DOE/EIS-0391

Draft Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington

Summary

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Cover Sheet

Responsible Agency: U.S. Department of Energy (DOE)

Cooperating Agency: Washington State Department of Ecology (Ecology)

Title: *Draft Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington* (*TC & WM EIS*) (DOE/EIS-0391)

Location: Benton County, Washington

Contacts: For copies of this draft environmental impact statement (EIS), call toll-free 888-829-6347, or contact Mary Beth Burandt at the address below.

For additional information on this *Draft TC & WM EIS*, contact:

Mary Beth Burandt, Document Manager
Office of River Protection
U.S. Department of Energy
Post Office Box 1178
Richland, WA 99352
Attention: *TC & WM EIS*
Email: TC&WMEIS@saic.com
Fax: 1-888-785-2865
Telephone and voicemail: 888-829-6347

For general information on the DOE National Environmental Policy Act (NEPA) process, contact:

Carol M. Borgstrom, Director
Office of NEPA Policy and Compliance (GC-20)
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585
Telephone: 202-586-4600, or leave a message at 800-472-2756

Abstract: The Hanford Site (Hanford), located in southeastern Washington State and situated along the Columbia River, is approximately 1,518 square kilometers (586 square miles) in size. Hanford's mission from the early 1940s to approximately 1989 included defense-related nuclear research, development, and weapons production activities. These activities created a wide variety of chemical and radioactive wastes. Hanford's mission now is focused on the cleanup of those wastes and ultimate closure of Hanford. To this end, several types of radioactive waste are being managed at Hanford: (1) high-level radioactive waste (HLW) as defined in DOE Manual 435.1-1; (2) transuranic (TRU) waste, which is waste containing alpha-particle-emitting radionuclides with atomic numbers greater than uranium (92) and half-lives greater than 20 years in concentrations greater than 100 nanocuries per gram of waste; (3) low-level radioactive waste (LLW), which is radioactive waste that is neither HLW nor TRU waste; and (4) mixed low-level radioactive waste (MLLW), which is LLW containing hazardous constituents as defined under the Resource Conservation and Recovery Act of 1976 (42 U.S.C 6901 et seq.). Thus, this *TC & WM EIS* analyzes the following three key areas:

1. **Retrieval, treatment, and disposal of waste from 149 single-shell tanks (SSTs) and 28 double-shell tanks (DSTs) and closure of the SST system.** In this *TC & WM EIS*, DOE proposes to retrieve and treat waste from 177 underground tanks and ancillary equipment and dispose of this waste in compliance with applicable regulatory requirements. At present, DOE is constructing a Waste Treatment Plant (WTP) in the 200-East Area of Hanford. The WTP would separate waste stored in Hanford's underground tanks into HLW and low-activity waste (LAW) fractions. HLW would be treated in the WTP and stored at Hanford until disposition decisions are made and implemented. (The analyses in this EIS are not affected by recent DOE plans to study alternatives for the disposition of the Nation's spent nuclear fuel and HLW because the EIS analysis shows that vitrified HLW can be stored safely at Hanford for many years.) LAW would

be treated in the WTP and disposed of at Hanford as decided in DOE's Record of Decision (ROD) issued in 1997 (62 FR 8693), pursuant to the *Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement* (DOE/EIS-0189, August 1996). DOE proposes to provide additional treatment capacity for the tank LAW that can supplement the planned WTP capacity in fulfillment of DOE's obligations under the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) as soon as possible. DOE would dispose of immobilized LAW and Hanford's (and other DOE sites') LLW and MLLW in lined trenches on site. These trenches would be closed in accordance with applicable regulatory requirements.

2. **Final decontamination and decommissioning of the Fast Flux Test Facility, a nuclear test reactor.** DOE proposes to determine the final end state for the aboveground, belowground, and ancillary support structures.

3. **Disposal of Hanford's waste and other DOE sites' LLW and MLLW.** DOE needs to decide where to locate onsite disposal facilities for Hanford's waste and other DOE sites' LLW and MLLW. DOE committed in the ROD (69 FR 39449) for the *Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Washington* (DOE/EIS-0286F, January 2004) that henceforth LLW would be disposed of in lined trenches. Specifically, DOE proposes to dispose of the waste in either the existing 200-East Area Integrated Disposal Facility (IDF) or the proposed 200-West Area IDF.

DOE has identified Preferred Alternatives for two of the three program areas and a range for the three key activities, as presented in this *TC & WM EIS*.

Public Comments: Comments on this draft EIS may be submitted during the 140-day comment period, which will begin when the U.S. Environmental Protection Agency publishes a Notice of Availability in the *Federal Register*. Public meetings on this EIS will be held during the comment period. The dates, times, and locations of these meetings will be published in a DOE *Federal Register* notice, and will also be announced by other means.

Draft Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (Draft TC & WM EIS)

Washington State Department of Ecology (Ecology) Foreword

Note: Ecology, as a cooperating agency, reviewed, provided comments on, and participated in the comment resolution process for the "preliminary draft" of this *Draft TC & WM EIS*. However, this foreword should be considered draft and subject to revision until Ecology has reviewed this *Draft TC & WM EIS* and, if necessary, supporting information.

Summary

Ecology believes that the U.S. Department of Energy (DOE) and its contractors have prepared a *Draft TC & WM EIS* that presents many important issues for discussion. Ecology's involvement to date shows that this document has benefitted from quality reviews and quality assurance procedures. The information in this document will help shed light on many key decisions that remain to be made about the Hanford Site (Hanford) cleanup.

Ecology expects DOE to consider our input through this foreword, as well as through any further comments made during the public comment process. We expect DOE to provide written responses to the major issues and comments prior to completion of the *Final TC & WM EIS*. Ecology will continue to work with DOE with the intent of helping to produce a final environmental impact statement (EIS) that fully informs future decisionmaking.

I. Introduction

Ecology has been a cooperating agency with DOE in the production of this *Draft TC & WM EIS*. DOE prepared this EIS to meet the requirements of the National Environmental Policy Act. In addition, Ecology will review this EIS to determine if it can be adopted in whole or in part to satisfy the requirements of the State Environmental Policy Act (SEPA). The information in this EIS will help inform Ecology and others about critical future cleanup decisions impacting Hanford's closure.

Ecology provides the following comments regarding this *Draft TC & WM EIS* to document areas of agreement or concern with this EIS and to assist the public in their review. Public and regulator input on this *Draft TC & WM EIS* are critical for the completion of an acceptable *Final TC & WM EIS*. Ecology encourages tribal nations, stakeholder groups, and the public to participate in the public comment process for this draft document.

When the *Final TC & WM EIS* is issued, Ecology will include a revised foreword to comment on the EIS conclusions. The foreword will also include the disposition of the comments we provided during the *Draft TC & WM EIS* review process.

II. Ecology's Role as a Cooperating Agency

Ecology is a cooperating agency in the preparation of this EIS. A state agency may be a cooperating agency on a Federal EIS when the agency has jurisdiction by law over, or specialized expertise concerning, a major Federal action under evaluation in the EIS.

As a cooperating agency, Ecology does not coauthor or direct the production of this EIS. Ecology does have access to certain data and information as this document is being prepared by DOE and its contractors. Our roles and responsibilities in this process are defined in a Memorandum of Understanding (MOU) between Ecology and DOE.

DOE retains responsibility for making final decisions in the preparation of the *Final TC & WM EIS*, as well as for determining the preferred alternative(s) presented in the EIS. However, Ecology's participation as a cooperating agency enables us to help formulate the alternatives presented in this *TC & WM EIS*.

Ecology's involvement as a cooperating agency—and the current scope of the *Draft TC & WM EIS*—is grounded in a series of events.

In February 2002, DOE initiated the "Environmental Impact Statement for Retrieval, Treatment, and Disposal of Tank Waste and Closure of Single-Shell Tanks at the Hanford Site, Richland, Washington," known as the "Tank Closure EIS." On March 25, 2003, Ecology became a cooperating agency for the "Tank Closure EIS." DOE and Ecology developed an MOU outlining respective agency roles and responsibilities.

While the "Tank Closure EIS" was being developed, another DOE EIS, the *Draft Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Washington (HSW EIS)*, was in the review stage. Among other matters, the HSW EIS examined the impacts of disposal at Hanford of certain volumes of radioactive waste and mixed radioactive and hazardous waste, including waste generated from beyond Hanford.

In March 2003, Ecology filed a lawsuit in the U.S. District Court seeking to prevent the importation and storage of certain offsite transuranic (TRU) and mixed TRU wastes that DOE had decided to send to Hanford prior to issuance of the *Final HSW EIS*. Ecology and intervening plaintiffs obtained a preliminary injunction against these shipments.

In January 2004, DOE issued the *Final HSW EIS*. Based on the *Final HSW EIS*, DOE amended a Record of Decision that directed offsite radioactive and hazardous wastes to Hanford (within certain volume limits) for disposal and/or storage. In response, Ecology amended its lawsuit to challenge the adequacy of the *HSW EIS* analysis.

In May 2005, the U.S. District Court expanded the existing preliminary injunction to enjoin a broader class of waste and to grant Ecology a discovery period to further explore issues with the *HSW EIS*.

In January 2006, DOE and Ecology signed a Settlement Agreement, ending litigation on the *HSW EIS* and addressing concerns found in the *HSW EIS* quality assurance review during the discovery period. The Settlement Agreement called for expanding the scope of the "Tank Closure EIS" to provide a single, integrated set of analyses of (1) tank closure impacts considered in the "Tank Closure EIS" and (2) the disposal of all waste types considered in the *Final HSW EIS*. The Settlement Agreement also called for an integrated cumulative impacts analysis.

Under the Settlement Agreement, the "Tank Closure EIS" was renamed the *TC & WM EIS*. Ecology's existing MOU with DOE was revised along with the Settlement Agreement so that Ecology remained a cooperating agency on the expanded *TC & WM EIS*.

The Settlement Agreement defined specific tasks to address concerns Ecology had with the *HSW EIS*. DOE has now revised information and implemented quality assurance measures used in this *TC & WM EIS* related to the solid waste portion of the analysis. Ecology has performed discrete quality assurance reviews of that information to help confirm that the quality assurance processes of DOE's EIS contractor have been followed.

Based on Ecology's involvement to date, we believe that positive changes have been made to address data quality shortcomings in the *HSW EIS*. These specifically relate to the following:

- The data used in analyzing impacts on groundwater
- The integration of analyses of all waste types that DOE may dispose of at Hanford
- The adequacy of the cumulative impact analysis

Ecology will review this *Draft TC & WM EIS* to confirm that the terms of the Settlement Agreement have been addressed to our satisfaction.

III. Regulatory Relationships and SEPA

After this *TC & WM EIS* is finalized, Ecology will proceed with approving regulatory actions required to complete the Hanford cleanup. These include actions under the Hanford Federal Facility Agreement and Consent Order (HFFACO, or Tri-Party Agreement) and actions that require state permits or modifications to existing permits, such as the Hanford Sitewide Permit. This permit regulates hazardous waste treatment, storage, and disposal activity at Hanford, including actions such as tank closure and supplemental treatment for tank waste.

Ecology must comply with SEPA when undertaking permitting actions. It is Ecology's hope that the *Final TC & WM EIS* will be suitable for adoption in whole or in part to satisfy SEPA.

In addition, Ecology will have a substantial role in establishing standards and methods for the cleanup of contaminated soil and groundwater at Hanford. These include areas that are regulated under hazardous waste corrective action authority and/or under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) through a CERCLA Record of Decision. Information developed in this EIS will thus be useful in other applications for the cleanup of Hanford.

IV. Ecology Insights and Alternatives Considered

This *Draft TC & WM EIS* considers 17 alternatives. DOE has not identified a specific preferred alternative. However, for the many decisions that are addressed in this EIS, DOE has selected a set of preferred alternatives. Ecology understands that the selection of a smaller number of preferred alternatives, or of a specific preferred alternative from that set, will be considered by DOE throughout public review of the *Draft TC & WM EIS*. When the final EIS is prepared, a preferred alternative will be identified by DOE.

The alternatives and tank closure options considered in this draft EIS include the following key decision areas:

- Additional tank waste treatment options (in addition to the Hanford Waste Treatment Plant [WTP] as provided in the *Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement)*
- Tank farm closure options
- Waste management options for the Central Plateau (including disposal of offsite defense wastes)
- Fast Flux Test Facility (FFTF) decommissioning

Ecology will update this foreword in the *Final TC & WM EIS* and will express its agreement or disagreement with DOE's preferred alternative for specific decisions in the foreword. In the interim, Ecology's insights, technical perspectives, and legal and policy perspectives are provided below. Areas of agreement with DOE and points of concern are noted.

Single-Shell Tank Retrieval Options

Ecology believes that DOE has presented an appropriate range of alternatives for evaluating tank waste retrieval and tank closure impacts. However, based on the hazardous waste tank closure standards of the "Dangerous Waste Regulations" (WAC 173-303-610[2]) and the HFFACO requirements, Ecology supports only alternatives that involve the retrieval of 99 percent or more of the waste from each of the 149 single-shell tanks (SSTs).

High-Level Radioactive Waste Disposal

High-level radioactive waste (HLW) associated with the tank waste includes, but may not be limited to, immobilized high-level radioactive waste (IHLW) and HLW melters (both spent and failed). It has been DOE's longstanding plan to store these wastes at Hanford and then ship and dispose of them in a deep geologic repository. The idea was that the nature of the geology would isolate the waste and protect humans from exposure to these very long-lived, lethal radionuclides. The Nuclear Waste Policy Act indicates that these waste streams require permanent isolation. By contrast, the immobilized low-activity waste (ILAW) glass, and perhaps other waste streams, may not require deep geologic disposal due to the level of pretreatment resulting in radionuclide removal and the degree of immobilization provided for in the ILAW glass.

However, the final decision on HLW disposal has recently become an issue with significant uncertainty. The *Draft TC & WM EIS* contains the following statement:

> As indicated in the Administration's fiscal year 2010 budget request, the Administration intends to terminate the Yucca Mountain program while developing nuclear waste disposal alternatives. Notwithstanding the decision to terminate the Yucca Mountain program, DOE remains committed to meeting its obligations to manage and ultimately dispose of HLW and SNF. The Administration intends to convene a blue ribbon commission to evaluate alternative approaches for meeting these obligations. The commission will provide the opportunity for a meaningful dialogue on how best to address this challenging issue and will provide recommendations that will form the basis for working with Congress to revise the statutory framework for managing and disposing of HLW and SNF.

Ecology reminds the readers that the Nuclear Waste Policy Act requires permanent isolation of these most difficult waste streams. Leaving these wastes stored at Hanford indefinitely is not a legal option, nor an acceptable option to the State of Washington.

Ecology is concerned about the glass standards and canister requirements for the IHLW. These standards were developed based on what was acceptable to Yucca Mountain. Now that Yucca Mountain is no longer the assumed disposal location, Ecology is concerned about what standards for glass and canisters will be utilized by the WTP. Ecology insists that DOE implement the most conservative approach in these two areas to guarantee that the glass and canister configurations adopted at the WTP will be acceptable at the future deep geologic repository.

In addition, Ecology maintains that DOE should build and operate adequate interim storage capacity for the IHLW and the HLW melters in a manner that does not slow down the treatment of tank waste.

This *Draft TC & WM EIS* assumes that the used (both spent and failed) HLW melters are HLW and, therefore, should be disposed of in a deep geologic repository. This EIS also assumes that the used HLW melters will stay on site before shipment to such a repository. DOE has not requested, and Ecology has not accepted, long-term interim storage of failed or spent HLW melters at Hanford.

Ecology does not agree that the HLW melters will or should stay on site. We do agree with the final disposal in a deep geologic repository. The disposal pathway for both the failed and the spent melters will require further evaluation than is presented in this *Draft TC & WM EIS*. Ecology and DOE will need to reach a mutual understanding and agreement on the regulatory framework for disposal.

Pretreatment of Tank Waste

This *Draft TC & WM EIS* includes numerous alternatives that pretreat tank waste to separate the high-activity components and direct them to a HLW stream. The HLW stream will be vitrified, resulting in a glass waste product that will be sent to a deep geologic repository. However, this draft EIS has one alternative that provides no pretreatment for some portion of the waste in the 200-West Area.

As a legal and policy issue, Ecology does not agree with alternatives that do not require pretreatment of the tank waste. Such alternatives do not meet the intent of the Nuclear Waste Policy Act to remove as many of the fission products and radionuclides as possible to concentrate them in the HLW stream. For this reason, Ecology requests that DOE rule out any alternative that does not pretreat tank waste.

TRU Tank Waste

This *Draft TC & WM EIS* considers the option of treating and sending waste from specific tanks to the Waste Isolation Pilot Plant (WIPP) as mixed TRU waste. This draft EIS also considers WTP processing of the waste from these specific tanks.

Ecology has legal and technical concerns with any tank waste being classified as mixed TRU waste at this time. DOE must provide peer-reviewed data and a strong, defensible, technically and legally detailed justification for the designation of any tank waste as mixed TRU waste, rather than as HLW. DOE must also complete the WIPP certification process and assure Ecology that there is a viable disposal pathway (i.e., permit approval from the State of New Mexico) before Ecology will modify the Hanford Sitewide Permit to allow tank waste to be treated as mixed TRU waste.

Supplemental Treatment

In this *Draft TC & WM EIS*, DOE considers changes to the treatment processes that the WTP would use. Specifically, this draft EIS considers technologies to supplement the WTP's treatment of low-activity waste (LAW). The WTP as it is currently designed does not have the capacity to treat the entire volume of LAW in a reasonable timeframe.

Ecology agrees on the need to evaluate supplemental LAW treatment. An additional supplemental LAW treatment system is necessary to treat all the tank waste in a reasonable amount of time. Ecology fully supports the *Draft TC & WM EIS* alternative that assumes a second LAW Vitrification Facility would provide additional waste processing. Building a second LAW Vitrification Facility has consistently been Ecology's baseline approach. We would prefer a second LAW Vitrification Facility as the preferred alternative for the following reasons:

- LAW vitrification is a mature technology that is ready to be implemented with no further testing.
- LAW vitrification produces a well-understood waste form that is extremely protective of the environment (the bulk vitrification waste form is not as protective).

- Negative data from the last bulk vitrification experimental testing indicate waste form performance and technology implementation issues.
- There has been a lack of significant progress on advancing a bulk vitrification test facility for actual waste.
- The environmental results from the waste performance presented in this *Draft TC & WM EIS* indicate that LAW vitrification is superior to bulk vitrification.
- A recently published DOE report indicates that a second LAW Vitrification Facility would be preferable.

Consistent with the standard of HFFACO Milestone M-62-08, Ecology will analyze the information from the bulk vitrification alternative. From this analysis, Ecology will determine if the performance of the waste forms is comparable with WTP borosilicate glass. Ecology's measuring stick for a successful supplemental treatment technology has always been whether it is "as good as glass" (from the WTP).

As a technical issue, Ecology does not think that the waste treatment processes of steam reforming and cast stone would provide adequate primary waste forms for disposal of tank waste in onsite landfills. This has already been the subject of a previous DOE down-select process, in which Ecology and other participants rated these treatment technologies as low. This draft EIS shows that the waste form performance would be inadequate for both cast stone and steam reforming. These alternatives do not merit any further review.

Specifically related to the steam reforming alternative, Ecology has technical concerns about the *Draft TC & WM EIS's* assumptions for contaminant partitioning and its effects on waste form performance. It is inappropriate to assign the same assumptions to steam reforming as those used for bulk vitrification, given the different maturities of the two technologies.

Secondary Waste from Tank Waste Treatment

This *Draft TC & WM EIS* evaluates the impacts of disposing of secondary waste that results from tank waste treatment. Ecology agrees with DOE that secondary waste from the WTP and supplemental treatment operations would need additional mitigation before disposal. This assumption is not reflected in (and, in fact, is contradicted by) the current DOE baseline, which does not assume such additional mitigation. DOE has not determined what the secondary waste treatment would be, but DOE and its contractor are evaluating various treatment options.

Tank Waste Treatment Flowsheet

In preparing this *Draft TC & WM EIS*, some assumptions were made about highly technical issues such as the tank waste treatment flowsheet, which is a representation of how much of which constituent ends up in which waste form and in what amount.

Certain constituents such as technetium-99 and iodine-129 are significant risk drivers because they are mobile in the environment and have long half-lives. This draft EIS assumes that 20 percent of the iodine-129 from the tank waste would end up in vitrified glass and 80 percent in the grouted secondary waste. The same assumption is made for bulk vitrification and the WTP LAW Vitrification Facility.

Based on its review of the *Draft TC & WM EIS's* contaminant flowsheets for the WTP and bulk vitrification, Ecology has technical concerns with this approach. The design configuration for the WTP indicates that iodine-129 recycles past the melter multiple times, which leads to a higher retention in the glass and less in the secondary waste. Therefore, Ecology believes the retention rate of iodine-129 in the

ILAW glass may be higher than that in bulk vitrification glass. However, Ecology is aware that there is uncertainty in the actual glass retention results.

Through our cooperating agency interactions, DOE has agreed to run a sensitivity analysis to show the information under a different approach. The sensitivity analysis in this *Draft TC & WM EIS* shows that if recycling of iodine-129 is as effective as the WTP flowsheets indicate, then the WTP with a Bulk Vitrification Facility alternative would place 80 percent of iodine-129 in secondary waste (a less-robust waste form). This compares to an alternative that includes a second LAW Vitrification Facility in addition to the WTP, which would place 30 percent of the iodine-129 in secondary waste. This 50 percent difference in capture reinforces Ecology's opinion that choosing Tank Closure Alternative 2B, which would use the WTP and a second LAW Vitrification Facility, would be best from a tank waste treatment perspective.

Waste Release

This *Draft TC & WM EIS* models waste releases from several different types of final waste forms, including the following:

- ILAW glass
- Failed and spent LAW melters
- Waste in bulk vitrification boxes
- Steam reformed waste
- Grouted LAW from tank waste
- Grouted secondary waste
- Waste left in waste sites
- Grouted waste in the bottom of tanks
- Direct buried waste in landfills
- Waste that has been macroencapsulated

Ecology understands the methods and formulas used for the waste form release calculations (for all waste types). However, we will need to see the modeling results and complete our technical review before we can validate this portion of this EIS.

Offsite Waste

DOE is decades behind its legal schedule in retrieving tank waste from SSTs and years behind its legal schedule in completing construction of the WTP. DOE has not even begun treating Hanford's 200 million liters (53 million gallons) of tank waste.

At its current pace, DOE is in danger of falling years behind its legal schedule in processing contact-handled TRU waste for disposal at WIPP. DOE has not yet even completed planning for a facility to process remote-handled TRU waste for such disposal. Massive areas of Hanford's soil and groundwater are contaminated, and many of these areas will likely remain contaminated for generations to come, even after final cleanup remedies have been instituted.

The State of Washington is aware that under DOE's plans, more curies of radioactivity would leave Hanford (in the form of vitrified HLW and processed TRU waste) than would be added to Hanford through proposed offsite waste disposal. However, based on the current state of Hanford's cleanup and the analysis in this *Draft TC & WM EIS*, the State of Washington objects to the disposal at Hanford of additional wastes that have been generated from beyond Hanford.

As this *Draft TC & WM EIS* shows, disposal of the proposed offsite waste would significantly increase groundwater impacts to beyond acceptable levels. Such disposal would add to the risk term at Hanford today, at a time when progress on reducing the bulk of Hanford's existing risk term has yet to be realized. DOE should take a conservative approach to ensure that the impact of proposed offsite waste disposal, when added to other existing Hanford risks, does not result in exceeding the "reasonable expectation" standard of DOE's own performance objectives (see DOE Manual 435.1-1, Section IV.P[1]) and of other environmental standards (e.g., drinking water standards).

The State of Washington supports a "no offsite waste disposal" alternative as its preferred alternative in the *Final TC & WM EIS*, to be adopted in a Record of Decision. DOE should forgo offsite waste disposal at Hanford (subject to the exceptions in the current *State of Washington v. Bodman* Settlement Agreement), at least until such time as it has made significant progress on SST waste retrieval and the tank waste treatment process. If DOE wishes to use Hanford as an offsite waste repository after that point, DOE should then re-evaluate the potential impacts of any proposed offsite waste disposal in light of the then-existing Hanford risk term.

Waste Disposal Location Alternatives

Ecology agrees with DOE that a preferred alternative locating the Integrated Disposal Facility in the 200-East Area appears better for long-term disposal of waste than in the 200-West Area because of the faster rate of groundwater flow in the 200-East Area.

Black Rock Reservoir

This *Draft TC & WM EIS* considers the groundwater impacts of locating Black Rock Reservoir upgradient of Hanford. This is noteworthy because leakage associated with the reservoir could have impacts on Hanford groundwater contamination. Ecology has reviewed the evaluation basis assumed in this draft EIS. On a technical basis, Ecology accepts that potential groundwater impacts of the proposed reservoir could (or likely would) adversely impact human health and the environment at Hanford.

Vadose Zone Modeling

This *Draft TC & WM EIS* uses the STOMP [Subsurface Transport Over Multiple Phases] modeling code for vadose zone modeling. Based on its current review, Ecology believes that the Hanford parameters used with this code are adequate for the purposes served by this EIS. Ecology notes that the *TC & WM EIS* STOMP modeling code parameters are based on a regional scale and may not be appropriate for site-specific closure decisions or other Hanford assessments. Use of STOMP in other assessments requires careful technical review and consideration of site-specific parameters. Further revisions of these STOMP parameters may be necessary.

Risk Assessment and Cumulative Impacts

This *Draft TC & WM EIS* evaluates risk under the alternatives and in the cumulative impact analyses. The risk assessment modeling presented in this draft EIS should not be interpreted as a Hanford sitewide comprehensive human health and ecological risk assessment, applied to the river corridor or other specific Hanford areas. Specific Hanford areas will require unique site parameters that are applicable to that area's specific use.

This *Draft TC & WM EIS* presents an evaluation of the cumulative environmental impacts of treatment and disposal of wastes at Hanford. The cumulative impact analyses allow DOE to consider the impacts of all cleanup actions it has taken or plans to take at Hanford.

V. Noteworthy Areas of Agreement

Ecology and DOE have discussed and reached agreement on the following significant issues and parameters for the purposes of this *Draft TC & WM EIS*:

- The manner in which DOE presents groundwater data and information (i.e. with pictures).

- The quality assurance requirements that DOE and Ecology identified in the *HSW EIS* (*State of Washington v. Bodman*) Settlement Agreement
- The Technical Guidance Document for *Tank Closure Environmental Impact Statement Vadose Zone and Groundwater Revised Analyses* Agreement, which focused on parameters shown to be important in groundwater analysis
- The location of calculation points for contaminant concentrations in groundwater
- The use of tank farm closure descriptions and alternative analysis
- The use of tank waste treatment descriptions and alternative analysis
- Inclusion of the US Ecology site and the cocooned reactors transported to the Central Plateau in the comprehensive cumulative impacts assessment
- Overall modeling approaches for vadose zone and groundwater
- The use of modeling assumptions for the double-shell tanks
- Alternative assumptions about how processes would treat existing wastes and generate other wastes during treatment processes, and how DOE would dispose of all of the wastes.
- The methods for evaluating and using waste inventory data
- Release mechanisms for contaminants from various waste forms
- An alternative in this *Draft TC & WM EIS* that evaluates impacts of treating and disposal of all tank waste and residue to meet the Resource Conservation and Recovery Act / Hazardous Waste Management Act HLW treatment standard of vitrification
- The inventory assumptions used for the pre-1970 burial grounds

Ecology's agreement on these issues and parameters is specifically for the purposes of this *Draft TC & WM EIS* and is based on Ecology's current knowledge and best professional judgment. Ecology's agreement should not be construed as applicable to any future documents, evaluations, or decisions at Hanford.

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List of Abbreviations and Acronyms

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CEQ	Council on Environmental Quality
CFR	*Code of Federal Regulations*
COPC	constituent of potential concern
CWC	Central Waste Complex
DOE	U.S. Department of Energy
DST	double-shell tank
Ecology	Washington State Department of Ecology
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ETF	Effluent Treatment Facility
FONSI	Finding of No Significant Impact
FFTF	Fast Flux Test Facility
"FFTF Decommissioning EIS"	"Environmental Impact Statement for the Decommissioning of the Fast Flux Test Facility at the Hanford Site, Richland, Washington" (rescoped in 2006 to the *TC & WM EIS*)
FR	*Federal Register*
Hanford	Hanford Site
Hanford Comprehensive Land-Use Plan EIS	*Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*
HLW	high-level radioactive waste
HSW EIS	*Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Washington*
IDF	Integrated Disposal Facility
IDF-East	200-East Area Integrated Disposal Facility
IDF-West	200-West Area Integrated Disposal Facility
IHLW	immobilized high-level radioactive waste
ILAW	immobilized low-activity waste
INL	Idaho National Laboratory
LAW	low-activity waste
LLBG	low-level radioactive waste burial ground
LLW	low-level radioactive waste
MFC	Materials and Fuels Complex
MLLW	mixed low-level radioactive waste
NEPA	National Environmental Policy Act

List of Abbreviations and Acronyms *(continued)*

NI PEIS	*Final Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility (Nuclear Infrastructure PEIS)*
NOI	Notice of Intent
ORP	Office of River Protection
PM_{10}	particulate matter with an aerodynamic diameter less than or equal to 10 micrometers
PPF	Preprocessing Facility
RCB	Reactor Containment Building
RCRA	Resource Conservation and Recovery Act
RH-SC	remote-handled special component
ROD	Record of Decision
ROI	region of influence
RPP	River Protection Project
RPPDF	River Protection Project Disposal Facility
RTP	Remote Treatment Project
SA	supplement analysis
SEPA	State Environmental Policy Act (Washington)
SNF	spent nuclear fuel
SPF	Sodium Processing Facility
SRF	Sodium Reaction Facility
SST	single-shell tank
"Tank Closure EIS"	"Environmental Impact Statement for Retrieval, Treatment, and Disposal of Tank Waste and Closure of Single-Shell Tanks at the Hanford Site, Richland, Washington" (rescoped in 2006 to the *TC & WM EIS*)
TC & WM EIS	*Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*
TPA	Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement)
TRU	transuranic
TWRS EIS	*Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement*
WESF	Waste Encapsulation and Storage Facility
WIPP	Waste Isolation Pilot Plant
WM PEIS	*Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*
WRAP	Waste Receiving and Processing Facility
WRF	waste receiver facility
WTP	Waste Treatment Plant

Measurement Units

The principal measurement units used in this *Draft Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (TC & WM EIS)* are SI units (the abbreviation for the Système International d'Unités). The SI is an expanded version of the metric system that was accepted in 1966 in Elsinore, Denmark, as the legal standard by the International Organization of Standardization. In this system, most units are made up of combinations of seven basic units, of which length in meters, mass in kilograms, and volume in liters are of most importance in this *TC & WM EIS*. Exceptions are radiological units that use the English system (e.g., rem, millirem).

Scientific (Exponential) Notation

Numbers that are very small or very large are often expressed in scientific, or exponential, notation as a matter of convenience. For example, the number 0.000034 may be expressed as 3.4×10^{-5} or 3.4E−05, and 65,000 may be expressed as 6.5×10^{4} or 6.5E+04. In this *TC & WM EIS*, numerical values that are less than 0.001 or greater than 9,999 are generally expressed in scientific notation, i.e., 1.0×10^{-3} and 9.9×10^{3}, respectively.

Multiples or submultiples of the basic units are also used. A partial list of prefixes that denote multiples and submultiples follows, with the equivalent multiplier values expressed in scientific notation.

Prefix	**Symbol**	**Multiplier**	
atto	a	0.000 000 000 000 000 001	1×10^{-18}
femto	f	0.000 000 000 000 001	1×10^{-15}
pico	p	0.000 000 000 001	1×10^{-12}
nano	n	0.000 000 001	1×10^{-9}
micro	μ	0.000 001	1×10^{-6}
milli	m	0.001	1×10^{-3}
centi	c	0.01	1×10^{-2}
deci	d	0.1	1×10^{-1}
deka	da	10	1×10^{1}
hecto	h	100	1×10^{2}
kilo	k	1,000	1×10^{3}
mega	M	1,000,000	1×10^{6}
giga	G	1,000,000,000	1×10^{9}
tera	T	1,000,000,000,000	1×10^{12}
peta	P	1,000,000,000,000,000	1×10^{15}
exa	E	1,000,000,000,000,000,000	1×10^{18}

The following symbols are occasionally used in conjunction with numerical expressions:

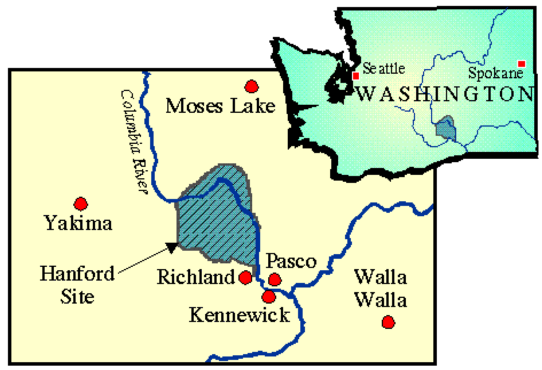
$<$ less than
$\leq$ less than or equal to
$>$ greater than
$\geq$ greater than or equal to

Conversions

English to Metric			Metric to English		
Multiply	**by**	**To get**	**Multiply**	**by**	**To get**
Area			**Area**		
square inches	6.4516	square centimeters	square centimeters	0.155	square inches
square feet	0.092903	square meters	square meters	10.7639	square feet
square yards	0.8361	square meters	square meters	1.196	square yards
acres	0.40469	hectares	hectares	2.471	acres
square miles	2.58999	square kilometers	square kilometers	0.3861	square miles
Length			**Length**		
inches	2.54	centimeters	centimeters	0.3937	inches
feet	30.48	centimeters	centimeters	0.0328	feet
feet	0.3048	meters	meters	3.281	feet
yards	0.9144	meters	meters	1.0936	yards
miles	1.60934	kilometers	kilometers	0.6214	miles
Temperature			**Temperature**		
degrees Fahrenheit	Subtract 32, then multiply by 0.55556	degrees Celsius	degrees Celsius	Multiply by 1.8, then add 32	degrees Fahrenheit
Volume			**Volume**		
fluid ounces	29.574	milliliters	milliliters	0.0338	fluid ounces
gallons	3.7854	liters	liters	0.26417	gallons
cubic feet	0.028317	cubic meters	cubic meters	35.315	cubic feet
cubic yards	0.76455	cubic meters	cubic meters	1.308	cubic yards
Weight			**Weight**		
ounces	28.3495	grams	grams	0.03527	ounces
pounds	0.45360	kilograms	kilograms	2.2046	pounds
short tons	0.90718	metric tons	metric tons	1.1023	short tons

SUMMARY

S.1 INTRODUCTION



The U.S. Department of Energy (DOE) prepared this *Draft Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (TC & WM EIS)*, which revises and updates previous analyses, to address the potential environmental impacts of three sets of proposed activity at the Hanford Site (Hanford):

- **Tank Closure.** Tank closure includes management of the waste inventory of about 55 million gallons of mixed radioactive and chemically hazardous waste, currently stored in underground storage tanks. The analysis considers tank waste storage, retrieval, treatment, and disposal, as well as the impacts of different scenarios for final closure of the single-shell tank (SST) system.
- **Fast Flux Test Facility (FFTF) Decommissioning.** This environmental impact statement (EIS) includes proposed activities to decommission FFTF, a nuclear test reactor at Hanford, including management of decommissioning-generated waste, such as remote-handled special components (RH-SCs), and disposition of Hanford's inventory of radioactively contaminated bulk sodium from FFTF and other onsite facilities.
- **Waste Management.** This EIS evaluates the potential impacts of ongoing solid waste management operations at Hanford, as well as the proposed disposal of low-level radioactive waste (LLW) and mixed low-level radioactive waste (MLLW) from Hanford and a limited volume of LLW and MLLW from other DOE sites in an Integrated Disposal Facility(ies) (IDF) located at Hanford.

This *TC & WM EIS* describes the potential environmental impacts and cost consequences of the proposed actions and reasonable alternatives for the major activities cited above. It was prepared in accordance with the National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. 4321 et seq.); DOE implementing procedures for NEPA (10 CFR 1021); and Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 CFR 1500–1508). Further, this EIS implements a Settlement Agreement signed on January 6, 2006, by DOE, the Washington State Department of Ecology (Ecology), and the Washington State Attorney General's Office. The agreement settles NEPA claims made in the case *State of Washington v. Bodman* (Civil No. 2:03-cv-05018-AAM), which addressed the *Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Washington (HSW EIS)* (DOE 2004). Ecology is participating in this NEPA activity as a cooperating agency; as such, it is responsible for reviewing the content of this *TC & WM EIS* under authority of Washington's State Environmental Policy Act (RCW 43.21C) to ensure it satisfies the State of Washington's requirements and supports its proposed action to issue permits under its hazardous waste program.

What is the Purpose of an Environmental Impact Statement (EIS)?

The primary purpose of an EIS is to serve as an action-forcing device to insure that the policies and goals defined in the National Environmental Policy Act are infused into the ongoing programs and actions of the Federal government. An EIS provides a full and fair discussion of potential significant environmental impacts and informs decision-makers and the public of the reasonable alternatives that would avoid or minimize adverse impacts or enhance the quality of the human environment. An EIS is used by Federal officials in conjunction with other relevant information to plan actions and make decisions (40 CFR 1502.1).

The information provided in this EIS will be considered, along with other pertinent information, in the final decision process for DOE's proposed actions.

S.1.1 History of the Hanford Site

Hanford occupies approximately 586 square miles in southeastern Washington State along the Columbia River. From the 1940s to 1989, Hanford's mission encompassed defense-related nuclear research, development, and weapons production activities. This included operation of a plutonium production complex with nine nuclear reactors and associated facilities.

To produce plutonium, uranium metal (fuel rods) was irradiated in reactors located near the Columbia River. The irradiated uranium metal (spent nuclear fuel [SNF]) was cooled and treated through chemical separation in reprocessing plants in the central part of Hanford. At the reprocessing plants, the SNF was dissolved in acid and the plutonium was separated from the remaining uranium and byproducts and used for nuclear weapons production.

Hanford's SNF reprocessing generated several hundred thousand metric tons of chemical and radioactive waste. Included were high-level radioactive waste (HLW), transuranic (TRU) waste, LLW, MLLW, and hazardous waste. The waste management process initially involved neutralizing the acidic waste with sodium hydroxide and sodium carbonate and storing the resulting caustic waste in large underground tanks until a long-term disposal solution could be found. From 1943 through early 1964, 149 SSTs were built to store waste in the 200 Areas of Hanford.

During the 1950s, uranium was extracted from some of the waste stored in SSTs, which introduced new chemicals to the tanks. Beginning in the 1960s, some waste was retrieved from SSTs and transferred to the B Plant at Hanford, where cesium and strontium were extracted, placed in capsules, and stored in a separate facility. This process removed approximately 40 percent of the fission product inventory from the tank waste. The remaining waste was returned to the tanks.

Waste Types Analyzed in This Environmental Impact Statement

Hazardous waste: A category of waste regulated under the Resource Conservation and Recovery Act (RCRA) (42 U.S.C. 6901 et seq.). To be considered hazardous, a waste must (1) be a solid waste under RCRA; (2) exhibit at least one of the four characteristics described in 40 CFR 261.20 through 261.24 (ignitability, corrosivity, reactivity, or toxicity); or (3) be specifically listed by the U.S. Environmental Protection Agency (EPA) in 40 CFR 261.31 through 261.33. Hazardous waste may also include solid waste designated as dangerous or extremely hazardous waste by the State of Washington in *Washington Administrative Code* Sections 173-303-070 through 173-303-100.

High-level radioactive waste (HLW): Highly radioactive waste material resulting from reprocessing of spent nuclear fuel (SNF), including liquid waste produced directly from reprocessing; any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and other highly radioactive material that is determined, consistent with existing law, to require permanent isolation (DOE Manual 435.1-1).

Low-activity waste (LAW): Waste that remains after as much radioactivity as technically and economically practical has been separated from HLW that, when solidified, may be disposed of as low-level radioactive waste (LLW) in a near-surface facility. In its final form, such solid LAW would not exceed 10 CFR 61.55 Class C radioisotope limits and would meet performance objectives comparable to those in 10 CFR 61, Subpart C. At the Hanford Site, this is mixed waste.

Low-level radioactive waste (LLW): Radioactive waste that is not HLW, SNF, transuranic (TRU) waste, byproduct material as defined in the Atomic Energy Act of 1954, as amended (42 U.S.C. 2011 et seq.), or naturally occurring radioactive material.

Mixed waste: Waste that contains source, special nuclear, or byproduct material that is subject to the Atomic Energy Act of 1954, as amended (42 U.S.C. 2011 et seq.), as well as a hazardous component subject to RCRA.

Transuranic (TRU) waste: Radioactive waste products containing more than 100 nanocuries (3,700 becquerels) of alpha-emitting TRU isotopes per gram of waste with half-lives greater than 20 years, except (1) HLW; (2) waste that does not need the degree of isolation required by the disposal regulations detailed in 40 CFR 191, as determined by the Secretary of Energy with the concurrence of the EPA Administrator; or (3) waste that the U.S. Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR 61.

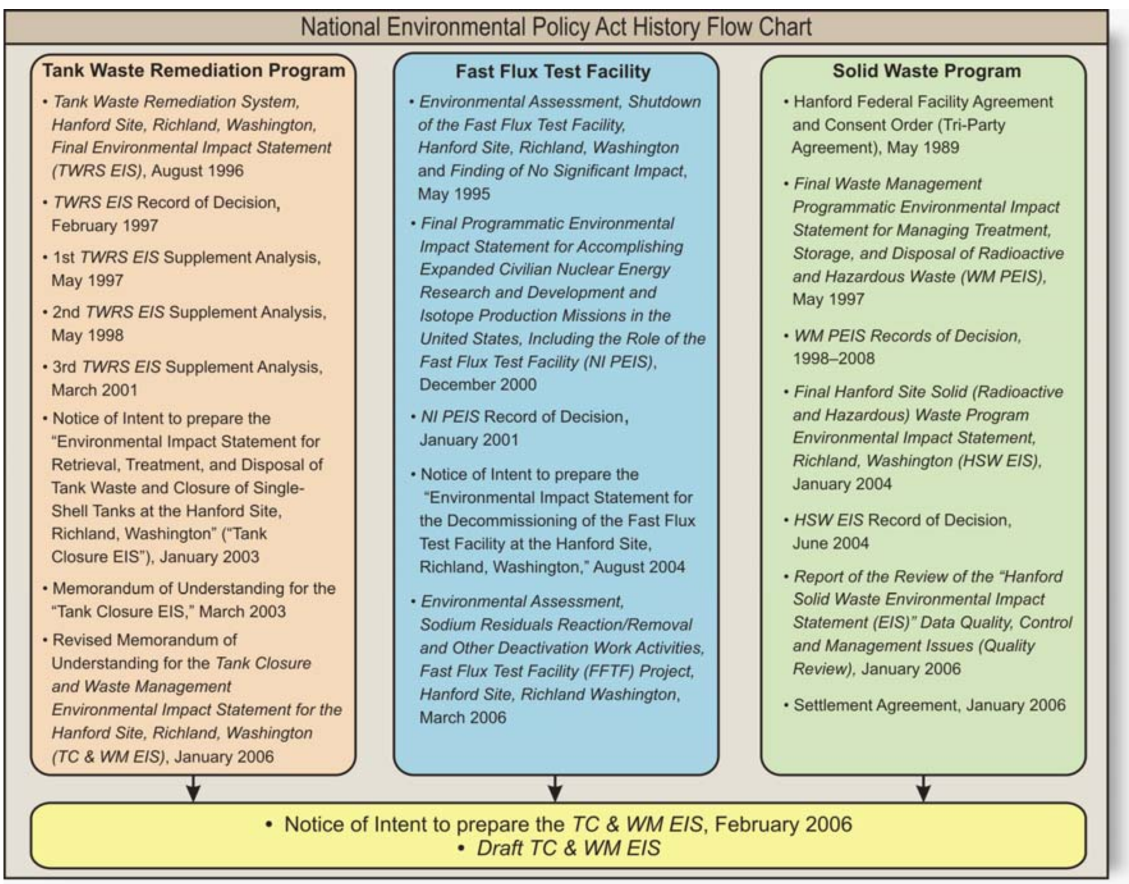
In the mid-1950s, leaks were suspected or detected in some SSTs. To address concerns about SST designs, Hanford adopted a new double-shell tank (DST) design, which would allow for detection of leaks and effective corrective actions before the waste could reach the surrounding soil. Between 1968 and 1986, 28 DSTs were constructed and filled with liquids pumped from SSTs that were interim-stabilized to minimize the potential for future leaks. The interim stabilization program was completed in 2004 (except for one tank). Newly generated waste is also stored in the DSTs.

> **What are single-shell tanks?**
>
> Single-wall underground storage tanks of varying size with carbon steel sides and bottom surrounded by reinforced-concrete shells.
>
> **What are double-shell tanks?**
>
> Carbon steel tanks built with external carbon steel–lined reinforced-concrete tanks, providing improved leak detection and waste containment.

DOE is processing Hanford's contact-handled TRU waste (which does not require special protective shielding) for shipment to the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico, consistent with previous Records of Decision (RODs) (63 FR 3629, 65 FR 10061) that address treatment and disposal of TRU waste (DOE 1997a, 1997b). DOE is disposing of Hanford's LLW and MLLW on site and has designated Hanford as a regional disposal site for LLW and MLLW from other DOE sites.

S.1.2 NEPA and Program Activities Leading Up to This *TC & WM EIS*

The history of this *TC & WM EIS* is complex, with a trail of NEPA documentation behind each of the proposed activities. The following flowchart provides a chronology of key, relevant documents that contributed to the development of this EIS. The subsequent sections briefly summarize the history of each of the three sets of proposed actions and present a timeline of events for each set.



S.1.2.1 Tank Waste Remediation Program

The following timeline provides a brief history of the tank waste remediation program and DOE's decisions regarding its status.

1991–1998: The Tank Waste Remediation System, a DOE organization, manages all aspects of Hanford's tank farms.

1996: DOE and Ecology coauthor the *Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement (TWRS EIS)* (DOE and Ecology 1996), consistent with the requirements of NEPA (10 CFR 1021) and Washington's State Environmental Policy Act (RCW 43.21C). The EIS evaluates the range of reasonable alternatives to manage and dispose of radioactive, hazardous, and mixed wastes stored in the Hanford tanks.

> Following issuance of the *Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement* Record of Decision, the U.S. Department of Energy has made progress in a number of areas identified as issues/concerns in the National Research Council's report. For example, past leaks and spills are being characterized and contaminant fate and transport uncertainties are being addressed through Resource Conservation and Recovery Act facility investigations, and new data have been incorporated into the conceptual models used to evaluate environmental impacts in this *Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*. Additionally, significant advances have been made in the design, testing, construction, and estimates of costs associated with vitrification of tank waste in the Waste Treatment Plant. Supplemental treatment technologies are also being considered in this environmental impact statement.

After issuing the Final *TWRS EIS*, DOE receives comments on the *Draft TWRS EIS* in the form of a National Research Council report, entitled *The Hanford Tanks: Environmental Impacts and Policy Choices* (National Research Council 1996), and addresses those comments in the *Final TWRS EIS* ROD. Conspicuous among the comments is that significant uncertainties limit DOE's ability to select a final disposal alternative for all tank waste and that DOE should consider remediation alternatives that involve both removal and treatment of waste and the advantages of in-place treatment versus isolation. The Council also recommends that DOE consider a phased decision strategy that incorporates multiple alternatives to allow the program to move forward.

> **What is the Phased Implementation Alternative?**
>
> The Preferred Alternative stipulated in the *Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement* involves a two-phase approach to tank waste treatment: an initial demonstration phase lasting approximately 10 years and a second phase in which large, production-level waste treatment plants would treat the remainder of the tank waste by 2028. Tank waste would be separated into high-level radioactive waste and low-activity waste (LAW) streams and vitrified. The LAW would be disposed of on site at the Hanford Site.

***February 1997*:** DOE publishes the *TWRS EIS* ROD (62 FR 8693), deciding to implement the Preferred Alternative (Phased Implementation). The *TWRS EIS* ROD defers the matter of tank closure pending development of further information and commits to future NEPA evaluations of the tank waste remediation program to determine whether previous decisions should be changed. The ROD also incorporates proposed design, construction, and operation of waste treatment facilities; tank farm operation and maintenance; and plans for transferal of waste from the tanks to treatment facilities.

May 1997: DOE publishes the first of three *TWRS EIS* supplement analyses (SAs) (DOE 1997c), consistent with its commitment to conduct periodic evaluations under NEPA. Upon examining the potential environmental impacts of tank farm infrastructure upgrades, e.g., upgrades of instrumentation and control, tank ventilation, and waste transfer, DOE concludes that the potential impacts would be minor in comparison with, and are enveloped by, the impacts previously assessed under the Phased Implementation Alternative.

1998: Congress creates the Office of River Protection (ORP) as required by the Strom Thurmond National Defense Authorization Act for Fiscal Year 1999 (P.L. 105-261). ORP's manager is responsible for all aspects of Hanford's tank farm operations, including oversight of the River Protection Project (RPP).

May 1998: DOE issues the second *TWRS EIS* SA (DOE 1998), addressing the impacts of emergent information on the design and construction of a new waste treatment plant under the privatization approach. DOE concludes that the information developed since preparation of the *TWRS EIS* only minimally affects the previously estimated impacts and that the *TWRS EIS* impacts discussion sufficiently covers the changes in environmental impacts.

July 1999: DOE issues DOE Order 435.1, *Radioactive Waste Management*, identifying retrieval goals as part of the HLW tank closure requirements

March 2001: DOE issues the third *TWRS EIS* SA (DOE 2001), considering information developed since approval of the *TWRS EIS* ROD relative to plans for treating Hanford tank waste. DOE concludes that no further NEPA review is needed prior to starting construction of Phase I treatment facilities, and that proposed changes to Phase II facilities to meet the goal of SST retrieval by 2018 will be included within the scope of a future NEPA analysis.

2002: DOE begins retrieval activities on the C-106 tank, an SST, consistent with Hanford Federal Facility Agreement and Consent Order, also known as the Tri-Party Agreement (TPA) (Ecology, EPA, and DOE 1989) Milestone M-45-00.

What is the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement)?

It is an agreement signed in 1989 by the U.S. Department of Energy, the U.S. Environmental Protection Agency, and the Washington State Department of Ecology that identifies milestones for key environmental restoration and waste management actions. One such milestone, M-45-00, established a 99 percent retrieval rate as a goal of tank closure activities at the Hanford Site.

January 2003: DOE publishes a Notice of Intent (NOI) (68 FR 1052) in the *Federal Register* to prepare the "Environmental Impact Statement for Retrieval, Treatment, and Disposal of Tank Waste and Closure of Single-Shell Tanks at the Hanford Site, Richland, Washington" ("Tank Closure EIS") (DOE/EIS-0356), which includes closure of the 149 SSTs and an analysis of newly available information on supplemental treatment of a portion of the low-activity waste (LAW) from all 177 tanks.

March 2003: DOE and Ecology sign a Memorandum of Understanding, effective March 25, 2003, that identifies Ecology as a cooperating agency in the preparation of the "Tank Closure EIS" and assists both agencies in meeting their respective responsibilities under NEPA and Washington's State Environmental Policy Act (SEPA) (RCW 43.21C).

January 2006: DOE and Ecology revise the original Memorandum of Understanding for the "Tank Closure EIS." The revision, signed January 6, 2006 (DOE and Ecology 2006), is consistent with the Settlement Agreement (see Section S.1.2.3 for a description of this agreement) and provides for Ecology's continuing participation as a cooperating agency in preparing this *TC & WM EIS*.

February 2006: DOE issues an NOI for the preparation of this *TC & WM EIS* (71 FR 5655).

Since issuance of the *TWRS EIS* ROD and subsequent SAs (see timeline discussion above), DOE has proceeded with plans to design, construct, and operate facilities that would separate waste into HLW and LAW streams, vitrify the HLW stream, and immobilize the LAW stream. These facilities are now under construction in the 200-East Area of Hanford and are collectively referred to as the "Waste Treatment Plant" (WTP). The WTP is the cornerstone of DOE's treatment capability for tank waste. The WTP will separate waste stored in Hanford's underground tanks into HLW and LAW fractions. HLW will be vitrified in the WTP and stored at Hanford until disposition decisions are made and implemented. Immobilized low-activity waste (ILAW) would be produced at the WTP.

Design of, and preliminary performance projections for, the WTP supports DOE's proposal to extend operations beyond the 10-year period (Phase I) originally planned in the *TWRS EIS* ROD. DOE also plans to enhance the throughput of the WTP rather than deploy a second, larger-scale treatment facility in 2012, as identified in the *TWRS EIS* ROD (Phase II). DOE determined that the original plan for a Phase II WTP would be prohibitively expensive, and it was believed that the enhanced WTP would implement the *TWRS EIS* ROD. Accordingly, DOE changed the mission of the WTP from demonstration plant to single, full-scale production facility.

Another change since issuance of the third SA concerns the design of the WTP Pretreatment Facility. The original design of that facility provided for the removal of technetium from the HLW stream. However, in light of reviews of technetium-99 in ILAW glass, DOE and Ecology agreed to delete technetium removal from the WTP permit (Hedges 2008). Thus, the design of the Pretreatment Facility, which is currently under construction, includes no provision for technetium-99 removal. For analysis purposes, however, this *TC & WM EIS* assumes that, with appropriate design and construction modifications, a technetium-99 removal capability could be added if required.

Issues facing DOE include uncertainties associated with the magnitude of waste retrieval required. DOE began waste retrieval from SSTs in 2002 with the C-106 tank, consistent with TPA Milestone M-45-00. Since completion of waste retrieval from that tank, retrieval from six other tanks has been completed. TPA Milestone M-45-00 specifies that closure will follow retrieval of as much tank waste as technically possible, the goal being 99 percent retrieval. The TPA's "Single Shell Tank Waste Retrieval Criteria Procedure" provides a procedure by which DOE can request an exception to this criterion if it deems it not to be achievable. This EIS provides information needed to make informed decisions regarding the impacts of meeting or not meeting the 99 percent retrieval goal.

S.1.2.2 Fast Flux Test Facility

The following timeline provides a brief look at the history of FFTF operations and DOE decisions regarding its status.

> The **Fast Flux Test Facility** is a U.S. Department of Energy–owned, formerly operating, 400-megawatt (thermal) liquid-metal (sodium)-cooled research and test reactor located in the 400 Area of the Hanford Site.

1978: FFTF construction is completed.

1980: Initial operations begin.

April 1982–April 1992: FFTF operates as a national research facility testing advanced nuclear fuels, materials, and components; nuclear power plant operations and maintenance protocols; and reactor safety designs. It also produces various medical and industrial isotopes, as well as hydrogen-3 (tritium) for the U.S. Fusion Research Program, and conducts cooperative international research work.

December 1993: DOE orders FFTF shutdown due to a lack of economically viable missions.

1994: Ecology, the U.S. Environmental Protection Agency, and DOE negotiate, under TPA authority, a set of transition phase milestones and targets for FFTF deactivation and shutdown (the first step toward FFTF decommissioning) (Ecology, EPA, and DOE 1995).

May 1995: An evaluation of impacts of FFTF deactivation in the *Environmental Assessment, Shutdown of the Fast Flux Test Facility, Hanford Site, Richland, Washington* results in a Finding of No Significant Impact (DOE 1995a).

1994–1997: Fuel is removed from the reactor vessel for storage in aboveground dry storage casks, and some nonessential FFTF operating systems are deactivated.

January 1997: The Secretary of Energy orders FFTF to be maintained in a standby condition while DOE evaluates its future role in tritium production. Consequently, FFTF transition work is limited to activities that would not inhibit a reactor restart.

1998: The TPA agencies revise the work schedules under the TPA M-81-00 series milestones (Ecology, EPA, and DOE 1999), which cover FFTF deactivation. The agencies' "Tentative Agreement" is issued for public comment and, as a result of the comments received, it is agreed that TPA M-81-00 series milestones and target dates will be temporarily suspended until the Secretary issues a final decision regarding the potential restart of FFTF.

December 1998: The Secretary announces that FFTF will not play a role in tritium production and that any other future FFTF mission decisions will be made by spring 1999.

May 1999: DOE initiates a two-phase process for finalizing a path forward for FFTF that includes development and review of a program-scoping plan.

December 2000: DOE issues the *Final Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility (Nuclear Infrastructure PEIS [NI PEIS])* (DOE 2000a) to document analyses of the potential expansion of domestic civilian nuclear energy research and development and isotope production using existing and new resources. In the *NI PEIS*, DOE evaluates the use of FFTF as an alternative irradiation services facility to accomplish these missions.

January 2001: In the *NI PEIS* ROD (66 FR 7877), DOE rules out the use of FFTF for isotope production and research missions and reaffirms its decision to permanently deactivate the facility.

April 2001: DOE suspends the decision made in the *NI PEIS* ROD to resume permanent FFTF deactivation while additional reviews of that decision are conducted.

December 2001: DOE decides to proceed with FFTF deactivation, including dry cask storage of irradiated fuel, dry storage of nonirradiated and sodium-bonded fuel, sodium draining and storage, and deactivation of the auxiliary plant systems.

2002: The TPA M-81-00 milestones are re-established and are revised to reflect the new due dates for FFTF deactivation activities (Ecology, EPA, and DOE 2002).

Late 2002: FFTF deactivation activities are temporarily suspended due to legal challenges by Benton County alleging that the 1995 environmental assessment is inadequate and that a full NEPA EIS on the complete decommissioning process should have been completed before any deactivation occurred.

February 28, 2003: The U.S. District Court of Eastern Washington rules in favor of DOE's decision to address only FFTF deactivation in the 1995 environmental assessment. Benton County subsequently appeals the U.S. District Court's ruling to the U.S. Ninth Circuit Court of Appeals, but files on May 6, 2003, a motion to dismiss the appeal.

August 2004: DOE issues an NOI for the preparation of the "Environmental Impact Statement for the Decommissioning of the Fast Flux Test Facility at the Hanford Site, Richland, Washington" ("FFTF Decommissioning EIS") (69 FR 50176).

February 2006: DOE issues an NOI for the preparation of this *TC & WM EIS* (71 FR 5655).

March 2006: DOE issues the *Environmental Assessment, Sodium Residuals Reaction/Removal and Other Deactivation Work Activities, Fast Flux Test Facility (FFTF) Project, Hanford Site, Richland, Washington* (DOE 2006a), addressing continuation of ongoing FFTF deactivation work that was not extensively discussed in the *Environmental Assessment, Shutdown of the Fast Flux Test Facility, Hanford Site, Richland, Washington* (DOE 1995a). The final FFTF decommissioning end state is addressed in this *TC & WM EIS*.

In previous NEPA reviews and associated RODs, DOE evaluated transportation, storage, treatment, use, and disposal of FFTF fuel at various DOE sites (DOE 1995a, 1995b, 1997d, 1999a, 2000b). Ongoing activities associated with management of the FFTF fuel are not evaluated in this EIS.

S.1.2.3 Hanford Solid Waste Program

The following timeline provides a brief history of Hanford's program to manage its waste inventories.

May 1989: Beginning in 1986, Ecology and EPA work with DOE to examine how to bring Hanford into compliance with Resource Conservation and Recovery Act (RCRA) and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The regulators and DOE agree to develop one compliance agreement that sets milestones for cleaning up past disposal sites under CERCLA and bringing operating facilities into compliance with RCRA. Negotiations conclude in late 1988, the Hanford Federal Facility Agreement and Consent Order, also known as the Tri-Party Agreement (TPA), is completed in 1988 and signed in 1989 (Ecology, EPA, and DOE 1989).

May 1997: DOE issues the *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste (WM PEIS)* (DOE 1997a), a DOE complex–wide study examining the environmental impacts of managing more than 2 million cubic meters (2.7 million cubic yards) of radioactive waste from past, present, and future DOE activities. DOE would conduct further NEPA reviews regarding the specific location of new facilities at selected sites, as appropriate.

1998–2008: DOE issues *WM PEIS* RODs for management of LLW, MLLW, HLW, TRU waste, and hazardous waste. Analyses of alternatives in this *TC & WM EIS* are consistent with, and tier from, DOE complex–wide policies and practices that have been described in the various *WM PEIS* RODs for each waste type. For example, Hanford is designated as a regional disposal site for LLW and MLLW from other DOE sites and is disposing of Hanford's LLW and MLLW on site.

March 2003: Ecology initiates litigation on issues related to importation, treatment, and disposal of radioactive and hazardous wastes generated off site as a result of nuclear defense and research activities. The court enjoins shipment of offsite TRU waste to Hanford for processing and storage pending shipment to WIPP.

January 2004: DOE issues the *Final HSW EIS* (DOE 2004), addressing ongoing solid waste management operations.

June 2004: DOE issues the *HSW EIS* ROD (69 FR 39449) announcing DOE's decision to dispose of Hanford LLW and MLLW and a limited volume of offsite LLW and MLLW in a new IDF in the 200-East Area (IDF-East) of Hanford.

2004: Ecology amends its 2003 complaint, challenging the adequacy of the *HSW EIS* analysis of offsite waste importation.

May 2005: The court grants a limited discovery period and continues its injunction against shipping offsite waste to Hanford.

July 2005: While preparing responses to Ecology's discovery requests, DOE contractor Battelle Memorial Institute, which assisted in preparing the *HSW EIS*, advises DOE of several differences in groundwater analyses between the *HSW EIS* and its underlying data. DOE notifies the court and the State of Washington.

September 2005: DOE convenes a team of experts in quality assurance, groundwater analysis, transportation, and human health and safety impacts analysis to conduct a quality assurance review of the *HSW EIS*.

January 2006: DOE's team completes its *Report of the Review of the "Hanford Solid Waste Environmental Impact Statement (EIS)" Data Quality, Control and Management Issues* (DOE 2006b).

January 6, 2006: DOE, Ecology, and the Washington State Attorney General's Office sign a Settlement Agreement ending the NEPA litigation (*State of Washington v. Bodman* [Civil No. 2:03-cv-05018-AAM]) and resolving Ecology's concerns, as well as addressing other concerns raised in the *Report of the Review of the "Hanford Solid Waste Environmental Impact Statement (EIS)" Data Quality, Control and Management Issues* (DOE 2006b). The agreement also calls for expanding the "Tank Closure EIS" to provide a single, integrated set of analyses that includes all waste types analyzed in the *HSW EIS* (LLW, MLLW, and TRU waste).

Under the agreement, pending finalization of this *TC & WM EIS*, the *HSW EIS* remains in effect to support ongoing waste management activities at Hanford (including transportation of TRU waste to WIPP) in accordance with regulations. The agreement also stipulates that this *TC & WM EIS* will supersede the *HSW EIS* upon completion. Until then, DOE will not rely on *HSW EIS* groundwater analyses for decisionmaking and will not import offsite waste to Hanford, apart from certain limited exemptions specified in the agreement.

February 2006: DOE issues an NOI for the preparation of this *TC & WM EIS* (71 FR 5655).

April 2006: Two cells of IDF-East are constructed. DOE decides to continue sending Hanford's MLLW off site for treatment and to modify Hanford's T Plant for processing remote-handled TRU waste and MLLW.

S.1.3 Purpose and Need for Agency Action

DOE needs to take action to accomplish the following objectives:

- Safely retrieve and treat radioactive, hazardous, and mixed tank waste; close the SST system; and store and/or dispose of the waste generated from these activities at Hanford. Further, DOE needs to treat the waste and close the SST system in a manner that complies with Federal and applicable Washington State laws and DOE directives to protect human health and the environment. Long-term actions are required to permanently reduce the risk to human health and the environment posed by waste in the 149 SSTs and 28 DSTs.

- Decommission FFTF and its support facilities at Hanford, manage waste associated with decommissioning the facilities, and manage disposition of the radioactively contaminated bulk sodium inventory at Hanford. These actions are necessary to facilitate cleanup at Hanford consistent with decisions reached by DOE as a result of previous NEPA reviews (DOE 1995a, 2000a; 66 FR 7877) and to comply with Federal, state, and local laws and regulations.

- Expand or upgrade existing waste storage, treatment, and disposal capacity at Hanford to support ongoing and planned waste management activities for on- and offsite waste. Some tank waste, LLW, and MLLW at Hanford, including waste resulting from FFTF decommissioning and waste from other DOE sites that do not have appropriate facilities, must be disposed of to facilitate cleanup of Hanford and other DOE sites.

S.1.3.1 Decisions to Be Made

In support of the proposed actions to retrieve, treat, and dispose of tank waste; decommission the FFTF; and expand waste disposal capacity at Hanford to provide for disposal of on- and offsite waste, this *TC & WM EIS* will support several decisions that DOE has to make related to the ORP mission. These potential decisions are outlined below.

- **Storage of Tank Waste.** All *TC & WM EIS* alternatives require tank storage; however, each alternative considers a different length of time. This *TC & WM EIS* evaluates the construction and operation of waste transfer infrastructure, including waste receiver facilities (WRFs), which are below-grade storage and minimal waste conditioning facilities; waste transfer line upgrades; and additional or replacement DSTs. This EIS also evaluates various waste storage facilities to manage the treated tank waste and the waste associated with closure activities. This includes construction and operation of additional immobilized high-level radioactive waste (IHLW) storage vaults, melter pads, TRU waste storage facilities, and ILAW storage facilities. This EIS also provides environmental impact information to assist in making informed decisions regarding continued storage of tank waste and storage to support treatment and disposal activities.

- **Retrieval of Tank Waste.** This EIS evaluates various retrieval technologies and benchmarks. The four waste retrieval benchmarks (0 percent, 90 percent, 99 percent, and 99.9 percent) address various requirement or retrieval activities. The No Action Alternative evaluates a 0 percent retrieval benchmark, as required by NEPA; 90 percent retrieval represents a programmatic risk analysis for the tank farms as defined by the TPA's "Single Shell Tank Waste Retrieval Criteria Procedure"; 99 percent retrieval is the goal established by TPA Milestone M-45-00; and 99.9 percent retrieval reflects multiple deployments of retrieval technologies to support clean closure requirements.

- **Treatment of Tank Waste.** Additional waste treatment capability can be achieved by building new treatment facilities that are either part of or separate from the WTP. DOE could also complete treatment sometime after 2028 by extending the current WTP operating period until all the waste is treated without supplemental treatment. The two primary choices that would comply with DOE's commitments are to treat all the waste in an expanded WTP or to provide supplemental treatment in conjunction with, but separate from, the WTP. DOE has conducted preliminary tests on three supplemental treatment technologies to determine whether one or more could be used to provide the additional capability needed to complete waste treatment. The decision of whether to treat all the waste in the WTP (as is or expanded) or to supplement its capacity by adding new treatment capability depends on the demonstration of supplemental treatment technology feasibility.

- **Disposal of Treated Tank Waste.** This *TC & WM EIS* addresses on- and offsite disposal, depending on the waste type. Onsite disposal includes disposal of treated tank waste and waste generated from closure activities that meet onsite disposal criteria. The decision to be made involves the onsite location of disposal facilities, specifically, one or two IDFs, which would manage treated tank waste, and the River Protection Project Disposal Facility (RPPDF), which would manage closure activity waste. This EIS will provide the environmental impact information needed to make informed decisions on tank waste that could be classified as TRU waste for disposal. Offsite disposal of tank waste determined to be TRU waste would occur at WIPP.

- **Closure of the SST System.** This *TC & WM EIS* addresses closure of the SST system under all Tank Closure alternatives except Tank Closure Alternatives 1 and 2A (see Section S.2 for a description of the alternatives analyzed in this *TC & WM EIS*). Although DOE is committed to retrieving at least 99 percent of the waste, consistent with the TPA, the range of potential impacts in the cases considered includes the potential impacts of residual waste left in the tanks at different retrieval benchmarks (0, 90, 99, and 99.9 percent). Several types of closure scenarios are also evaluated: clean closure, selective clean closure/landfill closure, and landfill closure with or without contaminated soil removal. In addition, two structurally different landfill barriers are considered to determine the effectiveness of the natural and engineered defense-in-depth barriers in minimizing any transport of waste over the long timeframes of interest.

- **Disposal of Hanford Waste and Offsite DOE LLW and MLLW.** The decision to be made concerns the onsite location of disposal facilities for Hanford's waste and other DOE sites' LLW and MLLW. DOE committed in the *HSW EIS* ROD to disposing of LLW in lined trenches. Thus, the decision is whether to dispose of waste at IDF-East or at a new IDF located in the 200-West Area (IDF-West).

- **Final Decommissioning of FFTF.** This decision would determine the end state for FFTF's aboveground, belowground, and ancillary support structures.

This *TC & WM EIS* is the next step in the process to close the tank farm waste management system, decommission FFTF, and expand waste management and disposal capacity at Hanford. The information provided in this EIS will be used both to identify a preferred alternative and to support (along with other data sources) future decisions regarding waste treatment and tank closure, FFTF decommissioning, and waste management and disposal capacity expansion. Public participation will continue throughout this process. Decisions based on the data presented in this EIS will be documented in a ROD or a series of RODs no sooner than 30 days after the U.S. Environmental Protection Agency's notice of the availability of the *Final TC & WM EIS* is published in the *Federal Register*. All project work resulting from the ROD that pertains to waste storage, treatment, or disposal facilities must undergo a permitting process with Ecology. Permit conditions will specify the safe handling and storage of the waste forms and will ensure any process air or liquid discharges are within regulatory limits. This permitting process offers additional opportunity for public input.

What is a Record of Decision (ROD)?

The final step in the National Environmental Policy Act process is issuing a ROD, or possibly a series of RODs, which records a Federal agency's decision concerning a proposed action for which the agency has prepared the environmental impact statement. Decisions stated in a ROD sometimes may be broad. Such decisions enable subsequent, more-detailed activities to move forward through implementing documents. Examples of implementing documents at the Hanford Site include Tri-Party Agreement milestones, closure plans, permit applications, contracts, and funding requests.

S.1.3.2 Decisions Not to Be Made

DOE will not make decisions on the following as part of this NEPA process:

- **DST Closure.** A closure configuration for the original 28 DSTs was evaluated in this EIS for engineering reasons related to the closure barrier placement. However, a decision on closure of DSTs is not part of the proposed actions because the DSTs are active components needed to complete waste treatment. Closure of the DSTs would need to be addressed at a later date subject to appropriate NEPA review.

- **WTP Closure.** The WTP is currently under construction in the 200-East Area of Hanford. As such, construction (and subsequent operations and deactivation) of the WTP from 2006 onward was analyzed under each Tank Closure alternative to establish a common reference point for use in comparing alternatives. However, closure of the WTP is not part of the proposed actions because it is a facility needed to complete waste treatment. Closure of the WTP would need to be addressed at a later date subject to appropriate NEPA review.

- **Groundwater Remediation.** Remediation of contaminated groundwater operable units is not part of the proposed actions for this EIS. Groundwater contamination in the non-tank-farm 200 Areas is being addressed under the CERCLA (42 U.S.C. 9601 et seq.) that will also satisfy substantive RCRA and Hazardous Waste Management Act corrective action requirements. NEPA values are integrated into the CERCLA analyses. However, contamination in the vadose zone resulting from tank farm past leaks is currently being evaluated under the RCRA facility investigation and corrective measures study process. Therefore, the vadose zone in the tank farms is part of an RCRA unit and is not included in the CERCLA groundwater operable unit. As a result, the vadose zone as impacted by the tank farms is part of this *TC & WM EIS* scope.

- **CERCLA Past-Practice Units.** There are six sets of cribs and trenches (ditches) that are contiguous to the SSTs and would fall under the barriers placed over the SSTs during closure. They are evaluated in this EIS as part of a connected action because they would be influenced by barrier placement. However, closure of these CERCLA past-practice units is not part of the proposed actions for this EIS. Closure of these units would be addressed at a later date subject to appropriate NEPA review.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, also known as Superfund)

A Federal law enacted in 1980 that provides the legal authority for emergency response and cleanup of hazardous substances released into the environment and for the cleanup of inactive waste sites. CERCLA's reauthorization in 1986 established the Federal government's responsibility to investigate and remediate releases of hazardous substances, including radioactive contaminants, from its agencies' facilities.

Resource Conservation and Recovery Act (RCRA)

This law, enacted in 1976, gives the U.S. Environmental Protection Agency (EPA) the authority to control hazardous waste from "cradle to grave" (i.e., from the point of generation to the point of ultimate disposal), including its minimization, generation, transportation, treatment, storage, and disposal. RCRA's applicability to the hazardous component of mixed waste (waste containing both radioactive and hazardous components) at U.S. Department of Energy (DOE) facilities was not recognized by DOE until 1987. In 1986, the Washington State Department of Ecology was authorized by the EPA to administer its own hazardous waste program, "Dangerous Waste Regulations," in lieu of the Federal RCRA program.

- **Deactivation of FFTF.** DOE does not intend to make any further decisions regarding deactivation of FFTF as a result of this EIS. Based on previous NEPA reviews (DOE 1995a, 2000a, 2006b), DOE decided to shut down and deactivate FFTF. Deactivation of FFTF as evaluated in those reviews consists of the following:

  - Removing fuel from FFTF facilities and storing in either the 400 Area or the 200 Areas
  - Draining metallic sodium from the reactor cooling systems and support facilities and storing in the 400 Area.
  - Removing and disposing of some radioactive and chemically hazardous materials
  - Deactivating plant systems as they are no longer required for safe operation

- Placing the remaining plant systems in a radiologically and industrially safe condition for long-term surveillance and maintenance
- Removal and packaging of the four RH-SCs for storage in the 400 Area

- **Disposition of the Cesium and Strontium Capsules.** Treatment of the cesium and strontium capsules, which are currently stored at the Waste Encapsulation and Storage Facility (WESF), is evaluated in this EIS based on the existing TPA milestone; however, the decision on final disposition of the cesium and strontium capsules will be determined at a later date subject to appropriate NEPA review.

- **HLW Transportation and Disposition.** The scope of this *TC & WM EIS* does not include making a decision on the ultimate disposition of HLW and any transportation related to such disposition. The *TWRS EIS* ROD to treat the Hanford tank waste has not changed. Funding for the Yucca Mountain facility has been eliminated in the Administration's fiscal year 2010 budget request. Notwithstanding the decision to terminate the Yucca Mountain program, which was the development of a geologic repository for the disposal of HLW and SNF, DOE remains committed to meeting its obligations to manage and ultimately dispose of HLW and SNF. The Administration intends to convene a blue ribbon commission to evaluate alternative approaches for meeting these obligations. Decisions reached through this process will need to be addressed at a later date subject to appropriate NEPA review.

S.1.4 Public Participation

Scoping is a process in which the public, regulators, and other interested parties provide comments directly to a Federal Agency on the scope of an EIS. This process is initiated by publication of the NOI in the *Federal Register*. The NOI to prepare this *TC & WM EIS* (71 FR 5655) was published on February 2, 2006, and initiated a 30-day scoping period that ended March 6, 2006. The NOI identified a set of preliminary alternatives available for public comment. A later notice (71 FR 8569) extended the scoping period to April 10, 2006. In the NOI, DOE requested comment on the proposed scope for the new *TC & WM EIS*. Public comments were submitted in a number of ways, including standard mail, electronic mail, fax, voicemail, and oral or written comments presented at formal public meetings. As stated in the NOI for this *TC & WM EIS*, DOE also considered earlier comments submitted in response to the 2003 NOI for the "Tank Closure EIS" (68 FR 1052) and the 2004 NOI for the "FFTF Decommissioning EIS" (69 FR 50176). Section S.1.4.1 discusses the *TC & WM EIS* scoping process and the comments received. Sections S.1.4.2 and S.1.4.3 similarly discuss the "Tank Closure EIS" and "FFTF Decommissioning EIS" scoping processes and comments, respectively. Information collected from the NEPA scoping process was used to modify the scope of this *TC & WM EIS*, as appropriate.

Ongoing dialogue with the public will continue as this Draft *TC & WM EIS* undergoes public review and comment (see Figure S–1). A 140-day comment period will begin when the EPA publishes a Notice of Availability in the *Federal Register*. Public hearings will be held during this comment period.

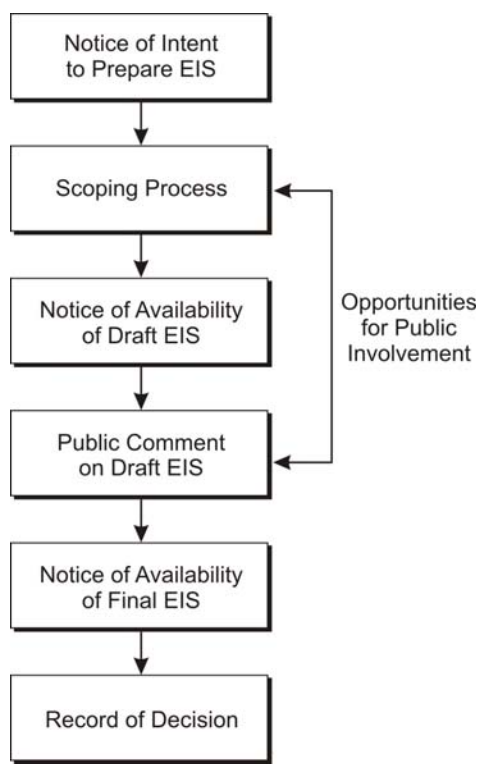


Figure S–1. National Environmental Policy Act (NEPA) Process

S.1.4.1 Public Meetings and Issues Identified During the *TC & WM EIS* Scoping Process

DOE and Ecology, a cooperating agency, conducted four public meetings on the proposed scope of this *TC & WM EIS* at the following locations:

Seattle, Washington	March 21, 2006
Portland, Oregon	March 22, 2006
Hood River, Oregon	March 23, 2006
Tri-Cities, Washington	March 28, 2006

Both oral and written comments were received by DOE during the *TC & WM EIS* scoping period. DOE received comments from approximately 150 commentors, considered all the comments received, and made changes to the *TC & WM EIS* scope as appropriate. The issues presented below reflect the key concerns expressed during the scoping period.

Issue: *DOE must do everything possible to avoid and/or mitigate contamination of the Columbia River and regional groundwater supplies due to the proposed actions.*

Response: This *TC & WM EIS* incorporates several mitigation measures into the proposed alternatives, including engineered barriers, contaminated soil removal, and waste treatment. This *TC & WM EIS* also explores other potential mitigation measures that could be pursued based on specific concerns.

Issue: *Complete Hanford waste cleanup activities as soon as possible, including removing both the waste and the tanks, as well as the waste currently buried in existing disposal facilities.*

Response: Retrieval of waste from the SSTs has been completed for seven tanks to date and is ongoing. The WTP is currently under construction to treat the tank waste. Removal of waste buried in existing disposal facilities is considered either as part of the alternatives or in the cumulative impacts section analyzed in this *TC & WM EIS*, depending on the waste stream.

Issue: *DOE should not consider an alternative for retrieving less than 99 percent of the tank waste, consistent with the TPA.*

Response: One *TC & WM EIS* alternative addresses a retrieval goal of 90 percent, less than the TPA Milestone M-45-00 minimum goal of 99 percent. Retrieval to 90 percent represents a range depicting the potential programmatic risk analysis process for the tank farms as defined by Appendix H of the TPA, "Single Shell Tank Waste Retrieval Criteria Procedure." This alternative evaluates the potential impacts that could occur from implementing that process. To date, Ecology and DOE have initiated the Appendix H process for one tank, 241-C-106.

Issue: *DOE needs more extensive, detailed data to complete this EIS; characterization data for all waste types is particularly lacking.*

Response: Both DOE and Ecology believe there is sufficient characterization information to support this *TC & WM EIS*. The goal of NEPA is to complete an impact analysis to support decisions that an agency needs to make related to a proposed Federal or state (in the case of Washington's State Environmental Policy Act) action early enough in the process to be useful. Additional information may be necessary before a final permit decision can be issued. This *TC & WM EIS* describes uncertainties in the analysis of potential impacts.

Issue: *Preserve FFTF for potential future uses such as medical isotope production.*

Response: DOE is not considering FFTF for medical isotope production at this time. DOE has previously weighed FFTF's potential use in other applications (DOE 2000a; 72 FR 331). There are currently no proposed uses. Irrespective of any proposed use, DOE needs to determine an appropriate end state for FFTF.

Issue: *Don't import waste from elsewhere to Hanford.*

Response: DOE is currently evaluating the potential for disposal of 62,000 cubic meters (2.2 million cubic feet) of LLW and 20,000 cubic meters (706,300 cubic feet) of MLLW from other DOE sites at Hanford. This is the amount identified in the Settlement Agreement for disposal at Hanford.

Issue: *DOE should ensure that independent experts provide objective oversight, analysis, and review throughout this EIS preparation process.*

Response: Throughout the EIS preparation process, DOE has coordinated and consulted, as appropriate, with the U.S. Fish and Wildlife Service, U.S. Bureau of Reclamation, Advisory Council on Historic Preservation, American Indian Tribes, and local agencies on matters within their technical expertise. In addition, a technical review group was formed to evaluate the conversion of the groundwater model from the previous models used on site to MODFLOW [modular three-dimensional finite-difference groundwater flow model].

Issue: *DOE should address health risks to Hanford workers and the public from the proposed actions.*

Response: This *TC & WM EIS* addresses human health risks to workers and the public from actions proposed under the alternatives.

S.1.4.2 Public Meetings and Issues Identified During the "Tank Closure EIS" Scoping Process

The NOI to prepare the "Tank Closure EIS" (68 FR 1052) initiated a 60-day scoping period that ended March 10, 2003. DOE conducted four public meetings on the proposed "Tank Closure EIS" scope. Meetings were held at the following locations:

Richland, Washington	February 5, 2003
Hood River, Oregon	February 18, 2003
Portland, Oregon	February 19, 2003
Seattle, Washington	February 20, 2003

DOE considered all oral and written comments received during the "Tank Closure EIS" scoping period. The comments summarized below represent those that impacted a major component of the scope of an alternative.

Issue: *The alternatives are too complicated to understand and the titles need clarification.*

Response: Alternative titles and descriptions were clarified and, where possible, alternative descriptions were simplified. However, the multitude and combinations of retrieval/treatment/disposal/closure options make this an inherently complex assessment. For this reason, DOE prepared a Reader's Guide to help readers navigate the document.

Issue: *The proposed "No Action" alternative is not an accurate portrayal of what is typically considered "no action."*

Response: In CEQ's "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations" (46 FR 18026), two types of No Action Alternatives are allowed. In one case, work is stopped and impacts are evaluated. In the second case, ongoing activities are evaluated as a "no change" and continuation of the present course of action.

In this EIS, DOE has chosen to show both types of no action. Under Tank Closure Alternative 1, the work would be stopped and impacts would be evaluated. Under Tank Closure Alternative 2A, DOE would evaluate retrieval from the tanks and treatment through the WTP, in accordance with the *TWRS EIS* ROD with modifications.

Issue: *No alternative is provided to address tank closure with the current all-vitrification waste treatment plans.*

Response: Tank Closure Alternative 2A retained implementation of the 1997 *TWRS EIS* ROD to address the current vitrification capacity of the existing WTP, which is currently under construction (i.e., Existing WTP Vitrification; No Closure). Tank Closure Alternative 2B was developed to address an expanded LAW vitrification capacity for the existing WTP, which would provide vitrification of all tank waste, and to add a landfill closure of the SST system (i.e., Implement the *Tank Waste Remediation System EIS* ROD with Modifications – Expanded WTP Vitrification; Landfill Closure).

Issue: *DOE is proposing to minimize the use of the WTP for tank waste treatment.*

Response: DOE is committed to completing construction of the WTP and operating the facility to vitrify all tank HLW and a portion of the LAW. Supplemental treatment technologies for LAW are part of the scope of this *TC & WM EIS*.

Issue: *DOE should stay the course on vitrifying all tank waste.*

Response: See previous response. With respect to the portion of the LAW that may not be treated in the WTP, DOE is evaluating supplemental treatment (supplemental to the WTP) for that waste. This *TC & WM EIS* evaluates whether completing treatment of this waste with supplemental technologies faster could result in decreased impacts on the public and environment.

Issue: *None of the action alternatives address the possibility that separation of waste into HLW and LAW constituents may not be allowed under DOE directives.*

Response: Tank Closure Alternative 6A was created to address a scenario where separation of the tank waste into HLW and LAW components is not performed. Alternatives 6B and 6C were created to implement the current vitrification facility, supplemented with additional vitrification capacity. Under all three subalternatives, treated waste would be managed as HLW.

Issue: *Technetium-99, with its very long half-life, would impact the groundwater and Columbia River if allowed to remain in the ILAW disposed of at Hanford.*

Response: This *TC & WM EIS* evaluates the impacts on the groundwater and Columbia River resources of various waste treatment and disposal scenarios related to technetium-99. Projected impacts will be considered in making the decisions discussed in Section S.1.3.1 of this document.

Issue: *Nuclear waste residuals would be abandoned inside the tanks and would impact the environment in the future.*

Response: NEPA requires consideration of all reasonable alternatives in EISs, as well as "no action," which serves as a baseline for comparison among alternatives. The No Action Alternative may not always be a reasonable alternative. To satisfy this requirement, DOE is evaluating the impacts of a range of waste retrieval benchmarks. The benchmarks considered are 0 percent of the tank volume (No Action Alternative), 90 percent, 99 percent, and 99.9 percent.

Issue: *Not enough information is available on supplemental treatment technology performance to make any decisions.*

Response: DOE is in the process of collecting available information on supplemental treatment technologies and is also funding additional studies where information gaps exist. Consistent with CEQ regulations, early evaluation is encouraged in an agency's planning process, when all information may not be available.

Issue: *Grout, or any similar waste form, does not have acceptable long-term performance.*

Response: DOE chose cast stone as a candidate nonthermal treatment technology to represent a lower-performing waste form for this assessment. WTP vitrification, bulk vitrification, and steam reforming were selected to represent a range of thermal waste form performance. The impacts of this treatment technology performance range will be considered in the decisions discussed in Section S.1.3.1.

Issue: *Tank Closure alternatives are either landfill for all or total removal of all—no graded approach is considered.*

Response: Tank Closure Alternative 4 was revised to include a selective clean closure of the BX tank farm (200-East Area) and SX tank farm (200-West Area) as representative tank farms and landfill closure of the remaining tank farms. The range of closure alternatives represents landfill closure, selective clean closure, and clean closure.

Issue: *This process is being rushed. There is no driver for addressing closure at this time.*

Response: DOE needs to begin specific planning actions to treat the tank waste and to close the SST system. These actions are necessary to protect human health and the environment and to comply with several enforceable milestones in the TPA, specifically

Milestone M-45-00, which requires complete closure of the SST system by September 30, 2024, and Milestone M-62-00, which requires completion of vitrification treatment of tank HLW and LAW by December 1, 2028.

S.1.4.3 Public Meetings and Issues Identified During the "FFTF Decommissioning EIS" Scoping Process

The NOI to prepare the "FFTF Decommissioning EIS" (69 FR 50176) initiated a 56-day scoping period that ended October 8, 2004. The NOI announced the schedule for the public scoping process and summarized the alternatives to be considered in the "FFTF Decommissioning EIS." Two scoping meetings were held at the following locations and dates:

Richland, Washington	September 22, 2004
Idaho Falls, Idaho	September 30, 2004

The following is a brief summary of the oral and written comments received by DOE during the "FFTF Decommissioning EIS" scoping period. DOE considered all comments received and made changes to the *TC & WM EIS* alternatives as appropriate.

Issue: *This EIS should evaluate each of the proposed alternatives, including suboptions, in a way that is complete and detailed. In particular, the alternative discussion should include a full evaluation of how each alternative would be implemented from beginning to end. The evaluation should include a full analysis of all impacts, including all impacts associated with transportation, handling, storage, treatment of radioactive and hazardous materials; a detailed explanation of the workforce requirements; and a complete description of the ultimate disposal of all waste, including residuals. The information should be presented in a comparative format that will allow stakeholders to evaluate each alternative relative to the others.*

Response: This *Draft TC & WM EIS* provides a full evaluation of each alternative. It includes impacts associated with transportation, handling, storage, and treatment of radioactive and hazardous materials; details on the workforce requirements; and a complete description of the ultimate disposition of waste, including residuals. These impacts are discussed in this draft EIS. A comparison of the alternatives is provided in this draft EIS for short-term impacts and long-term impacts.

Issue: *DOE should evaluate the environmental impacts of building a new facility at Hanford equivalent to the existing Sodium Processing Facility (SPF) at the Materials and Fuels Complex (MFC) at the Idaho National Laboratory (INL). In particular, the cost savings and reduced risks caused by eliminating the need for transportation to INL should be evaluated.*

Response: This *Draft TC & WM EIS* provides options for the processing of bulk sodium at both Hanford (Hanford Option) and the MFC at INL (Idaho Option). The Hanford Option would involve construction and operation of a new facility and eliminate the need for transportation to the INL's MFC.

Issue: *DOE should evaluate the environmental impacts of construction and operation of a new facility at Hanford equivalent to the proposed Remote Treatment Project (RTP) at the MFC.*

Response: This *Draft TC & WM EIS* provides options for treating RH-SCs at both Hanford and the MFC at INL. The Hanford Option would involve construction and operation of a new facility and eliminate the need for transportation to the INL's MFC.

Issue: *This EIS should include a Greenfield alternative that evaluates removal of all contaminated structures and equipment from the 400 Area. Cleanup should not result in a new waste site in the Hanford 400 Area that would require maintenance and monitoring for the foreseeable future.*

Response: FFTF Decommissioning Alternative 3: Removal is an alternative that looks at the (1) removal of all contaminated equipment while leaving small amounts of radioactivity in underground structures and (2) implementation of appropriate postclosure care, which may lead to unrestricted use of the site.

Issue: *The No Action Alternative is clearly dangerous and should not be included as a reasonable alternative.*

Response: NEPA requires consideration of all reasonable alternatives in EISs, as well as "no action," which serves as a baseline for comparison among alternatives. The No Action Alternative may not always be a reasonable alternative. To satisfy this requirement, under the No Action Alternative, DOE is evaluating the impacts of completing only those actions consistent with previous DOE NEPA decisions. Final decommissioning would not occur. The site would be maintained under administrative control for 100 years following the ROD.

Issue: *This draft EIS should evaluate all impacts of transportation associated with the radioactive sodium (in liquid and solid form), reactor components, and sodium-bonded SNF that would be shipped to the MFC for treatment, including estimates of the volumes and characteristics of all radioactive and hazardous materials and waste that would be produced at the MFC as a result of treatment of the incoming materials and waste.*

Response: This *Draft TC & WM EIS* evaluates the transportation impacts associated with the bulk sodium and the RH-SCs being considered for shipment to the MFC for processing or treatment. In previous NEPA reviews, DOE evaluated transportation and storage of FFTF fuel at either Hanford or INL (formerly Idaho National Engineering and Environmental Laboratory) (DOE 1995a, 1995b, 1997d); transportation and treatment of FFTF sodium-bonded fuel at INL's MFC (formerly Argonne National Laboratory-West) (DOE 1995a, 2000b); storage and possible disposal or commercial use of surplus plutonium (including a small quantity of nonirradiated FFTF fuel [DOE 1999a]); and transportation and disposal of SNF and HLW at a geologic repository (DOE 2002, 2008a). Ongoing activities associated with management of the FFTF fuel are not evaluated in this *Draft TC & WM EIS*.

Issue: *This EIS should consider alternatives that are economically sound and efficient.*

Response: This *Draft TC & WM EIS* summarizes and compares the relative costs of the alternatives.

Issue: *This EIS should consider the effects of decommissioning activities on adjacent Hanford facilities and their programs. The Laser Interferometer Gravitational-Wave Observatory research facility is in close proximity to FFTF and is highly sensitive to vibration.*

Response: This *Draft TC & WM EIS* provides an analysis of the impacts on other Hanford activities, including the Laser Interferometer Gravitational-Wave Observatory.

Issue: *DOE is not complying with the spirit or the letter of the NEPA regulations in preparing the* "FFTF Decommissioning EIS." *The distinction between deactivation and decommissioning, as well as irreversible versus reversible actions, is unclear.*

Response: Section S.1.2.2 provides a discussion of deactivation of the FFTF, including the court decision in the Benton County case against DOE. This Draft EIS also provides a discussion on the deactivation activities addressed by the *Environmental Assessment, Sodium Residuals Reaction/Removal and Other Deactivation Work Activities, Fast Flux Test Facility (FFTF) Project, Hanford Site, Richland, Washington* (DOE 2006a) and those proposed decommissioning activities under the scope of this *Draft TC & WM EIS*.

Issue: *This EIS should demonstrate that DOE intends to comply with Federal and state regulations and international (proliferation) and tribal agreements. Transportation and training agreements are not fully addressed.*

Response: This *Draft TC & WM EIS* discusses the Federal and state regulations that may be applicable to the proposed actions and consultations with tribes.

Issue: *FFTF should be preserved for various future missions. The decision to shut down FFTF is politically driven; political pressure may yet be able to reverse the process. FFTF should not be decommissioned.*

Response: Based on previous NEPA reviews (DOE 1995a, 2000a, 2006b), DOE decided to shut down and deactivate FFTF. DOE does not intend to make any further decisions regarding deactivation of FFTF.

S.2 DEVELOPMENT OF THE ALTERNATIVES

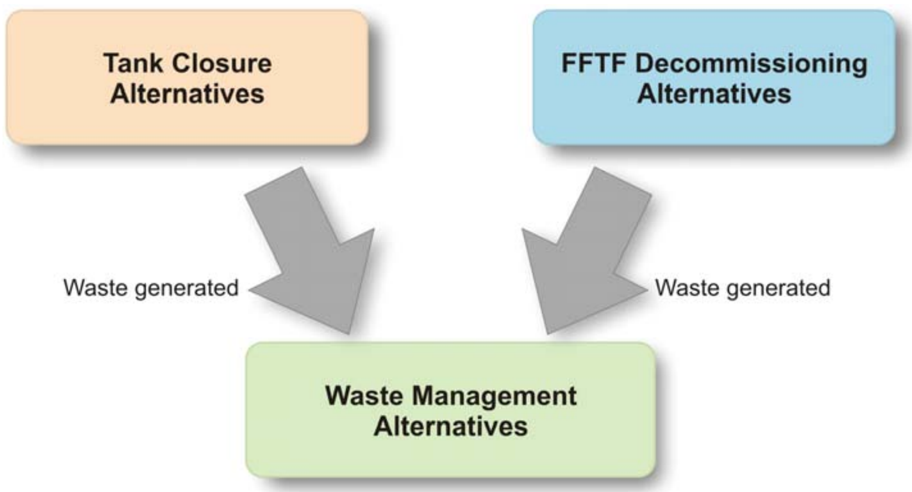
The alternatives presented in this *TC & WM EIS* were developed under NEPA to address the essential components of DOE's three sets of proposed actions (tank closure, FFTF decommissioning, and waste management) and to provide an understanding of the differences between the potential environmental impacts of the range of reasonable alternatives. In this *TC & WM EIS*, DOE evaluates the impacts associated with 11 Tank Closure alternatives, 3 FFTF Decommissioning alternatives, and 3 Waste Management alternatives. A No Action Alternative is required under the CEQ regulations to provide a point of comparison against which the proposed actions and alternatives can be compared (40 CFR 1502.14[d]).

For Tank Closure alternatives, impacts resulting from storage, retrieval, treatment, disposal, and closure activities at Hanford's HLW tank farms were evaluated, as were the impacts of a No Action Alternative. These Tank Closure alternatives represent the range of reasonable approaches to removing waste from the tanks to the extent that is technically and economically feasible; treating the waste by vitrifying it in the WTP and/or using one or more supplemental treatment processes; packaging the waste for either offsite shipment and disposal or onsite disposal; and closing the SST system to permanently reduce the potential risk to human health and the environment.

This *TC & WM EIS* also evaluates the impacts associated with three alternatives for decommissioning FFTF and associated support buildings; managing the resulting waste using existing capabilities; managing designated RH-SCs for which waste management capabilities do not currently exist; closing FFTF and its associated support buildings; and dispositioning the inventory of bulk sodium resulting from deactivation of FFTF, as well as bulk sodium from the Hallam Reactor and the Sodium Reactor Experiment, which is now in storage at Hanford. These FFTF Decommissioning alternatives represent the range of reasonable approaches to dismantling and removing the FFTF related structures, equipment, and materials within the 400 Area Property Protected Area; treating and disposing of these components and equipment as necessary either in place or at other facilities; treating RH-SCs either at a new facility at Hanford or at INL; converting Hanford bulk sodium to a concentrated caustic sodium hydroxide solution at Hanford or INL for reuse in the WTP to process tank waste or to support Hanford tank corrosion controls; and closing the area permanently (1) to reduce the potential risk to human health and the environment or (2) to prepare the area for future industrial use.

This *TC & WM EIS* also provides analyses of the impacts associated with Waste Management alternatives for managing the storage, processing, and disposal of solid waste at Hanford, as well as subsequent closure of associated disposal facilities. These Waste Management alternatives represent the range of reasonable approaches to continued storage of LLW, MLLW, and TRU waste at Hanford; onsite waste processing using two expansions of the Waste Receiving and Processing Facility (WRAP); onsite disposal of onsite-generated LLW and MLLW in cribs and trenches (ditches); disposal of tank, onsite-generated, FFTF decommissioning, waste management, and offsite-generated LLW and MLLW in new onsite facilities; and closure of disposal facilities to reduce water infiltration and the potential for intrusion.

Sections S.2.1, S.2.2, and S.2.3 include a general overview of how the alternatives were constructed to address the primary components of each set of proposed actions, a brief description of the range of activities that would occur under the No Action Alternatives and action alternatives for each set, and more-detailed descriptions of activities specific to each alternative. Tank closure, FFTF decommissioning, and waste management are organized by their essential components (e.g., disposal under waste management) in these sections.



Alternative Structure

S.2.1 Tank Closure Alternatives

The Tank Closure alternatives evaluated in this *TC & WM EIS* were constructed to address each of the primary tank closure components (storage, retrieval, treatment, and disposal of tank waste, and closure of the SST farms) and to consider a range of options for each component. At the end of this section, Table S–1 compares each of the Tank Closure alternatives by component.

Tank Closure Alternatives

Alternative 1: No Action

Alternative 2: Implement the *Tank Waste Remediation System EIS* Record of Decision with Modifications

- ***Tank Closure Alternative 2A:*** Existing WTP Vitrification; No Closure
- ***Tank Closure Alternative 2B:*** Expanded WTP Vitrification; Landfill Closure

Alternative 3: Existing WTP Vitrification with Supplemental Treatment Technology; Landfill Closure

- ***Tank Closure Alternative 3A:*** Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure
- ***Tank Closure Alternative 3B:*** Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure
- ***Tank Closure Alternative 3C:*** Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure

Alternative 4: Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure

Alternative 5: Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure

Alternative 6: All Waste as Vitrified HLW

- ***Tank Closure Alternative 6A:*** All Vitrification/No Separations; Clean Closure (Base and Option Cases)
- ***Tank Closure Alternative 6B:*** All Vitrification with Separations; Clean Closure (Base and Option Cases)
- ***Tank Closure Alternative 6C:*** All Vitrification with Separations; Landfill Closure

S.2.1.1 Tank Waste Storage

Tank farm storage operations (e.g., monitoring, routine maintenance, waste transfers) would be required under each Tank Closure alternative. Storage operations are considered a dependent function that varies with changes in the duration of waste retrieval and treatment operations. If tank waste were not retrieved and treated (the No Action Alternative), current, ongoing activities would continue and tank replacements and upgrades would be required.

Descriptions of tank waste storage activities under each Tank Closure alternative follow.

Alternative 1. Continue to store and monitor waste in the SSTs and DSTs for 100 years. Fill tanks that show signs of deterioration with grout/gravel. Continue to store cesium and strontium capsules in the WESF.

Alternative 2A. Continue current waste management operations using existing tank storage facilities. Replace DSTs in a phased manner through 2054 because they will all exceed their 40-year design life during the period of waste retrieval.

Alternative 2B. Continue current waste management operations using existing tank storage facilities. No new DSTs would be required, but four new WRFs would be constructed.

Alternatives 3A, **3B**, **and 3C.** Same as Alternative 2B.

Alternative 4. Same as Alternative 2B.

Alternative 5. Same as Alternative 2B.

Alternative 6A. Continue current waste management operations using existing tank storage facilities that would be modified as needed to support SST waste retrieval and treatment. Build new DSTs after the existing DSTs reach the end of their design life.

Alternatives 6B and 6C. Same as Alternative 2B.

S.2.1.2 Tank Waste Retrieval

Options range from retrieving none of the tank waste (the No Action Alternative) to retrieving the tank waste to the maximum extent that is both technically practical and required to support clean closure of the SST System. Retrieval to 90, 99, and 99.9 percent are analyzed using different retrieval technologies.

Descriptions of tank waste retrieval activities under each Tank Closure alternative follow.

Alternative 1. Do not retrieve waste from tanks.

Alternatives 2A and 2B. Retrieve tank waste to the 99 percent retrieval goal using currently available liquid-based waste retrieval and leak detection systems.

Alternatives 3A, **3B**, **and 3C.** Same as Alternatives 2A and 2B.

Alternative 4. Retrieve tank waste to the 99.9 percent retrieval goal using currently available liquid-based waste retrieval and leak detection systems and a final chemical wash step.

Alternative 5. Retrieve tank waste to the 90 percent retrieval goal using currently available liquid-based retrieval and leak detection systems.

Alternatives 6A and 6B. Same as Alternative 4.

Alternative 6C. Same as Alternatives 2A and 2B.

S.2.1.3 Tank Waste Treatment

Options range from treating none of the tank waste (the No Action Alternative) to treating all of the waste to the extent required to meet disposal requirements. Tank waste could be treated using a variety of technologies to make it safe for disposal, resulting in one or many waste forms. All of the action alternatives would continue to use the WTP in its current configuration, with some alternatives involving expansion.

Descriptions of tank waste treatment activities under each Tank Closure alternative follow.

Alternative 1. Stop construction of the WTP and isolate the WTP site pending some future use, if any. Do not build any vitrification or treatment capacity after 2008.

Alternative 2A. Construct and operate the existing WTP configuration (two HLW melters and two LAW melters). Treat HLW and LAW over the period 2018–2093. Pretreat all waste streams routed to the WTP, excluding the technetium-99 removal process. Replace the WTP after 60 years. No supplemental or TRU waste treatment is proposed. Retrieve cesium and strontium capsules from the WESF for de-encapsulation at the Cesium and Strontium Capsule Processing Facility and treatment in the WTP.

Alternative 2B. Supplement the existing WTP configuration (two HLW melters and two LAW melters) with expanded LAW vitrification capacity (an addition of four LAW melters) to increase the theoretical maximum capacity. Treat HLW over the period 2018–2040 and LAW over the period 2018–2043. Pretreat all waste streams routed to the WTP, and include the technetium-99 removal in the pretreatment process. No facilities would have to be replaced. No supplemental or TRU waste treatment is proposed. Retrieval, de-encapsulation, and treatment of cesium and strontium capsules same as Alternative 2A.

Alternative 3A. Operate the existing WTP configuration (two HLW melters and two LAW melters). Treat HLW and LAW over the period 2018–2040. Pretreat all waste streams routed to the WTP, but exclude technetium-99 removal from the pretreatment process. Supplement WTP capacity with bulk vitrification treatment at facilities in the 200-East and 200-West Areas to immobilize a portion of the LAW. In the 200-East Area, pretreat the waste feed in the WTP, but exclude technetium-99 removal from the pretreatment process. In the 200-West Area, pretreat the waste feed in a new Solid-Liquid Separations Facility. Treat and package a portion of the tank waste designated as mixed TRU waste for disposal at WIPP. Retrieval, de-encapsulation, and treatment of cesium and strontium capsules same as Alternative 2A.

Alternative 3B. Operate the existing WTP configuration (two HLW melters and two LAW melters). Treat HLW and LAW over the period 2018–2040. Pretreat all waste streams routed to the WTP, and include technetium-99 removal in the pretreatment process. Supplement WTP capacity with cast stone treatment at facilities in the 200-East and 200-West Areas to immobilize a portion of the LAW. In the 200-East Area, pretreat the waste feed in the WTP, and include technetium-99 removal in the pretreatment process. In the 200-West Area, pretreat the waste feed in a new Solid-Liquid Separations Facility. Treat and package a portion of the tank waste designated as mixed TRU waste for disposal at WIPP. Retrieval, de-encapsulation, and treatment of cesium and strontium capsules same as Alternative 2A.

Alternative 3C. Operate the existing WTP in its current configuration (two HLW melters and two LAW melters). Treat HLW and LAW over the period 2018–2040. Pretreat all waste streams routed to the WTP, but exclude technetium-99 removal from the pretreatment process. Supplement WTP capacity with steam reforming treatment at facilities in the 200-East and 200-West Areas to immobilize a portion of the LAW. In the 200-East Area, pretreat the waste feed in the WTP, but exclude technetium-99 removal from the pretreatment process. In the 200-West Area, pretreat the waste in a new Solid-Liquid Separations Facility. Treat and package a portion of the tank waste designated as mixed TRU waste for disposal at WIPP. Retrieval, de-encapsulation, and treatment of cesium and strontium capsules same as Alternative 2A.

Alternative 4. Operate the existing WTP in its current configuration (two HLW melters and two LAW melters). Treat HLW and LAW, including the highly contaminated waste stream resulting from clean closure of the BX and SX tank farms, over the period 2018–2043. Pretreat all waste streams routed to the WTP, but exclude technetium-99 removal from the pretreatment process. Supplement WTP capacity with a combination of cast stone and bulk vitrification treatment at facilities in the 200-East and 200-West Areas, respectively, to immobilize a portion of the LAW. Pretreat the waste stream feed for the 200-East Area Cast Stone Facility in the WTP, but exclude technetium-99 removal from the pretreatment process. Pretreat the waste stream feed for the 200-West Area Bulk Vitrification Facility in a new Solid-Liquid Separations Facility. Treat and package a portion of the tank waste designated as mixed TRU waste for disposal at WIPP. Retrieval, de-encapsulation, and treatment of cesium and strontium capsules same as Alternative 2A.

Alternative 5. Supplement the existing WTP configuration (two HLW melters and two LAW melters) with expanded LAW vitrification capacity at the WTP (an addition of one LAW melter) and a combination of cast stone and bulk vitrification treatment at facilities in the 200-East and 200-West Areas, respectively, to immobilize a portion of the LAW. Treat HLW and LAW over the period 2018–2034. Pretreat all waste streams routed to the WTP, but exclude technetium-99 removal from the pretreatment process. Implement sulfate removal technology following WTP pretreatment to potentially reduce the amount of ILAW glass produced in the WTP. Pretreat the waste stream feed for the 200-East Area Cast Stone Facility in the WTP, but exclude technetium-99 removal from the pretreatment process. Pretreat the waste stream feed for the 200-West Area Bulk Vitrification Facility in a new Solid-Liquid Separations Facility. Treat and package a portion of the tank waste designated as mixed TRU waste for disposal at WIPP. Retrieval, de-encapsulation, and treatment of cesium and strontium capsules same as Alternative 2A.

Alternative 6A. Modify the WTP configuration through expanded HLW vitrification capacity (five HLW melters and no LAW melters with the modified configuration) to allow for the processing of all waste as HLW. Treat waste over the period 2018–2163, replacing the WTP twice due to design-life constraints. Do not pretreat waste, remove technetium-99, treat LAW or TRU waste, or treat waste using supplemental technologies. Retrieval, de-encapsulation, and treatment of cesium and strontium capsules same as Alternative 2A.

Alternatives 6B and 6C. Supplement the existing WTP configuration (two HLW melters and two LAW melters) with expanded LAW vitrification capacity (an addition of four LAW melters). Treat HLW from 2018–2040 and LAW over the period 2018–2043. Pretreat all waste streams routed to the WTP, but exclude technetium-99 removal from the pretreatment process. Do not treat waste using supplemental treatment, and do not treat TRU waste. Retrieval, de-encapsulation, and treatment of cesium and strontium capsules same as Alternative 2A.

S.2.1.4 Tank Waste Disposal

Tank waste disposal options include on- and offsite disposal. Offsite disposal of TRU waste would be at WIPP. The amount of waste to be disposed of would vary depending on the volume retrieved and conformity of the treated waste with criteria for acceptance at the disposal facilities.

Descriptions of tank waste disposal activities under each Tank Closure alternative follow.

Alternative 1. Do not dispose of the waste in the SST and DST systems; retain it in the tank farms indefinitely.

Alternatives 2A and 2B. Dispose of LAW immobilized via the WTP on site in an IDF. Store IHLW on site in interim storage facilities until disposition decisions are made and implemented.

> **Tank Farm System End-State Management**
>
> **Administrative controls (Tank Closure Alternatives 1, 2A)** – Ensure safe operations through activities such as monitoring tanks for signs of deterioration that could lead to leaks.
>
> **Active institutional controls (active Government control) (Tank Closure Alternatives 2B–6C)** – Ensure safe storage of waste following treatment through activities such as erecting physical barriers or markers to preserve information and informing current and future generations of hazards and risks.
>
> **Postclosure care (Tank Closure Alternatives 2B, 3A, 3B, 3C, 4, 5, 6C)** – Monitor and maintain the disposal system (e.g., a landfill) to preserve system integrity and prevent or control releases.

Alternatives 3A, **3B**, **and 3C.** Dispose of LAW immobilized both via the WTP and external to the WTP on site in an IDF. Store IHLW on site in interim storage facilities. Package and store mixed TRU waste on site in a new storage facility pending disposal at WIPP.

Alternative 4. Same as Alternatives 3A, 3B, and 3C.

Alternative 5. Same as Alternatives 3A, 3B, and 3C.

Alternative 6A. Store IHLW canisters on site in interim storage facilities until disposition decisions are made and implemented. Replace the canister storage facilities when they reach their 60-year design life. Manage debris from clean closure as HLW and store it on site.

Alternative 6B. Store IHLW canisters on site in interim storage facilities until disposition decisions are made and implemented. Manage ILAW glass canisters as HLW and store them on site. Manage debris from clean closure as HLW and store it on site.

Alternative 6C. Store IHLW canisters on site in interim storage facilities until disposition decisions are made and implemented. Manage ILAW glass canisters as HLW and store them on site.

S.2.1.5 Tank Farm Closure

Options range from continuing tank farm operations (without closing the SST system) to closing the SST system under a landfill or clean closure configuration (or a combination of these two end states). In addition, each of these options may include one or more end-state management activities (administrative controls, active institutional controls, or postclosure care) that would take place at the completion of each closure action.

Descriptions of tank farm closure activities under each Tank Closure alternative follow.

Alternative 1. Do not close the tank farms. Maintain security and management of Hanford for a 100-year administrative control period ending in 2107. Continue to store waste and conduct routine monitoring of waste in tanks during this period.

Alternative 2A. Do not close the tank farms. Cease administrative control of the tank farms following a 100-year period ending in 2193.

Alternative 2B. As operations are completed, close the SST system and associated cribs and trenches (ditches) using a landfill barrier. Fill the tanks and ancillary equipment with grout to immobilize the residual waste, prevent future tank subsidence, and discourage intruder access. Remove 4.6 meters (15 feet) of soil from the BX and SX tank farms and replace it with clean soil from onsite sources. Dispose of contaminated soils and ancillary equipment on site in the RPPDF. Monitor the site using postclosure care for 100 years.

Alternatives 3A, 3B, and 3C. Same as Alternative 2B.

Alternative 4. As operations are completed, close the SST system and associated cribs and trenches (ditches), except the BX and SX tank farms, using a landfill barrier. Fill the tanks and ancillary equipment with grout to immobilize the residual waste, prevent long-term degradation of the tanks, and discourage intruder access. Clean-close the BX and SX tank farms by removing the tanks, ancillary equipment, and soils to a depth of 3 meters (10 feet) below the tank base. Treat the removed tanks, ancillary equipment, and soils in the Preprocessing Facility (PPF). Dispose of the resulting MLLW on site, and process the resulting highly contaminated liquid waste stream in the WTP. Excavate deep soils, where necessary, to remove contamination within the soil column, and treat these soils in the PPF. Process the resulting contaminated liquid waste stream in the WTP. Dispose of the washed soils in the RPPDF. Backfill the BX and SX tank farms with clean soil. Monitor the site using postclosure care for 100 years.

Alternative 5. As operations are completed, close the SST system and associated cribs and trenches (ditches) using a landfill barrier. Fill the tanks and ancillary equipment with grout to immobilize the residual waste, prevent long-term degradation of the tanks, and discourage intruder access. Leave SST system ancillary equipment outside the surface barriers in place. Monitor the site using postclosure care for 100 years.

Alternatives 6A and 6B. Clean-close all 200-East and 200-West Area SST farms following deactivation by removing all tanks, associated ancillary equipment, and contaminated soil to a depth of 3 meters (10 feet) directly beneath the tank base. Package these materials as HLW for storage on site. Excavate deep soils, where necessary, to remove contamination within the soil column, and treat these soils in the PPF to make them acceptable for disposal on site. Process the resulting liquid waste stream in the PPF and dispose of it on site in an IDF. Dispose of the washed soils in the RPPDF. Cover the cribs and trenches (ditches) associated with the tank farms with a landfill barrier (Base Cases) or clean-close them (Option Cases).

Table S–1. Comparison of the Tank Closure Alternatives

	Alternative 1: No Action	**Alternative 2A:** Existing WTP Vitrification; No Closure	**Alternative 2B:** Expanded WTP Vitrification; Landfill Closure	**Alternative 3A:** Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure	**Alternative 3B:** Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure	**Alternative 3C:** Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure	**Alternative 4:** Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure	**Alternative 5:** Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure	**Alternative 6A:** All Vitrification/No Separations; Clean Closure	**Alternative 6B:** All Vitrification with Separations; Clean Closure	**Alternative 6C:** All Vitrification with Separations; Landfill Closure
Storage											
Existing	✓										
New WRFs			✓	✓	✓	✓	✓	✓		✓	✓
New DSTs		✓						✓	✓		
Retrieval											
90 percent								✓			
99 percent		✓	✓	✓	✓	✓					✓
99.9 percent							✓		✓	✓	
Treatment											
WTP											
Existing vitrification only		✓		✓	✓	✓	✓				
Expanded LAW vitrification			✓					✓		✓	✓
Expanded HLW vitrification									✓		
Replacement of WTP		✓							✓		
Technetium-99 removal			✓		✓						
Sulfate removal								✓			
Cesium and strontium capsules		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Non-WTP											
Tank mixed TRU waste supplemental treatment				✓	✓	✓	✓	✓			
Thermal supplemental treatment				✓		✓	✓	✓			
Nonthermal supplemental treatment					✓		✓	✓			
Disposal (including post-treatment storage)											
On Site											
ILAW		✓	✓	✓	✓	✓	✓	✓		a	a
IHLW[b]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Grouted sulfate								✓			
Contaminated soil			✓	✓	✓	✓	✓		✓	✓	✓
SSTs							c		d	d	
Off Site											
Tank mixed TRU waste to WIPP				✓	✓	✓	✓	✓			
Closure											
Clean closure									✓	✓	
Selective clean closure/landfill closure							✓				
Landfill closure			✓	✓	✓	✓		✓			✓
Modified RCRA Subtitle C barrier			✓	✓	✓	✓	✓		e	e	✓
Hanford barrier								✓			

a Under Alternatives 6B and 6C, ILAW glass would be interim-stored on site and managed as IHLW glass.

b Although disposition decisions have not been made and implemented, these alternatives do not assume the inventory in the IHLW canisters remains on site. However, the number of storage facilities needed to store all the IHLW is one more than the number of canister storage facilities analyzed under Tank Closure Alternative 2B.

c Under Alternative 4, SSTs at the BX and SX tank farms would be removed and treated in the Preprocessing Facility.

d Under Alternatives 6A and 6B, all SSTs would be removed and packaged in shielded boxes for onsite storage pending disposition.

e Base Case: Construct modified RCRA Subtitle C barrier over six sets of cribs and trenches (ditches) in the B and T Areas. Option Case: Remove six sets of cribs and trenches (ditches) in the B and T Areas and remediate their deep-soil plumes.

Note: For a description of facilities and technologies, see Section S.3.1.

Key: DST=double-shell tank; HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; LAW=low-activity waste; RCRA=Resource Conservation and Recovery Act; SST=single-shell tank; TRU=transuranic; WIPP=Waste Isolation Pilot Plant; WRF=waste receiver facility; WTP=Waste Treatment Plant.

Alternative 6C. As operations are completed, close the SST system and associated cribs and trenches (ditches) with a landfill barrier. Fill the tanks with grout to immobilize the residual waste, prevent long-term degradation of the tanks, and discourage intruder access. Remove 4.6 meters (15 feet) of soil from the BX and SX tank farms and replace it with clean soil from onsite sources. Dispose of the removed contaminated soils and ancillary equipment on site in the RPPDF. Monitor the site using postclosure care for 100 years.

S.2.2 FFTF Decommissioning Alternatives

The FFTF Decommissioning alternatives evaluated in this *TC & WM EIS* were constructed to address the disposition of facilities, RH-SCs, and bulk sodium. In developing these alternatives, DOE considered a range of options for each component.

FFTF Decommissioning Alternatives

Alternative 1: No Action

Alternative 2: Entombment

Alternative 3: Removal

S.2.2.1 Facility Disposition

Options for facility disposition range from leaving the deactivated FFTF and associated facilities and components in place (No Action Alternative) to removing radioactive materials in varying degrees. Materials left in place would be either covered by an inert gas blanket (No Action Alternative) or entombed (stabilized with grout underground). Both action alternatives would include backfilling, compacting, contouring, and revegetating the area. However, where more structures (e.g., remains of the Reactor Containment Building [RCB]) and equipment were left in place (Entombment Alternative), an engineered barrier would be constructed and postclosure care provided. Where no barrier was constructed, administrative or institutional controls would be put in place. All of the above options would require treatment and disposal of hazardous and radioactive materials.

S.2.2.2 Disposition of Remote-Handled Special Components

Due to the inability to completely drain sodium from reactor components with high radiation levels (primarily cesium-137), these components would require remote-handling, -decontamination, and -disposal. Options for disposition of these RH-SCs range from leaving the untreated materials on site (No Action Alternative) to treating RH-SCs (removing the sodium residuals) and disposing of them on or off site (Entombment and Removal Alternatives). Options for treatment include constructing an RTP at Hanford for onsite treatment or transporting the RH-SCs to the RTP that is proposed for construction at INL. Options for the disposal of treated RH-SCs include disposal on site in an IDF or off site at the Nevada Test Site.

What are remote-handled special components (RH-SCs)?

RH-SCs are reactor system components that have high radiation levels (received during operation of the reactor) and/or cannot be effectively drained such that they require remote-handling (i.e., they must be handled at a distance—remotely—to protect workers from unnecessary exposure), decontamination, and disposal.

S.2.2.3 Disposition of Bulk Sodium

Options for the treatment and disposal of Hanford bulk sodium range from leaving the untreated materials on site in storage (No Action Alternative) to converting the bulk sodium to a caustic sodium hydroxide solution for reuse in processing tank waste at the WTP or for supporting Hanford tank corrosion controls (Entombment and Removal Alternatives). Options for converting the sodium range from conducting conversion activities on site at Hanford in the proposed Sodium Reaction Facility (SRF) (Hanford Reuse Option) to shipping the sodium to INL for conversion in the existing SPF (Idaho Reuse Option).

Table S–2 outlines key activities under each of the three components (disposition of facilities, RH-SCs, and bulk sodium) and compares these parameters by alternative.

Table S–2. Comparison of FFTF Decommissioning Alternatives

	Alternative 1: No Action	Alternative 2: Entombment	Alternative 3: Removal
Facility Disposition			
Facility equipment and components left in place under inert gas blanket	✓		
Dismantlement of RCB and adjacent support buildings		✓	✓
Removal of reactor vessel (internal piping and equipment, attached depleted-uranium shield)			✓
Onsite disposal of reactor vessel (internal piping and equipment, attached depleted-uranium shield)			✓
Removal and onsite disposal of radioactive or chemical waste	✓	✓	✓
Backfill and revegetation of ancillary facility areas		✓	
Backfill and revegetation of Property Protected Area			✓
Landfill barrier over RCB		✓	
Administrative controls for 100 years	✓		
Postclosure care and/or institutional controls for 100 years		✓	✓
Disposition of Remote-Handled Special Components			
Removal and storage on site per FONSI[a]	✓	✓	✓
Treatment at the Hanford Site		✓	✓
Treatment at Idaho National Laboratory		✓	✓
Onsite disposal		✓	✓
Offsite disposal		✓	✓
Disposition of Bulk Sodium			
Onsite storage	✓	✓	✓
Onsite conversion to caustic sodium hydroxide solution		✓	✓
Offsite conversion to caustic sodium hydroxide solution		✓	✓
Caustic sodium hydroxide solution shipped to the Waste Treatment Plant		✓	✓

[a] Per 2006 FONSI regarding *Environmental Assessment, Sodium Residuals Reaction/Removal and Other Deactivation Work Activities, Fast Flux Test Facility (FFTF) Project, Hanford Site, Richland, Washington* (DOE 2006a:Appendix B).

Note: For a description of facilities and technologies, see Section S.3.2.

Key: FFTF=Fast Flux Test Facility; FONSI=Finding of No Significant Impact; RCB=Reactor Containment Building.

S.2.3 Waste Management Alternatives

The Waste Management alternatives evaluated in this *TC & WM EIS* were constructed to address the essential components of the proposed actions: onsite storage and disposal of waste from Hanford and other DOE sites and closure of waste disposal facilities. In developing these alternatives, DOE considered a range of options for each component.

Waste Management Alternatives

Alternative 1: No Action

Alternative 2: Disposal in IDF, 200-East Area Only

Alternative 3: Disposal in IDF, 200-East and 200-West Areas

S.2.3.1 Storage

Waste storage options range from continued storage of LLW, MLLW, and TRU waste at existing facilities, with no acceptance of offsite waste shipments (No Action Alternative), to expansion of Hanford facilities' storage capacity to accommodate limited shipments of LLW and MLLW from offsite DOE sources (action alternatives). Hanford-generated waste would continue to be processed on site in existing facilities (No Action Alternative) or in expanded facilities (action alternatives). As appropriate, offsite-generated waste would be treated off site prior to shipment to Hanford.

S.2.3.2 Disposal

Waste disposal options include disposal on or off site. Options for onsite disposal include using existing disposal facilities such as the lined low-level radioactive waste burial ground (LLBG) trenches, expanding existing disposal facilities (IDF-East), and building new facilities (IDF-West and the RPPDF). The difference between the two action alternatives is that only IDF-East would be used to support Waste Management Alternative 2, but both IDFs would be used to support Waste Management Alternative 3. Under the No Action Alternative, any further construction of IDF-East would be discontinued, and the existing LLBG trenches would support planned activities.

Because of the large number of combinations of IDF and RPPDF configurations that could support the 11 Tank Closure alternatives and 3 FFTF Decommissioning alternatives, three waste disposal groups were analyzed under both action alternatives (Waste Management Alternatives 2 and 3). The size, capacity, and number of facilities associated with each disposal group were based on the amounts and types of waste generated under each of the three sets of action alternatives (Tank Closure, FFTF Decommissioning, and Waste Management). Table S–3 outlines Disposal Groups 1 through 3 under Waste Management Alternatives 2 and 3.

Table S–3. Disposal Groups

	Facility	Capacity (million cubic meters)	Operations Through (year)	Tank Closure Alternatives Supported	FFTF Decommissioning Alternatives Supported
Waste Management Alternative 2					
Disposal Group 1	IDF-East RPPDF	1.2 1.08	2050	2B, 3A, 3B, 3C, 4, 5, 6C	2, 3
Disposal Group 2	IDF-East RPPDF	0.425 8.37	2100	2A, 6B	2, 3
Disposal Group 3	IDF-East RPPDF	0.425 8.37	2165	6A	2, 3
Waste Management Alternative 3					
Disposal Group 1	IDF-East RPPDF IDF-West	1.1 1.08 0.09	2050	2B, 3A, 3B, 3C, 4, 5, 6C	2, 3
Disposal Group 2	IDF-East RPPDF	0.340 8.37	2100	2A, 6B	2, 3
	IDF-West	0.09	2050		
Disposal Group 3	IDF-East	0.340	2165	6A	2, 3
	RPPDF	8.37		6A	2, 3
	IDF-West	0.09	2050	6A	2, 3

Note: For a description of facilities, see Section S.3.3. To convert cubic meters to cubic yards, multiply by 1.308.

Key: FFTF=Fast Flux Test Facility; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; RPPDF=River Protection Project Disposal Facility.

S.2.3.3 Closure

Options range from operating the RPPDF and IDF(s) indefinitely using administrative controls (No Action) to closing these facilities by covering them with landfill barriers followed by postclosure care. Closure type does not vary among the alternatives; both Waste Management Alternatives 2 and 3 include closing the RPPDF and IDF(s) under engineered modified RCRA Subtitle C Barriers.

Table S–4 outlines key activities by alternative for waste storage, treatment, and disposal, as well as facility closure.

Table S–4. Comparison of Waste Management Alternatives

	Alternative 1: No Action	**Alternative 2: Disposal in IDF, 200-East Area Only**	**Alternative 3: Disposal in IDF, 200-East and 200-West Areas**
Storage			
Existing storage of LLW, MLLW, and TRU waste at CWC	✓		
Expanded storage of LLW, MLLW, and TRU waste at CWC		✓	✓
Existing storage of LLW, MLLW, and TRU waste at WRAP and T Plant	✓		
Expanded storage of LLW, MLLW, and TRU waste at WRAP and T Plant		✓	✓
Treatment			
Existing treatment of LLW, MLLW, and TRU waste at CWC	✓		
Expanded treatment of LLW, MLLW, and TRU waste at CWC		✓	✓
Existing treatment of LLW, MLLW, and TRU waste at WRAP and T Plant	✓		
Expanded treatment of LLW, MLLW, and TRU waste at WRAP and T Plant		✓	✓
Disposal			
Continued disposal of onsite-generated non-CERCLA, nontank LLW and MLLW in onsite lined trenches	✓	✓	✓
Construction of IDF-East terminated and facility deactivated	✓		
Disposal of tank, onsite-generated non-CERCLA, FFTF decommissioning, waste management, and offsite-generated LLW and MLLW at IDF-East		✓	
Disposal of tank waste only at IDF-East and onsite-generated non-CERCLA, FFTF decommissioning, waste management, and offsite-generated LLW and MLLW at IDF-West			✓
Disposal of rubble, ancillary equipment, and soils (not highly contaminated) from closure activities at RPPDF		✓	✓
Closure			
None	✓		
Landfill closure of IDF(s) and RPPDF		✓	✓
Administrative control for 100 years	✓		
Postclosure care for 100 years		✓	✓

Note: For a description of facilities and technologies, see Section S.3.3.

Key: CERCLA=Comprehensive Environmental Response, Compensation, and Liability Act; CWC=Central Waste Complex; FFTF=Fast Flux Test Facility; IDF=Integrated Disposal Facility; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; LLW=low-level radioactive waste; MLLW=mixed low-level radioactive waste; RPPDF=River Protection Project Disposal Facility; TRU=transuranic; WRAP=Waste Receiving and Processing Facility.

S.3 OVERVIEW OF FACILITIES AND TECHNOLOGIES

This section includes a discussion of the major existing and proposed facilities and technologies involved in the essential components of tank closure, FFTF decommissioning, and waste management.

S.3.1 Tank Closure

S.3.1.1 Tank Waste Storage

Single-Shell Tanks. SSTs were built in the 200 Areas of Hanford from 1943 to 1964 to store liquid radioactive waste created by the production and separation of plutonium (see Figure S–2). An SST is a single-wall underground storage tank with carbon steel sides and bottom surrounded by a reinforced-concrete shell. The total nominal holding capacity of the SSTs is approximately 356 million liters (94 million gallons), and the tanks currently contain approximately 120 million liters (32 million gallons) of radioactive and hazardous waste (DOE 2003a:6-7). These tanks contain salt cake and sludge; most of their free liquids were evaporated or transferred to the newer DSTs to reduce the potential consequences of leaks.

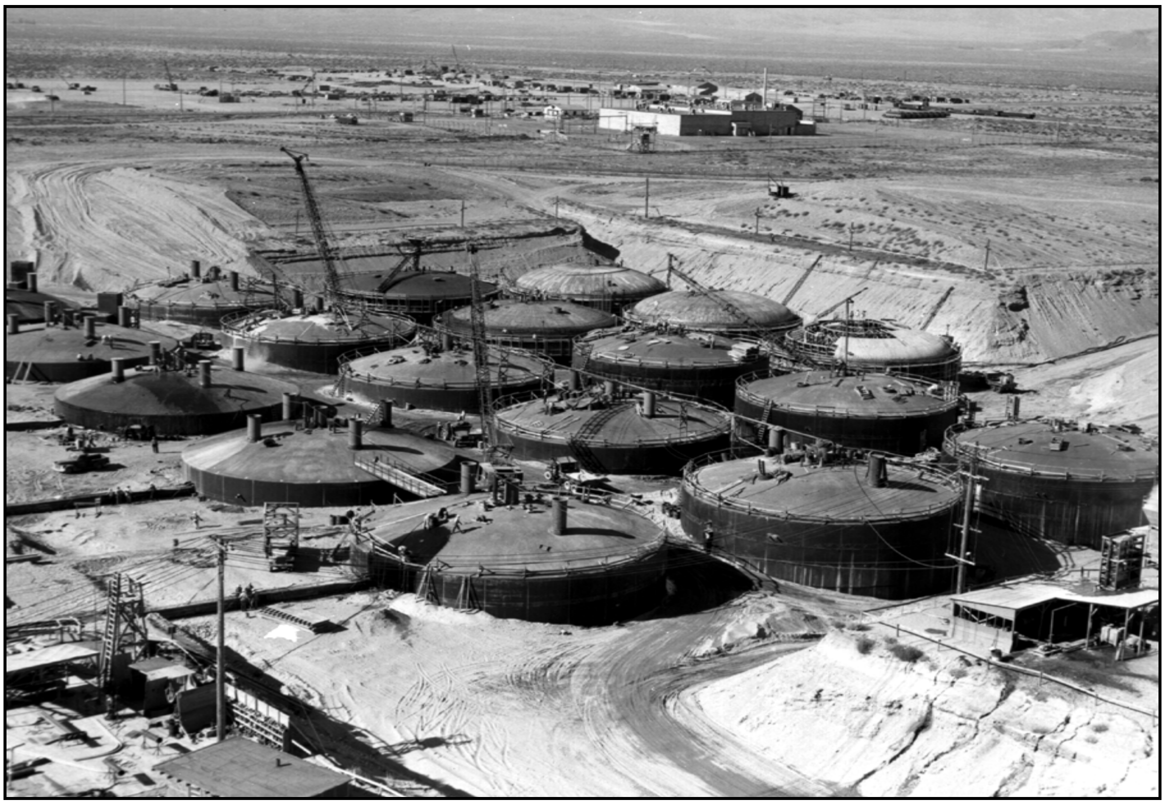


Figure S–2. The Hanford Site's Waste Tanks Under Construction

The tops of the tanks are buried from approximately 2.5 meters (8 feet) below ground to provide radiation shielding. The larger tanks have multiple risers (shielded openings) that provide tank access from the surface. These risers provide access points for monitoring instrumentation, video observation, tank ventilation systems, and sampling. As analyzed in this *TC & WM EIS*, 67 of the 149 SSTs are known or are suspected to have leaked liquid waste to the environment between the 1950s and the present, some of which has reached the groundwater. However, it is likely that some of the tanks have not actually leaked. Estimates of the total leak loss range from less than 2.8 million liters (750,000 gallons) to as much as 3.97 million liters (1,050,000 gallons) (Hanlon 2003:B-13–B-15).

Double-Shell Tanks. DSTs were built from 1968 to 1986. The DSTs contain a carbon steel tank inside a carbon steel-lined reinforced-concrete tank. This design provides improved leak detection and waste containment. To date, no leaks have been detected in the annulus, the space between the inner and outer tanks that houses equipment to detect and recover waste in the event of a leak from the inner tank. Like the SSTs, the DSTs are buried below ground and have risers for tank monitoring and access. The 28 DSTs have a total nominal holding capacity of 117 million liters (31 million gallons) and currently contain approximately 85 million liters (22.5 million gallons) of radioactive and hazardous waste, generally liquids and settled salts (DOE 2003a:6-8). Some tanks also contain a bottom layer of sludge.

Tank Farms. These SSTs and DSTs are distributed among 18 tank farms in the 200 Areas of Hanford. The 200 Areas are divided into east and west components (200-East Area and 200-West Area), and each tank farm contains 2 to 18 tanks. As shown in Figures S–3 and S–4, the 200-West Area includes 6 SST farms (S, SX, T, TX, TY, and U) and 1 DST farm (SY), and the 200-East Area includes 6 SST farms (A, AX, B, BX, BY, and C) and 5 DST farms (AN, AP, AW, AY, and AZ). Also shown in these figures are facilities proposed under the Tank Closure action alternatives.

S.3.1.2 Tank Waste Retrieval

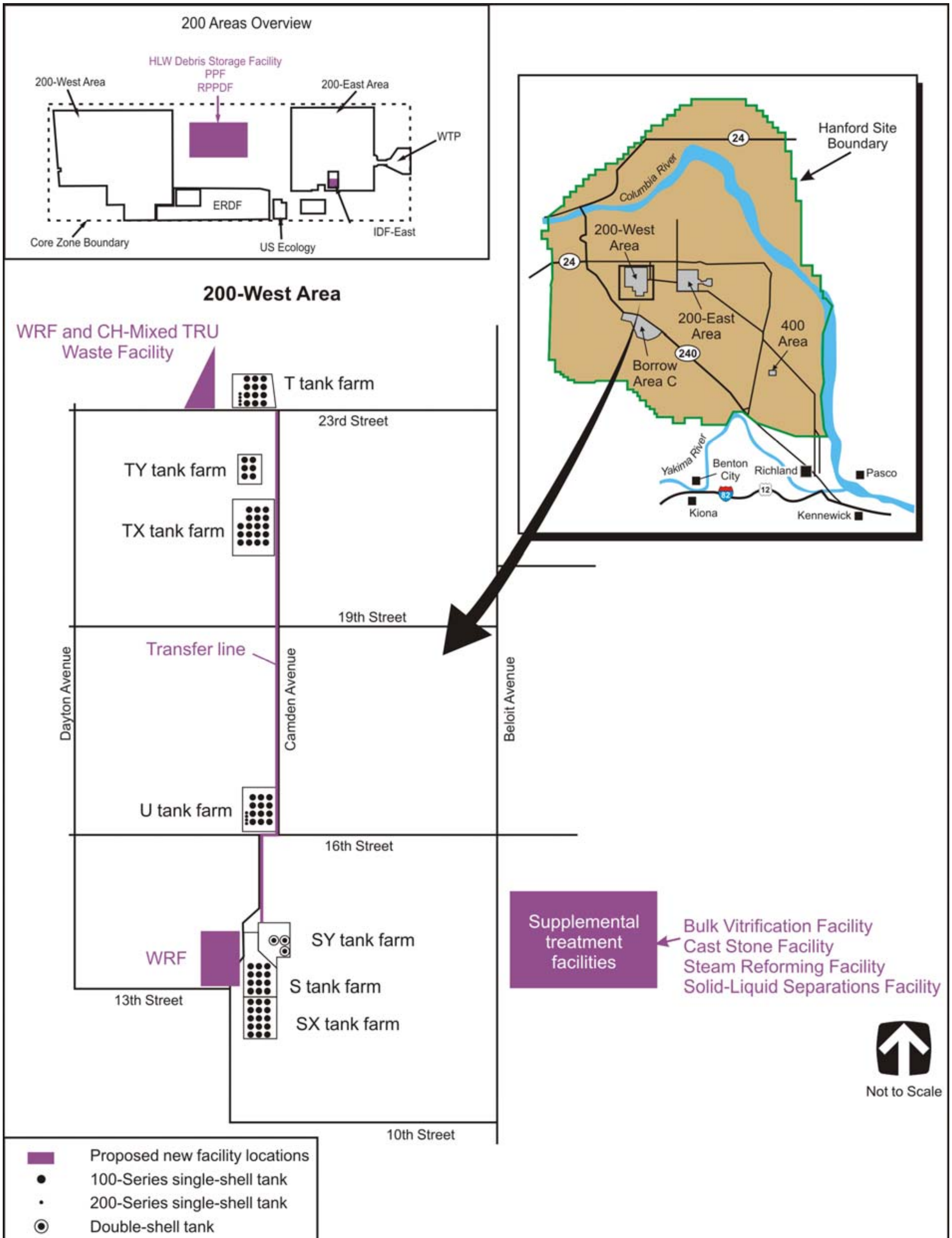
DOE evaluated four retrieval systems to determine whether they could achieve the goal of 90 percent (Tank Closure Alternative 5), 99 percent (Tank Closure Alternatives 2A, 2B, 3A, 3B, 3C, and 6C), or 99.9 percent (Tank Closure Alternatives 4, 6A, and 6B) retrieval of tank waste.

Modified Sluicing. Nozzles inserted into a tank pump liquid into it in a controlled manner. This sluicing liquid dissolves soluble waste materials and/or breaks down solids into waste slurry (watery mixture of insoluble waste materials), depending on its pressure and flow rate, and transfer pumps, within the tank, pump the waste slurry to a receiver tank at approximately the same rate as sluice liquid is pumped into the tank (DOE 2003b:4-2). This system is expected to retrieve waste to levels consistent with the 90 and 99 percent retrieval goals.

Mobile Retrieval System. This system retrieves waste by mobilizing it physically, using an in-tank vehicle, or by pumping in sluicing liquid from nozzles on the vehicle or on an articulated-mast system, which is a rotating arm extending from a stationary mast positioned in the center of a tank. The mobilized waste is then pumped out of the tank using vacuum hose-and-nozzle assemblies that are part of the in-tank vehicle and articulated-mast system. After retrieval, the vehicle can be used to rinse the tank walls and in-tank equipment (DOE 2003b:4-3). This system is expected to retrieve waste to levels consistent with the 90 and 99 percent retrieval goals.

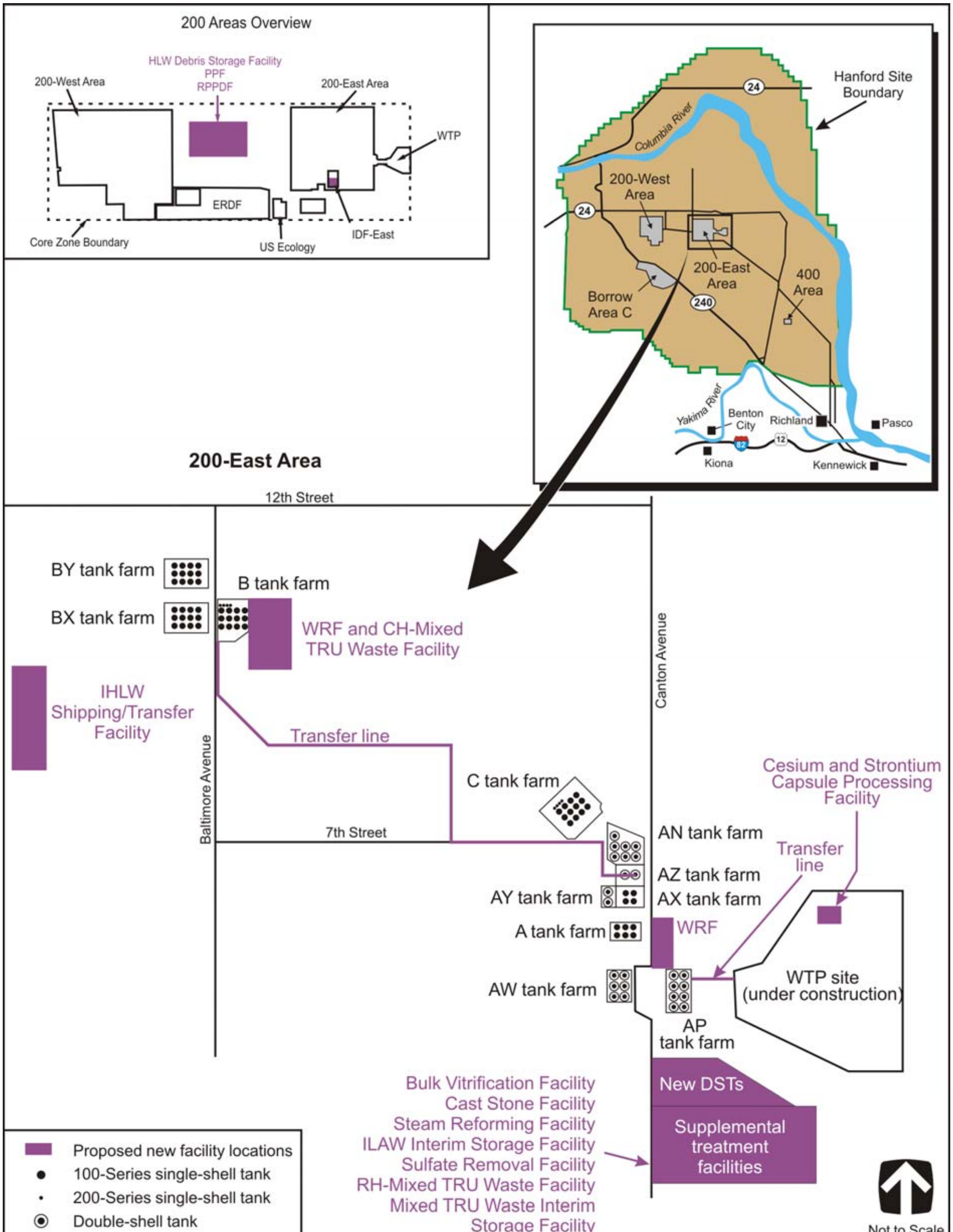
Vacuum-Based Retrieval. Instead of water, air is the conveyance medium for this vacuum system, which is deployed from an articulated-mast system in the center of the tank. The rotating arm can reach the entire tank base of one series of tanks, but only a portion of the base of another series, whose tanks have a larger diameter (DOE 2003b:4-5). This system is expected to retrieve waste to levels consistent with the 90 and 99 percent retrieval goals.

Chemical Wash System. If the foregoing retrieval methods were not adequate, chemicals could be introduced into a tank to dissolve the remaining waste into a solution that could be removed from the tank more easily. Chemicals could be introduced and solutions removed via the same equipment used to introduce and remove sluicing liquid or waste if the construction materials could withstand the chemicals and chemical cleaning solutions. Specific chemicals would be selected on a tank-by-tank basis (DOE 2003b:4-4). This system coupled with the monitored retrieval and vacuum-based systems is capable of retrieving 99.9 percent of the waste in the tanks.



Key: CH=contact-handled; ERDF=Environmental Restoration Disposal Facility; HLW=high-level radioactive waste; IDF-East=200-East Area Integrated Disposal Facility; PPF=Preprocessing Facility; RPPDF=River Protection Project Disposal Facility; TRU=transuranic; WRF=Waste Receiver Facility; WTP=Waste Treatment Plant.

Figure S–3. 200-West Area Proposed New Tank Closure Facility Locations



Key: CH=contact-handled; DST=double-shell tank; ERDF=Environmental Restoration Disposal Facility; HLW=high-level radioactive waste; IDF-East=200-East Area Integrated Disposal Facility; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; PPF=Preprocessing Facility; RH=remote-handled; RPPDF=River Protection Project Disposal Facility; TRU=transuranic; WRF=Waste Receiver Facility; WTP=Waste Treatment Plant.

Figure S–4. 200-East Area Proposed New Tank Closure Facility Locations

S.3.1.3 Tank Waste Transfer

Tank waste must be transferred between tanks and from tanks to treatment facilities. None of the existing SST transfer lines would be used. However, an extensive existing system of underground piping connecting all of the DSTs is operated routinely. The modified sluicing and mobile and vacuum-based retrieval systems would use hose-in-hose transfer lines on or near the surface, and new underground transfer lines would be built for distances that exceed the reach of the hose-in-hose lines. WRFs would help facilitate waste transfers, when necessary, by temporarily storing waste; conditioning it by dissolution, dilution, or size reduction of particles in the waste slurry; and providing batches for subsequent transfer. These facilities could also recirculate sluicing liquids back to the tanks (DOE 2003b:4-15).

Waste Treatment Plant

The Waste Treatment Plant (WTP) is currently being constructed at the Hanford Site. Site work associated with the project began in late 2001. As of fall 2008, project construction was approximately 40 percent complete. When completed, the WTP will be the largest radiochemical processing facility in the world. It will occupy 26 hectares (65 acres) and be composed of 38,000 tons of steel, 300 kilometers (1 million feet) of piping, 1,500 kilometers (5 million feet) of electrical cable, and 203,000 cubic meters (265,000 cubic yards) of concrete. The WTP will consist of four major facilities: the Pretreatment Facility, Low-Activity Waste Vitrification Facility, High-Level Radioactive Waste Vitrification Facility, and an Analytical Laboratory.

S.3.1.4 Tank Waste Treatment

Treatment technologies and associated facilities aim to change the physical or chemical character of the tank waste to make it less hazardous; reduce its volume; or make it safer for transport, storage, or disposal.

Waste Treatment Plant. The WTP is the cornerstone of tank waste treatment. It is designed to receive tank waste via pipelines from tank farms, treat waste, and convert treated waste into a glass form (by a process called vitrification) for storage, pending disposal. WTP facilities include the following:

- Pretreatment Facility – Removes selected radionuclides and HLW solids from retrieved tank waste to produce an HLW stream and a LAW stream
- HLW Vitrification Facility – Receives HLW stream from the Pretreatment Facility, combines it with glass-forming materials, and melts (using HLW melters) the combination to produce a molten glass waste form to be poured into stainless steel containers for cooling into a solid for storage, pending disposal
- LAW Vitrification Facility – Receives a LAW stream from the Pretreatment Facility, combines it with glass-forming materials, and melts (using LAW melters) the combination to produce a molten glass waste form to be poured into stainless steel containers for cooling into a solid for storage, pending disposal
- Analytical Laboratory – Characterizes samples of tank waste and ensures that final glass products meet all regulatory requirements and standards

An illustration of these four main components, as well as various support facilities, is provided as Figure S–5.

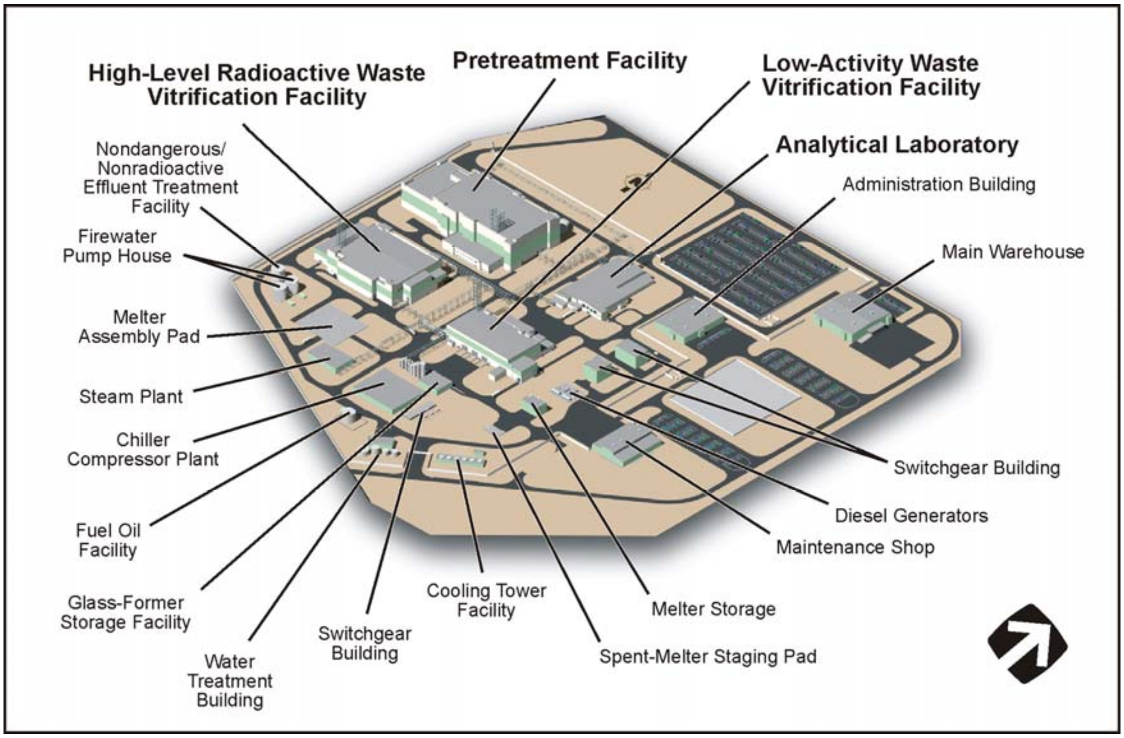


Figure S–5. Waste Treatment Plant Facilities

Thermal Supplemental Treatment: Bulk Vitrification and Steam Reforming. Thermal supplemental treatment would be used to treat a portion of the tank waste under certain alternatives (3A, 3C, 4, and 5). There are two representative thermal supplemental treatment processes analyzed in this *TC & WM EIS*: bulk vitrification and steam reforming.

Bulk Vitrification. Under Tank Closure Alternatives 3A, 4, and 5, the bulk vitrification process would convert LAW into a solid glass by drying the waste, mixing it with Hanford soils, and applying an electric current within a large steel container (electrodes would be inserted into the waste). The electric current would melt the mixture of waste and soils into a liquid glass, and a temporary offgas hood would collect air emissions and direct them toward a treatment system. Waste would be processed in vitrification boxes, which would cool for three days before transfer to a disposal site. The vitrified waste form would look similar to obsidian, a dark, volcanic glass. Glass performs well as a waste form for containment of radioactive and hazardous waste because it is durable and leach resistant. Bulk Vitrification Facilities are proposed for the 200-East and 200-West Areas.

Steam Reforming. Steam reforming is the thermal supplemental treatment technology that would be used under Tank Closure Alternative 3C. Steam reforming is a technology used for nonradioactive processing in the petroleum industry that can also be used to treat radioactive waste. Pretreated waste or LAW retrieved from the tanks would be diluted with water so it could be pumped into a vessel. Within the vessel, the water would be heated into steam, and the LAW material would be converted to granular minerals. Offgas would be treated and discharged. The steam reforming waste would be placed in steel packages for storage or disposal. Steam Reforming Facilities are proposed for the 200-East and 200-West Areas.

Nonthermal Supplemental Treatment: Cast Stone. The cast stone process is the representative nonthermal supplemental treatment process that would be used under Tank Closure Alternatives 3B, 4, and 5 to treat a portion of tank waste by mixing LAW with grout-formers (e.g., Portland cement), pumping it into disposal containers, and allowing it to solidify into a cement matrix. The formulation of grout-forming materials to be added to waste could be adjusted for batch-to-batch variations in waste retrieved from different tanks. Cast Stone Facilities are proposed for the 200-East and 200-West Areas.

Supplemental Treatment: Tank-Derived Mixed Transuranic Waste. Under Tank Closure Alternatives 3A, 3B, 3C, 4, and 5, waste that could be designated as mixed TRU waste would be retrieved from tanks, treated, and packaged for disposal at WIPP instead of being vitrified in the WTP. Mixed TRU waste would be categorized as contact-handled or remote-handled TRU waste. Retrieved mixed TRU waste would be transferred to the Contact-Handled-Mixed TRU Waste Facilities, mobile facilities that could relocate to each tank farm in the 200-East and 200-West Areas, or to the Remote-Handled-Mixed TRU Waste Facility, which would be permanently located in the 200-East Area, for dewatering and packaging. Liquids extracted during dewatering would be treated in the WTP, while solids would be packaged for eventual disposal at WIPP. Processed mixed TRU waste would have to meet the criteria for transportation, interim onsite storage in a new TRU Waste Interim Storage Facility, and disposal at WIPP.

Contact-handled transuranic waste has a radiation level less than or equal to 200 millirem* per hour at the surface of a waste container and can be safely handled by direct contact.

Remote-handled transuranic waste is packaged transuranic waste whose external surface dose rate exceeds 200 millirem per hour. This waste requires special shielding and handling to protect workers and the public.

* A millirem (one-thousandth of a rem) is a unit of measure of absorbed ionizing radiation used to assess the biological effects of a given dose of any type of radiation.

Solid-Liquid Separations Processes. The WTP would be used to pretreat tank waste before it was processed in supplemental treatment facilities in the 200-East Area. In contrast, a new Solid-Liquid Separations Facility in the 200-West Area would be used to pretreat tank waste that may contain low cesium-137 concentrations before it was processed in supplemental treatment facilities in the 200-West Area to avoid the necessity of cross-site transport. After using gravity settling and decanting processes, half of the solids would go to the WTP for further processing. Adding a chemical during settling would cause strontium-90 and TRU radionuclides to separate from the rest of the waste, resulting in a portion of the strontium-90 and TRU radionuclides being forwarded to the WTP and the balance to the selected supplemental treatment facility in the 200-West Area.

Sulfate Removal. Sulfate removal is a pretreatment process considered under Tank Closure Alternative 5 that could increase "waste loading" (i.e., the amount of waste per volume) in the glass produced in the WTP LAW Vitrification Facility, reducing the amount of glass that would be produced in the WTP over the life of the tank closure project by approximately 35 percent. Sulfate removal could also mitigate the risk of a corrosive molten sulfur salt layer that could build up in the LAW Vitrification Facility and potentially damage the LAW melter. First, strontium nitrate would be added to the tank waste, causing sulfate to separate out as a strontium sulfate precipitate, then the tank waste would be filtered and solidified using grout-forming additives. This process would be used between pretreatment at the WTP and treatment in the LAW Vitrification Facility. Waste headed for the supplemental treatment facilities would not be treated using this process. Two new facilities—a Sulfate Removal Facility and an associated grout facility—would be built in the 200-East Area adjacent to the WTP to implement this process.

Technetium-99 Removal. Technetium-99 is a long-lived, mobile radionuclide present in the tank waste that is of particular interest in regard to the performance of waste forms over the long term. For this reason, Tank Closure Alternatives 2B and 3B call for removal of technetium-99 from the LAW stream during WTP pretreatment via ion exchange. Technetium-99 would then be transferred to the HLW stream and vitrified as glass. Under all other Tank Closure alternatives, technetium-99 would remain in the LAW stream.

Cesium and Strontium Capsule Treatment. Cesium and strontium waste would be extracted from the cesium and strontium capsules currently in storage in the WESF in the 200-East Area and prepared into a slurry waste stream in a new Cesium and Strontium Capsule Processing Facility to be built in the 200-East Area. This stream would then be sent to the WTP for treatment. In all Tank Closure alternatives except Alternative 1, these activities would occur during a separate campaign after all HLW from the tanks had been treated.

S.3.1.5 Interfacing Facilities – Tank Waste Storage, Retrieval, and Treatment

The following facilities would interface with storage, retrieval, and treatment of tank waste:

Liquid Waste Processing Facilities. These facilities process liquid waste. The Effluent Treatment Facility (ETF) and Liquid Effluent Retention Facility process liquid waste streams (effluents) designated as radioactive and dangerous wastes. The Treated Effluent Disposal Facility disposes of nonradioactive, nondangerous liquid effluents. These three facilities would require life extension upgrades or replacements over the course of the tank closure project. Replacements of the ETF are analyzed in this EIS to support the Tank Closure alternatives. Life extension upgrades of the Liquid Effluent Retention Facility and the Treated Effluent Disposal Facility are assumed to allow operation through the end of the WTP service life.

242-A Evaporator. This facility uses an evaporation system to reduce the volume of liquid tank waste, concentrating radioactive waste solutions so that fewer tanks are required to store liquid waste. This evaporation process supports tank farm management and WTP operations; the facility would have to be replaced multiple times under some Tank Closure alternatives.

222-S Analytical Laboratory. This facility supports tank waste characterization, tank waste retrieval, and waste feed delivery to the WTP; upgrades to or replacements of this facility are not analyzed in this EIS because its use is expected to be limited following the start of operations of the WTP Analytical Laboratory.

S.3.1.6 Tank Waste Disposal

Onsite disposal of tank waste would occur in an IDF and the RPPDF, facilities discussed in the waste management section (Section S.3.3) of this Summary.

Hanford would provide onsite interim storage facilities for IHLW.[1] A new TRU Waste Interim Storage Facility would provide interim storage for mixed TRU waste pending shipment to WIPP.

S.3.1.7 Tank Farm Closure

The three approaches to SST farm closure evaluated under various Tank Closure action alternatives are outlined below.

Landfill Closure. Landfill closure of the SST system (Tank Closure Alternatives 2B, 3A–3C, 4 [selective landfill closure], 5, and 6C) would generally include the following:

[1] The analyses in this EIS are not affected by recent DOE plans to study alternatives for the disposition of the Nation's SNF and HLW because the EIS analysis shows that vitrified HLW can be stored safely at Hanford for many years until disposition decisions are made and implemented.

- Grout-filling of tanks
- Grouting of ancillary equipment (e.g., waste transfer system piping, in-tank equipment) and WRFs
- Removal of some ancillary equipment and near-surface contaminated soils
- Placement of a surface barrier (i.e., modified RCRA Subtitle C barrier or Hanford barrier)
- Postclosure care

Clean Closure. Clean closure of the SST system (Tank Closure Alternatives 4 [selective clean closure], 6A, and 6B) would include the following:

- Removal of ancillary equipment, WRFs, and SSTs.
- Deep soil removal.
- Additional waste preprocessing/packaging – Further treatment of contaminated ancillary equipment, rubble, and soils would occur in a new PPF; contaminated materials or materials treated in the PPF would be disposed of in the RPPDF or stored in shielded boxes on concrete pads. Depending on the alternative selected, the contaminated liquid waste from the acid wash would be neutralized and treated either in the WTP, resulting in IHLW, or in the PPF using a glass melter, resulting in an immobilized waste form similar to ILAW. The IHLW would require long-term onsite storage, and the PPF glass would be disposed of in an IDF.

Selective Clean Closure. Tank Closure Alternative 4 considers a hybrid approach to clean-close the BX and SX tank farms and landfill-close the balance of the SST system.

Landfill Barriers

Landfill barriers are above-grade, multilayered engineered surface barriers that would be placed over the tank farms and associated ditches to provide long-term containment and hydrologic protection of the waste site as part of landfill closure. These barriers would be constructed as a set of five “lobes” (two in the 200-East Area and three in the 200-West Area). The two types considered in this environmental impact statement are the following:

- Modified Resource Conservation and Recovery Act Subtitle C barrier (Tank Closure Alternatives 2B, 3A–3C, 4, 6C) – 8 layers, 2.7 meters (9 feet) thick; designed to provide 500-year protection without maintenance
- Hanford barrier (Tank Closure Alternative 5) – 10 layers, 4.6 meters (15 feet) thick; assumed to be designed to provide 1,000-year protection without maintenance; added protection against wind and water erosion, as well as plant, animal, and human intrusion

S.3.2 FFTF Decommissioning

FFTF is a DOE-owned, formerly operating thermal liquid-metal (sodium)-cooled research and test reactor (involved in projects such as fuel performance testing and medical isotope production) in the 400 Area of Hanford. Forty-five structures or buildings within the FFTF complex, shown in Figure S–6, would be decommissioned under the FFTF Decommissioning alternatives.

These buildings fall under the following groups:

Reactor Containment Building. The RCB is the major facility of the FFTF complex to be decommissioned. The building consists of a carbon steel cylindrical reactor-containment vessel 56.7 meters (186 feet) high by 41.1 meters (135 feet) in diameter, with reinforced-concrete cells from grade level to about 24 meters (78 feet) below grade. Below-grade structures containing the greatest radionuclide inventories include the reactor vessel, the Interim Examination and Maintenance Cell, the Test Assembly and Conditioning Station, and the Interim Decay Storage Vessel.

Reactor Support Buildings and Auxiliary Buildings. Various buildings surrounding the RCB are structurally independent from it and designed to withstand natural forces such as earthquakes.

Figure S–6. Fast Flux Test Facility Complex

S.3.2.1 Facility Disposition

Under FFTF Decommissioning Alternative 1, sodium residuals would be left in the RCB under an inert gas blanket. Under FFTF Decommissioning Alternatives 2 and 3, all sodium residuals would be removed from the RCB systems or treated in place. The sodium would be drained from plant systems to the extent practicable, followed by passivation and/or flushing with water to stabilize the residuals. Sodium residuals in small-diameter piping would be treated in the 400 Area after the components were removed from the reactor plant.

> **Passivation**
>
> Treatment of a metal to reduce the chemical reactivity of its surface.

Demolition debris, radioactive waste, and other regulated hazardous waste would be handled in the same manner under both action alternatives; only the volume of waste would change. Debris not placed in the RCB or other voids or used as backfill would be transported to an IDF for disposal. Radioactive liquid waste volume resulting from treatment of the sodium residuals would be reduced at FFTF, either through ion exchange and reuse or evaporation. The remaining liquids would be transported to the 200-Area ETF for processing and disposal. It was assumed for analysis purposes that a 90 percent reduction in volume could be achieved prior to shipment to the ETF.

> **Ion Exchange**
>
> A physiochemical process that removes anions (negatively charged ions) and cations (positively charged ions), including radionuclides, from liquid streams (usually water) for the purpose of purification or decontamination.

Various end-state approaches were evaluated in accordance with the specific objectives of each FFTF Decommissioning alternative. Under the No Action Alternative, the facilities and infrastructure within the Property Protected Area, including the RCB, would undergo long-term surveillance with appropriate monitoring and controls to ensure that environmental and safety concerns are minimized for the foreseeable future. Under FFTF Decommissioning Alternative 2, Entombment, a landfill barrier, such as a modified RCRA Subtitle C barrier, would be constructed over the RCB and other buildings that contain radioactive and/or hazardous wastes. In addition, the barrier would extend over part or all of the immediately adjacent facility footprints. Postclosure care would include monitoring of air, groundwater, and the vadose zone. Under FFTF Decommissioning Alternative 3, Removal, no barrier would be built. Below-grade portions of structures would be backfilled with soil and compacted to eliminate void spaces, contoured to prevent natural settling resulting in depressions, and revegetated. Institutional controls or postclosure care may be established and continue for 100 years after revegetation of the area is complete.

S.3.2.2 Disposition of Remote-Handled Special Components

Brief descriptions of the four FFTF traps that are considered RH-SCs follow.

- Sodium cold trap – Part of the coolant system when FFTF operated. The sodium cannot be fully drained, and high dose rates make it impossible to do manual work. DOE is proposing to flush the system with sodium, drain it to the maximum extent possible, and allow any remaining sodium to freeze. The cold trap would be removed using remote operations and special shielding.
- Cesium trap – Filter designed to remove radioactive cesium from sodium. The sodium cannot be fully drained. It would be removed using remote operations and special shielding.
- Sodium vapor traps (2) – Components in isolated cells within the RCB that served to minimize sodium vapor transport into the primary gas system piping. One vapor trap has large quantities of cesium-137, and considerable quantities have migrated beyond the trap into the downstream gas piping systems. Both of these traps would be remotely removed and shielded.

Removal of these RH-SCs from FFTF would be completed as part of the deactivation work and is evaluated in the *Environmental Assessment, Sodium Residuals Reaction/Removal and Other Deactivation Work Activities, Fast Flux Test Facility (FFTF) Project, Hanford Site, Richland, Washington* (DOE 2006a). The removed components would be stored within the FFTF complex under all FFTF Decommissioning alternatives. Under FFTF Decommissioning Alternatives 2 and 3, the RH-SCs would then be sent to the selected treatment facility once it had been built and was ready to receive them. FFTF Decommissioning Alternatives 2 and 3 include two "options" associated with treatment of RH-SCs at a Hanford or an INL facility: the Hanford Option and the Idaho Option.

Hanford Option. Because no facility currently exists at Hanford to treat these traps, under the Hanford Option DOE proposes building a new facility (the RTP) similar in design to INL's proposed RTP. RH-SCs would be removed from FFTF, stored on site at Hanford until the new RTP was permitted and built, then treated in the new RTP and disposed of in an IDF.

Idaho Option. DOE has already proposed constructing an RTP at INL to handle similar INL waste streams, and this facility is currently in the planning phase. Under the Idaho Option, RH-SCs from Hanford would be removed and shipped to INL for treatment in this proposed facility, then disposed of either at the Nevada Test Site or in a Hanford IDF.

Remote Treatment Project

The Remote Treatment Project at the Hanford Site or Idaho National Laboratory would include these primary design features:

- A waste processing cell used to prevent the release of radioactive and hazardous contaminants to the environment
- Waste processing equipment designed to handle and process the remote-handled waste received in liners, drums, and large waste boxes

S.3.2.3 Disposition of Bulk Sodium

Bulk sodium would undergo a sodium reaction process to produce a caustic sodium hydroxide solution at either the proposed SRF at Hanford or the existing SPF at INL. These two options associated with treatment of bulk sodium at Hanford or INL are called, respectively, the "Hanford Reuse Option" and "Idaho Reuse Option." At either facility, the basic chemical reaction is an exothermic (i.e., heat-emitting) reaction with water that produces a caustic sodium hydroxide solution that yields hydrogen gas.

> **Sources of Radioactively Contaminated Bulk Sodium**
>
> - Fast Flux Test Facility reactor coolant systems and storage vessels
> - Hallam Reactor
> - Sodium Reactor Experiment

Process steps at the SRF or the existing SPF include the following:

- Transfer liquid sodium from storage tank into facility's reaction vessel.
- Control reaction by adjusting injection rate of liquid reactants.
- Manage offgases emitted (e.g., through filtration).
- Pump final caustic solution to fill station for storage in transportation tanks or drums.

Hanford Reuse Option. Because no facility currently exists at Hanford to process the bulk sodium, under the Hanford Reuse Option DOE proposes to build the SRF directly adjacent to the existing Sodium Storage Facility to reduce cost and integrate operations. The Sodium Storage Facility would store bulk sodium until it could be transferred to the SRF for processing. Following processing, the resulting caustic sodium hydroxide solution would be reused in processing tank waste at the WTP, or for Hanford tank corrosion control.

Idaho Reuse Option. Under the Idaho Reuse Option, the bulk sodium would be stored in the Sodium Storage Facility at Hanford until shipped via truck and/or rail to INL for processing in the existing SPF. Following processing, the resulting caustic sodium hydroxide solution would be returned to Hanford for WTP or tank corrosion control purposes.

S.3.3 Waste Management

S.3.3.1 Solid Waste Management Facilities

Solid Waste Operations Complex. Facilities within the Hanford Solid Waste Operations Complex (SWOC) perform functions consistent with primary waste management processes: receipt, staging, storage, repackaging, treatment, and shipment of waste. Each process must be compliant with waste acceptance criteria. A description of the five components of the existing SWOC follows.

Low-Level Radioactive Waste Burial Grounds. The LLBGs are waste disposal areas, two in the 200-East Area and six in the 200-West Area, that contain lined and unlined trenches (Figure S–7 depicts a lined trench) of varying size and depth used for the disposal of LLW and MLLW and for retrievable storage of TRU waste. Particular trenches are dedicated to the receipt of LLW and MLLW, naval reactor compartments, TRU waste, packages difficult to handle, or radioactive lead solids. The trenches receive, store, and dispose of waste in generally the same manner, regardless of waste type. TRU waste packages are occasionally retrieved for assessment of the conditions of the waste containers and their immediate surroundings as an aid in planning future operations.

Figure S–7. Low-Level Radioactive Waste Burial Ground Lined Disposal Trench

Central Waste Complex. The Central Waste Complex (CWC) includes storage buildings and other structures that receive and store waste awaiting processing at other waste management facilities. The buildings and structures shown in Figure S–8 provide segregated areas to safely separate groups of incompatible wastes.

Figure S–8. Aerial View of the Central Waste Complex

T Plant. Primary activities of the T Plant are waste storage, decontamination, treatment, repackaging, and verification. Solid waste processing includes the addition of absorbent or grout material to the waste, neutralization, and amalgamation of mercury or other metals. Additional services include the sampling of drum headspace to support the TRU waste program and the management of analytical samples returned from commercial laboratories. Major facilities include the 221-T Canyon, which has remote-handled waste processing capabilities, and the 2706-T/TA/TB Facility. Figure S–9 provides an overview of the complex.

Figure S–9. Aerial View of the T Plant Complex

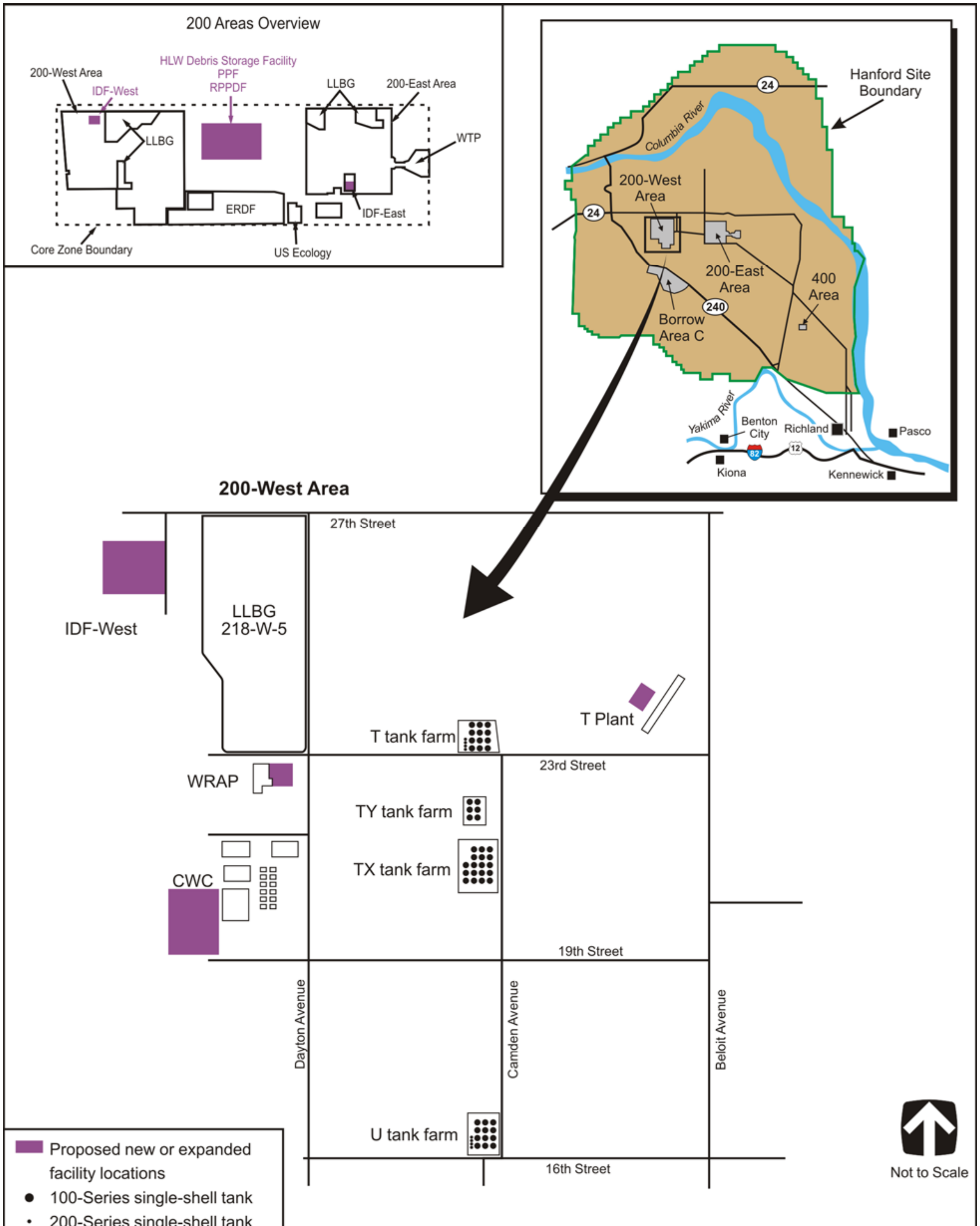
Waste Receiving and Processing Facility. Primary activities at WRAP are confirming, sampling, repackaging, certifying, storing, and treating waste for shipment to a treatment, storage, and disposal unit. WRAP, shown in Figure S–10, receives contact-handled waste containers from Hanford generators (e.g., LLBGs, CWC) and offsite generators. Radioactive waste is processed in three operational areas and inspections of sealed and open waste containers are conducted.

Figure S–10. Waste Receiving and Processing Facility

Integrated Disposal Facility (200-East or 200-West Area). The primary mission of an IDF is to dispose of LLW and MLLW. The existing facility, IDF-East (see Figure S–11), consists of two cells—one for LLW and one for MLLW—and is expandable. A similar facility is proposed for construction in the 200-West Area under Waste Management Alternative 3.

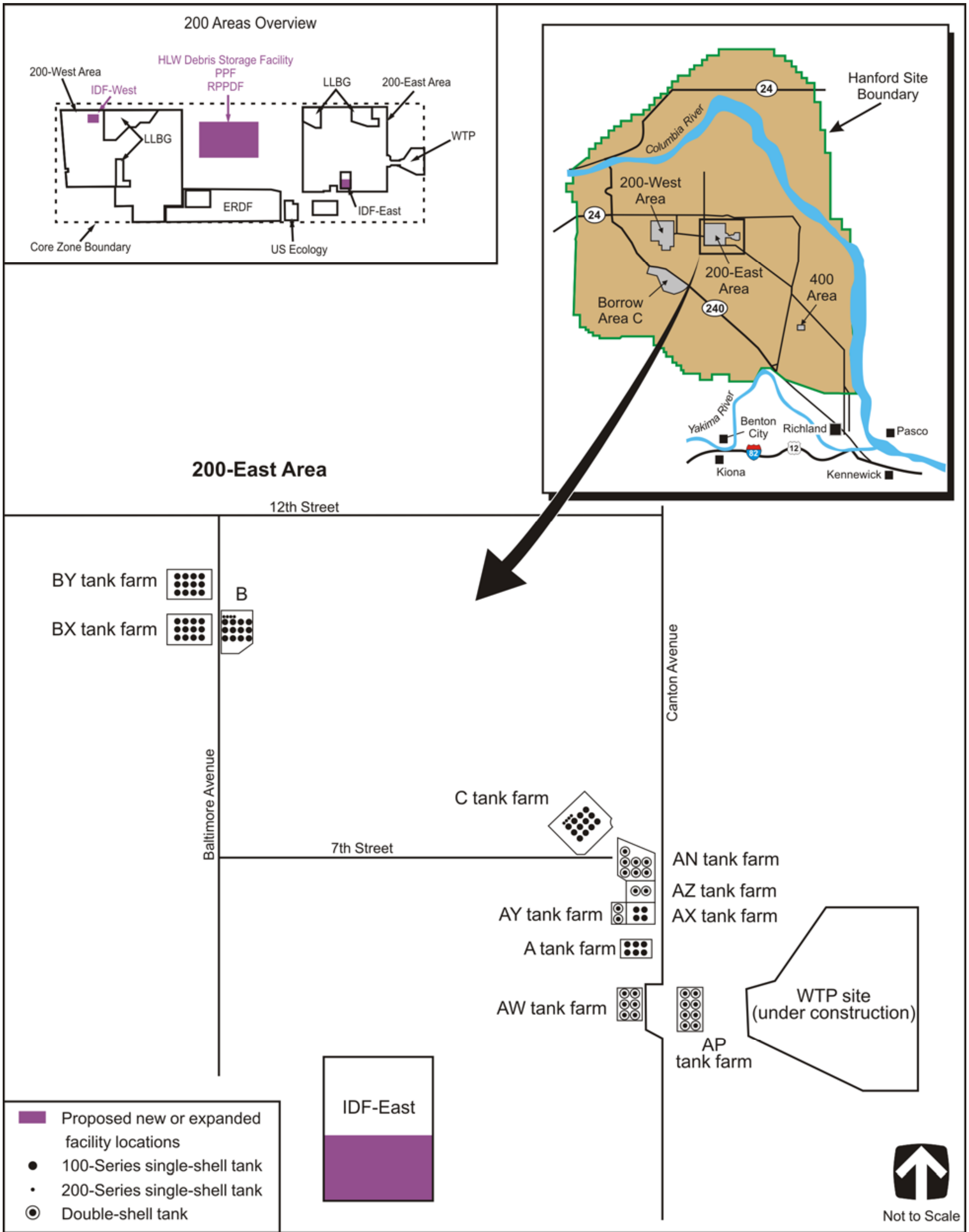
Figure S–11. 200-East Area Integrated Disposal Facility

Figures S–12 and S–13 show the locations of these waste management facilities in the 200-West and 200-East Areas.



Key: CWC=Central Waste Complex; ERDF=Environmental Restoration Disposal Facility; HLW=high-level radioactive waste; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; LLBG=low-level radioactive waste burial ground; PPF=Preprocessing Facility; RPPDF=River Protection Project Disposal Facility; WRAP=Waste Receiving and Processing Facility; WTP=Waste Treatment Plant.

Figure S–12. 200-West Area Waste Management Facility Locations



Key: ERDF=Environmental Restoration Disposal Facility; HLW=high-level radioactive waste; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; LLBG=low-level radioactive waste burial ground; PPF=Preprocessing Facility; RPPDF=River Protection Project Disposal Facility; WTP=Waste Treatment Plant.

Figure S–13. 200-East Area Waste Management Facility Locations

S.3.3.2 Proposed Solid Waste Management Activities

A number of specific activities for the management of LLW and MLLW from Hanford and other DOE sources are proposed under the Waste Management alternatives. The following is a brief description of these activities:

- **Use existing LLBGs.** Continue using two lined trenches for the receipt and disposal of onsite LLW and MLLW. Under the No Action Alternative, use them through 2035. Under Alternatives 2 and 3, use them until they are filled to capacity, by 2050.
- **Expand the CWC.** Add solid waste storage capacity.
- **Expand the T Plant.** Add a new building to the T Plant complex to process high-dose (i.e., RH) or oversized waste packages.
- **Expand WRAP.** Add facilities to process additional LLW, MLLW, and contact-handled TRU waste at the CWC; and remote-handled mixed TRU waste at WRAP.
- **Deactivate (No Action Alternative), expand or reduce (Alternative 2), or build a second IDF (Alternative 3).** These IDF activities include the following:
  - ***No Action Alternative.*** Deactivate the existing IDF site, remove the liner, and backfill the site to the natural grade.
  - ***Alternative 2.*** Expand or reduce the capacity of the existing 200-East Area facility, depending on the disposal group selected.
  - ***Alternative 3.*** Build a facility in 200-West Area. Dispose of Tank Closure alternative waste in the 200-East Area facility (capacity depends on the disposal group), and dispose of FFTF decommissioning waste, other onsite-generated waste, and offsite DOE waste in the 200-West Area facility (capacity is fixed under all disposal groups).
- **Build the RPPDF (action alternatives).** Dispose of waste resulting from closure activities in a new facility between the 200-East and 200-West Areas. The size and capacity depends on the disposal group selected.
- **Close the IDF(s) and the RPPDF.** Use a barrier, and manage closed facilities using postclosure care.

S.4 TECHNOLOGIES AND OPTIONS CONSIDERED BUT NOT EVALUATED IN DETAIL IN THE ALTERNATIVES

In developing the range of reasonable alternatives for tank closure, FFTF decommissioning, and waste management, DOE examined numerous technologies and options. The technologies and options discussed in this section were initially considered but were subsequently dismissed as reasonable alternatives under NEPA for meeting DOE's purpose and need. The following sections provide a brief discussion of these technologies and options as applicable to the three sets of proposed actions and the basis for why they were deemed unreasonable and were not considered further.

S.4.1 Tank Closure

Evaluation of tank waste disposal alternatives has been ongoing since waste storage in underground tanks was first recognized as a temporary solution to a long-term problem. Numerous technologies and approaches have been examined for the storage, retrieval, treatment, and disposal of tank waste, as well as closure of the SST system. This section summarizes the alternatives and technologies that were considered but not evaluated in detail in this *TC & WM EIS*. The following criteria were used to determine whether an alternative or technology would be appropriate for detailed evaluation.

- Is the alternative or technology relevant to the purpose and need for agency action in this EIS?
- Is the alternative or technology technically viable and practicable?

- Can the alternative or technology be designed to be protective of human health and the environment, with practicable mitigative measures?
- Is the technology sufficiently mature to allow detailed evaluation? Would the costs and time required to develop the technology for application at Hanford be feasible?
- Is the technology appreciably different from an alternative already included in this EIS, or does it offer potential advantages in terms of effectiveness, costs, or impacts on human health and the environment?

If the answer to any of the above questions was no, DOE determined that the alternative or technology was not reasonable for further consideration and evaluation in this *TC & WM EIS*. Therefore, the following waste storage, retrieval, treatment, and disposal and tank closure approaches were deemed unreasonable and were not evaluated in detail.

S.4.1.1 Tank Waste Storage

Some alternatives may require additional storage capacity above and beyond the current DST capacity. The selected storage arrangement is the construction of new below-grade DSTs. The following storage options were considered, but not evaluated:

- **Modification of Existing Canyon Facilities.** This option was not evaluated in detail because (1) the existing canyon facilities are not designed for storage of large volumes of liquid waste; (2) the existing radiation and contamination levels would result in elevated personnel exposure; (3) the low volume of storage space would not be cost-effective; and (4) environmental permitting is highly uncertain.
- **New Above-Grade DSTs.** This option was not evaluated in detail because (1) there are technical disadvantages associated with shielding large above-grade tanks and (2) the resources required for construction and operation of new above-grade tanks would be similar to those associated with below-grade tanks.

S.4.1.2 Tank Waste Retrieval

A number of technologies were initially considered for deployment to retrieve waste from the SSTs. Each of these technologies is flexible regarding the general equipment configuration, fluid velocities and flow rates, and methods of operation. Some are better suited to tank-specific considerations such as riser availability, waste condition, or in-tank interferences. Although the following technologies were ultimately not considered reasonable for detailed analysis in this *TC & WM EIS*, that does not preclude their future consideration as potentially viable approaches for retrieving waste from the SSTs.

Past-Practice Sluicing, Fluidic Mixing, and Salt Cake Dissolution. These retrieval technologies were addressed in the *TWRS EIS*. However, they are very similar to, and effectively encompassed by, the retrieval technologies evaluated in this *TC & WM EIS*.

Staging Waste in SSTs. This option was not evaluated in detail in this *TC & WM EIS* primarily because the SSTs cannot be made compliant with current regulations. In addition, this option would likely require extra DST space to be held in reserve in the event a leak was detected in one of the waste-staging SSTs. This would potentially decrease the available space in the DSTs by the volume of the largest SST used.

S.4.1.3 Tank Waste Treatment

The following treatment and pretreatment technologies were initially considered but were eliminated from detailed consideration in this *TC & WM EIS.*

Active Metal Reduction. This LAW treatment technology was not evaluated in detail in this *TC & WM EIS* primarily due to its relative technical immaturity and complexities, as well as operational safety issues related to flammable gas generation.

Fractional Crystallization. This technology was not evaluated in detail as a supplemental pretreatment process due to concerns over waste form performance with respect to nitrate, difficulty of operations, complexity of the process, and lack of deployment history.

HLW and LAW Vitrification with Phosphate Glass. This technology was not evaluated in detail because the phosphate glass formula has not been proven compatible with production-scale melters, and the resulting product glass has not been shown to meet the waste acceptance technical requirements for DOE's Civilian Radioactive Waste Management System (DOE 2007). Other WTP melter configurations and waste forms were not evaluated in detail in this *TC & WM EIS* because of DOE's intention to construct and operate the WTP as currently designed, using current melter technology and glass formulations.

Preprocessing Tank Waste with a Plasma Mass Separator. This technology was not evaluated in detail in this *TC & WM EIS* due to its present immaturity and the need for further testing and demonstration of its applicability to managing Hanford tank waste.

S.4.1.4 Tank Waste Disposal

The following disposal approaches were initially considered, but were eliminated from detailed evaluation in this *TC & WM EIS.*

Disposal of Hanford Waste to Offsite Facilities. The *WM PEIS* (DOE 1997a) provided analysis of potential environmental impacts of broad alternatives for DOE's waste management program to provide a basis for DOE decisions on programmatic configurations of sites for waste management activities. One of DOE's decisions based on the *WM PEIS* addressed disposal of LLW and MLLW, and DOE decided that Hanford would dispose of its own LLW and MLLW on site (65 FR 10061). There is no new information that would compel reconsideration of this decision. Therefore, the option of disposing of these wastes off site is eliminated from further consideration in this EIS.

Disposal of HLW Melters Taken Out of Service. As the HLW melters have not been installed or operated, a high degree of uncertainty exists about their operation, lifespan, waste characterization and waste classification. As a result, this *TC & WM EIS* assumed a conservative (i.e., economically and with consideration of the human health impacts of melter storage, transportation, and disposal) disposition of the melters; the HLW melters would be stored on site. Thus, onsite disposal was eliminated from further consideration in this EIS.

S.4.1.5 Tank Farm Closure

The following technologies, each of which could provide in situ (in place) soil remediation and offer alternatives to support tank farm closure, were considered but not selected for detailed analysis in this *TC & WM EIS*.

Subsurface Barriers. This option was not evaluated in detail because (1) use of subsurface barriers would reduce only a small amount of the risk associated with waste retrieval, tank stabilization, and surface-barrier technologies; (2) the performance of subsurface barriers is highly uncertain, so their use is expected to have a limited impact on risk, but would carry a high cost-benefit ratio; and (3) the potential risks to workers involved in implementing subsurface-barrier approaches would increase substantially compared to the risks associated with using surface barriers and waste retrieval.

In Situ Soil Remediation. A variety of in situ soil remediation technologies were initially considered but were not evaluated in detail because of the difficulties and uncertainties associated with placement of treatment zones and their performance verification. In situ treatment generally requires long periods of time and provides questionable uniformity of treatment because of the variability in soil and aquifer characteristics. The overall efficacy of in situ processes is also relatively difficult to verify.

Gravel-Filling of Tanks. Although gravel or grout could be used to adequately stabilize waste tanks structurally and both are considered viable as a potential corrective action or emergency response, this *TC & WM EIS* does not evaluate this option in detail for closure purposes, primarily because the gravel would not prevent water intrusion and possible mobilization of contaminants from stabilized residual waste. In addition, the use of grout, rather than gravel, represents a more conservative estimate for commitment of resources.

S.4.2 Fast Flux Test Facility

This section describes the potential alternatives that were considered, but not evaluated in detail, for decommissioning the FFTF complex, managing and disposing of one or more of the FFTF waste streams, or disposing of Hanford's radioactively contaminated bulk sodium inventory. These alternatives were not evaluated in detail because DOE determined they are not reasonable due to current Hanford activities, likely environmental impacts, public and worker safety considerations, and implementation issues and concerns.

Restart FFTF to Support Isotope Production or Research Missions. On the basis of previous NEPA evaluations, DOE decided to shut down and deactivate FFTF (DOE 1995a, 2000a). Deactivation of the facility is currently in progress; therefore, restart is not considered to be a reasonable alternative.

Turn the FFTF Complex into a Museum or Find Another Alternative Use. During the public scoping meetings for this *TC & WM EIS*, some of the comments received suggested cleaning out the FFTF facility and turning it into a publicly accessible museum. Because the structures would need to be maintained for an indefinite period of time, this approach would be closely analogous to the No Action Alternative. This suggestion was not considered a reasonable alternative due to the radiological and unique chemical hazards associated with the facility, the age of the buildings, and the lack of a financial sponsor. However, any documentation necessary to preserve information regarding FFTF's historic aspects will be developed in conjunction with the State Historic Preservation Officer and applicable regulations.

Interim Safe Storage. The production reactors along the Columbia River are undergoing a cleanout process, referred to as "interim safe storage." As part of that process, all SNF is being removed, surrounding buildings are being demolished, the main reactor building is being cleaned and partially dismantled (to the shield walls), and a new roof is being installed. In the interim safe storage configuration, storage and maintenance costs are very low and the reactor can be left for up to 75 years, allowing radionuclides to decay before further action would be needed, thus reducing worker exposure during waste disposal. With respect to decommissioning FFTF, the interim safe storage approach would be closely analogous to the No Action Alternative, with enhanced isolation of the RCB. Because of the chemical hazards associated with the reactive sodium coolant and the relatively low cumulative doses associated with the proposed decommissioning activities, as well as DOE's desire to accelerate and complete the required cleanup actions, this approach was not deemed a reasonable alternative.

Recycle Debris. One option for disposal of some of the demolition debris would be to recycle the steel and concrete. The potential presence of radioactivity and hazardous chemicals and the expense required to decontaminate the debris and ensure its suitability for unrestricted release made this option impractical. Therefore, it was not considered a reasonable alternative.

Convert Bulk Sodium to a Solid Waste. DOE previously decided to convert Hanford's bulk sodium to a caustic sodium hydroxide solution for use in tank waste processing at the WTP (Ecology, EPA, and DOE 2002), thus avoiding the expense of converting the reactive sodium to a solid form and disposing of it as radioactive waste, as well as the cost of procuring additional resources needed to treat Hanford's tank waste. DOE did not consider this option, primarily based on the loss of a beneficial use of the sodium, to be a reasonable alternative that required further evaluation.

Alternative Barrier Concepts. Under FFTF Decommissioning Alternative 2, a closure barrier would be constructed over the FFTF buildings in accordance with applicable regulations. Because the final design of the barrier is still to be determined, various design options were considered. For the *TC & WM EIS* analysis, the modified RCRA Subtitle C barrier was assumed.

S.4.3 Waste Management

As discussed in Section S.1, DOE and Washington State executed a Settlement Agreement on January 6, 2006, ending the NEPA litigation (*State of Washington v. Bodman* [Civil No. 2:03-cv-05018-AAM]) regarding the state's concerns about the groundwater-related and other analyses presented in the *HSW EIS* (DOE 2004). This agreement and the concurrent Memorandum of Understanding between DOE and Ecology (DOE and Ecology 2006) directed DOE to revise or update analyses from the *HSW EIS*, as appropriate, in the new *TC & WM EIS*. The new EIS would also ensure all waste types addressed in the *HSW EIS* alternatives and cumulative impact analyses are integrated. The alternatives evaluated in this *TC & WM EIS* represent the range of reasonable alternatives covering a full spectrum of tank closure, FFTF decommissioning, and waste management activities. In addition, any combination of the Waste Management No Action Alternative with waste-generating Tank Closure or FFTF Decommissioning alternatives was considered unreasonable, and therefore activities necessary to support such alternative combinations were not evaluated in this *TC & WM EIS*.

S.5 SUMMARY OF ENVIRONMENTAL IMPACTS AND KEY FINDINGS

S.5.1 Approach to Impact Analysis

Methods for assessing environmental impacts in this *TC & WM EIS* vary for each resource area. For example, pollutant emissions from tank waste retrieval, treatment, disposal, and closure activities were evaluated for their effect on ambient concentrations and their compliance with ambient standards. Comparison with regulatory standards is a commonly used method for benchmarking environmental impacts, and appropriate comparisons have been made in a number of resource analyses to provide perspective on the magnitude of identified impacts. For waste management, waste generation rates were compared with the capacities or expected capacities of waste management facilities. Impacts in all resource areas were estimated using a consistent set of input variables and computations. Moreover, efforts were made to ensure that calculations in all areas used accepted protocols and up-to-date models.

Resources Analyzed in This Environmental Impact Statement

- Land resources
- Infrastructure
- Noise and vibration
- Air quality
- Geology and soils
- Water resources
- Ecological resources
- Cultural and paleontological resources
- Socioeconomics
- Public and occupational health and safety
  - Normal operations
  - Facility accidents/intentional destructive acts
  - Transportation
- Environmental justice
- Waste management
- Industrial safety

Potential environmental impacts were analyzed for each resource area by alternative, as well as by a combination of alternatives, referred to in this *TC & WM EIS* as "alternative combinations." Combined impacts analyses have not been performed for noise or facility accidents due to the nature of these resource areas. This *TC & WM EIS* also analyzed potential cumulative impacts (i.e., impacts that can result from individually minor but collectively significant, actions taking place over a period of time). The cumulative impact analysis for this *TC & WM EIS* involved combining the impacts on key resource indicators (within select alternative combinations) with the impacts of other past, present, and reasonably foreseeable activities in the region of influence (ROI). The ROIs for different resources can vary widely in extent. For example, the ROI for geology and soils would be confined to Hanford and nearby offsite areas, whereas the air quality ROI would include more distant areas that could be affected by activities proposed for each *TC & WM EIS* alternative. In general, cumulative impacts were calculated by adding the impacts values for the baseline affected environment (i.e., conditions attributable to past and present actions by DOE and other public and private entities), the *TC & WM EIS* alternatives, and other future actions. These cumulative values were then weighed against appropriate impact indicators (e.g., regulatory standards, capacity limits, current usage) to determine the potential for impact.

Region of Influence

A site-specific geographic area in which the principal direct and indirect effects of actions are likely to occur and are expected to be of consequence for local jurisdictions.

Alternative Combinations Used in the Cumulative Impact Analysis

Several hundred impacts scenarios could result from the potential combinations of the 11 Tank Closure, 3 FFTF Decommissioning, and 3 Waste Management alternatives when factored with their associated option cases and waste disposal groups. For purposes of the cumulative impacts analysis, the following combinations of alternatives were chosen to capture the range of actions and associated overall short- and long-term impacts that could result from implementation of the three sets of proposed actions.

- **Combination 1:** All No Action Alternatives
- **Combination 2:** Tank Closure Alternative 2B (Expanded WTP Vitrification; Landfill Closure), FFTF Decommissioning Alternative 2 (Entombment) with the Idaho Option for disposition of RH-SCs and the Hanford Reuse Option for disposition of bulk sodium, and Waste Management Alternative 2 (Disposal in IDF, 200-East Area Only) with Disposal Group 1
- **Combination 3:** Tank Closure Alternative 6B, Base Case (All Vitrification with Separations; Clean Closure), FFTF Decommissioning Alternative 3 (Removal) with the Idaho Option for disposition of RH-SCs and the Hanford Reuse Option for disposition of bulk sodium, and Waste Management Alternative 2 (Disposal in IDF, 200-East Area Only) with Disposal Group 2

Alternative Combination 1 represents the potential short-term impacts resulting from minimal U.S. Department of Energy (DOE) action and the greatest long-term impacts with respect to groundwater. Alternative Combination 2 is a midrange case representative of DOE's Preferred Alternative(s). Alternative Combination 3 would result in maximum reasonably foreseeable short-term impacts on most resource areas in terms of the intensity of the potential impact and therefore represents, on the whole, a combination that would result in maximum potential short-term impacts, but would likely have the lowest long-term impacts on groundwater.

S.5.2 Analytical Uncertainties

The following sections describe the technical and regulatory uncertainties inherent in the analysis of the Tank Closure, FFTF Decommissioning, and Waste Management alternatives evaluated in this *TC & WM EIS*.

S.5.2.1 Tank Closure

Even with the knowledge and experience gained over the past decade of managing Hanford's tank system, there are still many technical and regulatory uncertainties. Some of these uncertainties cannot be fully resolved until tank waste storage, retrieval, treatment, and disposal and tank closure activities have been demonstrated. A major focus of the RPP is managing these uncertainties while making progress toward tank closure. The following is a brief discussion, by primary component, of the overarching technical and programmatic uncertainties facing the RPP in its tank waste management program.

S.5.2.1.1 Tank Waste Storage

There is uncertainty associated with tank waste inventories in terms of both chemical and radioactive contaminants. A prioritized sampling and estimation process, termed the "Best-Basis Inventory" process, was developed for estimation of the inventories present in the HLW tanks. However, in some cases, the number of available measurements was limited and estimates of the tank inventories for some waste constituents were supplemented by process modeling techniques. Thus, due to the spatial variability in the characteristics and concentrations of the waste, and gaps in knowledge of separations-processes and waste management conditions, uncertainty exists regarding the estimated waste inventories in the HLW tanks. In addition, records that were kept on the waste that was put into the tanks, waste that was transferred between tanks, and waste that was decanted off and discharged into shallow subsurface cribs and trenches (ditches) were not always complete. Although the overall quantities of radionuclides generated at Hanford are relatively well known, the actual amounts in specific waste sites are more uncertain. Also, the tank waste contains a complex mix of chemical and radiological constituents that is constantly changing as chemical reactions and radioactive decay occur. This results in an uncertain and continuously changing inventory of waste. This *TC & WM EIS* addresses this uncertainty by making conservative assumptions regarding the waste inventories based on process knowledge, assay results of sampled waste, or other available information from waste generators.

S.5.2.1.2 Tank Waste Retrieval

The efficiency and effectiveness of current methods for retrieving waste from the tanks (e.g., modified sluicing) and the quantity of liquid waste that might be released to the environment during retrieval are uncertain. For example, it is not certain whether the modified sluicing technique can retrieve all types of sludge or the dense, highly compacted waste on the tank bottom. Using large volumes of liquids during modified sluicing also may cause liquids to be released through cracks in the tanks. Other retrieval techniques such as the mobile retrieval system, vacuum-based retrieval, and chemical washing have been used on only a limited basis at Hanford and other DOE sites, so those technologies carry potential uncertainties as well.

S.5.2.1.3 Tank Waste Treatment

Separation of waste into HLW and LAW streams and vitrification of these waste streams have been conducted at other DOE sites and in Europe. However, these treatment processes have not been performed on Hanford tank waste on a production scale; therefore, the impacts and operating efficiencies are uncertain. Full-scale production of ILAW using the bulk vitrification, cast stone, and steam reforming processes has not been conducted anywhere within the DOE complex. As a result, uncertainties exist regarding waste loading and waste form quality and performance. The adequacy of the ETF to treat anticipated secondary wastes from the WTP and supplemental treatment facilities is also uncertain.

S.5.2.1.4 Tank Waste Disposal

The final waste classifications of certain waste streams have not been determined due to regulatory uncertainties that could affect implementation of tank management actions. For example, DOE Manual 435.1-1 provides a process for determining whether waste resulting from processing SNF (e.g., ILAW, tank residual waste at closure) can be considered both "waste incidental to reprocessing" and non-HLW, which would allow the waste to be managed as LLW or TRU waste, as appropriate. However, in July 2003, the parts of DOE Order 435.1 that deal with the procedures for determining waste incidental to reprocessing were declared invalid by the U.S. District Court for the District of Idaho. In November 2004, the court's decision was reversed on appeal by the U.S. Court of Appeals for the Ninth Circuit and remanded to the District Court, which in turn dismissed the case in March 2006. For analysis purposes, this *TC & WM EIS* assumes for some of the alternatives that historical processing data will support management of some of the tank waste as non-HLW. For other alternatives (e.g., Alternatives 6A and 6B), the opposite is assumed (i.e., all tank waste is assumed to be HLW).

An IHLW glass disposal location has not been established at this time. This EIS assumed the use of a thin-wall IHLW glass canister to maximize the volume of HLW put into each canister and minimize the number of canisters needed. Due to uncertainties regarding final canister design and capacity, as well, as off-site shipping schedules, the EIS analysis included assumptions for onsite (interim) storage of IHLW glass until disposition decisions are made and implemented.

The impacts associated with disposal of ILAW are also uncertain at this time. Because the release rates for ILAW glass are low and are supported by experiment, there is less uncertainty regarding this waste form compared to bulk vitrification glass, cast stone waste, and steam reforming waste. Of these supplemental treatment ILAW forms, the least amount of characterization and testing has been performed for steam reforming waste. Thus, the greatest degree of uncertainty relative to waste form performance is associated with the steam reforming waste.

S.5.2.1.5 Tank Waste Closure

Clean closure of the tank farms requires construction and use of containment structures during the removal of 149 SSTs, ancillary equipment, and deep soil. There is substantial uncertainty associated with the technical feasibility, schedules, costs, and worker impacts associated with these clean closure activities. This *TC & WM EIS* evaluated the use of engineering structures, including shielding and remote equipment, to minimize worker exposure when removing the tanks. Even with these mitigation measures, the worker radiological dose would be an order of magnitude higher as compared to that under landfill closure. Containment of air releases would be needed to mitigate impacts due to tank, ancillary equipment, and soil removal; requiring construction of movable containment structures. Although the technology for installation of such containment structures is understood, there is a large degree of uncertainty concerning the feasibility of installing these structures over a large area the size of a tank farm and, under some alternatives, of constructing and using multiple structures. There is also uncertainty related to the pathway identified for disposition of the tanks, which would need to be cut up and packaged. This EIS assumed that the tanks would be packaged and disposed on site; however, they would have to go through the DOE Manual 435.1-1 process to determine the appropriate disposition pathway (i.e., whether waste is HLW, TRU waste, or LLW).

Selective clean closure/landfill closure evaluated in Tank Closure Alternative 4 would remove two of the tank farms, one in the 200-East Area and one in the 200-West Area, reducing the volume of material that is removed. However, this volume reduction would not lessen the high degree of technical uncertainties related to how soils would be removed and treated, or to the infrastructure and additional capability needed to manage the new waste generated from the removal. Although not to the same levels as clean closure, the following technical uncertainties exist: characteristics of borrow material, land and terrestrial resource disturbances, waste generation, and worker safety and health issues.

The technical uncertainties associated with tank removal and deep soil remediation beneath the tanks, under the selective clean closure and clean closure alternatives, would have to be weighed against the order(s)-of-magnitude increase in short-term impacts on resource areas that would result from implementing these alternatives.

The *TC & WM EIS* analyses rely on various modeling approaches to predict the consequences of RPP mission activities that DOE may undertake in the future. Some of these models are complex and rely on assumptions that are subject to a large degree of uncertainty, particularly when trying to predict potential impacts out to 10,000 years. One such uncertainty is how waste moves in the vadose zone and groundwater. The *TC & WM EIS* analyses assume that both the groundwater flow field and infiltration rate will remain constant over 10,000 years, and that the location of the river channel will remain the same over the same period. These assumptions affect the ability to accurately predict when groundwater impacts will reach their peak. Long-term impact analysis indicates that the largest potential impact on human health may be due to past-practice discharges to cribs and trenches (ditches) and past leaks from SSTs. Contaminant movement rates through the vadose zone for such releases strongly depend on the area saturated by the initial release and subsequent horizontal spreading of the released volume of liquid. These two sensitive variables cannot be known with certainty and, coupled with natural variability in precipitation, recharge, and vadose zone hydraulic conditions, make any estimates of a rate of release to the unconfined aquifer highly uncertain. Contaminant movement rates in the unconfined aquifer were projected with greater certainty by measuring past and current contaminant concentrations and calibrating the water-movement models to hydraulic-head measurements.

S.5.2.2 FFTF Decommissioning

It was assumed under FFTF Decommissioning Alternatives 2 and 3 that Hanford's bulk sodium inventory would be converted to a caustic solution for use in processing tank waste at the WTP or for Hanford tank corrosion control. However, there is uncertainty regarding whether these processing or corrosion control demands would require reuse of the entire available inventory or whether an alternative disposition pathway for this material would be necessary. There is also uncertainty regarding the potential shipment of RH-SCs to INL for processing, as no U.S. Nuclear Regulatory Commission-licensed transportation cask currently exists with the capacity to handle these components for shipment. For analysis purposes, this EIS assumes that a suitable transportation cask or other shielded container would be available at the time of removal to transport these components.

S.5.2.3 Waste Management

There is substantial uncertainty associated with the sources, volumes, and potential long-term performance of radiological and chemical offsite waste inventories forecast for disposal at Hanford. Because similar uncertainties also exist regarding potential volumes and characteristic of the waste to be generated on site, it was assumed for analysis purposes that proposed expansions to the Hanford waste management facilities (e.g., the CWC, T Plant, or WRAP) would be required as soon as possible following issuance of the ROD for this *TC & WM EIS*.

S.5.3 Summary of Short-Term Environmental Impacts

The following section provides a summary-level comparison of the potential environmental impacts of implementing each of the *TC & WM EIS* alternatives. This section focuses on potential short-term impacts on the resource areas identified in Section S.5.1. Potential long-term impacts are presented in conjunction with the key environmental findings identified in Section S.5.4. A detailed discussion of long-term impacts by alternative and resource area is found in Chapter 5 of this *TC & WM EIS*.

> **Maximally Exposed Individual (MEI)**
>
> A hypothetical individual whose location and habits result in the highest total radiological or chemical exposure (and thus dose) from a particular source for all exposure routes (e.g., inhalation, ingestion, direct exposure). As used in this environmental impact statement, the MEI refers to an individual located off site, unless characterized otherwise in terms of time or location.
>
> **Latent Cancer Fatalities**
>
> Deaths from cancer resulting from, and occurring sometime after, exposure to ionizing radiation or other carcinogens.
>
> **Rem**
>
> A rem is a unit of dose equivalent that allows comparison of the biological effects of radionuclides that emit different types of radiation.
>
> **Person-rem**
>
> A person-rem is a unit of collective radiation dose applied to populations or groups; it is a unit for expressing dose when summed across all persons in a specified population or group.

Short-term impacts are associated with the active project phase during which construction, operations, deactivation, and closure activities would take place, and extend through the applicable 100-year administrative control, institutional control, or postclosure care period. The comparison of impacts is presented to aid the decisionmakers and public in understanding the potential short-term environmental consequences of proceeding with each of these alternatives. Short-term impacts of Tank Closure alternatives are summarized in Table S–5; of FFTF Decommissioning alternatives in Table S–6, and of Waste Management alternatives in Table S–7.

Table S–5. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts

Parameter/ Resource	Tank Closure Alternative										
	1 No Action	**2A** Existing WTP Vitrification; No Closure	**2B** Expanded WTP Vitrification; Landfill Closure	**3A** Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure	**3B** Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure	**3C** Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure	**4** Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure	**5** Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure	**6A Base** *6A Option* All Vitrification/No Separations; Clean Closure	**6B Base** *6B Option* All Vitrification with Separations; Clean Closure	**6C** All Vitrification with Separations; Landfill Closure
Land Resources											
Land Use (percent of total land commitment within either the Industrial-Exclusive Zone or Borrow Area C, as appropriate)	17 hectares (0.3 percent) committed to tank closure within the Industrial-Exclusive Zone.	49.4 hectares (1 percent) committed to tank closure within the Industrial-Exclusive Zone.	100 hectares (2 percent) committed to tank closure within the Industrial-Exclusive Zone.	102 hectares (2 percent) committed to tank closure within the Industrial-Exclusive Zone.	102 hectares (2 percent) committed to tank closure within the Industrial-Exclusive Zone.	102 hectares (2 percent) committed to tank closure within the Industrial-Exclusive Zone.	78.6 hectares (1.6 percent) committed to tank closure within the Industrial-Exclusive Zone.	104 hectares (2.1 percent) committed to tank closure within the Industrial-Exclusive Zone.	236 hectares (4.7 percent) committed to tank closure within the Industrial-Exclusive Zone. 86.2 hectares required outside of Industrial-Exclusive Zone.	142 hectares (2.8 percent) committed to tank closure within the Industrial-Exclusive Zone. 86.2 hectares required outside of Industrial-Exclusive Zone.	145 hectares (2.9 percent) committed to tank closure within the Industrial-Exclusive Zone.
	2 hectares (0.2 percent) affected within Borrow Area C	27.5 hectares (3 percent) affected within Borrow Area C.	94.7 hectares (10 percent) affected within Borrow Area C.	101 hectares (11 percent) affected within Borrow Area C.	93.5 hectares (10 percent) affected within Borrow Area C.	93.9 hectares (10 percent) affected within Borrow Area C.	102 hectares (11 percent) affected within Borrow Area C.	118 hectares (13 percent) affected within Borrow Area C.	494 hectares (53 percent) affected within Borrow Area C.	239 hectares (26 percent) affected within Borrow Area C.	104 hectares (11 percent) affected within Borrow Area C.
									Option Case 210 hectares (4.1 percent) committed to tank closure within the Industrial-Exclusive Zone. 86.2 hectares required outside of Industrial-Exclusive Zone.	*Option Case* 117 hectares (2.3 percent) committed to tank closure within the Industrial-Exclusive Zone. 86.2 hectares required outside of Industrial-Exclusive Zone.	
									571 hectares (62 percent) affected within Borrow Area C.	316 hectares (34 percent) affected within Borrow Area C.	

Table S–5. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/ Resource	**Tank Closure Alternative**										
	1 No Action	**2A Existing WTP Vitrification; No Closure**	**2B Expanded WTP Vitrification; Landfill Closure**	**3A Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure**	**3B Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure**	**3C Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure**	**4 Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure**	**5 Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure**	**6A Base *6A Option* All Vitrification/No Separations; Clean Closure**	**6B Base *6B Option* All Vitrification with Separations; Clean Closure**	**6C All Vitrification with Separations; Landfill Closure**
Land Resources *(continued)*											
Visual resources	Little change in the overall visual character of the 200 Areas and Borrow Area C.	Little change in the overall visual character of the 200 Areas and moderate change to Borrow Area C.	Little change in the overall visual character of the 200 Areas and a highly noticeable change to Borrow Area C, especially as seen from State Route 240 and nearby higher elevations.						Highly noticeable change in the visual character of both the 200 Areas and Borrow Area C, especially as seen from State Route 240 and nearby higher elevations.	Noticeable change to the visual character of the 200 Areas and a highly noticeable change to Borrow Area C, especially as seen from State Route 240 and nearby higher elevations.	
Infrastructure											
Total Requirements											
Electricity (million megawatt-hours)	0.12	35.6	17.9	14.1	12.1	20.1	14.8	12.2	186 *188*	21.1 *23.8*	17.9
Diesel fuel (million liters)	35.9	4,950	4,040	1,860		1,980	2,050	4,110	23,100 *23,200*	4,360 *4,440*	4,040
Gasoline (million liters)	4.61	218	156	116			133	124	723 *720*	216 *212*	156
Water (million liters)	3,300	208,000	86,300	77,000		77,300	82,200	92,500	644,000 *644,000*	92,600 *92,800*	86,300
Peak Annual Demand											
Electricity (million megawatt-hours)	0.035	0.56	1.16	0.78	0.47	0.83	0.55	0.62	1.94 *1.97*	1.24 *1.28*	1.16
Diesel fuel (million liters)	11.8	112	271	80.8	81.2	86.1	76.2	229	234 *237*	255 *259*	271

Table S–5. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/ Resource	**Tank Closure Alternative**										
	1 No Action	**2A Existing WTP Vitrification; No Closure**	**2B Expanded WTP Vitrification; Landfill Closure**	**3A Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure**	**3B Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure**	**3C Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure**	**4 Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure**	**5 Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure**	**6A Base *6A Option* All Vitrification/No Separations; Clean Closure**	**6B Base *6B Option* All Vitrification with Separations; Clean Closure**	**6C All Vitrification with Separations; Landfill Closure**
Infrastructure *(continued)*											
Peak Annual Demand *(continued)*											
Gasoline (million liters)	1.0	5.33	8.18	5.03			10.9	5.89	8.95 *7.54*	6.56 *6.58*	8.18
Water (million liters)	1,090	3,720	3,560	2,180		2,190	2,180	3,800	6,580 *6,580*	3,500 *3,500*	3,560
Noise and Vibration											
	Current noise levels reduced following WTP construction.	Negligible offsite impact of onsite activities. Minor traffic noise impacts.									
Air Quality											
Peak Year Incremental Criteria Pollutant Concentrations as Compared to Most Stringent Guideline or Standard *(micrograms per cubic meter)*[a]											
Carbon monoxide (1-hour) standard=40,000	23,300	**40,600**	36,300	**56,600**	**57,700**	**57,600**	35,700	**47,300**	31,900 *22,400*	34,200 *34,200*	33,600
Nitrogen oxides (annual) standard=100	8.56	18.4	20.4	17.9	18.1		13.1	21.1	19.3 *14.9*	14.2 *14.7*	20.4
PM_{10} (24-hour) standard=150	**546**	**1,600**	**4,510**				**2,960**	**4,920**	**5,040** ***3,650***	**5,110** ***1,690***	**4,570**
Sulfur oxides (1-hour) standard=660	24.0	64.6	99.4	126	82.1	81.6	71.8	106	53.3 *41.6*	65.4 *70.3*	99.5
Peak Year Incremental Toxic Chemical Concentrations *(micrograms per cubic meter)*[a]											
Ammonia (24-hour) ASIL[b]=100	26.1	19.6	11.7	11.9		12.0	11.8	12.0	10.2 *9.91*	11.9 *11.9*	11.4
Benzene (annual) ASIL[b]=0.12	0.00264	0.00592	0.00456	0.00602	0.00627	0.00602	0.00344	0.00594	0.00479 *0.00278*	0.00460 *0.00355*	0.00458

Table S–5. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/ Resource	Tank Closure Alternative: 1 No Action	2A Existing WTP Vitrification; No Closure	2B Expanded WTP Vitrification; Landfill Closure	3A Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure	3B Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure	3C Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure	4 Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure	5 Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure	6A Base *6A Option* All Vitrification/No Separations; Clean Closure	6B Base *6B Option* All Vitrification with Separations; Clean Closure	6C All Vitrification with Separations; Landfill Closure
Air Quality *(continued)*											
Peak Year Incremental Toxic Chemical Concentrations *(micrograms per cubic meter)*[a] *(continued)*											
Toluene (24-hour) ASIL[b]=400	1.69	4.07	3.40	5.78	6.03	5.78	2.77	5.19	3.50 *2.34*	3.73 *2.58*	3.40
Xylene (24-hour) ASIL[b]=1,500	0.51	1.22	1.03	1.71	1.78	1.71	0.82	1.55	1.07 *0.68*	1.13 *0.77*	1.03
Geology and Soils											
Construction impacts	Negligible, incremental impact on geology and soils.	Small impact from construction, including potential for short-term soil erosion. Excavation depths limited to 12 meters.					Similar to Alternatives 2A through 3C, except extensive excavation work required for clean closure of BX and SX tank farms, with excavation depths of 20 meters to as much as 78 meters.	Similar to Alternatives 2A through 3C.	Similar to Alternatives 2A through 3C, except extensive excavation work required for clean closure of all tank farms, with excavation depths of 20 meters to as much as 78 meters.		Similar to Alternatives 2A through 3C.
New permanent land disturbance (hectares)	2	59.8	111	118	112	112	120	138	704 *781*	356 *433*	165
Geologic resource requirements, i.e., fill from Borrow Area C (cubic meters)	92,800	1,250,000	4,330,000	4,610,000	4,280,000	4,290,000	4,660,000	5,380,000	22,500,000 *26,000,000*	10,900,000 *14,400,000*	4,750,000

Table S–5. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/ Resource	Tank Closure Alternative										
	1 **No Action**	**2A** **Existing WTP Vitrification; No Closure**	**2B** **Expanded WTP Vitrification; Landfill Closure**	**3A** **Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure**	**3B** **Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure**	**3C** **Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure**	**4** **Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure**	**5** **Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure**	**6A Base** ***6A Option*** **All Vitrification/No Separations; Clean Closure**	**6B Base** ***6B Option*** **All Vitrification with Separations; Clean Closure**	**6C** **All Vitrification with Separations; Landfill Closure**
Water Resources											
Surface water	No additional impact on surface water in the short term. Water use and wastewater generation and discharges would decrease from current levels.	Short-term increase in stormwater runoff during construction, but no direct disturbance to surface-water features. No direct, routine discharge of effluents during operations to surface waters or to the subsurface. Water use would not exceed site capacity. Activities in Borrow Area C could encroach on the probable maximum flood zone associated with Cold Creek, especially under Alternatives 6A and 6B.									
Vadose zone and groundwater	No additional impact in the short term.	Potential for SST retrieval leaks in the short term without any recovery once in the subsurface. Groundwater mounds could begin to re-expand due to increased discharge of sanitary wastewater, nonhazardous process wastewater, and treated radioactive liquid effluents to onsite treatment and disposal facilities during waste treatment.					Potential for retrieval leaks similar to Alternatives 2A through 3B. Deep soil excavation for selective clean closure would require dewatering and could locally affect groundwater flow and contaminant plumes.	Similar to Alternatives 2A through 3C.	Potential for SST retrieval leaks in the short term. Deep soil excavation for clean closure would require dewatering and could locally affect groundwater flow and contaminant plumes.		Similar to Alternatives 2A through 3C.

Table S–5. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/ Resource	Tank Closure Alternative: 1 No Action	2A Existing WTP Vitrification; No Closure	2B Expanded WTP Vitrification; Landfill Closure	3A Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure	3B Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure	3C Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure	4 Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure	5 Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure	6A Base *6A Option* All Vitrification/No Separations; Clean Closure	6B Base *6B Option* All Vitrification with Separations; Clean Closure	6C All Vitrification with Separations; Landfill Closure
Ecological Resources											
Terrestrial resources	No additional disturbance to sagebrush habitat in the 200 Areas.	14.2 hectares of sagebrush habitat affected in the 200 Areas.	1.2 hectares of sagebrush habitat affected in the 200 Areas.	4 hectares of sagebrush habitat affected in the 200 Areas.	4.9 hectares of sagebrush habitat affected in the 200 Areas.	4.8 hectares of sagebrush habitat affected in the 200 Areas.	4.4 hectares of sagebrush habitat affected in the 200 Areas.		182 hectares of sagebrush habitat affected within the 200 Areas under both Base and Option Cases.	98.3 hectares of sagebrush habitat affected within the 200 Areas under both Base and Option Cases.	46.1 hectares of sagebrush habitat affected in the 200 Areas.
	No sagebrush habitat affected within Borrow Area C.	No sagebrush habitat affected within Borrow Area C.	No sagebrush habitat affected within Borrow Area C.	No sagebrush habitat affected within Borrow Area C.	No sagebrush habitat affected within Borrow Area C.	No sagebrush habitat affected within Borrow Area C.	No sagebrush habitat affected within Borrow Area C.		No sagebrush habitat affected within Borrow Area C.	No sagebrush habitat affected within Borrow Area C.	No sagebrush habitat affected within Borrow Area C.
Wetlands	No impact on wetlands within 200 Areas or Borrow Area C.										
Aquatic resources	No impact on aquatic resources within 200 Areas or Borrow Area C.										
Threatened and endangered species	No impact on any federally or state-listed threatened or endangered species.	No impact on any federally or state-listed threatened or endangered species.	No impact on any federally or state-listed threatened or endangered species.	No impact on any federally or state-listed threatened or endangered species.					No impact on any federally or state-listed threatened or endangered species under both Base and Option Cases.		No impact on any federally or state-listed threatened or endangered species.
	No impact on state-listed species within the 200 Areas.	Potential impacts on 4 state-listed species.	Potential impacts on 2 state-listed species.	Potential impacts on 6 state-listed special status species.					Potential impacts on 6 state-listed special status species under both Base and Option Cases.		Potential impacts on 4 state-listed special status species.
	Minimum potential for impact on 4 state-listed species within Borrow Area C.	Potential impacts on 4 state-listed species within Borrow Area C.	Potential impacts on 4 state-listed species within Borrow Area C.	Potential impacts on 4 state-listed special status species within Borrow Area C.					Potential impacts on 4 state-listed special status species within Borrow Area C under both Base and Option Cases.		Potential impacts on 4 state-listed special status species within Borrow Area C.

Table S–5. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/ Resource	Tank Closure Alternative										
	1 No Action	**2A Existing WTP Vitrification; No Closure**	**2B Expanded WTP Vitrification; Landfill Closure**	**3A Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure**	**3B Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure**	**3C Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure**	**4 Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure**	**5 Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure**	**6A Base *6A Option* All Vitrification/No Separations; Clean Closure**	**6B Base *6B Option* All Vitrification with Separations; Clean Closure**	**6C All Vitrification with Separations; Landfill Closure**
Cultural and Paleontological Resources											
Prehistoric resources	No impact on prehistoric resources.										
Historic resources	No impact on historic resources.								Impact on National Register–ineligible resources (i.e., areas where old cans and bottles were disposed of).		
American Indian interests	The 2 hectares (5 acres) of Borrow Area C that would be excavated would be noticeable from higher elevations but would not dominate the view.	The 27.5 hectares (68 acres) excavated from Borrow Area C would be readily visible from Rattlesnake Mountain and higher elevations. Upon completion of work, the area would be recontoured and revegetated, lessening the visual impact.	The 200-East and 200-West Area containment structures and closure barriers would be visible from higher elevations. 94.7 hectares (234 acres) of Borrow Area C would be excavated. Upon completion of work, the area would be recontoured and revegetated, lessening the visual impact.	Impacts would be similar to Alternative 2B. An additional 6.1 hectares (15 acres) of land would be disturbed within Borrow Area C.	Impacts would be similar to Alternative 2B. Excavated land in Borrow Area C would be slightly less (1.2 hectares [3acres]) but the visual impacts would be similar.	Impacts would be similar to Alternative 2B. Nearly the same amount of geologic material would be required from Borrow Area C (93.9 hectares [232 acres]).	Impacts would be similar to Alternative 2B. An additional 7.3 hectares (18 acres) of land would be disturbed.	Impacts would be similar to Alternative 2B. 118 hectares (291 acres) of Borrow Area C would be excavated. This would be readily visible from Rattlesnake Mountain and higher elevations. Upon completion of work, the area would be recontoured and revegetated, lessening the visual impact.	Construction of facilities would noticeably add to the industrial nature of the 200 Areas; 494 hectares (1,220 acres) of Borrow Area C would be excavated. This would be readily visible from Rattlesnake Mountain. Upon completion of work, the area would be recontoured and revegetated, lessening the visual impact.	Impacts would be similar to, but less than, those under Alternative 6A, Base Case. Land impact of construction of facilities and material excavated from Borrow Area C would be approximately half as much as under 6A. This would be readily visible from Rattlesnake Mountain. Upon completion of work, the area would be recontoured and revegetated, lessening the visual impact.	There would be an overall increase to the industrial appearance of the 200 Areas. 61.1 hectares (151 acres) of land would be converted to industrial use. 104 hectares (257 acres) of Borrow Area C would be excavated. These areas would be visible from nearby higher elevations.

Table S–5. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/ Resource	Tank Closure Alternative										
	1 No Action	**2A Existing WTP Vitrification; No Closure**	**2B Expanded WTP Vitrification; Landfill Closure**	**3A Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure**	**3B Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure**	**3C Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure**	**4 Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure**	**5 Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure**	**6A Base *6A Option* All Vitrification/No Separations; Clean Closure**	**6B Base *6B Option* All Vitrification with Separations; Clean Closure**	**6C All Vitrification with Separations; Landfill Closure**
Cultural and Paleontological Resources *(continued)*											
American Indian interests *(continued)*									*Option Case* Impacts would be similar to those under the Base Case. An additional 76.5 hectares (189 acres) would be excavated from Borrow Area C, further impacting the viewshed.	*Option Case* Impacts would be similar to those under the Base Case. An additional 76.5 hectares (189 acres) would be excavated from Borrow Area C, further impacting the viewshed.	
Paleontological Resources	No impact on paleontological resources.										
Socioeconomics											
Peak annual workforce (FTEs)	1,730	4,920	6,860	5,330	5,260	5,460	8,000	6,100	8,500 *10,100*	7,870 *10,300*	6,870
Peak daily commuter traffic (vehicles per day)	1,400	4,000	5,500	4,300	4,200	4,300	6,400	4,900	6,800 *8,100*	6,300 *8,200*	5,500
Peak daily truck loads – off site	4	15	48	24	37	142	64	57	58 *71*	66 *83*	50
Impact on the ROI	Potential for immediate decrease in FTEs.	Potential for change in the socioeconomic ROI, including increases in population, demand and cost for housing and community services, and level-of-service impacts on local transportation.									

Table S–5. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

<table>
<tr><th rowspan="2">Parameter/ Resource</th><th colspan="11">Tank Closure Alternative</th></tr>
<tr><th>1
No Action</th><th>2A
Existing WTP Vitrification; No Closure</th><th>2B
Expanded WTP Vitrification; Landfill Closure</th><th>3A
Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure</th><th>3B
Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure</th><th>3C
Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure</th><th>4
Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure</th><th>5
Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure</th><th>6A Base
6A Option
All Vitrification/No Separations; Clean Closure</th><th>6B Base
6B Option
All Vitrification with Separations; Clean Closure</th><th>6C
All Vitrification with Separations; Landfill Closure</th></tr>
<tr><td colspan="12">Public and Occupational Health and Safety – Normal Operations</td></tr>
<tr><td colspan="12">Offsite Population Impact – Life of the Project</td></tr>
<tr><td>Dose (person-rem)</td><td>600</td><td>1,100</td><td>460</td><td>570</td><td>380</td><td>570</td><td>490</td><td>460</td><td>560
760</td><td>600
710</td><td>460</td></tr>
<tr><td>LCF[c]</td><td>0
(4×10^{-1})</td><td>1
(6×10^{-1})</td><td colspan="2">0
(3×10^{-1})</td><td>0
(2×10^{-1})</td><td colspan="3">0
(3×10^{-1})</td><td>0
(3×10^{-1})
1
(5×10^{-1})</td><td>0
(4×10^{-1})
0
(4×10^{-1})</td><td>0
(3×10^{-1})</td></tr>
<tr><td colspan="12">Peak Year Maximally Exposed Individual Impact</td></tr>
<tr><td>Dose (millirem per year)</td><td>0.13</td><td>1.4</td><td>1.7</td><td colspan="5">1.4</td><td>1.4
1.4</td><td>1.7
1.7</td><td>1.6</td></tr>
<tr><td>Increased risk of an LCF</td><td>8×10^{-8}</td><td>8×10^{-7}</td><td>1×10^{-6}</td><td colspan="5">8×10^{-7}</td><td>8×10^{-7}
8×10^{-7}</td><td>1×10^{-6}
1×10^{-6}</td><td>1×10^{-6}</td></tr>
<tr><td colspan="12">Peak Year Onsite Maximally Exposed Individual Impact</td></tr>
<tr><td>Dose (millirem per year)</td><td>0.018</td><td>0.058</td><td>0.097</td><td colspan="5">0.058</td><td>0.059
0.059</td><td>0.096
0.098</td><td>0.094</td></tr>
<tr><td>Increased risk of an LCF</td><td>1×10^{-8}</td><td>4×10^{-8}</td><td>6×10^{-8}</td><td colspan="5">4×10^{-8}</td><td>4×10^{-8}
4×10^{-8}</td><td>6×10^{-8}
6×10^{-8}</td><td>6×10^{-8}</td></tr>
<tr><td colspan="12">Radiation Worker Population Impact – Life of the Project</td></tr>
<tr><td>Dose (person-rem)</td><td>280</td><td>23,000</td><td>11,000</td><td colspan="2">10,000</td><td>11,000</td><td>43,000</td><td>8,800</td><td>120,000
120,000</td><td>82,000
85,000</td><td>11,000</td></tr>
<tr><td>LCF[c]</td><td>0
(2×10^{-1})</td><td>13</td><td>7</td><td colspan="3">6</td><td>26</td><td>5</td><td>72
75</td><td>49
51</td><td>7</td></tr>
<tr><td colspan="12">Average Annual Impact per Radiation Worker</td></tr>
<tr><td>Dose (millirem per year)</td><td>140</td><td>170</td><td colspan="4">160</td><td>520</td><td>150</td><td>420
400</td><td>870
790</td><td>160</td></tr>
<tr><td>Increased risk of an LCF</td><td>9×10^{-5}</td><td colspan="3">1×10^{-4}</td><td>9×10^{-5}</td><td>1×10^{-4}</td><td>3×10^{-4}</td><td>9×10^{-5}</td><td>2×10^{-4}
2×10^{-4}</td><td>5×10^{-4}
5×10^{-4}</td><td>1×10^{-4}</td></tr>
<tr><td colspan="12">Peak Year Noninvolved Worker Impact</td></tr>
<tr><td>Dose (millirem per year)</td><td colspan="2">0.71</td><td>0.29</td><td>0.18</td><td>0.17</td><td>0.18</td><td>0.20</td><td>0.18</td><td>0.18
0.20</td><td>0.33
0.40</td><td>0.28</td></tr>
<tr><td>Increase risk of an LCF</td><td colspan="2">4×10^{-7}</td><td>2×10^{-7}</td><td colspan="6">1×10^{-7}</td><td colspan="2">2×10^{-7}</td></tr>
</table>

Table S–5. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/ Resource	Tank Closure Alternative									
	1 No Action	**2A Existing WTP Vitrification; No Closure**	**2B Expanded WTP Vitrification; Landfill Closure**	**3A Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure**	**3B Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure**	**3C Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure**	**4 Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure**	**5 Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure**	**6A Base *6A Option* All Vitrification/No Separations; Clean Closure**	**6B Base *6B Option* All Vitrification with Separations; Clean Closure**	**6C All Vitrification with Separations; Landfill Closure**
Public and Occupational Health and Safety – Facility Accidents											
Offsite Population Consequences											
Dose (person-rem)	0.96	58,000							780	58,000	
Number of LCFs[c]	0 (6×10^{-4})	35							0 (5×10^{-1})	35	
Maximally Exposed Offsite Individual Consequences											
Dose (rem)	0.00021	4.3							0.058	4.3	
Increased risk of an LCF	1×10^{-7}	3×10^{-3}							4×10^{-5}	3×10^{-3}	
Noninvolved Worker Consequences											
Dose (rem)	0.22	13,000							180	13,000	
Increased risk of an LCF[d]	1×10^{-4}	1							2×10^{-1}	1	
Offsite Population Risk											
Annual number of LCFs[c]	0 (3×10^{-7})	0 (2×10^{-2})							0 (2×10^{-4})	0 (2×10^{-2})	
Number of LCFs over life of the project[c]	0 (3×10^{-5})	1	0 (4×10^{-1})					0 (3×10^{-1})	0 (3×10^{-2})	0 (4×10^{-1})	
Maximally Exposed Offsite Individual Risk											
Annual increased risk of an LCF	6×10^{-11}	1×10^{-6}							2×10^{-8}	1×10^{-6}	
Increased risk of an LCF over life of the project	6×10^{-9}	1×10^{-4}	3×10^{-5}					2×10^{-5}	3×10^{-6}	3×10^{-5}	
Noninvolved Worker Risk											
Annual increased risk of an LCF	7×10^{-8}	8×10^{-3}							1×10^{-4}	8×10^{-3}	
Increased risk of an LCF over life of the project	7×10^{-6}	6×10^{-1}	2×10^{-1}					1×10^{-1}	2×10^{-2}	2×10^{-1}	

Table S–5. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

	Tank Closure Alternative										
Parameter/ Resource	**1 No Action**	**2A Existing WTP Vitrification; No Closure**	**2B Expanded WTP Vitrification; Landfill Closure**	**3A Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure**	**3B Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure**	**3C Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure**	**4 Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure**	**5 Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure**	**6A Base *6A Option* All Vitrification/No Separations; Clean Closure**	**6B Base *6B Option* All Vitrification with Separations; Clean Closure**	**6C All Vitrification with Separations; Landfill Closure**
Public and Occupational Health and Safety – Transportation											
Traffic Accidents (nonradiological fatalities)	0 (0.009)	0 (0.44)	1 (0.57)	1 (0.75)	1 (1.02)	4 (3.63)	1 (1.26)	1 (0.94)	3 (3.30) *6* *(6.47)*	1 (1.26) *2* *(2.37)*	1 (0.62)
Offsite Population											
Dose (person-rem)	0	73		347	266	337	306	257	60 *74*	90 *102*	73
LCFs	0	4.4×10^{-2}		2.1×10^{-1}	1.6×10^{-1}	2.1×10^{-1}	1.8×10^{-1}	1.5×10^{-1}	3.6×10^{-2} *4.4×10^{-2}*	5.4×10^{-2} *6.1×10^{-2}*	4.4×10^{-2}
Worker											
Dose (person-rem)	0	260	262	842	1,089	1,224	1,086	790	450 *498*	560 *608*	262
LCFs	0	1.6×10^{-1}		5.1×10^{-1}	6.5×10^{-1}	7.3×10^{-1}	6.5×10^{-1}	4.7×10^{-1}	2.7×10^{-1} *3.0×10^{-1}*	3.4×10^{-1} *3.6×10^{-1}*	1.6×10^{-1}
Environmental Justice											
Human health impacts	No disproportionately high and adverse human health impacts on minority or low-income populations due to normal facility operations or postulated facility accidents.										
Waste Management (all values are in cubic meters unless otherwise noted; values rounded to no more than three significant digits)											
Disposed of Off Site and/or Stored On Site											
IHLW glass (No. of canisters)	N/A	14,200 (12,000)		10,300 (8,700)			12,800 (10,800)	9,200 (7,800)	203,000 (171,000) *203,000* *(171,000)*	14,200 (12,000) *14,200* *(12,000)*	14,200 (12,000)
IHLW cesium and strontium glass (No. of canisters)	N/A	400 (340)							400 (340) *400* *(340)*	400 (340) *400* *(340)*	400 (340)
Other HLW	N/A								337,000 *337,000*	337,000 *337,000*	N/A

Table S–5. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/ Resource	**Tank Closure Alternative**										
	1 No Action	**2A Existing WTP Vitrification; No Closure**	**2B Expanded WTP Vitrification; Landfill Closure**	**3A Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure**	**3B Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure**	**3C Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure**	**4 Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure**	**5 Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure**	**6A Base *6A Option* All Vitrification/No Separations; Clean Closure**	**6B Base *6B Option* All Vitrification with Separations; Clean Closure**	**6C All Vitrification with Separations; Landfill Closure**
Waste Management (all values are in cubic meters unless otherwise noted; values rounded to no more than three significant digits) *(continued)*											
Disposed of Off Site and/or Stored On Site *(continued)*											
HLW melters (No. of melters)	N/A	3,670 (30)	1,350 (11)	1,100 (9)			1,230 (10)	858 (7)	17,800 (145) *17,800* *(145)*	1,350[e] (11) 1,350 (11)	1,350[e] (11)
Mixed TRU waste (includes tank and secondary, CH and RH)	N/A	219	206	3,850			4,080	3,480	530 *530*	412 *412*	206
Hazardous waste	12	79,200	79,300			79,700	79,900	79,200	83,000 *83,100*	80,900 *81,000*	79,700
Disposed of On Site											
ILAW glass (No. of canisters)	N/A	213,000 (92,300)		65,800 (28,500)			63,800 (28,700)	71,800 (31,100)	N/A	215,000[f] (93,000) *215,000* *(93,000)*	213,000[f] (92,300)
PPF Melters (No. of melters)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3,060 (25) *17,900* *(146)*	1,960 (16) *11,400* *(93)*	N/A
Bulk vitrification glass	N/A			103,000	N/A		40,500	36,600	N/A		
Cast stone waste	N/A				232,000	N/A	144,000	50,000	N/A		
Sulfate grout waste	N/A							19,800	N/A		

Table S–5. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

<table>
<tr><th rowspan="2">Parameter/
Resource</th><th colspan="11">Tank Closure Alternative</th></tr>
<tr><th>1
No Action</th><th>2A
Existing WTP Vitrification; No Closure</th><th>2B
Expanded WTP Vitrification; Landfill Closure</th><th>3A
Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure</th><th>3B
Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure</th><th>3C
Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure</th><th>4
Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure</th><th>5
Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure</th><th>6A Base
6A Option
All Vitrification/No Separations; Clean Closure</th><th>6B Base
6B Option
All Vitrification with Separations; Clean Closure</th><th>6C
All Vitrification with Separations; Landfill Closure</th></tr>
<tr><td colspan="12">Waste Management (all values are in cubic meters unless otherwise noted; values rounded to no more than three significant digits) (continued)</td></tr>
<tr><td colspan="12">Disposed of On Site (continued)</td></tr>
<tr><td>Steam reforming waste</td><td colspan="5">N/A</td><td>261,000</td><td colspan="5">N/A</td></tr>
<tr><td>PPF glass (No. of canisters)</td><td colspan="8">N/A</td><td colspan="2">1,540
(670)
42,200
(18,300)</td><td>N/A</td></tr>
<tr><td>LAW melters (No. of melters)</td><td>N/A</td><td>7,700
(30)</td><td>8,000
(31)</td><td colspan="3">2,260
(9)</td><td>2,570
(10)</td><td>2,460
(10)</td><td>N/A</td><td>8,000[e]
(31)
8,000
(31)</td><td>8,000[e]
(31)</td></tr>
<tr><td>LLW (secondary)</td><td>35</td><td>34,300</td><td>37,700</td><td>28,600</td><td>22,100</td><td>21,900</td><td>42,000</td><td>20,700</td><td>93,000
138,000</td><td>99,800
144,000</td><td>34,700</td></tr>
<tr><td>Liquid LLW (liters)</td><td>N/A</td><td colspan="5">9,690</td><td>2,370,000,000</td><td>9,690</td><td>9,690
4,640,000,000</td><td>9,691
4,630,000,000</td><td>9,690</td></tr>
<tr><td>Closure LLW</td><td colspan="2">N/A</td><td colspan="4">679</td><td>2,400</td><td>N/A</td><td colspan="2">4,070
5,430</td><td>525,000</td></tr>
<tr><td>MLLW (secondary)</td><td>21</td><td>39,500</td><td>37,000</td><td>42,000</td><td>35,200</td><td>21,330</td><td>43,600</td><td>22,800</td><td>110,000
153,000</td><td>105,000
148,000</td><td>40,100</td></tr>
<tr><td>Closure MLLW</td><td colspan="2">N/A</td><td colspan="4">525,000</td><td>1,010,000</td><td>3,060</td><td colspan="2">2,410,000
8,310,000</td><td>53</td></tr>
</table>

Table S–5. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/ Resource	Tank Closure Alternative										
	1 No Action	**2A Existing WTP Vitrification; No Closure**	**2B Expanded WTP Vitrification; Landfill Closure**	**3A Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure**	**3B Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure**	**3C Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure**	**4 Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure**	**5 Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure**	**6A Base *6A Option* All Vitrification/No Separations; Clean Closure**	**6B Base *6B Option* All Vitrification with Separations; Clean Closure**	**6C All Vitrification with Separations; Landfill Closure**
Industrial Safety											
Worker Population Impact – Total Project											
Total recordable cases (fatalities)	163 (0)	7,040 (0.92)	3,940 (0.52)	3,570 (0.46)	3,530 (0.46)	3,650 (0.47)	4,550 (0.58)	3,320 (0.43)	25,500 (3.3) *26,200* *(3.4)*	5,190 (0.67) *5,760* *(0.75)*	3,950 (0.52)

[a] Concentrations exceeding applicable standards, discussed in the air quality sections of Chapter 4 of this *TC & WM EIS*, are presented in **bold** text. The Federal standard for $PM_{2.5}$ is 35 micrograms per cubic meter (24-hour average). No specific data for $PM_{2.5}$ were available, but for the purposes of analysis, concentrations were assumed to be the same as for PM_{10}. Radiological air quality impacts are included separately under the public and occupational health and safety sections.

[b] Acceptable Source Impact Levels (ASILs) are used by the state in the permitting process and represent concentrations sufficiently low to protect human health and safety from potential carcinogenic and other toxic effects (WAC 173-460).

[c] The number of LCFs in a population is presented as an integer; where the value is 0, the calculated value (dose × 0.0006 LCFs per person-rem) is presented in parentheses.

[d] Increased likelihood of a latent cancer fatality, assuming the accident occurs, except at high individual doses (hundreds of rem or more) where acute radiation injury may cause death within weeks. Value cannot exceed 1.

[e] Under Alternatives 6B and 6C, HLW and LAW melters from the WTP would be managed as HLW.

[f] Under Alternatives 6B and 6C, ILAW glass would be produced but would be managed as HLW.

Note: To convert cubic meters to cubic yards, multiply by 1.308; hectares to acres, by 2.471; liters to gallons, by 0.26417; meters to yards, by 1.0936.

Key: ASIL=Acceptable Source Impact Level; Base=Base Case; CH=contact-handled; FTE=full-time equivalent; HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; LAW=low-activity waste; LCF=latent cancer fatality; LLW=low-level radioactive waste; MLLW=mixed low-level radioactive waste; N/A=not applicable; National Register=National Register of Historic Places; Option=Option Case; PM_n=particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; PPF=Preprocessing Facility; RH=remote-handled; ROI=region of influence; SST=single-shell tank; TRU=transuranic; WTP=Waste Treatment Plant.

Source: Chapter 4 of this *TC & WM EIS.*

Table S–6. FFTF Decommissioning Alternatives – Summary of Short-Term Environmental Impacts

Parameter/Resource	FFTF Decommissioning Alternatives and Options						
				Alternative 2 or 3			
	Alternative 1: No Action	Alternative 2: Entombment–Facility Disposition	Alternative 3: Removal–Facility Disposition	Disposition of RH-SCs (Hanford Option)	Disposition of RH-SCs (Idaho Option)	Disposition of Bulk Sodium (Hanford Reuse Option)	Disposition of Bulk Sodium (Idaho Reuse Option)
Land Resources							
Land Use (total land commitment)	No change in land use in the 400 Area, 200 Areas, or Borrow Area C.	2.1 hectares affected within the 400 Area. 2.8 hectares (0.3 percent) affected within Borrow Area C.	2.4 hectares affected within the 400 Area. 3.2 hectares (0.3 percent) affected within Borrow Area C.	0.1 hectares affected in 200-West Area.	0.1 hectares affected within the MFC.	0.1 hectares affected in 400 Area.	No change in land use within the MFC.
Visual resources	No change in the visual character of the 400 Area or 200 Areas.	Overall improvement in visual character of 400 Area. Minor change in visual character of Borrow Area C.		No meaningful change in the visual character of the 200-West Area.	No meaningful change in the visual character of the MFC.	No meaningful change in the visual character of the 400 Area.	No change in the visual character of the MFC.
Infrastructure							
Total Requirements							
Electricity (million megawatt-hours)	0.60	0.0032	0.0064	0.0000011		0.0013	
Diesel fuel (million liters)	0.0	4.02	3.76	0.24		1.09	0.12
Gasoline (million liters)	0.11	0.36	0.37	0.090		0.42	0.012
Water (million liters)	7,980	19.6	18.9	8.53		2.92	2.72
Peak Annual Demand							
Electricity (million megawatt-hours)	0.006	0.0032		0.00000071		0.00069	
Diesel fuel (million liters)	0.0	1.74	1.11	0.12		0.47	0.058
Gasoline (million liters)	0.0011	0.098	0.050	0.045		0.18	0.0088
Water (million liters)	79.8	11.4	10.5	3.75	3.74	1.36	

Table S–6. FFTF Decommissioning Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/Resource	FFTF Decommissioning Alternatives and Options						
				Alternative 2 or 3			
	Alternative 1: No Action	Alternative 2: Entombment–Facility Disposition	Alternative 3: Removal–Facility Disposition	Disposition of RH-SCs (Hanford Option)	Disposition of RH-SCs (Idaho Option)	Disposition of Bulk Sodium (Hanford Reuse Option)	Disposition of Bulk Sodium (Idaho Reuse Option)
Noise and Vibration: Negligible offsite impact of onsite activities. Minor traffic noise impacts.							
Air Quality							
Peak Year Incremental Criteria Pollutant Concentrations as Compared to Most Stringent Guideline or Standard (micrograms per cubic meter)[a]							
Carbon monoxide (1-hour) standard=40,000	31.3	435	381	39.3	0	5,160	66.6
Nitrogen oxides (annual) standard=100	0.0006	2.84	2.04	Does not occur in peak year	0	Does not occur in peak year	0.772
PM_{10} (24-hour) standard=150	0.0027	31.3	72	41.9	0	22.5	13.5
Sulfur oxides (1-hour) standard=660	0.042	30.6	50.4	0.062	0	6.97	N/A
Peak Year Incremental Toxic Chemical Concentrations (micrograms per cubic meter)[a]							
Ammonia (24-hour) ASIL=100	0.00013	0.196	0.026	0.0157	0	14.0	0.007
Benzene (annual) ASIL=0.12	0.00000319	0.0106		Does not occur in peak year	0	Does not occur in peak year	0.0008
Toluene (24-hour) ASIL=400	0.0034	11.3		Does not occur in peak year	0	Does not occur in peak year	0.0517
Xylene (24-hour) ASIL=1,500	0.00095	3.18		Does not occur in peak year	0	Does not occur in peak year	0.0147

Table S–6. FFTF Decommissioning Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/Resource	FFTF Decommissioning Alternatives and Options						
				Alternative 2 or 3			
	Alternative 1: No Action	Alternative 2: Entombment–Facility Disposition	Alternative 3: Removal–Facility Disposition	Disposition of RH-SCs (Hanford Option)	Disposition of RH-SCs (Idaho Option)	Disposition of Bulk Sodium (Hanford Reuse Option)	Disposition of Bulk Sodium (Idaho Reuse Option)
Geology and Soils							
Construction impacts	No incremental impact on geology and soils.	Minimal impact associated with facility demolition in previously disturbed area. Potential for short-term soil loss from wind and water erosion during demolition, backfilling, and barrier construction. Excavation depths generally limited to 0.91 meters (3 feet) in the 400 Area.	Similar to, but somewhat greater than, Alternative 2: Entombment, due to reactor vessel removal and greater demands for geologic and soil resources from Borrow Area C.	Impacts of construction limited to previously disturbed area in 200-West Area. Excavation depths to 6 meters (20 feet) within the Hanford formation.	Similar to, but somewhat greater than, the Hanford Option due to the potential for blasting at the MFC to excavate the subgrade portion of the RTP in near-surface basalt.	Limited impact on geology and soils in the Hanford 400 Area.	Minimal impact on geology and soils within the MFC at INL.
New permanent land disturbance (hectares)	0.0	3.5	3.2	0.1			<0.1
Geologic resource requirements (cubic meters)	0.0	122,000	143,000	4,670	4,580	202	35.5
Water Resources							
Surface water	No additional impacts on surface water in the short term. Wastewater generation and discharges would decrease from current levels.	No impact expected on surface-water features. Potential for contaminated runoff from demolition and work areas with no effect expected beyond the 400 Area.	Similar to, but somewhat greater than, Alternative 2: Entombment, due to reactor vessel removal and slightly larger area of disturbance and associated runoff.	Little or no impact on surface-water features or quality in the 200-West Area.	Little or no impact on surface-water features or quality within the MFC.	Limited impact on surface-water features or quality in the Hanford 400 Area.	No impacts on surface-water resources from construction and operations within the MFC at INL.

Table S–6. FFTF Decommissioning Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/Resource	FFTF Decommissioning Alternatives and Options						
				Alternative 2 or 3			
	Alternative 1: No Action	Alternative 2: Entombment–Facility Disposition	Alternative 3: Removal–Facility Disposition	Disposition of RH-SCs (Hanford Option)	Disposition of RH-SCs (Idaho Option)	Disposition of Bulk Sodium (Hanford Reuse Option)	Disposition of Bulk Sodium (Idaho Reuse Option)
Water Resources *(continued)*							
Vadose zone and groundwater	No additional impact in the short term. Groundwater use would decrease following deactivation.	Barrier emplacement would delay contaminant migration from the 400 Area.	Short-term, positive impact of removal of sources of residual contamination associated with the FFTF RCB.	No direct discharge of effluents from facility operations to the vadose zone or groundwater.			
Ecological Resources							
Terrestrial resources	No impact within 400 Area or Borrow Area C.	No impact within 400 Area. No disturbance to sagebrush habitat within Borrow Area C.		No impact within the 200-West Area.	No impact within the MFC.	No impact within the 400 Area.	No impact within the MFC.
Wetlands	No impact within 400 Area or Borrow Area C.			No impact within the 200-West Area.	No impact within the MFC.	No impact within the 400 Area.	No impact within the MFC.
Aquatic resources	No impact within 400 Area or Borrow Area C.			No impact within the 200-West Area.	No impact within the MFC.	No impact within the 400 Area.	No impact within the MFC.
Threatened and endangered species	No impact on federally or state-listed threatened or endangered species within the 400 Area or Borrow Area C.	No impact on any federally or state-listed threatened or endangered species. No impact on state-listed special status species within the 400 Area. Minimal potential for impact on 4 state-listed special status species within Borrow Area C.		No impact on federally or state-listed threatened, endangered, or special status species within the 200-West Area.	No impact on federally or state-listed threatened, endangered, or special status species within the MFC.	No impact on federally or state-listed threatened, endangered, or special status species within the 400 Area.	No impact on federally or state-listed threatened, endangered, or special status species within the MFC.
Cultural and Paleontological Resources							
Prehistoric resources	No impact on prehistoric resources.						
Historic resources	No impact on historic resources.						
American Indian interests	No impact on American Indian interests.	Excavation activities would impact the view from State Route 240 and higher elevations, including Rattlesnake Mountain.		No impact on American Indian interests.			
Paleontological resources	No impact on paleontological resources.						

Table S–6. FFTF Decommissioning Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/Resource	FFTF Decommissioning Alternatives and Options						
				Alternative 2 or 3			
	Alternative 1: No Action	Alternative 2: Entombment–Facility Disposition	Alternative 3: Removal–Facility Disposition	Disposition of RH-SCs (Hanford Option)	Disposition of RH-SCs (Idaho Option)	Disposition of Bulk Sodium (Hanford Reuse Option)	Disposition of Bulk Sodium (Idaho Reuse Option)
Socioeconomics							
Peak annual workforce (FTEs)	1	50	85	53	46	65	55
Peak daily commuter traffic (vehicles per day)	1	40	68	43	46	52	55
Peak daily truck loads – off site	Less than 1	3	2	1	Less than 1	Less than 1	Less than 1
Impact on the ROI	Little or no impact on socioeconomic ROI.	The impact on the Hanford and INL socioeconomic ROIs would be small.					
Public and Occupational Health and Safety – Normal Operations[a]							
Offsite Population Impact – Life of the Project							
Dose (person-rem)	b	0.000001	b	0.00014	0.000011	0.0072	0.00042
LCF[c]	b	0 (6×10^{-10})	b	0 (8×10^{-8})	0 (7×10^{-9})	0 (4×10^{-6})	0 (3×10^{-7})
Peak Year Maximally Exposed Individual Impact							
Dose (millirem per year)	b	0.00000003	b	0.0000016	0.0000014	0.00012	0.000045
Increased risk of an LCF	b	2×10^{-14}	b	1×10^{-12}	8×10^{-13}	7×10^{-11}	3×10^{-11}
Peak Year Onsite Maximally Exposed Individual Impact							
Dose (millirem per year)	b	0.0000000019	b	0.000000034	N/A	0.000011	N/A
Increased risk of an LCF	b	1×10^{-15}	b	2×10^{-14}	N/A	7×10^{-12}	N/A
Radiation Worker Population Impact – Life of the Project							
Dose (person-rem)	1	0.37	6.3	1.2		3.7	3.6
LCF[c]	0 (6×10^{-4})	0 (2×10^{-4})	0 (4×10^{-3})	0 (7×10^{-4})		0 (2×10^{-3})	
Average Annual Impact per Radiation Worker							
Dose (millirem per year)	50	100	100	20		39	
Increased risk of an LCF	3×10^{-5}	6×10^{-5}	6×10^{-5}	1×10^{-5}		2×10^{-5}	
Peak Year Noninvolved Worker Impact							
Dose (millirem per year)	b	0.00000000066	b	0.00019	0.0000011	0.0000037	0.000055
Increased risk of an LCF	b	4×10^{-16}	b	1×10^{-10}	7×10^{-13}	2×10^{-12}	3×10^{-11}

Table S–6. FFTF Decommissioning Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/Resource	Alternative 1: No Action	Alternative 2: Entombment–Facility Disposition	Alternative 3: Removal–Facility Disposition	Alternative 2 or 3: Disposition of RH-SCs (Hanford Option)	Alternative 2 or 3: Disposition of RH-SCs (Idaho Option)	Alternative 2 or 3: Disposition of Bulk Sodium (Hanford Reuse Option)	Alternative 2 or 3: Disposition of Bulk Sodium (Idaho Reuse Option)
Public and Occupational Health and Safety – Facility Accidents							
Offsite Population Consequences							
Dose (person-rem)	0.048	d		4.4	0.25[e]	0.048	0.0002[e]
Number of LCFs[c]	0 (3×10^{-5})	d		0 (3×10^{-3})	0 (2×10^{-4})[e]	0 (3×10^{-5})	0 (1×10^{-7})[e]
Maximally Exposed Offsite Individual Consequences							
Dose (rem)	0.000001	d		0.00011	0.0001[e]	0.000001	0.000000055
Increased risk of an LCF	6×10^{-10}	d		7×10^{-8}	6×10^{-8}[e]	6×10^{-10}	3×10^{-11}[e]
Noninvolved Worker Consequences							
Dose (rem)	0.00000087	d		0.0009	0.0036[e]	0.00000087	0.00000034
Increased risk of an LCF	5×10^{-10}	d		5×10^{-7}	2×10^{-6}[e]	5×10^{-10}	2×10^{-10}[e]
Offsite Population Risk							
Annual number of LCFs[c]	0 (3×10^{-10})	d		0 (3×10^{-5})	0 (2×10^{-6})[e]	0 (3×10^{-10})	0 (1×10^{-12})[e]
Number of LCFs over the life of the project[c]	0 (3×10^{-8})	d		0 (1×10^{-4})	0 (8×10^{-6})[e]	0 (4×10^{-9})	0 (2×10^{-12})[e]
Maximally Exposed Offsite Individual Risk							
Annual increased risk of an LCF	6×10^{-15}	d		7×10^{-10}	6×10^{-10}[e]	6×10^{-15}	3×10^{-16}[e]
Increased risk of an LCF over the life of the project	6×10^{-13}	d		3×10^{-9}	3×10^{-9}[e]	8×10^{-14}	6×10^{-16}[e]
Noninvolved Worker Risk							
Annual increased risk of an LCF	5×10^{-15}	d		5×10^{-9}	2×10^{-8}[e]	5×10^{-15}	2×10^{-15}[e]
Increased risk of an LCF over the life of the project	5×10^{-13}	d		3×10^{-8}	1×10^{-7}[e]	7×10^{-14}	4×10^{-15}[e]
Public and Occupational Health and Safety – Transportation							
Traffic accidents[c] (nonradiological fatalities)	0 (0.0003)	0 (0.019)	0 (0.021)	0 (0.0026)	0 (0.0013)	0 (0.0004)	0 (0.0053)
Offsite Population							
Dose (person-rem)	0	f	0.0025	0.0048	0.330	0.0112	0.945
LCFs	0	N/A	1.5×10^{-6}	2.9×10^{-6}	2.0×10^{-4}	6.7×10^{-6}	5.7×10^{-4}

Table S–6. FFTF Decommissioning Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/Resource	FFTF Decommissioning Alternatives and Options						
				Alternative 2 or 3			
	Alternative 1: No Action	Alternative 2: Entombment–Facility Disposition	Alternative 3: Removal–Facility Disposition	Disposition of RH-SCs (Hanford Option)	Disposition of RH-SCs (Idaho Option)	Disposition of Bulk Sodium (Hanford Reuse Option)	Disposition of Bulk Sodium (Idaho Reuse Option)
Public and Occupational Health and Safety – Transportation *(continued)*							
Worker							
Dose (person-rem)	0	f	0.033	0.032	0.839	0.115	3.52
LCFs	0	N/A	2×10^{-5}	1.9×10^{-5}	5×10^{-4}	6.9×10^{-5}	2.1×10^{-3}
Environmental Justice							
Human health impacts	No disproportionately high and adverse human health impacts on minority or low-income populations due to normal facility operations or postulated facility accidents.						
Waste Management (cubic meters unless otherwise noted; values rounded to no more than three significant digits)							
Disposed of Off Site and/or Stored On Site							
LLW	1,700	7	692	68		10	N/A
MLLW	57	N/A	8	7		400	275
Hazardous	396	N/A	73	N/A			
Liquid LLW (liters)	623,000	182,000	324,000	N/A			
Industrial Safety							
Worker Population Impact – Total Project							
Total recordable cases (fatalities)	0.42 (0)	8.1 (0)	9.5 (0)	4.7 (0)	3.2 (0)	5.8 (0)	2.0 (0)

a Concentrations associated with FFTF Decommissioning alternatives and options are not projected to exceed applicable standards. The Federal standard for $PM_{2.5}$ is 35 micrograms per cubic meter (24-hour average). No specific data for $PM_{2.5}$ were available, but for the purposes of analysis, concentrations were assumed to be the same as for PM_{10}. Radiological air quality impacts are included separately under the public and occupational health and safety sections.

b Impacts on remote receptors would be negligible under Alternatives l and 3.

c The number of LCFs in a population is presented as an integer; where the value is 0, the calculated value (dose × 0.0006 LCFs per person-rem) is presented in parentheses.

d Impacts of accidents associated with facility disposition (building entombment or removal) would be less than those for disposition of RH-SCs or bulk sodium.

e Impacts are only for accidents that could occur at INL. Impacts identified for disposition of RH-SCs or bulk sodium at Hanford could also occur under the Idaho options during removal and preparation of material for shipment.

f All materials are sanitary and hazardous waste, not radioactive.

Note: To convert cubic meters to cubic yards, multiply by 1.308; hectares to acres, by 2.471; liters to gallons, by 0.26417; meters to yards, by 1.0936.

Key: ASIL=acceptable source impact level; FFTF=Fast Flux Test Facility; FTE=full-time equivalent; INL=Idaho National Laboratory; LCF=latent cancer fatality; LLW=low-level radioactive waste; MFC=Materials and Fuels Complex; MLLW=mixed low-level radioactive waste; N/A=not applicable; PM_n=particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; %=percent; RCB=Reactor Containment Building; rem=Röentgen equivalent man; RH-SCs=remote-handled special components; ROI=region of influence; RTP=Remote Treatment Project; wt=weight.

Source: Chapter 4 of this *TC & WM EIS.*

Table S–7. Waste Management Alternatives – Summary of Short-Term Environmental Impacts[a]

Parameter/Resource	Waste Management Alternatives and Disposal Groupings							
	Alternative 1: No Action	Alternatives 2 and 3: Treatment and Storage	Alternative 2: Disposal Group 1	Alternative 2: Disposal Group 2	Alternative 2: Disposal Group 3	Alternative 3: Disposal Group 1	Alternative 3: Disposal Group 2	Alternative 3: Disposal Group 3
Land Resources								
Land Use (total land commitment)	No change in land use within the 200 Areas or Borrow Area C.	2.7 hectares affected within the 200-West Area.	63.9 hectares affected within and adjacent to the 200-East Area. 41.7 hectares affected within Borrow Area C.	247 hectares affected within and adjacent to the 200-East Area. 159 hectares affected within Borrow Area C.		76.9 hectares of land affected within and adjacent to the 200 Areas. 36.8 hectares affected within Borrow Area C.	253 hectares affected within and adjacent to the 200 Areas. 157 hectares affected within Borrow Area C.	
Visual resources	No change in the visual character of the 200 Areas.	No meaningful change in the visual character of the 200-West Area.	Noticeable change in the visual character of the 200 Areas and Borrow Area C, especially from nearby higher elevations, or, in the case of Borrow Area C, State Route 240.					
Infrastructure								
Total Requirements								
Electricity (million megawatt-hours)	0.0056	0.55	0.0085					
Diesel fuel (million liters)	13.9	42.0	215	1,420	2,180	215	1,410	2,170
Gasoline (million liters)	1.23	8.48	13.2	74.6	100	13.2	74.6	100
Water (million liters)	35.7	430	2,620	20,800	36,800	2,610	20,700	36,500
Peak Annual Demand								
Electricity (million megawatt-hours)	0.00019	0.018	0.00019					
Diesel fuel (million liters)	3.46	2.60	39.0	151		38.9	149	
Gasoline (million liters)	0.012	1.01	3.68	14.2		3.66	14.1	
Water (million liters)	25.5	23.9	67.0	259		66.7	256	

Table S–7. Waste Management Alternatives – Summary of Short-Term Environmental Impacts[a] *(continued)*

Parameter/Resource	Waste Management Alternatives and Disposal Groupings							
	Alternative 1: No Action	**Alternatives 2 and 3: Treatment and Storage**	**Alternative 2: Disposal Group 1**	**Alternative 2: Disposal Group 2**	**Alternative 2: Disposal Group 3**	**Alternative 3: Disposal Group 1**	**Alternative 3: Disposal Group 2**	**Alternative 3: Disposal Group 3**
Noise and Vibration: Negligible offsite impact of onsite activities. Minor traffic noise impacts.								
Air Quality								
Peak Year Incremental Criteria Pollutant Concentrations as Compared to Most Stringent Guideline or Standard (micrograms per cubic meter)[b]								
Carbon monoxide (1-hour) standard=40,000	451	12,200	**49,800**	**257,000**		**51,200**	**256,000**	
Nitrogen oxides (annual) standard=100	1.24	3.47	19.2	92.1		20.1	92.0	
PM_{10} (24-hour) standard=150	**507**	**717**	**3,360**	**17,200**		**3,420**	**17,300**	
Sulfur oxides (1-hour) standard=660	0.71	16.5	68.4	353		70.5	352	
Peak Year Incremental Toxic Chemical Concentrations (micrograms per cubic meter)[b]								
Ammonia (24-hour) ASIL=100	0.210	8.74	3.84	20.0		4.09	20.0	
Benzene (annual) ASIL=0.12	0.000264	0.001	0.007	0.033		0.007	0.033	
Toluene (24-hour) ASIL=400	0.027	1.84	6.00	31.2		6.20	31.1	
Xylene (24-hour) ASIL=1,500	0.01	0.526	1.78	9.27		1.84	9.25	

Table S–7. Waste Management Alternatives – Summary of Short-Term Environmental Impacts[a] *(continued)*

Parameter/Resource	Waste Management Alternatives and Disposal Groupings							
	Alternative 1: No Action	**Alternatives 2 and 3: Treatment and Storage**	**Alternative 2: Disposal Group 1**	**Alternative 2: Disposal Group 2**	**Alternative 2: Disposal Group 3**	**Alternative 3: Disposal Group 1**	**Alternative 3: Disposal Group 2**	**Alternative 3: Disposal Group 3**
Geology and Soils								
Construction impacts	Little additional impact on geology and soils.	Limited impact on geology and soils from construction of new/expanded facilities in previously disturbed areas. Excavation depths up to 3 meters.	Small-to-moderate impact of construction, including potential for short-term soil erosion. Excavation depths to 14 meters.	Impacts similar in nature to, but greater than, those under Alternative 2, Disposal Group 1. Excavation depths to 14 meters.	The impacts would be identical to those under Alternative 2, Disposal Group 2.	Similar to those under Alternative 2, Disposal Group 1, but impacts more dispersed across the 200 Areas.	Similar to those under Alternative 2, Disposal Group 2, but impacts more dispersed across the 200 Areas.	Similar to those under Alternative 2, Disposal Group 3, but impacts more dispersed across the 200 Areas.
New permanent land disturbance (hectares)	0.0	2.7	104	398		98.7	397	
Geologic resource requirements (cubic meters)	6,230	10,600	1,980,000	7,610,000		1,760,000	7,550,000	
Water Resources								
Surface water	No additional impacts on surface water in the short term.	Negligible potential impact on surface water from stormwater runoff.	Short-term increase in stormwater runoff during construction, but little-to-no impact on surface-water features. Water use would not exceed site capacity.	Similar to those under Alternative 2, Disposal Group 1, with greater potential for stormwater runoff during construction. Longer period of operations than under Alternative 2, Disposal Group 1. Water use would not exceed site capacity.	Potential construction impacts would be similar to those under Alternative 2, Disposal Group 2. Longer period of operations than under Alternative 2, Disposal Group 2. Water use would not exceed site capacity.	Similar to those under Alternative 2, Disposal Group 1.	Similar to those under Alternative 2, Disposal Group 2.	Similar to those under Alternative 2, Disposal Group 3.

Table S–7. Waste Management Alternatives – Summary of Short-Term Environmental Impacts[a] *(continued)*

Parameter/Resource	Waste Management Alternatives and Disposal Groupings							
	Alternative 1: No Action	**Alternatives 2 and 3: Treatment and Storage**	**Alternative 2: Disposal Group 1**	**Alternative 2: Disposal Group 2**	**Alternative 2: Disposal Group 3**	**Alternative 3: Disposal Group 1**	**Alternative 3: Disposal Group 2**	**Alternative 3: Disposal Group 3**
Water Resources *(continued)*								
Vadose zone and groundwater	No additional impact in the short term.	No direct discharge of effluents from facility operations to the vadose zone or groundwater.	No impact on groundwater flow from construction. No impact on groundwater in the short term from collection and treatment of leachate.	Similar to those under Alternative 2, Disposal Group 1.	The potential for impacts during operations would increase proportionally to the lifespan of the disposal facilities.	Similar to those under Alternative 2, Disposal Group 1.	Similar to those under Alternative 2, Disposal Group 2.	Similar to those under Alternative 2, Disposal Group 3.
Ecological Resources								
Terrestrial resources	No impact within the 200 Areas or Borrow Area C.	0.4 hectares of sagebrush habitat affected in the 200 Areas. No sagebrush habitat affected within Borrow Area C.	63.9 hectares of sagebrush habitat affected in the 200 Areas. No sagebrush habitat affected within Borrow Area C.	247 hectares of sagebrush habitat affected in the 200 Areas. No sagebrush habitat affected within Borrow Area C.		76.9 hectares of sagebrush habitat affected in the 200 Areas. No sagebrush habitat affected within Borrow Area C.	253 hectares of sagebrush habitat affected in the 200 Areas. No sagebrush habitat affected within Borrow Area C.	
Wetlands	No impact on wetlands within the 200 Areas or Borrow Area C.							
Aquatic resources	No impact on aquatic resources within the 200 Areas or Borrow Area C.							
Threatened and endangered species	No impact on federally or state-listed threatened, endangered, or special status species.	No impact on federally or state-listed threatened, endangered, or special status species within the 200 Areas.	No impact on federally or state-listed threatened or endangered species. Potential impact on 4 state-listed special status species within the 200 Areas. Potential impact on 4 state-listed special status species within Borrow Area C.	No impact on federally or state-listed threatened or endangered species. Somewhat greater potential to impact 4 state-listed special status species within the 200 Areas than under Disposal Group 1, as more sagebrush habitat would be disturbed. Potential impact on 4 state-listed special status species within Borrow Area C.		No impact on federally or state-listed threatened or endangered species. Potential impact on 5 state-listed special status species within the 200 Areas. Potential impact on 4 state-listed special status species within Borrow Area C.	No impact on federally or state-listed threatened or endangered species. Somewhat greater potential impact on 5 state-listed special status species within the 200 Areas than under Disposal Group 1, as more sagebrush habitat would be disturbed. Potential impact on 4 state-listed special status species within Borrow Area C.	

Table S–7. Waste Management Alternatives – Summary of Short-Term Environmental Impacts[a] *(continued)*

Parameter/Resource	Waste Management Alternatives and Disposal Groupings							
	Alternative 1: No Action	**Alternatives 2 and 3: Treatment and Storage**	**Alternative 2: Disposal Group 1**	**Alternative 2: Disposal Group 2**	**Alternative 2: Disposal Group 3**	**Alternative 3: Disposal Group 1**	**Alternative 3: Disposal Group 2**	**Alternative 3: Disposal Group 3**
Cultural and Paleontological Resources								
Prehistoric resources	No impact on prehistoric resources.							
Historic resources	No impact on historic resources.							
American Indian interests	No impact on American Indian interests.	Impacts on viewshed from higher elevations, including Rattlesnake Mountain.	Expansion of IDF-East and construction of the RPPDF would affect 62.3 hectares. Excavation of Borrow Area C would involve 41.7 hectares. This would change the viewscape from Rattlesnake Mountain and higher elevations.	Expansion of IDF-East and construction of the RPPDF would affect 240 hectares. Excavation of Borrow Area C would involve 159 hectares. This would change the viewscape from Rattlesnake Mountain and higher elevations.		The impact would be similar to those under Alternative 2, Disposal Group 1.	The impact would be similar to those under Alternative 2, Disposal Groups 2 and 3.	
Paleontological resources	No impact on paleontological resources.							
Socioeconomics								
Peak annual workforce (FTEs)	109	449	1,180	4,540		1,170	4,500	
Peak daily commuter traffic (vehicles per day)	88	360	943	3,640		940	3,600	
Peak daily truck loads – off site	Less than 1	2	28	34		28	33	
Impact on the ROI	Little impact on socioeconomic ROI.	Potential for change in the socioeconomic ROI, including level-of-service impacts on local transportation. Impacts would be similar under both alternatives.						

Table S–7. Waste Management Alternatives – Summary of Short-Term Environmental Impacts[a] *(continued)*

Parameter/Resource	Waste Management Alternatives and Disposal Groupings							
	Alternative 1: No Action	**Alternatives 2 and 3: Treatment and Storage**	**Alternative 2: Disposal Group 1**	**Alternative 2: Disposal Group 2**	**Alternative 2: Disposal Group 3**	**Alternative 3: Disposal Group 1**	**Alternative 3: Disposal Group 2**	**Alternative 3: Disposal Group 3**
Public and Occupational Health and Safety – Normal Operations[c]								
Offsite Population Impact – Life of the Project								
Dose (person-rem)	d	0.00067	e					
LCF[f]	d	0 (4×10^{-7})	e					
Peak Year Maximally Exposed Individual Impact								
Dose (millirem per year)	d	0.00000021	e					
Increased risk of an LCF	d	1×10^{-13}	e					
Peak Year Onsite Maximally Exposed Individual Impact								
Dose (millirem per year)	d	0.000000057	e					
Increased risk of an LCF	d	3×10^{-14}	e					
Radiation Worker Population Impact – Life of the Project								
Dose (person-rem)	37	3,000	360	3,600	6,400	360	3,500	6,400
LCF[f]	0 (2×10^{-2})	2	0 (2×10^{-1})	2	4	0 (2×10^{-1})	2	4
Average Annual Impact per Radiation Worker								
Dose (millirem per year)	200		200					
Increased risk of an LCF	1×10^{-4}		1×10^{-4}					
Peak Year Noninvolved Worker Impact								
Dose (millirem per year)	d	0.00023	e					
Increased risk of an LCF	d	1×10^{-10}	e					

Table S–7. Waste Management Alternatives – Summary of Short-Term Environmental Impacts[a] *(continued)*

Parameter/Resource	Alternative 1: No Action	Alternatives 2 and 3: Treatment and Storage	Alternative 2: Disposal Group 1	Alternative 2: Disposal Group 2	Alternative 2: Disposal Group 3	Alternative 3: Disposal Group 1	Alternative 3: Disposal Group 2	Alternative 3: Disposal Group 3
Public and Occupational Health and Safety – Facility Accidents								
Offsite Population Consequences								
Dose (person-rem)	1,100	g	1,100					
Number of LCFs	1		1					
Maximally Exposed Offsite Individual Consequences								
Dose (rem)	0.25	g	0.25					
Increased risk of an LCF	2×10^{-4}		2×10^{-4}					
Noninvolved Worker Consequences								
Dose (rem)	260	g	260					
Increased risk of an LCF	3×10^{-1}		3×10^{-1}					
Offsite Population Risk								
Annual number of LCFs[f]	0 (7×10^{-3})	g	0 (7×10^{-3})					
Number of LCFs over the life of the project[f]	0 (2×10^{-1})		0 (3×10^{-1})	1 (6.3×10^{-1})	1 (1.1)	0 (3×10^{-1})	1 (6.3×10^{-1})	1 (1.1)
Maximally Exposed Offsite Individual Risk								
Annual increased risk of an LCF	2×10^{-6}	g	2×10^{-6}					
Increased risk of an LCF over the life of the project	4×10^{-5}		6×10^{-5}	1×10^{-4}	2×10^{-4}	6×10^{-5}	1×10^{-4}	2×10^{-4}
Noninvolved Worker Risk								
Annual increased risk of an LCF	3×10^{-3}	g	3×10^{-3}					
Increased risk of an LCF over the life of the project	9×10^{-2}		1×10^{-1}	3×10^{-1}	5×10^{-1}	1×10^{-1}	3×10^{-1}	5×10^{-1}

Table S–7. Waste Management Alternatives – Summary of Short-Term Environmental Impacts[a] *(continued)*

Parameter/Resource	Alternative 1: No Action	Alternatives 2 and 3: Treatment and Storage	Alternative 2: Disposal Group 1	Alternative 2: Disposal Group 2	Alternative 2: Disposal Group 3	Alternative 3: Disposal Group 1	Alternative 3: Disposal Group 2	Alternative 3: Disposal Group 3
	Waste Management Alternatives and Disposal Groupings							
Public and Occupational Heath and Safety – Transportation								
Traffic accidents[h] (nonradiological fatalities)	0 (0.003)	0 (0.03)	0 (0.07)	0 (0.25)	0 (0.32)	0 (0.06)	0 (0.25)	0 (0.32)
Offsite Population								
Dose (person-rem)	0.083	352	i					
LCFs	5×10^{-5}	2.2×10^{-1}	i					
Worker								
Dose (person-rem)	2.62	2,621	i					
LCFs	1.6×10^{-3}	1.57	i					
Environmental Justice								
Human health impacts	No disproportionately high and adverse human health impacts on minority or low-income populations due to normal facility operations or postulated facility accidents.							
Waste Management (all values are in cubic meters unless otherwise noted; values rounded to no more than three significant digits)								
LLW	38	1,460	58					
MLLW	N/A	98	N/A					
Hazardous	38	N/A	58					
Industrial Safety								
Worker Population Impact – Total Project								
Total recordable cases (fatalities)	10 (0)	379 (0.05)	199 (0.03)	1,280 (0.16)	2,050 (0.26)	214 (0.03)	1,290 (0.17)	2,050 (0.26)

[a] Total impacts associated with each action alternative would be equal to the sum of the (1) treatment and storage and (2) disposal group values.

[b] Concentrations exceeding applicable standards, discussed in the air quality sections of Chapter 4 of this *TC & WM EIS* are presented in **bold** text. The Federal standard for $PM_{2.5}$ is 35 micrograms per cubic meter (24-hour average). No specific data for $PM_{2.5}$ were available, but for the purposes of analysis, concentrations were assumed to be the same as for PM_{10}. Radiological air quality impacts are included separately under the public and occupational health and safety sections.

[c] Disposal group radiological impacts of normal operations are additive to the treatment and storage impacts under Alternatives 2 and 3.

[d] Impacts of the Waste Management No Action Alternative are from existing, permitted facilities and are included in current annual dose estimates.

[e] Regardless of disposal group, emissions from burial ground operations would have negligible impact on distant receptors.

[f] The number of LCFs in a population is presented as a whole number; where the value is less than 0, the calculated value (dose × 0.0006 LCFs per person-rem) is presented in parentheses.

[g] Nearest whole integer (calculated value in parentheses).

[h] Treatment and storage accident consequences and risks are encompassed in the values presented for disposal.

[i] The impacts of transporting the materials under these disposal groups have already been considered under the Tank Closure and FFTF Decommissioning alternatives.

Note: To convert cubic meters to cubic yards, multiply by 1.308; hectares to acres, by 2.471; liters to gallons, by 0.26417; meters to yards, by 1.0936.

Key: ASIL=acceptable source impact level; FTE=full-time equivalent; IDF-East=200-East Area Integrated Disposal Facility; LCF=latent cancer fatality; LLW=low-level radioactive waste; MLLW=mixed low-level radioactive waste; N/A=not applicable; PM_n=particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; ROI=region of influence; RPPDF=River Protection Project Disposal Facility.

Source: Chapter 4 of this *TC & WM EIS.*

S.5.4 Key Environmental Findings

The following sections present an overview of the key findings associated with the Tank Closure, FFTF Decommissioning, and Waste Management alternatives, as well as cumulative impacts. Both short- and long-term impact analyses are included in this key findings discussion; however, the majority of the findings focus on long-term impacts.

In this EIS, estimates of long-term impacts on human health were developed for four types of receptors: the drinking-water well user, resident farmer, American Indian resident farmer, and American Indian hunter-gatherer. Detailed results presented in this *TC & WM EIS* show that estimates of human health impacts for all types of receptors increase or decrease in proportion to those estimated for the drinking-water well user. For this reason, this key environmental findings discussion presents results only for the drinking-water well user.

S.5.4.1 Tank Closure Alternatives

The Tank Closure action alternatives described in this *TC & WM EIS* represent the range of reasonable approaches to storing Hanford tank waste; removing the waste from the tanks to the extent technically and economically feasible; treating the waste through vitrification in the existing WTP, in an expanded WTP, and/or in conjunction with one or more supplemental treatment technologies; packaging the waste for onsite storage or disposal or offsite shipment and disposal; and closing the SST system to permanently reduce the potential risk to human health and the environment. These alternatives were developed in part to allow comparisons of the short-term impacts of the construction, operation, and deactivation of the additional facilities proposed for storage, retrieval, treatment, and disposal of waste from the SST system, and for closure of the SST system. These action alternatives were also developed to allow similar comparisons of the long-term water quality, human health, and ecological risk impacts resulting from completion of these activities. The following is a brief discussion of the key findings for the Tank Closure alternatives.

> **Core Zone Boundary**
>
> The core zone is a portion of the Central Plateau within the Hanford Site, encompassing the 200-East and 200-West Areas, that lies within the Industrial-Exclusive land use designation. The Core Zone Boundary is the perimeter of the core zone that is used as a line of analysis for groundwater transport calculations.

Tank Farm Waste Retrieval. The Tank Closure alternatives allow the range of retrieval options to be evaluated. Under Tank Closure Alternative 1, the tank waste would not be retrieved. Under Tank Closure Alternative 5, retrieval of 90 percent of the waste would occur. Tank Closure Alternatives 2A, 2B, 3A, 3B, 3C, and 6C would achieve 99 percent retrieval. Tank Closure Alternatives 4, 6A, and 6B would retrieve 99.9 percent of the tank waste.

Continued storage of tank waste with no removal or treatment would have negligible additional short-term impacts but significant long-term impacts. Retrieving the tank waste rather than leaving it in place would reduce long-term impacts on groundwater and human health.

For potential short-term impacts, resource requirements and human health effects associated with tank waste retrieval are similar, and rather small compared with other construction, operations, and closure-related impacts under all Tank Closure alternatives.

The influence of degree of retrieval on the magnitude of long-term human health impacts is most clearly discernable through consideration of impacts due to tank farm sources other than past leaks. Potential long-term impacts due to sources in SST and DST farms include losses from residual waste remaining in tanks and ancillary equipment following retrieval, as well as retrieval leaks at SST farms. Estimates of lifetime radiological risk for a drinking-water well user at the Core Zone Boundary for these sources at all tank farms are presented in Figure S–14: Tank Closure Alternative 1 (no retrieval), Tank Closure Alternative 5 (90 percent retrieval), Tank Closure Alternatives 2B, 3A, 3B, 3C and 6C (99 percent retrieval), and Tank Closure Alternative 4 (99.9 percent retrieval). The results show that failure to retrieve waste under Tank Closure Alternative 1 would have the greatest potential impact on human health. For Tank Closure alternatives that include retrieval of waste, impacts due to tank farm residuals and ancillary equipment, and to a lesser degree, retrieval leaks, are the important contributors to estimates of impacts prior to calendar year 4000, and Tank Closure Alternative 4 has the lowest estimate of risk due to selective clean closure (complete removal of SST farms BX and SX). Estimates of impacts over longer periods are reduced in approximate proportion to the degree of retrieval.

Radiological Risk

In general, a measure of potential harm to populations or individuals due to the presence or occurrence of an environmental or manmade hazard. In terms of human health, risk comprises three components: a sequence of events leading to an adverse impact, the probability of occurrence of that sequence of events, and the severity of the impact. For the release of radionuclides affecting a population, the impact is the occurrence of a fatal cancer; risk is expressed as the expected number of latent cancer fatalities (i.e., the product of probability of occurrence and the magnitude of impact). For the release of radionuclides affecting individuals, the impact is the incidence of cancer; risk is expressed as the probability over a lifetime of developing cancer.

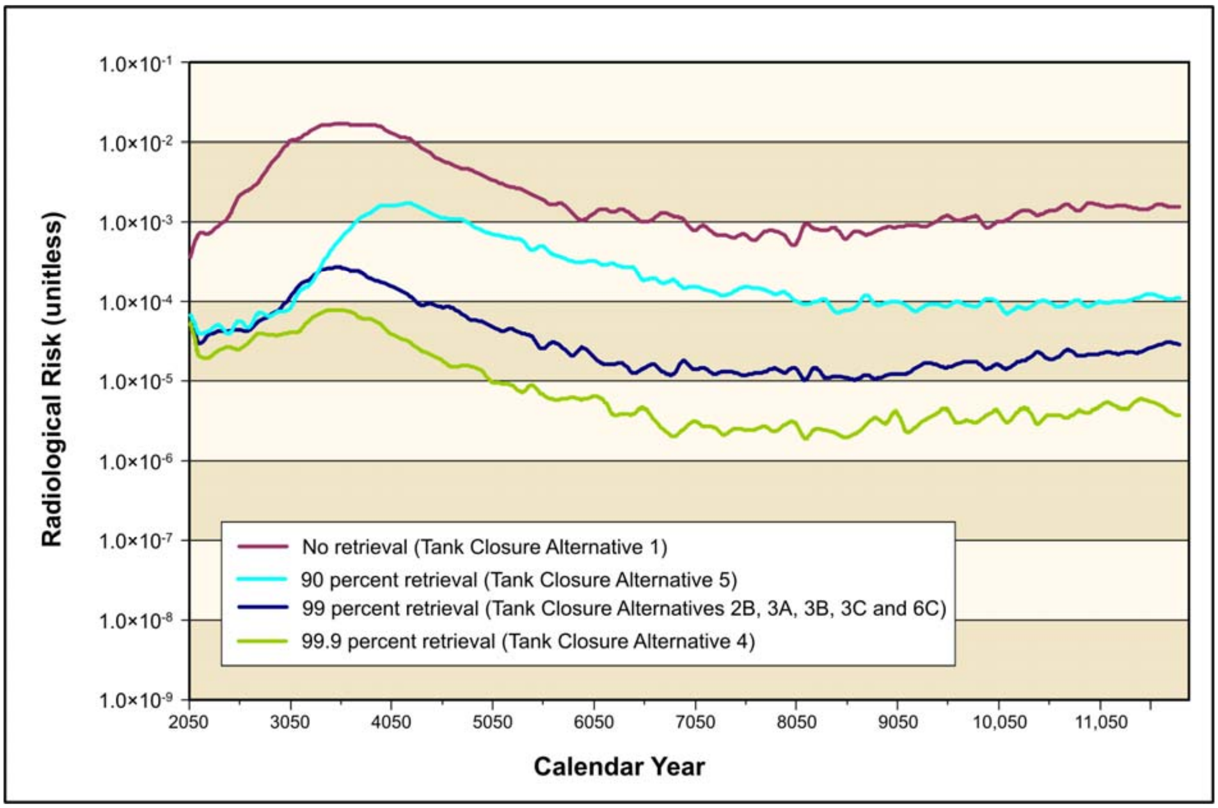


Figure S–14. Lifetime Radiological Risk for the Drinking-Water Well User at the Core Zone Boundary due to Releases from Tank Farm Residuals and Ancillary Equipment and to Retrieval Leaks

WTP Configuration. Use of the WTP would be required under each of the Tank Closure action alternatives, with the WTP configuration varying among these alternatives.

- Under Tank Closure Alternative 1, construction of the WTP would not be completed and no tank waste would be treated.
- Tank Closure Alternatives 2A, 3A, 3B, 3C, and 4 would use the existing WTP configuration.
- Tank Closure Alternatives 2B, 5, 6B, and 6C would use the existing WTP configuration supplemented with expanded ILAW treatment capacity.
- Tank Closure Alternative 6A would require modification of the WTP to provide IHLW vitrification capacity only—that is, no LAW vitrification capacity.

> **Secondary Waste**
>
> Secondary waste is waste generated as a result of other activities, e.g., waste retrieval or waste treatment, that is not further treated by the Waste Treatment Plant or supplemental treatment facilities, and includes liquid and solid wastes. Liquid waste sources could include process condensates, scrubber wastes, spent reagents from resins, offgas and vessel vent wastes, vessel washes, floor drain and sump wastes, and decontamination solutions. Solid waste sources could include worn filter membranes, spent ion exchange resins, failed or worn equipment, debris, analytical laboratory waste, high-efficiency particulate air filters, spent carbon adsorbent, and other process-related wastes. Secondary waste can be characterized as low-level radioactive waste, mixed low-level radioactive waste, transuranic waste, or hazardous waste.

Potential short-term impacts, including resource demands (e.g., land, utilities, geologic resources, workforce); air pollutant emissions; human health impacts; and waste generation, vary roughly in proportion to the magnitude of construction, with total operational impacts generally proportional to the duration of waste treatment. Using the existing WTP treatment configuration would extend treatment time and require replacement DSTs, which would increase short-term impacts. Using the existing WTP configuration supplemented by expanded ILAW treatment capacity would reduce the treatment time and result in minor impacts on most resources. Alternative 6A would have the highest demands for, and thus the greatest short-term impacts on, most resources. This is because this alternative would have the highest construction demands coupled with the longest period of WTP operations. It would be necessary to construct replacement WTP facilities twice as the predecessor facilities reached the end of their operational lifetimes. Varying the WTP configuration would not change the quantity and performance of waste forms and, therefore, would have minor influence on long-term impacts.

Primary, Supplemental, and Secondary Waste Forms. The Tank Closure alternatives also were developed to evaluate potential impacts of the primary waste form and a range of supplemental thermal and nonthermal waste forms. The primary waste form planned for disposal on site is ILAW glass; the thermal supplemental treatment waste forms are represented in this EIS by bulk vitrification glass and steam reforming waste; and the nonthermal supplemental treatment waste form is represented by cast stone waste. Waste processing using each of the primary or supplemental treatment technologies that generate these waste forms also produces secondary wastes, whose impacts are included as part of the evaluation. The Tank Closure alternatives that use these various supplemental treatment technology configurations are as follows:

- Tank Closure Alternative 2B – Thermal (ILAW glass) primary treatment in the 200-East Area
- Tank Closure Alternative 3A – Thermal (ILAW glass) primary treatment in the 200-East Area; thermal (bulk vitrification) supplemental treatment in both the 200-East and 200-West Areas

- Tank Closure Alternative 3B – Thermal (ILAW glass) primary treatment in the 200-East Area; nonthermal (cast stone) supplemental treatment in both the 200-East and 200-West Areas

- Tank Closure Alternative 3C – Thermal (ILAW glass) primary treatment in the 200-East Area; thermal (steam reforming) supplemental treatment in both the 200-East and 200-West Areas

Differences in potential short-term impacts of facility construction and supplemental treatment operations among the Tank Closure alternatives identified above are relatively small for most resource areas. Volumetrically, Tank Closure Alternative 2B produces no supplemental treatment waste for disposal, while Alternative 3C produces the highest amount (i.e., approximately 260,000 cubic meters [340,000 cubic yards]). While Tank Closure Alternative 3C would be similar to other supplemental treatment alternatives in its demands for, and thus total short-term construction and operational impacts on, most resources, it would have higher impacts in some resource areas, such as electric power consumption.

Estimates of potential long-term human health impacts due to disposal at the IDF barrier in the 200-East Area are presented in Figure S–15 for the combined effect of primary, supplemental, and secondary wastes for the Waste Management alternatives and disposal groups that include the Tank Closure alternatives described above. The results show that segregation of the maximum amount of waste into the primary waste form (ILAW glass for Tank Closure Alternative 2B) produces the lowest estimate of risk. Because of the low rate of release from ILAW glass, the major impact of this treatment process is attributable to releases from secondary wastes, including the release of iodine-129 captured in the offgas of the melters that is solidified in the ETF secondary waste. A combination of the thermal treatment primary waste form (ILAW glass) with the thermal treatment bulk vitrification glass and secondary wastes (Tank Closure Alternative 3A) results in the next lowest estimate of impacts. The increase in Tank Closure Alternative 3A risk estimated for this treatment process relative to the Tank Closure Alternative 2B primary waste (ILAW glass) is due to the release from the inventory of technetium-99 deposited in the castable refractory block surrounding the bulk vitrification glass waste form. The treatment process resulting in the nonthermal cast stone waste form (Tank Closure Alternative 3B) produces higher estimates of impact due to the remaining inventory of technetium-99 not immobilized into IHLW glass and the relatively poor performance of the current Hanford site-specific grout formulation in retaining this radionuclide. The thermal treatment steam reforming waste form (Tank Closure Alternative 3C) provides the poorest performance of the supplemental waste forms based on assumed release mechanism data.

The analysis suggests that additional treatment or waste form development may be needed for secondary waste. DOE is currently evaluating potential secondary waste form research and development activities, which include ceramic and other waste forms. It is anticipated that research and development efforts will continue to address treatment of the liquid secondary waste, as this stream would not be generated until the WTP was operational. Measures could also be pursued involving the increased capture of iodine-129, technetium-99, or other target constituents in ILAW glass.

Tank-Derived TRU Waste. Under Tank Closure Alternatives 3A, 3B, 3C, 4, and 5, the waste in some selected tanks would be managed as mixed TRU waste and therefore, disposed of at WIPP. These alternatives were developed to determine the environmental impacts related to that approach.

Treating tank-derived TRU waste decreases the WTP and supplemental treatment process timeframes and reduces the volume of waste to be disposed of on site in an IDF and the associated long-term impacts. While treatment of some of the tank waste as TRU waste increases short-term impacts (e.g., air emissions, worker dose), the total incremental impact over the tank-derived TRU waste treatment period is negligible compared with other waste treatment impacts.

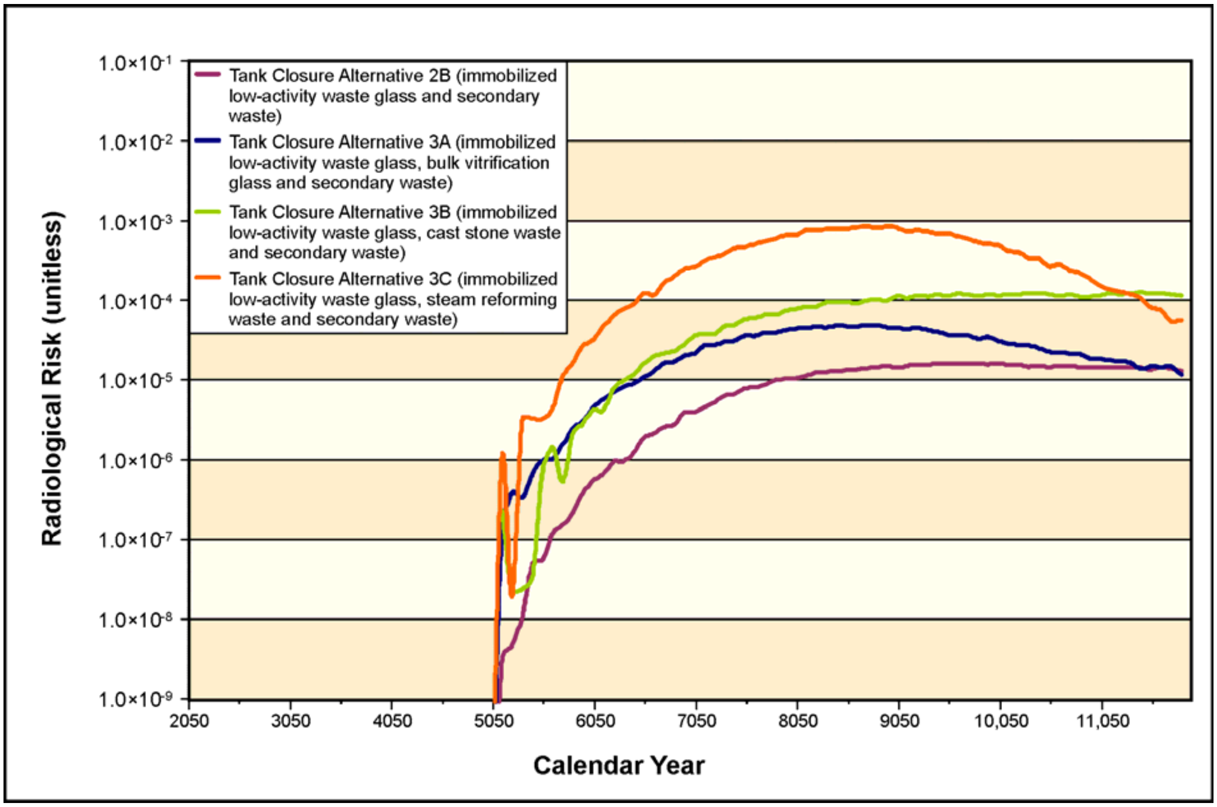


Figure S–15. Lifetime Radiological Risk for the Drinking-Water Well User at the 200-East Area Integrated Disposal Facility Barrier from Tank Closure Treatment Process–Generated Waste Forms

Technetium-99 Removal in WTP. The Tank Closure action alternatives were also developed to compare WTP pretreatment with or without technetium-99 removal. Tank Closure Alternatives 2B and 3B include technetium-99 removal within the WTP pretreatment process, while Tank Closure Alternatives 2A, 3A, 3C, 4, 5, and 6A through 6C do not.

Tank Closure Alternative 2B includes technetium-99 removal in the WTP, a pretreatment activity that separates technetium-99 and sends it for immobilization into IHLW glass. By contrast, Tank Closure Alterative 2A assumes no technetium-99 removal in the WTP; therefore, most of the technetium-99 is immobilized in ILAW glass and disposed of onsite in an IDF. The analysis indicates that ILAW glass with or without technetium-99 has similar potential short-term and long-term impacts. The analysis further indicates that removal of technetium-99 and disposal of it offsite as IHLW glass provides little reduction in the concentrations of technetium-99 at either the Core Zone Boundary or the Columbia River nearshore. This is because the rate of release of technetium-99 from ILAW glass is small when compared to the rate of release of technetium-99 from other sources such as ETF-generated secondary wastes and tank closure secondary wastes.

Sulfate Grout. Under Tank Closure Alternative 5, an additional sulfate removal technology is evaluated after WTP pretreatment to increase the waste loading in ILAW glass, thereby reducing the amount of ILAW glass produced in the WTP and allowing earlier completion of treatment. This alternative was developed to determine the environmental impact of a shorter treatment timeframe. Use of the sulfate removal technology results in a reduced treatment timeframe and reduced ILAW glass volume, with minimal potential short-term impacts and no long-term impacts. Tank Closure Alternative 5 short-term construction and operational impacts would be very similar to those of other Tank Closure alternatives, although impacts of the operation of the Sulfate Removal Facility would result in higher demands for some resources such as liquid fuels and water.

Closure of the Six Sets of Cribs and Trenches (Ditches). Although the scope of this *TC & WM EIS* does not include decisions to be made for six sets of cribs and trenches that are contiguous to the SST farms, they are included in the alternative analysis because of their close proximity to the SST farms and because it is difficult to distinguish sources of contamination in the vadose zone or groundwater. Tank Closure Alternatives 1 and 2A assume no closure of the SST system, including the cribs and trenches, while all the remaining Tank Closure alternatives assume landfill closure of the cribs and trenches, except for Tank Closure Alternatives 6A, Option Case, and 6B, Option Case. These two alternatives analyze clean closure of the cribs and trenches.

Overall potential total short-term and peak short-term environmental impacts of closure activities would exceed total facility construction impacts under most alternatives, especially in terms of air emissions and resource demands. For closure of the cribs and trenches, there would be some impact tradeoffs between landfill closure of the cribs and trenches under the Base Cases and clean closure under the Option Cases. Landfill barrier construction would result in higher peak and total nonradiological air pollutant emissions than tank farm clean closure would. By contrast, clean closure of the cribs and trenches under the Alternatives 6A and 6B, Option Cases, would increase the total closure impacts, such as demands for utility resources and geologic materials, workforce requirements, and secondary waste generation, to levels measurably higher than those of the Base Cases.

Closure Options Analyzed in This Environmental Impact Statement

Landfill closure – Following tank waste retrieval, the single-shell tank (SST) system would be closed in accordance with state, Federal, and/or U.S. Department of Energy requirements for closure of a landfill. Landfill closure typically includes site stabilization and emplacement of a barrier followed by a postclosure care period.

Clean closure – Following tank waste retrieval, the tanks, ancillary equipment, and contaminated soils would be removed as necessary to protect human health and the environment and to allow unrestricted use of the tank farm area.

Selective clean closure/landfill closure – This hybrid closure approach would implement clean closure of a representative tank farm in each of the 200-East and 200-West Areas (i.e., the BX and SX tank farms), while implementing landfill closure for the balance of the SST farm system.

Cribs and trenches are major contributors to potential long-term groundwater impacts for all Tank Closure alternatives due to their early discharges in the 1950s and 1960s. As shown in Figure S–16, for Tank Closure Alternative 1 (no landfill closure of the cribs and trenches), Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C (landfill closure of the cribs and trenches), and Tank Closure 6B, Option Case (clean closure of the cribs and trenches), estimates of human health impacts (radiological risk to the drinking-water well user) correlate with the closure options. For example, Tank Closure Alternative 1 and Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C have similar radiological risk to the drinking-water well user at the Core Zone Boundary throughout the period of analysis, because the contaminants have already reached the vadose zone or groundwater and, therefore, there is minimal benefit to the addition of a landfill closure barrier. By contrast, results for Tank Closure Alternative 6B, Option Case, indicate that clean closure of the cribs and trenches significantly reduces radiological risk to the drinking-water well user at the Core Zone Boundary after calendar year 7000. The variability in lifetime radiological risk represented in Figure S–16 is attributable primarily to the release of multiple constituents at differing times and rates from 35 sources comprising these sets of cribs and trenches and secondarily from variability in prediction of concentration inherent in the method applied (i.e., particle tracking) for simulation of transport of contaminants in the unconfined aquifer.

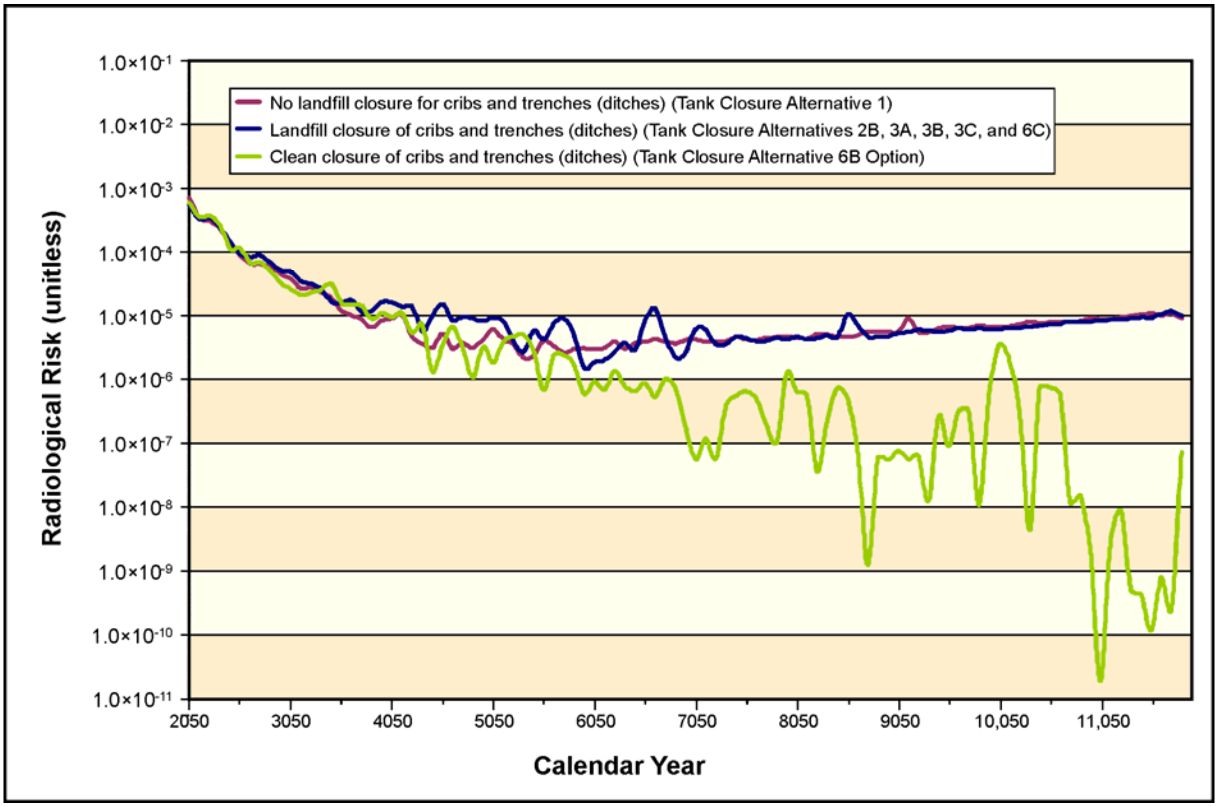


Figure S–16. Lifetime Radiological Risk for the Drinking-Water Well User at the Core Zone Boundary due to Releases from the Six Sets of Cribs and Trenches (Ditches)

Closure of SST System Past Leaks. Currently, 67 of Hanford's 149 SSTs are listed as "known or suspected" leakers. The Tank Closure alternatives were developed to compare the long-term impacts on groundwater of closing the SST system, including the SST farm past leaks. Tank Closure Alternatives 1 and 2A assume no closure of the SST system, and past leaks would remain. Tank Closure Alternatives 2B, 3A, 3B, 3C, 5, and 6C assume landfill closure of the entire SST system, and past leaks would remain. Tank Closure Alternative 4 assumes selective clean closure/landfill closure, which includes clean closure of the BX and SX SST farms and landfill closure of the remaining SST farms, and past leaks would be removed at the two clean-closed SST farms. Tank Closure Alternatives 6A, Base and Option Cases, and 6B, Base and Option Cases, assume clean closure of the SST farms, and past leaks would be removed at all the SST farms.

Over the short-term, past leaks in and around the SST farms could affect clean closure activities. For example, construction dewatering would likely be necessary in some tank farm excavations to allow clean closure to proceed, and depending on the amount of pumping required and the levels of contamination found, may increase worker dose. Also, the water could require special handling and treatment at the ETF prior to release to the environment due to the expected high contamination levels.

Past leaks are major contributors to potential long-term groundwater impacts. As shown in Figure S–17, for Tank Closure Alternative 2A (no landfill closure), Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C (landfill closure), Tank Closure Alternative 4 (selective clean closure/landfill closure) and Tank Closure Alternative 6B, Base Case (clean closure of the SST system), estimates of human health impacts (radiological risk to the drinking-water well user) correlate with the closure options. For example, Tank Closure Alternative 2A has the highest radiological risk to the drinking-water well user at the Core Zone Boundary, while Tank Closure Alternative 6B, Base Case, has the lowest radiological risk to the drinking-water well user at the Core Zone Boundary. Impact estimates for Tank Closure Alternative 4 show a reduction in risk due to selective clean closure.

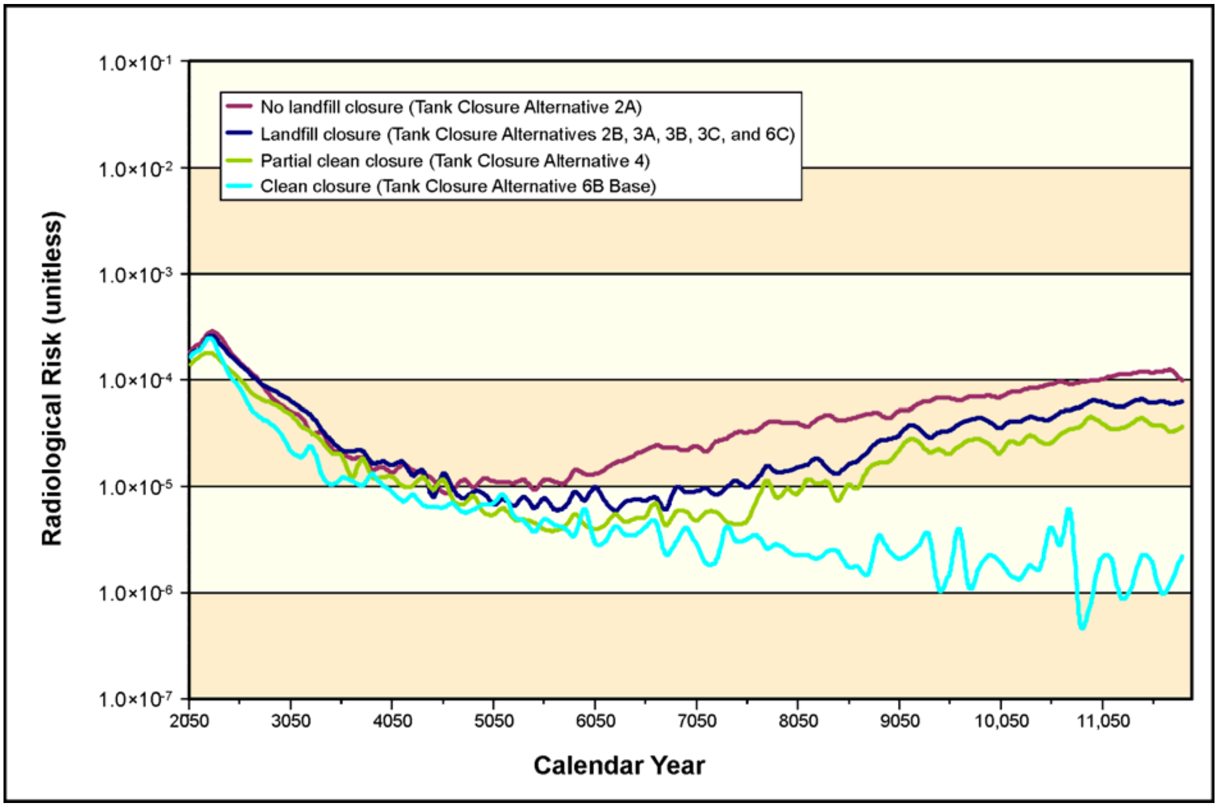


Figure S–17. Lifetime Radiological Risk for the Drinking-Water Well User at the Core Zone Boundary due to Past Leaks at Single-Shell Tank Farms

Closure of SST System. The Tank Closure alternatives were also developed to compare the potential long-term impacts on groundwater of closing the SST system. Proposed closure options range from clean closure or selective clean closure/landfill closure to landfill closure with or without any contaminated soil removal. The closure assumptions of the Tank Closure alternatives are summarized below.

- Tank Closure Alternatives 1 and 2A assume no closure of the SST system.
- Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C assume landfill closure using an engineered modified RCRA Subtitle C barrier and removal of 4.6 meters (15 feet) of contaminated soils (which includes ancillary equipment) from two SST farms (BX and SX).
- Tank Closure Alternative 4 assumes selective clean closure of two SST farms (BX and SX) and landfill closure of the remaining SST farms using an engineered modified RCRA Subtitle C barrier.
- Tank Closure Alternative 5 assumes landfill closure of the SST farms using a Hanford barrier without removal of contaminated soils or ancillary equipment.
- Tank Closure Alternatives 6A and 6B assume clean closure of the SST system. The Base Cases would place an engineered modified RCRA Subtitle C barrier over the six sets of cribs and trenches (ditches) in the B and T tank farms, while the Option Cases would include deep soil removal and remediation of these six sets of cribs and trenches (ditches).

As previously mentioned, total short-term and peak short-term environmental impacts of SST farm closure activities would exceed total facility construction impacts for most alternatives, and would substantially add to short-term environmental impacts overall, especially in terms of emissions, worker doses, and resource demands. In terms of land resources, clean closure would allow future use of the tank farm areas, but, unlike all other Tank Closure alternatives, would require significant new, permanent land disturbance for new facilities to treat, store, and dispose of tank waste. In addition, geologic resource requirements (mainly for Borrow Area C material to backfill tank farm excavations) under Alternatives 6A and 6B would be higher than those under the landfill closure alternatives. The peak workforce would double to support clean closure, as compared to the landfill closure alternatives. Also worker population radiological dose increases by up to a factor of 10 in association with clean closure activities. Landfill closure using the Hanford barrier under Tank Closure Alternative 5 would result in higher peak and total nonradiological air pollutant emissions than landfill closure employing the modified RCRA Subtitle C barrier, as well as increased demands for utility resources and geologic materials.

Clean closure of the SST system when compared to landfill closure of the SST system would have the following potentially adverse short-term impacts:

- Total land commitments would increase by twofold
- Electricity use would increase by one order of magnitude
- Geologic resource requirements would increase fivefold
- Sagebrush habitat affected would increase by over two orders of magnitude
- Average radiation worker dose from normal operations would increase by over twofold
- LLW and MLLW generation volumes would increase by threefold
- Total recordable worker occurrences would increase by six fold

One other significant uncertainty of clean closure in terms of technical feasibility and risk is the depth of excavation and soil exhumation that would be required. At a minimum, deep soil removal, including excavation to a depth of about 20 meters (65 feet) below land surface, would be required. This excavation depth should be sufficient to remove soils and sediments contaminated by retrieval-related leaks, as well as contamination from historic waste releases that have accumulated horizontally on compacted strata beneath the waste tanks. For some SST sites, excavation to depths of up to 78 meters (255 feet) below the land surface may be required to remediate contaminant plumes from past-practice discharges that have migrated through the vadose zone soils and sediments and possibly to the water table. Since an effort of this scale in a radioactive environment has never been undertaken in the United States, it is unclear whether this operation could be conducted with adequate considerations for worker safety.

As shown by the radiological risk curves presented in Figure S–18, the radiological risk peak occurs at approximately calendar year 4300 under Tank Closure Alternative 5 while at calendar year 3600 under Tank Closure Alternative 2B. The magnitude difference between the two curves is not a result of barrier performance, but of the volume of tank farm residuals (due to different retrieval assumptions). Thus, the Hanford barrier has negligible human health benefits (i.e., radiological risk to the drinking-water well user) at the Core Zone Boundary when measured against the modified RCRA Subtitle C barrier; it would delay release from landfills for only several hundred years.

Figure S–18, which also includes retrieval leaks and releases from the SST residuals and ancillary equipment for Tank Closure Alternatives 2B (landfill closure) and 4 (selective clean closure/landfill closure), shows that the human health impacts (radiological risk to the drinking-water well user) at the Core Zone Boundary correlate to the closure actions. For example, Tank Closure Alternative 2B has a higher radiological risk than Tank Closure Alternative 4. Note: Tank Closure Alternative 6B is not included in Figure S–18 because there are no long-term human health impacts; the three groundwater sources (tank retrieval leaks, releases from the tank residuals, and releases from ancillary equipment) are completely removed under this alternative.

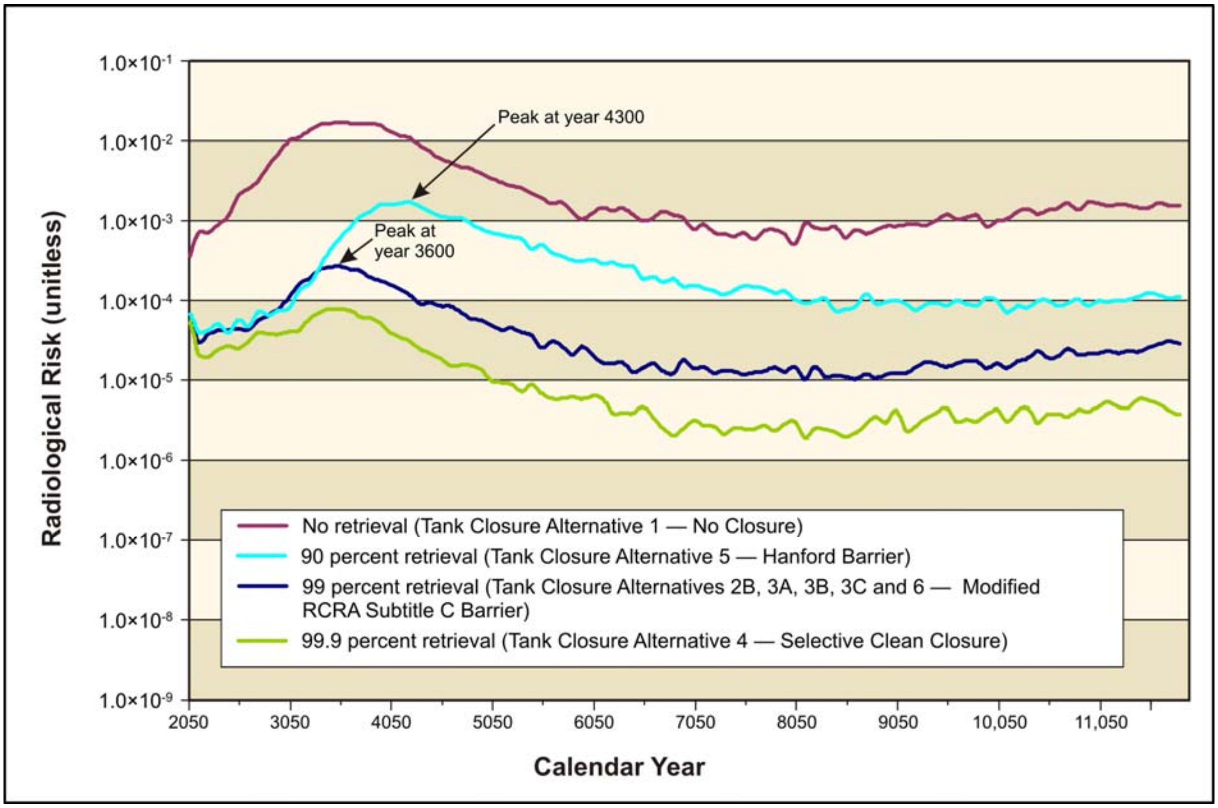


Figure S–18. Lifetime Radiological Risk for the Drinking-Water Well User at the Core Zone Boundary due to Releases from Tank Farm Residuals and Ancillary Equipment and to Retrieval Leaks

Figures S–16 and S–17, which include the releases from the six sets of cribs and trenches (ditches) and the past leaks from the SSTs, respectively, also show that the clean closure of the SST farms (Tank Closure Alternatives 6B Base and Option Cases) provides some beneficial long-term impacts to the groundwater after calendar year 6000. However, clean closure would provide little, if any, reduction in long-term impacts to the groundwater before the calendar year 6000, due to the early releases from past leaks and cribs and trenches (ditches) contiguous to the SST farms.

The *TC & WM EIS* analysis further shows that the clean closure of the SST farms and contaminated soil would not reduce the concentrations of iodine-129 and technetium-99 below their respective benchmark concentrations for at least the first 2,000 years; concentrations will remain within an order of magnitude above the benchmark concentrations (i.e., 10 picocuries per liter and 9,000 picocuries per liter, respectively) through the duration of the period of analysis. Thus there would still be groundwater impacts under the clean closure alternatives due to the early releases from past leaks and intentional releases through the cribs and trenches (ditches).

As a result of the above conclusions and the excessive cost (see Table S–13), DOE believes that clean closure may not be a viable alternative. Therefore, DOE prefers landfill closure. Hanford represents somewhat of a unique situation compared with other DOE sites such as West Valley, New York. Some of the tanks at Hanford have leaked and discharged contaminants to the soil column. In addition, there were intentional discharges to the soil column through the six sets of cribs and trenches (ditches) from the 1940s through the 1970s. Hanford also used many different separations processes, which produced a heterogeneous waste. In some cases, select radiological constituents at Hanford exist in amounts that are orders of magnitude higher than those at other DOE sites.

S.5.4.2 FFTF Decommissioning Alternatives

The FFTF Decommissioning alternatives were structured to encompass the range of facility disposition options. Under FFTF Decommissioning Alternative 1 (No Action), the facilities would be left in place and stabilized under a blanket of inert gas. By contrast, under FFTF Decommissioning Alternatives 2 (Entombment) and 3 (Removal), radioactive materials would be removed in varying degrees. FFTF Decommissioning Alternative 2 would remove and dispose of a minimal amount of radioactive materials and entomb the rest. All above-grade RCB and adjacent support facilities would be dismantled and either consolidated, entombed in below-grade spaces, or disposed of in an IDF. FFTF Decommissioning Alternative 3 would remove nearly all radioactive materials, including the reactor vessel, internal piping and equipment, and attached depleted-uranium shield, and dispose of these materials onsite in an IDF. Though the treatment of the RH-SCs and the disposition of bulk sodium are analyzed in FFTF Decommissioning Alternatives 2 and 3, they are nondiscriminating activities and, therefore, are not included in this discussion on key findings.

As shown in Table S–6, potential short-term impacts on most resource areas would be similar under FFTF Decommissioning Alternatives 2 and 3, with a few notable exceptions. Emissions of nonradiological air pollutants, particularly particulate matter, associated with construction of facilities to support decommissioning activities and geologic resource requirements for backfill and site regrading following completion of removal activities would be higher under FFTF Decommissioning Alternative 3. Worker radiological doses and waste generation due to removal activities would also be higher under this alternative.

Because of the relatively small inventory of hazardous constituents at FFTF relative to that of facilities within the Core Zone Boundary, and the low rate of recharge to groundwater, potential long-term health impacts under all alternatives would be minimal and there would be little difference between the No Action and Entombment Alternatives, except that Entombment would delay any impacts for 500 years. From a facility disposition perspective, other than the need to treat the bulk sodium and RH-SCs so the recovered sodium could be used in the WTP or for Hanford corrosion control, there would be little environmental impact on groundwater under any of the FFTF Decommissioning alternatives. The FFTF could remain in surveillance and maintenance status.

S.5.4.3 Waste Management Alternatives

The Waste Management alternatives described in this *TC & WM EIS* represent the range of reasonable approaches to storing and treating onsite-generated LLW, MLLW, and TRU waste; disposing of onsite- and offsite-generated LLW and MLLW (at Hanford) and onsite-generated TRU waste (at WIPP); and closing the disposal facilities to reduce water infiltration and the potential for intrusion. They were developed partly to compare the potential short-term impacts of the expansion of existing facilities and construction of new facilities, as well as the operation and deactivation of facilities used to store, treat, and dispose of waste. They were also developed to compare the potential long-term water quality, human health, and ecological risk impacts resulting from these activities.

Waste disposal would be required under all three Waste Management alternatives. The disposal options for waste and the amount of waste vary among the alternatives. Waste Management Alternative 1 would continue disposal of onsite-generated non-CERCLA, nontank LLW and MLLW in LLBG 218-W-5, trenches 31 and 34. For conservative analysis purposes, both Waste Management Alternatives 2 and 3 would provide for continued operation of these trenches through 2050, though the waste would be disposed of in an IDF. Waste Management Alternative 2 would provide for completion of IDF-East for the disposal of tank, onsite-generated non-CERCLA, FFTF decommissioning, waste management, and offsite-generated LLW and MLLW. Waste Management Alternative 3 would provide for the disposal of these waste types in two IDF facilities: IDF-East and IDF-West. Only waste from tank treatment operations would be disposed of in IDF-East. All other wastes would be disposed of in IDF-West. Both Waste Management Alternatives 2 and 3 would include construction and operation of the RPPDF for the disposal of lightly contaminated equipment and soils from closure activities.

For the disposal groupings under Waste Management Alternatives 2 and 3, potential demands for, and short-term impacts on, most resources would vary primarily in direct relation to the size (i.e., disposal capacity), and operational lifespan of the disposal facilities. Potential total short-term and peak short-term environmental impacts of disposal activities are projected to be very similar for Waste Management Alternatives 2 and 3. Thus, for short-term impacts, disposal facility configuration and location are not discriminators.

Low-Level Radioactive Waste Burial Ground 218-W-5, Trenches 31 and 34. Under Waste Management Alternative 1 (No Action), the existing LLBG 218-W-5, trenches 31 and 34, would continue to accept onsite-generated non-CERCLA, nontank LLW and MLLW wastes. The analysis indicates that it would be safe to continue to dispose of LLW and MLLW in these trenches. Potential short-term impacts of ongoing disposal operations would be negligible.

Estimates of potential long-term impacts expressed as radiological risk to the drinking-water well user at the Core Zone Boundary due to the LLBG 218-W-5, trenches 31 and 34, are presented in Figure S–19. The estimated radiological risk is well below 1×10^{-6}, especially as compared with the risks associated with the sources remaining at the SST farms under the Tank Closure alternatives (see Figure S–14).

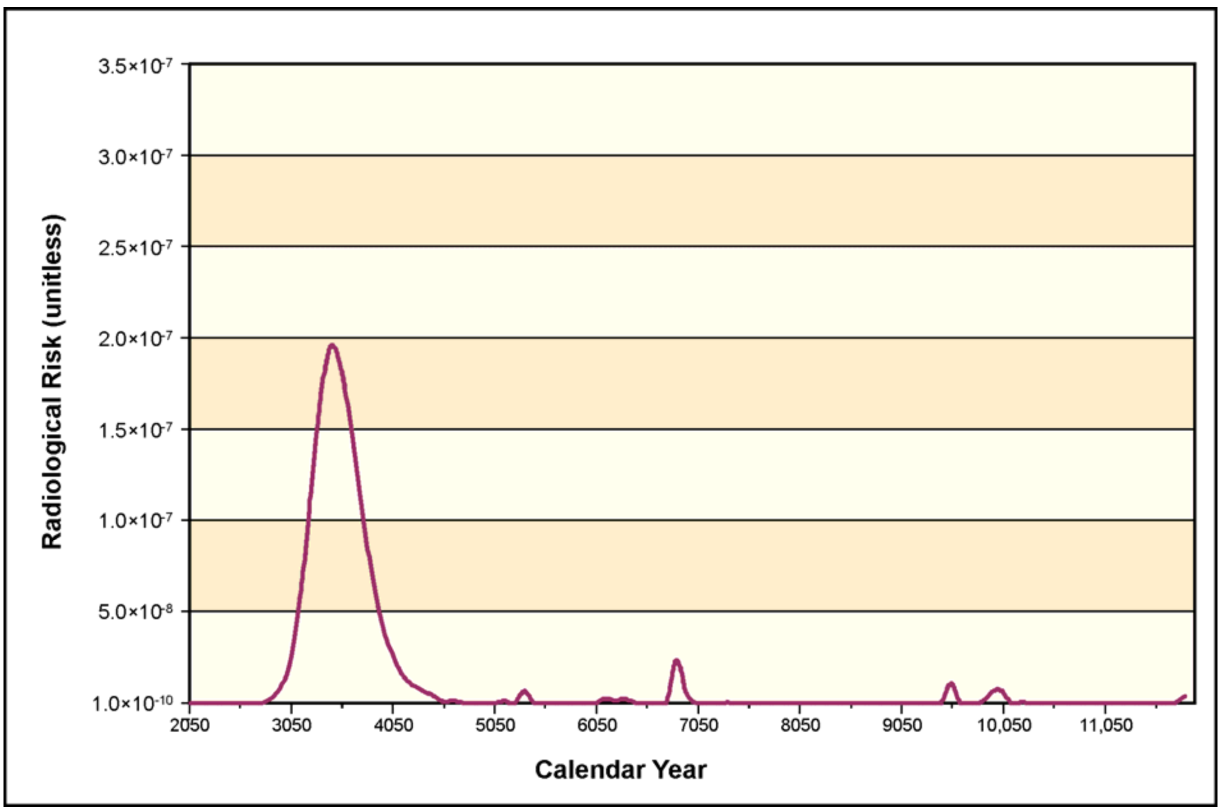


Figure S–19. Waste Management Alternative 1 (No Action) Lifetime Radiological Risk for the Drinking-Water Well User at the Core Zone Boundary due to Low-Level Radioactive Waste Burial Ground 218-W-5, Trenches 31 and 34

Disposal of Waste in IDF-East and IDF-West. Onsite-generated non-CERCLA, FFTF decommissioning, waste management, and offsite-generated LLW and MLLW would be disposed of in an IDF in the 200-East Area and the 200-West Area under Waste Management Alternatives 2 and 3, respectively.

Total short-term impacts of constructing and operating two IDFs under Waste Management Alternative 3 would be substantially the same as those under Waste Management Alternative 2 across nearly all resource areas. This is because no economy of scale is estimated to be achieved by having two IDFs, and short-term impacts are generally proportional to the total size (i.e., disposal capacity) and operational lifespan of disposal facilities rather than the number or location thereof.

Benchmark

Dose or concentration known or accepted to be associated with a specific level of effect. In some cases for groundwater, the benchmark is the maximum contaminant level (MCL). For example, the benchmark for iodine-129 is 1 picocurie per liter and for technetium-99 it is 900 picocuries per liter.

The long-term analysis indicates that an IDF in the 200-West Area does not perform as well as an IDF located in the 200-East Area because of the higher assumed infiltration rate for the 200-West Area location. As indicated in Figure S–20, long-term human health impacts (radiological risk to the drinking-water well user) due to the waste streams listed above are higher at the IDF-West barrier boundary than at the IDF-East barrier boundary through calendar year 6550. In addition, Waste Management Alternative 3, which includes both IDF-West and IDF-East, shows greater exceedances of the benchmark concentrations at the Core Zone Boundary than Waste Management Alternative 2, which includes only IDF-East. Table S–8 provides the estimated concentration at the year of peak concentration for two of the predominant contaminants, technetium-99 and iodine-129, at the IDF-East and IDF-West barrier due to releases from all sources.

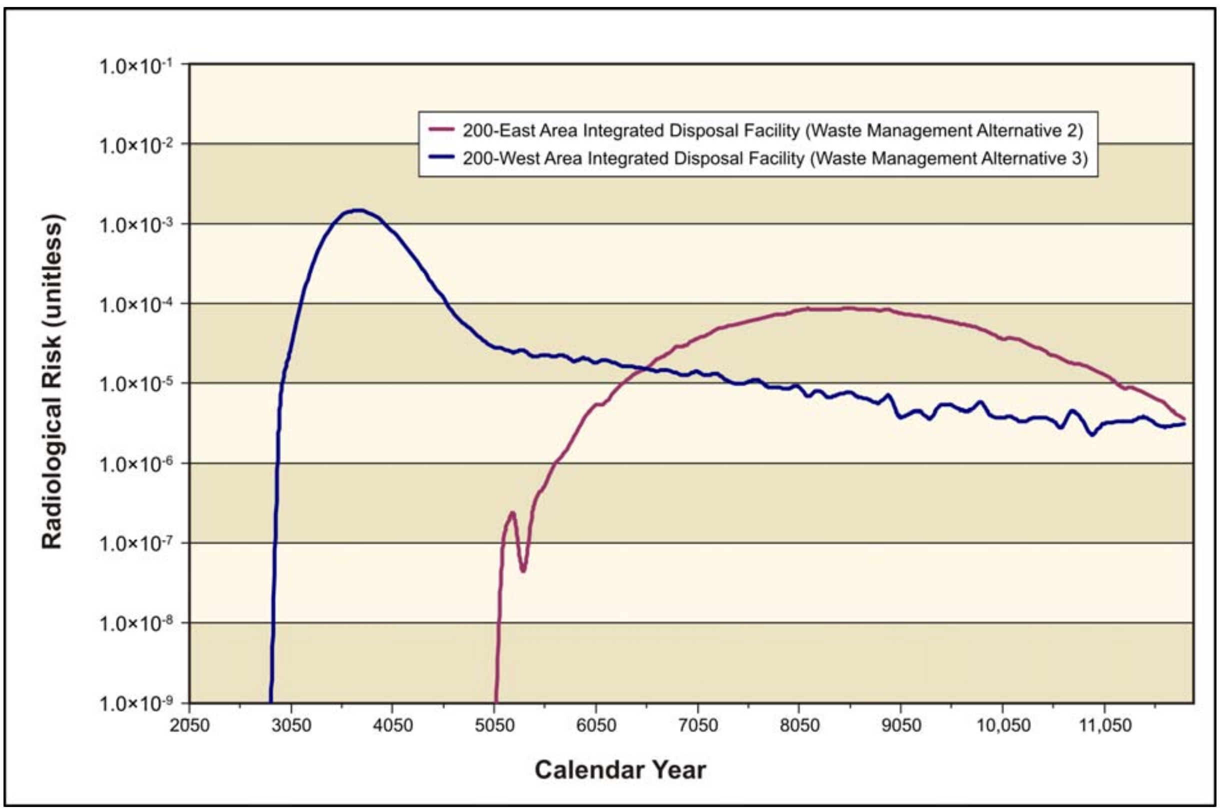


Figure S–20. Lifetime Radiological Risk for the Drinking-Water Well User at the 200-East and 200-West Area Integrated Disposal Facility Barriers

Table S–8. Maximum Concentrations of Technetium-99 and Iodine-129 in the Peak Year at the IDF-East and IDF-West Barriers

Contaminant	IDF-East (Waste Management Alternative 2)	IDF-West (Waste Management Alternative 3)	Benchmark Concentration
Radionuclide in picocuries per liter			
Technetium-99	1910	20,200	900
	(9005)	(3713)	
Iodine-129	18	173	1
	(8196)	(3797)	

Note: Corresponding calendar years are shown in parentheses.

Key: IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility.

Disposal of Offsite Waste. Under Waste Management Alternatives 2 and 3, waste from other DOE facilities (i.e., offsite waste) is accepted and disposed of on site in an IDF. Under Waste Management Alternative 2, offsite waste is disposed of in IDF-East; under Waste Management Alternative 3, offsite waste is disposed of in IDF-West. The analysis shows that receipt of offsite waste streams that contain specified amounts of certain radionuclides, specifically iodine-129 and technetium-99, could have an adverse impact on the environment. Comparison of estimates of human health impacts at the IDF-East barrier under Waste Management Alternatives 2 and 3 for Tank Closure Alternative 2B, (see Figure S–21) illustrates this finding. Estimates of radiological risk for Waste Management Alternative 2, which includes the disposal of offsite waste at IDF-East, are a factor of approximately seven higher than those under Waste Management Alternative 3, which does not include disposal of offsite waste at IDF-East. Table S–9 provides the estimated concentrations at the year of peak concentration for two of the predominant contaminants, technetium-99 and iodine-129, at the IDF-East barrier. Under both alternatives, as shown by the analysis, certain radionuclides, specifically technetium-99 and iodine-129 in offsite waste, are major contributors to groundwater impacts.

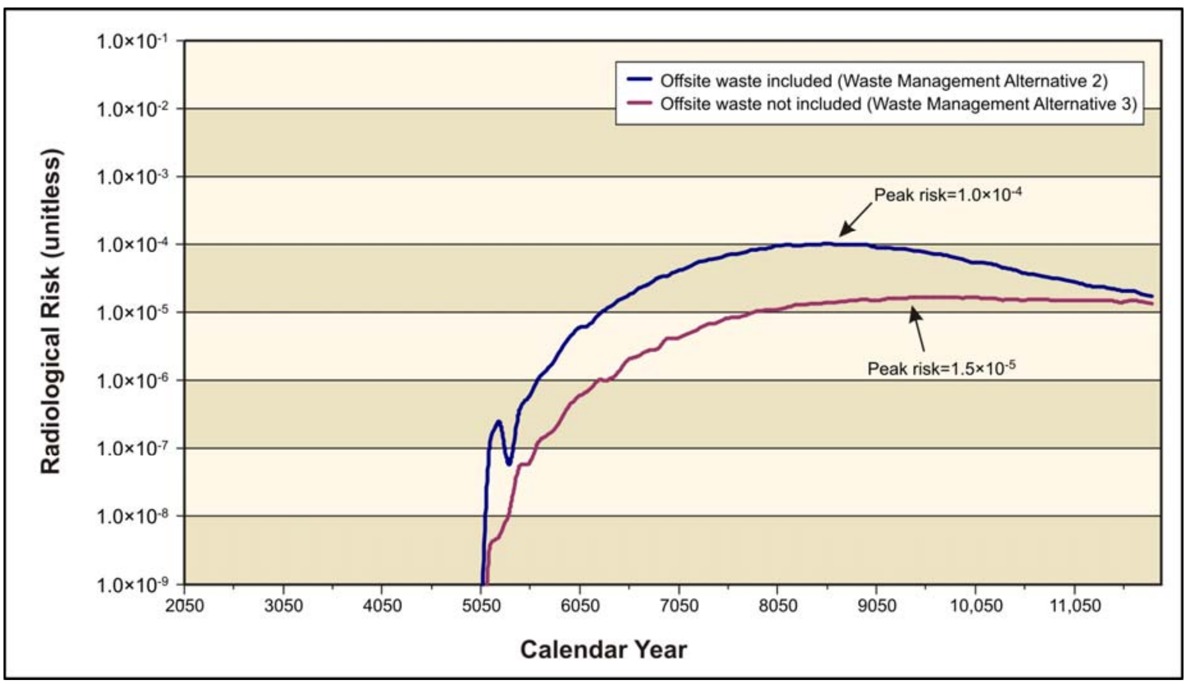


Figure S–21. Tank Closure Alternative 2B Lifetime Radiological Risk for the Drinking-Water Well User at the 200-East Area Integrated Disposal Facility Barrier

Table S–9. Maximum Concentrations of Technetium-99 and Iodine-129 in the Peak Year at the IDF-East Barrier

Contaminant	Waste Management Alternative 2	Waste Management Alternative 3	Benchmark Concentration
Radionuclide in picocuries per liter			
Technetium-99	1910	471	900
	(9005)	(8991)	
Iodine-129	18	1.4	1
	(8196)	(11,243)	

Note: Corresponding calendar years are shown in parentheses.
Key: IDF-East=200-East Area Integrated Disposal Facility.

Disposal of Tank Closure Waste in the RPPDF. Waste Management Alternatives 2 and 3 would include construction and operation of the RPPDF for the disposal of lightly contaminated equipment and soils from closure activities. As shown in Figure S–22, the RPPDF is a secondary contributor to human health impacts (radiological risk to the drinking-water well user) at the Core Zone Boundary throughout the period of analysis; the estimated radiological risks are less than 1×10^{-4}. The figure shows the higher lifetime radiological risk (approaching 1×10^{-4}) under Tank Closure Alternative 6B, Base Case, which is due to the disposal of large amounts of vadose zone sediments excavated from all SST farms, compared with the estimates under Tank Closure Alternative 4, which are due to disposal of vadose zone sediments from only two SST farms (BX and SX).

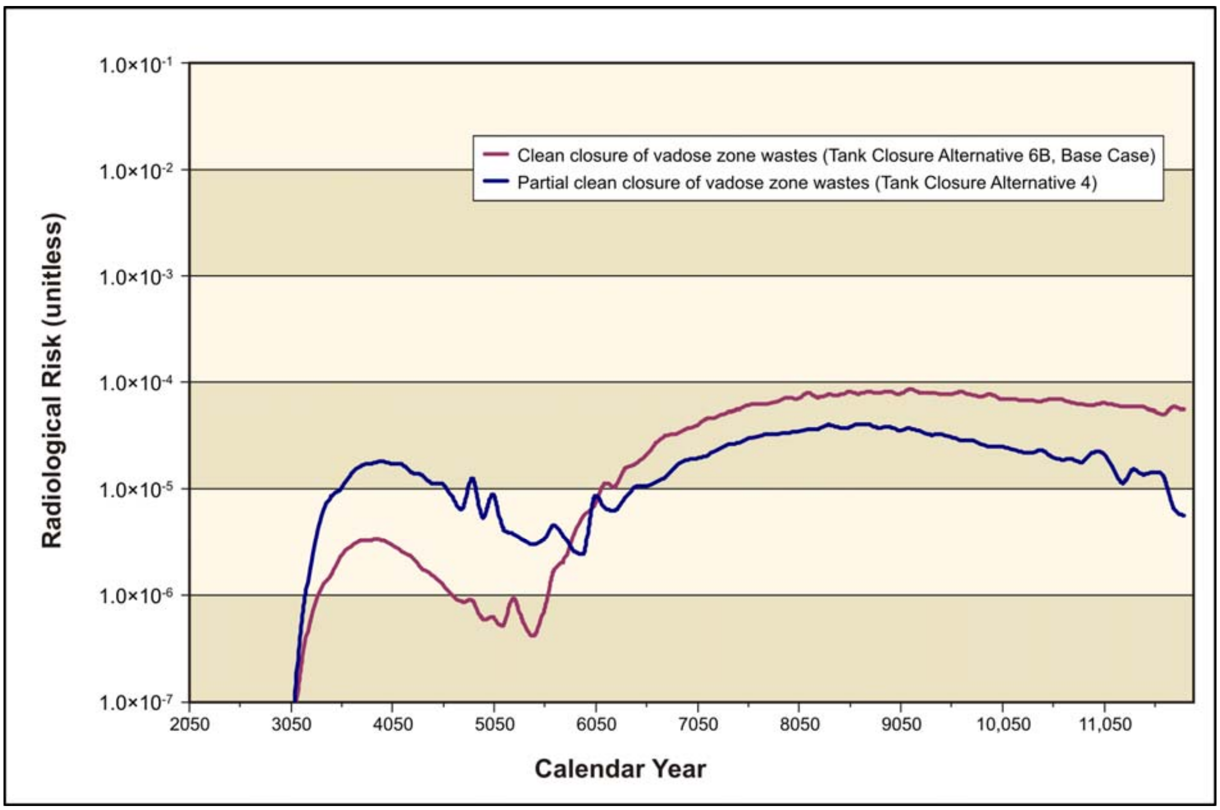


Figure S–22. Lifetime Radiological Risk for the Drinking-Water Well User at the Core Zone Boundary from River Protection Project Disposal Facility Releases

S.5.4.4 Cumulative Impacts

The CEQ NEPA regulations (40 CFR 1500–1508) define cumulative impacts as impacts on the environment that result from the proposed actions when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions (40 CFR 1508.7). Thus, the cumulative impacts of an action can be viewed as the total effects on a resource (e.g., land, air, water, soil), ecosystem, or human community of that action and all other activities affecting that resource no matter what entity (Federal, non-Federal, or private) is taking the action (EPA 1999). This *TC & WM EIS* considers three categories of past, present, and reasonably foreseeable future actions: (1) DOE actions at Hanford; (2) non-DOE actions at Hanford; and (3) other actions in the ROI. A total of 51 present, or reasonable foreseeable future actions, or sets of actions, were evaluated for their contributions to cumulative impacts.

Cumulative impacts at INL were considered and found to be insignificant. There would be few actions that could substantially contribute to cumulative impacts at INL because (1) there would be no marked increase in daily effluent emissions from, or waste generation by, the facilities; (2) sodium hydroxide, produced at INL's SPF, would be returned to Hanford for use in processing tank waste; (3) hazardous and radioactive wastes would not be disposed of at INL; and (4) impacts of the activities would be small. The transportation of materials and waste to and from INL is, however, included in the cumulative impacts analysis.

Cumulative impacts are estimated by summing three major components: (1) baseline impacts; (2) impacts of each alternative combination from this *TC & WM EIS*; and (3) impacts of reasonably foreseeable future actions. Information on baseline impacts was taken largely from the description of the Hanford affected environment in this *TC & WM EIS*. The impacts of each alternative combination are from the environmental consequences sections of this *TC & WM EIS*. Information on the impacts of reasonably foreseeable future DOE and non-DOE actions was obtained from various sources, including other NEPA documents, RCRA and CERCLA reports, annual environmental reports, planning documents, databases, and interviews with state and local officials.

For purposes of cumulative impacts analysis, three combinations of alternatives were chosen to represent key points within the range of actions and associated overall impacts that could result from full implementation of the three sets of proposed actions (see text box in Section S.5.1 for a description of the alternative combinations). Alternative Combination 1 represents the potential impacts resulting from minimal DOE action, Alternative Combination 2 is a midrange case representative of DOE's Preferred Alternative(s) (see Section S.7), and Alternative Combination 3 represents a combination that generally results in maximum potential short-term impacts but the least long-term impacts. Selection of these three alternative combinations for cumulative impacts analysis in this EIS is done only to establish overall cumulative impact reference cases for stakeholders and decisionmakers, and does not preclude the selection and implementation of different combinations of the various alternatives in support of final agency decisions.

Because of the comprehensive nature of this *TC & WM EIS*, cumulative impacts were evaluated for all resource areas except for the impacts of accidents on public and occupational health and safety. As analyzed in this *TC & WM EIS*, alternative combinations would contribute little to short-term cumulative impacts on the following resource areas: land use; infrastructure (e.g., water use); water resources; ecological resources; cultural and paleontological resources (i.e., prehistoric, historic, and paleontological resources); socioeconomic resources; public and occupational health and safety – population dose; public and occupational health and safety – transportation; waste management; and industrial safety. They would also contribute little to long-term cumulative impacts on environmental justice. Cumulative impacts on the remaining resources areas are described below.

Generally, short-term cumulative impacts are the highest when Alternative Combination 3 is included and are the lowest when Alternative Combination 1 is included. This is because Alternative Combination 3 generally uses the most resources and produces the most effluents and wastes, and Alternative Combination 1 the least. By contrast, long-term cumulative groundwater related impacts are generally highest with Alternative Combination 1 and lowest with Alternative Combination 3. This is largely because Alternative Combination 1 would leave the most waste and contaminants in the ground and Alternative Combination 3 the least. Although the long-term cumulative groundwater related impacts are highest with Alternative Combination 1 and lowest with Alternative Combination 3, cumulative groundwater-related impacts are dominated by the impacts of past releases.

S.5.4.4.1 Short-Term Cumulative Impacts

The short-term cumulative impacts were assumed to occur during the active project phase for each of the three *TC & WM EIS* alternative combinations and were assessed for a period of approximately 200 years.

Visual Resources. Activities associated with Alternative Combination 1 would contribute the least to cumulative visual impacts and Alternative Combination 3 the most. In most cases, activities at Hanford would not result in a change in the U.S. Bureau of Land Management visual contrast rating, as projects would be located in or adjacent to areas already developed. However, the rating for Borrow Area C would change from Class II to Class III under Alternative Combination 1 and to Class IV under Alternative Combinations 2 and 3. In the latter case, mining would dominate an area that had previously undergone minimal development. Many activities at Hanford would not be visible from public viewpoints (e.g., nearby higher elevations, highways, the Columbia River) and, thus, would contribute little to overall cumulative impacts on visual resources.

Infrastructure (Electricity Use). The capacity of the Hanford electrical transmission system (1.74 million megawatt-hours per year) (Uecker 2007) would not be exceeded on a cumulative basis. Peak cumulative electrical demands would range from about 10 percent of capacity under Alternative Combination 1 to 80 percent under Alternative Combination 3. According to the analysis performed, up to 93 percent of the cumulative effect on electric power capacity would be attributable to *TC & WM EIS* activities alone.

Noise and Vibration. Cumulative noise impacts would result primarily from increased vehicle traffic on access roads to Hanford. The cumulative traffic in the region is expected to result in some increase in traffic noise. Traffic associated with Alternative Combination 1 would contribute the least to cumulative sound levels and Alternative Combination 3 the most. Because of the distance to the site boundary, little or no change is expected in overall noise levels off site due to construction, operations, and decommissioning activities at Hanford.

It is expected that vibrations from heavy vehicles, large construction equipment, and blasting during building, road construction, and mining could have an impact on the Laser Interferometer Gravitational-Wave Observatory. Although DOE would coordinate vibration-producing activities with the operators of the facility, cumulative impacts of these activities are expected to result in some interference with facility operation.

Air Quality. Cumulative concentrations of carbon monoxide, nitrogen oxides, and sulfur oxides could be up to 495, 112, and 74 percent of applicable standards, respectively. Cumulative concentrations of particulate matter (PM_{10}) could be up to 155 times the applicable standard. The cumulative carbon monoxide concentration under Alternative Combinations 2 and 3 could exceed the 10,000-microgram-per-cubic-meter 8-hour standard. The cumulative nitrogen oxides concentration under Alternative Combination 3 could exceed the 100-microgram-per-cubic-meter annual standard. Cumulative PM_{10} concentrations under the all *TC & WM EIS* alternative combinations could exceed the

150-microgram-per-cubic-meter 24-hour standard. The peak cumulative concentrations of carbon monoxide and nitrogen oxides under the *TC & WM EIS* alternatives would result primarily from fuel-burning activities. The peak cumulative concentration of PM_{10} under the *TC & WM EIS* alternatives would result primarily from construction and earthmoving activities.

Geology and Soils. Projected cumulative demands for geologic and soil resources would range from about 98 percent of capacity under Alternative Combination 1 to 131 percent under Alternative Combination 3. At 56.9 million cubic meters (74.4 million cubic yards), the projected cumulative demands for other DOE and non-DOE activities would almost exceed the 57.9 million cubic meters (75.7 million cubic yards) of available geologic and soil reserves in Borrow Area C and gravel pit No. 30 at Hanford (DOE 1999b:D-4; SAIC 2006), even without the additional contribution under the *TC & WM EIS* alternative combinations.

Although the projected volumes for geologic and soil resources are believed to be conservative, the analysis indicates that completion of all contemplated future actions could require use and development of geologic and soil resources beyond Borrow Area C and gravel pit No. 30. Geologic and soil resources, including relatively large volumes of gravel, sand, and silt, are available from the suprabasalt sediments and associated soils across Hanford and elsewhere in the region. Rock in the form of basalt is also plentiful. Alternatively, any shortfall could be fully or partially provided from offsite commercial sources, but would result in additional small transportation impacts due to increased truck transportation to and from Hanford, as well as additional costs for obtaining these materials from commercial sources.

Cultural and Paleontological Resources (American Indian Interests). Cumulative impacts that include Alternative Combination 1 would be the least disruptive and those that included Alternative Combination 3 the greatest. This is because activities under Alternative Combination 3 would disturb the greatest land area and alter the existing viewshed to the greatest degree. Some activities at Hanford and offsite activities would be visible from Rattlesnake Mountain, Gable Mountain, or Gable Butte, areas of noted cultural and religious significance to American Indians. Onsite DOE activities that could be visible include the excavation and use of geologic materials from borrows pits, the transport of materials on the borrow site haul road from State Route 240 to Borrow Area C, and the construction and operation of the Environmental Restoration Disposal Facility.

Many of the non-DOE activities considered in the cumulative impacts analysis are of limited size, in or near presently developed areas, or at a distance from Hanford. These activities would have little to no effect on the viewshed. Some offsite activities such as wind turbines, the proposed Black Rock Reservoir, and the Red Mountain American Viticulture Area might be visible from Rattlesnake Mountain.

Public and Occupational Health and Safety—Normal Operations. The worker population dose of 320 person-rem under Alternative Combination 1 would represent a negligible contribution to the total cumulative dose of 99,000 person-rem received by workers since the beginning of Hanford operations in 1944. Alternative Combination 2 and 3 doses of 14,000 and 89,000 person-rem, respectively, would represent 12 and 47 percent of the cumulative doses of 113,000 and 188,000 person-rem, respectively. The cumulative worker population dose would occur to several generations of workers and would not impact the same worker population.

> **Person-rem**
> A unit of collective radiation dose applied to populations or groups of individuals; that is, a unit for expressing the dose when summed across all persons in a specified population or group.

The cumulative dose to the offsite maximally exposed individual of 2 to 3 millirem per year would be below the 10-millirem-per-year limit for offsite doses (40 CFR 61, Subpart H; WAC 173-480-040). This conservatively assumes that the doses to the maximally exposed individual for each action are additive, despite the fact that the maximally exposed individual location for most actions is different.

For comparison, the background radiation dose a person would receive is estimated at 365 millirem per year (Poston et al. 2007:10.146).

S.5.4.4.2 Long-Term Cumulative Impacts

Long-term cumulative impacts occur following the project phase for each alternative. For this *TC & WM EIS*, long-term cumulative impacts were assessed out to approximately 10,000 years in the future.

Groundwater Quality. The concentrations for the selected parameters presented in Table S–10 show that the non-*TC & WM EIS* actions are responsible for the bulk of the peak groundwater concentrations. Only for iodine-129 and technetium-99 are the maximum cumulative groundwater concentrations appreciably higher (i.e., approximately twice as high) after adding in the contributions from the *TC & WM EIS* alternative combinations. For cumulative groundwater concentrations including Alternative Combination 1, tank farm residuals, past discharges to cribs and trenches (ditches), and non-*TC & WM EIS* sources in the Plutonium-Uranium Extraction area are the dominant contributors to impacts. For cumulative groundwater concentrations including Alternative Combinations 2 and 3, past discharges to cribs and trenches (ditches), non-*TC & WM EIS* sources in the Plutonium-Uranium Extraction area, and waste management sources are the dominant contributors to impacts.

Table S–10. Groundwater Quality – Maximum Concentration of Selected Contaminants at Columbia River Nearshore (peak year in parentheses)[a, b]

Resource Area	Total of Non-*TC & WM EIS* Actions	Cumulative Total		
		With Alternative Combination 1	With Alternative Combination 2	With Alternative Combination 3
Hydrogen-3 (tritium)	4,190,000 (1986)	4,190,000 (1986)	4,190,000 (1986)	4,190,000 (1986)
Technetium-99	2,830 (1999)	5,360 (4032)	2,870 (1999)	2,870 (1999)
Iodine-129	9 (4540)	18 (4411)	9 (4540)	9 (4540)
Uranium isotopes	22,400 (1973)	22,400 (1973)	22,400 (1973)	22,400 (1973)
Chromium	16,100 (1978)	16,100 (1978)	16,100 (1978)	16,100 (1978)
Nitrate	502,000 (1973)	505,000 (1973)	505,000 (1973)	505,000 (1973)
Total uranium	15,400 (1964)	15,400 (1964)	15,400 (1964)	15,400 (1964)

a Radionuclides in picocuries per liter; chemicals in micrograms per liter.

b The peak cumulative concentration for some constituents occurs in the past. The relationship of past to future cumulative constituent concentrations is presented in the time-versus-concentration plots in Chapter 6 of this *TC & WM EIS*.

Key: *TC & WM EIS*=*Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*.

Human Health. The bulk of the cumulative human health impacts would result from releases of contaminants attributable to past leaks and releases independent of the alternatives evaluated in this *TC & WM EIS*. The alternative combinations generally add little to the impacts produced by past leaks and releases from non-*TC & WM EIS* sources.

Ecological Risk. The predicted cumulative concentrations of mercury in onsite soil, mercury in surface water, and benzene in surface water could potentially result in adverse impacts on ecological receptors. For mercury in soil, most of the elevated concentration is attributable to air emissions associated with *TC & WM EIS* Alternative Combinations 2 and 3. Conversely, the majority of the elevated concentrations for mercury and benzene in surface water are from past leaks and releases. In general, potential offsite sources of air emissions are not expected to contribute significantly to the cumulative ecological risk at Hanford.

> **Hazard Quotient**
> The value used as an assessment of non-cancer-associated toxic effects of chemicals (e.g., kidney or liver dysfunction).

Predicted impacts of groundwater releases not associated with the *TC & WM EIS* alternatives (e.g., past leaks) are much greater than those from releases associated with the *TC & WM EIS* alternatives. For chromium, for example, predicted concentrations resulting from groundwater releases not associated with the *TC & WM EIS* alternatives are approximately 10 times the estimated concentrations associated with the *TC & WM EIS* alternatives. Chromium in aquatic biota, including salmonids, is the only constituent of potential concern (COPC) with a Hazard Quotient exceeding 1 for the *TC & WM EIS* alternative combinations. Hazard Quotients less than 1 indicate no risk to the receptor.

S.5.4.4.3 Regional and Global Cumulative Impacts

Ozone Depletion. The use of ozone depleting compounds has been phased out, and they are no longer routinely used. Any release of ozone-depleting compounds, as might occur during the demolition of older air conditioning systems, would be incidental to the conduct of *TC & WM EIS* activities. In any case, emissions of ozone-depleting compounds would be very small and would represent a negligible contribution to the destruction of the Earth's protective ozone layer.

Global Climate Change. The "natural greenhouse effect" is the process by which part of terrestrial radiation is absorbed by gases in the atmosphere, warming the Earth's surface and atmosphere. This greenhouse effect and the Earth's radiation balance are affected largely by water vapor, carbon dioxide, and trace gases, which absorb infrared radiation and are referred to as greenhouse gases. Other greenhouse gases include nitrous oxide, halocarbons, and methane.

The *TC & WM EIS* alternatives could produce 2.75 metric tons (under FFTF Decommissioning Alternative 1 over a period of 100 years) to 0.246 million metric tons (under Tank Closure Alternative 6A, Option Case, over a period of 257 years) of carbon dioxide per year. Based on Hanford fuel use in 2006 (see Chapter 3, Section 3.2), baseline carbon dioxide emissions are 14,200 metric tons per year. Based on fuel consumption averages for INL, baseline carbon dioxide emissions are 35,200 metric tons per year. The emissions under the alternatives would add to global annual emissions of carbon dioxide, which are estimated to be 26.4 billion metric tons from fossil fuel use worldwide (IPCC 2007:3). The emission estimates for the *TC & WM EIS* alternatives account for facility specific fuel-burning and process sources from construction and operations activity and mobile source emissions from material and waste shipments. Emissions from employee vehicles and indirect emissions from electricity use were not estimated. Table S–11 summarizes the estimated annual average carbon dioxide emissions by *TC & WM EIS* alternative.

Table S–11. Estimated Annual Average Carbon Dioxide Emissions by Alternative

Alternative	Emissions (metric tons per year)
Tank Closure (TC)	
TC Alternative 1	1.07×10^4
TC Alternative 2A	7.03×10^4
TC Alternative 2B	7.59×10^4
TC Alternative 3A	3.53×10^4
TC Alternative 3B	3.6×10^4
TC Alternative 3C	5.39×10^4
TC Alternative 4	3.92×10^4
TC Alternative 5	8.29×10^4

Table S–11. Estimated Annual Average Carbon Dioxide Emissions by Alternative *(continued)*

Alternative	Emissions (metric tons per year)
Tank Closure *(continued)*	
TC Alternative 6A, Base Case	2.39×10^5
TC Alternative 6A, Option Case	2.46×10^5
TC Alternative 6B, Base Case	5.81×10^4
TC Alternative 6B, Option Case	6.85×10^4
TC Alternative 6C	7.61×10^4
FFTF Decommissioning	
FFTF Decommissioning Alternative 1	2.75
FFTF Decommissioning Alternative 2[a]	1.98×10^3
FFTF Decommissioning Alternative 3[a]	1.54×10^2
Waste Management (WM)	
WM Alternative 1	1.23×10^3
WM Alternative 2	4.1×10^4
WM Alternative 2, Disposal Group 1	4.11×10^3
WM Alternative 2, Disposal Group 2	2.02×10^4
WM Alternative 2, Disposal Group 3	2.33×10^4
WM Alternative 3	4.1×10^4
WM Alternative 3, Disposal Group 1	5.03×10^3
WM Alternative 3, Disposal Group 2	2.11×10^4
WM Alternative 3, Disposal Group 3	2.38×10^4

a Including emissions for options at Idaho National Laboratory.
Key: FFTF=Fast Flux Test Facility.

S.5.5 Mitigation

DOE has identified potential mitigation measures that would prevent or reduce potential environmental impacts from implementation of the *TC & WM EIS* alternatives. As specified in CEQ NEPA regulations (40 CFR 1508.20), mitigation includes the following:

- Avoiding the impact altogether by not taking a certain action or parts of an action
- Minimizing impacts by limiting the degree or magnitude of the action and its implementation
- Rectifying the impact by repairing, rehabilitating, or restoring the affected environment
- Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action
- Compensating for the impact by replacing or providing substitute resources or environments

All of the *TC & WM EIS* alternatives—i.e., the alternatives for tank closure, FFTF decommissioning, and waste management, including the No Action Alternatives—have the potential to impact one or more resource areas over the timeframes analyzed in this EIS. Various measures could be implemented across all alternatives, regardless of impact severity, to mitigate environmental impacts to the maximum extent practical.

S.5.5.1 Mitigation Measures Incorporated in the Alternatives

DOE has incorporated a number of design features, or strategic elements, into the development of the action alternatives to determine what reduction of resource area impacts might be realized. The following are examples of such design features analyzed in this *TC & WM EIS.*

Separations Technology. Several WTP pretreatment steps considered for the alternatives would enable the separation of tank waste in preparation for appropriate treatment and disposal. Liquid-solid separations, cesium removal, and strontium and TRU waste separations are examples of pretreatment technologies.

Sulfate and/or Technetium Removal. Additional pretreatment technologies considered for some alternatives may increase waste loading in the WTP, thereby reducing the volume of primary waste forms, or may enhance the long-term performance of waste forms in a landfill.

Engineered Barriers. The emplacement of engineered barriers over permanent disposal facilities and in-place closure of tank farms, cribs and trenches (ditches), and other facilities are analyzed to determine potential long-term benefits. Furthermore, the differences between a RCRA Subtitle C barrier and a more-robust Hanford barrier design are considered for certain alternatives.

Tank Waste Retrieval. The potential benefits of various levels of tank waste retrieval—i.e., retrieval conducive to the achievement of 10, 1, and 0.1 percent residual waste in the SSTs—are analyzed. Consistent with the various levels of tank waste retrieval, several different retrieval technologies are considered, including modified sluicing, mobile retrieval systems, vacuum-based retrieval, and chemical washing.

Supplemental Tank Waste Treatment. For some alternatives, the effectiveness of supplemental treatment technologies in expediting the treatment of tank waste is assessed. Configurations include the addition of WTP LAW melters or the construction and operation of bulk vitrification, cast stone, and/or steam reforming treatment facilities.

Potential Mitigation Measures That Could Be Pursued

Research/select tank retrieval technologies that avoid or minimize leakage.

Use existing buildings, right-of-ways, and infrastructure or construct new facilities on previously disturbed land.

Adhere to standard best management practices for soil erosion and sediment control during construction to minimize wind and water erosion.

Implement spill prevention and control and stormwater pollution prevention plans.

Continue to implement the as-low-as-is-reasonably-achievable principle during construction and operations to reduce radiological exposure of workers.

Continue safety training to help protect workers and prepare for possible emergencies and accidents.

Continue to perform cultural and biological surveys prior to and during construction.

Incorporate high-efficiency motors, pumps, lights, and other energy conservation measures into the design of new facilities.

Sequence facility operations to minimize peak use of utilities.

Implement ambient air monitoring for construction zones to monitor effectiveness of engineering controls.

Excavate soil beneath domed containment structures to ensure that contaminated fugitive dust is not released to the atmosphere.

Provide programs for employees that include flexible hours or staggered work shifts for workers to reduce peak traffic volumes.

Incorporate water conservation practices into routine operations.

Expedite restoration of land upon completion of its use.

Continue implementing the U.S. Department of Energy's pollution prevention and waste minimization program.

Clean Closure. Some alternatives are analyzed for the utility of clean closure of the SST farms, which includes complete exhumation of the SSTs and removal of underlying impacted soils. An option for clean closure of the B and T cribs and trenches (ditches) is also analyzed.

Tank Waste Treatment and Disposal. Some alternatives analyze the reduction in onsite long-term environmental impacts that may be achieved by treating and/or managing all tank waste as HLW, requiring onsite storage in aboveground HLW storage facilities; this option would not require disposal in an onsite IDF.

Certain resource areas may potentially result in impacts that may require aggressive mitigating measures. Operation of the WTP HLW and LAW melter, for example, would require a significant amount of electric power. Mitigating such a potential disruption in the electrical supply could require development of an energy consumption plan that would identify energy conservation practices, as well as explore options for providing supplemental electricity. Additional pretreatment or treatment technologies targeted on specific COPCs that have the potential to enhance waste performance and mitigate long-term environmental impacts may have to be considered.

When considering long-term impacts on groundwater resources, and subsequently any ecological and human receptors that may come into contact with groundwater through various exposure scenarios, the COPCs that account for almost 100 percent of the risk and hazard drivers include tritium, iodine-29, technetium-99, uranium-238, chromium, nitrate, and total uranium. Several of these constituents are projected to exceed benchmark standards at the Core Zone Boundary or Columbia River at various times. Iodine-129 and technetium-99 become dominant COPCs under the Waste Management action alternatives, when compared to other *TC & WM EIS* sources.

Offsite Waste Disposal. A potential contributing factor to the groundwater-related impacts of the Waste Management alternatives is the disposal of offsite waste from other DOE facilities. This *TC & WM EIS* shows that receipt of offsite waste streams that contain specific amounts of certain isotopes, specifically iodine-129 and technetium-99, could have an adverse impact on the environment. Mitigation measures that would increase the capture of iodine-129 and technetium-99 (e.g., use of robust, long-term-performing waste forms such as ILAW glass) could reduce potential long-term impacts. Another means of mitigating such impacts would be for DOE to limit or restrict disposal of waste streams containing iodine-129 or technetium-99 at Hanford.

S.5.5.2 Resource Management and Mitigation Plans

The 1996 *TWRS EIS* (DOE and Ecology 1996) described possible mitigation measures for the projected short- and long-term impacts of the proposed action alternatives for tank waste retrieval and treatment. DOE committed to these mitigation measures, as documented in the 1997 *TWRS EIS* ROD (62 FR 8693). These mitigation measures would continue to be implemented, as applicable, for the tank waste retrieval and treatment activities discussed in this EIS.

The 1999 *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement (Hanford Comprehensive Land-Use Plan EIS)* (DOE 1999b) identifies specific mitigation measures, policies, and management controls that direct land use at Hanford. DOE committed to these mitigation measures, as documented in the *Hanford Comprehensive Land-Use Plan EIS* ROD (64 FR 61615). These commitments were reaffirmed in the 2008 *Supplement Analysis, Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (DOE 2008b) and in the associated ROD (73 FR 55824). These mitigation measures would continue to be implemented, where applicable, for the tank waste retrieval and treatment activities discussed in this EIS. DOE has prepared or will potentially prepare a number of area and resource management plans. These plans are currently in draft form, have been completed, are being revised, or are waiting for available funds and program prioritization (DOE 2008b).

Following completion of this *TC & WM EIS* and its associated ROD, DOE would be required to prepare a mitigation action plan that addresses mitigation commitments expressed in the ROD (10 CFR 1021.331). This plan would be prepared before DOE would implement any *TC & WM EIS* alternative actions that are the subject of a mitigation commitment. Furthermore, because of the long timeframes required to conclude each alternative's life cycle, additional and more-effective mitigation measures made available in the future could reduce the environmental impacts associated with a particular proposed action. DOE will continue to identify and incorporate new technologies or practices that could reduce the impacts throughout the life cycle of a selected alternative.

S.6 COST OF THE ALTERNATIVES

The *Cost Report for "Tank Closure and Waste Management Environmental Impact Statement" Alternatives* was prepared to estimate the consolidated costs for continued operation of existing facilities; construction, operations, and deactivation of new or modified facilities; and associated activities to support the proposed actions (e.g., waste form disposal costs) (DOE 2009).[2] The costs were calculated using constant 2008 dollars. Because the alternatives cover a broad range of remediation and closure pathways, the estimates developed for the various alternatives span a wide range of potential costs.[3]

Each of the *TC & WM EIS* Tank Closure, FFTF Decommissioning, and Waste Management alternatives is affected by uncertainties that influence confidence in the cost estimate. The following are among the uncertainties common to most of the alternatives (DOE 2009).

- **Conservative estimates.** NEPA analysis provides an understanding of the potential environmental impacts associated with the proposed actions and the alternatives. Conservative estimates of labor and material requirements, technology performance, and other aspects of the alternatives were adopted. To the extent that conservatism is inherent in the components of the alternatives, the cost estimate for the alternatives reflects higher costs than the point estimates developed for allocation of budgets and other planning exercises.
- **Scope definition.** The level of definition associated with the alternatives and/or specific work elements contributes to uncertainty. Cost estimates based on limited definition (planning-level estimates or preconceptual data) are more uncertain than estimates based on detailed design information. Furthermore, there may be greater uncertainty regarding cost estimates for activities involving unspecified radiological and chemical inventories (e.g., resulting from soil remediation) because of the unknown impact the actual inventory may have on remediation costs.
- **Schedule and duration of activities.** With the exception of the No Action Alternatives, each alternative includes durations for completing the waste retrieval and treatment, storage, and disposal components of the RPP mission, as well as the deactivation and closure components, which vary among the alternatives. Cost estimates based on projecting current costs far into the future introduce other significant uncertainties. These uncertainties are driven by economic conditions and labor and material markets; changes in regulatory, technical, and safety requirements; political, scientific, and cultural conditions; and technological advances. All of the alternatives also assume a 100-year period of administrative controls/postclosure care following completion of decontamination and decommissioning and/or closure activities. Cost estimates for

[2] In an EIS, the costs estimated and presented for each alternative are different in nature than the cost estimates used to support the annual DOE budget process (such as the budget estimates for RPP contracts). Budgets to support DOE contracts typically address a near-term timeframe (generally within 5 years) because more-specific information regarding discrete work activities is generally available with a higher degree of certainty.

[3] Because of the wide range of potential costs, the higher Tank Closure alternative costs are presented in billions of 2008 dollars, whereas the lower FFTF Decommissioning and Waste Management alternative costs are presented in millions of 2008 dollars.

activities extending into the next century are inherently uncertain and should be interpreted as only rough estimates used to describe the total cost of an alternative and the relative cost differences among the alternatives.

- **Development and use of technologies.** With the exception of the No Action Alternatives, each alternative involves development and use of unique, specialty technologies to address complex problems. These technologies are in varying stages of completion, ranging from conceptual design to pilot demonstration to full-scale construction. Consequently, in estimating costs, technology performance (e.g., facility throughputs, waste loading, separations efficiencies) was assumed based upon the design criteria. Should these key performance assumptions be found invalid, impacts on the alternative cost, schedule, and scope would occur.
- **Dependence upon external interfaces.** Many of the alternatives depend on the ability of WIPP and onsite disposal facilities to accept and dispose of waste forms (e.g., CH- and RH-mixed TRU waste). Impacts on various alternatives' cost, schedule, and scope would occur if the adopted assumptions for each of the alternatives proved invalid.
- **Embedded costs.** Efforts were made to remove embedded escalation costs, management reserves, contingency fees, and other fees (e.g., WTP estimate-at-completion values from the source data when the contribution of these overall cost additions were clearly identified in source documentation).
- **Disposal costs.** Actual disposal costs are not currently available. Only estimated disposal costs based on the assumed waste types, quantities, and radiological content have been published. The estimated disposal costs will continue to vary as disposal facilities near completion, disposal quantities and types are modified, and cost bases are refined.

S.6.1 Tank Closure Alternatives

Cost estimates for each Tank Closure alternative are provided in Tables S–12 through S–14. Table S–12 provides the estimated potential costs of construction, operations, and deactivation for each of the primary components of the proposed actions (storage, retrieval, treatment, disposal, and closure); costs for final waste form disposal on or off site are excluded. Table S–13 provides the costs of final waste form disposal both on and off site by alternative. These costs represent the post-treatment disposal costs for ILAW, mixed TRU waste, MLLW, LLW, melters taken out of service, and HLW shielded boxes. Offsite disposal costs for IHLW are not included in the cost data. Alternatives that generate higher volumes of IHLW could ultimately have proportionally higher transportation and disposal costs. No credit was taken for cost-reducing actions such as waste volume reduction, alternative waste packaging, or use of alternative disposal sites.

Table S–12. Tank Closure Alternatives – Summary Cost Estimates,[a] Excluding Waste Form Disposal Costs (Billions of 2008 Dollars)

Work Element	Storage	Retrieval	Treatment	Disposal[b]	Closure	Total[c]
Alternative 1: No Action						
Construction	0.02	--	1.9	8.4	--	2.0
Operations	0.6	--	--	8.7	--	0.6
Deactivation	0.4	--	--	0.6	--	0.4
Total[c]	**1.0**	**--**	**1.9**	**17.7**	**--**	**3.0**
Alternative 2A: Existing WTP Vitrification; No Closure						
Construction	3.5	2.8	14.7	1.2	--	22.1
Operations	16.0	2.1	24.5	1.0	0.7	44.3
Deactivation	0.4	0.1	0.9	<0.01	--	1.4
Total[c]	**19.8**	**5.1**	**40.2**	**2.2**	**0.7**	**67.9**
Alternative 2B: Expanded WTP Vitrification; Landfill Closure						
Construction	1.5	2.6	8.7	1.5	2.3	16.6
Operations	7.1	1.5	11.3	0.7	0.5	21.1
Deactivation	--	0.1	0.6	<0.01	1.8	2.5
Total[c]	**8.6**	**4.2**	**20.6**	**2.1**	**4.6**	**40.1**
Alternative 3A: Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure						
Construction	1.5	2.6	8.1	1.6	2.3	16.2
Operations	6.4	1.4	11.0	0.7	0.5	19.9
Deactivation	--	0.1	0.5	<0.01	1.8	2.4
Total[c]	**7.9**	**4.2**	**19.6**	**2.3**	**4.6**	**38.5**
Alternative 3B: Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure						
Construction	1.5	2.6	7.9	1.6	2.3	15.9
Operations	6.4	1.4	11.2	0.7	0.5	20.1
Deactivation	--	0.1	0.5	<0.01	1.8	2.4
Total[c]	**7.9**	**4.2**	**19.6**	**2.3**	**4.6**	**38.4**
Alternative 3C: Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure						
Construction	1.5	2.6	9.5	1.6	2.3	17.5
Operations	6.4	1.4	11.0	0.7	0.5	19.9
Deactivation	--	0.1	0.5	<0.01	1.8	2.4
Total[c]	**7.9**	**4.2**	**21.0**	**2.3**	**4.6**	**39.8**
Alternative 4: Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure						
Construction	1.5	3.6	8.0	1.6	3.0	17.8
Operations	6.9	1.8	11.9	0.7	2.5	23.7
Deactivation	--	0.2	0.5	<0.01	1.4	2.1
Total[c]	**8.4**	**5.6**	**20.4**	**2.3**	**6.9**	**43.6**
Alternative 5: Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure						
Construction	1.8	2.1	8.4	1.3	2.2	15.9
Operations	5.4	1.1	8.7	0.7	0.3	16.3
Deactivation	--	0.1	0.6	<0.01	0.8	1.5
Total[c]	**7.3**	**3.4**	**17.7**	**1.9**	**3.4**	**33.7**

Table S–12. Tank Closure Alternatives – Summary Cost Estimates,[a] Excluding Waste Form Disposal Costs (Billions of 2008 Dollars) *(continued)*

Alternative 6A: All Vitrification/No Separations; Clean Closure						
Construction	8.1 *8.1*	5.1 *5.1*	21.8 *21.8*	69.9 *69.9*	2.6 *3.8*	107.5 *108.7*
Operations	28.7 *28.7*	3.4 *3.4*	48.6 *48.6*	36.2 *36.2*	10.9 *21.0*	127.8 *138.0*
Deactivation	--	0.3 *0.3*	1.4 *1.4*	<0.01 *<0.01*	3.2 *3.6*	4.9 *5.3*
Total[c]	**36.8** ***36.8***	**8.8** ***8.8***	**71.8** ***71.8***	**106.1** ***106.1***	**16.6** ***28.4***	**240.1** ***251.9***
Alternative 6B: All Vitrification with Separations; Clean Closure[d]						
Construction	1.5 *1.5*	3.6 *3.6*	8.8 *8.8*	3.2 *3.2*	2.6 *3.8*	19.7 *20.9*
Operations	7.1 *7.1*	1.8 *1.8*	12.3 *12.3*	0.7 *0.7*	9.3 *19.5*	31.1 *41.3*
Deactivation	--	0.2 *0.2*	0.6 *0.6*	<0.01 *<0.01*	3.2 *3.6*	4.0 *4.4*
Total[c]	**8.6** ***8.6***	**5.6** ***5.6***	**21.7** ***21.7***	**3.8** ***3.8***	**15.1** ***26.9***	**54.8** ***66.6***
Alternative 6C: All Vitrification with Separations; Landfill Closure						
Construction	1.5	2.6	8.7	2.3	2.3	17.3
Operations	7.1	1.5	11.2	0.7	0.5	20.9
Deactivation	--	0.1	0.6	<0.01	1.8	2.5
Total[c]	**8.6**	**4.2**	**20.4**	**2.9**	**4.6**	**40.7**

[a] Estimates are costs to the Hanford Site only.

[b] Includes post-treatment storage. Costs for disposal of the final waste forms (i.e., low-activity waste and transuranic waste) are presented separately in Table S–13.

[c] Total may not equal the sum of the contributions due to rounding.

[d] Values presented are for Base Case. Values for the Option Case (additional clean closure of six adjacent cribs and trenches [ditches]) are presented in italics.

Note: Costs associated with the 100-year administrative and/or institutional control periods were assigned in the following manner: Alternatives 1 and 2A under "Storage" and all other alternatives under "Closure."

Key: WTP=Waste Treatment Plant.

Source: DOE 2009:Table 4-1.

Table S–13. Tank Closure Alternatives – Costs for Final Waste Form Disposal (Billions of 2008 Dollars)

Tank Closure Alternative		Final Waste Form Disposal Costs
1	No Action	--
2A	Existing WTP Vitrification; No Closure	0.3
2B	Expanded WTP Vitrification; Landfill Closure	0.8
3A	Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure	1.3
3B	Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure	1.5
3C	Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure	1.5
4	Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure	2.0
5	Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure	0.8

Table S–13. Tank Closure Alternatives – Costs for Final Waste Form Disposal (Billions of 2008 Dollars) *(continued)*

Tank Closure Alternative		Final Waste Form Disposal Costs
6A	All Vitrification/No Separations; Clean Closure[a]	2.8 *9.2*
6B	All Vitrification with Separations; Clean Closure[a]	2.8 *9.1*
6C	All Vitrification with Separations; Landfill Closure	0.6

[a] Values presented are for the Base Case. Values for the Option Case (additional clean closure of six adjacent cribs and trenches [ditches]) are presented in italics.

Key: WTP=Waste Treatment Plant.

Source: DOE 2009:Table 5-1.

The highest relative costs would apply to Tank Closure alternatives with more restrictive scopes (i.e., 99.9 percent retrieval of SST waste and/or clean closure components [Alternatives 4, 6A, and 6B]); extended schedules (Alternatives 2A and 6A); and high waste-form disposal costs (Alternatives 6A and 6B). These higher costs would be driven by required construction of treatment systems; longer relative operating schedules for waste treatment and tank farm facilities; and clean closure of the SST farms (Alternatives 6A and 6B).

DOE would proceed with onsite disposal of some of the final waste forms (e.g., ILAW) only if their disposal complies with applicable laws. Table S–14 combines the cost data in Tables S–12 and S–13 to project a total cost for each Tank Closure alternative.

Table S–14. Tank Closure Alternatives – Total Cost Projections, Including Waste Disposal Costs (Billions of 2008 Dollars)[a]

	Tank Closure Alternative	Total Cost
1	No Action	3.0
2A	Existing WTP Vitrification; No Closure	68.2
2B	Expanded WTP Vitrification; Landfill Closure	40.9
3A	Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure	39.8
3B	Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure	39.9
3C	Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure	41.3
4	Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure	45.6
5	Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure	34.5
6A	All Vitrification/No Separations; Clean Closure[b]	242.9 *261.1*
6B	All Vitrification with Separations; Clean Closure[b]	57.6 *75.7*
6C	All Vitrification with Separations; Landfill Closure	41.3

[a] Offsite disposal costs for immobilized high-level radioactive waste are not included.

[b] Values presented are for the Base Case. Values for the Option Case (additional clean closure of six adjacent cribs and trenches [ditches]) are presented in italics.

Key: WTP=Waste Treatment Plant.

Source: DOE 2009:Tables S-12 and S-13.

S.6.2 FFTF Decommissioning Alternatives

Table S–15 provides summary cost estimates for each of the FFTF Decommissioning alternatives in terms of construction, operations, and deactivation. Table S–16 presents the separate projected waste disposal costs for each alternative, as well as the projected waste volumes produced under each alternative, as the disposal costs shown depend on the type and quantities of waste produced. Table S–17 combines the data in Tables S–15 and S–16 to provide the total estimated cost of each FFTF Decommissioning alternative.

Table S–15. FFTF Decommissioning Alternatives – Summary Cost Estimates, Excluding Waste Form Disposal Costs (Millions of 2008 Dollars)

Work Element	FFTF Decommissioning Alternatives				
	Alternative 1: No Action[a]	Alternative 2: Entombment		Alternative 3: Removal	
Facility Disposition					
Construction	--	3.9		2.5	
Operations	--	99.1		109.2	
Deactivation	492.5	0.7		0.3	
Subtotal[b, c]	**492.5**	**103.7**		**112.1**	
		Hanford Option[d]	**Idaho Option[e]**	**Hanford Option[d]**	**Idaho Option[e]**
Disposition of Bulk Sodium	--	**64.3**	**33.9**	**64.3**	**33.9**
Disposition of RH-SCs[a]	--	**121.1**	**121.2**	**121.1**	**121.2**

a The No Action Alternative includes 100 years of surveillance and maintenance activities.
b Costs for disposal of the final waste forms are presented separately in Table S–16.
c Subtotal may not equal the sum of the contributions due to rounding.
d Hanford Reuse Option for disposition of bulk sodium.
e Idaho Reuse Option for disposition of bulk sodium.
Key: FFTF=Fast Flux Test Facility; RH-SCs=remote-handled special components.
Source: DOE 2009:Table 4–3.

Table S–16. FFTF Decommissioning Alternatives – Waste Form Disposal Cost Estimates (Millions of 2008 Dollars)

Waste Category (cubic meters disposed of)	Alternative 1: No Action[a]	Alternative 2: Entombment[b]	Alternative 3: Removal[b]
Low-level radioactive waste	1,700	140	750
Mixed low-level radioactive waste	60	670	280
Hazardous waste	400	--	60
Nonhazardous waste	--	460	460
Disposal Cost (millions of 2008 dollars)	**2.1**	**0.9**	**1.1**

a Waste volumes are secondary solid waste only.
b Waste volumes are a summation of primary and secondary solid waste and are not expected to differ between the Hanford or Idaho options for disposition of remote-handled special components and bulk sodium.
Note: To convert cubic meters to cubic feet, multiply by 35.315.
Key: FFTF=Fast Flux Test Facility.
Source: DOE 2009:Table 5-5.

Table S–17. FFTF Decommissioning Alternatives – Total Cost Projections, Including Waste Disposal Costs (Millions of 2008 Dollars)

FFTF Decommissioning Alternatives		Total Cost
1	No Action	494.6
2	Entombment	
	Disposition of RH-SCs: Idaho Option Disposition of bulk sodium: Hanford Reuse Option	290.1
	Disposition of RH-SCs: Hanford Option Disposition of bulk sodium: Idaho Reuse Option	259.6
	Disposition of RH-SCs: Hanford Option Disposition of bulk sodium: Hanford Reuse Option	289.9
	Disposition of RH-SCs: Idaho Option Disposition of bulk sodium: Idaho Reuse Option	259.7
3	Removal	
	Disposition of RH-SCs: Idaho Option Disposition of bulk sodium: Hanford Reuse Option	298.7
	Disposition of RH-SCs: Hanford Option Disposition of bulk sodium: Idaho Reuse Option	268.1
	Disposition of RH-SCs: Hanford Option Disposition of bulk sodium: Hanford Reuse Option	298.5
	Disposition of RH-SCs: Idaho Option Disposition of bulk sodium: Idaho Reuse Option	268.3

Key: FFTF=Fast Flux Test Facility; RH-SCs=remote-handled special components.
Source: Tables S–15 and S–16.

S.6.3 Waste Management Alternatives

Table S–18 provides the summary cost estimates for each of the Waste Management alternatives in terms of construction, operations, and deactivation of treatment and storage activities, as well as the construction, operations, closure, and transportation activities that would occur in association with each disposal group. Table S–19 presents the separate costs for disposal of offsite-generated LLW and MLLW; onsite-generated non-CERCLA, nontank waste; and secondary waste from disposal operations. These disposal costs do not differentiate between on- and offsite waste generators and are presented only for Waste Management Alternatives 2 and 3 (Waste Management Alternative 1: No Action, would not receive any waste for disposal). Table S–20 combines the data in Tables S–18 and S–19 to provide the total estimated cost of each Waste Management alternative.

Table S–18. Waste Management Alternatives – Summary Cost Estimates, Excluding Waste Form Disposal Costs (Millions of 2008 Dollars)

Work Element	Alternative 1: No Action	Alternative 2: Disposal in IDF, 200-East Area Only			Alternative 3: Disposal in IDF, 200-East and 200-West Areas		
Treatment and Storage							
Construction	--	337.9			337.9		
Operations	17.5	2,016.0			2,016.0		
Deactivation	451.3	30.7			30.7		
Subtotal	468.8	2,384.5			2,384.5		
Disposal		**Group 1**	**Group 2**	**Group 3**	**Group 1**	**Group 2**	**Group 3**
Construction	--	118.9	459.3	459.3	118.5	459.7	459.7
Operations	--	649.9	5,268.9	9,465.3	647.0	5,242.0	9,399.8
Closure	--	946.2	1,128.9	1,128.9	1,386.4	1,570.3	1,570.3
Transportation[a]	--	521.5	521.5	521.5	521.5	521.5	521.5
Subtotal	--	2,236.5	7,378.5	11,575.0	2,673.4	7,793.6	11,951.3
Total[b]	468.8	4,621.1	9,763.1	13,959.5	5,057.9	10,178.1	14,335.9

a Costs associated with transportation of offsite low-level radioactive waste and mixed low-level radioactive waste to Hanford for disposal. The waste quantity, generation location, and transportation distance are the same for each disposal group.

b Total may not equal the sum of the contributions due to rounding. Costs for disposal of the final waste forms are presented separately in Table S–19.

Key: IDF=Integrated Disposal Facility.

Source: DOE 2009:Tables 4-2, 4-4, and 4-5.

Table S–19. Waste Management Alternatives – Waste Form Disposal Costs

Waste Category (cubic meters disposed of)	Alternative 1: No Action[a]	Alternative 2: Disposal in IDF, 200-East Area Only	Alternative 3: Disposal in IDF, 200-East and 200-West Areas
Offsite-generated LLW and MLLW	--	82,000	82,000
Onsite-generated non-CERCLA, nontank waste	--	5,300	5,300
Secondary waste	--	3,000	3,000
Disposal Cost (millions of 2008 dollars)	**--**	**96.1**	**96.1**

a No waste would be received for disposal under this alternative.

Key: CERCLA=Comprehensive Environmental Response, Compensation, and Liability Act; IDF=Integrated Disposal Facility; LLW=low-level radioactive waste; MLLW=mixed low-level radioactive waste.

Source: DOE 2009:Table 5-4.

Table S–20. Waste Management Alternatives – Total Cost Projections, Including Waste Disposal Costs (Millions of 2008 Dollars)

Waste Management Alternatives		Total Cost
1	No Action	468.8
2	Disposal in IDF, 200-East Area Only	
	Disposal Group 1	4,717.2
	Disposal Group 2	9,859.2
	Disposal Group 3	14,055.6
3	Disposal in IDF, 200-East and 200-West Areas	
	Disposal Group 1	5,154.0
	Disposal Group 2	10,274.2
	Disposal Group 3	14,432.0

Key: IDF=Integrated Disposal Facility.

Source: Tables S–18 and S–19**.**

S.7 PREFERRED ALTERNATIVES

CEQ regulations require an agency to identify its preferred alternative(s), if one or more exists, in a draft EIS (40 CFR 1502.14[e]). The preferred alternative is the alternative that the agency believes would fulfill its statutory mission while giving consideration to environmental, economic, technical, and other factors.

This *TC & WM EIS* considers three sets of actions: tank closure, FFTF decommissioning, and waste management. The range of reasonable approaches to these three sets of actions is covered by a total of 17 alternatives.

S.7.1 Tank Closure

Eleven alternatives for potential tank closure actions are evaluated in this draft EIS. These alternatives cover tank waste retrieval and treatment, as well as closure of the SSTs. DOE does not have specific preferred alternatives for retrieval or treatment of the tank waste, but has identified a range of preferred retrieval and treatment options. For retrieval, DOE prefers Tank Closure alternatives that would retrieve at least 99 percent of the tank waste. All Tank Closure alternatives would do this, with the exception of Alternative 1 (No Action) and Alternative 5. For treatment, DOE prefers Tank Closure Alternatives 2A, 2B, 3A, 3B, 3C, 4, and 5 because they would allow separation and segregation of the tank waste for management and disposition as LLW and HLW, according to the risks posed. In contrast, DOE does not prefer Tank Closure Alternatives 6A, 6B, or 6C because they would treat all tank waste as HLW. For closure of the SSTs, DOE prefers landfill closure, as provided under Tank Closure Alternatives 2B, 3A, 3B, 3C, 5, and 6C, for the reasons described in Section S.5.4.1. The Tank Closure alternatives that capture each of DOE's preferred retrieval, treatment, and closure options are Alternatives 2B, 3A, 3B, and 3C. For storage, DOE prefers Alternatives 2A, 2B, 3A, 3B, 3C, 4, and 5. These alternatives assume shipment of IHLW canisters for disposal off site.

As indicated in the Administration's fiscal year 2010 budget request, the Administration intends to terminate the Yucca Mountain program, which was the development of a geologic repository for the disposal of HLW and SNF, while developing nuclear waste disposal alternatives. Notwithstanding the decision to terminate the Yucca Mountain program, DOE remains committed to meeting its obligations to manage and ultimately dispose of HLW and SNF. The Administration intends to convene a blue ribbon commission to evaluate alternative approaches for meeting these obligations. The commission will provide the opportunity for a meaningful dialogue on how best to address this challenging issue and will provide recommendations that will form the basis for working with Congress to revise the statutory framework for managing and disposing of HLW and SNF.

Specific to this draft EIS, the inventory contained in the IHLW canisters is not included in the long-term groundwater analysis because it was assumed the canisters would be shipped off site. It was assumed in the EIS that the canisters would not be shipped immediately after the IHLW generation. Storage capacity was analyzed under the short-term impact analysis for onsite IHLW interim storage. The number of storage facilities needed to store the IHLW canisters on site is one more than the number of canister storage facilities analyzed under Tank Closure Alternative 2B. DOE expects the impacts to be similar.

S.7.2 FFTF Decommissioning

There are three FFTF Decommissioning alternatives from which the Preferred Alternative was identified: (1) No Action, (2) Entombment, and (3) Removal. DOE's Preferred Alternative for FFTF Decommissioning is Alternative 2, Entombment, which would remove all above-grade structures, including the reactor building. Below-grade structures, the reactor vessel, piping, and other components would remain in place and be filled with grout to immobilize the remaining radiological and hazardous constituents. Waste generated from these activities would be disposed of in an IDF, and a modified RCRA Subtitle C barrier would be constructed over the filled area. The RH-SCs would be processed at INL, but bulk sodium inventories would be processed at Hanford.

S.7.3 Waste Management

Three Waste Management alternatives were identified for the proposed actions: (1) Alternative 1, No Action, under which all onsite-generated LLW and MLLW would be treated and disposed of in the existing, lined 218-W-5 LLBG trenches and no offsite-generated waste would be accepted; (2) Alternative 2, which would continue treatment of onsite-generated LLW and MLLW in expanded, existing facilities and dispose of onsite-generated and previously treated offsite-generated LLW and MLLW in a single IDF (IDF-East); and (3) Alternative 3, which also would continue treatment of onsite-generated LLW and MLLW in expanded, existing facilities, but would dispose of onsite-generated and previously treated offsite-generated LLW and MLLW in two IDFs (IDF-East and IDF-West). DOE's preferred Waste Management Alternative is Alternative 2, disposal of onsite-generated LLW and MLLW waste streams in a single IDF (IDF-East). Disposal of single shell tank closure waste, that is not highly contaminated, such as rubble, soils, and ancillary equipment in the RPPDF are also included under this alternative. After completion of disposal activities, IDF-East and the RPPDF would be landfill-closed under an engineered modified RCRA Subtitle C barrier. The Preferred Alternative also includes limitations and exemptions on off-site waste importation at Hanford until at least the Waste Treatment Plant is operational, as those limitations and exemptions are defined in DOE's January 6, 2006 Settlement Agreement with the State (as amended on June 5, 2008) regarding Washington v. Bodman, No. 2:03-cv-05018-AAM.

S.8 GUIDE TO THE CONTENTS OF THIS *TC & WM EIS*

The organization and content of this *Draft TC & WM EIS* is provided in this section. A separate *Reader's Guide* has also been published that serves as an introduction and guide to the contents of this EIS. This guide includes roadmaps to the Tank Closure, FFTF Decommissioning, and Waste Management alternatives and summarizes the key features of each alternative. The guide also identifies where related discussions can be found in the various chapters and appendices of this *TC & WM EIS* and assists the reader to navigate through this EIS.

Summary—This separate volume summarizes the entire *TC & WM EIS*.

Chapter 1—Proposed Actions: Background, Purpose, and Need. Chapter 1 provides background information regarding preparation of this *TC & WM EIS*, including the purpose and need for agency action regarding final waste disposition, SST system closure, and FFTF decommissioning; the anticipated decisions to be made based on the EIS analyses; a summary of the issues identified during scoping; the scope of this EIS, including brief summaries of the alternatives; the relationship of the proposed actions to other actions or programs; the cooperating agencies; and the organization of this EIS.

Chapter 2—Proposed Actions and Alternatives. Chapter 2 describes the alternatives evaluated in this EIS. This chapter also includes a description of the processes and facilities that could be used to implement each of the alternatives and a summary of the short- and long-term environmental impacts and cost estimates of each alternative.

Chapter 3—Affected Environment. Chapter 3 describes the existing Hanford and INL environments that may be affected by the alternatives under consideration. In general, Hanford as a whole is described first, followed by the 200 and 400 Areas. The existing environments described include human, air, surface, and subsurface media that could be affected by activities related to tank waste retrieval, treatment, and disposal; SST system closure; FFTF decommissioning; and waste management.

Chapter 4—Short-Term Environmental Consequences. Chapter 4 discusses the short-term environmental impacts associated with the various EIS alternatives for tank closure, FFTF decommissioning, and waste management. Impacts produced by construction, operations, decontamination, and decommissioning are considered.

Chapter 5—Long-Term Environmental Consequences. Chapter 5 discusses the long-term environmental impacts associated with the various EIS alternatives for tank closure, FFTF decommissioning, and waste management, focusing on long-term environmental impacts on groundwater and human health, as well as ecological risks.

Chapter 6—Cumulative Impacts. Chapter 6 discusses the cumulative impacts associated with the various EIS alternatives.

Chapter 7—Environmental Consequences Discussion. Chapter 7 discusses possible measures to mitigate impacts identified in Chapters 4, 5, and 6; unavoidable adverse environmental impacts; the relationship between short-term use of the environment and long-term productivity; and any irreversible and irretrievable resource commitments.

Chapter 8—Potentially Applicable Laws, Regulations, and Other Requirements. Chapter 8 describes the environmental laws, regulations, permits, and consultations that are potentially applicable to the various activities related to tank waste retrieval, treatment, and disposal and SST system closure; FFTF decommissioning; and waste management associated with the alternatives. Federal laws and regulations; Executive orders; DOE directives, orders, and guidance; and other compliance actions related to protection of the environment also are described.

Chapter 9—Glossary. Chapter 9 contains definitions of important technical terms that may not be commonly used, including both discipline-specific and DOE- and Hanford-unique terms.

Chapter 10—List of Preparers. Chapter 10 identifies the DOE and contractor preparers of this EIS. Information is provided for each preparer in the following areas: (1) name, (2) affiliation, (3) education, (4) experience, and (5) EIS responsibility.

Chapter 11—Distribution List. Chapter 11 contains the external distribution list for this EIS, which includes Federal, state, and local elected and appointed officials and agencies; American Indian representatives; environmental and public interest groups; and organizations and individuals who requested/were sent a copy of this draft EIS.

Chapter 12—Index. Chapter 12 contains the index of key words and terms found in this EIS.

In addition, the following appendices are provided to support these chapters:

- **Appendix A** *Federal Register* and Other Public Notices
- **Appendix B** Contractor and Subcontractor National Environmental Policy Act Disclosure Statements
- **Appendix C** Cooperating Agency, Consultation, and Other Interaction Documentation
- **Appendix D** Waste Inventories
- **Appendix E** Descriptions of Facilities, Operations, and Technologies
- **Appendix F** Direct and Indirect Impacts: Assessment Methodology
- **Appendix G** Air Quality Analysis
- **Appendix H** Transportation
- **Appendix I** Workforce Estimates
- **Appendix J** Environmental Justice
- **Appendix K** Human Health Risk Analysis
- **Appendix L** Groundwater Flow Field Development
- **Appendix M** Release to Vadose Zone
- **Appendix N** Vadose Zone Flow and Transport
- **Appendix O** Groundwater Transport Analysis

- **Appendix P** Ecological Resources and Risk Analysis
- **Appendix Q** Human Health, Dose, and Risk Analysis
- **Appendix R** Cumulative Impacts: Assessment Methodology
- **Appendix S** Waste Inventories for Cumulative Impact Analyses
- **Appendix T** Supporting Information for the Short-Term Cumulative Impact Analyses
- **Appendix U** Supporting Information for the Long-Term Cumulative Impact Analyses
- **Appendix V** Black Rock Reservoir Sensitivity Analysis

S.9 GLOSSARY

accident – In the context of this environmental impact statement, a specific, identifiable, unexpected, unusual, and unintended event or sequence of events that results in undesirable consequences.

acid – A chemical compound with a pH value lower than 7.0.

activity – (1) A measure of the amount of radiation emitted from a radioactive material, expressed in either curies or becquerels. (See *becquerel* and *curie*.) (2) An action, operation, or effort.

additive – The property whereby the total effect of multiple agents is the sum of effects of the agents acting separately under the same conditions.

administrative control – Provisions related to organization and management, procedures, record-keeping, assessment, and reporting that are necessary to ensure safe operation of a facility.

affected environment – The existing biological, physical, social, and economic conditions of an area that are subject to direct and/or indirect changes as a result of a proposed human action.

air pollutant – Generally, an airborne substance that, in sufficiently high concentrations, could harm living things or cause damage to materials. From a regulatory perspective, air pollutants are substances for which emissions or atmospheric concentrations are regulated or for which maximum guideline levels have been established to enable assessment of their potential for harmful effects on human health and welfare.

air quality – The cleanliness of the air as measured by the levels of pollutants relative to the standards or guideline levels established to protect human health and welfare.

alternative – One of two or more actions, processes, or propositions from which a decisionmaker will determine the course to be followed. The National Environmental Policy Act of 1969 (NEPA), as amended, states that in preparing an environmental impact statement (EIS), an agency "shall ... study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources" (Title 42 of the *United States Code*, Section 4322(2)(E)). Council on Environmental Quality NEPA-implementing regulations indicate that the alternatives section in an EIS is "the heart of the environmental impact statement" (Title 40 of the *Code of Federal Regulations*, Section 1502.14) and include rules for presenting the alternatives, including no action, and their estimated impacts.

ambient – Surrounding.

ambient air – The atmosphere surrounding people, plants, and structures.

ambient air quality standards – As prescribed by regulations, the level of pollutants in the air that may not be exceeded during a specified time in a defined area. Air quality standards are used to provide a measure of the health-related and visual characteristics of the air.

ancillary equipment – Structures associated with tank operations, including miscellaneous underground storage tanks; the waste transfer system (diversion boxes, valve pits, and transfer piping); tank pits; tank risers; in-tank equipment; and miscellaneous facilities used in the treatment, transfer, or storage of tank waste.

anion – A negatively charged ion.

annulus – The space between the inner and outer shells of a double-shell tank.

aquatic – Living or growing in, on, or near water.

aquatic biota – The sum total of living organisms within any designated aquatic area.

aquifer – An underground geologic formation, group of formations, or part of a formation that is capable of yielding a significant amount of water to wells or springs.

Atomic Energy Act – A law enacted in 1946 and amended in 1954 that placed nuclear production and control of nuclear materials under the oversight of a civilian agency, originally the Atomic Energy Commission.

backfill – Excavated earth or other material transferred into an open trench, cavity, or other opening in the earth.

background radiation – Radiation from cosmic sources; naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material); and atmospheric fallout (e.g., from the testing of nuclear explosive devices).

barrier – Any material or structure that prevents or substantially delays movement of constituents toward the accessible environment, especially an engineered structure used to isolate contaminants from the environment in accordance with appropriate regulations.

basalt – The most common volcanic rock, dark gray to black in color, high in iron and magnesium, low in silica, and typically found in lava flows.

baseline – The existing environmental conditions against which the impacts of the proposed actions and their alternatives can be compared.

becquerel – A unit of radioactivity equal to one disintegration per second. Thirty-seven billion becquerels equal 1 curie.

benchmark – Dose or concentration known or accepted to be associated with a specific level of effect.

best management practices (BMPs) – Structural, nonstructural, and managerial techniques, other than techniques for effluent limitations, used to prevent or reduce pollution of surface water. They are the most effective and practical means to control pollutants that are compatible with the productive use of the resource to which they are applied. BMPs are used in both urban and agricultural areas. BMPs can include activity schedules; practice prohibitions; maintenance procedures; treatment requirements; operating procedures; and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

biota (biotic) – The plant and animal life of a region.

borrow – Excavated material that has been taken from one area to be used as raw material or fill at another location.

borrow area (pit, site) – An area designated as the excavation site for geologic resources such as rock/basalt, sand, gravel, or soil to be used elsewhere for fill.

bound – To use simplifying assumptions and analytical methods in an analysis of impacts or risks such that the result overestimates or describes an upper limit on (i.e., "bounds") potential impacts or risks.

bulk vitrification – A supplemental thermal treatment process that converts low-activity waste into a solid glass form by drying that waste, mixing it with soil, and applying electrical current to the mix within a large steel container.

burial ground – A place for burying low-level radioactive waste and mixed low-level radioactive waste so as to prevent the escape of hazardous chemicals radiation, and the dispersion thereof, into the environment.

byproduct material – Any radioactive material (except special nuclear material [SNM]) yielded in, or made radioactive by exposure to radiation during, the process of producing or utilizing SNM; also, the tailings or waste produced by the extraction or concentration of uranium or thorium from any ore that is processed primarily for its source material content.

Byproduct material is exempt from regulation under the Resource Conservation and Recovery Act (RCRA). However, the exemption applies only to the actual radionuclides dispersed or suspended in the waste substance. Any nonradioactive hazardous waste component of the waste is subject to regulation under RCRA.

cancer – The name given to a group of diseases characterized by uncontrolled cellular growth where the cells have invasive characteristics that enable the disease to transfer from one organ to another.

canister – A general term for a container, usually cylindrical, used in the handling, storage, transportation, or disposal of waste.

canyon – In the nuclear industry, a large, heavily shielded concrete building that contains a remotely operated nuclear materials processing facility.

capacity (electric) – An electric power plant's maximum power output.

carbonate – A salt or ester of carbonic acid.

carbon dioxide – A colorless, odorless gas that is a normal component of ambient air and a product of fossil fuel combustion, animal expiration, and the decay or combustion of animal or vegetable matter.

carbon monoxide – A colorless, odorless, poisonous gas produced by incomplete fossil fuel combustion.

carcinogen – A substance or agent that produces or incites cancerous growth.

cask – A heavily shielded container used to store or ship radioactive materials.

cast stone – A nonthermal waste stabilization process that may be performed at ambient temperatures and pressures and involves mixing the waste with grout formers (e.g., Portland cement, fly ash, and slag) and conditioners to produce a solid waste form.

cation – A positively charged ion.

Central Plateau – The elevated area in the center of the Hanford Site where the 200-East and 200-West Areas are located.

characterization – See *waste characterization.*

Clean Air Act – This act mandates and provides for enforcement of regulations to control air pollution from various sources.

clean closure – The premise of clean closure is that all hazardous waste has been removed from a given Resource Conservation and Recovery Act (RCRA)-regulated unit and any releases at or from the unit have been remediated so that further regulatory control under RCRA Subtitle C is not necessary to protect human health and the environment. Under State of Washington requirements (*Washington Administrative Code* 173-303-64) for closure of a tank system, the owner or operator must remove or decontaminate all waste residues, contaminated containment system components (e.g., liners), contaminated soils, and structures and equipment contaminated with waste and must manage them as dangerous waste as required.

cleanup – Refers to the full range of projects and activities undertaken to address environmental and legacy waste issues associated with the Hanford Site.

closure – Refers to the deactivation and stabilization of a waste treatment, storage, or disposal unit (such as a waste treatment tank, waste storage building, or landfill) or hazardous materials storage unit (such as an underground storage tank). For storage units, closure typically includes removal of all residues, contaminated system components, and contaminated soil. For radioactive and hazardous waste disposal units (i.e., where waste is left in place), closure typically includes site stabilization and emplacement of surface barriers. Specific requirements for the closure process are found in the regulations applicable to many types of waste management units and hazardous material storage facilities. For the State of Washington, hazardous waste disposal unit closure regulations are found at *Washington Administrative Code* 173-303-610.

Code of Federal Regulations **(CFR)** – All Federal regulations that are in effect are published in codified form in the CFR.

collective dose – The sum of the individual doses received in a given period of time by a specified population from exposure to a specified source of radiation. Collective dose is expressed in units of person-rem or person-sieverts.

community – *(biotic definition)* All plants and animals occupying a specific area under relatively similar conditions.

(environmental justice definition) A group of people or a site within a spatial scope exposed to risks that potentially threaten health, ecology, or land values or exposed to industry that stimulates unwanted noise, smell, industrial traffic, particulate matter, or other nonaesthetic impacts.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) – A Federal law (also known as Superfund) enacted in 1980 and reauthorized in 1986 (Title 42 of the *United States Code*, Section 9601 et seq.) that provides the legal authority for emergency response and cleanup of hazardous substances released into the environment and for the cleanup of inactive waste sites.

conformity – Conformity is defined in the Clean Air Act as the action's compliance with an implementation plan's purpose of eliminating or reducing the severity and number of violations of the National Ambient Air Quality Standards and achieving expeditious attainment of such standards. Such activities will not cause or contribute to any new violation of any standard in any area; increase the frequency or severity of any existing violation of any standard in any area; or delay timely attainment of any standard, any required interim emission reduction, or other milestones in any area.

contact-handled waste – Radioactive waste or waste packages whose external dose rate is low enough to permit contact-handling by humans during normal waste management activities (e.g., waste with a surface dose rate not exceeding 200 millirem per hour).

container – In regard to radioactive waste, the outside envelope in the waste package that provides the primary containment function of the waste package, which is designed to meet the containment requirements of Title 10 of the *Code of Federal Regulations*, Part 60.

contamination – The deposition of undesirable material in air, soils, water, or ecological resources or on the surfaces of structures, areas, objects, or personnel.

coolant – A substance, either gas or liquid, circulated through a nuclear reactor or processing plant to remove heat.

cooperating agency – "Any Federal agency (other than a lead agency) that has jurisdiction by law or special expertise with respect to any environmental impact involved in a proposal (or a reasonable alternative) for legislation or other major Federal action significantly affecting the quality of the human environment. A state or local agency of similar qualification or, when the effects are on a reservation, an Indian tribe, may, by agreement with the lead agency, become a cooperating agency" (Title 40 of the *Code of Federal Regulations*, Section 1508.5).

core zone – A portion of the Central Plateau within the Hanford Site, encompassing the 200-East and 200-West Areas, that lies within the Industrial-Exclusive land use designation established under the 1999 *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*.

Core Zone Boundary – The perimeter of the core zone that is used as a line of analysis for groundwater transport calculations.

crib – An underground structure designed to distribute liquid waste, usually through a perforated pipe, to the soil directly or to a connected tile field. Cribs use the filtration and ion exchange properties of the soil to contain radionuclides. A crib is operated only if radionuclide contamination observed in the groundwater beneath the crib is below a prescribed limit.

criteria pollutant – An air pollutant that is regulated by National Ambient Air Quality Standards. The U.S. Environmental Protection Agency must describe the characteristics and potential health and welfare effects that form the basis for setting or revising the standard for each regulated pollutant. Criteria pollutants include sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, lead, and two size classes of particulate matter: less than or equal to 2.5 and 10 micrometers (0.0001 and 0.0004 inches) in diameter. New pollutants may be added to or removed from the list of criteria pollutants as more information becomes available.

cultural resources – Archaeological sites, historical sites, architectural features, traditional use areas, and American Indian sacred sites.

cumulative impacts – Impacts on the environment that result from incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions, regardless of the agency or person undertaking such other actions. Cumulative impacts can result from individually minor, but collectively significant, actions that take place over a period of time (Title 40 of the *Code of Federal Regulations*, Section 1508.7).

curie – A unit of radioactivity equal to 37 billion disintegrations per second (i.e., 37 billion becquerels); also, a quantity of any radionuclide or mixture of radionuclides having 1 curie of radioactivity.

dangerous waste – Solid waste designated in *Washington Administrative Code* 173-303-070 through 173-303-100 as dangerous, extremely hazardous, or mixed waste.

deactivation – Placing a facility in a stable and known condition, including removal of hazardous and radioactive materials, to ensure adequate protection of workers, public health and safety, and the environment, thereby limiting the long-term cost of surveillance and maintenance. Actions include the removal of fuel, draining and/or de-energizing nonessential systems, removal of stored radioactive and hazardous materials, and related actions. Deactivation does not include all decontamination necessary for the dismantlement and demolition phase of decommissioning (e.g., removing contamination remaining in fixed structures and equipment after deactivation).

As applied to waste treatment, removal of the hazardous characteristics of a waste due to its ignitability, corrosivity, and/or reactivity.

decay (radioactive) – See *radioactive decay.*

decommissioning – The process of closing and securing a nuclear facility or nuclear material storage facility to provide adequate protection from radiation exposure and to isolate radioactive contamination from the human environment. It takes place after deactivation and includes surveillance, maintenance, decontamination, and/or dismantlement. These actions are taken at the end of the facility's life to retire it from service with adequate regard for the health and safety of workers and the public and protection of the environment. The ultimate goal of decommissioning is unrestricted release or restricted use of the site.

decontamination – The removal or reduction of residual chemical, biological, or radiological contaminants and hazardous materials by mechanical, chemical, or other techniques to achieve a stated objective or end condition.

dewatering – The removal of water. Saturated soils are "dewatered" to make construction of building foundations easier.

discharge – In surface-water hydrology, the amount of water issuing from a spring or in a stream that passes a specific point in a given period of time.

disposal – As generally used in this environmental impact statement, the placement of waste with no intent to retrieve. Statutory or regulatory definitions of disposal may differ.

disposal groups – Specific combinations of waste capacities allocated to the River Protection Project Disposal Facility and 200-East (or both 200-East and 200-West) Area Integrated Disposal Facility(ies) over varying operational timeframes, based on the different types and amounts of waste generated under the three sets of alternatives analyzed in this environmental impact statement.

disposition – The ultimate "fate" or end use of a surplus U.S. Department of Energy facility following transfer of the facility to the Office of the Assistant Secretary for Environmental Management.

DOE orders – Requirements internal to the U.S. Department of Energy that establish policy and procedures, including those for compliance with applicable laws.

dose – The accumulated radiation or hazardous substance delivered to the whole body or a specified tissue or organ within a specified time and originating from an external or internal source.

dose (chemical) – The amount of a substance administered to, taken up by, or assimilated by an organism. It is often expressed in terms of the amount of substance per unit mass of the organism, tissue, or organ of concern.

dose (radiological) – A generic term that means absorbed dose, effective dose equivalent, committed effective dose equivalent, or total effective dose equivalent, as defined elsewhere in this glossary.

dose equivalent – A measure of radiological dose that correlates with biological effect on a common scale for all types of ionizing radiation. Defined as a quantity equal to the absorbed dose in tissue multiplied by a quality factor (the biological effectiveness of a given type of radiation) and all other necessary modifying factors at the location of interest. The units of dose equivalent are the rem and the sievert.

dose rate – The radiation dose delivered per unit of time (e.g., rem per year).

double-shell tank – A large reinforced concrete underground container with two steel liners to provide containment and backup containment of liquid waste. The space between the liners has instruments that detect leaks from the inner liner.

ecology – A branch of science dealing with the interrelationships of living organisms with one another and with their nonliving environment.

ecosystem – A community of organisms and their physical environment that interact as an ecological unit.

efficacy – A measure of the probability and intensity of beneficial effects.

effluent – A waste stream flowing into the atmosphere, surface water, groundwater, or soil; frequently applied to waste discharged to surface water.

emission – A material discharged into the atmosphere from a source operation or activity.

emission standard – A requirement established by the state or the U.S. Environmental Protection Agency that limits the quantity, rate, or concentration of air pollutant emissions on a continuous basis, including any requirement relating to (1) operation or maintenance of a source to ensure continuous emission reduction and (2) any design, equipment, work practice, or operational standard.

endangered species – *Federal:* Species that are in danger of extinction throughout all or a significant portion of their ranges and that have been listed as endangered by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service following procedures outlined in the Endangered Species Act (Title 16 of the *United States Code*, Parts 1551 through 1599) and its implementing regulations (Title 50 of the *Code of Federal Regulations* [CFR], Part 424). The lists of endangered species can be found in 50 CFR, Section 17.11 (wildlife); 50 CFR, Section 17.12 (plants); and 50 CFR, Section 222.23(a) (marine organisms).

Washington State: Any wildlife species native to the state of Washington that is seriously threatened with extinction throughout all or a significant portion of its range within the state within the foreseeable future if factors contributing to its decline continue (*Washington Administrative Code* 232-12-297; Washington State Natural Heritage Program, established by the Natural Area Preserves Act [*Revised Code of Washington*, Chapter 79.70]).

entombment – A process whereby aboveground structures are decontaminated and dismantled, belowground structures are grouted and left in place, and an infiltration barrier is placed over the contaminated material.

environmental assessment (EA) – A concise public document that a Federal agency prepares under the National Environmental Policy Act (NEPA) to provide sufficient evidence and analysis to determine whether a proposed agency action would require preparation of an environmental impact statement (EIS) or a Finding of No Significant Impact. A Federal agency may also prepare an EA to aid its compliance with NEPA when no EIS is necessary or to facilitate its preparation of an EIS when one is necessary.

An EA must include brief discussions of the (1) need for the proposal, (2) alternatives, (3) environmental impacts of the proposed actions and alternatives, and (4) a list of agencies and persons consulted.

environmental impact statement (EIS) – The detailed written statement that is required by Section 102(2)(C) of the National Environmental Policy Act (NEPA) for a proposed major Federal action that could significantly affect the quality of the human environment. A U.S. Department of Energy (DOE) EIS is prepared in accordance with applicable requirements of the Council on Environmental Quality's NEPA regulations (Title 40 of the *Code of Federal Regulations* [CFR], Parts 1500–1508) and the DOE NEPA regulations found in 10 CFR, Part 1021. The statement includes, among other information, discussions of the environmental impacts of the proposed actions and the range of reasonable alternatives; the adverse environmental effects that cannot be avoided should the proposal be implemented; the relationship between short-term use of the environment and long-term productivity; and any irreversible and irretrievable commitments of resources.

environmental justice – The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, and socioeconomic groups, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, or commercial operations or the execution of Federal, state, local, or tribal programs or policies. Executive Order 12898 directs Federal agencies to make achieving environmental justice part of their missions by identifying and addressing disproportionately high and adverse effects of agency programs, policies, and activities on minority and low-income populations.

erosion – Removal of material by water, wind, or ice.

excavation – A cavity in the earth formed by cutting, digging, or scooping using heavy construction equipment.

exposure – The condition of being subject to the effects of, or acquiring a dose of, a potential stressor such as a hazardous chemical agent or ionizing radiation; also, the process by which an organism acquires a dose of a chemical such as mercury or a physical agent such as ionizing radiation. Exposure can be quantified as the amount of the agent available at various boundaries of the organism (e.g., skin, lungs, gut) and available for absorption.

Fast Flux Test Facility (FFTF) – A liquid-metal (sodium)-cooled and -moderated nuclear test reactor at the Hanford Site. It was fueled with a mixture of plutonium-uranium dioxide and had a 400-megawatt power level. It is presently being deactivated.

Finding of No Significant Impact (FONSI) – A Federal agency, having prepared an environmental assessment of an action, issues this public document that briefly presents the reasons the action has no potential to have a significant effect on the human environment and, thus, will not require preparation of an environmental impact statement.

fissile material – Although sometimes used as a synonym for fissionable material, this term has acquired a more restricted meaning, namely, any material fissionable by thermal (slow) neutrons. The three primary fissile materials are uranium-233, uranium-235, and plutonium-239.

fission – A nuclear transformation that is typically characterized by the splitting of a heavy atomic nucleus into at least two other nuclei, the emission of one or more neutrons, and the release of a relatively large amount of energy. Fission of heavy atomic nuclei can occur spontaneously or be induced by neutron bombardment.

fission products – Radioactive elements or compounds formed by the fission of heavy elements, plus the nuclides formed by the radioactive decay of those elements or compounds.

floodplain – The lowlands and relatively flat areas adjoining inland and coastal waters and the flood-prone areas of offshore islands. Floodplains include, at minimum, that area with at least a 1 percent chance of being inundated by a flood in any given year.

The *probable maximum flood* is the hypothetical flood considered to be the most severe reasonably possible flood, based on comprehensive hydrometeorological application of maximum precipitation and other hydrological factors favorable for maximum flood runoff (e.g., sequential storms and snowmelts). It is usually several times larger than the maximum recorded flood.

formation – In geology, the primary unit of formal stratigraphic mapping or description. Most formations possess certain distinctive features.

fuel rod – A nuclear reactor component that includes the fissile material.

fusion – The combining of two light atomic nuclei (such as hydrogen isotopes or lithium) to form a heavier atomic nucleus. Fusion is accompanied by the release of large amounts of energy.

generator – Within the context of this environmental impact statement, generators refer to organizations within the U.S. Department of Energy (DOE) or managed by DOE whose act or process produces low-level radioactive waste (LLW), mixed LLW, or transuranic waste.

geologic repository – A place to dispose of radioactive waste deep beneath Earth's surface.

geology – The science that studies the materials, processes, environments, and history of Earth, including rocks and their formation and structure.

graded approach – A process by which the level of analysis, documentation, and actions necessary to comply with a requirement are commensurate with (1) the relative importance to safety, safeguards, and security; (2) the magnitude of any hazard involved; (3) the life-cycle stage of a facility; (4) the programmatic mission of a facility; (5) the particular characteristics of a facility; and (6) any other relevant factor.

grading – Any stripping, cutting, filling, stockpiling, or combination thereof that modifies the land surface.

gravel pit No. 30 – This gravel pit, located between the 200-East and 200-West Areas, is an approximately 54-hectare (134-acre) borrow site containing a large quantity of aggregate (sand and gravel) suitable for multiple uses. Gravel pit No. 30 provides aggregate for onsite concrete batch plants in support of the construction of new facilities, including those at the Waste Treatment Plant adjacent to the 200-East Area.

groundwater – Water below the ground surface in a zone of saturation.

grout – A fluid mixture of cement-like materials and liquid waste that sets up as a solid mass and is used for waste fixation, immobilization, and stabilization.

habitat – The environment occupied by individuals of a particular species, population, or community.

half-life (radiological) – The time in which one-half of the atoms of a particular radioactive isotope disintegrate to another nuclear form. Half-lives vary from millionths of a second to billions of years.

Hanford barrier – A horizontal, multilayered, above-grade soil structure used as a representative surface barrier (cap) for closure at a Hanford Site landfill. The barrier's function is to isolate the waste site from the environment by preventing or reducing the likelihood of wind erosion; water infiltration; or plant, animal, or human intrusion.

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

Hazard Quotient – The value used as an assessment of non-cancer-associated toxic effects of chemicals, e.g., kidney or liver dysfunction. It is a ratio of the estimated exposure to that level of exposure at which it is expected that adverse health effects would begin to be produced. It is independent of a cancer risk, which is calculated for only those chemicals identified as carcinogens.

hazardous air pollutants – Air pollutants that are not covered by ambient air quality standards, but may present a threat of adverse human health or environmental effects. Those specifically listed in Title 40 of the *Code of Federal Regulations*, Section 61.01, are asbestos, benzene, beryllium, coke oven emissions, inorganic arsenic, mercury, radionuclides, and vinyl chloride. More broadly, hazardous air pollutants include any of the 189 pollutants listed in or pursuant to Section 112(b) of the Clean Air Act.

hazardous chemical – Under Title 29 of the *Code of Federal Regulations*, Part 1910, Subpart Z, hazardous chemicals are defined as "any chemical that is a physical hazard or a health hazard." Physical hazards include combustible liquids, compressed gases, explosives, flammables, organic peroxides, oxidizers, pyrophorics, and reactives. A health hazard is any chemical for which there is good evidence that acute or chronic health effects occur in exposed employees. Hazardous chemicals include carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, agents that act on the hematopoietic system, and agents that damage the lungs, skin, eyes, or mucous membranes.

hazardous material – A material, including a hazardous substance, as defined by Title 49 of the *Code of Federal Regulations*, Section 171.8, that poses a risk to health, safety, or property when transported or handled.

hazardous substance – Any substance subject to the reporting and possible response provisions of the Clean Water Act and the Comprehensive Environmental Response, Compensation, and Liability Act.

hazardous waste – A category of waste regulated under the Resource Conservation and Recovery Act (RCRA). To be considered hazardous, a waste must be a solid waste under RCRA and must exhibit at least one of four characteristics described in Title 40 of the *Code of Federal Regulations* (CFR), Sections 261.20 through 261.24 (i.e., ignitability, corrosivity, reactivity, or toxicity), or it must be specifically listed by the U.S. Environmental Protection Agency in 40 CFR, Sections 261.31 through

261.33. Hazardous waste may also include solid waste designated by Washington State in *Washington Administrative Code* 173-303-070 through 173-303-100 as dangerous or extremely hazardous waste.

high-efficiency particulate air filter – An air filter capable of removing at least 99.97 percent of particles 0.3 micrometers (about 0.00001 inches) in diameter. These filters include a pleated fibrous medium (typically fiberglass) that is capable of capturing very small particles.

high-level radioactive waste – As defined in the *Radioactive Waste Management Manual* (U.S. Department of Energy Manual 435.1-1), highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and other highly radioactive material that is determined, consistent with existing law, to require permanent isolation.

historic resources – (1) Archaeological sites, architectural structures, and objects produced after the advent of written history or dating to the time of the first European-American contact in an area.

(2) As defined by the National Historic Preservation Act of 1966, as amended (Title 16 of the *United States Code*, Part 470 et seq.), any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion on, the National Register of Historic Places, including artifacts, records, and material remains related to such a property or resource.

hydrology – The science dealing with the properties, distribution, and circulation of natural water systems.

immobilization – Placing waste within a material such as concrete or glass to reduce (immobilize) the dispensability and leachability of the radioactive or hazardous components within the waste.

immobilized high-level radioactive waste (IHLW) – High-level radioactive waste as defined in the *Radioactive Waste Management Manual* (U.S. Department of Energy Manual 435.1-1) that has been immobilized (vitrified) by processing it through the Waste Treatment Plant.

immobilized low-activity waste (ILAW) – (1) Waste immobilized by the Waste Treatment Plant or processed by supplemental treatment (i.e., bulk vitrification, cast stone, steam reforming). After receiving the necessary approvals, ILAW could be managed as low-level radioactive waste incidental to reprocessing, as defined in U.S. Department of Energy Manual 435.1-1. Because it is produced from treatment of Hanford Site tank waste, it also could be managed as a mixed waste. (2) Waste that contains mostly nonradioactive chemical constituents.

infrastructure – The basic facilities, services, and utilities needed for the functioning of an industrial facility. Transportation and electrical systems are part of the infrastructure.

ingestion – The action of taking solids or liquids into the digestive system.

inhalation – The action of taking airborne material into the respiratory system.

institutional control – The period of time when a site is under active governmental controls. Institutional controls may include administrative or legal controls, physical barriers or markers, and methods to preserve information and data and to inform current and future generations of hazards and risks.

Integrated Disposal Facility – A permitted landfill on the Hanford Site with two separate, expandable cells—one for the disposal of low-level radioactive waste and another for the disposal of mixed low-level radioactive waste.

involved worker – A worker participating in a proposed action.

ion – An atom that has too many or too few electrons, causing it to be electrically charged.

ion exchange – A unit physiochemical process that removes anions and cations, including radionuclides, from liquid streams (usually water) for the purpose of purification or decontamination.

ion exchange resin – An organic polymer that functions as an acid or base. These resins are used to remove ionic material from a solution. Cation exchange resins are used to remove positively charged particles (cations); anion exchange resins are used to remove negatively charged particles (anions).

ionizing radiation – Alpha particles, beta particles, gamma rays, high-speed electrons, high-speed protons, and other particles or electromagnetic radiation that can displace electrons from atoms or molecules, thereby producing ions.

irradiated – Exposed to ionizing radiation. The condition of nuclear reactor fuel elements and other materials in which atoms bombarded with nuclear particles have undergone nuclear changes.

isotope – Any of two or more variations of an element in which the nuclei have the same number of protons (i.e., the same atomic number) but different numbers of neutrons so that their atomic masses differ. Isotopes of a single element possess almost identical chemical properties, but often different physical properties (e.g., carbon-12 and -13 are stable; carbon-14 is radioactive).

landfill closure – Landfill closure typically includes site stabilization and emplacement of a surface barrier, followed by a postclosure care period.

land use designations – Land use designations at the Hanford Site were established by the U.S. Department of Energy under the 1999 *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* Record of Decision, amended in September 2008. Changes to land use are subject to procedures identified in that environmental impact statement.

Industrial: An area that is suitable and desirable for activities such as reactor operations; rail and barge transport facilities; mining; manufacturing; food processing; assembly, warehouse, and distribution operations; and other industrial uses.

Industrial-Exclusive: An area that is suitable and desirable for treatment, storage, and disposal of hazardous, dangerous, radioactive, and nonradioactive wastes and related activities.

Conservation (Mining): An area reserved for management and protection of archaeological, cultural, ecological, and natural resources. Limited and managed mining (e.g., quarrying for sand, gravel, basalt, and topsoil for governmental purposes only) could occur as a special use within appropriate areas (a permit would be required). Limited public access would be consistent with resource conservation. This designation includes related activities.

latent cancer fatality – Death from cancer occurring sometime after, and postulated to be due to, exposure to ionizing radiation or other carcinogens.

leachate – As applied to mixed low-level radioactive waste trenches, any liquid, including any suspended components in the liquid, that has percolated through, or drained from, hazardous waste.

lobe – A lobe is a section of a barrier that covers a contiguous area of tank farms. Three barrier lobes are anticipated in the 200-West Area, and two much larger lobes are anticipated in the 200-East Area.

lost workdays – The total number of workdays (consecutive or not) during which employees were away from work or limited to restricted work activity because of an occupational injury or illness.

low-activity waste (LAW) – Waste that remains after as much radioactivity as technically and economically practical has been separated from high-level radioactive waste that, when solidified, may be disposed of as low-level radioactive waste in a near-surface facility. In its final form, such solid LAW would not exceed Title 10 of the *Code of Federal Regulations* (CFR), Section 61.55, Class C radioisotope limits and would meet performance objectives comparable to those in 10 CFR, Part 61, Subpart C.

low-income population – Low-income populations, as defined in terms of U.S. Census Bureau annual statistical poverty levels (Current Population Reports, Series P60 on Consumer Income), may consist of groups or individuals who either live in geographic proximity to one another or are geographically dispersed or transient (such as migrant workers or American Indians), where either type of group experiences common conditions of environmental exposure or effect.

low-level radioactive waste – Radioactive waste that is not high-level radioactive waste, spent nuclear fuel, transuranic waste, byproduct material (as defined in Section 11e(2) of the Atomic Energy Act of 1954, as amended), or naturally occurring radioactive material.

maximally exposed individual (MEI) – A hypothetical individual whose location and habits result in the highest total radiological or chemical exposure (and thus dose) from a particular source for all exposure routes (e.g., inhalation, ingestion, direct exposure). As used in this environmental impact statement, the MEI refers to an individual located off site, unless characterized otherwise in terms of time or location.

maximum contaminant level (MCL) – The U.S. Environmental Protection Agency (EPA) standards for drinking water quality under the Safe Drinking Water Act. The MCL for a given substance is the maximum permissible concentration of that substance in water delivered by a public water system. The primary MCLs (Title 40 of the *Code of Federal Regulations* [CFR], Part 141) are intended to protect public health and are federally enforceable. They are based on health factors, but are also required by law to reflect the technological and economic feasibility of removing the contaminant from the water supply. Secondary MCLs (40 CFR, Part 143) are set by EPA to protect the public welfare. These secondary drinking water regulations control substances in drinking water that primarily affect aesthetic qualities (such as taste, odor, and color), which are related to public acceptance of water. These regulations are not federally enforceable, but are intended as guidelines for the states.

megawatt – A unit of power equal to 1 million watts. *Megawatt-thermal* is commonly used to describe heat produced, while *megawatt-electric* describes electricity produced.

melter – The type of melters used in the Waste Treatment Plant (WTP) to treat tank waste are joule-heated melters. Joule heating involves placing electrodes into a material (a slurry of tank waste mixed with glass-forming materials) and applying electrical potential. This results in an electrical current and resistance heating. WTP melters include (1) high-level radioactive waste (HLW) melters used to treat the HLW stream, with a theoretical maximum capacity (TMC) of producing 3 metric tons of glass (MTG) per day, and (2) low-activity waste (LAW) melters used to treat the LAW stream, with a TMC of producing 15 MTG per day.

migration – The natural movement of a material through the air, soil, or groundwater; also, seasonal movement of animals from one area to another.

millirem – One-thousandth of 1 rem.

minority – Individuals who are members of the following population groups: American Indian or Alaska Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic.

minority population – Minority populations exist where either (1) the minority population of the affected area exceeds 50 percent or (2) the minority population percentage of the affected area is meaningfully greater than that in the general population or in some other appropriate unit of geographic analysis (such as a governing body's jurisdiction, a neighborhood, census tract, or other similar unit). "Minority populations" include either a single minority group or the total of all minority persons in the affected area. They may consist of groups of individuals living in geographic proximity to one another or a geographically dispersed/transient set of individuals (such as migrant workers or American Indians), where either type of group experiences common conditions of environmental exposure or effect.

miscellaneous underground storage tanks – These tanks were used for waste storage in the past, and some are currently being used for a variety of purposes. The tanks vary in capacity from 3,407 to 189,270 liters (900 to 50,000 gallons) and are considered part of the Hanford Site tank waste system.

mitigation – Mitigation includes (1) avoiding an impact altogether by not taking a certain action or parts of an action; (2) minimizing impacts by limiting the degree or magnitude of an action and its implementation; (3) rectifying an impact by repairing, rehabilitating, or restoring the affected environment; (4) reducing or eliminating the impact over time by preservation and maintenance operations during the life of an action; or (5) compensating for an impact by replacing or providing substitute resources or environments.

mixed low-level radioactive waste – Low-level radioactive waste determined to contain source, special nuclear, or byproduct material that is subject to the Atomic Energy Act of 1954, as amended, as well as a hazardous component subject to the Resource Conservation and Recovery Act, as amended, or *Washington Administrative Code* 173-303-140.

mixed waste – Waste that contains source, special nuclear, or byproduct material that is subject to the Atomic Energy Act of 1954, as amended, as well as a hazardous component subject to the Resource Conservation and Recovery Act.

modified RCRA Subtitle C barrier – Landfill cover described by Resource Conservation and Recovery Act regulations that also accounts for the unique climatic conditions at the Hanford Site. The design includes layers for foundation and slope, gas collection, low-permeability barrier, drainage, and cover soil.

National Ambient Air Quality Standards – Standards defining the highest allowable levels of certain pollutants in the ambient air (outdoor air to which the public has access). Because the U.S. Environmental Protection Agency must establish the criteria for setting these standards, the regulated pollutants are called criteria pollutants. Criteria pollutants include sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, lead, and two size classes of particulate matter: less than or equal to 2.5 and 10 micrometers (0.0001 and 0.0004 inches, respectively) in diameter. Primary standards are established to protect public health; secondary standards are established to protect public welfare (e.g., visibility, crops, animals, buildings).

National Emission Standards for Hazardous Air Pollutants (NESHAPs) – Emission standards set by the U.S. Environmental Protection Agency for air pollutants that are not covered by National Ambient Air Quality Standards and may, at sufficiently high levels, cause increased fatalities, irreversible health effects, or incapacitating illness. These standards are given in Title 40 of the *Code of Federal Regulations*, Parts 61 and 63. NESHAPs are given for many specific categories of sources (e.g., equipment leaks, industrial process cooling towers, drycleaning facilities, petroleum refineries).

National Environmental Policy Act of 1969 (NEPA) – This act is the basic national charter for protection of the environment. It establishes policy, sets goals (Section 101), and provides means for carrying out policy (Section 102). Section 102(2) contains "action-forcing" provisions to ensure that Federal agencies follow the letter and spirit of the act. For major Federal actions significantly affecting the quality of the human environment, Section 102(2)(C) of NEPA requires Federal agencies to prepare a detailed statement that analyzes the environmental impacts of the proposed actions and other specified information.

National Pollutant Discharge Elimination System (NPDES) – A provision of the Clean Water Act that prohibits discharge of pollutants into waters of the United States unless a special permit is issued by the U.S. Environmental Protection Agency; a state; or, where delegated, a tribal government on an American Indian reservation. The NPDES permit lists either permissible discharges, the level of cleanup technology required for wastewater, or both.

National Register of Historic Places – The official list of the Nation's historic resources that are worthy of preservation. The National Park Service maintains the list under direction of the Secretary of the Interior. Buildings, structures, objects, sites, and districts are included in the National Register for their importance in American history, architecture, archaeology, culture, or engineering. Properties included in the National Register range from large-scale, monumentally proportioned buildings to smaller-scale, regionally distinctive buildings. Listed properties are not just of nationwide importance; most are primarily significant at the state or local level. Procedures for listing properties in the National Register are found in Title 36 of the *Code of Federal Regulations*, Part 60.

neutralization – Changing the pH of a solution to near 7 by adding an acidic or basic material.

neutron – An uncharged elementary particle with a mass slightly greater than that of the proton. Neutrons are found in the nucleus of every atom heavier than hydrogen-1.

nitrate – A compound containing nitrogen, typically seen as a negative anion composed of one nitrogen and three oxygen atoms.

nitrogen – A natural element with the atomic number 7. It is a diatomic, colorless, odorless gas that constitutes about four-fifths of the volume of the atmosphere.

nitrogen oxides – The oxides of nitrogen, primarily nitrogen oxide and nitrogen dioxide. These are produced by the combustion of fossil fuels and can constitute an air pollution problem. Nitrogen dioxide emissions contribute to acid deposition and formation of atmospheric ozone.

noise – Any sound that is undesirable because it interferes with speech and hearing, is intense enough to damage hearing, or is otherwise annoying or undesirable.

noninvolved worker – A worker on the site of an action, but not participating in the action.

normal operations – All normal (incident-free) conditions, as well as those abnormal conditions that frequency estimation techniques indicate typically occur with a frequency greater than 0.1 events per year. As used in this environmental impact statement, normal operations refers to routine waste management activities, e.g., waste treatment activities (including processing), packaging and repackaging, storage, and final disposal of waste, excluding accident conditions (except minor process upsets).

Notice of Intent – An announcement of the initiation of an environmental impact scoping process. The Notice of Intent is usually published in both the *Federal Register* and a local newspaper. The scoping process includes holding at least one public meeting and requesting written comments on issues and environmental concerns that an environmental impact statement should address.

nuclear reactor – A device that sustains a controlled nuclear-fission chain reaction that releases energy in the form of heat.

offsite/off site – Outside of the site boundary.

onsite/on site – Within the site boundary.

operable unit – A term for each of a number of separate activities undertaken as part of a Superfund site cleanup. A typical operable unit would be removal of drums and tanks from the surface of a site.

order of magnitude – As used in this environmental impact statement, an order of magnitude is taken as a power (or factor) of 10.

oxide – A compound of oxygen and another element.

ozone – The triatomic form of oxygen. In the stratosphere, ozone protects Earth from the Sun's ultraviolet rays, but in lower levels of the atmosphere, ozone is considered an air pollutant.

parameter – A term in a model or equation representing a measurable property or quantity of fixed or variable value.

particulate matter (PM) – Any finely divided solid or liquid material other than uncombined (i.e., pure) water. A subscript denotes the upper limit of the diameter of the particles included. Thus, $PM_{2.5}$ includes only particulate matter with an aerodynamic diameter less than or equal to 2.5 micrometers (0.0001 inches); PM_{10}, less than or equal to 10 micrometers (0.0004 inches).

past-practice unit – The Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) defines past-practice unit as a waste management unit where wastes or substances have been disposed of (intentionally or unintentionally) that is not subject to regulation as a treatment, storage, or disposal unit. Due to the relatively large number of past-practice units at the Hanford Site, these units have been organized into groups called operable units for investigation and response action to prioritize the cleanup work to be done at the site.

pathways (exposure) – The means by which a substance moves from an environmental source to an organism.

person-rem – A unit of collective radiation dose applied to populations or groups of individuals; that is, a unit for expressing the dose when summed across all persons in a specified population or group. One person-rem equals 0.01 person-sieverts.

picocurie – One trillionth (10^{-12}) of a curie.

plume – The elongated volume of contaminated water or air originating at a pollutant source, such as an outlet pipe or a smokestack. A plume eventually diffuses into a larger volume of less-contaminated material as it is transported away from the source.

plutonium – A heavy, radioactive metallic element with the atomic number 94. It is produced artificially by neutron bombardment of uranium. Plutonium has 15 isotopes, with atomic masses ranging from 232 to 246 and half-lives ranging from 20 minutes to 76 million years.

$PM_{2.5}$ and **PM_{10}** – See *particulate matter*.

pollution prevention – The use of materials, processes, and practices that reduce or eliminate the generation and release of pollutants, contaminants, hazardous substances, and waste into land, water, and air. For the U.S. Department of Energy, this includes recycling activities.

population dose – See *collective dose*.

priority habitat – A habitat type with unique or significant value to many species that may be described by a (1) unique vegetation type or dominant plant species of primary importance to fish and wildlife (e.g., oak woodlands, eelgrass meadows) or (2) successional stage (e.g., old growth and mature forests). Alternatively, a priority habitat may consist of a specific habitat element (e.g., consolidated marine/estuarine shorelines, talus slopes, caves, snags) of key value to fish and wildlife.

process – Any method or technique designed to change the physical or chemical character of a product.

processing – As used in this environmental impact statement, any activity necessary to prepare waste for disposal. Processing waste may consist of repackaging, removal, or stabilization of nonconforming waste or treatment of physically or chemically hazardous constituents in compliance with state or Federal regulations.

radiation (ionizing) – See *ionizing radiation*.

radioactive decay – The decrease in the amount of any radioactive material with the passage of time due to spontaneous nuclear disintegration (i.e., emission from atomic nuclei of charged particles, photons, or both).

radioactivity – *(process definition)* The spontaneous transformation of unstable atomic nuclei, usually accompanied by the emission of ionizing radiation.

(property definition) The property of unstable nuclei in certain atoms to spontaneously emit ionizing radiation during nuclear transformations.

radioisotope or radionuclide – An unstable isotope that undergoes spontaneous transformation, emitting radiation.

radiological risk – In general, a measure of potential harm to populations or individuals due to the presence or occurrence of an environmental or manmade radiological hazard. In terms of human health, risk comprises three components: a sequence of events leading to an adverse impact, the probability of occurrence of that sequence of events, and the severity of the impact. For the release of radionuclides affecting a population, the impact is occurrence of a fatal cancer; risk is expressed as the expected number of latent cancer fatalities (i.e., the product of probability of occurrence and the magnitude of impact). For the release of radionuclides affecting individuals, the impact is incidence of cancer; risk is expressed as the probability over a lifetime of developing cancer.

radon – A gaseous, radioactive element with the atomic number 86 resulting from the radioactive decay of radium. Radon occurs naturally in the environment and can collect in unventilated enclosed areas, such as basements. Large concentrations of radon can cause lung cancer in humans.

reactivity – The rate of nuclear disintegration in a nuclear reactor.

reactor containment – A steel-reinforced concrete dome built over a nuclear reactor to trap radioactive vapors that might otherwise be released into the environment during a nuclear accident.

reactor coolant system – The system used to transfer energy from the reactor core either directly or indirectly to the heat rejection system.

receptor – An organism that is exposed to chemicals or radionuclides in the environment.

Record of Decision (ROD) – *(National Environmental Policy Act [NEPA] definition)* A concise public document that records a Federal agency's decision(s) concerning proposed actions for which the agency has prepared an environmental impact statement. The ROD is prepared in accordance with Council on Environmental Quality NEPA regulations (Title 40 of the *Code of Federal Regulations*, Section 1505.2). A ROD identifies the alternatives considered in reaching the decision, the environmentally preferred alternative(s), the factors balanced by the agency in making the decision, and whether all practicable means to avoid or minimize environmental harm were adopted, and if not, why they were not.

(Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] definition) A document that records the selection of remedial actions, facts, analyses, public participation, and site-specific policy determinations considered in the course of carrying out CERCLA cleanup activities.

refractory block – A solid object composed of a nonmetallic material that maintains its strength and integrity when exposed to extreme heat. Refractory blocks are used in the construction of structures or system components that are exposed to extremely high temperatures.

region of influence – A site-specific geographic area in which the principal direct and indirect effects of actions are likely to occur and are expected to be of consequence for local jurisdictions.

release – Any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing of a material into the environment. Statutory or regulatory definitions of release may differ.

rem – See *roentgen equivalent man*.

remediation – The process, or a phase in the process, of rendering radioactive, hazardous, or mixed waste environmentally safe, whether through processing, entombment, or other methods.

remote-handled waste – In general, refers to radioactive waste that must be handled at a distance (remotely) to protect workers from unnecessary exposure (e.g., waste with a dose rate of 200 millirem per hour or more at the surface of the waste package).

resin – See *ion exchange resin*.

resource – Valued attribute of a system.

Resource Conservation and Recovery Act (RCRA), as amended – This law gives the U.S. Environmental Protection Agency the authority to control hazardous waste from "cradle to grave" (i.e., from the point of generation to the point of ultimate disposal), including its minimization, generation, transportation, treatment, storage, and disposal. RCRA also sets forth a framework for management of nonhazardous solid waste.

***Revised Code of Washington* (RCW)** – The compilation of all permanent laws now in force in the State of Washington; a collection of session laws (enacted by the legislature and signed by the governor or enacted via the initiative process), arranged by topic, with amendments added and repealed laws removed. Temporary laws such as appropriation acts are not included.

risk – In general, a measure of potential harm to populations or individuals due to the presence or occurrence of an environmental or manmade hazard. Risk is calculated as the product of the probability of an occurrence of an impact and the magnitude of the impact. The probability can be interpreted as a relative frequency of occurrence, a quantity with no assigned units.

In terms of human health, risk comprises three components: a sequence of events leading to an adverse impact, the probability of occurrence of that sequence of events, and the severity of the impact. For the release of radionuclides affecting a population, the impact is occurrence of a fatal cancer; risk is expressed as the expected number of latent cancer fatalities (i.e., the product of probability of occurrence and the magnitude of impact). For the release of radionuclides affecting individuals, the impact is incidence of cancer; risk is expressed as the probability over a lifetime of developing cancer.

River Protection Project (RPP) – The Hanford Site's U.S. Department of Energy RPP mission is to retrieve and treat the site's tank waste and to close the tank farms to protect the Columbia River.

roentgen equivalent man (rem) – A unit of dose equivalent. The dose equivalent in rem equals the absorbed dose in rad in tissue multiplied by the appropriate quality factor and possibly other modifying factors. Rem refers to the dosage of ionizing radiation that will cause the same biological effect as 1 roentgen of x-ray or gamma-ray exposure. One rem equals 0.01 sieverts.

runoff – The portion of rainfall, melted snow, or irrigation water that flows across the ground surface and eventually enters streams.

Safe Drinking Water Act – This act protects the quality of public water supplies, water supply and distribution systems, and all sources of drinking water.

sand – Loose grains of rock or mineral sediment formed by weathering that range in size from 0.0625 to 2.0 millimeters (0.0025 to 0.08 inches) in diameter and often consist of quartz particles.

sanitary waste – Liquid or solid waste generated by normal housekeeping activities (includes sludge) that is not hazardous or radioactive.

scope – The range of actions, alternatives, and impacts to be considered in a document prepared pursuant to the National Environmental Policy Act of 1969.

scoping – An early and open process for determining the scope of issues to be addressed in an environmental impact statement (EIS) and for identifying significant issues related to proposed actions. The scoping period begins upon publication in the *Federal Register* of a Notice of Intent to prepare an EIS. The public scoping process is that portion of the process where the public is invited to participate. The U.S. Department of Energy (DOE) also conducts an early internal scoping process for environmental assessments and EISs. For EISs, this internal scoping process precedes the public scoping process. DOE's scoping procedures are found in Title 10 of the *Code of Federal Regulations*, Section 1021.311.

secondary waste – Waste generated as a result of other activities, e.g., waste retrieval or waste treatment, that is not further treated by the Waste Treatment Plant or supplemental treatment facilities, and includes liquid and solid wastes. Liquid waste sources could include process condensates, scrubber wastes, spent reagents from resins, offgas and vessel vent wastes, vessel washes, floor drain and sump wastes, and decontamination solutions. Solid waste sources could include worn filter membranes, spent ion exchange resins, failed or worn equipment, debris, analytical laboratory waste, high-efficiency particulate air filters, spent carbon adsorbent, and other process-related wastes. Secondary waste can be characterized as low-level radioactive waste, mixed low-level radioactive waste, transuranic waste, or hazardous waste.

security – An integrated system of activities, systems, programs, facilities, and policies for the protection of restricted data and other classified information or matter; nuclear materials, weapons and components; and/or U.S. Department of Energy contractor facilities, property, and equipment.

sediment – Soil, sand, and minerals washed from land into water and deposited on the bottom of a water body.

seismic – Pertaining to any Earth vibration, especially an earthquake.

severe accident – An accident with a frequency rate of less than 10^{-6} per year that would have more-severe consequences than a design-basis accident in terms of damage to the facility, offsite consequences, or both. Also called "beyond-design-basis reactor accidents" in this environmental impact statement.

shielding – In regard to radiation, any material of obstruction (bulkheads, walls, or other construction) that absorbs radiation to protect personnel or equipment.

shutdown – Facility condition where operations and/or construction activities have ceased.

silt – Loose particles of rock or mineral sediment ranging in size from about 0.002 to 0.0625 millimeters (0.00008 to 0.0025 inches) in diameter. Silt is finer than sand, but coarser than clay.

single-shell tank (SST) – Underground reinforced concrete containers with one carbon steel liner that are covered with 2 to 3 meters (6.6 to 9.8 feet) of earth. Capacity ranges from 208,175 to 3.79 million liters (55,000 to 1 million gallons). SSTs have been used to store radioactive and mixed waste.

single-shell tank (SST) system – An area of the Hanford Site high-level radioactive waste tank farm system that includes 149 SSTs, ancillary equipment, and soils (from surface soils to the interface with groundwater) within SST farms and/or waste management area boundaries used to support Hanford Site waste retrieval and storage activities.

site – A geographic entity comprising leased or owned land, buildings, and other structures required to perform program activities.

soils – All unconsolidated materials above bedrock; natural earthy materials on Earth's surface, in places modified or even made by human activity, that contain living matter and either support or are capable of supporting plants out of doors.

solid waste – In general, nonliquid, nonsoluble discarded materials, ranging from municipal garbage to industrial waste, that contains complex and sometimes hazardous substances, including sewage sludge, agricultural refuse, demolition waste, and mining residues. For purposes of regulation under the Resource Conservation and Recovery Act, solid waste is "any garbage; refuse; sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility; and other discarded material." Solid waste includes solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations and from community activities. Solid waste does not include solid or dissolved material in domestic sewage or irrigation return flows or industrial discharges, which are point sources subject to permits under Section 402 of the Clean Water Act. Finally, solid waste does not include source, special nuclear, or byproduct material as defined by the Atomic Energy Act. A more-detailed regulatory definition of solid waste can be found in Title 40 of the *Code of Federal Regulations*, Section 261.2.

source term – The amount of a specific pollutant (e.g., chemical, radionuclide) emitted or discharged to a particular environmental medium (e.g., air, water) from a source or group of sources. It is usually expressed as a rate (i.e., amount per unit time).

spent nuclear fuel – Fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated.

stabilization – Mixing an agent such as Portland cement with waste to increase the mechanical strength of the resulting waste form and decrease its leachability.

State Environmental Policy Act (SEPA) – The State of Washington's environmental law enacted in 1971 as Chapter 43.12C of the *Revised Code of Washington*. The purposes of this law are to (1) declare a state policy that will encourage productive and enjoyable harmony between man and his environment, (2) promote efforts that will prevent or eliminate damage to the environment and biosphere, (3) stimulate the health and welfare of man, and (4) enrich the understanding of the ecological systems and natural resources important to the state and Nation.

steam reforming – A thermal process that immobilizes waste by converting (1) low-activity waste solutions (tank waste) to granular minerals and volatilizing water and (2) the decomposing organic compounds, nitrate, and nitrite present in the tank waste to carbon dioxide, water, and nitrogen.

storage – Holding waste for a temporary period, at the end of which the waste is treated, disposed of, or stored elsewhere.

sulfate removal – Sulfate, a significant component in the supernatant fractions of tank waste at the Hanford Site, poses serious economic impacts (creating more glass) and risks for the low-activity waste (LAW) vitrification process. Sulfate tends to phase-separate in the melter, forming a corrosive molten sulfate salt layer on top of the glass melt that will damage the melter if allowed to accumulate. Removal of the sulfate from the LAW before vitrifying can mitigate these problems. The sulfate removal approach comprises sulfate precipitation using strontium nitrate addition, filtration, and solidification with grout-forming additives for immobilized waste.

sulfur oxides – Common air pollutants, primarily sulfur dioxide, a heavy, pungent, colorless gas formed in the combustion of fossil fuels and considered a major air pollutant, and sulfur trioxide. Sulfur dioxide is involved in the formation of acid rain. It can also irritate the upper respiratory tract and cause lung damage.

supplemental treatment – As used in this environmental impact statement, a waste treatment process used to solidify or immobilize the low-activity waste fraction of tank waste in addition to the Waste Treatment Plant vitrification process.

surface water – All bodies of water on the surface of Earth that are open to the atmosphere, such as rivers, lakes, reservoirs, ponds, seas, and estuaries.

tank systems – *Single-shell tank (SST) system:* All 149 SSTs, ancillary equipment (e.g., pipes and pits), and soils (from surface to interface with groundwater) within SST farms and/or waste management area boundaries.

Double-shell tank (DST) system: Existing and new DSTs, as well as the ancillary equipment and soils within the DST farms.

target – A tube, rod, or other form containing material that, on being irradiated in a nuclear reactor or an accelerator, would produce a desired end product.

terrestrial – Of or pertaining to life on land.

thermal treatment – Treatment of waste in a device that uses elevated temperature to change the chemical, physical, or biological character of the waste. Examples include, but are not limited to, vitrification, pyrolysis, steam reforming, and calcination.

threatened species – *Federal:* Species that are likely to become endangered species within the foreseeable future throughout all or a significant portion of their ranges and have been listed as threatened by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service following the procedures set out in the Endangered Species Act (Title 16 of the *United States Code*, Parts 1551 through 1599) and its implementing regulations (Title 50 of the *Code of Federal Regulations* [CFR], Part 424).

The lists of threatened species can be found at 50 CFR, Sections 17.11 (wildlife), 17.12 (plants), and 227.4 (marine organisms).

Idaho State: Any wildlife species native to the state that is likely to become an endangered species within the foreseeable future throughout a significant portion of its range within the state if factors contributing to its decline continue.

Washington State: Any wildlife species native to the state that is likely to become an endangered species within the foreseeable future throughout a significant portion of its range within the state if factors contributing to its decline continue (*Washington Administrative Code* 232-12-297; Washington State Natural Heritage Program, established by the Natural Area Preserves Act [*Revised Code of Washington*, Chapter 79.70]).

total recordable cases – The total number of cases recorded of work-related (1) deaths or (2) illnesses or injuries resulting in loss of consciousness, restriction of work or motion, transfer to another job, or required medical treatment beyond first aid.

total uranium – As used in this environmental impact statement, the total concentration of all of the 14 isotopes of uranium used for calculating *nonradiological* human health and ecological risk.

transuranic – Refers to any element with an atomic number higher than uranium (atomic number 92), including neptunium, plutonium, americium, and curium. All transuranic elements are produced artificially and are radioactive.

transuranic isotope – Isotopes of any element having an atomic number greater than 92 (the atomic number of uranium).

transuranic (TRU) waste – Radioactive waste containing more than 100 nanocuries (3,700 becquerels) of alpha-emitting TRU isotopes per gram of waste, with half-lives greater than 20 years, except for: (1) high-level radioactive waste; (2) waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the U.S. Environmental Protection Agency, does not need the degree of isolation required by Title 40 of the *Code of Federal Regulations* (CFR), Part 191, disposal regulations; or (3) waste that the U.S. Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR, Part 61.

treatment – The physical, chemical, or biological processing of dangerous waste to make such waste nondangerous or less dangerous, safer for transport, amenable for energy or material resource recovery, amenable for storage, or lesser in volume, with the exception of compacting, repackaging, and sorting, as allowed under *Washington Administrative Code* 173-303-400(b) and 173-303-600. For radioactive waste, treatment is any method, technique, or process designed to change the physical or chemical character of waste to render it less hazardous; safer to transport, store, or dispose of; or lesser in volume.

trench (ditch) – A depression dug in the ground, open to the atmosphere, and designed for disposal of low-level or intermediate-level radioactive waste. It uses the moisture retention capability of the relatively dry soils above the groundwater.

Tri-Party Agreement (TPA) – See *Hanford Federal Facility Agreement and Consent Order*.

uranium – A radioactive, metallic element with the atomic number 92; one of the heaviest naturally occurring elements. Uranium has 14 known isotopes, of which uranium-238 is the most abundant in nature. Uranium-235 is commonly used as a fuel for nuclear fission.

uranium-238 – As used in this environmental impact statement, the total concentration of all of the 14 isotopes of uranium used for calculating *radiological* human health and ecological risk.

U.S. Nuclear Regulatory Commission (NRC) – The Federal agency that regulates the civilian nuclear power industry in the United States.

vadose zone – The region of soil and rock between the ground surface and the top of the water table in which pore spaces are only partially filled with water. Over time, contaminants in the vadose zone often migrate downward to the underlying aquifer.

viewshed – The extent of an area that may be viewed from a particular location. Viewsheds are generally bounded by topographic features such as hills or mountains.

vitrification – A method used to immobilize waste (radioactive, hazardous, and mixed). This involves adding glass formers and waste to a vessel and melting the mixture into a glass. The purpose of this process is to permanently immobilize the waste and isolate it from the environment.

***Washington Administrative Code* (WAC)** – Regulations of the executive branch agencies in the State of Washington as issued by the authority of statutes. The WAC codifies the regulations of the State of Washington and arranges them by subject or responsible agency. The WAC, which is a source of primary law, also states how agencies shall organize and adopt rules and regulations.

waste acceptance criteria – The technical and administrative requirements that a waste must meet for it to be accepted at a treatment, storage, or disposal facility.

waste characterization – Identification of waste composition and properties to determine appropriate storage, treatment, handling, transportation, and disposal requirements by (1) reviewing process knowledge, (2) nondestructive examination, (3) nondestructive assay, or (4) sampling and analysis.

waste classification – Wastes are classified according to U.S. Department of Energy Manual 435.1-1, *Radioactive Waste Management Manual*, and include high-level radioactive, transuranic, and low-level radioactive wastes.

waste container – Any portable device in which a material is stored, transported, treated, disposed of, or otherwise handled (*Washington Administrative Code* 173-303-400). A waste container may include any liner or shielding material that is intended to accompany the waste in disposal. At the Hanford Site, waste containers typically consist of 208- or 320-liter (55- or 85-gallon) drums and standard waste boxes. Other sizes and styles of containers may also be employed, depending on the physical, radiological, and chemical characteristics of the waste.

waste disposal – See *disposal*.

Waste Isolation Pilot Plant (WIPP) – A U.S. Department of Energy facility designed and authorized to permanently dispose of transuranic radioactive waste in a mined underground facility in deep geologic salt beds. WIPP is located in southeastern New Mexico, 42 kilometers (26 miles) east of the city of Carlsbad.

waste management – The planning, coordination, and direction of those functions related to the generation, handling, treatment, storage, transportation, and disposal of waste, as well as associated surveillance and maintenance activities.

waste minimization and pollution prevention – An action that economically avoids or reduces the generation of waste and pollution by source reduction, reducing the toxicity of hazardous waste and pollution, improving energy use, or recycling. These actions will be consistent with the general goal of minimizing present and future threats to human health, safety, and the environment.

waste stream – A waste or group of wastes from a process or a facility with similar physical, chemical, or radiological properties. In the context of this environmental impact statement, a waste stream is defined as a collection of wastes with physical and chemical characteristics that will generally require the same management approach (use of the same treatment, storage, and disposal capabilities).

waste treatment facilities – Includes existing and new facilities required to complete waste treatment.

Waste Treatment Plant (WTP) – Facility designed and built to thermally treat and immobilize tank waste at the U.S. Department of Energy's Hanford Site.

water table – The boundary between the unsaturated zone and the deeper, saturated zone. The upper surface of an unconfined aquifer.

wetlands – Those areas that are inundated by surface water or groundwater with a frequency that is sufficient to support, and under normal circumstances do or would support, a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction. Wetlands generally include swamps, marshes, bogs, and similar areas (e.g., sloughs, potholes, wet meadows, river overflow areas, mudflats, natural ponds).

Jurisdictional wetlands are those wetlands protected by the Clean Water Act. They must have a minimum of one positive wetland indicator from each parameter (i.e., vegetation, soil, and hydrology). The U.S. Army Corps of Engineers requires a permit to fill or dredge jurisdictional wetlands.

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