected cumulative frequency distributions are refinements that are believed to be unwarranted for the level of decisions to be made. Operations would proceed using established radiation protection procedures for protective action for workers. The DOE subscribes to the policy of keeping exposures as low as reasonably achievable (ALARA) in all of its operations, and this continuous review and control policy would be applied. The aforementioned controls, procedures and manuals were all written in compliance with, or in fulfillment of, applicable guidelines established by the International Commission on Radiological Protection (ICRP) and the National Committee on Radiation Protection and Measurements (NCRP) and DOE Orders.

3.4.1.2 Comment:

Reviewers stated that a major weakness of Appendix H was the omission of occupational doses resulting from accidents, as would be required for an NRC licensee. The reviewers also felt Appendix H was weak in its presentation of accident source terms, especially in regard to toxic chemicals (Letter Numbers: 231, 234).

Response:

Appendix H is in essence a summary; the supporting document (Mishima et al. 1986), about 170 pages, was felt to be too long to include in the appendix.

Under existing DOE policies and guidelines, occupational risks and preventive measures, both design and procedural, are the subject of review and assessment at the design, construction and prestartup phases of a facility. Occupational doses resulting from accident conditions will be assessed in terms of acceptable risks to the worker at that time. These risks to the worker will meet requirements as specified in DOE Order 5480.1, Chapter 11, Radiological Safety. Although agency EISs normally focus on impacts to the population, they do address routine occupational doses (see comment 3.4.1.1). Occupational doses from accidents in support of NRC licensing normally appear as part of a Safety Analysis Report (SAR). It is doubtful that selection of alternatives as presented in this EIS would be significantly enhanced by an analysis of occupational doses as a result of accidents.

Considering toxic chemicals, additional assessments are planned that will consider these wastes. It was concluded that radiological impacts would be a sufficient indicator of the impacts of accidents for discriminating among the alternatives at this stage in the selection process.

3.4.1.3 Comment:

The question was raised that if the alternatives are still in their conceptual stage and cannot be used to project exposure times, how were the estimates of radiation worker exposure in Chapter 5 determined, and why can these values not be evaluated in a manner analogous to that described in Appendix F? Another reviewer requested additional information on this topic. Reviewers expressed concern over the magnitude of releases and doses estimated for the conceptual vitrification and repository operations (Letter Numbers: 170, 215, 217, 223).

Response:

Estimates of radiation exposure to workers resulting from work in the conceptual facilities were based on past Hanford Site average doses for radiation workers. The projections of man-years required to operate the facilities were determined by ratio of the capital cost of the projected facility to that of existing analogous facilities. Radiation worker exposure was then obtained by multiplying the historical average radiation worker dose per year by the number of worker years projected. Estimates of facility releases were based on process flowsheets, total quantities of material handled, and comparison to similar facilities. Insufficient detail exists to make more precise estimates.

As a basis for further comparison of the defense waste releases and doses, the potential doses to workers and the public from radon emanation from the proposed repository have been analyzed in DOE/ET-0029 (DOE 1979). For a repository in basalt, the annual whole-body dose to a maximally exposed individual off site is reported to be 2 x 10^{-6} rem/yr. Doses (from the naturally occurring radon) to the work force during construction are reported to be about 900 man-rem per year, totaling 6000 man-rem for repository construction.

3.4.1.4 Comment:

A reviewer questioned whether the repository construction and operation effects included the data for underground uranium and phosphate mining, as these activities may incur higher rates of nonradiological and radiological injuries or illnesses (Letter Numbers: 231, 234).

Response:

The data cited in the draft EIS include uranium mines and are used to estimate impacts from the construction phase of the repository. Radiological impacts occur during and after repository operation, and are addressed primarily in Sections 5.2.2 and 5.2.4 of the EIS. Radiological effects of uranium mining or "other pre-disposal uranium or plutonium processing" steps such as those included in "nuclear fuel-cycle EISs" are not factored into radiological impacts described in Appendix F and are beyond the scope of this EIS.

3.4.1.5 Comment:

Reviewers noted that, in Section 3.4.1.1, several different types of doses were used to present different impacts. The reviewers requested that a common basis be used for comparison. The EPA asked for annual dose information for individuals (Letter Numbers: 217, 243-EPA).

Response:

For many of the situations hypothesized in the draft EIS, a common basis would obscure the impacts being described. In most cases, perspective has been provided by comparison to natural background dose converted to comparable units. Section 3.4.1.1 was revised to include the requested annual dose information for individuals.

3.4.1.6 Comment:

A reviewer noted that, since most of the Hanford workers live in the general vicinity of the Hanford facilities, they are also exposed to accidental and routine releases of radionuclides to the environment. Thus, the full dose for Hanford workers should be the accumulated total of the occupational and environmental exposure (Letter Number: 215).

Response:

It is acknowledged that the total dose to the workers would include that accumulated while living near the site. However, the additional doses reported for offsite public to be added are insignificant by comparison.

3.4.1.7 Comment:

Reviewers suggested that the draft EIS should 1) include a complete discussion of all occupational risks associated with each alternative, both radiological and nonradiological, and compare these by fatal injuries, cancer incidence, other long-term effects of chemical exposure and workdays lost; 2) provide clear and "precise" calculations of all radiation doses in such a way that occupational and public doses may be differentiated readily; and 3) use "heavy industrial incidence rates for new processing technologies when predicting injuries and fatalities" (Letter Numbers: 71, 217).

Response:

Based on past experience, control of occupational exposures by radiation standards in the type of facilities and operations discussed in the EIS precludes any significant occupational exposure to toxic chemicals. Thus, no occupational exposures to toxic chemicals have been calculated.

All Chapter 5 radiation dose tables contain columns labeled "Occupational Doses" and "Population Dose Commitments." The "Maximum Individual" dose commitment column may not be so obviously tied to members of the public, but that is the intent, as was defined on page 5.8 of the draft EIS (p. 5.12 of the final EIS). The "less-than" (<) values used in the Chapter 5 tables were used to avoid exponents or strings of zeros in the tables; this was done in an attempt to make these tables more readable. Doses indicated by "less-than" values have been replaced by the calculated value in response to the reviewer's comment for clarification.

Construction of facilities associated with new processing technologies is based on experience included in DOE's historical safety performance. Incidence rates based on this safety performance record are data based on more closely related activities and are therefore more realistic than those from heavy industries.

3.4.1.8 Comment:

A reviewer noted that more recent estimates are available for manpower required to construct and operate a basalt repository (Letter Number: 215).

Response:

It is acknowledged that since manpower requirements were estimated for this EIS, more recent estimates have been generated specific to repository construction and operation. The manpower estimates in the EIS are dominated by onsite retrieval and processing activities which are separate from the repository activities. Use of the newer data would not significantly change the analysis in the EIS, and relative comparisons among the disposal alternatives and no disposal action are still valid.

3.4.1.9 Comment:

A reviewer stated that, although a variety of treatment and decontamination processes are referred to throughout the document, no mention is made of water requirements, wastewater streams, or air emissions from these processes. The technical aspects of the systems as well as the necessary infrastructure requirements and byproducts should be addressed (Letter Number: 223).

Response:

Liquid and gaseous emissions and technical aspects of processes are described in Appendix B. The meaning of "infrastructure requirements and byproducts" is not clear, but total resource requirements are given in Appendix L and final waste forms are described in Appendix B.

3.4.1.10 Comment:

One reviewer noted that the EIS used DOE and contractor incidence rates for the five-year period of 1976-1980. The reviewer asked for evidence that this period is long enough to be statistically representative of future potential incidence rates (Letter Number: 215).

Response:

Statistics for occupational health and safety since 1943 have been recorded and published by the Atomic Energy Commission (AEC) (for 1943 to 1975), the Energy Research and Development Administration (for 1975 to 1977), and the Department of Energy. The general trend since 1943 has been a consistent decline in injury, illness, and fatality rates (AEC 1975; DOE 1982). Fatality rates, in particular, fluctuate most highly from year to year, and yet the average fatality rate for every 5-year period since 1943 has steadily declined (AEC 1975; DOE 1982a).

Assuming all incidence rates will continue to decline, the projections calculated in this EIS are conservative.

3.4.1.11 Comment:

Reviewers stated that nonradiological occupational risks, except for those associated with transportation, are not enumerated or analyzed in sufficient detail. One reviewer noted that retrieval and vitrification appear to include greater nonradiological occupational hazard than the in-place stabilization methods (Letter Numbers: 71, 171, 217).

Response:

The reviewer is correct in noting that retrieval will require more effort (in terms of manpower) and hence more worker risk as projected in Appendix L. The analyses remain valid for comparison purposes. The preferred alternative includes further study of waste-handling procedures, which may lead to predictions of reduced occupational risks.

3.4.2 Transportation Impacts

3.4.2.1 Comment:

Reviewers stated that the major deficiency of Appendices G, I, and L is the limited scope of nonradiological effects, in that they cover occupational impacts only. Other data and impacts suggested included traffic accidents involving civilians, commuter employee vehicle accidents, vehicle accidents involving nonradiological materials shipments, accidents stemming from generally increased economic activity, property damage from the foregoing, increased airborne emissions from vehicles and data on local/regional traffic volumes, accident frequency and transportation injuries/fatalities and transportation safety issues (Letter Numbers: 171, 215, 231, 234).

Response:

The total nonradiological accident impacts in Appendices I and L include nonoccupational ("civilian") as well as occupational impacts.

The remaining categories of secondary indirect impacts cited here were not included in the draft EIS. However, the relative proportions of the cited impacts can be ascertained by comparing the estimated annual work force requirements for each alternative (Appendix K, Tables K.1 through K.4). Section K.3.2 of Appendix K provides a brief discussion on traffic impacts.

3.4.2.2 Comment:

Reviewers requested that DOE carefully consider impacts from transportation before implementing shipment of wastes, and expressed their concerns about or opposition to the transportation of waste to or from Hanford and their fear of potential impacts or accidents from such shipments. Several observed that the draft EIS did not consider a working agreement regarding the shipment of wastes with Northwest states, and requested the communities on routes be informed of waste shipments. Other reviewers noted that transportation risks and impacts should not preclude disposal of Hanford defense waste at an offsite geologic repository (Letter Numbers: 1, 18, 20, 30, 38, 40, 47, 49, 57, 62, 72, 75, 82, 92, 121, 125, 130, 134, 135, 144, 145, 159, 171, 175, 181, 186, 187, 191, 194, 196, 202, 210, 213, 214, 216, 217, 218, 219, 223, 227, 228, 229).

Response:

The impacts from the transportation of defense wastes are included in Chapter 5 of the final EIS. Working agreements between affected states relate to the Nuclear Waste Policy Act, which involves the transportation of commercial waste. If geologic disposal of Hanford waste is implemented in an offsite geologic repository, then this would require transportation through one or more states. The DOE will then work with states through which waste would be transported to ensure compliance with applicable transportation regulations.

See also comment 3.4.2.6.

3.4.2.3 Comment:

Reviewers commented that the draft EIS should have identified the routes over which the waste would be transported. Another reviewer requested that DOE work with states to identify preferred routes from among those available within the interstate system. It was also felt that the EIS should discuss the historical safety of shipping hazardous materials by rail, as well as specific operational controls that might be implemented to enhance shipment by rail (Letter Numbers: 25, 171, 209, 210, 223).

Response:

A route-specific analysis for transport of waste to a commercial repository is not warranted at this time because a geologic repository has not been identified. The results of the present analysis, which attempts to bound actual impacts of transportation, are believed sufficient to form the basis for decision.

Historical safety with respect to transportation was addressed at Section I.4. Accident frequencies and severities for rail transport were given in Table I.8. Additional specific operational controls to enhance rail shipment safety have not been addressed, but will be before implementation of any alternative employing rail transport. See also responses to comments 3.4.2.4 and 3.4.2.6.

3.4.2.4 Comment:

One reviewer commented on Section I.1.1.3, noting that this section discusses the transportation requirements as delineated by the Department of Transportation (DOT). These requirements state that in the event of any conflict between state and local transportation requirements and the DOT requirements, the DOT requirements pre-empt state and local requirements. Does this also include those state and local transportation requirements which may be more conservative? (Letter Number: 223).

Response:

The DOT encourages states to develop their own system of preferred routes. This must be accomplished by a state agency which must use DOT Guidelines that include a comparative radiological risk assessment, local considerations, and continuity of routes between adjoining jurisdictions and states. Thus, if a state routing agency can prove, using the DOT Guidelines, that an alternative route is more conservative, and if the alternative route does not interfere with route continuity (i.e., if it can be matched up with preferred routes in adjoining states), the state can designate the more conservative route as the preferred route. Other state and local requirements would be considered consistent with 40 CFR 177.825 (Docket HM-164) unless they conflict with the criteria shown on p. I.4.

3.4.2.5 Comment:

Reviewers requested consideration for aquatic ecology protection; i.e., there should be an analysis of which waterways will be crossed in the transport of wastes and of the risks associated with these crossings (Letter Numbers: 223, 238/241-DOC).

Response:

The water immersion accident does not contribute significantly to the risks of transportation for two reasons. First, the probability of a water immersion accident is very low, on the order of 10^{-11} per mile according to Dennis et al. (1978). Second, the consequences of a water immersion accident would also be small. This is because the waste forms are not highly soluble in water, except for cesium and strontium, which are protected by three levels of packaging. As a result, the risks of the water immersion scenarios are low in comparison to other scenarios and are not significant contributors to transportation risks. This is also why the water immersion scenarios are not included in RADTRAN.

3.4.2.6 Comment:

One reviewer commented that transportation of "highway route controlled quantities" of radioactive materials as described in Section I.1.1.3 is required by Docket HM-164 (40 CFR 177.825) to use the interstate highway system (Letter Number: 209).

Response:

Section I.1.1.3 provides an overview discussion of the Department of Transportation's routing regulations and addresses the general requirements that are imposed on shippers and carriers, as well as prohibitions against conflicting requirements imposed by state and local governments. A detailed discussion of these regulations is beyond the scope of an environmental impact statement. Only generic routes and national average data were used in the analysis for Hanford defense waste shipments. Once the disposal decision has been made and a geologic repository is selected, possible transportation routes will be examined before DOE selects routes for shipments of highway-route-controlled quantities of radioactive materials to that commercial repository and to the WIPP. This examination includes consideration of possible bad weather conditions, conditions of bridges and tunnels, locations of heavily populated areas, state-designated preferred routes, highway construction, and potential sources of delays in route. The specific routes that would ultimately be used would be chosen with regard for these conditions as much as possible.

3.4.2.7 Comment:

Reviewers noted that offsite waste was received at the Hanford Site from other locations and wanted to know how much waste had been received and whether the impacts have been included in the EIS. The reviewers also wanted to know who pays for disposal of wastes (Letter Numbers: 103, 217).

Response:

Some defense TRU wastes cited are occasionally sent to Hanford from other DOE contractors for storage before disposal. All stored TRU wastes are included in the retrievably stored TRU waste class and, under the geologic, reference, or preferred alternatives, would go to the WIPP for permanent disposal. Commercial and defense low-level wastes are outside the scope of this EIS. The DOE and therefore ultimately the taxpayer is responsible for costs involved in the disposal of defense wastes.

3.4.2.8 Comment:

One reviewer noted that calculated transportation-related costs may have been too high because the 3000-mile distance to the repository was used (Letter Number: 215).

Response:

A 3000-mile distance was selected to provide an upper limit for the transportation costs. Transportation costs were calculated for both an onsite and an offsite repository because the location of the first repository is still unknown.

3.4.2.9 Comment:

One reviewer noted that pp. xliii-xlvii of the draft EIS reported that many of the assumptions in its analysis of transportation impacts were conservative. The reviewer thought that such assumptions require references, and that these should be included in

Appendix I. The draft EIS should discuss the limitations of models, the range of uncertainty associated with key parameters and the sensitivity of risk estimates to changes in parameter values (Letter Number: 223).

Response:

In response to the comment, Appendix I has been revised in the final EIS.

3.4.2.10 Comment:

One reviewer felt that the illustrations of the railroad cask to be used for high-level and transuranic waste (p. I.7) are insufficient. Also, there is no illustration showing how the encapsulated waste is to be transported (Letter Number: 209).

Response:

Shipping casks for strontium/cesium canisters have not yet been built. However, their designs are expected to be similar to the rail cask shown in Figure I.1 of the EIS. The text was revised to provide additional descriptions of the status of the shipping casks. The revision is shown in the final EIS in Sections I.1.2 and I.2.2. However, such casks do not currently exist and only conceptual designs are available.

3.4.2.11 Comment:

Reviewers commented that in the event radioactive wastes are shipped through the Umatilla Reservation, potential adverse environmental impacts need to be calculated. The reviewer pointed out deficiencies in the RADTRAN II model (Letter Numbers: 231, 234).

Response:

No unique impacts from transportation would be expected simply because the shipping route passed through the Umatilla Indian Reservation. The particularly long and steep grade known as Cabbage Hill has considerable potential for runaway vehicles and special precautions would be developed to prevent such accidents.

The reviewers also are apparently questioning the validity of assuming a minimum distance from the accident and then estimating the atmospheric dispersion characteristics from that point.

The reviewers apparently believe that this assumption would understate the impacts because there would be no impacts in the region between the release point (cask) and the minimum-distance boundary. A minimum-distance boundary is needed because the atmospheric dispersion equations are logarithmic. This means that if a minimum distance of zero meters from the release point were specified, the results would indicate that the concentrations of released materials become infinite; clearly an impossible case. RADTRAN II sets this minimum distance at 30 m, which is a reasonable assumption considering that the accidents would occur on or near the roadway or rail. Given the minimum width of rail and interstate rights-of-way, it is not likely that any persons, other than those involved in the accident, would be within 30 m of the accident.

3.4.2.12 Comment:

Reviewers voiced concern about DOE packaging standards; some commented that the drop test for waste containers was only 29 feet and that the thermal test was conducted at only 800°C for only 30 minutes (Letter Numbers: 49, 147, 171, 209, 217).

Response:

The DOE packagings must meet Department of Transportation (DOT) requirements for providing protection of public health and the environment as provided by NRC-certified packagings. The DOE has also agreed to NRC certification of packagings that will transport wastes to a commercial repository. Furthermore, the TRUPACT is currently undergoing full-scale testing for conformance with DOT regulations. The DOE is confident that the test conditions provide an adequate safety margin and will continue to rely on the DOT to verify the adequacy of the test criteria.

See also comment 3.4.2.13.

3.4.2.13 Comment:

Reviewers urged that DOE should take positive action to ensure that the overall transportation system is fully developed before waste shipments begin. Reviewers advised that NRC certification would be an important step toward ensuring safe transport and would also help overcome public concern about DOE's tendency to be self regulated. The question was raised whether different criteria would be used by DOE and NRC for design certification of packagings and noted that DOE should clearly describe options available to DOE (Letter Numbers: 147, 217, 223).

Response:

The DOE plans to obtain an NRC Certificate of Compliance for the TRUPACT Type B shipping container, which will be used to transport Hanford transuranic wastes. DOE is designing a Type B shipping cask to transport the solidified tank wastes and possibly strontium/cesium capsules. It is not clear at this time whether an NRC Certificate of Compliance for this shipping cask is required. In all cases, for offsite shipping, the containers must meet all DOT regulations; these are the same regulations that NRC uses to certify shipping containers.

The final EIS, Section I.1.1.1, has been revised in response to the comment.

3.4.2.14 Comment:

One reviewer commented on Table I.11 and requested more information on the risk associated with the transportation of strontium/cesium capsules. Another reviewer noted that the likelihood of using cesium capsules from Hanford in the future for food irradiation creates a potential for increased waste transportation to and from Hanford. The impact from these shipments should be included in the impact analysis. One reviewer wanted information on returned capsules (Letter Numbers: 174, 209, 210, 243-EPA).

Response:

Additional information on strontium and cesium was obtained to develop improved estimates of their dispersibility and respirability. Table I.8, Table I.11, and Section I.4.3 were revised to incorporate improved data on the strontium/cesium waste form. Results were incorporated into Table I.11. Additional references were cited.

Leasing and shipping of cesium and strontium capsules are outside the scope of this EIS and are therefore not addressed. The actual shipments of cesium and strontium capsules to commercial irradiators began in February 1985. To date, no capsules have been returned to Hanford for retirement.

The strontium fluoride waste form appears to consist of a hard, nonfriable ceramic (Fullam 1981). Often, large chunks are encapsulated. Fullam indicated that heating of strontium fluoride, such as would be expected in a fire, will cause the material to sinter and agglomerate and hence less likely to become airborne. For these reasons, the dispersible and respirable fractions were assumed to be 0.01 and 0.0005, respectively.

No strontium fluoride or cesium chloride capsules are disposed of in Hanford Site burial grounds.

3.4.2.15 Comment:

One reviewer requested a summary table of total transportation impacts (Letter Number: 223).

Response:

Although a summary table might be useful, the different types of impacts are presented separately to avoid misinterpretation of the results through invalid comparisons. For example, routine radiation doses and accident risks should not be added together, because routine doses are actually "consequences"; i.e., they will occur at some level equal to or less than those estimated in Appendix I. On the other hand, accident risks are probabilistically derived and may or may not occur.

3.4.2.16 Comment:

One reviewer noted that the discussion on p. xliv does not explain why doses to populations in vehicles and persons residing along transportation routes were not calculated (Letter Number: 223).

Response:

The doses to these population groups have been calculated; however, as indicated on p. xliv of the draft EIS, the doses to these groups are insignificant when compared to doses to truck drivers and persons nearby at truck stops.

3.4.2.17 Comment:

One reviewer noted that the discussions on pp. I.20 and I.23 of the draft EIS report that parameter values for release fractions, dispersibility and respirability are uncertain and require further research. Some indication of the probable range of parameter values and the sensitivity of risk estimates to these parameters should be included, especially since strontium and cesium dominate the calculated risk from accidents (Letter Number: 223).

Response:

The final EIS, Section I.4.3, has been revised in response to the comment.

3.4.2.18 Comment:

One reviewer commented that the differences in risks associated with onsite and offsite transportation for the geologic disposal alternative and the reference alternative are not clear (Letter Number: 215).

Response:

The risks of the reference alternative are dominated by the shipments of transuranic waste to the Waste Isolation Pilot Plant. Transuranic wastes are shipped off site regardless of the onsite or offsite destination of high-level waste (HLW). In Table I.16, it can be seen that HLW shipments contribute less than 5% of the total nonradiological impacts for the option in which HLW is shipped off site and less than 1% of the impacts for the HLW onsite option. Table I.10 indicates that these percentages of radiological impacts are, respectively, approximately 7% and less than 1%. This indicates that the final destination of the HLW in the reference alternative does not significantly affect the total transportation impacts. In the geologic disposal alternative, however, the HLW volume is large enough that the impacts estimated for offsite shipments of HLW contribute about 50% of the total radiological and nonradiological impacts. If the shipments are destined for an onsite repository, the HLW shipments contribute less than 1% of the total transportation impacts. For these reasons, the risk levels for the reference alternative are not sensitive to the destination of the high-level waste shipments, but risk levels for the geologic disposal alternative are sensitive to the destination of the HLW shipments.

3.4.2.19 Comment:

One reviewer commented on Table I.11 of the draft EIS: Discussions leading up to this table, e.g., Section I.5.1 and Table I.10, have indicated that there is a range of radiological risk (100 to 1000 health effects per million man-rem). This range is not reflected anywhere in Table I.11 (Letter Number: 243-EPA).

Response:

The values that appeared in Table I.11 were based on 200 fatal cancers per million man-rem. Table I.11 has been revised in the final EIS to show the results of use of 100 to 1000 health effects per million man-rem, in concert with such usage elsewhere in the document.

3.4.2.20 Comment:

One reviewer requested a summary explanation for the statement made on p. I.17, Section I.4.1, for the percentage of accidents that do not exceed the test conditions for Type B packaging (Letter Number: 223).

Response:

To put this probability increase in perspective, the total number of accidents for the geologic disposal alternative, and then the number of accidents that would exceed the regulatory test conditions, was estimated. The total number of accidents was estimated by multiplying the accident rates by the total transportation distance. Only the one-way shipping distance was used because casks are empty when they are returned to Hanford and have no material to release. The total number of accidents for this alternative was estimated to be approximately 30. The assumption that 99.5% of all accidents are less severe than the regulatory test conditions is derived from the WIPP EIS (DOE 1980). Based on that percentage, the probability of an accident involving Hanford defense waste shipments that exceeds the test conditions is 0.005 times 30, or about 0.15. Thus, there is about one chance in seven that such an accident will occur over the entire Hanford defense waste shipping campaign; given that this shipping campaign involves over 7000 shipments, the probability is low.

3.4.2.21 Comment:

One reviewer commented that aggregated accident rates discussed on p. I.18 and I.20 of the draft EIS may not be indicative of accident rates along specific routes. Treating accident rates and population categories as independent variables may underestimate risk (Letter Number: 223).

Response:

It is agreed that the accident rates used in the analysis may not be indicative of accident rates on specific segments of road or rail lines. "Generic" accident data have been used in other major environmental impact statements and are judged to be adequate for this analysis as well. The accident rates used in the analysis are, however, functions of the population zone being traveled through; i.e., separate accident rates are used for travel in rural, suburban and urban areas. Higher accident rates are used for urban areas than for rural and suburban areas. As a result, accident rates and population categories are not treated as independent variables.

3.4.2.22 Comment:

Reviewers noted that the projection of accidents per year is based on current transportation data. This does not take into consideration that there may be significantly more shipments on highways in the future (Letter Numbers: 49, 223).

Response:

The statement in the document is intended to put the accident history of radioactive material shipping in perspective. The value of 30 accidents per year involving radioactive materials applies to all shipments, including medical and industrial isotopes, uranium fuel cycle materials, and power plant wastes. The number of shipments estimated in the document represents only a small incremental increase in the number of radioactive material shipments on our nation's highways and rail lines, given that there are already 2.8 million packages shipped annually (see p. I.17). To put this in clearer perspective, additional calculations were performed to estimate the annual number of accidents associated with Hanford defense waste shipments. Using the accident rates per kilometer presented in Table I.8, shipping distances, and estimated annual number of shipments of each waste type, the annual number of accidents involving offsite shipments of Hanford defense wastes is estimated at approximately one per year. This is about a 3% increase above historic accident rates.

3.4.2.23 Comment:

Reviewers commented that discussions of impacts from accidents involving radioactive materials were lacking in detail. One reviewer noted that in Section I.3.1.1 a statement had been included that promised adjustment of RADTRAN II figures by RADTRAN III figures that were as yet unpublished. Another reviewer commented that impacts from accidents (maximum doses and health effects) were not included (Letter Numbers: 111, 171, 209, 239-NRC).

Response:

Appendix I includes maximum doses and health effects from accidents. The use of RADTRAN II in Figure I.3 is for illustration purposes. Reference to RADTRAN III is designed to create awareness of an updated version. These references provide levels of detail that cannot be appropriately included in the EIS.

3.4.2.24 Comment:

Several reviewers cited the need for DOE continuation of assistance in the preparation of community emergency services for potential accidents during the shipment of radioactive materials (Letter Numbers: 1, 6, 40, 49, 64, 111, 147, 171, 209, 210, 217, 218, 219, 223. Hearing Numbers: 610, 640).

Response:

Procedures for emergency response are required, as discussed in Section I.8. It is the policy of DOE, upon request from state, federal or local authorities, NRC licensees, private organizations, or commercial carriers to provide radiological assistance teams to support state or local authorities.

3.4.2.25 Comment:

One reviewer commented that the draft EIS is lacking in information regarding transportation accidents and emergency response and that Section I.8 ignores federal responsibility for training state and local first responders. Other reviewers wanted to know who assumes liability for shipping accidents (Letter Numbers: 209, 210, 223).

Response:

Section I.1 of the final EIS has been expanded. Section I.8 is not intended to include specific details regarding emergency response planning or training activities. However, the most effective means of providing emergency response capability is through close coordination of federal, state and local governments. Upon request, the DOE provides training to local agencies in corridor states as well as origin and destination states. The Federal Emergency Management Agency (FEMA) document referenced in Section I.8 establishes the framework for planning and implementing an effective emergency response plan. The DOE intends to foster this coordination and to provide assistance to state and local governments where needed.

The Price-Anderson Act provides a system of private insurance or Federal Government indemnity for public liability associated with nuclear material in the course of transportation to/from a covered nuclear facility. In addition, the DOE has the authority to indemnify its contractors for nuclear hazards. As a result, the Federal Government assumes financial responsibility for such liability. At this time, liability coverage can amount to approximately $600,000,000 although there are provisions in the Price-Anderson Act for exceeding this limit, if necessary, upon review and approval of the Congress. The Price-Anderson Act expires in 1987. There has been considerable effort spent in Congress in the last two years to renew the Act and continue Federal Government insurance-indemnity coverage.

3.4.2.26 Comment:

Reviewers commented that local jurisdictions and state agencies often do not have the resources to plan adequately for emergency situations and requested that this be factored into the risk assessment (Letter Numbers: 171, 210, 223).

Response:

An underlying assumption in the RADTRAN methodology is that there will be no evacuation of the population that might be affected by a transportation accident. This means that the population surrounding a route will be exposed to radiation for the entire time that a cloud of released radioactive materials is passing by. No sheltering or evacuation of local residents is assumed in the population dose calculations. This could be interpreted as a situation in which there are no emergency response capabilities. Therefore, the situation has been factored into the analysis.

3.4.2.27 Comment:

One reviewer commented that the discussion on p. xlv of "groundshine, resuspension and ingestion" highlights the need to ensure that plans, procedures, and funding for emergency response and cleanup are in place before substantial numbers of defense waste shipments begin. The reviewer suggested that some description of the assumptions about emergency response and cleanup effectiveness used in the RADTRAN II analysis should be included (Letter Number: 223).

Response:

Groundshine, resuspension and ingestion are potential generic pathways to radiation exposure following an accident involving radioactive material. Suitable waste form (monolithic solid) containers and casks all serve to obviate release of radioactive material. The only significant release noted in the draft EIS was from fracture of encapsulated waste. Further investigations indicate that the analysis in the draft EIS was overly pessimistic, and Section I.4.3 has been revised accordingly.

See also comment 3.4.2.26.

3.4.3 Potential for Accidents

3.4.3.1 Comment:

Several reviewers made reference to the potential for accidents at Hanford that could have devastating effects on a local, regional or national basis. In some cases, reviewers perceived the Hanford geology, hydrology or proximity to the Columbia River as factors complicating the accident potential or consequences (Letter Numbers: 32, 41, 51, 57, 63, 73, 85, 193, 231, 234).

Response:

Several scenarios that involved accidents or waste disposal features not operating as planned were analyzed in this EIS to determine the impacts on the public and the environment from implementation of the waste disposal alternatives. Most impacts were found to be small, although those associated with human intrusion into waste sites could be severe (even fatal). None of the scenarios yielded significant impacts on the Columbia River, the public along the river, or the public in the Hanford environs.

3.4.3.2 Comment:

One reviewer noted that radioactive releases from accidents would be in noncompliance with 40 CFR 191.03. The reviewer also asked for the specific dose values, rather than <0.1 rem values, to be presented in Tables 5.2, 5.12, 5.21 and 5.31. Another reviewer requested specific information concerning DOE's dose guidelines and advocated comparison of calculated doses from the EIS with the most stringent guidelines available (Letter Numbers: 215, 243-EPA).

Response:

The DOE interprets the standard at 191.03 (b) to apply to planned operations, and for planned operations the radiological dose limits clearly would be met. Foreseeable accident conditions are factored into facility design and procedures for operations to preclude their occurrence. Thus, reasonable assurance is provided that planned operations would not exceed permissible radiation doses even under most accident conditions. The upper-bound accidents that were presented in the draft EIS were intended to provide an indication of the level of severity of highly improbable accidents that might be associated with waste disposal. Except for perspective, comparison of the impacts of highly improbable accidents with dose limits for reasonably assured operational impacts is believed unwarranted. (It may be noted that the doses from postulated improbable accidents were less than those that would be permitted under 191.04, Alternative Standards.)

A regulatory compliance analysis is beyond the scope of this EIS; nevertheless, regulatory compliance analyses will be performed and reviewed before disposal actions are implemented for defense wastes covered by the HDW-EIS. The dose limits under which the DOE presently conducts its operations are shown in Chapter 6 of the final EIS.

Data presented in the referenced tables were rounded off to <0.1 rem to avoid using exponentials in the tables. These values have been replaced with the calculated results.

3.4.3.3 Comment:

One reviewer asked DOE to clarify upper-bound accidents for no disposal action and doses in Section 5.5.2.2 text of the draft EIS (Letter Number: 243-EPA).

Response:

The text has been revised to point out that the upper-bound accident and resulting dose for existing tank waste under the no disposal action are different from those for the disposal alternatives because 1) a ferrocyanide precipitate explosion is not credible for the no disposal action, and 2) the upper-bound dose due to failure of a diversion box valve is the same as that calculated for the identical accident under the other alternatives.

3.4.3.4 Comment:

One reviewer commented extensively that the accident analysis had not taken into account the experience at the Hanford Site or at DOE's Savannah River Plant, especially the potential for a hydrogen explosion in a double-shell tank. The reviewer also suggested that Hanford technical staff are incapable of performing objective accident analyses because of a self interest to preserve their jobs (Letter Number: 242).

Response:

The accident analyses performed were for the purpose of assessing the permanent waste disposal operations, not the ongoing waste management operations that were the basis for most of the reviewer's points. For the defense waste disposal alternatives, the double-shell tank explosion is not considered to be the upper-bound accident. All pertinent information was considered in the analyses as reflected in the referenced documents (especially Mishima et al. 1986) and the EIS itself.

The reviewer's suggestion of a conflict of interest based on job jeopardy is illogical. Hanford employee families would be among the populations at high risk if accidents were to happen. It is not credible that any reasonable person would knowingly subject his or her family to such risk.

3.4.3.5 Comment:

One reviewer asked for a listing and description of accidents (steam explosions in tanks, fires, accidental releases of radioactivity) that have occurred at Hanford tank farms (Letter Number: 174).

Response:

A list and description of past operational accidents is not within the scope of this EIS. Accident events at Hanford have been investigated and documented as unusual occurrences. In accordance with DOE-RL policy, these documents are placed in the public reading room in the Federal Building, Richland, Washington. Unusual occurrence records from 1972 to the present may be found there.

3.4.3.6 Comment:

Reviewers noted that no probabilities are given for the airplane crash scenario (Letter Numbers: 231, 234).

Response:

Probabilities for all scenarios were intentionally omitted (except for meteorites--to show that they were negligible), since they are highly speculative (or arbitrary). The reference (NSC 1977) indicates that the airplane crash probability is 5 x 10^{-9}/year.

3.4.3.7 Comment:

Several reviewers expressed concern that acts of terrorism, sabotage or war could result in dispersal of Hanford's radioactive wastes over surrounding areas and that the resulting consequences should be modeled in the EIS. Reviewers were particularly concerned about wastes disposed of near surface, including the "two tons" of plutonium in the soil (Letter Numbers: 57, 82, 147, 156, 160, 171, 175, 177, 216, 217, 223, 240).

Response:

It is true that the draft EIS indicates that there are "two tons" of plutonium in the soil at Hanford; however, the emphasis should be on in the soil. The contaminated soils or other waste disposal facilities are probably not attractive targets for terrorists. There are much more efficient ways for terrorists to meet their objectives than attempting to disperse the defense wastes. Also, since the spread of contamination could render the land unusable to either side, war is not seen as a significant threat to waste disposal sites.

3.4.3.8 Comment:

Several reviewers mentioned the possibility of accidental nuclear criticality, due either to intrusion of water into a subcritical mass of plutonium or reconfiguration of plutonium into a critical mass. Reviewers referred to the Kyshtym disaster in the Soviet Union and the possibility that this type of accident might occur at the Hanford Site. One reviewer referred to "what nearly happened at Hanford" (Letter Numbers: 47, 57, 63, 77, 104, 110, 231, 234).

Response:

In Appendix H of the EIS, the possibility of a criticality was not analyzed. It was concluded that existing conditions do not warrant further concern for criticality.

Although not known for certain, it is doubtful that the Kyshtym accident was initiated by a criticality (criticality does not necessarily result in an explosion). A more likely cause would have been a nitrate (chemical) explosion, not unlike the Texas City disaster, but resulting in widespread high-level contamination.

The reference to "what nearly happened at Hanford" is presumed to relate to the plutonium in the Z-9 trench. The Z-9 trench, which was mentioned directly by other reviewers, contained a quantity of plutonium. It is believed that, without deliberate, prolonged human intervention to rearrange the material, no potential for criticality would ever have existed. The perception of risk, plus the value of the relatively large quantity of plutonium, prompted mining of the plutonium.

3.4.3.9 Comment:

A reviewer asked about the relevance of the document by Mishima et al. (1986) to the discussion of accident release inventories in Section H.2.2 (Letter Number: 223).

Response:

The reference includes discussions of the rationale used in selecting specific quantities of waste for release. Mishima et al. (1986) also indicate how inventories in the data packages were converted to proper units for performing dose calculations.

3.4.3.10 Comment:

A reviewer stated that the document by Sutter (1983) does not support the draft EIS estimate that 1% of the contents of a contact-handled TRU waste package would become airborne, as particles with 10 μm aerodynamic equivalent diameter (AED), in an explosion or pressurized release. Also, the dispersion value used for a dropped shipping container was not found in the reference document (Richardson 1980) (Letter Number: 223).

Response:

Although not considered a real possibility, the contamination is assumed to exist as a powder during the depressurization. The reference (Sutter 1983) lists several values for the fractional airborne release of depleted uranium dioxide (DUO) at 50 psig for the two weights of material used: 2%, 3% and 4% (Table A.1, Sutter 1983). The DUO values are used because this material is similar to plutonium dioxide (the most probable form of radioactive contamination in waste) in density and characteristics. The fractions of material 10 μm AED and smaller from these experiments are 0.7%, 0.6%, 1.4% and 1.0% (Table B.1, Sutter 1983). The mean value is 0.925%, which was rounded up to 1%.

The reference given for the dispersion value (Richardson 1980) was in error. The reference should have been to Mishima et al. (1986); the text of the final EIS has been corrected. The event is postulated to occur within a nuclear-grade facility, and the event itself does not generate conditions that would degrade the facility containment substantially. The airborne material would be filtered by at least two banks of high-efficiency particulate air (HEPA) filters. The emission from the facility is estimated to be 2.5×10^{-9}. Using the weight of material in the capsule, the weight emitted is estimated at 5.5×10^{-6} grams. This was rounded up to 1×10^{-5} grams.

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3.5 LONG-TERM IMPACTS

3.5.1 Protective Barriers

Protective barriers are central to all the Hanford disposal alternatives. Because of the number of comments received in this area, Appendix M has been revised to include a more detailed discussion of the Protective Barrier Program. The reference Adams and Wing (1987) is also an important source of information for the interested reader.

Barrier Design

3.5.1.1 Comment:

A reviewer noted that on page M.2. second paragraph, a "multiyear research and demonstration project focused on barrier performance" is outlined that would obtain laboratory and field data under both as-designed and perturbed conditions. It was not clear to the reviewer how this project can contribute to the selection of the alternative methodologies for disposing defense wastes. Others encouraged the DOE to conduct these further studies and to resolve uncertainties with respect to the effectiveness of the barriers. Information in the draft EIS on the schedule, scope, and planned utilization of this project in decision-making was requested. One reviewer asked whether barrier testing had been completed. Reviewers noted that the proposed protective barrier design is only one possible candidate and that DOE is expected to present other proposed designs with in-depth analysis and ask for comments at that time (Letter Numbers: 147, 171, 217, 223, 239-NRC, 243-EPA).

Response:

A detailed program plan for studying barriers has been prepared, and initial work has started. This program is called the Protective Barrier/Marker Performance Technology Development Program (Barrier Development Program), as outlined by Adams and Wing (1987). What was presented in the draft EIS was intended as a barrier conceptual design, not a final design. The Barrier Development Program is currently evaluating the protective barrier proposed in the draft EIS under a variety of stressed conditions (elevated rainfall, plant and animal intrusion, erosion, etc.). Based on the results, it will be determined whether redesign of the protective barrier, additional waste form modification, or waste retrieval will be required in order to meet the long-term environmental protection requirements. Results of these evaluations will be made publicly available.

3.5.1.2 Comment:

One reviewer stated that "There is no way to illustrate or prove the effectiveness of the proposed basic barrier design in relation to the storage of nuclear waste." Another reviewer felt that current technology does not support the barrier concepts outlined in the EIS. Another stated that more research is needed in this area, and that published data probably already exist and could be used in developing the barrier design (Letter Numbers: 172, 216).

Response:

The concept has been demonstrated for waste disposal in France and at other sites in the United States. Published data were considered in the design of the protective barrier. The revised Appendix M details some of these studies. Additional references have been added to strengthen the support of the barrier concept. These references support the conclusion that the concept of multilayer systems is viable for semiarid site conditions for which the barrier was designed. Field tests, wind tunnel tests and lysimeter studies are under way to test barrier performance under Hanford Site conditions.

3.5.1.3 Comment:

Reviewers commented that technical references used in Appendix M were incorrectly applied or did not support the conclusion that was drawn from them, thus making the barrier appear more effective or more developed than the references allowed. One reviewer also pointed to the multiyear design and field-testing program of DOE's Los Alamos National Laboratory as a more accurate and conservative engineered barrier development. Moreover, the use of data developed in other appendices of the draft EIS resulted in the compounding of errors. The reviewer requested a thorough revision, review, and evaluation before the final EIS is issued (Letter Numbers: 147, 216, 217, 223).

Response:

Appendix M has been revised to more clearly illustrate the capillary barrier concept and its application for Hanford Site conditions. The references in question were reviewed and the applicable areas in each reference were documented. Results of the review support the concept of a capillary barrier for enhancing water removal and minimizing plant and animal intrusion. The work at Los Alamos is specifically studying the use of capillary barriers and supports the view presented in Appendix M that capillary barriers can be used to provide plant and animal intrusion control. A comprehensive barrier development program is under way at the Hanford Site (Adams and Wing 1987).

3.5.1.4 Comment:

One reviewer expressed confidence that the proposed design, with some improvements, will protect the waste against accidental disturbance (Letter Number: 13).

Response:

Support for the proposed concept is acknowledged.

3.5.1.5 Comment:

A reviewer commented that the barrier construction discussed in the reference (Cline, Gano and Rogers 1980) on p. M.1.10 of the draft EIS is different from that proposed in the EIS itself (Letter Number: 223).

Response:

The design of the conceptual barrier presented is not identical to the barrier shown in the reference. This reference was used to demonstrate that roots in general first penetrated 1 meter of soil, then subsequently moved laterally along interfaces above the barrier rock. Where vines had infiltrated the rock, there was one case of root penetration. No tests were done by Cline and coworkers to show how rock layer moisture affected barrier performance.

3.5.1.6 Comment:

One reviewer wanted to know whether the proposed protective barrier includes all the components required under Environmental Protection Agency (EPA) regulations for hazardous waste disposal sites (Letter Number: 223).

Response:

At the present time, the barrier design over tanks is envisioned to include features specific to the Resource Conservation and Recovery Act (RCRA). If EPA regulations are imposed at specific sites (e.g., grout areas), the cover and liner design criteria will be incorporated into the barrier for those sites. While RCRA cover and liner design requirements are shown in the revised grout vault design, RCRA liners are not deemed feasible for some waste sites, and are not directly applied to the sites (e.g., tank farms). Note that EPA cover and liner systems are not required to be designed for more than a 30-year performance period. Nevertheless, requirements for long-term protection of defense waste goes well beyond 30-year expectations.

3.5.1.7 Comment:

Reviewers commented that many uncertainties remain unresolved regarding the long-term performance of the barrier, and that substantial research and development must be completed before a preferred alternative can be selected.

Reviewers noted that the performance of the protective barrier could be compromised through settling or subsidence, biogenic activity (among other mechanisms), liquefaction of the base of the soil cover if near saturation and during significant seismic events, and also through human intrusion. (Letter Number: 141, 201, 217, 219, 231, 234, 239-NRC).

Response:

Barrier performance can be affected by human intrusion and subsidence, but probably not by liquifaction because the soil at Hanford will not be saturated. The Barrier Development Program (Adams and Wing 1987), which is estimated to take 5 to 7 years to complete, is designed to evaluate the barrier in terms of subsidence and biogenic activity.

3.5.1.8 Comment:

Reviewers commented that in view of the difficulty in estimating many of the parameters used in the analysis and the relative uncertainty of many of the conclusions, safe disposal should not rely solely on the barrier and additional measures should be undertaken to prevent contaminants from entering the groundwater table. One reviewer suggested that an impermeable barrier, in addition to the surface barrier, be laid beneath waste tanks that contain transuranic (TRU) wastes and low-level waste areas (Letter Numbers: 53, 141, 171, 172, 177, 217, 219, 223).

Response:

It is not deemed economically or technically feasible to place an impermeable barrier below existing waste areas (i.e., the tank would have to be removed from the ground, the barrier laid down and the waste replaced). The concept of requiring a very low-permeability diversion "cap" or cover over the waste (but below the riprap) is being considered. This cap would divert moisture from the waste, but would not create a "bathtub" effect underneath the waste.

3.5.1.9 Comment:

Reviewers stated that the in-place stabilization alternative must include an impenetrable cover to prevent individual maximum annual doses for the well drilling and excavation scenarios of 1,000 to 100,000 rem/yr. Such a cover is technically feasible, though at considerably higher cost than the proposed cover, which might make the geologic disposal alternative more cost competitive with in-place stabilization (Letter Numbers: 231, 234).

Response:

An impenetrable cover to preclude the drilling and excavation scenario doses has not been considered in the barrier concept because it is not considered to be technically feasible from a drilling-capability point of view. The passive controls, such as redundant markers, are intended to reduce the probability of such a scenario.

3.5.1.10 Comment:

One reviewer commented on the barrier design shown in Figure M.3 and noted that in the event that water, through hydraulic pressure, migrates into the coarse layer, the slope of the coarse layer must be adequate (probably greater than 5%) to ensure that water does not migrate further into the waste. The reviewer felt that this slope needs to be shown in Figure M.3 (Letter Number: 239-NRC).

Response:

The Barrier Development Program (Adams and Wing 1987) will evaluate conditions under which sloping layers may be needed.

3.5.1.11 Comment:

One reviewer questioned whether the protective barriers would be large enough to adequately extend beyond any waste underneath, taking into consideration lateral migration, so that no possibility of animal or plant intrusion would exist (Letter Number: 223).

Response:

Barrier overhang was assumed to extend from 10 to 30 meters beyond the waste. A careful study of lateral migration is part of the Barrier Development Program (Adams and Wing 1987). This study will provide input to determine optimal barrier overhang. Section B.1.4.3 of the final EIS has been revised accordingly.

3.5.1.12 Comment:

One reviewer noted that page 3.26 of the draft EIS states that empty and partially filled tanks are to be covered by the protective barrier. The reviewer asked whether the barrier would include not only the tanks themselves but tank-farm-related facilities as well, such as diversion boxes, catch tanks, low-level liquid sites that are associated with the tanks, underground and unencased pipelines, etc.; or whether the barrier would be just for the tanks themselves. The reviewer wondered, if the latter were the case, how these other tank-farm-related facilities would be addressed (Letter Number: 223).

Response:

Pump pits, etc., will be grouted, voids will be filled, and barriers will be placed over the entire tank farm. The barrier is conceptually designed to extend up to 30 meters beyond the tanks, and will cover the bulk of the tank-farm-related equipment.

3.5.1.13 Comment:

One reviewer suggested that the fine-textured soil layer and vegetation on top of the barrier be eliminated and replaced with a sterilized rock barrier to discourage future farming (Letter Number: 223).

Response:

A sterilized rock barrier would not work for infiltration control. Instead it would act as a water catchment, collecting most or all precipitation while silting and subsequent vegetation of a rock on gravel would be expected in time (after assumed loss of active institutional control). A surface of fine soil with adequate water-holding capacity is preferred over coarse soils or rock cover materials. The fine soil enhances water storage near the surface; this water can be recycled by evapotranspiration in an arid climate. See Appendix M of the EIS for a detailed explanation of the function of the fine-textured soil layer. Farming (human intrusion) is to be discouraged by the warning markers.

3.5.1.14 Comment:

One reviewer requested more discussion as to why the multilayer soil barrier design was chosen over soil mounding, revegetated covers, synthetic and natural impermeable layers and others (Letter Number: 223).

Response:

Before 1984, Rockwell Hanford Operations performed an analysis/evaluation of several of the aforementioned barrier systems and concluded that, for Hanford Site conditions, natural earthen materials would provide the greatest long-term protection and meet the other criteria of reducing animal, plant and water intrusion. See Appendix M, and also see the Barrier Development Program (Adams and Wing 1987) for discussion of an alternative design for a redundant low-permeability (clay or asphalt) cap.

3.5.1.15 Comment:

One reviewer noted that surface armoring with gravel or rock was proposed on pages M.24 and M.25, and suggested the use of "stone mulch," a surface gravel layer, to substantially retard soil evaporation. The reviewer raised the question as to how an effective erosion protection can be achieved without degrading the barrier's moisture retardation function (Letter Number: 223).

Response:

Armoring protects against wind and water erosion but may in some cases have negative impacts on infiltration control. In other cases armoring enhances vegetation, thus reducing infiltration. Such interactions are currently being studied under the Barrier Development Program (Adams and Wing 1987).

3.5.1.16 Comment:

A reviewer, commenting on p. M.8 of the draft EIS, noted that a "stone mulch" would inhibit evapotranspiration and asked about the quantitative effects of the subsurface markers and gravel armoring on the hydraulic performance of the barrier (Letter Number: 223).

Response:

Evapotranspiration can be enhanced by a "surficial stone" mulch as has been demonstrated by Los Alamos National Laboratory in recent field trials. While it is true that water storage in the barrier can be decreased, the effect to the barrier can be offset by increased moisture loss by plants. Such a synergistic effect must be evaluated carefully. This effect will be studied in field plots and lysimeters under the ongoing Barrier Development Program at Hanford (Adams and Wing 1987). The density of the markers (mass/volume of soil) should not be high enough to cause significant loss of storage. Markers will be placed in field tests to study their effect on evapotranspiration.

3.5.1.17 Comment:

One reviewer questioned the consistency of the way in which the capillary theory was applied to the barrier design. The reviewer gave as examples Table M.1, which suggests that changes in potential water storage are possible by varying the texture of the upper soil zone, and Table M.2, which shows an alternative configuration whereby the upper layer is kept constant and the texture of the coarse capillary barrier is varied (Letter Number: 223).

Response:

Both Table M.1 and M.2 are useful in showing that storage changes can be obtained by modifying the soil texture of the layers; a pattern of fine soil over coarse soil provides the sharpest textural break and enhances the potential for increased water storage. Since

Table M.2 was conceptual only, it has been deleted to avoid confusion. It should be noted that the Barrier Development Program (Adams and Wing 1987) will test the specifics of enhanced storage in layered soils.

3.5.1.18 Comment:

One reviewer noted that the discussion in Section M.1.3 of the draft EIS implies that a multilayer system with a capillary barrier can eliminate deep drainage, and that field testing of such a barrier was under way. The reviewer noted, however, that the references cited present data that moisture migration cannot be completely prevented, but that they reported no field tests in progress. In addition, although discussions in Section M.1.3 refer to multilayer cover systems for restricting gas exhalation from waste materials, the reviewer did not find any portion of the draft EIS that described gas exhalation as a problem. Also the discussion in Section M.1.3 did not show that water infiltration was a problem. The reviewer inquired into field testing of barriers to demonstrate the barrier concept (Letter Number: 223).

Response:

The reference by Winograd (1981) cites a study at Cadarache, France, in which a capillary barrier was specifically tested for water infiltration. After a multiyear test, Rancon (1980) reported that the test trench "remained a dry structure." In addition, other tests cited by the reviewer, as for example the tests at Los Alamos, are specifically examining the capillary barrier concept for infiltration and biointrusion control of low-level waste sites. A capillary barrier, with an underlying compacted clay layer used for radon control, can provide for redundancy as described in Section M.5.2.3; hence, the references are appropriate. Testing of the layered soil barrier system is presently being performed under the Barrier Development Program (Adams and Wing 1987).

As the reviewer noted, gas exhalation is not a problem. The inclusion of the Bone and Schruben (1984) reference refers to field testing of a capillary barrier for radon gas control. Features of a capillary barrier are described. Also, see comment 3.5.1.41.

3.5.1.19 Comment:

A reviewer commenting on Section M.5.2.3 noted that if initial conditions in the gravel underneath the fine soil were assumed to have a finite moisture content and a unit downward gradient, then flow would occur upon the beginning of the simulation. The reviewer noted that the initial conditions and unsaturated hydraulic conductivity of the gravel are very important to the performance of the protective barrier. A sensitivity analysis was suggested (Letter Number: 215).

Response:

The reviewer is correct; however, the modeling demonstrates that the unsaturated flow is very low in the gravel and may occur in either direction depending on the pressure gradient in the fine soil layer. A number of model studies have been completed and additional ones are planned as part of the Barrier Development Program (Adams and Wing 1987).

3.5.1.20 Comment:

One reviewer noted that Section 0.3.1.1 states that, after emplacement of the protective barrier, "... existing soil moisture will drain from the soil profile more slowly as the new cover moisture equilibrium is approached." The reviewer noted that the opposite is likely to occur (Letter Number: 215).

Response:

Recent investigation further supports the assumption of slow drainage beneath the barrier. (See Fayer, Gee and Jones 1986.)

3.5.1.21 Comment:

The functional ability of the barrier system will depend upon the suitability of the site soils. The document does not discuss the nature, depth, or availability of the site soils. There is no mention of impacts to the site due to excavation of soils, the ability of the soils to maintain a vegetative cover over 10,000 years, or the likelihood of erosion under a drier (or wetter) climate. All of these factors will affect the efficiency of the barrier.

One reviewer responded to Section M.2 and asked whether the specific onsite resources of fine soil, gravel and riprap have been identified, quantified, and tested for uniformity and quality. The reviewer also asked for specific information as to whether these materials are available on site (Letter Numbers: 71, 171, 217, 223).

Response:

Suitable soils appear to be available on the Hanford Site. Several candidate locations have been identified for obtaining the soil. In addition to meeting technical criteria, selection will depend on results of archaeological surveys of the sites. Soil removal sites would be revegetated upon completion of use. Indigenous vegetation would be introduced on the barrier and as such would likely be maintained over a long period of time. Stone mulch would be investigated as a means of reducing the likelihood of soil erosion. These and other factors are the subjects of investigation in the Barrier Development Program described in Adams and Wing (1987).

3.5.1.22 Comment:

One reviewer commented on Section M.3.1, observing that neither the draft EIS nor any field studies had demonstrated that the protective barriers prevent downward percolation, especially during extreme precipitation events (Letter Number: 215).

Response:

Rancon (1980; cited by Winograd 1981) observed for a capillary barrier system that infiltration was apparently prevented even with incidence of intense irrigation and high rainfall. Tests for drainage in response to elevated or extreme events will be conducted on test barriers at the Hanford Site. It may be shown that if the barrier performs adequately most of the time, but fails under extreme but infrequent (once in a thousand years) events, that the total recharge to the water table may still meet a specified design criterion, which would be based on a long-term-minimum recharge rate.

3.5.1.23 Comment:

With respect to Section M.5.4, one reviewer commented about the reference to the presence of glacial-fluvial sediments overlain by fine-textured sediments as possibly a good analog to the multilayer system. The reviewer suggested the use of instrumentation and other types of water investigations at the sites in addition to geotechnical stability studies (Letter Number: 215).

Response:

Natural analog studies are an important part of the Barrier Development Program (Adams and Wing 1987), and preliminary studies of natural analog sites at Hanford have been completed.

3.5.1.24 Comment:

One reviewer asked whether the clay layer discussed in Section M.5 is contemplated above or below the riprap zone. The reviewer also asked for documentation to show that the clay layer could be effective in reducing drainage in the long term (Letter Number: 223).

Response:

Redundancy in layering is discussed in Section M.5. The clay layer would be placed below the upper riprap zone. Testing of clay layer materials as an alternative design will require specific tests, such as wetting and drying, compaction and permeability tests. If it is determined that a redundant barrier system is needed, such tests would be conducted as part of the Barrier Development Program (Adams and Wing 1987).

3.5.1.25 Comment:

One reviewer noted that the use of cheatgrass as described in Section M.5.1.2 is currently prohibited for any stabilization project on the Hanford Site. Also, cheatgrass is an annual plant; during draught conditions it may not adequately prevent significant erosion. Other reviewers wondered what other plants would replace the cheatgrass over time (Letter Numbers: 223, 231, 234).

Response:

The surface will be stabilized with perennial grasses and shrubs. The exact composition will be evaluated in the Barrier Development Program (Adams and Wing 1987). In the model simulations, cheatgrass was chosen to be a worst case. Another reason for that choice is that the only transpiration data available for the Hanford Site at the present time are those data collected for cheatgrass.

Cheatgrass was not chosen as a stabilizer, but to illustrate what might be expected if more stable, perennial grasses and shrubs were removed. The simulations also showed the results of infiltration on bare soils that would reflect removal of plants (i.e., a worst-case situation). The issues of barrier vegetation and erosion control are discussed in Appendix M and the Barrier Development Program (Adams and Wing 1987).

3.5.1.26 Comment:

One reviewer expressed skepticism about the "geotextile" concept. Another reviewer wanted to know the function of the geotextile in the barrier (Letter Numbers: 78, 223).

Response:

The geotextile is used primarily to aid in layer construction as is typically done in road-base for highways and similar construction operations. As stated in Section M.2, no credit is taken for the geotextile as an enhancement of barrier lifetime.

3.5.1.27 Comment:

A reviewer wanted to know whether any analysis had been performed of the long-term and dynamic stability of the fine soil/riprap interface, i.e., silica glass geotextile, and whether any engineering field test had been planned to evaluate these factors. Another reviewer stated that the use of such a membrane could be expected to create increased moisture under the barrier due to capillary moisture rise and condensation from air moving through the soil (Letter Numbers: 223, 231, 234).

Response:

The geotextile is used primarily for construction purposes, and is standard engineering practice for subgrade material and filter-layer segregation. The specific geotextile has not been selected, but materials most commonly used are woven fabric with a significant porosity and high permeability to water and air. There are no analyses planned for the long-term and dynamic stability of the fine soil/riprap engineered field tests. There will be a gravel filter separating the fine soil and riprap. Expected moisture profiles beneath the barriers are discussed in Appendix O, Section O.4.1.4. Since the riprap and filter system and geotextile are all porous, condensation above the waste is not expected. Engineering field tests are planned to assess the performance stability of this filter system under the Barrier Development Program (Adams and Wing 1987). Graded filter systems are common in dam construction, have proven stability, and are believed to be practicable.

3.5.1.28 Comment:

A reviewer commented on the description of the protective barrier on p. 3.11 of the draft EIS and noted that there is little discussion of the rock/gravel layer, no discussion of the geotextile, and insufficient discussion of the functioning of the barriers and biointrusion (Letter Number: 223).

Response:

Because of the need to keep Volume 1 to a reasonable size, these more detailed discussions appear in Appendix M. Appendix M has been revised to more clearly discuss the uncertainties in performance and the plans to evaluate barrier performance at Hanford. Included as part of that plan is a more thorough evaluation of animal intrusion on barrier performance, including infiltration. The thickness of the barrier will discourage animal intrusion into the waste.

3.5.1.29 Comment:

One reviewer commented on Figure B.23 and noted that the drawing is not to scale and does not include all sites to be included in the barrier system. The reviewer also suggested that the sites should be shown in relation to some of the major facilities to provide some idea of the scale and location (Letter Number: 223).

Response:

Figure B.23 of the EIS illustrates the principle of barrier sites within the area that could be delineated by markers around a secondary perimeter including both 200 West and 200 East Areas. The detail suggested is not required to illustrate this principle. The scale can be seen in Figure 1.9.

3.5.1.30 Comment:

Several reviewers commented that archaeological evidence cited in the draft EIS to support the protective barrier concept is unsubstantiated. One reviewer noted that archaeologists typically look into mounds or marked areas as sites for investigation (Letter Numbers: 215, 216, 223, 242. Hearing Number: 408).

Response:

Neither of the archaeological references cited in the summary nor any of those in Appendix M are intended as substantiation that a barrier can be designed to adequately protect Hanford wastes over the long term. However, the references were intended to show that the principle of a multilayer earthen barrier is conceptually sound. Although the effectiveness of the proposed protective barrier design for Hanford defense waste has yet to be tested, the concept of multilayer barriers can be designed to exclude moisture under hydrologic conditions far more severe than those on the the Hanford plateau.

The Silla dynasty tombs of Korea are described by Hoefer, Lueras and Chung (1983). The tombs have apparently remained free of water since their construction over 1000 years ago. The DOE has no data on the geology of that area; however, it is known that the annual rainfall where the tombs are located is much greater than that of the Hanford Site, and the soil is saturated at shallow depth. A more remarkable find has been reported recently (Lee, Oscarson and Cheung 1986) in a 2100-year-old tomb in Hunan Province, China. In this tomb, which was protected by a multilayered barrier, was the preserved body of a Chinese woman. Not only were her skin and organs well preserved, her silk garments were undamaged. Since both the organs and the silk were highly susceptible to decay, the discovery suggests that air as well as moisture was excluded from the tomb for 2100 years.

Cobble lenses underlying fine soils in the Columbia Basin plateau are examples of multilayer deposits that have persisted in nature for more than 12,000 years. They are geologic evidence that multilayered deposits, such as those envisioned for the protective barrier, can persist for long time periods in the Hanford Site environment.

3.5.1.31 Comment:

One reviewer, commenting on Section M.4 of the draft EIS, pointed out that it is meaningless to conclude that 85 to 95 out of 100 individuals would heed the warning markers if no explanation were provided. Another reviewer suggested that an estimate of the number of intrusions could be made on the basis of the historical record of unearthing burial grounds. Reviewers noted that human curiosity is likely to lead to disturbance of waste, especially if the English language is replaced over time (Letter Numbers: 215, 219, 223, 240).

Response:

As stated in Appendix M, the percentage of individuals heeding the warning markers was purely judgmental. This exercise was performed in an effort to indicate how the question "of what value are the records, markers, etc." might be answered. Impacts of intrusions were presented both ways, where markers, etc., were assumed to have the effectiveness described and where no credit was taken for their existence. With respect to language, warnings would be written in several languages as well as in pictograms.

3.5.1.32 Comment:

Reviewers felt that the barrier is unlikely to effectively eliminate infiltration for 10,000 years (Letter Numbers: 171, 219, 223, 243-EPA).

Response:

Because of the uncertainty in the ability of the protective barrier to effectively eliminate infiltration for 10,000 years, several barrier failure scenarios were analyzed and their impacts presented in the EIS. The barrier is designed to reduce the likelihood of infiltration into the waste or reduce it to an acceptable level and to provide protection against plant, animal and human intrusion. Reduction in recharge below a prescribed limit is a design objective for the barrier. Because of the uncertainties attributable to the long time period (10,000 years) and other factors such as waste-form release rates and chemical interactions between soil and waste, the exact design limit of the barrier (i.e., average annual recharge of 0.5 cm/yr, 0.1 cm/yr, 0.05 cm/yr) has not been resolved for a given climate. Until then, a barrier of earthen material with appropriate qualities (hydrologically suitable) can be used to minimize or limit infiltration such that even finite, but infrequent, failure (due to extreme events) will not result in excess or unacceptable recharge.

3.5.1.33 Comment:

One reviewer felt that potential environmental impacts of possible root and animal intrusion or farming and irrigation near or over proposed barriers were not adequately addressed. The reviewer asked if the environmental impacts on the site would be small enough that the Yakima Indians would again have access to the area for hunting, fishing, and gathering as stated in the 1855 treaty (Letter Number: 223).

Response:

Under expected conditions environmental impacts associated with waste disposed of beneath barriers are calculated to be small. The barrier itself will be designed to minimize animal and root penetration. The barrier and marker system are expected to curtail any use of the land atop the barriers. The amount of overhang of the barriers has not been decided upon; it will likely be waste-site specific. These and other facets of the barrier design are to be developed in accordance with the Barrier Development Program (Adams and Wing 1987).

There is no intent to return the Hanford Site to a status of "open and unclaimed land" to which privileges resulting from 1855 treaties with several Indian tribes might apply. The Hanford site is not presently, nor is it expected to be, a significant impediment to those Indians' rights to take fish at "all other usual and accustomed stations in common with citizens of the Territory." See also Sections 3.4.4, 4.8.4, and 4.8.5 of the final EIS.

3.5.1.34 Comment:

One reviewer, the NRC, noted that the multilayer capillary barrier design ("wick" design) should be based on extreme precipitation events (Letter Number: 239-NRC).

Response:

As is discussed in Appendix M, Section M.5.2.2 (Precipitation), it is not just the rainfall distribution but the combination of rainfall and evapotranspiration distributions and amounts that is important in determining drainage rates at a given site. A variety of rainfall distributions including extreme events (1000-year storms, etc) will be modeled in the Barrier Development Program (Adams and Wing 1987).

3.5.1.35 Comment

One reviewer felt that the assumptions made in the draft EIS were nonconservatively low, yielding nonconservatively low dose rates. The reviewer felt that these nonconservative assumptions yielded more similar release rates for the different disposal alternatives. The reviewer felt a more conservative approach would favor less reliance on protective barriers and more reliance on geologic disposal (Letter Number: 223).

Response

The assumptions used in the draft EIS are believed to be appropriate for the level of analysis required early in the decision making process. Part of the apparent similarity of impacts of the alternatives under anticipated operating conditions centers on three nuclides: carbon-14, technicium-99, and iodine-129, all of which are assumed to travel through the vadose zone at the same rate as water. The bulk of these nuclides are disposed of near surface in the in-place stabilization and disposal and reference alternatives. Carbon-14 and iodine-129 are disposed of near surface in the geologic disposal alternative. Thus there is little difference in impacts when these nuclides dominate. In an extreme case if the barriers were to fail in a few hundred years, strontium-90 would dominate the radiological impacts and a more dramatic difference would be seen among the alternatives. Such a case, however, is not believed to be credible.

3.5.1.36 Comment:

Reviewers commented that several barrier features might result in degraded barrier performance in ways that were ignored in the draft DEIS. Possible adverse consequences included settlement-induced basins because of low densification of barrier materials, concentration of moisture by subsurface markers, reduction of evapotranspiration by surface armoring to prevent wind erosion, and attraction of burrowing animals to the riprap layer (Letter Numbers: 215, 223).

Response:

Barrier failure scenarios were analyzed, moreover, a discussion of a development and evaluation program (Adams and Wing 1987) designed to answer those and other concerns has been added to Appendix M.

3.5.1.37 Comment:

A reviewer commented that simulation techniques used to test the multilayer cover were unclear, or nonconservative, with respect to various input parameters including soil moisture, precipitation, soil characteristic curves, plant growth cycles, and potential evapotranspiration (Letter Number: 223).

Response

The modeling presented in Appendix M shows scoping calculations ranging from those for coarse soil and no plant cover to fine soil and plant cover under high rainfall conditions. For the conditions specified, the modeling is believed to adequately demonstrate ranges in barrier effectiveness and the concepts of layered-soil effects on water storage and subsequent removal by evaporation and transpiration.

3.5.1.38 Comment:

One reviewer felt there is a substantial likelihood of barrier failure and that natural biological, erosive, and physical causes are just as plausible as a human cause. The reviewer felt that the draft EIS was not conservative in estimating barrier failure consequences. The reviewer commented that catchment basins could form over 50% of the barrier surface rather than the 10% postulated in the disruptive failure scenario. The reviewer felt the functional barrier failure scenario was overly mild and would be more credible if the infiltration rate was increased to between 1 and 2 cm/yr over the entire barrier (Letter Number: 223).

Response:

The draft EIS at pages M.24 and M.25 addresses several possibilities for disturbance of the barrier. However plausible disruption by natural forces may be, DOE believes that human caused disruption is the more likely. Other failure scenarios would of course lead to different consequences. In an extreme case it could be assumed that catchment basins formed such that 100% of the waste were contacted. An approximation of the impacts from such disruption can be made by multiplying the results of the disruptive failure analysis presented in Appendix R (infiltration of 15 cm/yr) by a factor of 10. Even at that extreme, the relative merits of the various alternatives are essentially unchanged.

3.5.1.39 Comment:

One reviewer noted that the riprap layer is proposed to be loosely consolidated and the minimum porosity of the fine soil layer is approximately 43%. The reviewer asked what data exists to ensure that settlement of the barrier surface will not occur, given these relatively low constructed densities (Letter Number: 223).

Response:

The "low" density cited is typical of silty soils. It is expected that the Barrier Test Program will show that these kinds of densities exist on the Hanford Site for soils that have been in place for thousands of years. No settlement is expected for the long-term resident soils. Fine soils generally have lower densities than do coarser soils.

3.5.1.40 Comment:

A reviewer commented that references Gee et al. (1981) and Hartley and Gee (1981) discuss barriers to limit exhalation of radon gas which the reviewer felt are fundamentally different in design and purpose than the moisture-infiltration barriers described in the draft EIS. The reviewer felt the references were not applicable (Letter Number: 223).

Response:

A barrier that prevents radon gas exhalation would also prevent water infiltration; therefore discussions which apply to radon gas control also have application as an infiltration barrier. Tests of such barriers are included in the Protective Barrier Test Plan (Adams and Wing 1987).

3.5.1.41 Comment:

A reviewer felt that the reference, Bone and Schruben (1984), was not applicable because it discusses a radon and erosion barrier of fundamentally different design and purpose than the moisture-infiltration barriers proposed in the draft EIS. The reviewer further commented that the reference mentions the need to prevent human intrusion rather than addressing considerations for barrier design in a substantive way (Letter Number: 223).

Response:

The reference was included to illustrate other uses for a multilayer barrier. The authors stated explicitly, "The primary passive controls inhibiting human intrusion will be the thick earthen and rock covers." The citation has been removed from Section M.1.3.

3.5.1.42 Comment:

A reviewer commented that the references cited in the draft EIS discussion of layered soil's effects on water storage (Hillel and Van Bavel 1976; Hillel 1977; and Hillel and Talpaz 1977) refer only to simulations of these effects and that each reference includes a similar disclaimer about the applicability of the simulations to actual field situations. The reviewer quotes from Hillel and Van Bavel 1986 (p. 814), "Hence, we make no claim that our reported results are realistic in the sense that they can serve directly to describe any particular field situation" (Letter Number: 223).

Response:

Model simulations are designed to mimic field observations; hence the description of water movement in soils provided in the cited references and discussed later in the text are held to demonstrate the concepts adequately.

3.5.1.43 Comment:

A reviewer commented that, contrary to its citation, the Miller and Aarstad 1963 reference does not discuss gravel layers. Also, the reference does not present a characteristic curve, as mentioned in the citation (Letter Number: 223).

Response:

The reference cited in the draft EIS was incorrect; the document referred to should have been Miller and Bunger (1963). Appendix M has been corrected.

3.5.1.44 Comment:

A reviewer commented that the referenced report Miller (1969) considers soil drainage values of 0.01 to 0.1 cm negligible, which is not the case for the purposes of the draft EIS (Letter Number: 223).

Response:

The reference was cited to demonstrate increased water storage in layered soils. Its use should not be construed to defend a specific drainage value nor to provide barrier specifications.

3.5.1.45 Comment:

A reviewer commented that Brownell et al. (1971) do not provide explicit soil moisture information; only one example chart of soil moisture is presented with no reference to soil type or location (Letter Number: 223).

Response:

The cited reference shows soil moisture data for work done at the Hanford Site. The work relates to unsaturated flow in the 200 Areas. Other references were cited which provide more detail on sediment type and locations. Additional references have been added to Appendix M (LaSalla and Doty 1975; Routson and Kecht 1979).

3.5.1.46 Comment:

A reviewer commented that Brownell et al. (1975) mention specific soil moisture ranges for vadose zone sediments but does not report measurements in undisturbed soils. The reviewer added that soils monitored in lysimeters were thoroughly mixed, obliterating natural structure. The reference reported percolation to a depth of 6 m, suggesting a potential for greater buildup of moisture than reported in the draft EIS (Letter Number: 223).

Response:

All waste sites are essentially disturbed soils; moisture contents from disturbed sites are important data since long-term changes of moisture can provide answers to questions of flow rates and directions. The statement in question is a general one and is supported by the cited reference. The fact that the sediments are coarse and well drained is well known.

3.5.1.47 Comment:

A reviewer stated that Enfield, Hsieh and Warrick (1973) do not report soil moistures as stated. The reviewer also stated that the reference is illustrative of the difficulty and lack of precision that have characterized investigations of soil moisture movement at Hanford (Letter Number: 223).

Response:

Moisture potentials and conductivities are the important aspects of the cited reference. This reference is key in supporting the concept that drainage is low at some Hanford Sites. However, more refined analysis is required to determine recharge with precision. Such an analysis is under way (Adams and Wing 1987). Appendix M has been modified to clarify these points.

3.5.1.48 Comment:

A reviewer commented that the moisture figures reported by Gee and Heller (1985) differ from those stated in the draft EIS. The referenced report gives wide ranges in deep drainage rates at every site which, according to the reviewer, indicates the lack of precision obtained to date in soil moisture movement characterizations at Hanford (Letter Number: 223).

Response:

The principal thrust of the citation was that, in general, soils at Hanford are coarse and hence drain freely. Appendix M has been modified to strengthen the point. For a discussion of the range in deep drainage at Hanford see Appendix A of Fayer, Gee and Jones (1986).

3.5.1.49 Comment:

One reviewer noted that contrary to the citations in the draft EIS no soil moistures were reported for natural (undisturbed) soils in Hsieh, Brownell and Reisenauer (1973) and Jones (1978) and that no soil moistures were reported outside caissons in Jones and Gee (1984) and Jones, Campbell and Gee (1984). The reviewer also noted that all of these references suggest a potential for perching and local soil moisture buildups in excess of the ranges cited in the draft EIS (Letter Number: 223).

Response:

The soil used in the lysimeter test cited was taken from the 200 Areas plateau--the same area where the wastes under discussion are stored. All waste sites would be considered disturbed. The lysimeter soil mixture reflects one of several mixtures of soil that might be found at a waste site--which is the point of the discussion about moisture content. The soil has a loamy sand texture. The hydrologic properties (water retention and unsaturated conductivity), the key parameters for flow analysis, are given in the cited reference. Texture is only a qualitative index and provides no information to quantify flow rates.

Rains had wet the soil before placement in the lysimeter; hence, high water content soil was placed in the lysimeter because the soil "borrow" pile was wet. The high water content in the open bottom lysimeter gradually decreased in time, suggesting slow redistribution of moisture. Unfortunately, that lysimeter was evacuated. (See discussion in Gee and Heller 1985.)

3.5.1.50 Comment:

A reviewer commented that Isaacson, Brownell and Hanson (1974) and Reisenauer (1979) indicate 5 to 9% moisture by volume in loamy sand and gravelly sand, respectively, not the 2 to 5 wt% mentioned in the draft EIS (Letter Number: 223).

Response:

The point being made is that the weight percent multiplied by the bulk density is the volume percent for soils having bulk densities of 1.8 to 2.0. The volume percent of soils with weight percentages of 2 to 5 is 4 to 10 volume percent, clearly in the range discussed in the cited reference. A discussion of volume versus weight percent is given in Hillel (1981); this has little direct application to the issue of recharge, however.

3.5.1.51 Comment:

One reviewer said that the unsaturated flow model "UNSAT1D" was criticized in the referenced Jones, Campbell and Gee (1984), yet this model was used in the draft EIS (Letter Number: 223).

Response:

The unsaturated flow model UNSAT-1D was the best available modeling technology available at the time impact calculations were performed for the draft EIS. The "criticism" mentioned in the comment focused on the lack of calibration of the code to specific Hanford Site conditions. An improved version of UNSAT-1D, i.e., UNSAT H, is being used to support the Barrier Development Program (Adams and Wing 1987). The improved version, presently benchmarked and verified, is undergoing calibration by specific Hanford conditions. See Fayer, Gee and Jones (1986) and comment 3.5.1.60.

3.5.1.52 Comment:

A reviewer commented that Kinnison (1983), referenced in the draft EIS, does not seem to explicitly treat Hanford data. The reviewer also said that according to Stone et al. (1983), referenced in the draft EIS, the maximum amount of annual precipitation to occur on an average of once every 100 years is over 32 cm, versus the 30.1 cm cited in the draft EIS (Letter Number: 223).

Response:

A discussion of the extreme value statistics analysis of the Hanford data is given in a private communication to the author of Appendix M. Appendix M correctly states the appropriate analysis of the data from the Hanford Meteorology Station.

3.5.1.53 Comment:

A reviewer commented that Kukla (1979) does not address the methodology described in the citation in the draft EIS (using the 100-year maximum) for assessing precipitation under a wetter climate (Letter Number: 223).

Response:

The reference citation was provided merely to indicate that an analysis has been performed that supports the estimate of a probable two-fold increase in average annual precipitation that is reasonable for future climate scenarios.

3.5.1.54 Comment:

A reviewer said that a reference cited in the draft EIS (Simmons and Gee 1981) uses a cheatgrass growing season of 70 days while the draft EIS uses 120 days. The reviewer felt this discrepancy could result in significant differences in the calculated moisture flux through the protective barrier (Letter Number: 223).

Response:

The growing season extension was for winter months when evapotranspiration is lowest. Since plants also grow in winter, it was more correct to extend the growing season. A growing season (transpiration) cycle of 152 days was assumed. Little change in recharge results from winter evapotranspiration calculations. Such sensitivity to drainage is currently being tested (Adams and Wing 1987). Also see comment 3.5.1.70.

3.5.1.55 Comment:

A reviewer commented that Sehmel (1976, 1979, 1981) did not refer explicitly to waste on construction sites or wind erosion at Hanford as the author felt was implied in the citations in the draft DEIS. The reviewer also felt that Sehmel (1979) was general in nature with the only reference to Hanford being example data sets. The reviewer added that, contrary to the citation, no specific reference to the proposed barrier or to data deficiencies at Hanford was mentioned in the reference (Letter Number: 223).

Response:

There are no data available that explicitly deal with wind erosion at Hanford that might affect barrier performance. The reference was cited to point out that limited wind erosion studies have been conducted and that additional information is needed. Wind erosion is also a subject of investigation in Adams and Wing (1987).

Modeling and Analysis of Barrier Performance

3.5.1.56 Comment:

A reviewer commented that the highest research priority should be given to actual barrier performance under extreme climate conditions. If the barriers do not perform as anticipated, the geologic disposal alternative should be selected (Letter Numbers: 71, 147, 217).

Response:

The DOE agrees on the matter of high research priority, as evidenced in the Barrier Development Program (Adams and Wing 1987). Information available to date has indicated that a multilayer barrier can be designed to meet criteria for long-term isolation of waste at the Hanford Site.

3.5.1.57 Comment:

Several reviewers commented that the effectiveness and durability of the protective barrier and marker system cannot be substantiated on the basis of the analyses performed to date, and that the information provided in the draft EIS was too optimistic. Extensive analysis and testing of the barrier design to predict its performance was urged. One reviewer stated that DOE contractors misled the public to believe the barrier is safe (Letter Numbers: 5-DOI, 8, 12, 64, 92, 116, 155, 171, 201, 215, 217, 223, 239-NRC, 243-EPA).

Response:

Because of the potential for water infiltration, biointrusion and human intrusion, a protective barrier was specified for any of the disposal alternatives. There are both archaeological and geological bases for the barrier concept. The final barrier will be designed to provide a margin of safety that will meet long-term objectives of waste disposal. However, since the barrier design is conceptual at this time, the margin of safety will be demonstrated after a more definitive design is developed. Testing of the barrier design concept and performance is under way in the Barrier Development Program (Adams and Wing 1987). Appendix M has been revised to include details of this program.

3.5.1.58 Comment:

One reviewer noted the discussion in the Introduction to Volume II of the draft EIS, and commented that the layered barrier covers have not been shown to prevent infiltration. The reviewer suggested that by assuming that the coarse rock layer is impermeable, its successful performance in simulation is created artificially. The reviewer suggested that engineered and natural layered systems should be monitored with highly sensitive methods such as tracers (Letter Number: 215).

Response:

Layered soils have been observed to limit infiltration. Field tests at the Hanford Site will further evaluate this layered-soil phenomenon. Models do not ensure that there will be no flow through layers. The unsaturated conductivity of coarse layers is functionally dependent upon the capillary pressure head, and flow is governed by head gradients. Significant drainage occurs when the gradients are in the right direction and the conductivity is high enough. Test case 1 in Table M.7 demonstrates this point. Precision lysimetry will be used to measure drainage in field tests of the protective barrier (Adams and Wing 1987). In addition, tracers are being considered for some unsaturated flow studies to provide additional confirmation of flow rates in Hanford Site sediments.

3.5.1.59 Comment:

A reviewer questioned the performance of the proposed barrier, and pointed to the need to test the soils having a loam or silt content adequate for the proposed barrier. The reviewer noted that at least three full years of testing are required, and that such testing should include the effects of biointrusion and barrier disruption and have the highest priority (Letter Number: 217).

Response:

A research and development program has been initiated and 5 to 7 years of tests are planned; the Barrier Development Program is designed to test soils, biointrusion, and other aspects of barrier performance (Adams and Wing 1987).

3.5.1.60 Comment:

A reviewer questioned whether the results of the model simulation reported in the draft EIS really reflect the performance of a multilayer barrier, and whether the equations used in the simulation really portray how water will or will not move through the barrier (Letter Number: 5-DOI).

Response:

The model results represent the general performance features of the multilayer barrier with respect to rainfall, plant water intake, and infiltration into (and drainage through) the barrier for the specific conditions indicated. The equations were developed from the fundamental physics and hydraulics of the system. An updated version of the model has been benchmarked and verified for numerical correctness (see Fayer, Gee and Jones 1986) and represents the best available understanding of soil water flow at the present time.

3.5.1.61 Comment:

One reviewer noted that, although the types of input data for the modeling are presented in Section M.5.1.1, a list of the actual values used in the simulations is not presented (Letter Number: 215).

Response:

Example input data and example calculations for modeling are listed in the report by Fayer, Gee and Jones (1986).

3.5.1.62 Comment:

One reviewer noted that Table M.7 does not list mass balance errors associated with each simulation. The final EIS should list the input parameters and grid information used in the simulations and also the mass balance errors (Letter Number: 215).

Response:

Mass balance errors are stated in Section M.5.2.1. As indicated in the text, the mass balance is obtained simply by subtracting the sums of the drainage, evaporation/transpiration, and storage change from the precipitation; hence, it is available from the data provided in Table M.7. Examples of input parameters and grid spacing used in recent modeling of the barrier are available in the report by Fayer, Gee and Jones (1986).

3.5.1.63 Comment:

One reviewer commented on Section M.5.2.4 and requested some discussion regarding the two-dimensional aspects of plant/root uptake of moisture (Letter Number: 215).

Response:

Ideally, three-dimensional data are needed to quantify effects of water movement at a waste site. Unfortunately, only limited data are available at this time. One-dimensional modeling provides insight into the mechanisms involved in the water dynamics (e.g., evaporation, redistribution, drainage) that occur at a waste site. As two- and three-dimensional data become available from the Barrier Development Program (Adams and Wing 1987), these data will be incorporated into the working models of the Hanford Site.

3.5.1.64 Comment:

A reviewer commented on the results of various simulations of the moisture barrier performance reported in Table M.7 and Section M.5.2.1, and pointed out that in only one of the four test cases involving 1.5 m of fine soil were results reported for enough years to establish equilibrium between yearly precipitation and drainage plus evapotranspiration. The reviewer requested results for cases 2, 3 and 6 (Letter Numbers: 215, 223).

Response:

Two cases (4 and 5) with 1.5 m of fine soil were run with hourly input for a one-year period; this year was then repeated to 16 years. Years 15 and 16 were identical in water balance components (i.e., storage, drainage and evapotranspiration), indicating that an equilibrium water condition had been reached. The other cases also show the trends and reflect less severe cases of water distribution or plant cover. Additional cases will be run with other climate, soil, and plant inputs as part of the Barrier Development Program (Adams and Wing 1987).

3.5.1.65 Comment:

A reviewer noted that a discussion on simulated cover systems is included in Section M.5.2.1, and wanted to know how the drainage data were derived. The reviewer also wondered whether actual barriers would be constructed for testing before commitment to disposal implementation. Another reviewer thought that drainage would occur very differently from the projection described in the draft EIS (Letter Numbers: 215, 223).

Response:

The drainage data were obtained from UNSAT-1D model results using the Richards equation methodology described in detail in Appendix M. The Barrier Development Program (Adams and Wing 1987) is designed to test for water infiltration and drainage from experimental barrier systems before commitment is made to a specific barrier design. Actual barriers will be constructed for test purposes.

3.5.1.66 Comment:

One reviewer commented on Section M.5.3 and observed that uncertainties in modeling call for the demonstration of the protective barrier in a pilot model instrumented to monitor moisture movement. The reviewer also noted that average annual pan evaporation rates should be included as part of the barrier performance evaluation; water budgets cannot be assessed without them (Letter Number: 215).

Response:

This activity is being planned as part of the Barrier Development Program (Adams and Wing 1987). Field tests and large instrumented lysimeters will be used to measure water balance parameters of the test barrier. Average annual pan evaporation rates are useful in agriculture, but would not be appropriate for accurately estimating combined evapotranspiration from soil and plant surfaces as required in the development of barriers. The method provides a simple measure of maximum evaporation rate but in a non-agricultural setting in an arid climate would usually result in a negative water balance, that is, would predict more water evaporated than fell.

3.5.1.67 Comment:

One reviewer wanted to know how apparent contradictions in references cited in Section M.5.1.2 of the draft EIS affect the simulation results in drainage test cases 2, 3 or 6 in Table M.7 (Letter Number: 223).

Response:

Appendix M was written independently of recharge assumptions; hence, they do not affect the simulation results.

3.5.1.68 Comment:

A reviewer noted that the draft EIS did not consider barometric pressure and/or vapor transport mechanisms (Letter Number: 223).

Response:

Thermal and pressure effects were not considered because the thermal gradients, at the depth of the gravel interface, are expected to be small in comparison to capillary pressure gradients. At greater depths, the geothermal gradient is expected to be so small that induced vapor flow would account for less than 0.1 mm/yr. The soil is expected to be unsaturated, so effects of atmospheric pressure fluctuation are insignificant. Thermal effects under actual field conditions will be evaluated in the Barrier Development Program (Adams and Wing 1987).

3.5.1.69 Comment:

Reviewers commenting on Section M.4 noted that the method for combining the individual protective factors to obtain an overall risk either is not appropriate or requires further documentation. The method for combining the individual protective factors should accommodate the possibility that a single primary cause might render two or more of the protective mechanisms ineffective. One of the reviewers noted that the reported risk reduction factors require further documentation and collaboration with other experts before the final EIS is completed. This procedure is also expected when specific alternatives and designs are proposed (Letter Numbers: 239-NRC, 243-EPA).

Response:

Risk reduction factors attempt to provide a rough indication of the usefulness of markers, barriers and passive institutional controls (such as land-use records) in reducing the likelihood of intrusion. Because of the subjective nature of assigning risk reduction factors, the number of intrusions into wastes were developed and used in determining radiological impacts both with and without the use of risk reduction factors.

3.5.1.70 Comment:

A reviewer noted that in the discussion of plant cover reported in Section M.5, a cheatgrass growing cycle of 152 days is reported; however, the cited reference reports 70 days. The reviewer asked why the transpiration cycle was lengthened and what effect this would have on the simulation of the test cases 2 and 3 in Table M.7 (Letter Number: 223).

Response

Cheatgrass actually begins growing in the fall; hence, it has a longer growing cycle than 70 days (Harris and Campbell 1981). The longer cycle was felt to be more realistic. Because the growth period simulated for the extended time was during a period of low potential evapotranspiration, little effect, if any, is expected on cases 2 and 3 in Table M.7. The transpiration component presently used in the model underpredicts actual transpiration, and thus is conservative, even for the 152-day growing cycle. Measurements of seasonal and annual transpiration rates of grasses and shrubs at the Hanford Site have been initiated (Adams and Wing 1987). See also comment 3.5.1.54.

Precipitation, Infiltration and Recharge Rates

3.5.1.71 Comment:

Reviewers commented that the recharge rates used to analyze long-term performance were not conservative. One reviewer commented that assumptions were far more conservative than the environment could reflect (Letter Numbers: 215, 223. Hearing Number: 342).

Response:

Average annual recharge rates vary from 0 to nearly 16 cm/yr, depending on the cover conditions (soil and vegetation) and the precipitation pattern (amount and distribution). The use of 0.5 cm/yr was considered to reflect conditions that exist under current normal precipitation and adequate soil and vegetative cover. Elevated recharge occurs when increased precipitation is incident on bare surfaces or coarsely textured, sparsely vegetated surfaces when potential evapotranspiration is low. Long-term performance was also modeled at 5-cm/yr average annual recharge and up to 15-cm/yr infiltration through the wastes.

3.5.1.72 Comment:

A reviewer noted that the fine-soil characteristic curve shown on Figure M.4 displays an unusually sharp change in slope at a capillary pressure head of about 1,000 cm. The reviewer also inquired about the magnitude of hysteresis in this soil, the probable effect of incorporating hysteresis in the analysis of barrier performance, and the basis for selecting 1.5 m as the design thickness of the upper fine soil layer (Letter Number: 223).

Response:

Figure M.4 has been redrawn to reflect the more continuous functional relationship between pressure and water content for the fine soil. Hysteresis observed in laboratory soils tests is considered to be of second-order importance in actual field situations; hence, it was not included in the analysis. (See Nielson, van Genuchten and Biggar 1986 for a discussion of hysteresis in unsaturated soils.) The conceptual 1.5-m depth was selected in part by application of standard reclamation practices and knowledge of typical root-zone water storage considerations, and also on the basis of computer modeling cases which evaluate various barrier soil layer thickness. The actual thickness selected will be based on field data; the 1.5-cm depth is, at this time, conceptual only. (See Appendix M for further discussion.)

3.5.1.73 Comment:

The range of average annual recharge to the system is from 0.5 to 5 cm/yr. On the basis of work done by Gee and Kirkham (1984), these rates appear to be low. Since precipitation at Hanford is approximately 15 cm/yr and is predominantly accumulated in the winter months as snowfall, the analyses of impacts based on these estimates should be revised to handle a larger range of recharge values (Letter Number: 215).

Response:

The average annual recharge of 0.5 to 5 cm/yr on the 200 Areas plateau represents about 3% to 30% of annual average precipitation. It is believed that these figures reasonably bound the actual values. However, in the case of barrier failure where evapotranspiration might be reduced or absent, a recharge of 15 cm/yr was also used in impact analysis.

3.5.1.74 Comment:

The postulated "functional" barrier failure is not adequately conservative. Inasmuch as 0.1 cm/yr infiltration is only 1/300th of the assumed 30 cm/yr rainfall, this scenario represents a rather insignificant failure. It would be more appropriate to assume that a larger percentage of rainfall, perhaps 10%, infiltrates the barrier (Letter Number: 215).

Response:

The 0.1 cm/yr average annual recharge over 50% of the waste was postulated to simulate a barrier failure resulting from use of materials that were not up to specification. It was considered a "more likely" failure mode but was not postulated as a severe failure. The disruptive failure, while seen as less likely, was postulated to be more severe in terms of precipitation infiltration; 50% of precipitation infiltrated the waste. The disruptive failure that was considered involved 10% of the waste and, to a first approximation, multiplying impacts of that failure by 10 would yield impacts for 100% involvement of 50% of 30 cm/yr precipitation.

3.5.1.75 Comment:

One reviewer wanted to know how extreme and/or closely spaced precipitation events affect barrier performance and whether the frequency distribution of such events was analyzed and incorporated in the simulation. Another reviewer inquired why, in Section M.5.2.2, potential evapotranspiration was assumed to be higher during the rainfall condition. This reviewer also felt that rainfall distribution should have been clearly documented and a comparison made to demonstrate that modified-climate events of extreme precipitation have been incorporated in the modeling (Letter Numbers: 215, 223).

Response:

As indicated in Appendix M, the barrier performance depends on precipitation distribution and intensity. This can be modeled. The 1947 and 1948 years used to simulate climate each had more than 50% above normal precipitation; hence, they had above-normal precipitation events and the actual potential evapotranspiration for three years was used. The Barrier Development Program (Adams and Wing 1987) will both model and measure effects of elevated precipitation and extreme-event scenarios on barrier performance.

3.5.1.76 Comment:

One reviewer commented on the discussion in Section M.5.2 and asked whether it was assumed that potential evapotranspiration would remain the same as it is at present, even if the climate became wetter, and, if this assumption was made, what the rationale was (Letter Number: 223).

Response:

The assumption of potential evapotranspiration (PET) was not made. The model is constructed to account properly for the PET changes with time. If wetter climate information is available, it can be used to determine the PET for the corresponding wetter climate.

3.5.1.77 Comment:

A reviewer wanted to know if the combined effects from decreasing cheatgrass transpiration to 70 days, increasing precipitation to 32 cm/yr, and reducing potential evapotranspiration (PET) for a wetter climate would result in significant drainage through the moisture barrier in test cases 2, 3, or 6 (Letter Number: 223).

Response:

Reducing wintertime plant transpiration and modifying the PET to correspond to wetter conditions would not have a significant effect on drainage if the climate were similar to that simulated (30 cm/yr) for test cases 2, 3 and 6. Under those conditions the soil and plant properties appear adequate to enhance annual water cycling. Increased precipitation under generally arid site conditions favors increased plant growth, enhancing evapotranspiration and surface water losses. The wetter climate condition and extreme event effects on barrier control of infiltration will be tested under the Barrier Development Program (Adams and Wing 1987).

3.5.1.78 Comment:

A reviewer stated that DOE misinterpreted the findings of Kirkham and Gee (1984), noting that those authors found that significant drainage (recharge) can occur through the root zone to the unconfined system; an amount that the draft EIS interprets as "small"; and, furthermore, that for nonvegetated soil, nearly half of all the annual precipitation is recharged. The reviewer said this is not "small" and urged the use of more conservative estimates of coarse-grained soil recharge. According to another reviewer, previous studies that suggest no recharge (p. 4.18) are questionable (Letter Numbers: 215, 243-EPA).

Response:

The Kirkham and Gee (1984) report indicates that during a wet year, i.e., above normal rainfall conditions, there are sites where recharge may occur. The report does not indicate that one-half of the annual precipitation is lost to recharge. In the absence of shrubs and deep-rooted perennial grasses, significant quantities of recharge (up to as much as one-third of the annual precipitation) may move below the root zone. In contrast, in the presence of deep-rooted plants, nearly all the water is lost to evapotranspiration. A recent report (Fayer, Gee and Jones 1986) indicates that in the 200 Area where deep-rooted plants are present, eventually all the water--to the limits of measurement--is lost to evapotranspiration. The key features that control drainage are plant cover, soil type, and climate. All three factors must be considered before generalizations can be made. The references cited on p. 4.18 simply present the range of documented recharge information which does give evidence of "no downward percolation" under some conditions.

3.5.1.79 Comment:

One reviewer commented on Section M.1.1 and pointed out that such processes as vapor transport, flow along thin films of water, and intense, episodic precipitation (thunderstorms, snowmelts) might contribute to processes that could affect barrier performance (Letter Number: 215).

Response:

Numerous processes will affect barrier performance. Flow rates due to vapor transport (nonisothermal processes) are relatively low (often much less than 10^{-3} mm/yr). Episodic precipitation will probably have the most pronounced effect.

3.5.1.80 Comment:

A reviewer commented that inadequate consideration has been given to the analysis of erosion scenarios due to local intense precipitation, and recommended that a mixed rock/soil cover be considered. The rock cover should be designed for an occurrence of localized intense precipitation (Letter Number: 239-NRC).

Response:

Tests of rock and gravel admixtures into the fine soil, and evaluations of the impact of these admixtures on water infiltration and erosion, are important studies under way that are being considered in the Barrier Development Program (Adams and Wing 1987).

3.5.1.81 Comment:

Reviewers had the following comments: 1) The assumed maximum annual precipitation (Appendix M) is 30.1 cm, with two cases covering maxima in spring and fall. This figure has been approached within recent years, and much wider swings are observed in tree rings going back several hundred years. Established scientific methods backcast for a million years, and they forecast times within the 10,000 year period when climates will be warmer and wetter, then cooler and highly variable due to the onset of a glacial period. The effect of prolonged heavy storms, documented in the Los Alamos reports, is not modeled, yet it will probably dominate barrier performance. The final EIS should reexamine this issue, using a more informed estimate of precipitation events. 2) There is no reference to support the draft EIS statement that "The 100-year maximum precipitation is considered a reasonable estimate for the mean value of precipitation in a future climate scenario at Hanford (Kukla 1979)" (Letter Numbers: 171, 223).

Response:

1) The figure of 30.1 cm precipitation is the estimated 100-year recurrence precipitation under the present climate. That value was assumed for purposes of future climate scenario development to be the "average" annual precipitation. If the distribution in the future climate scenario were similar to that of the present climate, the extreme associated with the 30.1 cm would be about 60 cm. Tree ring, fossil pollen and earth orbit perturbations were considered in terms of the ability to reasonably predict future climate. For present purposes it was concluded that even if future climates could be predicted with certainty, the matter of infiltration of precipitation into wastes and recharge that carried the wastes to groundwater would remain unresolved due to the complicating factors of vegetation and evapotranspiration. As a consequence, recharge was treated parametrically. The Los Alamos experience is referred to in the revised Appendix M and is being taken into account in the Barrier Development Program (Adams and Wing 1987).

2) The draft EIS statement was not intended to imply that a "100-year maximum" method was used to predict future climate. Rather, it was intended that a mean value of 30.1 cm/yr, as used in the analysis, was a possible future climate condition and that Kukla (1979) has suggested that a wide range of precipitation (0.5 to 2 or 3 times present values) was possible under various scenarios. A large uncertainty exists in predicting future Hanford climate. The final EIS has been revised at Appendix M to clarify this point. An evaluation of climate change and its effect on barrier performance is a part of the Barrier Development Plan (Adams and Wing 1987).

3.5.1.82 Comment:

One reviewer felt that the subsidence methodology described on page 3.21 is suspect. If empty tanks are filled with grout, there would probably be no problem with them. If they are filled with soil, gravel, or sand, however, there is the possibility of compaction due to shaking by small earthquakes over the centuries, leaving a void at the top of the tank. Subsidence of the barrier may then occur when the top of the tank eventually collapses (Letter Number: 223).

Response:

The subject text was meant to describe options. In response to the comment the phrase "singly or in combination" has been added. In practice it may be best to first lay in gravel in the tanks to provide space within which the semi-solid and liquid wastes could move (rather than having them migrate to the top of the fill) followed by a capping of grout to finish the tank fill.

Barrier Failure and Disruptive Scenarios

3.5.1.83 Comment:

Reviewers noted that Section M.5.4 of the draft EIS does not discuss biointrusion, nor was it included in any of the diagrams in Section M.3.2. Reviewers commented that biointrusion should be minimized and included in testing (Letter Numbers: 217, 223, 239-NRC. Hearing Number: 606).

Response:

Section M.5.4 discusses barrier cover disturbances but does not treat biointrusion as a barrier failure mechanism. Biotic transport is discussed in Appendix R, Section R.5.2. A discussion of testing to be done in conjunction with the barrier development program that relates to the effects of roots and animal burrows in the top 1.5 meter of top soil of the barrier on water infiltration is presented in Section M.7 of the final EIS. The barrier as described is designed to preclude the animal and root pathway. Although not considered a significant factor in routine dose calculations, the possibility of biointrusion is included in the analysis of barrier failure scenarios.

3.5.1.84 Comment:

Reviewers expressed concern with the discussion of biointrusion in Section M.3.2 and commented that the barrier would become ineffective following the intrusion by plants and animals through the fine soil layer. One reviewer also pointed out that references cited in the draft EIS indicate a number of plant and animal species that could readily penetrate the upper 1.5 m of soil. A reviewer inquired into the likely effects of large pores on the performance of the moisture barrier, particularly in combination with local catchment basins formed by erosion or subsidence due to barrier settlement or tank collapse (Letter Numbers: 171, 219, 223).

Response:

Section M.3.3 has been revised to reflect the issue of annual plant intrusion into barriers. Moreover, biointrusion is a major component of the Barrier Development Program (Adams and Wing 1987). Biointrusion through the fine soil layer is unlikely but possible under certain conditions. Subsidence, for example, is a condition that under extreme rainfall/snowmelt could cause infiltration and/or enhance biointrusion through the fine soil. A critical aspect of the analysis is the periodicity of these events. Barrier tests to failure, using elevated precipitation and subsidence phenomena, are planned under the Barrier Development Program (Adams and Wing 1987).

3.5.1.85 Comment:

One reviewer noted that Section 3.3.4.1 mentions the potential for release of radioactive particulate matter as a result of the collapse of tank domes. The reviewer asked what effect dome collapse would have on settlement and failure of the protective barrier (Letter Number: 223).

Response:

Section 3.3.4.1 deals with the no disposal action alternative in which there are no barriers placed over wastes. In the disposal alternatives the tanks are filled with gravel or other material to prevent tank dome collapse.

3.5.1.86 Comment:

One reviewer commented that the failure scenario postulated in Sections M.5.20 and M.5.21 of the draft EIS suggests a 50% loss of soil cover that would result in exposure of 10% of the underlying waste, when in reality a larger volume of waste would be affected due to leaching and moisture (Letter Number: 223).

Response:

It was intended that loss of soil, in whatever amount, over the waste was modeled such that 10% of the waste was exposed to infiltration of 50% of an annual average precipitation of 30.1 cm/yr.

3.5.1.87 Comment:

A reviewer commented on Section M.6.2 and noted that the value of 0.1 cm/yr recharge was chosen arbitrarily, and that the choice of a value that may occur under normal conditions is inadequate for use in simulation of a barrier failure scenario (Letter Number: 215).

Response:

The functional failure scenario was arbitrarily defined as 50% of the barrier allowing 0.1 cm/yr of water to infiltrate the waste under precipitation conditions of 30 cm/yr. Under normal (arid climate) conditions, for the cover system described in Appendix M, no recharge is expected. Barrier failure, if it occurs, will probably be episodic. Hence, failure may occur once every 100 or 1000 years with the expected net effect being a recharge to the groundwater of less than 0.1 cm/yr, since drainage through the thick unsaturated zone will dampen any episodic drainage events that might occur. Additional extreme events will be evaluated under the Barrier Development Program (Adams and Wing 1987).

3.5.1.88 Comment:

One reviewer pointed out that in Section M.5.4, the subsidence of the barrier was considered only for the tanks, not for the pre-1970 buried transuranic waste. The reviewer suggested that the proposed grouting solution to this problem should be investigated along with tank stability research (Letter Number: 215).

Response:

Both grouting and tank stability research for both tanks and burial grounds are part of the Interim Hanford Waste Management Technology Plan (DOE 1986a). Issues related to subsidence and its effect upon barriers will be evaluated in the Barrier Development Program (Adams and Wing 1987).

3.5.1.89 Comment:

One reviewer noted that, in Section 0.3.1.2, no basis is provided for the assumption that 50% of incipient precipitation would infiltrate the basalt riprap and that this infiltrating water would directly contact 10% of the waste (Letter Number: 215).

Response:

The choice of 50% incipient precipitation infiltrating the waste under the "disruptive failure" scenario is based on the reasoning that--under extreme conditions (i.e., removal of some of surface soil)--infiltration into riprap could occur. The amount of infiltrating water that will contact the waste directly is not known and must be estimated because the system is a dynamic one. Wind removal will probably be offset with depositional materials. Ashfall (volcanic activity) has occurred a number of times at the Site during the past 10,000 years and is likely to occur again. These deposits lessen the severity of a single disruptive event, so that the effect is only a transient one. The 10% value was an arbitrary choice for waste area contacted. It was assumed that disruptive events such as wind scouring or subsidence would only affect a small fraction of the total cover area. Evaluation of disruptive events (wind and water erosion, subsidence, etc.) is part of the Barrier Development Program (Adams and Wing 1987).

3.5.1.90 Comment:

Reviewers wanted to know whether backup protection will be provided in the event that the fine-soil barrier should be removed, and what would prevent contaminant migration to water systems (Letter Numbers: 44, 214, 217).

Response:

No reasonable scenario was developed in which total fine-soil removal was considered. Therefore, no backup protection was provided. However, redundant barriers, such as asphalt or compacted clay placed below the riprap, have been considered and will be evaluated in the Barrier Development Program (Adams and Wing 1987) if found to be necessary.

3.5.1.91 Comment:

Reviewers commented that the 50% functional barrier failure in Section 5.21 is described in contradictory terms. The reviewer noted that 0.1-cm infiltration based on the projected 5-cm/yr recharge potential under wetter conditions does not seem proportionate for a 50% failure scenario (Letter Numbers: 171, 223).

Response:

The final EIS has been revised to remove the apparent contradiction.

3.5.1.92 Comment:

One reviewer commented on Section M.5.4 of the draft EIS and questioned why vibrations and earthquakes that would impact a protective barrier are considered highly unlikely to occur (Letter Number: 223).

Response:

Natural analog studies indicate the presence of stable layer formations (i.e., fine soil over cobble/gravel) that have persisted for over 10,000 years on the Hanford Site. This longevity suggests that layered soils are either stable under the Hanford seismic environment or that minimal vibrations have occurred. Under the Barrier Development Program (Adams and Wing 1987), the stability of the barriers will be tested for seismic and other vibrations.

3.5.1.93 Comment:

One reviewer commented on Section M.5.4 and noted that vibration and shaking from repository construction may weaken the protective barrier if the repository is constructed on the Hanford Site in proximity to the 200 Areas (Letter Number: 215).

Response:

There is no evidence that construction activities (drilling, etc.) will have impacts on the protective barrier. Tests will be conducted as part of the Barrier Development Program to confirm that the barrier will be stable under a variety of seismic and construction-induced vibrations.

3.5.1.94 Comment:

A reviewer questioned how the basalt riprap described in the Chapter 1 discussion of barriers would discourage farming if there were 5 feet of soil over it. The reviewer thought that above-ground markers have the best chance of discouraging intrusion (Letter Number: 243-EPA).

Response:

As the reviewer has noted, the above-ground markers provide the best chance of discouraging intrusion. Moreover, the soil over the barrier is not likely to be superior to other nearby soil and, if it were necessary to haul farm equipment up the 45-degree riprap slope to the top of the 17-foot-high barrier, farming atop the barrier could well be seen as not worth the effort.

3.5.1.95 Comment:

One reviewer noted that the failure scenarios analyzed for the protective barrier were inadequate, such as the continuing erosion of the system once failure has occurred (Letter Number: 177).

Response:

Scenarios were selected that were considered realistic but conservative. Additional research concerning the effects of erosion on the barrier is planned under the Barrier Development Program (Adams and Wing 1987).

3.5.1.96 Comment:

One reviewer commented on a reference by Bander (1982) cited on p. M.24 of the draft EIS and asked whether there is evidence to support a lower rate of erosion for the type of soil proposed for the protective barrier (Letter Number: 223).

Response:

Bander cited high erosion rates (several cm/yr) for tailings piles in Colorado. The protective barrier surface soil will consist of vegetated fine soils (e.g., silts or silt loams). Tailings materials (typically fine sands) are not silt loams; they have entirely different wind erosion potential. Studies being conducted under the Barrier Development Program (Adams and Wing 1987) will investigate wind erosion rates of fine soil (even unvegetated) under Hanford Site climatic conditions. The rates of erosion are being determined by wind tunnel testing.

3.5.1.97 Comment:

One reviewer commented on Section M.4 and noted that the final EIS should provide a stronger basis to support the effectiveness of the proposed barriers as a deterrent to inadvertent intrusions (Letter Number: 239-NRC).

Response:

Risk reduction factors were used in the draft EIS in an attempt to provide some indication of the usefulness of markers, barriers and passive institutional controls in reducing the likelihood of intrusion. Because there is little basis for the values used, impacts were also estimated and presented where no credit was taken for risk reduction factors, under the assumption that they were totally ineffective.

3.5.1.98 Comment:

A reviewer noted that the draft EIS assumes less than one intrusion into the waste will occur in the 10,000-year regulatory period and suggested that a more realistic estimate should be made. Another reviewer pointed out that it only takes one exception to this assumption to permanently disrupt the barrier (Letter Numbers: 215, 218).

Response:

Although fatal intrusion was estimated to be no more than one, multiple intrusions over 10,000 years were calculated (see Table S.6). In addition to a rather low probability of drilling, the period in which drilling would be fatal was less than 500 years and applied only to cesium capsules. Therefore, the DOE believes that the estimate of intrusions with fatal consequences is realistic. Where a drill has penetrated through the barrier and through the waste, a path would be made for infiltrating water. However, the impacts resulting from such a pathway would surely be bounded by the disruptive barrier-failure scenario.

3.5.1.99 Comment:

Reviewers commented on p. M.16 and Table M.7 of the draft EIS and noted that the cited references and information given did not support the claim that multilayer covers can be designed to prevent or minimize water infiltration into the waste and limit biotic and human intrusion (Letter Numbers: 171, 223).

Response:

The text of the final EIS has been revised to reflect the fact that barrier tests at Los Alamos National Laboratory and elsewhere suggest that the multilayer barrier may have application for infiltration and biointrusion control, but must be tested on a site-specific basis. Such testing is planned.

3.5.1.100 Comment:

Reviewers noted that the protective barrier is unlikely to stay in place because of winds and range fires and probable climate change. Another reviewer did not find a discussion of range fires in the draft EIS (Letter Numbers: 44, 57, 223).

Response:

Impacts from fire (denuded surface of barrier), wind and climate change were considered in Appendix M. Although wind and initiation of lightning-induced range fires cannot be controlled, research efforts to evaluate more fully their effects are being initiated under the Barrier Development Program, as outlined by Adams and Wing (1987).

3.5.1.101 Comment:

One reviewer questioned the reliability of the multilayer protective barrier system for the shallow burial sites. The reviewer's concerns are with water intrusion from increased irrigation in the future, with change in the water level of the Columbia River Basin from the removal of dams, and with weather pattern changes (such as an arid period) that result in the death of vegetation on the barrier, followed by wind removing the soil. Already, in two different locations in the 200 Areas, harvester ants and termites have burrowed into waste and resurfaced radioactivity (Letter Number: 64).

Response:

Because no waste site at Hanford is presently covered with a protective barrier, intrusion by plants and animals, including ants and termites, is currently possible. The barrier is designed to minimize these intrusions. There is evidence from the Los Alamos studies (Perkins and Cokal 1986; Hakonson 1986; Nyhan et al. 1986) that multilayer protective barriers can provide adequate control from infiltration and biointrusion. As stated previously, additional research on infiltration and biointrusion is planned for barrier performance. Intense irrigation on top of the barrier as presently practiced might lead to infiltration of water into the waste sites. If the Columbia Basin dams were gone, the water level of the Columbia River would decrease at present impoundment areas but would not likely affect conditions on the 200 Areas plateau. Floods (except glacial) would not reach the elevation of the plateau. In a severe drought some soil might be removed, but experience in the area suggests that incoming windborne soils are likely to deposit on the barrier. That is, graveled landscaping tends to fill with windborne soil.

3.5.2 Geohydrologic Transport

This section includes comments received on areas pertaining to geohydrologic transport. Because of the volume of comments received on this topic, this section has been divided into a number of subheadings: General, Modeling, Travel Time/Retardation, Release Rates, Migration, Vadose Zone, and Climate. Comments pertaining strictly to groundwater concerns have been placed in Section 3.5.3.

General

3.5.2.1 Comment:

A reviewer wanted to know if the various radionuclides have different inherent mobilities; whether the relative mobilities change with changing climatic conditions; and whether these mobilities have peculiar implications for the final selection of the waste disposal option (Letter Number: 171).

Response:

Various elements have different inherent mobilities. The relative mobilities probably do not change with expected changing climatic conditions. Although a humid climate is not expected, the principal difference with climate change (wetter) is the potential for more infiltrating water with which to leach wastes and transport them to the accessible environment. Implications of mobilities are important in consideration of disposal options. For example, radionuclides of short half lives and low mobility disposed of near surface would not reach the accessible environment; radionuclides of very long life (e.g., a million years) disposed of near surface would reach the accessible environment eventually regardless of low mobility.

A substantial amount of research, currently planned in part by the BWIP and by the Barrier Development Program (Adams and Wing 1987), will be necessary to resolve some questions of the potential effects of climatic change on relative mobilities. Although little is known about the climate and biomass variability at Hanford, it is probably not credible that the Hanford climate will change to one of humid climate/vegetation if future climatic variability estimated from past data and from Milankovitch models is valid. Rather, a similar vegetative community with perhaps different ratios of similar species seems to be most likely. In such a case, there probably would be no climatic effect on hydrogeochemistry and hence on the relative mobilities of radionuclides.

3.5.2.2 Comment:

A reviewer pointed out that the statement that unconfined aquifer sediments are well weathered is unsubstantiated (Letter Number: 243-EPA).

Response:

The statement has been removed from page 0.35.

3.5.2.3 Comment:

A reviewer asked for clarification of the Richards equation and suggested that the assumption that the soil moisture profile will drain to equilibrium in a negligible time is tenuous (Letter Number: 243-EPA).

Response:

Equation 0.1 (Section 0.4.1.1) of the EIS is a reduced form of the Richards' equation as described by Gardner (1958). Except where referenced, the remaining equations in this section are related to soil data fitting as described by Campbell (1974). An assumption implied, but not stated in this section, is that the waste will be beneath the barrier for 100 years before the assumed loss of active institutional control. This is the time that allows the equilibrium assumption to be applied. See also comment 4.2.43.

3.5.2.4 Comment:

Reviewers noted that only one geologic cross section (Figure 4.3) is presented, and that it is too generalized and exaggerated to present a proper perspective of the subsurface (Letter Numbers: 215, 231, 234).

Response:

Additional data are provided to assist the reader, including detailed cross sections through the 200 Areas (Tallman et al. 1979).

3.5.2.5 Comment:

One reviewer felt that unsaturated flow along the edge of and under the protective barrier is not presently understood and that DOE needs to re-evaluate its approach to analyzing this moisture movement. The reviewer questioned the redistribution of moisture present in the soil when the barrier is placed and asked whether it might migrate significantly downward. The reviewer advocated using the 5-cm/yr basis for making this judgment (Letter Number: 215).

Response:

Appendix O has been revised in response to these comments. New modeling techniques are being developed that hold promise for analyzing these very difficult physical and mathematical problems involving moisture movement in large-scale, low-moisture, coarse-grained soils. Redistribution of the moisture in soils of low moisture content, as will occur beneath a barrier, is a long-term transient problem also included in the modeling research.

Modeling

3.5.2.6 Comment:

Several reviewers commented on various aspects of the radionuclide transport modeling in the draft EIS. The level of realism or conservatism of the models and assumptions or data used as input to the models was the main thrust of most comments. There was concern that the models were simplistic and did not account for all factors that could influence transport such as geochemical conditions, kinetics of sorption-desorption, solubility and transverse dispersion. Reviewers addressed what they regarded as nonconservative assumptions and data input to the models--including boundary conditions, hydraulic conductivity, advective transport, recharge rates, retardation factors, diffusion coefficients, release rates, and chemical complexing with radionuclides--which point to the need to strengthen groundwater modeling and analysis (Letter Numbers: 147, 171, 215, 217, 223, 231, 234, 239-NRC).

Response:

More conservative values could be chosen for some parameters used in the draft EIS. However, where values could be supported by available data, they were used; where values could not be supported by available data, conservative values were used. This recipe for impact analysis is believed to lead to a bounding analysis which would provide impact estimates not likely to be exceeded in actual practice.

Conservatism in terms of release and transport parameters used in the draft EIS is based on an understanding of the waste chemistry, past operations practices, and contaminant mobility studies. Release and transport parameters (maximum contaminant concentrations and distribution coefficients) utilized in the draft EIS are conservative, considering the chemical conditions of the waste form and the Hanford Site environment. To gain a more thorough understanding of how maximum contaminant concentrations and distribution coefficients were chosen for various waste forms, a brief review of the references utilized in the derivation of these parameters is presented below.

Maximum contaminant concentrations used for release of radionuclides and certain hazardous chemicals (except cadmium and fluoride) in the draft EIS were taken from Schulz (1980). The objective of the Schulz report was to identify radionuclide removal techniques for various Hanford defense waste solutions and dissolved saltcake. The solutions and dissolved saltcake samples were taken from some of the most highly concentrated wastes at the Hanford Site.

Since treatment of tanked wastes was prescribed for only the most highly radioactive wastes contained in single- and double-shell tanks, these were the solutions Schulz chose for his laboratory evaluation of radionuclide treatment techniques. Table I describes the characteristics of the tanked wastes analyzed for Schulz. The characteristics listed in Table I provide additional background on the relative potential hazard of tanked waste at the Hanford Site. These characteristics were used to select a site for in situ disposal demonstration of single-shell tanks. Only tanks containing wastes with no highly hazardous characteristics were candidates for the in situ disposal demonstration project. This implies that tanks with any of the four characteristics (high volume, high heat, high complexant, and high TRU) may represent a potentially higher risk than tank wastes without these characteristics. Definitions of each of these characteristics follow.

1. High-volume tanks contain wastes in excess of the amount necessary to exceed nominal tank capacity when the dome fill material is added.
2. High-heat tanks contain wastes that generate greater than 15,000 Btu/hr (4.4 kW). These wastes contain high fission product inventories and, hence, represent maximum activities for certain radionuclides.
3. High-complexant tanks contain in excess of 0.1% by weight organic carbon. Tanks with this characteristic are considered to contain radionuclides in their most mobile form.
4. High-TRU tanks contain in excess of 100 curies of transuranic isotopes.

TABLE I. Characteristics of Tanked Wastes Analyzed by Schulz (1980)

Salt Cake Solutions	
116-TX	High volume
105-B	High heat, high volume
105-S	No distinguishing characteristics
108-S	High heat, high complexant, high volume
109-S	High heat, high complexant, high volume
110-S	High heat, high complexant, high TRU, high volume
102-S	High heat, high complexant
103-S	High volume
Hanford Liquid Waste Solutions	
110-S	High heat, high complexant, high TRU, high volume
106-U	No distinguishing characteristics
111-U	No distinguishing characteristics
102-S	High volume
118-TX	High TRU

A further review of Table I illustrates that for the most part Schulz analyzed and tested radionuclide removal techniques on wastes with high fission product inventories, high transuranic contents, and high complexant concentrations to increase radionuclide mobility. These tank wastes are considered to be among the worst-case chemical compositions. In the draft EIS, the maximum concentration of each constituent analyzed by Schulz was used as the release rate for all single-shell tanks. Thus, overall release rates are considered to be conservative.

Past operations practices also need to be reviewed to put the issue of conservatism into proper perspective. Over the past 40 years a variety of chemical processes have been used to process irradiated nuclear fuel. A summary of these processes is given in ERDA-1538 (ERDA 1975) and DOE (1986a). Of particular interest are the chemical consumption inventories for various plants given in Volume II, Appendix II.1-F, of ERDA-1538. A review of the chemical consumption data suggests that many of the complexants expected to mobilize radionuclides were only used for the waste fractionation process at B Plant. Citric acid, ethylenediaminetetracetic acid (EDTA), and hydroxyethylenediaminetriacetic acid (HEDTA) were used at B Plant in the processing of self-boiling wastes stored in single-shell tanks and current acid waste from PUREX.

The waste fractionation process was not used before 1968 and neither were these complexants. The complexants were used to process certain wastes produced earlier than 1968, but not a large fraction of the wastes stored in single-shell tanks was reprocessed. Citric acid, HEDTA, and EDTA are known to complex cobalt, strontium, and americium (Delegard and Gallagher 1983). These facts indicate that only a small fraction of the wastes containing these complexants are stored in single-shell tanks and that only a few of the single-shell tanks contain these complexants. This EIS assumes that every single-shell tank includes these complexants and thus inflates possible mobility calculations. Although other complexants may be present in certain tank wastes, it is not expected that higher soluble concentrations of any radionuclide would exist than those assumed in the EIS.

Additional information about the REDOX process (DOE 1986a) suggests that most of the organic carbon contained in single-shell tanks may be methyl isobutyl ketone from the solvent extraction process. The REDOX process was used for fuels separation from 1951 to 1967. Most of the liquid wastes generated at REDOX were highly radioactive and were stored in tanks (DOE 1986a). Single-shell tanks servicing the REDOX Plant have the letter designation S or SX. Schulz (1980) analyzed eight tank wastes from tanks with the S or SX designation, and the highest concentration observed for each radionuclide in any tank was chosen to represent the concentrations in all tanks. Review of past processes also supports the contention that release and transportation parameters used in the draft EIS are conservative, because it can be shown that many of the single-shell tanks contain few complexants as well as insoluble sludges with lower release rates.

3.5.2.7 Comment:

One reviewer commented on transport and attenuation modeling, and requested that DOE demonstrate that the simplified models and assumptions are sufficiently realistic (or conservative) to support the decisions to be made using them. Noting that the draft EIS states that DOE is developing new models, the reviewer advocated using the new models to evaluate the accuracy of the simplistic models and ultimately incorporating the new models into future impact assessment calculations (Letter Number: 239-NRC).

Response:

Discussion of the models and assumptions in this EIS was intended to provide the demonstration requested. The analysis that is presented in the draft EIS was performed with the best available methodology and data. When the advanced transport and attenuation models are completed, they will be employed in the support of final disposal system designs and environmental assessments as required.

3.5.2.8 Comment:

Reviewers noted that a version of the TRUST model was used to attempt a simulation of two-dimensional ground water flow in the vadose zone, but that the writers were apparently unable to operate the model (Letter Numbers: 231, 234).

Response:

It is assumed that the comment refers to the model TRUNC, a version of TRUST. Scientists at PNL are experienced in operating the TRUNC code; however, application of the code to the problem of soil moisture movement in coarse soil beneath a protective barrier proved unsuccessful. The problem involved in applying TRUNC to barriered soils arises from the extremely dry soil regime of the Hanford Site, which requires a nonlinear model with fine spatial resolution. A subsequent effort to apply the UNSAT2 code to solve the transient moisture movement problem was also inconclusive. Currently, the Hanford Defense Waste Technology program is funding the development and testing of a multigrid code designed to solve the steady-state and transient cases of moisture movement beneath the protective barrier.

3.5.2.9 Comment:

Reviewers noted: 1) There are contradictory statements in Sections 0.4.3.2 and 0.4.3.5 as to how the TRANSS model accommodates the dispersion coefficient. 2) Because hydraulic flow velocities in the saturated zone are so high, they are relatively unimportant in the overall analysis of contaminant travel time. The concern should not be with the process used in calibrating the numerical model of the unconfined aquifer. 3) The weighting process for depth zones and the range of average values used in the analysis is questionable. 4) How does the use of more conservative retardation factors and diffusion coefficients affect travel times, first arrival, and peak concentrations for the various release scenarios? 5) Was the actual TRANSS model used in the transport modeling? 6) Attempts should be made to incorporate transverse dispersion effects into the transport model, considering the possibility of this actually resulting in faster-than-anticipated contaminant transport rates (Letter Numbers: 147, 217, 223, 243-EPA).

Response:

1. The TRANSS code employs a convective-dispersive equation with the dispersion coefficient set to a local-scale value adjusted for column length in the unsaturated zone. The saturated zone dispersive transport mechanism is modeled by a distribution of velocities and not the standard second-order dispersion model, even though the standard model is included.

2. The credibility of the overall analysis depends on all components of the system. Reliance of the TRANSS transport model on travel time predictions of the VTT groundwater code makes the calibration of VTT an important consideration. The TRANSS model relies on a two-dimensional conceptual model of aquifer hydraulics incorporated in the VTT code. Discrete depth zones are not employed in the analysis of water flow or contaminant migration.

3. It was not clear what parameter was being discussed in reference to the "range of average values." Consequently, information on hydraulic conductivity and travel times is provided. The vertically averaged hydraulic conductivity values used in the steady-state VTT model of the unconfined aquifer range from 10 to 10,000 ft/day. Travel time distributions used to simulate longitudinal dispersion vary tremendously and depend on source location, recharge rate, and point of public exposure (e.g., well or river). The shortest and longest water travel times used in the draft EIS analysis are 16 years and 550 years, respectively, for travel to the Columbia River from 200 Area sources. These values appear in different source/recharge scenarios. A typical range of travel times to the Columbia River used for contaminant migration from the 200 East Area under a recharge condition of 5 cm/yr is 16 to 24 years; under a 0.5-cm/yr recharge condition (assumed to be representative of current climate conditions) the range is 230 to 550 years.

4. In general, the use of more conservative retardation factors and diffusion coefficients leads to shorter travel times, earlier first arrivals, and greater peak concentrations for contaminants under investigation. The values of retardation factors and diffusion coefficients used in the EIS were chosen to provide for a bounding impact analysis; that is, more realistic factors and coefficients would be less conservative.

5. The TRANSS model was recently documented and released (Simmons, Kincaid and Reisenauer 1986).

6. Although transverse dispersion would not create faster longitudinal movement, its effects should be included in the transport analysis for completeness. However, such a model requires a tested and calibrated simulation code that can treat three-dimensional dispersion processes that include a transverse component. Moreover, the appropriate field-scale dispersion parametric data that are required by a more advanced model are not currently available for the Hanford Site. Development of this software and data is not deemed to be a high priority because the assessment presented is conservative and thus meets the present needs of this EIS.

3.5.2.10 Comment:

A reviewer asked how temperature-related dependencies have been addressed in the modeling of radionculide transport from leaking tanks (Letter Number: 223).

Response:

Temperature-related dependencies were not addressed in the modeling because solutions that might migrate from a tank would rapidly reach ambient soil temperature.

3.5.2.11 Comment:

An analytical, one-dimensional transport model was used to simulate contaminant transport through both the unsaturated and saturated zones. The model is referred to as a stochastic-convective model because it uses the dispersion term to simulate the random nature of travel time estimates along streamlines of flow. Reviewers found this section of Appendix O confusing, and suggested that an example calculation would aid in interpreting exactly how the model was used (Letter Numbers: 231, 234).

Response:

The contention apparently is that the model is characterized as stochastic-convective "because it uses the dispersion term of the (advection dispersion) equation to simulate the random nature of travel time estimates along streamlines of flow." In fact the stochastic-convective characterization arises because of the opposite reasoning; the random nature of travel time estimates is used to simulate the dispersion term. The theoretical-mathematical model employed in the draft EIS is based on the knowledge that dispersion is a description of the variation in solute arrival about the mean solute travel time. Thus, a direct estimate of the dispersion mechanism is made when one quantifies the random nature of travel time. Rather than make a single simulation of the transport pathway using a single, arbitrarily defined dispersion coefficient, a suite of advection-dominated simulations is made and then integrated in the TRANSS code to provide the transport simulation. The suite of advection-dominated simulations is selected to represent the travel-time distribution which characterizes the random nature of advecting transport.

Since publication of the draft EIS, the TRANSS code has been documented (Simmons, Kincaid and Reisenauer 1986).

3.5.2.12 Comment:

Reviewers noted that a constant dispersion coefficient based on dispersion through the unsaturated zone is used in both the unsaturated and saturated zones, but that nowhere in Appendix O or Q is the method of calculating the dispersion coefficient described (Letter Numbers: 231, 234).

Response:

The value of the dispersion coefficient used to simulate dispersion in the unsaturated zone was omitted in the draft EIS. The value of the dispersion coefficient used for the unsaturated zone flow in the EIS was 0.82 m^2/yr. In comparison to dispersion coefficients that might be applied to the saturated zone, the unsaturated zone dispersion coefficient is relatively low. Its use throughout the travel pathway (i.e., unsaturated and saturated zones) is required because an analytical model is employed which contains a diffusion-dispersion (i.e., second-order partial derivative) term. To set the dispersion coefficient to zero would violate constraints of the analytical solution. Thus, the relatively low value of the unsaturated zone dispersion coefficient is used throughout the simulation to 1) represent the dispersive mechanism in the unsaturated zone where travel-time variability is not quantified and 2) enable an analytical solution to the stochastic-convective model.

3.5.2.13 Comment:

A reviewer asked for more discussion in the EIS regarding the establishment of a constant dispersion coefficient over the entire flow system based on dispersion in the saturated zone (Letter Number: 215).

Response:

The problem with determining a dispersion coefficient for the unsaturated zone is the lack of sufficient field-scale measurements in soils. A recent literature review of field-scale physical solute transport processes by Waldrof (1985) concludes that it is reasonable to assume that longitudinal dispersivity should increase with the scale of the experiment and may depend upon other factors, i.e., soil type, soil heterogeneity, and moisture content. The report also states that because of the lack of data it is not possible to recognize any dependency on these factors.

A study of unsaturated zone transport using Hanford soils and a number of different tracer experiments in laboratory columns determined Peclet numbers to be in the range from 35 to 135 (Gee and Campbell 1980). The laboratory data needed to be adjusted because of the difference in scale. The dispersion coefficient used for the unsaturated zone flow in the EIS was 0.82 m^2/yr, which was calculated as follows assuming a Peclet number of 50 based on data from the two references:

$$\text{dispersion coefficient } D_e = (a)\ (v) \quad \text{where } v = L/t$$

$$\text{Peclet number} = L/a = 50$$

$$\text{dispersivity } a = 0.02\ L$$

$$\text{length } L = 64\ \text{m}$$

$$\text{time } t = 100\ \text{years}$$

then

$$D_e = 0.82\ m^2/yr$$

The length and time values represent the column length and travel time in the vadose zone used in the EIS for 5-cm/yr recharge.

3.5.2.14 Comment:

Reviewers felt that field evidence is absent or does not support model boundary condition assumptions concerning head along river boundaries (lateral) and (zero) water flux at an (underlying) "impermeable" boundary. A reviewer requested a detailed explanation of calibration and transmissivity value calculations.

The reviewer felt that the understanding of hydraulic conductivity distributions should be increased as rapidly as possible to allow calibration of the VTT model, and that confident simulations of contaminant transport should wait until the VTT model is fully calibrated.

Another reviewer commented that Section O.4.2 of the draft EIS discusses the travel time results of the VTT code in terms of longitudinal dispersion and transverse mixing. Dispersion and mixing have nothing to do with the calculation of average travel times (Letter Numbers: 215, 243-EPA).

Response:

Analysis of measurements and data analysis from dozens of observation wells adjacent to the Columbia River and numerous wells throughout the Hanford Site, as well as geohydrologic studies made over the past 40 years, confirm that the Columbia River is the baseline for the unconfined groundwater system underlying the Hanford Site; i.e., groundwater flows toward and into the Columbia River (Bierschenk 1959). There are times, when the stage of the river increases rapidly, that the water table gradient is locally reversed close to the river and river water enters the aquifer (bank storage); but this is a short-term effect. The U.S. Geological Survey Professional Paper #717 confirms this evaluation (Newcomb, Strand and Frank 1972). The river elevations along the Site provide an excellent boundary for the model because the sediments are permeable and groundwater elevations are higher than the river everywhere on the Site.

Based on potentiometric and stratigraphic considerations, it is concluded that the unconfined groundwater system and the confined aquifers are not interconnected, except for a small area north of the 200 Areas (see comments 3.5.3.14 and 3.5.3.16). The conditions where large volumes of water can be interchanged between the two hydrologic systems through basalt joints and fractures are not present on the Hanford Site.

The reviewer provides no reference to support for the contention that dispersion can act to increase transport rates over advective rates. The basic flow equations support DOE's contention that, for saturated flow in permeable media under gradients normally encountered in unconfined groundwater systems, longitudinal dispersion will not materially affect the rate of movement of contaminants in the system.

Water flux at the lateral aquifer boundaries was determined using the hydraulic gradient as measured in wells and the transmissivity data available under past water table conditions. During modeling, however, the future flux accumulated from an assumed upgradient area was applied to the boundary, and the potential surface and transmissivity were permitted to adjust iteratively to determine the new groundwater boundary elevation. The model was calibrated to the Site using a zero water flux across the underlying impermeable boundary. Head measurements in the confined and unconfined aquifers indicate the vertical flux. Most of the measured aquifer property data used in the groundwater model are discussed by Kipp et al. (1972, update 1975) and by Cearlock, Kipp, and Friedrichs (1975) referred to in Appendix O. The latest update to include new data occurred in 1982 (Eddy, Prater and Rieger 1983).

The numerical model (VTT code application) of the Hanford Site unconfined groundwater system has been calibrated and verified using comprehensive hydrologic field data collected over a period of more than 35 years. The model has been updated as new data on water level or transmissivity are collected from Hanford wells. The model is considered adequate to generate flow fields for the transport model in the EIS scenarios. While details of calibration and transmissivity could be discussed on an individual basis, to include them in the EIS would result in unwarranted detail.

Sections 0.4.3.1 through 0.4.3.6 give a detailed discussion of how the transport model operates and the role of the VTT-derived model in providing the flow field data. The point that was being made on page 0.26 was out of place and has been moved to Section 0.4.3.2.

3.5.2.15 Comment:

One reviewer commented: "Section 0.4.2 discusses assumptions made for numerical analysis of flow in the unconfined aquifer. While the assumptions listed on page 0.26 represent great simplification of actual physical conditions, one in particular appears significantly non-conservative. Vertical averaging of hydraulic conductivities could result in horizontal travel times that are too long by an order of magnitude or more, if large variations in hydraulic conductivity are present. This averaging in effect ignores aquifer-scale longitudinal dispersion, as is indicated at the bottom of page 0.26. A conservative approach for travel time calculation would use the large values of hydraulic conductivity observed. The effect of this assumption is not large in the final analysis, however (Letter Number: 223).

Response:

Admittedly, faster and slower zones are theoretically averaged when one symbolically integrates the vertical conductivity distribution. An explicit vertical integration of discrete values is not done. Indeed, measures of discrete vertically distributed conductivity are rarely if ever taken and do not exist for the unconfined aquifer underlying Hanford. Field measured values of conductivity represent a vertically averaged quantity over the screened interval of each particular well. The VTT model of Hanford is calibrated to the measured values of hydraulic conductivity and hydraulic head. Formation thickness and effective porosity are also used in the VTT model calibration.

No specific range of hydraulic conductivities has been considered in the "vertical averaging" of hydraulic conductivity. The vertical average is performed mathematically on the three-dimensional equation rather than on a set of discrete, vertically distributed hydraulic conductivity values.

3.5.2.16 Comment:

Comments were received specifically concerning the unit hydraulic gradient model. One reviewer felt that the use of this model requires estimating or determining three soil parameters: the saturated moisture content, saturated hydraulic conductivity, and "b" value, the latter depending in turn on the precise relationship between soil moisture content and capillary water potential. These soil parameters (from references cited in the draft EIS) would appear not to have been characterized precisely, especially considering hysteresis and spatial variation among natural soils on the Hanford Site. The reviewer asked how the travel times in the vadose zone were obtained. Another reviewer stated that procedure described to estimate travel time in the vadose zone is not correct. A reviewer also pointed out that the relationships assigned for the soil moisture characteristic curve and the unsaturated hydraulic conductivity curve are not properly referenced. They are presented in a way that implies that Equations (0.2) and (0.3) are absolute, universally accepted relationships similar to Richards' equation (0.1). This is clearly not the case and their use in this analysis should be justified (Letter Numbers: 215, 223).

Response:

The unit hydraulic gradient model for determining steady-state travel time in an unsaturated soil is not limited to the use of a curve-fitting technique that determines a "b" value. Any method that yields the relationships between the curves of hydraulic conductivity, moisture content and pressure for a soil can be used with Equations 0.1, 0.4, 0.8 and 0.9 to determine travel times. Soil parameters are well-determined for a very limited set of locations. Hysteresis is a transient process, not accounted for in the long-term nature of this EIS analysis, and a phenomenon that is most important near the soil surface and not in the deeper profile.

The contention that a unit gradient cannot exist unless the soil moisture is uniform is incorrect. While it is correct that the suction forces are greater than the gravitational force, the gradient of the hydraulic potential will be nearly unity. Moisture contents need not be uniform. Since the water that passes through the waste form and eventually reaches the groundwater is the transporting fluid, the surface infiltration, most of which is transpired or evaporated, is not used. The water infiltrating (migrating) through the soil zone containing the waste (buried at depth) is considered to be the annual recharge.

Richards' equation adds neither conservatism nor nonconservatism to the calculation; it represents the fundamental relationships among the forces that describe flow of water in unsaturated porous media.

While it is correct that there may be a transient condition that transmits water at a greater rate than in the steady-state system, most of the moisture pulse resulting from a transient such as a 1.3-cm/hr precipitation for one hour would be dampened in the first few meters of soil. Also, most of the moisture would be evaporated or transpired back to the atmosphere.

The moisture contents appearing in Section P.1.4, in Table P.3, were determined by calculating the moisture contents of an equivalent uniform soil which could transmit 0.5-cm/yr and 5-cm/yr infiltration through the 64-m soil profile in the time determined by the application of the unit hydraulic gradient model to a layered soil profile made up of soils for which data were available. Sample calculations for real soil profiles unrelated to waste sites but on the Hanford Site can be found in Heller, Gee and Myers (1985).

In the absence of any detailed analyses of deep drainage in the unsaturated zone, it is common to assume that unit gradient conditions (or near-unit gradient conditions) can exist to cause recharge (Baver et al. 1972). Hence the analysis, while not detailed, is believed to be reasonable for present purposes.

3.5.2.17 Comment:

The following comments were received specific to the diffusion-controlled release model: 1) The derivation of time to source depletion does not define the parameter M_o in Equation 0.15. 2) The DOE has unsuccessfully attempted to characterize moisture movement beneath the protective barrier. This moisture movement is not understood and does not allow the DOE to assume that advection transport is negligible under the protective barrier. Assuming diffusion as the only alternative to transport overestimates the travel time. An example calculation results in a travel time from the waste to the edge of the barrier of 136,000 years. 3) An assumption is made that there will be a linear concentration profile throughout the diffusion zone. Diffusion-controlled profiles will be concave and not linear in this region. The approach to modeling diffusion in this section is questioned since there are analytical solutions to the one-dimensional diffusion equation that include source decay and contaminant decay, as would be more appropriate. The diffusion coefficients used (Appendix P) are in some cases not conservative. 4) How would a more realistic model of transport in the diffusion controlled zone affect travel times and concentrations? (Letter Numbers: 215, 223).

Response:

1) The definition of M_o was inadvertently omitted from Appendix O and has been added to the final EIS (Section 0.4.1.3). The advection of moisture beneath a protective barrier and the possible moisture movement through a barrier are being studied in the Barrier Development Program (Adams and Wing 1987).

2) In the second part of the comment, the DOE could not follow the line of reasoning that results in 136,000 yr. However, if one starts with Equation 0.14; (Appendix O) and substitutes in $\Theta D = D_p$, then

$$T = RL^2\Theta/4D_p$$

Substituting D_p from Equation (0.21), the time, T, of first arrival is then

$$T = RL^2\Theta/4(D_o a\ \exp(b\Theta))$$

where $a = 0.005$
$b = 10$
$\Theta = 0.078$ (or 7.8%)
$L = 10$ m

$D_0 = 1\ cm^2/day$ (from Table P.3)

$R = 1$ (from Table Q.9).

The time of first arrival is 1.79×10^6 days, about 5000 years.

3) If diffusion dominates transport beneath the protective barrier and one considers the three-dimensional vadose zone, then a concave steady-state profile will develop. The quasi-steady-state linear concentration profile model was adopted because of the need to model a finite domain, decaying source boundary condition, and zero concentration effluent boundary condition. This model provides only an approximation to contamination migration beneath a barrier; a research plan has been implemented to improve the realism of models depicting moisture movement and solute transport beneath the protective barrier system.

The conceptual model of the protective barrier system acknowledges that the barrier may not operate perfectly through the period of interest. For example, 100-year or 1000-year precipitation events will probably result in some net infiltration. However, the overall infiltration rate through the barrier would have a very low annual average value; perhaps on the order of 0.1 cm/yr or lower. (The effects of 0.1 cm/yr average annual recharge in a water climate can be estimated by doubling the impacts associated with the functional barrier failure scenario.) The conceptual model implies equally important advection and diffusion processes.

4) How a more realistic model of transport in the diffusion-controlled zone would affect predicted travel times and concentrations can only be determined by developing and executing the more realistic model of transport beneath a protective barrier. The necessary research program has been initiated.

3.5.2.18 Comment:

A reviewer noted that the draft EIS (Section 0.4, p. 0.16) states that the results of running numerical models generate the conceptual model of a site. This seems to be fundamentally backwards. The model is set up based on the modeler's conceptual idea of the flow field. The results should confirm the conceptual model, not create it (Letter Number: 215).

Response:

The conceptual models are used to formulate the numerical modes and codes. However, the discussion referred to is meant to indicate that both the numerical and conceptual models are improved through the iterative calibration procedure. The text has been revised to clarify this point.

3.5.2.19 Comment:

A reviewer noted that the draft EIS (Vol. II, p. xxxvii) states that transmissivity values were "adjusted through model calibration to reproduce the water table under transient modeling conditions." The reviewer feels that the term "transient modeling conditions" is ambiguous, because an aquifer cannot be under any kind of "modeling conditions" (Letter Number: 215).

Response:

The referenced text has been revised to clarify this point.

3.5.2.20 Comment:

A reviewer noted apparently conflicting statements (pp. 0.2 and 0.28) regarding the calibration/validation of models (Letter Number: 223).

Response:

The statement from page 0.2 refers to the groundwater model of the unconfined aquifer. Page 0.2 has been revised for clarification. The statement from page 0.28 refers to the contaminant transport model. These are two distinctly different modeling capabilities.

The "relatively good understanding of the behavior of various contaminants in this zone" refers to the knowledge of conservative contaminant migration, e.g., tritium and nitrate in the unconfined aquifer. "Behavior" of these contaminants relates to the fact that they move with the water in the aquifer. The travel times of the contaminants in the unconfined aquifer have shown that an effective porosity of 0.1 should be used in the groundwater model.

The statements on page 0.28, which indicate that the calibration and ultimately the validation of the transport model are limited to the confidence in the travel time distribution, are true. Rigorous validation of all travel times predicted by the groundwater code has not been completed, because the groundwater code is calibrated primarily to observed heads, not travel time. Knowledge from aquifer monitoring bears directly on estimates of travel time and hence indirectly on estimates of contaminant movement. In any case, to the extent that the groundwater model has been calibrated, it will provide a minimum travel time for any constituent. Until the transport model and its longitudinal dispersion submodel are calibrated to contaminant plume data, the transport model cannot be considered calibrated. Data needed for this calibration are not yet available.

3.5.2.21 Comment:

Several reviewers recognized a potential for existing groundwater contamination or monitoring data to be used in upgrading the Hanford Site geohydraulic modeling. One reviewer noted that 40 years of monitoring data is an excellent data base compared to most hydrogeological data bases and affords an opportunity to refine and bound the modeling effort. Another reviewer asked for an explanation of why data are insufficient to calibrate an advection-diffusion model and suggested that a detailed inventory of what types of data are available should have been in the draft EIS (Letter Numbers: 215, 239-NRC, 243-EPA).

Response:

To the extent practicable, the DOE has used, and continues to use, the available monitoring data to develop the modeling of the unsaturated groundwater. However, successful use of monitoring data for contaminant transport model development requires explicit knowledge of source-term location and migration paths for specific radionuclides found in the environment.

Typically, monitoring data reflect a superposition of migration from several sources, which limits the usefulness of these data for this purpose. To the extent practicable, the data have been considered in the EIS modeling effort.

Section 0.4.3.1 discusses data requirements and current modeling limitations. In addition to the data listed, a detailed characterization of releases from sources would be needed. These data have not been developed.

3.5.2.22 Comment:

Regarding Volume 2, p. xxxv, a reviewer stated it is highly doubtful that the statement "Hanford sediments are negatively charged" is all-encompassing (Letter Number: 215).

Response:

The EIS has been revised to clarify the statement.

3.5.2.23 Comment:

Reviewers pointed out a need for additional site-specific geohydrological and geochemical data and other research data to reduce the number and significance of uncertainties and assumptions and to develop or validate/calibrate hydrologic models used in the draft EIS assessments (Letter Numbers: 215, 239-NRC, 243-EPA).

Response:

Programs are presently under way at the Hanford Site which address the issues related to the geochemical and geohydrological environment as they influence the release and transport of radionuclides and hazardous chemicals. The DOE's intent, to perform additional development and evaluation work before the implementation of disposal of wastes covered under this EIS, is reflected in the preferred alternative.

3.5.2.24 Comment:

One reviewer questioned the utility of any approach to model a site-specific process in the subsurface, when parameters selected represent regional (macro-scale) processes. Uncertainties increase for models which use macro-scale factors to evaluate local processes, such as contaminant transport. The reviewer noted evidence of the highly porous nature of surficial sediments at Hanford and further contended that there is evidence of contaminant migration at locations within the facility where migration should not be occurring (Letter Number: 243).

Response:

The best data available were used to develop the impacts via groundwater; some were of necessity representative of overall conditions on the 200 Areas plateau. Although the lack of detailed data on soil characteristics in the vadose zone beneath each of the wastes sites detracts from the precision of estimates of travel time through the vadose zone from the waste to groundwater, travel time in the vadose zone can be of little consequence in terms of impacts in the long-term. For most radionuclides of interest in this EIS, the half-lives are very long compared with the travel time in the vadose zone. Thus, they are likely to reach groundwater without significant decay sometime in the 10,000-year time period, even if movement is retarded to some degree. As a consequence, additional precision in parameters is probably unnecessary from this standpoint.

For nuclides like strontium-90 and cesium-137 transport and retardation could be more important, however travel time needs to be only about 600 years from waste form to the environment for these nuclides to have decayed to insignificant levels. Impacts on individuals depend on the rate of arrival of radionuclides (concentrations of radionuclides in drinking water) to the user. The rate of arrival is governed, for the most part, by the release rate of the radionuclides from the waste form.

Travel Time/Retardation

3.5.2.25 Comment:

A reviewer pointed out a contradiction of an introductory statement in Appendix O which states that there is relatively good understanding of contaminant behavior in the saturated zone, while it is repeatedly stated in the remainder of the appendix that characterization of the hydraulic properties of unsaturated soils and of chemical retardation factors is inadequate to permit credible numerical simulation (Letter Number: 223).

Response:

Appendix O has been revised to correct the apparent contradiction. Knowledge of contaminant behavior in the saturated zone is largely based on nonretarded chemical or radionuclide species, e.g., nitrate ion or tritium. Because of this, knowledge of contaminant behavior does not necessarily imply a knowledge of chemical retardation for all radionuclides of interest. The existing data on contaminant concentrations in wells at Hanford provide relatively good qualitative understanding of contaminant behavior in terms of transport of nonretarded species in the unconfined aquifer. Modeling of the contaminant plume to establish a calibrated model and quantitative understanding of transport in the saturated zone has only recently been initiated.

3.5.2.26 Comment:

A reviewer commented that one of the most important factors is the speed at which groundwater travels through rock. Groundwater travels relatively quickly through basalt, which is the rock found beneath the Hanford Site (Letter Number: 155).

Response:

Groundwater travel time in basalt is not a factor in the EIS impact assessments. Defense wastes that are disposed of in the geologic repository (whether it be on or off site) were assumed to meet the requirements of 40 CFR 191, and therefore no contaminant transport analysis was required for these wastes. Impact calculations do consider potential transport of wastes disposed of in-place or near-surface under the EIS alternatives, as they may be subject to transport by unconfined groundwater in unconsolidated sediments overlying basalts.

3.5.2.27 Comment:

Based on models described in Appendix O, travel times through the unsaturated zone are much larger than travel times through the saturated zone. Reviewers felt that very little information is given on exactly how these computations were performed and the assumptions that were made (Letter Numbers: 231, 234).

Response:

Flow rates are much slower in the unsaturated zone; under unsaturated flow conditions, hydraulic conductivity is orders of magnitude less than for the saturated system. In addition, the potentials or driving forces are lower in the unsaturated zone. The reader is referred to Appendix O for a more detailed technical treatment.

3.5.2.28 Comment:

Reviewers expressed concern that the lack of geochemical data may have necessitated the use of too many assumptions in the release and transport analysis. Of particular concern are the assumptions of instantaneous equilibrium and reversibility for retardation calculations and the assumption of spatial and temporal invariability of the "chemical environment." Collection of more geochemical data was recommended. One reviewer cited an example of reactions between calcite, dolomite, and groundwater that indicated that carbon-14 had not reached equilibrium in all three of these media over the past 10,000 years (Letter Numbers: 215, 243-EPA).

Response:

Chemical equilibrium is reached when the rate of the forward and reverse reactions of a chemical equation are equivalent. Isotopic equilibrium is defined as the condition where the isotopes of any element are in the same ratio throughout a closed chemical system. In the case of the reviewer's example, the isotopic ratio of carbon-14 to both carbon-12 and carbon-14 is different for the three media. These isotopic ratios have no influence on the assumption of chemical equilibrium, because chemical equilibrium occurs independently of isotopic equilibrium. Isotopic equilibrium is not considered as a retardation mechanism for any radionuclide in this EIS and surely would not occur in the short-term laboratory studies used to develop radionuclide transport parameters.

Instantaneous equilibrium and reversibility for retardation calculations are not always conservative when reaction kinetics inhibit solubility and sorption behavior; however, for the HDW-EIS, sorption parameters were derived from laboratory experiments with extremely short reaction times in comparison to the geologic environment. Radionuclide sorption experiments were designed for short contact times (less than 30 days). Sorption studies were performed with a 7-day contact time (Delegard and Barney 1983). If kinetic reactions are an important aspect of radionuclide retardation, it is clear that such reactions are not likely to occur in the short-duration laboratory experiments. Longer contact times similar to those expected in the geochemical environment would allow chemical reactions to proceed toward completion. As mentioned in Appendix O (p O.7), radionuclide retardation mechanisms such as chemical precipitation, chemical substitution of one element for another in a solid phase, and exchange of stable isotopes in the geochemical system for radioactive isotopes in the waste leachates and affected environment are long-term chemical processes that could further reduce the mobility of radionuclides. These chemical processes probably did not reach equilibrium in the 7-day laboratory contact period, and therefore the distribution coefficients derived from such experiments are conservative when compared to the hundreds to thousands of years travel times in the subsurface environment at the Hanford Site.

Programs presently under way at the Hanford Site are addressing issues related to the "chemical environment and its influence on the release and transport of radionuclides and hazardous chemicals." These programs address each aspect of the chemical environment including waste form studies, unsaturated zone research, groundwater investigations, and release and transport technology development. In addition, the Hanford Site Performance Assessment Program addresses the technology development aspects of the release and transport analysis. Together, these programs will provide much of the geochemical information required to perform a more representative assessment of the "chemical environment" at Hanford.

3.5.2.29 Comment:

A reviewer pointed out that the statement of "good correlation" between actual and predicted travel time in the unconfined aquifer (p. xxxvii) should be supported by some quantitative validation (Letter Number: 215).

Response:

Modeling results (Friedrichs 1977) predict that the tritium plume from the PUREX plant will start reaching the Columbia River in about 25 to 30 years and will dissipate in more than 180 years. The peak activity is expected in more than 30 years. Groundwater monitoring (Eddy and Wilber 1981) detected the first tritium activity (from PUREX waste disposal sites to a well near the Columbia River) in 1980, 25 years after PUREX startup. The peak of the plume has not been detected as of 1985, a 30-year travel time.

3.5.2.30 Comment:

A reviewer noted that the radionuclide travel time analysis incorporates assumptions described earlier in the draft EIS and, as a result, the quantitative transport assessments tabulated in Appendix Q compound the errors and uncertainties discussed for appendices M, O, and P; the net effect is that these results are nonconservative. The most significant of these errors or uncertainties includes the development of offsite irrigation scenarios and the omission of these in the transport analysis. Also, the reviewer noted several new errors or uncertainties in Appendix Q. The reviewer asked the following questions:

1) In view of a number of factors indicating much smaller possible vadose-zone thicknesses in the 200 West Area, why was 64 m used in all calculations of unsaturated zone travel times for the disposal sites in all 200 Areas?

2) Section Q.4 of the draft EIS (aquifer modeling) discusses the simulated steady-state configuration of the water table corresponding to the scenarios for 0.5-cm/yr and 5-cm/yr infiltration (recharge). The modeling implies that with

0.5 cm/yr recharge, the water table drops to near its pristine (pre-1945) condition, while 5-cm/yr recharge causes the water table to rise above its present level.

a) To what extent did these simulations use actual measured aquifer properties?

b) The simulated 1983 water table (Figure Q.3) differs from the water table observed in the fall of 1982, as the latter is depicted on Figure 4.8. To what extent were attempts made to calibrate simulations of the 0.5-cm/yr and 5-cm/yr recharge scenarios against pre-1945 and later water level data?

3) Section Q.7 of the draft EIS computes vadose zone travel times in the 300 Area TRU burial grounds at 14 and 114 years for recharges of 5.0 and 0.5 cm/yr, respectively. According to the unit hydraulic gradient model (Appendix O), these values imply average soil moisture contents of 8.75% and 7.125%, respectively, for recharges of 5.0 and 0.5 cm/yr, versus 6.4% and 7.8% assumed in Appendix P for the 200 Areas. A finer-textured soil is implied for the 300 Area. Is this supported by actual soil moisture characterization?

4) What is the DOE's estimate of the probability of occurrence of the offsite irrigation scenario discussed in Section Q.8?

5) The two offsite irrigation scenarios developed in Section Q.8 describe offsite land areas that are or may be irrigated in the future. Do historic soil surveys indicate significant agricultural potential of any other areas tributary to or overlying the unconfined aquifer modeled in the draft EIS?

6) Irrigation losses to the groundwater table of 10% and 20% are used in Section Q.8 of the draft EIS to analyze water table effects of future irrigation. These figures appear nonconservative in relation to average deep percolation rates. Probably only trickle systems or intensively managed sprinkler systems could attain these rates in the relatively sandy soils of the Hanford region. Would the capital and operational costs for such systems, compared to the incremental costs of pumping additional water from the basalt aquifer and/or Columbia River, justify such low, deep, percolation rates?

7) What specifically is the quantitative effect of the irrigation scenarios presented in Section Q.8 on contaminant travel times from the 200 Areas?

8) Deep percolation losses of 20% (or greater) in combination with irrigation of all potentially irrigable land would appear to represent a reasonable, but more conservative irrigation scenario than those presented in Section Q.8. What are the minimum and average vadose zone thicknesses and the maximum rise in water table beneath the 200 Area tank bottoms that would result from this more conservative scenario?

9) Have the reduced contaminant travel times due to water table rises associated with offsite irrigation been incorporated in the overall analyses of long-term performance of waste disposal systems or to probability and consequence of radionuclide release and transport after disposal? If not, why not? (Letter Number: 223).

Response:

The following responses are listed in sequence to correspond with the reviewer's questions.

1) The travel times were originally calculated for the 200 East Area soil profiles, in which the 64 m depth represented a conservative estimate. At the time the draft EIS was prepared there were insufficient soil data from 200 West Area wells to calculate travel times in the unsaturated zone from the primary waste sites. This was expressed in the last paragraph of Section Q.3. Since that time soil data have been accumulated for a well profile near the TY Tank Farm. The present depth to the groundwater is approximately 47 m at that one site. For a 5.0 cm/yr infiltration flux, the travel time is estimated to be 155 years. On the average, 200 West soils are finer and have higher moisture contents than are soils in 200 East. Vadose zone thickness would have to be reduced to less than about 30 m in the 200 West Area for the travel time to drop below the 100-year travel time used for the calculations. Thus, results using the 64-m depth and 100-year travel time will be conservative.

2a) Most of the measured aquifer property data used in the groundwater model are discussed in the references, Kipp et al. (1976) and Cearlock, Kipp, and Friedrichs (1975), contained in Appendix O. The latest update to include new data occurred in 1982 (Eddy, Prater and Rieger 1983).

b) No attempts were made to match a 1945 water table condition with the model, because little data are available except in old, unsurveyed farm wells in the area of the former town sites of White Bluffs and Hanford. The water table maps that exist are subject to question.

3) The differences in moisture content discussed in this question are due to roundoff of depth-to-groundwater numbers used in the calculations. If the correct depth of 9 m is used, the moisture contents can be calculated. Because the bottoms of the old trenches are not accurately known and because of bank storage caused by river fluctuations, a minimum vadose zone thickness was used.

4) The probability of offsite irrigation has not been estimated. The analysis performed and described in Appendix Q assesses the impact if irrigation occurs.

5) The only soil survey of the Hanford Site was conducted by Hajek (1966). Most of the soils were found to be Class IV, indicating there were severe permanent limitations for permanent cropland use.

6) Present irrigation practices are undergoing re-evaluation to reduce energy costs and water usage. Projections beyond the decade are speculative.

7) The effect of irrigation on travel times has not been calculated. However, travel times in the unconfined aquifer are small compared to those in the vadose zone for the disposal alternatives and hence would not affect the estimated impacts.

8) It is not known what all "potentially irrigable land" means, since severe limitations due to soil type exist for much of the Hanford Site. However, given sufficient cheap power and economic incentive, a large part of the Site could be farmed. This scenario has not been analyzed.

9) Changes in groundwater level associated with upgradient-offsite irrigation were estimated and presented in Appendix Q; the probability and consequences of such irrigation have not been quantified. Qualitatively, the probability is low for such irrigation because the volume of groundwater available from the unconfined aquifer would necessitate pumping irrigation water from the deep inter-basalt aquifers or the Columbia River. Because surface streams would form at the edges of the higher plateau and provide an avenue for water table drainage, the wastes would remain in the unsaturated zone. Contaminant travel times through the vadose zone, other factors held constant, would be expected to decrease. Pathways in the unconfined aquifer would be expected to change as well. Additional analysis was not considered necessary for further discriminating among the alternatives. See also Appendix Q.

3.5.2.31 Comment:

One reviewer stated that the contaminant transport assessment calculations do not account for all factors that can influence contaminant retardation such as variable geochemical conditions due to spatial variation in groundwater or soil chemistry. The DOE should examine the impact of changing geochemical conditions on contaminant retardation and assess the effect of those geochemical processes not accounted for by their current methodology. Other reviewers stated that the EIS was "purely speculative" in discussing the effect of natural and chemical mechanisms on the travel time and contaminant concentrations. A reviewer inquired why, if the processes are so effective (at delaying travel times), current contaminant plumes are entering the Columbia from the 200 Areas in less than 40 years (Letter Numbers: 155, 215, 239-NRC).

Response:

The shortcomings of the current models and assumptions have been addressed in this EIS along with more comprehensive models, which are being developed at the Hanford Site. Investigations over the past 35 years show conclusively that the subsurface geologic media act as a chromatographic column to remove or decrease the concentration of reactive ions (such as plutonium, strontium or cesium) in liquid wastes disposed of to the ground. The reactive materials are found in measurable amounts (in the ground and groundwater) only in the immediate vicinity of the disposal sites (Price et al. 1979; Rhodes 1957; Routson, Barney and Seil 1978; Routson, Barney and Smith 1980; Routson et al. 1981; Brown et al. 1979; Haney 1959; Kasper 1981b, 1982; Kasper et al. 1979; Price and Ames 1975; Raymond and McGhan 1967; Smith 1980, 1981; and Van Luik and Smith 1982).

The conservative (nonreactive) ions and elements (such as tritium, nitrate, iodine, and technetium) move to the water table along with the groundwater without being significantly retarded. However, the contaminants in the aquifer are reduced in concentration by hydrodynamic dilution and dispersion (See Appendix O references Simmons 1981, 1982; Appendix V reference Cline, Rieger and Raymond 1985).

Some contaminants have reached the Columbia River in very short times because of the infiltration of Hanford process water at about 5000 cm/yr. This is contrasted to the expected normal recharge of vegetated sites of about 0.5 cm/yr.

3.5.2.32 Comment:

One reviewer suggested that dispersion can act to result in contaminant transport rates that are faster than advective rates (Letter Number: 243-EPA).

Response:

Calculated results from basic flow equations do not support this statement. For saturated flow in permeable media under gradients normally encountered in unconfined groundwater systems, longitudinal dispersion will not materially affect the rate of movement of nonsorbed or retarded contaminants in the system.

3.5.2.33 Comment:

Reviewers pointed out that there is no information to support the statement (p. 4.21) in the draft EIS that contamination now existing in the unconfined aquifer is expected to decay or dissipate before occurrence of any waste-related contamination from the proposed alternatives. Other reviewers asked for assessment of the impacts of additional contaminants attributable to past disposal in cribs, trenches, and injection wells (Letter Numbers: 215, 243-EPA).

Response:

The statement referred only to tritium and nitrate, which are readily transported by water, rather than the all-inclusive "present contamination." The intuitive nature of the statement has been clarified. Additional consideration of the potential impacts of existing groundwater contamination is provided in the revised cumulative impacts section (Section 5.1.4).

3.5.2.34 Comment:

Regarding Appendix O, a reviewer commented that more information on paleogeomorphology at Hanford would improve the understanding of flow and transport in the unconfined aquifer system. The reviewer provided information from a 1962 document which addressed the apparently rapid dispersal of tritium in the unconfined aquifer system at Hanford (Letter Number: 239-NRC).

Response:

One of the specific purposes of drilling more than 1900 wells on the Hanford Site was to define the geomorphology and characteristics of the subsurface geohydrologic units (see the numerous geologic and hydrologic references in Chapter 4 and Appendices O and Q).

The reviewer is correct in the observation that there are channels incised in the Ringold Formation, and that these channels are filled with Hanford Formation deposits. In some locations, the unconfined water table occurs above the bottom of the channels. This accounts for the more rapid movement of groundwater (and associated conservative contaminants) southerly and easterly from the 200 East Area toward the Columbia River. The location and characteristics of the higher-permeability materials are taken into account in both groundwater monitoring activities and in the numerical model of the unconfined aquifer.

3.5.2.35 Comment:

A reviewer noted that DOE does not show that the Delegard and Barney (1983) K_d values are directly applicable to the transport and attenuation models in the draft EIS. Another reviewer commented that the draft EIS states that conservative values of K_d have been used whenever a range exists, and asked that these ranges be listed in the text or at least referenced in the document so that the degree of conservatism can be evaluated. Another reviewer noted that the K_d values in the Delegard and Barney study were predicted values from quadratic expressions generated by a factor analysis of different solutions. The values are quite variable (Letter Numbers: 215, 223, 239-NRC).

Response:

Distribution coefficients used in the draft EIS were taken from contaminant mobility studies performed at the Hanford Site. These laboratory experiments (Rai, Serne and Moore 1980, 1981; Delegard and Barney 1983) were performed to simulate a particular chemical system. The two studies by Rai and colleagues were used to describe the mobility of americium and plutonium in dilute groundwater conditions. Delegard and Barney performed laboratory experiments to describe the mobility of radionuclides in the presence of highly alkaline tank wastes and high complexant concentrations. Distribution coefficients used for various waste forms in the draft EIS are consistent with the chemical conditions expected for radionuclide and hazardous chemical release from each waste form. A third reference for the cesium distribution coefficient, Routson et al. (1981), was inadvertently omitted from the draft EIS reference list.

Tables II and III are composites of Tables 1 and 10 from the Delegard and Barney (1983) report. These tables illustrate the chemical compositions of the solutions used in the distribution coefficient experiments performed by Delegard and Barney. The four solution compositions are an extremely conservative representation of any liquid waste leached or of releases from a Hanford waste form. Information in Tables II and III supports DOE's contention for conservatism for strontium, neptunium, plutonium and americium in all waste forms, because even the compositions of the solutions portrayed in the draft EIS as being dilute and noncomplexed are assigned K_d values for solutions that have high ionic strength and contain

TABLE II. Composition of Hanford Sorption Test Solutions

Component	Concentration, M
$NaNO_3$	1
$NaNO_2$	1
Na_2CO_3	0.025
Na_2SO_4	0.005
Na_3PO_4	0.005
HF	0.005
Hydroxyacetic acid	0.05
Citric acid	0.015

TABLE III. Variable Components in Hanford Test Solutions from Delegard and Barney (1983)

	Concentration, M			
Component	Dilute Noncomplexed	Dilute Complexed	Concentrated Noncomplexed	Concentrated Complexed
Na	3.8	3.8	5.8	5.8
NaOH	1.0	1.0	4.0	4.0
$NaAlO_2$	0	0	0.5	0.5
HEDTA	0	0.1	0	0.1
EDTA	0	0.05	0	0.05

significant complexant concentrations. The "dilute" waste solution used for the Delegard and Barney experiments has an ionic strength of greater than 3.8 M. The actual Hanford groundwater ionic strength is less than 0.10 M. Thus, to consider 3.8 M laboratory solutions as dilute is to make a very conservative assumption. In addition, the noncomplexed waste streams tested contained 0.05 M hydroxyacetic acid and 0.015 M citric acid. These constituents were found to complex certain radionuclides (Delegard and Gallagher 1983) and so even the noncomplex distribution coefficients values used in the draft EIS were produced with simulated waste solutions containing 0.065 M complexing agent. In addition, the dilute and concentrated complexed solution types both contain 0.215 M organic complexant. In all cases the chemical conditions simulated by Delegard and Barney are consistent with the most mobile chemical conditions probable on the Hanford Site; thus, the K_d values found in Delegard and Barney can be considered conservative compared to probable values for the specific scenario addressed in the EIS.

3.5.2.36 Comment:

A reviewer stated that the accuracy of the K_d values measured by Delegard and Barney (1983) are in question because, for example, they did not account for container wall adsorption in their experiments (Letter Number: 223).

Response:

The reviewer may have overlooked the fact that these experiments were performed after solubility studies using the same radionuclides and similar solution compositions in identical containers (polyethylene). The solubility studies were performed to test for container sorption and to limit the contribution of chemical precipitation during the experiment. In addition, Delegard and Barney (1983) pretreated the sediment and container with the test solution before introducing the radionuclide. These experimental practices all serve to limit the potential for container sorption.

3.5.2.37 Comment:

A reviewer posed several questions/comments related to the conservatism of the analyses of release rates: 1) given the nonconservative approach in choosing molecular diffusion coefficients and K_d values, how choosing more conservative values would affect the release and transport scenarios; 2) the effect of the use of the relative errors of the K_d values (statistical uncertainty) shown by Delegard and Barney (1983) on the results of the release and transport modeling; 3) incorrect quotation of the K_d values taken from Routson et al. (1981); 4) the effect of variations in reliability of the analytical techniques used in determining the K_d values; 5) the basis for the assumption that complexing solutions would lose complexing ability and would break down and release bound radionuclides; 6) the reason for the assumption that TRU wastes are uncomplexed solutions (the reviewer felt that the references suggest that the TRU wastes are complexed solutions); 7) why samarium is assumed to behave chemically similarly to americium (Letter Number: 223).

Response:

1) The DOE believes that the draft EIS approach is conservative. The use of lower K_d values could indicate earlier arrival times and higher concentrations.

2) The type of statistical analysis suggested here will be required to show compliance with 40 CFR 191. See Appendix S for an example of this type of analysis (variations on K_d values).

3) The K_d attributed to Routson et al. (1981) is misstated. Only one distribution coefficient (K_d) listed in Tables P.6, P.26, and P.27 is from a Routson report. The K_d for cesium was extracted from Table 26 of Routson et al. (1981).

4) The degree of conservatism or nonconservatism might be affected.

5) Some initial experiments, performed to determine degradation products formed from the oxidative decomposition of HEDTA, EDTA, and citrate, suggest that further degradation of organic complexants in high-level and tank wastes is likely to occur. The EIS analysis takes no credit for complexant degradation. The net effect is that EIS travel times are shorter, concentrations higher, and doses higher than would be the case if the complexants were to break down.

6) The TRU wastes discussed in the draft EIS were segregated into four major groups (see Table P.13). Only one group of these sites received liquids; these sites are described as TRU-contaminated soil sites (see Table A.9). Information about the complexant content of wastes disposed of to many of these sites is available in the "Draft Phase I Installation Assessment of Inactive Waste-Disposal Sites at Hanford" (DOE 1986b). This report discusses chemical inventories discharged to most of the facilities listed in Table A.9 of the draft EIS. In addition, several of the sites included as TRU-contaminated soil sites have been investigated and

are discussed in Appendix V. The chemical inventories contained in the Draft Phase I Report and the individual site investigations suggest that few complexants were discharged to these facilities.

7) Lack of data for samarium necessitated the use of a surrogate distribution coefficient. Since samarium and americium exhibit chemically similar behavior under oxidizing conditions, the distribution coefficient for americium was chosen.

Release Rates

3.5.2.38 Comment:

A reviewer noted a possible contradiction. The draft EIS states that the release of radionuclides from contaminated soils is assumed to be controlled by adsorption for carbon, strontium, cesium and neptunium. However, according to Table P.27, adsorption will not control carbon. In addition, neptunium is probably controlled by solubility, not by adsorption (Letter Number: 223).

Response:

Table P.27 lists "zero" as the distribution coefficient for carbon-14. This indicates that carbon-14 is a water-coincident contaminant (moves at the same rate as the water) and is instantaneously released from the solid waste materials into the available moisture within the waste form during transport. The statement on P.19 was in error for neptunium and has been corrected.

3.5.2.39 Comment:

A reviewer stated that the diffusion-controlled release scenario using uncorrected molecular diffusion coefficients of 1.0 cm^2/day as shown in Table P.3 is not conservative. For example, Cs^+ and NO_3^- both have molecular diffusion coefficients 50% greater or 1.5 cm^2/day at 65°F (Letter Number: 223).

Response:

The reviewer did not reference the source of the value 1.5 cm^2/day cited for nitrate self-diffusion. Most diffusion coefficients are determined in simple solutions (e.g., a binary salt with one cation and one anion) and use limiting equations (based on infinite dilution) that are simplifications of actual conditions. The soil pore water is a complex mixture of numerous cations and anions at concentrations often considerably greater than the infinite dilution state chosen as the "standard." Furthermore, the electrostatic nature of the soil surface adds another complicating force that precludes the accurate use of simple, limiting-law techniques to measure diffusion coefficients. The value 1 cm^2/day was chosen as a representative value.

3.5.2.40 Comment:

A reviewer suggested that DOE should consider, in the transport calculations, the effects of prior releases of contaminants on geochemical conditions and subsequent effects on transport and attenuation of contaminants (Letter Number: 239-NRC).

Response:

The DOE does not have the specific data with which to make the requested assessment. However, any changes in geochemical condition as a result of the discharge of these wastes are believed to be within the bounds of assumptions made for the assessments that were performed under the EIS alternatives.

3.5.2.41 Comment:

The leach rate may not be the same for different (grouted) wastes. The assumed leach rate for nitrate ion should be replaced by measured leach rates upon completion of Hanford grout testing, and this should be reflected in the final analysis and final EIS (Letter Number: 223).

Response:

The leach rate can definitely be expected to vary for different grouted wastes. Data reflecting the specific leach rate for each grouted waste will not be available until grout testing is completed; thus, this EIS does not include specific leach rate data for grout. However, detailed analyses will be performed preceding actual disposal that will use actual leach rates for each waste.

3.5.2.42 Comment:

A reviewer said it was not clear where the 14,000-year figure came from in the statement on p. P.19 that the diffusion-controlled pathway commonly exhibits release periods in excess of the value dictated by the grout release mechanism for 14,000 years (Letter Number: 223).

Response:

The period of release defined by the grout release mechanism is given by the inverse of the leach rate. The leach rate was given as 0.007%/yr. The reciprocal yields the time (14,000 years) to 100% leached away. The text in Appendix P has been revised to clarify.

Migration

3.5.2.43 Comment:

A reviewer commented that microbiological processes have not been studied to assess their importance in the migration of trace elements and radionuclides, although several studies are referenced that illustrate that microbiological activity can be important in trace element attenuation (Letter Number: 215).

Response:

Microbiological activity can be of major importance in trace element and radionuclide migration in chemical systems that can support microbial growth. The chemical environment at the Hanford Site is not conducive to microbiological activity. Gamma radiation from radionuclides contained in concentrated waste forms (i.e., single- and double-shell tanks) sterilizes the local environment in and near the waste. Some monitoring for micro-organisms has been performed. Results of the monitoring supports the premise that little microbiological activity exists in the unconfined aquifer.

3.5.2.44 Comment:

A reviewer commented that illustrations of existing contamination plumes (Figures V.7, V.8, and V.21) and the in-place disposal (Figure V.9) imply that no contamination has exceeded or will exceed the limits of the plume characterized. Migration of the material appears to have been by gravity flow as well as by failed well casing. The changes in distribution of contaminants show that contaminants have migrated. It is also possible that the characterization data contain considerable inaccuracy. In either case, contamination cannot be proven to be contained by the "in-place" design of Figure V.9 (Letter Number: 44).

Response:

The in-place disposal concept does not imply that contamination has not exceeded the limits of the plume characterization. These are liquid-waste sites. The DOE agrees that contamination migrated by gravity down the failed well casing. This is different from the situation after the barriers are in place, in which the function of the barrier is to reduce infiltration of precipitation and thereby to reduce future migration of contamination.

3.5.2.45 Comment:

Commenting on the disposal pond summary statement on page V.32, one reviewer noted that the draft EIS implies that cesium, plutonium and strontium levels in sediment samples fully delineate the extent of contamination caused by these disposal ponds (Letter Number: 215).

Response:

The purpose of the study and the discussion presented in the draft EIS was to define the near-surface distribution of contaminants. No implication of the full extent of contamination was intended.

3.5.2.46 Comment:

One reviewer pointed out the possibility that migration of waste from the 200 West Area to the existing commercial low-level waste facility near the southwest corner of the 200 East Area could adversely affect groundwater-monitoring activities associated with that facility (Letter Number: 239-NRC).

Response:

If wastes are to be disposed according to the in-place stabilization and disposal alternative in the 200 West Area, suitable monitoring activities would be initiated upgradient of the commercial low-level waste site and toward the 200 West Area in order to detect any release or transport of radionuclides from 200 West Area that might affect groundwater-monitoring activities associated with the commercial low-level waste facility.

See also comment 2.1.7.

3.5.2.47 Comment:

A reviewer asked whether any of the contaminants, such as carbon and strontium, will migrate through the vapor phase. The reviewer noted that it may not be conservative to assume only diffusion of contaminants in the liquid phase through the unsaturated zone (Letter Number: 5-DOI).

Response:

Migration of contaminants in the vapor phase was judged not to play a significant role in transport through the vadose zone.

An important waste management study (Striegl and Ruhl 1985) measured the concentration of carbon-14 in CO_2 in the gaseous phase. Little carbon-14 was found in the water vapor phase in the unsaturated soils near the Sheffield low-level waste burial ground. No samples of water vapor had greater than off-site background levels, even for tritium. The molecular ratio of liquid water to water vapor per unit volume of the unsaturated zone at Sheffield is about 20,000 to 1.

Vadose Zone

3.5.2.48 Comment:

Several reviewers expressed concern about the assumption of vertical versus lateral flow in the vadose zone beneath the edge of the protective barrier. The basis for their concerns included insufficient vadose zone thickness resulting from increased annual precipitation, thinner vadose zone leading to intrusion by plant roots, gradients established as a result of decreased moisture content of the soil beneath the barrier, quantification of the "small degree" of lateral movement, and the effect of large differences in hydraulic conductivities. A reviewer also stated that the draft EIS implies that movement of radionuclides in the vadose zone can be neglected beyond the barrier (Letter Numbers: 5-DOI, 215, 243-EPA).

Response:

The vadose zone in the vicinity of the area under consideration for waste disposal presently ranges from 56 to 100 m deep. In modeling waste transport and travel times under the EIS scenarios, a nominal depth of 64 m was taken as the distance from the water table to the bottom of the waste tanks and proposed grout disposal trenches for both climate conditions. Under any reasonable climate change or surface water inundation condition, it is difficult to conceive of a decrease of the vadose zone thickness to as little as 10 m, let alone zero. For a 64-m vadose zone thickness, recent modeling studies (Fayer et al. 1985) show that flow is not vertical underneath the edge of the barrier; however, depending upon the textural characteristics of the soil, the flow can be essentially vertical at the barrier edge when the soil is as coarse as it is generally at the tank farm sites.

Spreading of contaminants in the vadose zone would be of concern if point sources of water existed over the waste sites or if transient fluxes were considered. With a uniform distribution of infiltrating water and a steady-state system, horizontal spreading would be a slow process because of a lack of a gravitational driving force. The EIS assessment results in an estimate of about 5000 years before radionuclides reach the advecting zone. Beyond the barrier, contaminants would be transported downward through the vadose zone by advecting water of regional recharge. Movement of contaminants in the vadose zone beyond the barrier will occur, but the advection assumption yields a more direct, rapid transport path and a more conservative result.

Additional research on barrier performance is in progress; thus, further information on moisture movement beneath and adjacent to the barrier will be forthcoming. Barrier research and final barrier design would also provide for precluding or minimizing root intrusion.

3.5.2.49 Comment:

One reviewer noted that the use of the Langmuir isotherm instead of the Freundlich isotherm, which is used in the draft EIS, would provide a more realistic representation of sorption. The Freundlich isotherm is limited because 1) it predicts infinite adsorption at infinite concentration (i.e., no maximum), and 2) it does not pass through the origin (i.e., no "zero" adsorption). The Langmuir isotherm, on the other hand, is a quadratic expression that 1) provides for a maximum and 2) passes through the origin. Rubin and Mercer (1981) indicate that the Langmuir isotherm is much more preferable to the Freundlich isotherm where sufficient data exist. Therefore, the adsorption data should be reconsidered with respect to the Langmuir model. The reviewer also pointed out that the draft EIS incorrectly implies that H^+ competition is the only way pH manifests itself on adsorption, and further stated that "pH affects the surface charge rather than competes with ions for adsorption sites" (Letter Number: 215).

Response:

Rubin and Mercer (1981) studied the adsorption of cadmium, zinc and lead onto four activated carbons versus pH. The effects of adding various concentrations of chelating agents 1,10-phenanthroline or EDTA were also studied. The authors' conclusions were that for their system the Langmuir isotherm described the data better than the Freundlich isotherm. The Freundlich isotherm changes when surface coverage approaches one monolayer of metal on the carbon surface. At smaller loading the two isotherms give comparable results; see Figure 2, p. 306 in the Rubin and Mercer report.

The experimental system described by Rubin and Mercer--high metal content adsorbing onto activated carbon--bears little resemblance to the perceived Hanford nuclear waste disposal system. Therefore, the advantage of applying the Langmuir isotherm over the Freundlich isotherm for the Hanford Site is questionable.

3.5.2.50 Comment:

A reviewer commented that a paragraph in Appendix Q (p. Q.6) appears to refer to vadose zone transport modeling only (Letter Number: 243-EPA).

Response:

The reviewer apparently referred to the third paragraph on Q.3, which does refer only to vadose zone modeling.

3.5.2.51 Comment:

Several reviewers commented on soils data. One reviewer stated that data from Isaacson, Brownell and Hanson (1974) and Gee and Heller (1985) partially contradict figures used in the draft EIS and asked whether actual moisture of undisturbed Hanford soils is likely to be more variable than the draft EIS indicates. Another reviewer asked for soils data in the unsaturated zone, referred to on page Q.2, to be included in the final EIS. Yet another reviewer stated that six samples (page R.4) are insufficient to delineate the characteristics of a population and suggested that at least 30 samples for each soil layer are needed to establish variability within a sample population (Letter Numbers: 215, 223, 243-EPA).

Response:

The EIS text has been revised on page M.9 to remove the apparent contradiction. Soil moisture is likely to vary considerably depending upon the soil texture and capillary suction as shown in Table IV below.

The EIS text has also been revised on page Q.2 to clarify that a 5-gal sample was taken from each of the six major soil horizons and that replicate measurements were made on each sample.

It is also recognized that six samples are insufficient to characterize a large horizon from a statistical point of view.

TABLE IV. Soils Data: Laboratory-Measured Soil-Water Retention Curves

Suction Head, cm	Sample No. AP-1	AP-2	AP-3	AP-4	Suction Head, cm	Sample No. AP-5	AP-6
	Moisture Content, volume fraction					Moisture Content, volume fraction	
2	0.414	0.520	0.435	0.453	5	0.425	0.414
4	0.405	0.517	0.432	0.449	10	0.422	0.410
6	0.373	0.516	0.428	0.445	15	0.419	0.409
8	0.326	0.514	0.425	0.428	20	0.416	0.406
10	0.268	0.505	0.418	0.405	50	0.403	0.388
20	0.122	0.477	0.292	0.206	70	0.397	0.375
50	0.058	0.231	0.099	0.127	100	0.388	0.310
100	0.046	0.157	0.077	0.079	500	0.230	0.210
500	0.040	0.110	0.070	0.043	1000	0.160	0.120
1000	0.030	0.100	0.060	0.041	15300	0.070	0.080
15300	0.020	0.070	0.050	0.040			
Saturated Hydraulic Conductivity, cm/min	0.153	0.358	0.486	0.135		0.0182	0.0082

Climate

3.5.2.52 Comment:

Reviewers asked for additional discussion of the basis for the climate change assumptions of Appendix S; especially the basis for the recharge rates used and their relationship to current recharge rates (Letter Numbers: 223, 239-NRC).

Response:

Appendix S has been revised to present additional climate change assumptions. The current climate recharge rate was used as a central value, and a probabilistic distribution of recharge values around it was assumed.

3.5.2.53 Comment:

One reviewer noted that by timing the wetter climate/barrier removal scenario to start 500 years after the loss of institutional control, the strontium and cesium have essentially decayed to low levels. This scenario, run earlier than the year 2650, could have more serious consequences (Letter Number: 215).

Response:

The 500-year time frame was chosen to be as realistic as possible because climatic changes are long-term events; anything less than 500 years seemed inappropriate. When considering the travel time of water through the vadose zone, coupled with the retardation factor for cesium, the total inventory of cesium would decay before it reached groundwater. However, in the case of strontium, travel time of the water coupled with the retardation factor for strontium yields about a 400- to 500-year time period before the strontium could reach the water table and be diluted. Therefore, only the largest inventories of strontium would lead to potentially significant groundwater concentrations if the climate were to become wetter after substantially less than 500 years.

3.5.2.54 Comment:

Reviewers commented that the final EIS must consider the possibility that future precipitation at the Hanford Site may be greater than 30 cm/yr, and that the water table may rise as the result of climate changes induced by the greenhouse effect or volcanic activity. The EIS should also address the possibility of glacial action sooner than 40,000 years and glacial flooding that disperses plutonium from stabilized in-place sites in a way that increases environmental risks (Letter Numbers: 171, 208).

Response:

The draft EIS has addressed climate change (including precipitation), glaciation and glacial flooding in ways which are in concert with available data and expert opinion. The scenarios that have been presented are those which are reasonably extreme in order to avoid unnecessary bias for or against reasonable defense waste disposal alternatives. As for precipitation, the issue is not how much precipitation occurs, but how much of the precipitation is recharged through or past the edges of the barrier.

3.5.2.55 Comment:

One reviewer could find no reference that supported the draft EIS statement, "The 100-year maximum precipitation is considered a reasonable estimate for the mean value of precipitation in a future climate scenario at Hanford (Kukla 1979)" (Letter Number: 223).

Response:

The draft EIS statement was not intended to imply that a "100-year maximum" method was used to predict future climate. Rather, it was intended that a mean value of 30.1 cm/yr, as used in the analysis, was a possible future climate condition and that Kukla (1979) has suggested that a wide range of precipitation (0.5 to 2 or 3 times present values) were possible under various scenarios. A large uncertainty exists in predicting future Hanford climate. The final EIS has been revised in Appendix M to clarify this point. An evaluation of climate change and its effect on barrier performance is a part of the Barrier Development Plan (Adams and Wing 1987).

3.5.3 Groundwater

Recharge

3.5.3.1 Comment:

Reviewers made the following comments: 1) there will be artificial recharge in the 200 Areas from ongoing Hanford Site operations for many years; 2) site characterization activities for the Basalt Waste Isolation Project (BWIP) will use large quantities of water--it was assumed that a maximum of 20% of the irrigation water applied would become groundwater recharge; 3) effects of irrigation on the level of the water table relative to the Wye and 300 Areas might change radionuclide concentrations and travel times, 4) future irrigated farming of the 200 Areas should not be discounted; and 5) contrary to conclusions reached in the draft EIS, there may be downward percolation precipitation on the 200 Areas plateau (Letter Numbers: 215, 217, 223, 231, 234).

Response:

The assumption that little or no recharge of natural precipitation occurs on the 200 Areas plateau due to evapotranspiration is supported by ongoing lysimeter tests (Fayer, Gee and Jones 1986). The perturbations caused by operations and characterization by the BWIP will have disappeared well before the assumed site closure time if the Site is closed in the year 2050.

Where saline waters and saline soils are present, intentional over-irrigation is practiced. The problem is generally associated with shallow water tables and poor drainage. Waters in this area, whether from the river or pumped from deep aquifers, tend to be low in salts and the soils are very deep.

Consequence analysis was not performed for an onsite irrigation scenario. As shown in Figure Q.6, the 15-cm/yr irrigation recharge produces a water table similar to that of the 5-cm/yr climate change scenario on which analyses were based. Travel times for radionuclide transport resulting from irrigation were not incorporated in the long-term performance assessments shown in the draft EIS. The water table distortions caused by irrigation are well beyond the present calibrated limits of the groundwater model.

The assumption that the 200 Area would not be irrigated is based partially on the effectiveness of the monument and marker system, the presence of barriers, severe limitations of