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JUL 2 3 2014

14-ECD-0030

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Ms. Hedges:

TRANSMITTAL OF CLEAN CLOSURE PRACTICABILITY DEMONSTRATION FOR THE SINGLE-SHELL TANKS DOE/ORP-2014-02

The U.S. Department of Energy (DOE), Office of River Protection is submitting the Clean Closure Practicability Demonstration for the Single-Shell Tanks (SST). The information presented demonstrates that clean closure of any portion of the SST system is impracticable as defined in the regulations (WAC 173-340-200, "Definitions"). For the purposes of the analysis, DOE used the procedures and criteria of WAC 173-340-360(3)(e), "Disproportionate Cost Analysis," and WAC 173-340-360(3)(f), "Evaluation Criteria" as a guideline.

The information source used to support preparation of this Clean Closure Practicability Demonstration is the DOE/EIS-0391, *Final Tank Closure and Waste Management Environmental Impact Statement (TC&WM EIS) for the Hanford Site, Richland, Washington* (TC&WM EIS) (DOE 2012) and subsequent Record of Decision (78 FR 75913, December 13, 2014). This document encompasses the analysis in the TC&WM EIS and is presented by Waste Management Area.

Since the TC&WM EIS had extensive public review and comment associated with it, which included the landfill and clean closure alternatives, and all comments were addressed in the Final TC&WM EIS comment response document, DOE is submitting this information for inclusion in the SST operating record.

To fulfill existing Tri-Party Agreement requirements, assist in developing a recovery plan for the missed closure milestones, and to facilitate closure plan submittals based on the Rev. 9 permit discussions, DOE would like a response from the Washington State Department of Ecology agreeing to landfill closure, consistent with the Final TC&WM EIS and Record of Decision, by September 30, 2014.

If you have any questions, please contact Lori A. Huffman, Director, Environmental Compliance Division, (509) 376-0104.

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U.S. Department of Energy
Office of River Protection
DOE/ORP-2014-02

Clean Closure Practicability Demonstration for the Single-Shell Tanks

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

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P.O. Box 450
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(267 Pages)

Clean Closure Practicability Demonstration for the Single-Shell Tanks

DOE/ORP-2014-02, Revision 1

Mary Beth Burandt

Mary Beth Burandt

Executive Summary

The purpose of this *Clean Closure Practicability Demonstration for the Single-Shell Tanks (Clean Closure Practicability Demonstration)* is to describe the activities required to meet the clean closure performance standards for the Hanford Site single-shell tank (SST) system as required by Washington State regulations (WAC 173-303-610 (2)(b), "Closure and Post Closure"; WAC 173-303-640(8)(a), "Closure and Post Closure Care") and to present the potential human health and environmental impacts and costs associated with meeting these requirements. The information presented was used as a guideline by the U.S. Department of Energy (DOE) to demonstrate that clean closure of any portion of the SST system is impracticable as defined in the regulations (WAC 173-340-200, "Definitions")[1] and as demonstrated using the procedures and criteria (WAC 173-340-360(3)(e),"Disproportionate Cost Analysis" and (f), "Evaluation Criteria"). The evaluation looked at the following:

> **Disproportionate cost analysis**. Costs are disproportionate to benefits if the incremental costs of the alternative over that of a lower cost alternative exceed the incremental degree of benefits achieved by the alternative over that of the other lower cost alternative.
>
> **Evaluation criteria.** The following criteria shall be used to evaluate and compare each cleanup action alternative when conducting a disproportionate cost analysis under (e) of this subsection to determine whether a cleanup action is permanent to the maximum extent practicable. This included items like protectiveness, permanence, cost, effectiveness over the long term, management of short term risk, technical and administrative implementability, and considerations of public concerns.

If it is determined that clean closure of any portion of the SST system is impracticable, then that portion of the SST system can be closed as a landfill and must meet the landfill closure performance standard.

The information source used to support preparation of this *Clean Closure Practicability Demonstration* is the DOE/EIS-0391 *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington* (*Final TC & WM EIS*) (DOE 2012) and subsequent Record of Decision (78 FR 75913, December 13, 2014). The *Final TC & WM EIS* analyzed four different alternatives for closure of the SST system. Alternatives vary depending on factors such as the extent of waste retrieval from the SST system and regulatory decisions regarding the method of closure; that is, clean closure, landfill closure, or selective clean closure (combination of clean and landfill closure). Two *Final TC & WM EIS* alternatives were chosen as the basis for this *Clean Closure Practicability Demonstration*. The first, Tank Closure Alternative 6B (All Vitrification with Separations; Clean Closure), Base Case, examined the potential environmental impacts associated with clean closure of the 12 SST farms that contain 149 SSTs. This alternative included retrieval of the tank waste to a level that

[1] Washington Administrative Code (WAC) 173-340-200 defines "Practicable" as follows, "Practicable means capable of being designed, constructed and implemented in a reliable and effective manner including consideration of cost. When considering cost under this analysis, an alternative shall not be considered practicable if the incremental costs of the alternative are disproportionate to the incremental degree of benefits provided by the alternative over other lower cost alternatives."

would allow safe removal of the tank structures, ancillary equipment, and contaminated soils. For more-detailed descriptions of Tank Closure Alternative 6B, Base Case, and Waste Management Alternative 2, Disposal Group 2, see the *Final TC & WM EIS*, Chapter 2, Sections 2.5.2.6.2 and 2.5.4.2, respectively.

This *Clean Closure Practicability Demonstration* examines the potential short-term impacts of clean closure of the 12 SST farms and disposal of the associated waste streams, as analyzed in the *Final TC & WM EIS*. However, the information is in a slightly different format; specifically, by the seven tank farm waste management areas (WMA),(i.e., WMAs A/AX, B/BX/BY, C, S/SX, T, TX/TY, and U).

DOE has concluded that clean closure of the 149 SSTs and contaminated soil is technically and financially impracticable for the seven WMAs. Although there would be some potential beneficial long-term impacts on groundwater, the reduction of concentration of radiological risk has a large degree of technical uncertainty. Excavation of the tanks would be required to be a minimum of 65 feet up to 255 feet. A containment structure to span the WMAs of the required size has never been attempted and after treatment of the contaminated soil it would be disposed of in a disposal facility very close to the existing tanks, between 200 East and 200 West. DOE has determined landfill closure of the SST system, which would include corrective/mitigation actions that may require soil removal or treatment of the vadose zone, is a more appropriate approach for SST system closure than clean closure.

REFERENCES

78 FR 75913, 2013, "Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington," Federal Register, Vol. 78, Issue 240, December 13.

DOE/EIS-0391-F, 2012, Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington, U.S. Department of Energy, Office of River Protection, Richland, Washington, November.

WAC 173 340 200, "Accumulating Dangerous Waste On-Site," Washington Administrative Code, as amended.

WAC 173 340 360(3)(e) and (f), "Emergencies," Washington Administrative Code, as amended.

WAC 173-303-610, "Closure and Post-Closure," Washington Administrative Code, as amended.

WAC 173-303-640, "Tank Systems," Washington Administrative Code, as amended.

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List of Acronyms and Abbreviations

°C	degree(s) Celsius
°F	degree(s) Fahrenheit
ALARA	as low as is reasonably achievable
BLM	U.S. Bureau of Land Management
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Clean Closure Practicability Demonstration	*Clean Closure Practicability Demonstration for the Single-Shell Tanks*
CY	calendar year
dBA	decibels A-weighted
DOE	U.S. Department of Energy
DST	double-shell tank
Ecology	Washington State Department of Ecology
ERDF	Environmental Restoration Disposal Facility
FTE	full-time equivalent
HLW	high-level radioactive waste
IDF	Integrated Disposal Facility
IDF-East	200-East Area Integrated Disposal Facility
ILAW	immobilized low-activity waste
LAW	low-activity waste
LCF	latent cancer fatality
LIGO	Laser Interferometer Gravitational-Wave Observatory
LLW	low-level radioactive waste
LOS	level of service
MEI	maximally exposed individual
MLLW	mixed low-level radioactive waste
MRS	mobile retrieval system
MUST	miscellaneous underground storage tank
NPDES	National Pollutant Discharge Elimination System
ORP	Office of River Protection
PM	particulate matter
PM_n	particulate matter with an aerodynamic diameter less than or equal to *n* micrometers
PPF	Preprocessing Facility
PUREX	Plutonium-Uranium Extraction
RCRA	Resource Conservation and Recovery Act
REDOX	Reduction-Oxidation

List of Acronyms and Abbreviations *(continued)*

ROI	region of influence
RPPDF	River Protection Project Disposal Facility
RSE	rubble, soil, and equipment
SST	single-shell tank
TC & WM EIS	*Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*
TNT	trinitrotoluene
TRC	total recordable case
TRU	transuranic
US Ecology	US Ecology Commercial Low-Level Radioactive Waste Disposal Site
VBR	vacuum-based retrieval
WMA	waste management area
WRF	waste receiver facility
WTP	Waste Treatment Plant

CHAPTER 1
PURPOSE, SCOPE, AND DOCUMENT ORGANIZATION

The purpose of this *Clean Closure Practicability Demonstration for the Single-Shell Tanks (Clean Closure Practicability Demonstration)* is to describe the activities required to meet the clean closure performance standards for the Hanford Site single-shell tank (SST) system as required by Washington State regulations (WAC 173-303-610(2)(b), "Closure and Post-Closure"); WAC 173-303-640(8)(a), "Closure and Post-closure Care") and to present the potential human health and environmental impacts and costs associated with meeting these requirements. This information can be used to demonstrate whether clean closure of any portion of the SST system is impracticable as defined in the regulations (WAC 173-340-200, "Definitions")[2] and as demonstrated using the following procedures and criteria (WAC 173-340-360(3)(e), "Disproportionate Cost Analysis" and (f), "Evaluation Criteria"), as follows:

> (e) Disproportionate cost analysis.
>
> (i) Test. Costs are disproportionate to benefits if the incremental costs of the alternative over that of a lower cost alternative exceed the incremental degree of benefits achieved by the alternative over that of the other lower cost alternative.
>
> (ii) Procedure.
>
> (A) The alternatives evaluated in the feasibility study shall be ranked from most to least permanent, based on the evaluation of the alternatives under (f) of this subsection and the definition of permanent solution in (c) of this subsection.
>
> (B) The most practicable permanent solution evaluated in the feasibility study shall be the baseline cleanup action alternative against which cleanup action alternatives are compared. If no permanent solution has been evaluated in the feasibility study, the cleanup action alternative evaluated in the feasibility study that provides the greatest degree of permanence shall be the baseline cleanup action alternative.
>
> (C) The comparison of benefits and costs may be quantitative, but will often be qualitative and require the use of best professional judgment. In particular, the department has the discretion to favor or disfavor qualitative benefits and use that information in selecting a cleanup action. Where two or more alternatives are equal in benefits, the department shall select the less costly alternative provided the requirements of subsection (2) of this section are met.
>
> (f) Evaluation criteria. The following criteria shall be used to evaluate and

[2] WAC 173-340-200 defines "Practicable" as follows, "Practicable means capable of being designed, constructed and implemented in a reliable and effective manner including consideration of cost. When considering cost under this analysis, an alternative shall not be considered practicable if the incremental costs of the alternative are disproportionate to the incremental degree of benefits provided by the alternative over other lower cost alternatives."

compare each cleanup action alternative when conducting a disproportionate cost analysis under (e) of this subsection to determine whether a cleanup action is permanent to the maximum extent practicable.

(i) Protectiveness. Overall protectiveness of human health and the environment, including the degree to which existing risks are reduced, time required to reduce risk at the facility and attain cleanup standards, on-site and offsite risks resulting from implementing the alternative, and improvement of the overall environmental quality.

(ii) Permanence. The degree to which the alternative permanently reduces the toxicity, mobility or volume of hazardous substances, including the adequacy of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of waste treatment process, and the characteristics and quantity of treatment residuals generated.

(iii) Cost. The cost to implement the alternative, including the cost of construction, the net present value of any long-term costs and agency oversight costs that are cost recoverable. Long-term costs include operation and maintenance costs, monitoring costs, equipment replacement costs, and the cost of maintaining institutional controls. Cost estimates for treatment technologies shall describe pretreatment, analytical, labor, and waste management costs. The design life of the cleanup action shall be estimated and the cost of replacement or repair of major elements shall be included in the cost estimate.

(iv) Effectiveness over the long term. Long-term effectiveness includes the degree of certainty that the alternative will be successful, the reliability of the alternative during the period of time hazardous substances are expected to remain on-site at concentrations that exceed cleanup levels, the magnitude of residual risk with the alternative in place, and the effectiveness of controls required to manage treatment residues or remaining wastes. The following types of cleanup action components may be used as a guide, in descending order, when assessing the relative degree of long-term effectiveness: Reuse or recycling; destruction or detoxification; immobilization or solidification; on-site or offsite disposal in an engineered, lined and monitored facility; on-site isolation or containment with attendant engineering controls; and institutional controls and monitoring.

(v) Management of short-term risks. The risk to human health and the environment associated with the alternative during construction and implementation, and the effectiveness of measures that will be taken to manage such risks.

(vi) Technical and administrative implementability. Ability to be implemented including consideration of whether the alternative is technically possible, availability of necessary offsite facilities, services and materials, administrative and regulatory requirements, scheduling, size, complexity, monitoring requirements, access for construction operations and monitoring, and integration

with existing facility operations and other current or potential remedial actions.

(vii) Consideration of public concerns. Whether the community has concerns regarding the alternative and, if so, the extent to which the alternative addresses those concerns. This process includes concerns from individuals, community groups, local governments, tribes, federal and state agencies, or any other organization that may have an interest in or knowledge of the site.

If it is determined that clean closure of any portion of the SST system is impracticable, then that portion of the SST system can be closed as a landfill and must meet the landfill closure performance standard.

Closure and post closure regulations (WAC 173-303-610(2)(b); WAC 173-303-640(8)(a)), which are sometimes referred to as "Clean Closure regulations" require that all dangerous waste, waste constituents, dangerous waste residues, equipment, bases, liners, materials containing or contaminated with dangerous waste or waste residue, and contaminated soils and groundwater throughout the closing unit must be removed or decontaminated. The removal or decontamination must ensure that the levels of dangerous waste or dangerous waste constituents or residues do not exceed the following guidelines:

- For soil and groundwater in any areas affected by releases from the SST system, the numeric cleanup levels pursuant to unrestricted use exposure assumptions in (WAC 173-340) Model Toxics Control Act regulations. These are the numeric cleanup levels calculated according to Method B of the act, although Method A may be used as appropriate.
- For all structures, equipment, bases, liners, etc., clean closure standards as provided in the Washington State Department of Ecology (Ecology) document *Guidance for Clean Closure of Dangerous Waste Units and Facilities* (Ecology 2005).

The information source used to support preparation of this *Clean Closure Practicability Demonstration* is the DOE/EIS-0391 *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington* (*TC & WM EIS*) (DOE 2012). The *Final TC & WM EIS* analyzed different alternatives for closure of the SST system. Alternatives vary depending on factors such as the extent of waste retrieval from the SST system and regulatory decisions regarding the method of closure; i.e., clean closure, landfill closure, or selective clean closure (combination of clean and landfill closure). Two *Final TC & WM EIS* alternatives were chosen as the basis for this *Clean Closure Practicability Demonstration*. The first, Tank Closure Alternative 6B (All Vitrification with Separations; Clean Closure), Base Case, examined the potential environmental impacts associated with clean closure of the 12 SST farms that contain 149 SSTs. This alternative included retrieval of the tank waste to a level that would allow safe removal of the tank structures, ancillary equipment, and contaminated soils. Following tank waste retrieval, the tanks, ancillary equipment, and any contaminated soils would be removed as necessary to protect human health and the environment and to allow unrestricted use of the tank farm areas. In addition to tank closure, the *Final TC & WM EIS* evaluated alternatives for disposal of the associated waste streams. Given its compatibility with Tank Closure Alternative 6B, Base Case, Waste Management Alternative 2 (Disposal in the Integrated Disposal Facility [IDF], 200-East Area Only), Disposal Group 2, was chosen as the second *Final TC & WM EIS* alternative to support the *Clean Closure Practicability Demonstration* analysis.

Under Waste Management Alternative 2, Disposal Group 2, tank waste would be disposed of in the IDF in the 200-East Area Integrated Disposal Facility (IDF-East), and lightly contaminated equipment and soils resulting from clean closure activities would be disposed of in the proposed River Protection Project Disposal Facility (RPPDF). For more-detailed descriptions of Tank Closure Alternative 6B, Base Case, and Waste Management Alternative 2, Disposal Group 2, see the *Final TC & WM EIS*, Chapter 2, Sections 2.5.2.6.2 and 2.5.4.2, respectively.

This *Clean Closure Practicability Demonstration* examines the potential short-term impacts of clean closure of the 12 SST farms and disposal of the associated waste streams, as analyzed in the *Final TC & WM EIS*. However, the information is presented here in a slightly different format; specifically, by the seven tank farm waste management areas (WMA), (i.e., WMAs A/AX, B/BX/BY, C, S/SX, T, TX/TY, and U).

The following sections provide an overview of the clean closure process, the technologies and strategies evaluated to support clean closure, and the uncertainties and assumptions associated with these technologies. Chapter 2 of this plan provides a summary overview of the potential human health and environmental impacts associated with the activities required to achieve clean closure of the SST system. Chapter 3 provides more-detailed analysis of these impacts, as well as cost estimates, of clean closure of each WMA. Chapter 4 provides the technical conclusions based on WAC-173-340-360(3)(e) and (f) why clean closure is not technically or financially practicable.

1.1 OVERVIEW OF THE CLEAN CLOSURE PROCESS

For clean closure of the seven WMAs, various retrieval technologies were evaluated to determine their ability to achieve certain established waste retrieval benchmarks. To support clean closure of the tank farms, it was assumed that this waste retrieval benchmark would be 99.9 percent retrieval. A 99.9 percent retrieval involves removing tank waste to achieve a residual waste volume equal to 1 cubic meter (36 cubic feet) for the 100-series SSTs and 0.08 cubic meters (3 cubic feet) for the 200-series SSTs. The capabilities of four retrieval systems to attain this benchmark of 99.9 percent retrieval were analyzed: modified sluicing; mobile retrieval system (MRS); vacuum-based retrieval (VBR) and chemical wash tank cleaning.

Following retrieval, all 149 SSTs in the seven WMAs would be removed, along with the ancillary equipment associated with tank farm operations and the 3 meters (10 feet) of soil directly beneath these tanks. In addition, contaminated soil plumes would be removed (to the depth of groundwater, where necessary) from any tank farms showing evidence of deep soil contamination. The tank farms would then be backfilled with clean soil from onsite sources (specifically, Borrow Area C). The removed soils would be treated in the Preprocessing Facility (PPF), as necessary, to support onsite disposal in either IDF-East or the proposed RPPDF. The highly and moderately contaminated rubble, soil, and equipment (RSE) from this removal action, which is expected to include tank steel, concrete, ancillary equipment, and contaminated soils, would be compacted to the extent practical, boxed in shielded storage boxes, and stored for future disposal as high-level radioactive waste (HLW) in the HLW Debris Storage Facilities.

During the tank, ancillary equipment, and deep soil removal process, overarching containment structures, or "bubbles," would be constructed to contain radioactive and hazardous materials, and retaining walls would be installed to support excavation.

1.2 TECHNOLOGIES TO SUPPORT CLEAN CLOSURE

1.2.1 Retrieval Technologies and Strategy

The *Final TC & WM EIS* evaluated several retrieval technologies that could be used to retrieve waste from the SSTs. Tank-specific considerations such as riser availability, waste condition, or in-tank interferences might favor one retrieval technology over another, leading to selection of that technology to retrieve waste from a particular tank. For analysis purposes, the following waste retrieval technologies and support facilities were evaluated for the SST system:

- **Modified sluicing** could be implemented for 100-series SSTs; because of concerns about potential leakage during retrieval, as well as regulatory prohibitions against introducing liquids into leaking tanks, use of modified sluicing would be limited to those tanks that are not classified as known or suspected leakers. A number of the known or suspected leakers, however, may be candidates for use of modified sluicing after further evaluation of historical leak data. Based on current design information, modified sluicing is expected to be capable of retrieving waste to both the 90 percent and 99 percent waste retrieval benchmarks, but not to 99.9 percent retrieval.
- **Mobile retrieval systems (MRS)** could be used to retrieve waste from 100-series SSTs that are classified as known or suspected leakers. This technology would retrieve the waste using lower liquid volumes, thereby reducing the potential volume of a retrieval leak, should one occur. Based on current design information, the MRS is expected to be capable of retrieving waste to both the 90 percent and 99 percent waste retrieval benchmarks, but not to 99.9 percent retrieval.
- **Vacuum-based retrieval (VBR)** could be used to retrieve waste from the 200-series tanks, miscellaneous underground storage tanks (MUST), and waste receiver facilities (WRF). This technology is flexible because it can be operated as a dry vacuum retrieval method, but liquid can also be introduced near the vacuum head if necessary, depending on the type of waste to be retrieved. This technology is suited for use in small tanks, and it would minimize the potential for leakage in some of the 200-series tanks that are classified as known or suspected leakers. Based on current design information, the VBR system is expected to be capable of retrieving waste to both the 90 percent and 99 percent waste retrieval benchmarks, but not to 99.9 percent retrieval.
- **Chemical wash tank cleaning** (coupled with the MRS and the VBR system) is capable of retrieving 99.9 percent of the waste in the tanks. This technology was selected to obtain clean closure, based on the uncertainty associated with achieving 99.9 percent waste retrieval using modified sluicing, the MRS, or the VBR system.
- **Waste receiver facilities (WRF)** aid in retrieval of waste from the SSTs and miscellaneous underground storage tank (MUSTs) for transfer to the double-shell tank (DST) system. WRFs may also be used to condition waste from SSTs and DSTs for transfer to waste treatment facilities. WRFs accumulate waste during retrieval; condition waste by dissolution, dilution, or size reduction of particles; and provide batches of waste for subsequent transfer. The WRFs could also be used to recirculate sluicing liquids back to the SSTs. Not all SST retrievals would necessarily require WRFs. The facility footprint of a WRF would be approximately 61 meters (200 feet) long by 15 meters (50 feet) wide, with four separate process cells. Operations in each process cell would be conducted remotely (no personnel would be present during processing). The cell would be serviced by an overhead crane. Each WRF would also have a separate control room

for operations personnel, an equipment load-out bay, and a dedicated maintenance area. The tanks, cells, and crane area would be appropriately ventilated.

For analysis purposes, the *Final TC & WM EIS* assumed four WRFs would be constructed near clusters of SSTs, as follows:

- Adjacent to the B, BX, and BY Tank Farms in the 200-East Area (WRF-B)
- Between the T and TY Tank Farms in the 200-West Area (WRF-T)
- Between the U and S Tank Farms in the 200-West Area (WRF-S)
- Adjacent to the A Tank Farm in the 200-East Area (WRF-A)

1.2.2 Tank, Ancillary Equipment, and Soil Removal Strategy

The scope of the tank, ancillary equipment, and deep soil removal and associated technology would involve the complete removal of the tanks and ancillary equipment, excavation of all soil in the tank farms down to the soil/groundwater interface, and disposal of the debris and soil. Some SST farms may have considerable uncontaminated soils. Some soils would be directly disposed of as is, while others may require additional treatment to meet Resource Conservation and Recovery Act (RCRA)/dangerous waste disposal requirements (WAC 173-303, "Dangerous Waste Regulations"). The resulting excavation would then be backfilled with clean soil from Borrow Area C. The overall removal concept is depicted in Figures 1–1 and 1–2.

Containment Structures. The clean closure approach would require installation of deep pilings for soil support and worker safety, as well as construction and operation of an overarching containment structure or "bubble" over each tank farm prior to tank and deep soil removal. A containment structure would be built over a group of tanks. Then the ancillary equipment, tanks, and contaminated soil down to the groundwater (70 to 76 meters [200 to 250 feet] below the ground surface in most tank farms) would be completely removed. The technology would require an overarching containment structure (bubble) to be placed over all or part of a tank farm prior to tank or soil removal. The structure would be filtered and have at least two zones of negative pressure, each with personnel and equipment air locks. The bubble would be used to keep fugitive dusts containing hazardous or radioactive particles from escaping to the environment. Shielded-cab excavation and size-reduction equipment would be used under the bubble (DOE 2003a).

Use of a containment structure represents a reasonable and responsible case for providing protection during soil and tank removal and the greatest benefits with respect to resource use. Although the Hanford environmental restoration contractor has been routinely cleaning up Columbia River corridor sites without the use of containment structures, a containment structure may be required for soils with large inventories of contaminants (e.g., in tank farms where SSTs have leaked).

Tank Closure Alternatives 6B, Base Case, assumed that six containment enclosures would be required. Each containment structure could be utilized twice. The enclosures would be built around the following sets of tanks:

- A and AX Tank Farms (WMA A/AX)
- B, BX, and BY Tank Farms (WMA B/BX/BY)

- C Tank Farm (WMA C)
- S and SX Tank Farms (WMA S/SX)
- T, TX, and TY Tank Farms (WMAs T and TX/TY)
- U Tank Farm (WMA U)

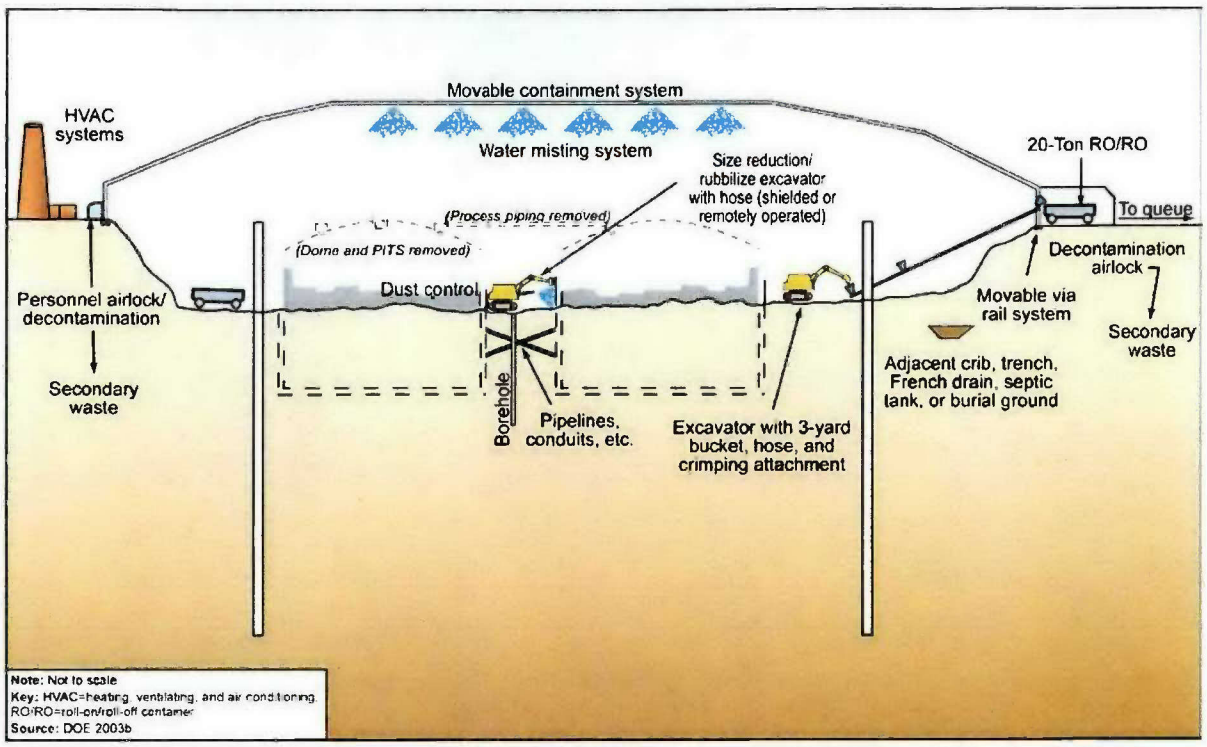


Figure 1-1 Conceptual Drawing of Clean Closure Showing Domes and Pits Partially Removed

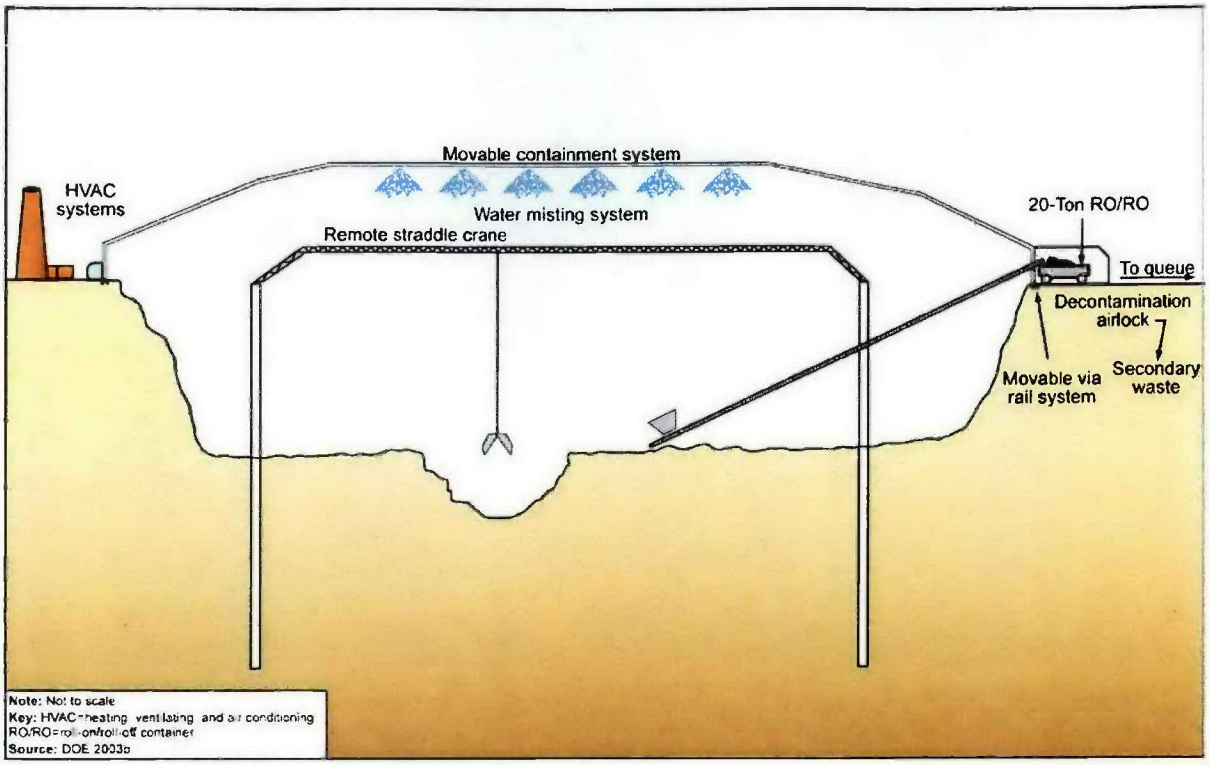


Figure 1-2 Conceptual Drawing of Clean Closure After Removal of Tanks

Ancillary Equipment Removal. All ancillary equipment components would be removed, reduced in size, packaged, and prepared for disposal. When necessary, this work would be performed remotely using shielded heavy equipment and hydraulic excavators with specialized implements designed for demolition and material handling. To reduce the volume of heavily contaminated debris, a vacuum scabbler would be used to remove thin, highly contaminated layers of concrete. A truck-mounted vacuum system, similar to the system already in use in the tank farms, would be used for shallow excavations in areas that are otherwise limited to hand excavation.

Ancillary equipment removal concepts and information were taken from the *AX Tank* Farm *Ancillary Equipment Study* (Skelly 1998). The number of different types of ancillary equipment, and the large number of pieces, combine to make removal a substantial effort.

Tank Removal. Removal of the tanks would involve the following activities:

- All contaminated tanks, ancillary equipment, and contaminated soils would be removed.
- Several large, movable enclosures (containment structures) spanning the width of each tank farm would be constructed for required confinement of radioactive and hazardous materials.
- The vadose zone and groundwater would be characterized to assess the nature and extent of contamination from losses during tank waste retrieval and to gather geotechnical data.

- Retaining walls would be installed. The outer wall would extend around the perimeter of the tank farm and would support excavation down to the tank base elevation. This wall would be installed before construction of the tank farm containment structure. The remaining walls would be installed following tank removal and would extend down from the tank base elevation to support excavation of tank leak plumes. A 30-centimeter-thick (1-foot-thick) layer of high-flow, low-strength grout would be placed in each of the tanks to reduce worker exposures from residual waste in the tanks.
- Soil cover would be removed from grade level down to the top of the tank domes. The excavated, lightly contaminated soil would be placed into containers for transport to, and disposal in, the proposed onsite RPPDF.
- The tank domes would be demolished and the rubble placed inside the tank for additional radiation shielding.
- The soil surrounding the tanks would be excavated, debris would be placed in containers, and lightly contaminated soil would be transported to the onsite RPPDF.
- Tank sidewalls would be demolished and rubble placed in containers. This waste would be packaged in shielded containers for disposition as HLW.
- The tank slab and footing would be demolished, and the debris and the 3 meters (10 feet) of soil under the tank slab would be placed in shielded boxes. This waste would be packaged in shielded containers for disposition as HLW.
- The base slabs would be demolished, involving the most adverse working and material-handling conditions encountered during tank removal. Base slab demolition would involve the use of 5-centimeter-thick (2-inch-thick) sheets of steel laid down on the soil as the slab is removed to provide shielding and reduce worker radiological exposure rates to manageable levels (DOE 2003b).

Deep Soil Removal. After the tanks are removed, contaminated soil from past tank leaks would be excavated. To accommodate larger excavation volumes, a conveyor system would be constructed to move the soil from the excavation area to the container loading area. A straddle crane and rail system would be installed within the confinement facility to support soil excavation. The crane, with a clamshell attached, would be fully operable from a remote location and would use cameras to view the excavation area. The straddle crane would be mounted on three parallel sets of east–west rails supported by steel girders. To increase production by the crane, a belt conveyor system would be constructed to move the contaminated soil from the floor of the excavation to the container loading zone.

Lightly contaminated soil meeting waste acceptance criteria would be placed into roll on/roll off containers and transported to the onsite RPPDF for disposal. The soil immediately beyond the 3-meter (10-foot) layer of soil below the tank bases is expected to have higher concentrations of radionuclides. These soils and other highly contaminated soils would be placed in shielded boxes and transported to the PPF for decontamination (DOE 2003b).

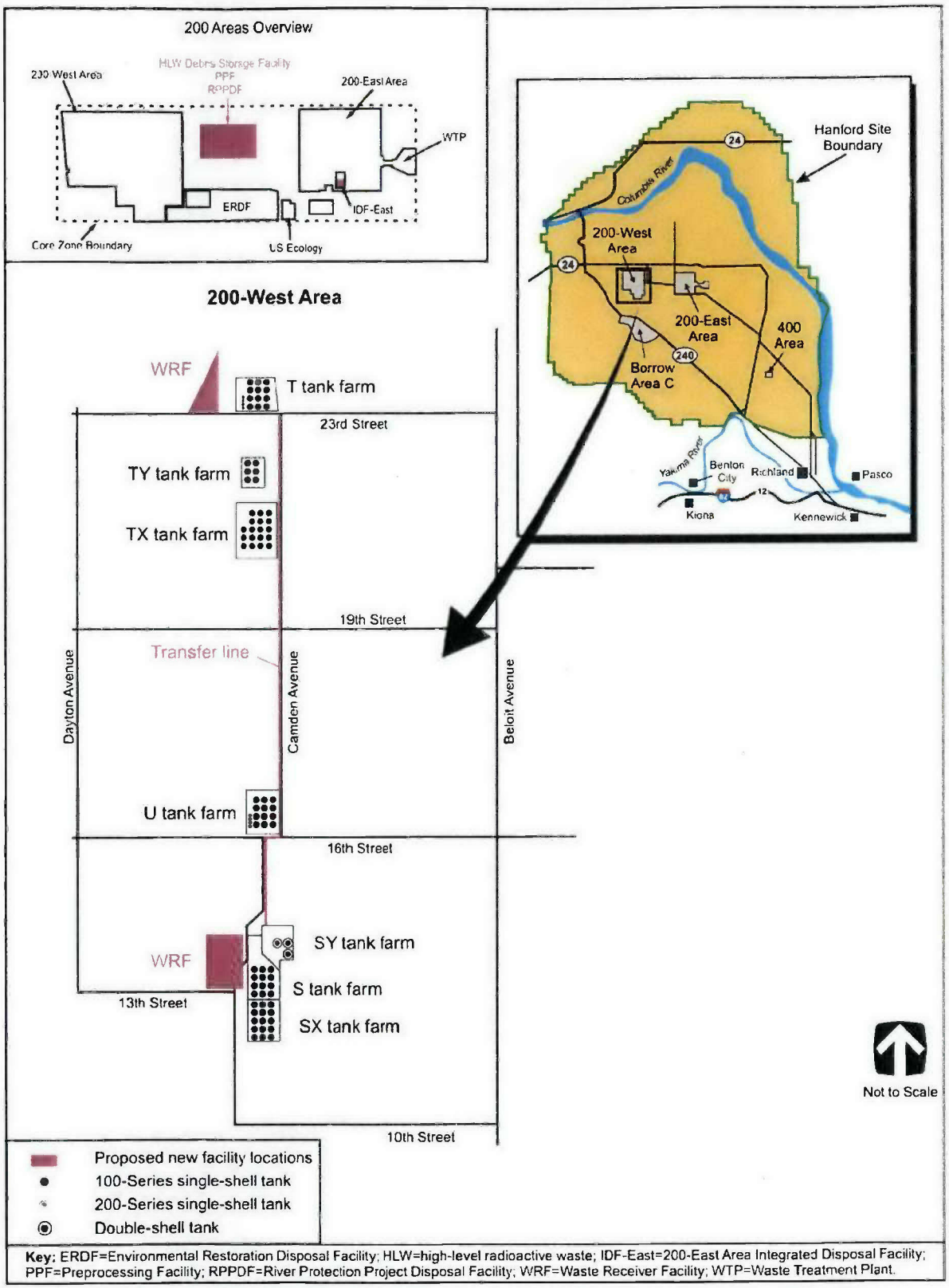
1.2.3 Tank and Soil Treatment, Storage, and Disposal

Several new facilities would be required to support clean closure of the SST system. The following provides a brief summary description of these facilities; their proposed locations are depicted in Figures 1–3 and 1–4.

HLW Debris Storage Facility. Tank debris and RSE resulting from tank removal are expected to be heavily contaminated with tank waste. These materials would be considered HLW and would be packaged in shielded storage boxes for disposal as HLW. To accommodate the shielded storage boxes, covered concrete pads would be constructed near the PPF. It was assumed that the boxed HLW would require long-term onsite storage until disposition decisions are made and implemented. It was also assumed that the radionuclide and chemical inventories in this waste would be contained during onsite storage. Therefore, this waste would not represent a source of groundwater contamination.

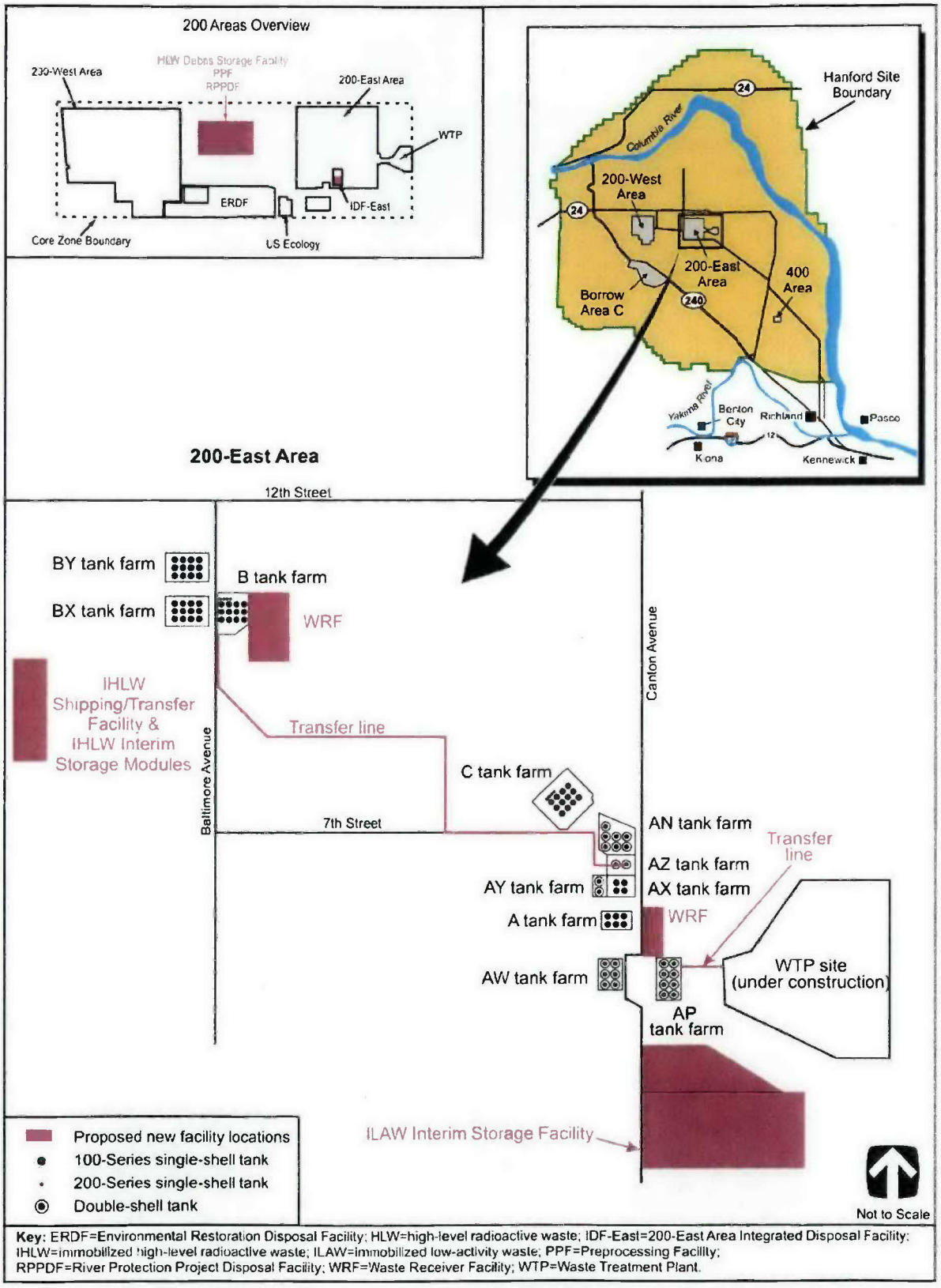
Preprocessing Facility (PPF). The highly contaminated soils from deep soil excavation (plumes) would be removed, transported to the PPF in shielded boxes, and subjected to a weak acid wash. This resultant liquid waste stream would be further treated in the PPF and immobilized by treatment in a glass melter system to produce an immobilized waste form that would be equivalent in long-term performance to immobilized low-activity waste (ILAW) glass. This PPF glass would be disposed of in IDF-East. The decontaminated (washed) rubble and soil from the PPF decontamination operations would be packaged and disposed of on site in the proposed RPPDF.

River Protection Project Disposal Facility (RPPDF). A single RPPDF would be constructed at a site near IDF-East. It was assumed the RPPDF would be the same depth as the IDF, 13.1 meters (43 feet). To accommodate the waste resulting from clean closure of the WMAs, the RPPDF would have a capacity of approximately 8.37 million cubic meters (295.6 million cubic feet) and would be required to operate through 2100. Following closure of the RPPDF, a modified RCRA Subtitle C barrier would be placed over the landfill, and postclosure care is planned for 100 years following completion of the barrier construction.



Key: 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; WRF=Waste Receiver Facility; WTP=Waste Treatment Plant.

Figure 1-3 Proposed Locations of Facilities in the 200-West Area to Support Clean Closure of the Single-Shell Tank System



Key: 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; RPPDF=River Protection Project Disposal Facility; WRF=Waste Receiver Facility; WTP=Waste Treatment Plant.

Figure 1-4 Proposed Locations of Facilities in the 200-East Area to Support Clean Closure of the Single-Shell Tank System

Integrated Disposal Facility (IDF) (200-East Area). The primary mission of an IDF is to dispose of low-level radioactive waste (LLW) and mixed low-level radioactive waste (MLLW). In April 2006, the RCRA-permitted IDF-East was partially completed at Hanford. IDF-East measures 457 meters (1,500 feet) wide by 233 meters (765 feet) long by 12.8 meters (42 feet) deep, currently consists of two cells, and is expandable. As currently planned, one cell would be used to dispose of MLLW, including vitrified low-activity waste from the Waste Treatment and Immobilization Plant (WTP) and 50 large containers of waste from the planned Demonstration Bulk Vitrification System Project. The second cell would be used to dispose of LLW from Hanford cleanup activities. Each cell has a 2.1-meter-thick (7-foot-thick) liner system consisting of a 0.9-meter (3-foot) clay liner topped by two separate, high-density polyethylene liners, a geosynthetic clay liner, and 0.3 meters (1 foot) of drain gravel. These layers are covered with a 0.9-meter (3-foot) earthen layer to protect the liners from heavy equipment during waste placement operations (CH2M HILL 2006). IDF-East would be used to dispose of the PPF glass from the soil cleaning process. Following closure of IDF-East, a modified RCRA Subtitle C barrier would be placed over the landfill, and postclosure care is planned for 100 years following completion of the barrier construction.

Borrow Area C Operations. Borrow Area C comprises approximately 930 hectares (2,300 acres) and is located south of the Hanford 200-West Area along State Route 240. It is a proposed supply site for the sand, soil, and gravel needed to support environmental remediation activities throughout Hanford. Specific activities discussed in this *Clean Closure Practicability Demonstration* require the use of borrow materials from Borrow Area C. Resource material from Borrow Area C would be used primarily for construction of new facilities, backfilling and regrading where facilities and/or contaminated soils were removed from the ground, and creation of modified RCRA Subtitle C barriers for the IDF and proposed RPPDF.

Conventional excavation, loading, and transporting equipment would be used at Borrow Area C. Conveyor systems may be employed to move excavated material to stockpile areas or load trucks and may be outfitted with crushing, sorting, and screening systems to segregate rock and fines according to Hanford's needs. Basalt, when encountered, would be blasted with controlled, subsurface detonations.

Borrow Area C was evaluated for use as a borrow area because it is relatively close to most of the locations of the proposed activities that would require borrow materials and because it could provide the variety of gravel, sand, and soil types necessary to support such activities.

1.2.4 Groundwater Remediation

Groundwater quality beneath large portions of Hanford has been affected by past liquid waste discharges, primarily to ponds, cribs, and trenches (ditches) and from spills, injection wells, and leaks from waste storage tanks. Additional contaminants from spills, leaking waste tanks, and burial grounds (landfills) have also impacted groundwater in some areas. Contaminant concentrations in the existing groundwater plumes are expected to decline through radioactive decay, chemical degradation, and dispersion. However, contaminants also exist within the vadose zone beneath the waste sites, as well as in waste storage and disposal facilities. These contaminants could continue to move downward into the unconfined aquifer system. Some contaminants, such as hydrogen-3 (tritium), move with the groundwater, while movement of other contaminants (e.g., strontium, cesium, plutonium) is slower because they react with, or are sorbed on, the surface of minerals within the aquifer or the vadose zone (Duncan 2007:4.73,

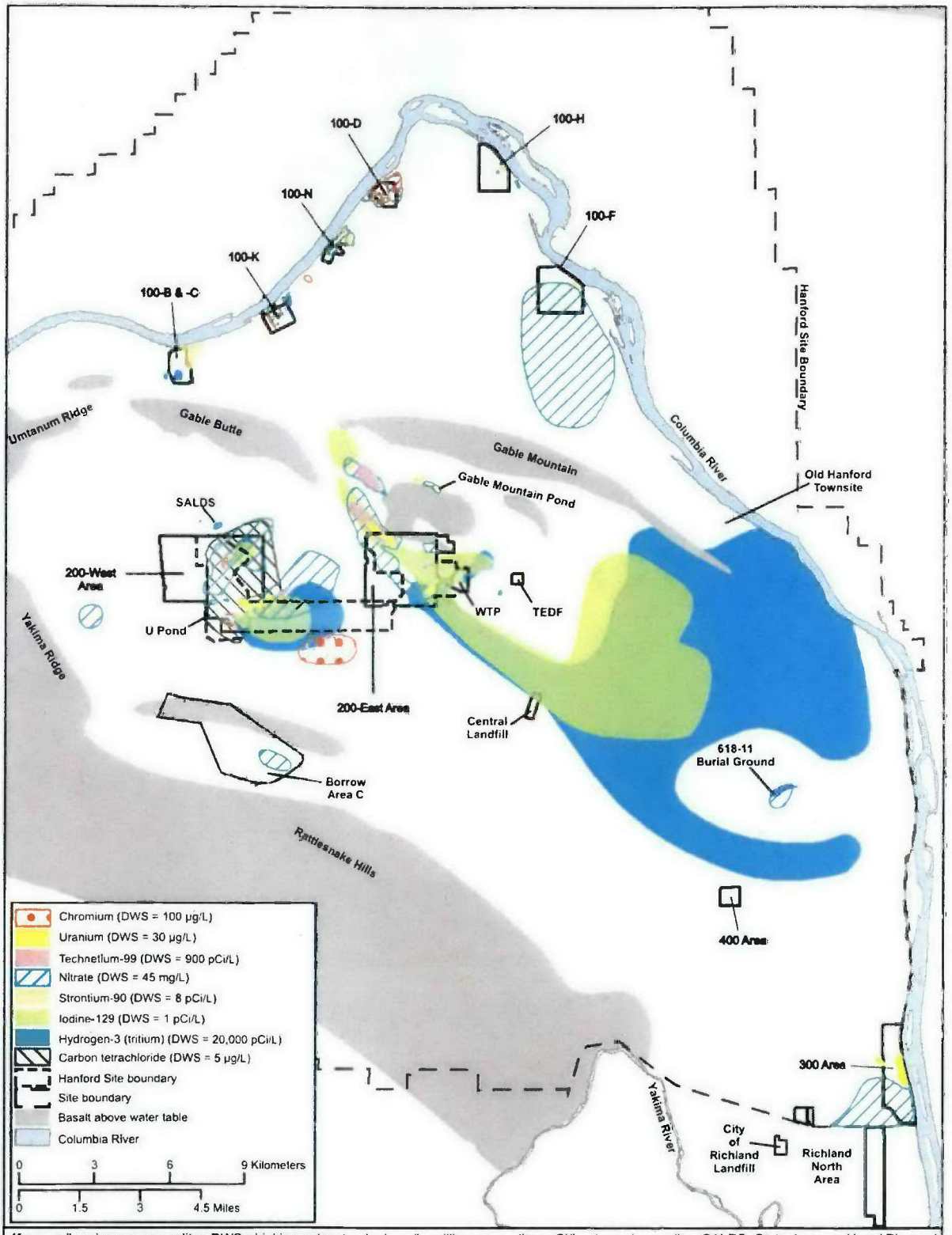
4.74). Groundwater contamination is monitored and is being actively remediated in several areas through pump-and-treat operations. The unconfined aquifer system contains radioactive and nonradioactive contaminants at levels that exceed water quality criteria and standards. During reporting period 2009 (i.e., October 1, 2008, through December 31, 2009), 922 wells and 326 aquifer tubes were sampled for radioactive and/or chemical constituents. Overall, tritium, nitrate, and iodine-129 continue to be the most widespread groundwater contaminants associated with past Hanford operations (DOE 2010:1.0-3, 1.0-4).

Figure 1–5 depicts the distribution of major radionuclides and hazardous chemicals in the unconfined aquifer system, including those concentrations above applicable maximum contaminant level or drinking water standards, during reporting period 2009. The figure depicts groundwater quality on a regional scale and includes the locations of former waste management sites (e.g., Gable Mountain Pond, U Pond, B Pond, effluent disposal cribs) and burial grounds. Also shown are locations of active waste management and treatment facilities, such as the State-Approved Land Disposal Site, 200 Area Treated Effluent Disposal Facility, and Environmental Restoration Disposal Facility.

The areas of the tritium and iodine-129 plumes are the largest areas in which contaminant concentrations exceed drinking water standards. These dominant plumes have sources in the 200-East Area and extend toward the east and southeast. Less-extensive tritium and iodine-129 plumes are also present in the 200-West Area. Technetium-99 concentrations exceed the standards in plumes within both the 200-East and 200-West Areas. One technetium-99 plume has moved to the northwest beyond the 200-East Area. Uranium is less mobile than tritium, iodine-129, or technetium-99; isolated plumes are found in the 200-East, 200-West, and 300 Areas. Strontium-90 concentrations exceed the standards in the 100 Areas, the 200-East Area, and beneath the former Gable Mountain Pond. Other radionuclides, including cesium-137, cobalt-60, and plutonium, are even less mobile in the subsurface and exceed drinking water standards in only a few wells in the 200-East Area (DOE 2010).

Remediation of the groundwater beneath the SST system is being addressed in conjunction with the Hanford cleanup activities. The regulatory framework for the non–SST system sources includes Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), which provides the basis for evaluating the end-state conditions likely to result from the cleanup activities. The major Hanford cleanup actions that involve the non–SST system sources include river corridor and Central Plateau sources and their associated groundwater. Response actions to existing contamination, which is already in the soil and groundwater (see Figure 1–5), is currently ongoing, and Hanford Federal Facility Agreement and Consent Order, also known as the Tri-Party Agreement milestones are in place to address future remediation activities. An overview of Hanford cleanup activities, including the decision making process, cleanup requirements, and goals and milestones, is provided in the *Central Plateau Cleanup Completion Strategy* (DOE 2009), as well as in Appendix U of the *Final TC & WM EIS* (DOE 2012). Clean closure of the SST system down to the groundwater would have a beneficial impact on the groundwater, but because the SST system is a small contributor to the overall groundwater contamination, decisions regarding further groundwater cleanup would have to be made along with those for other non–SST system sources. The cost of groundwater remediation beneath Hanford for all SST system WMAs has not been included in the impracticability determination analysis (see Chapter 4 of this *Clean Closure Practicability Demonstration*) because the SST system is one unit out of many groundwater contamination contributors. Decisions on the

CERCLA groundwater operable units have not been made, nor has an assessment of how the recently installed groundwater pump-and-treat units will perform in the long term. It is reasonable to assume that the cost related to cleanup of all existing plumes in the groundwater would be higher than that estimated for the disproportionate cost analysis provided in Chapter 4 of this Clean Closure Practicability Demonstration. Therefore, the cost analysis provided for the clean closure of the WMAs, not including groundwater remediation, is considered the lower bound.



Key: µg/L=micrograms per liter; DWS=drinking water standard; mg/L=milligrams per liter; pCi/L=picocuries per liter; SALDS=State-Approved Land Disposal Site; TEDF=Treated Effluent Disposal Facility; WTP=Waste Treatment Plant.
Source: Modified from DOE 2010.

Figure 1-5 Distribution of Major Radionuclides and Hazardous Chemicals in the Unconfined Aquifer System during Reporting Period 2009

1.3 CLEAN CLOSURE UNCERTAINTIES AND ASSUMPTIONS

Clean closure of the tank farms in the seven WMAs would require construction and use of containment structures during removal of 149 SSTs, ancillary equipment, and deep soil. Substantial uncertainty is associated with the technical feasibility, schedules, costs, and worker impacts of containment structures. The uses of such engineered structures, including shielding and remote-handling equipment, were evaluated to minimize worker exposure when removing the tanks. Even with these mitigation measures, the worker radiation dose would be an order of magnitude higher than that resulting from landfill closure, as analyzed in the *Final TC & WM EIS* (DOE 2012). 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, a large degree of uncertainty exists concerning the feasibility of installing these structures over a large area the size of a tank farm and, in some cases, of constructing and using multiple structures.

Uncertainty also exists related to the pathway identified for disposition of the removed tanks, which would need to be cut up and packaged. It is assumed that the tanks would be packaged and disposed of onsite; however, they would have to go through the *Radioactive Waste Management Manual* (DOE Manual 435.1-1) process to determine the appropriate disposition pathway (i.e., whether waste is HLW, transuranic waste, or LLW).

The following is a list of assumptions and other uncertainties associated with clean closure:

- For analysis purposes, it was assumed that 99.9 percent of the waste would be removed from the tanks, before tank removal operations begin, but leakage of 15,140 liters (4,000 gallons) per SST could occur during retrieval of waste from the SSTs.
- Tank removal would include removal of all contaminated soils in a tank farm, including excavation of plumes to groundwater, if necessary.
- The equipment used for soil excavation and tank removal would require additional radiation shielding to protect the equipment operators.
- Tank base materials are expected to have high radionuclide concentrations, so a new design for remote-handling equipment would be required.
- Uncertainty is associated with the remote operation of the debris- and soil-cleaning process within the PPF.
- The PPF process is an immature design with very little data available and would probably change as more-detailed design efforts are undertaken (DOE 2003b).

1.4 STRUCTURE OF THIS *CLEAN CLOSURE PRACTICABILITY DEMONSTRATION*

This Clean Closure Practicability Demonstration is organized as follows;

- **Chapter 1—Purpose, Scope, and Document Organization.** Chapter 1 discusses the purpose of this *Clean Closure Practicability Demonstration*, including the regulations governing clean closure and impracticability determinations, and the scope of this document, including a brief background on the information source. It also provides an overview of the clean closure process; a presentation of the technologies to support clean

closure; a discussion on clean closure uncertainties and assumptions; and the organization of this document.

- **Chapter 2—Summary of Waste Management Area Clean Closure Impacts.** Chapter 2 provides a summary overview of the potential human health and environmental impacts of clean closure of the WMAs, presented by resource area or discipline: land resources, infrastructure, noise and vibration, air quality, geology and soils, water resources, ecological resources, cultural and paleontological resources, socioeconomics, existing human health risk, environmental justice, waste management, and industrial safety. The impacts discussion is followed by a summary cost analysis.
- **Chapter 3—Waste Management Area Clean Closure Short-Term Environmental Consequences.** Chapter 3 provides more-detailed analysis of the potential short-term human health and environmental impacts of clean closure, presented by resource area or discipline for each of the seven WMAs. Impacts produced by the construction, operations, deactivation, and closure activities required to implement clean closure are considered. Following each WMA's impacts presentation is a WMA-specific cost analysis of clean closure implementation.
- **Chapter 4—Impracticability Determination for Clean Closure of the Single-Shell Tank System.** Chapter 4 discusses an impracticability determination, as defined by *Washington Administrative Code* regulations, for clean closure of the SST system. This discussion includes a disproportionate cost analysis and the *Washington Administrative Code* evaluation criteria used to conduct that analysis. Each criterion is discussed as it relates to clean closure of the SST system.

1.5 REFERENCES

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WAC 173-303-640, Washington State Department of Ecology, "Dangerous Waste Regulations: Tank Systems," Olympia, Washington.

WAC 173-340, Washington State Department of Ecology, "Model Toxics Control Act – Cleanup," Olympia, Washington.

WAC 173-340-200, Washington State Department of Ecology, "Model Toxics Control Act – Cleanup: Definitions," Olympia, Washington.

WAC 173-340-360, Washington State Department of Ecology, "Model Toxics Control Act – Cleanup: Selection of Cleanup Actions," Olympia, Washington.

CHAPTER 2
SUMMARY OF WASTE MANAGEMENT AREA CLEAN CLOSURE IMPACTS

This chapter of this *Clean Closure Practicability Demonstration for the Single-Shell Tanks (Clean Closure Practicability Demonstration)* provides a summary overview of the potential short-term human health and environmental impacts of implementing clean closure of the 12 single-shell tank (SST) farms, grouped into seven waste management areas (WMA), at the Hanford Site (Hanford), including disposal of the associated waste streams. The information source used to support preparation of this *Clean Closure Practicability Demonstration* is the *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (TC & WM EIS)* (DOE 2012). Impacts are presented here by resource area or discipline: land resources, infrastructure, noise and vibration, air quality, geology and soils, water resources, ecological resources, cultural and paleontological resources, socioeconomics, existing human health risk, environmental justice, waste management, and industrial safety. Impacts produced by the construction, operations, deactivation, and closure activities required to implement clean closure of the WMAs are considered. Discussion of the impacts is followed by a summary cost analysis.

2.1 LAND RESOURCES

2.1.1 Land Use

Clean closure of the seven WMAs would involve land-disturbing activities associated with construction of an underground transfer line, WRFHLW Debris Storage Facility, PPF, IDF, and the proposed River Protection Project Disposal Facility (RPPDF). Closure activities would also require the extraction of material from Borrow Area C. For most facilities and activities, the acreage requirement was determined by use of a scaling factor that adjusted the total land requirement for closing all Hanford tank farms, as reported in the *Final TC & WM EIS* (DOE 2012), to a specific value for each WMA. However, this was not done for the WRF and PPF, as the minimum requirement to close a WMA is one facility. Also, it was not necessary to scale the length of the underground transfer line.

As shown in Table 2–1, most of the land required for clean closure of each WMA evaluated is located between the 200-East and 200-West Areas and within Borrow Area C, all of which is undeveloped. Undeveloped land would not be required in the 200-West Area for clean closure of any of the seven WMAs; however, a small portion of undeveloped land in the 200-East Area would potentially be affected by construction of the underground transfer line and IDF.

Table 2-1 Waste Management Area Clean Closure Land Requirements (acres)

Waste Management Area	Land Impacted in 200-East Area	Land Impacted in 200-West Area	Land Impacted Between 200-East and 200-West Areas[a]	Land Impacted Within Borrow Area C[a]	Total Land Impacted
A/AX	10.8	0	61.7	68.8	141
B/BX/BY	16.4	0	112	265	393
C	11.9	0	23	108	143
S/SX	5.04	8.54	190	177	381
T	3.08	8.54	122	108	242
TX/TY	4.48	8.54	151	157	321
U	3.08	8.54	87.9	108	208

[a] Land between the 200-East and 200-West Areas and land within Borrow Area C is considered undeveloped.
Note: To convert acres to hectares, multiply by 0.40469.

2.1.2 Visual Resources

As noted in Section 2.1.1, most of the land required for clean closure of each of the seven WMAs is not currently developed. Within the 200-East and 200-West Areas, development would have little impact on visual resources, as these areas are already highly industrialized. However, the use of land between the 200-East and 200-West Areas would impact visual resources, as most of this land is not developed. The conversion of this land to an industrial use would add noticeably to the overall developed nature of the area and would be visible from nearby higher elevations. The viewscape from these higher elevations is important to American Indians with cultural ties to Hanford. Clean closure activities would involve constructing containment structures over the WMAs; however, these structures would be removed upon completion of clean closure activities. Although there would be an overall increase in the industrial appearance of the 200 Areas, the U.S. Bureau of Land Management (BLM) Visual Resource Management Class IV rating would not change. Management activities within Class IV areas dominate the view and typically are the focus of viewer attention.

As also noted above, Borrow Area C would be excavated for clean closure of each of the seven WMAs. Development of Borrow Area C would be readily visible from State Route 240 and Rattlesnake Mountain and would change the BLM visual resource management rating from Class II to Class IV. Management activities within Class II areas may be seen but should not dominate the view. Upon completion of work, excavations in Borrow Area C would be recontoured and revegetated, thereby lessening the visual impact.

2.2 INFRASTRUCTURE

This section presents the potential impacts of the WMA clean closure activities on key utility infrastructure resources, including projected demands for electricity, fuel, and water, over the timeframes considered for clean closure of each WMA. For analysis purposes, clean closure project timeframes for each WMA include the active project phase (during which construction, operations, deactivation, and closure activities were assumed to be ongoing) and extend through

the 100-year postclosure care period. Total and peak annual utility infrastructure requirements, as well as those of the component project phases (i.e., construction, operations, deactivation, and closure, as applicable), were projected for each WMA.

Assumptions for electricity demand include power to operate portable demolition equipment, work area lighting, and other items as part of facility construction, as well as power to meet the much larger demands of operational facilities. During construction, deactivation, and closure, electric power may be provided via either direct-service and temporary connections or portable diesel- or gasoline-fired generators. Projections include consumption of fuel to power fuel-fired generators and heavy and mobile equipment to support all clean closure project phases for each WMA. It was assumed for analysis purposes that liquid fuels are not capacity-limiting resources, as supplies would be replenished from offsite sources to support clean closure of each WMA and would be provided at the point of use on an as-needed basis. Facility operations would consume liquid fuels primarily to produce steam and hot water for facility processes, provide space heating, and, to a lesser degree, operate backup generators.

Water would be required during construction for soil compaction, dust control, and possibly work surface and equipment washdown. Standard construction practices dictate that, at least initially, construction water would be trucked to construction locations on an as-needed basis for these uses until water supply and wastewater treatment utilities are in place. Concrete and grout would be produced in onsite batch plants, which would require large volumes of water. By comparison, relatively little water would be required to meet the potable and sanitary needs of the construction workforce. During operations, water would be required to support process makeup requirements and facility cooling, as well as the potable and sanitary needs of the operations workforce and other uses. To stabilize and partially decontaminate waste treatment, retrieval, and disposal facilities, water would also be used during facility deactivation activities; however, this requirement would be relatively small compared with those for construction and operational demands and for many closure activities, including construction of surface barriers.

Table 2–2 summarizes the projected utility infrastructure resource requirements for clean closure of the WMAs. Projected demands for key utility infrastructure resources and impacts of clean closure implementation on the respective utility systems at each WMA are discussed further in the following sections. For each WMA, the activity with the largest total demand for each utility is identified, and the peak demand amount and the years of peak demand are discussed for electricity, fuel, and water.

Table 2-2 Waste Management Area Clean Closure Summary of Utility Infrastructure Requirements (2 pages)

Waste Management Area	Activity Phase	Electricity (million megawatt-hours)	Diesel Fuel[a]	Gasoline	Water
			(million liters)		
A/AX	Construction	0.002	12.1	0.782	59.3
	Operations	0.005	89.9	2.94	2,090
	Deactivation	0.00[b]	0.08	0.101	0.00[b]
	Closure	0.156	45.6	5.01	145
	Total[c]	**0.163**	**147**	**8.83**	**2,290**
	Peak (Year)	**10.6 (2089–2095)**	**24.0 (2101)**	**2.26 (2101)**	**267 (2094–2095)**
B/BX/BY	Construction	0.009	29.1	2.93	98.7
	Operations	0.018	180	5.58	4,620
	Deactivation	0.00[b]	0.303	0.390	0.00[b]
	Closure	0.395	94.3	7.99	269
	Total[c]	0.422	303	16.90	4,990
	Peak (Year)	**0.017 (2035–2036)**	**39.2 (2101)**	**3.70 (2101)**	**333 (2043)**
C	Construction	0.004	7.50	1.17	8.61
	Operations	0.007	32.6	0.874	1,050
	Deactivation	0.00[b]	0.123	0.159	0.00[b]
	Closure	0.101	17.9	1.16	69.9
	Total[c]	0.112	58.2	3.37	1,130
	Peak (Year)	**0.008 (2050–2061)**	**3.03 (2101)**	**0.419 (2014)**	**92.4 (2062–2069)**
S/SX	Construction	0.006	38.3	2.05	204
	Operations	0.013	314	10.5	7,390
	Deactivation	0.00[b]	0.202	0.260	0.00[b]
	Closure	0.563	153	13.9	384
	Total[c]	0.582	506	26.7	7,980
	Peak (Year)	**0.041 (2038–2039)**	**83.0 (2101)**	**7.82 (2101)**	**398 (2038–2039)**
T	Construction	0.004	24.3	1.25	131
	Operations	0.007	190	6.31	4,280
	Deactivation	0.00[b]	0.123	0.159	0.00[b]
	Closure	0.333	96.4	8.66	242
	Total[c]	0.344	311	16.4	4,650
	Peak (Year)	**25.07 (2089–2096)**	**53.3 (2101)**	**5.02 (2101)**	**309 (2098–2099)**

Table 2–2 Waste Management Area Clean Closure Summary of Utility Infrastructure Requirements (2 pages)

Waste Management Area	Activity Phase	Electricity (million megawatt-hours)	Diesel Fuel[a]	Gasoline	Water
			(million liters)		
TX/TY	Construction	0.005	31.3	1.81	161
	Operations	0.011	240	7.91	5,470
	Deactivation	0.00[b]	0.180	0.231	0.00[b]
	Closure	0.445	123	11.2	313
	Total[c]	0.461	394	21.2	5,940
	Peak (Year)	**0.031 (2062–2065)**	**65.6 (2101)**	**6.17 (2101)**	**351 (2062–2065)**
U	Construction	0.004	18.6	1.23	89.2
	Operations	0.007	136	4.44	3,170
	Deactivation	0.00[b]	0.123	0.159	0.00[b]
	Closure	0.246	69.2	6.08	183
	Total[c]	0.257	224	11.90	3,450
	Peak (Year)	**0.016 (2035–2042)**	**36.0 (2101)**	**3.40 (2101)**	**327 (2035–2042)**

a Assumed to be inclusive of all Number 2 diesel fuel, including road diesel and heating fuel oil.

b Deactivation values of "0.00" reflect no demand for that utility.

c Totals may not equal the sum of the contributions due to rounding.

Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate. To convert liters to gallons, multiply by 0.26417.

Source: SAIC 2010.

2.3 NOISE AND VIBRATION

Facility construction, operations, deactivation, and closure activities would result in minor noise impacts of operation of employee vehicles, trucks, construction equipment, generators, and other equipment. The offsite noise levels from activities at the WTP and 200-East and 200-West Areas would be negligible due to the distance to the Hanford boundary. Heavy diesel equipment used for construction is expected to cause the highest noise levels. For example, if 504 items of construction equipment were operating at the RPPDF site with a sound pressure level of 88 decibels A-weighted (dBA) at 15 meters (50 feet), the contribution to the sound level at the nearest site boundary would be 21 dBA (SAIC 2012). During a normal daytime shift, the estimated maximum sound level at the site boundary would be well below the Washington State standard daytime maximum noise-level limit of 60 dBA for industrial sources impacting residential receptors (WAC 173-60).

Perceived Change in Sound Level

Change in Level	Perceived Change to the Human Ear
± 1 dB	Not perceptible
± 3 dB	Threshold of perception
± 5 dB	Clearly noticeable
± 10 dB	Twice (or half) as loud
± 20 dB	Fourfold change

Key: dB=decibel. **Source:** MPCA 1999:9.

Some disturbance of wildlife near the 200 Areas could occur as a result of heavy machinery noise during construction, deactivation, and closure activities. Noise from operational activities is expected to be similar to that from existing activities in these areas, resulting in little change in noise levels and impacts on wildlife. Mitigation of impacts on threatened and endangered species is discussed in Section 2.7.2 of this Clean Closure Practicability Demonstration.

The number of employee vehicles and trucks delivering materials for various phases of WMA clean closure activities would vary over the duration of the project. The increase in the number of employee vehicle and truck trips is expected to result in a minor increase in traffic noise levels along routes to the site.

Activities at Hanford associated with clean closure of the WMAs would involve excavation, earthmoving, transportation of fill material, and other vehicle traffic through Hanford, which could result in ground vibration potentially affecting operations of the Laser Interferometer Gravitational-Wave Observatory (LIGO). Most of the activities that would have impacts on LIGO would require the use of heavy vehicles or large construction equipment. It is expected that blasting would also have an impact on this facility if it is required for mining. Although the U.S. Department of Energy (DOE) would coordinate vibration-producing activities with LIGO, the impacts of such activities are expected to interfere to some degree with the operations of this facility.

Effects of Criteria Air Pollutants

Criteria air pollutants can harm health and the environment and cause property damage. The following are the chief pollutants of concern:

Carbon Monoxide – A colorless, odorless, and tasteless gas that is produced naturally by the human body, where it serves various physiological purposes. At abnormally high levels, however, carbon monoxide is highly toxic to humans and animals because prolonged exposure by inhalation can reduce oxygen in the bloodstream, causing a variety of diseases, including neurodegeneration, hypertension, heart failure, and inflammation.

Nitrogen Dioxide – One of the main precursors to the formation of ground-level ozone, nitrogen dioxide also contributes to the formation of acid rain and toxic chemicals, deterioration of water quality, impairment of visibility, and global warming.

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. Human or animal exposure to abnormally high levels of ozone can cause breathing difficulties such as aggravated asthma symptoms, as well as more-long-term respiratory illnesses such as lung irritation, reduced lung capacity, and permanent lung damage. High ozone levels also can make sensitive plants more susceptible to damage, affect the appearance of other plants, and reduce crop yields and forest growth.

Particulate Matter (PM) – Any finely divided solid or liquid material other than uncombined (i.e., pure) water. Inhalation of PM can result in increased respiratory symptoms, decreased lung function, aggravated asthma, development of chronic bronchitis, irregular heartbeat, nonfatal heart attacks, and premature death in people with heart or lung disease. Fine PM ($PM_{2.5}$) is a major cause of reduced visibility. PM also can contribute to acidification of streams and lakes, changes in the nutrient balance of coastal waters and larger river basins, depletion of nutrients in soil, damage to forests and crops, and damage to stone and other building materials.

Sulfur Dioxide – A common air pollutant that contributes to the formation of acid rain, which damages trees, crops, and buildings and makes soils, lakes, and streams acidic. Sulfur dioxide also contributes to reduced visibility.

Lead – The primary sources of lead emissions are ore and metals processing and leaded aviation gasoline use. Exposure to lead can damage organs, including the kidneys, liver, brain, and nerves, especially in infants and young children; it is also harmful to animals and fish.

Source: EPA 2007.

2.4 AIR QUALITY

WMA clean closure activities would result in some air quality impacts due to air pollutant emissions from employee vehicles, trucks, construction equipment, heating equipment, generators, and process equipment. Criteria pollutant concentrations that would result from

the WMA closure activities were modeled, and the year with peak concentrations for each WMA, pollutant, and averaging time was identified. Comparisons of these concentrations with the ambient standards are reflected in Table 2–3. The maximum concentrations resulting from these activities for each WMA would be below the ambient standards for the annual concentrations of nitrogen dioxide, except for WMA B/BX/BY and all sulfur dioxide averaging period concentrations. Standards would be exceeded for the 24-hour concentrations of particulate matter (PM), the annual concentrations of $PM_{2.5}$ [PM with an aerodynamic diameter less than or equal to 2.5 micrometers], the 1-hour concentrations of nitrogen dioxide, and the 1-hour and 8-hour concentrations of carbon monoxide. The peak period identified for each WMA and the primary contributing activities are discussed below. Maximum air quality impacts are expected to occur along State Route 240, along or near the Hanford boundary to the east and southeast, or along the Hanford Reach boundary to the west and southwest. The PM concentration estimates are high as a result of the correspondingly high estimated emissions. PM concentrations would be reduced by applying appropriate dust control measures (see the *Final TC & WM EIS*, Chapter 7, Section 7.1 [DOE 2012]).

Table 2-3 Waste Management Area Clean Closure Maximum Incremental Criteria Pollutant Concentrations

Pollutant and Averaging Period	Standard[a] (micrograms per cubic meter)	Maximum Modeled Increment (micrograms per cubic meter)						
		Waste Management Area						
		A/AX	B/BX/BY	C	S/SX	T	TX/TY	U
Carbon Monoxide								
8-hour	10,000[b]	**41,200**	**82,300**	**41,200**	**41,200**	**41,200**	**41,200**	**41,200**
1-hour	40,000[b]	**267,000**	**514,000**	**257,000**	**257,000**	**257,000**	**257,000**	**257,000**
Nitrogen Dioxide								
Annual	100[b]	88.9	**178**	88.9	88.9	88.9	88.9	88.9
1-hour	188	**179,000**	**357,000**	**179,000**	**179,000**	**179,000**	**179,000**	**179,000**
PM_{10}[c]								
Annual	50[d]	**119**	**120**	**119**	**119**	**119**	**120**	**119**
24-hour	150[b]	**16,800**	**16,900**	**16,800**	**16,800**	**16,800**	**16,900**	**16,800**
$PM_{2.5}$								
Annual	15[d]	**119**	**120**	**119**	**119**	**119**	**120**	**119**
24-hour	35[b]	**16,800**	**16,900**	**16,800**	**16,800**	**16,800**	**16,900**	**16,800**
Sulfur Dioxide								
Annual	50[d]	0.176	0.352	0.176	0.176	0.176	0.176	0.176
24-hour	260[d]	24.5	48.9	24.5	24.5	24.5	24.5	24.5
3-hour	1,300[b]	120	240	120	120	120	120	120
1-hour	197[e]	**353**	**706**	**353**	**353**	**353**	**353**	**353**

[a] The more stringent of the Federal and Washington State standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (40 CFR 50), other than those for ozone, particulate matter, lead, and those based on annual averages, are not to be exceeded more than once per year. The 24-hour PM_{10} standard is attained when the expected number of days with a 24-hour average concentration above the standard is less than or equal to 1. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard. The annual $PM_{2.5}$ standard is met when the 3-year average of the annual means is less than or equal to the standard. The 24-hour $PM_{2.5}$ standard is met when the 3-year average of the 98th percentile 24-hour averages is less than or equal to the standard. The 1-hour nitrogen dioxide standard is met when the 3-year average 98th percentile of the daily maximum 1-hour average does not exceed the standard value.

[b] Federal and Washington State standard.

[c] The Federal standards for $PM_{2.5}$ are 15 micrograms per cubic meter annual average and 35 micrograms per cubic meter 24-hour average. No specific data for $PM_{2.5}$ were available, but for analysis purposes, concentrations were assumed to be the same as those of PM_{10}.

[d] Washington State standard.

[e] Federal standard.

Note: The National Ambient Air Quality Standards also include standards for lead and ozone. No sources of lead emissions have been identified for the activities evaluated. Washington State also has ambient standards for fluorides. Concentrations in **bold** text indicate potential exceedance of the standard.

Key: PM_n=particulate matter with an aerodynamic diameter less than or equal to *n* micrometers.

Source: Based on emissions data in SAIC 2012.

Construction activities considered in estimating PM emissions include general construction equipment activity, windblown particulates from disturbed areas, resuspension of road dust, fuel combustion in construction equipment, and concrete batch plant operations. The emission factor used for these estimates is intended to provide a gross estimate of total suspended particulate emissions when detailed engineering data that would allow for a more refined estimate are not available. For the purpose of this analysis, emissions of PM_{10} [PM with an aerodynamic diameter less than or equal to 10 micrometers] and $PM_{2.5}$ from general construction activities were assumed to be the same as the total suspended particulate emissions. This results in a substantial overestimate of PM_{10} and $PM_{2.5}$ emissions. Further, the analysis did not consider emission controls that could be applied in the construction areas, as discussed in the *Final TC & WM EIS*, Chapter 7, Section 7.1. A refined analysis of emissions based on more-detailed engineering data on the construction activities and application of appropriate control technologies is expected to result in substantially lower estimates of emissions and ambient concentrations from the major construction activities.

The sulfur dioxide emission factor used for fuel-burning sources was based on equipment burning a distillate fuel with a sulfur content of about 0.0015 percent (15 parts per million), which was phased in beginning in 2007.

No adjustment was made for more-restrictive emission standards for nitrogen dioxide and PM, which also were phased in beginning in 2007. In future years, pollutant emissions and impacts are expected to be smaller than estimated in this analysis as better fuels, combustion technologies, emission controls, and alternative energy sources are developed.

The contributions to the total ambient concentrations from sources in the region and existing and reasonably anticipated sources at Hanford that are unrelated to WMA clean closure activities are expected to change over the period of the activities evaluated. The existing contributions of Hanford sources and regional monitored concentrations are discussed in the *Final TC & WM EIS*, Chapter 3, Section 3.2.4.

The Clean Air Act, as amended, requires that Federal actions conform to the host state's "state implementation plan" (see the *Final TC & WM EIS*, Appendix G, Section G.4). The final rule, "Determining Conformity of General Federal Actions to State or Federal Implementation Plans," requires a conformity determination for certain size projects in nonattainment areas. Hanford is within an area currently designated as in attainment for criteria air pollutants. Therefore, a conformity determination for these WMAs is not necessary to meet the requirements of the final rule (40 CFR 93, Subpart B).

Both carcinogenic and noncarcinogenic nonradioactive toxic pollutant concentrations were evaluated. Potential exposure of members of the public to airborne pollutants would come from process emissions during operations and emissions from equipment used during construction, operations, deactivation, and closure. Selected air toxics were modeled because they represent toxic constituents associated with emissions from operation of gasoline- and diesel-fueled equipment. Ammonia was also selected for modeling because of its relatively high concentration compared with other toxic constituents in the tank vapor spaces. Ammonia's concentration, combined with its toxicity, makes it a good indicator constituent for analysis; that is, if ammonia is found to be within the acceptable source impact level, other toxics should be as well. Maximum concentrations resulting from clean closure of each WMA and the Washington State acceptable source impact levels are presented in Table 2–4. These concentrations were below the acceptable source impact levels for all WMAs. The acceptable source impact levels used by the state in the permitting process represent concentrations that are sufficiently low to protect human health and safety from potential carcinogenic and other toxic effects (WAC 173-460 "Controls for New Sources of Toxic Air Pollutants").

Table 2-4 Waste Management Area Clean Closure Maximum Incremental Nonradioactive Toxic Chemical Concentrations

Pollutant	Averaging Period	Acceptable Source Impact Level[a]	Maximum Modeled Increment (micrograms per cubic meter)						
			Waste Management Area						
			A/AX	B/BX/BY	C	S/SX	T	TX/TY	U
Ammonia	24-hour	70.8	20.0	40.0	20.0	20.0	20.0	20.0	20.0
Benzene	Annual	0.0345	0.0323	0.0646	0.0323	0.0323	0.0323	0.0323	0.0323
1,3-Butadiene	Annual	0.00588	0.000842	0.00168	0.000842	0.000842	0.000842	0.000842	0.000842
Formaldehyde	Annual	0.167	0.0278	0.0555	0.0278	0.0278	0.0278	0.0278	0.0278
Mercury	24-hour	0.09	0.00000491	0.00000655	0.0000000614	0.00000647	0.00000631	0.00000635	0.00000655
Toluene	24-hour	5,000	31.2	62.5	31.2	31.2	31.2	31.2	31.2
Xylene	24-hour	(b)	9.27	18.5	9.27	9.27	9.27	9.27	9.27

[a] Micrograms per cubic meter. WAC 173-460.

[b] Not listed in WAC 173-460.

Note: To convert cubic meters to cubic feet, multiply by 35.315.

Source: Based on emissions data in SAIC 2012.

For noninvolved workers at nearby facilities, the highest annual concentration of each nonradioactive toxic chemical was used to estimate the Hazard Quotient for each chemical, as described in the *Final TC & WM EIS*, Appendix G. The Hazard Quotients were summed to give the Hazard Index from noncarcinogenic chemicals associated with clean closure of each WMA. A Hazard Index of less than 1 indicates that adverse health effects of non-cancer-causing agents are not expected. Hazard Indices for each WMA are summarized in Table 2–5. For carcinogens, the highest annual concentration was used to estimate the increased cancer risk from exposure to a chemical. Cancer risks from nonradioactive toxic pollutant emissions due to clean closure of each WMA are summarized in Table 2–6.

Table 2-5 Waste Management Area Clean Closure Nonradioactive Airborne Toxic Chemical Hazard Index for the Nearest Noninvolved Worker

	Hazard Quotient						
	Waste Management Area						
Chemical	**A/AX**	**B/BX/BY**	**C**	**S/SX**	**T**	**TX/TY**	**U**
Ammonia	1.14×10^{-1}	2.25×10^{-1}	1.13×10^{-1}	1.69×10^{-1}	1.14×10^{-1}	1.51×10^{-1}	1.14×10^{-1}
Mercury	2.14×10^{-5}	2.86×10^{-5}	2.68×10^{-7}	2.83×10^{-5}	2.76×10^{-5}	2.77×10^{-5}	2.86×10^{-5}
Toluene	1.89×10^{-3}	3.70×10^{-3}	1.89×10^{-3}	1.98×10^{-3}	1.89×10^{-3}	1.94×10^{-3}	1.89×10^{-3}
Xylene	2.84×10^{-2}	5.56×10^{-2}	2.84×10^{-2}	3.00×10^{-2}	2.85×10^{-2}	2.93×10^{-2}	2.84×10^{-2}
Hazard Index	1.44×10^{-1}	2.84×10^{-1}	1.44×10^{-1}	2.01×10^{-1}	1.44×10^{-1}	1.82×10^{-1}	1.44×10^{-1}

Source: Based on emissions data in SAIC 2012.

Table 2-6 Waste Management Area Clean Closure Nonradioactive Airborne Toxic Chemical Cancer Risk for the Nearest Noninvolved Worker

	Cancer Risk						
	Waste Management Area						
Chemical	**A/AX**	**B/BX/BY**	**C**	**S/SX**	**T**	**TX/TY**	**U**
Benzene	1.20×10^{-5}	2.36×10^{-5}	1.20×10^{-5}	1.38×10^{-5}	1.20×10^{-5}	1.26×10^{-5}	1.20×10^{-5}
1,3-Butadiene	1.30×10^{-6}	2.55×10^{-6}	1.29×10^{-6}	1.56×10^{-6}	1.30×10^{-6}	1.38×10^{-6}	1.30×10^{-6}
Formaldehyde	1.82×10^{-5}	3.59×10^{-5}	1.82×10^{-5}	2.18×10^{-5}	1.83×10^{-5}	1.94×10^{-5}	1.83×10^{-5}

Source: Based on emissions data in SAIC 2012.

2.5 GEOLOGY AND SOILS

This section presents the potential impacts of the clean closure activities for the seven WMAs on key geology and soil resources. Activities include site excavation and grading; construction of building foundations, roadways, parking areas, and laydown areas; disturbances from exhumation of contaminated soils and other media associated with clean tank closure; and construction, operations, closure, and postclosure operations of the IDF and the proposed RPPDF.

Excavation depths for facility construction required for clean closure are not expected to exceed approximately 12 meters (40 feet) and would be limited by the depth of excavation needed to pour concrete foundations for the various treatment facilities. The gravel, sand, and silt deposits of the Hanford formation, which compose the uppermost strata across the 200 Areas, are up to 65 meters (213 feet) thick across the 200 Areas, so the lateral and vertical extent of this unit

would not be greatly impacted by facility construction. Uncontaminated soils and sediments excavated during facility construction would typically be stockpiled on site for future construction uses, such as foundation backfill.

Consumption of geologic resources (rock, minerals, and soils) to support facility construction, operations, and deactivation, as applicable, would constitute the major indirect impact on geologic and soil resources from implementation of clean closure of each WMA and associated waste management activities, as summarized in Table 2–7. Varying quantities of geologic resources would be required for ongoing facility construction; upgrades to existing facilities, including the 200 Area tank farms; waste retrieval activities; and, most substantially, tank farm closure. Geologic resources, including relatively large volumes of gravel, sand, and silt, are available from the suprabasalt sediments and associated soils at Hanford. Rock, in the form of basalt, is also plentiful. As discussed in the *Environmental Assessment, Use of Existing Borrow Areas, Hanford Site, Richland, Washington* (DOE 2001a), a number of active gravel and sand pits and two rock quarries at Hanford have been identified for use in providing a continual supply of borrow materials for new facility construction, maintenance of existing facilities, and fill and capping material for remediation and other activities. Of the two active quarries on the site, quarry No. 2 (Borrow Area C), located due south of the 200-West Area just south of State Route 240, has large volumes of basalt and sand (DOE 2001a). This approximately 926.3-hectare (2,289-acre) borrow area has been designated as a source of materials such as rock riprap (basalt), aggregate (gravel and sand), and soil (silt and loam) that would be needed to support tank farm closure and supporting activities, as described in this *Clean Closure Practicability Demonstration* (DOE 2003a).

In addition, gravel pit No. 30, located between the 200-East and 200-West Areas, would continue to provide aggregate (gravel and sand) for operation of onsite concrete batch plants to support new facility construction. Cement (a product of limestone and other minerals) to feed the batch plants would continue to be procured via offsite sources. Additional borrow materials would also be required for site grading, backfilling excavations, and other uses and could be obtained from either Borrow Area C or gravel pit No. 30.

Materials would also be required for construction of barriers for landfill closure of the IDF and proposed RPPDF. These engineered barriers would be composed of layers of topsoil in the upper part, underlain by layers of sand, gravel, asphalt, and/or riprap in the lower part. The structures would be approximately 2.7 meters (9 feet) thick for the modified Resource Conservation and Recovery Act (RCRA) Subtitle C barriers. For postclosure care of the landfills, sodium bentonite clay or grout would be required for completion of groundwater monitoring wells (DOE 2003a).

Development of Borrow Area C using modern open-pit excavation techniques (with excavations averaging 4.6 meters [15 feet] deep) and allocating 20 percent of the total site for cut-slope maintenance, haul roads, and stockpile and buffer areas could yield, conservatively, 34.3 million cubic meters (44.9 million cubic yards) of borrow material to address the geologic resource requirements discussed above. In addition, gravel pit No. 30 is an approximately 54-hectare (134-acre) borrow site containing a large quantity of aggregate suitable for multiple uses (DOE 2001a). Aggregate reserves at gravel pit No. 30 are estimated at 15.3 million cubic meters (20 million cubic yards) of material (DOE 1999), part of the estimated total of 49.6 million cubic

meters (64.9 million cubic yards) of borrow materials available on site. To access Borrow Area C, a 2.0-kilometer long (1.25-mile-long) paved haul road was completed in 2006 from State Route 240 and the intersection of Beloit Avenue south to Borrow Area C to enable transport of excavated borrow materials to points of use across Hanford. It was assumed for analysis purposes that gravel pit No. 30 and Borrow Area C would be available and would be operated for as long as necessary to support the active project phase associated with each WMA.

Facilities constructed to support WMA clean closure would be deactivated when they are no longer needed. This activity is not expected to directly impact geology and soils, as facilities would not be demolished or destroyed, and no additional land disturbance should be required. Waste materials and contaminated media would be removed from deactivated facilities and properly disposed of; they would not be disposed of in an unabated manner where they could contaminate geologic materials or underlying groundwater.

Table 2-7 Waste Management Area Clean Closure Summary of Major Geologic and Soil Resource Impact Indicators and Requirements

Waste Management Area	Construction Materials				Other Borrow Materials[a]				Closure-Specific Materials		
	Concrete/ Grout	Cement[b]	Sand[b]	Gravel[b]	Rock/ Basalt	Sand	Gravel	Soil (Specification Backfill)	Grout[c]	Cement	Sand[d]
A/AX	64,500	13,600	31,500	29,500	0	245,000	125,000	4,210,000	970	120	470
B/BX/BY	188,000	41,700	91,300	97,800	0	388,000	206,000	7,970,000	1,640	190	770
C	61,500	14,800	29,800	37,300	0	22,900	16,700	1,190,000	120	14	60
S/SX	192,200	38,600	93,300	79,300	0	852,000	431,000	11,000,000	3,360	400	1,640
T	119,000	23,600	57,500	48,000	0	547,000	277,000	9,100,000	2,160	260	1,050
TX/TY	161,000	32,900	78,000	69,000	0	671,000	341,000	11,400,000	2,650	310	1,290
U	98,700	20,700	48,000	45,100	0	368,000	188,000	6,380,000	1,460	170	710

a Resources for miscellaneous uses not exclusively tied to facility construction, operations, or closure, such as site grading and backfill for operations.

b Cement, sand, and gravel are components of concrete.

c Grout is composed of cement, sand, fly ash, and other materials.

d Principal component of grout that would be obtained from onsite deposits.

Note: All values are expressed in cubic meters. To convert cubic meters to cubic feet, multiply by 35.315.

Construction of new facilities to support clean closure of the SST system, as analyzed in the *Final TC & WM EIS* (DOE 2012) under Tank Closure Alternative 6B, Base Case, would permanently disturb about 119 hectares (294 acres) of land. Most of this activity would be located within or adjacent to the 200-East or 200-West Area.

To support clean closure activities, domed containment structures would be temporarily erected over each tank farm in the 200-East and 200-West Areas to facilitate excavation and removal of contaminated soils, tanks, and associated ancillary equipment within these areas. Finally, a PPF for treatment of highly contaminated deep soils generated during clean closure activities would be constructed to the west of the 200-East Area. An additional 240 hectares (592 acres) would be excavated from Borrow Area C, totaling 359 hectares (886 acres) of new, permanent land disturbance.

Excavation work associated with constructing an expanded IDF in the 200-East Area (IDF-East) and the proposed RPPDF between the 200-East and 200-West Areas would constitute the major direct impact on geology and soils due to WMA clean closure activities. Construction of IDF-East and the RPPDF would require excavation to a depth of approximately 14 meters (45 feet) (see the *Final TC & WM EIS*, Appendix E, Sections E.3.4 and E.3.5 [DOE 2012]). Blasting should not be required to support construction of these facilities because the gravel, sand, and silt deposits of the Hanford formation, which compose the uppermost strata across the 200 Areas, are up to 65 meters (213 feet) thick across the 200 Areas. Coarse aggregate (gravel) would be used to construct drainage layers that are integral to each engineered disposal facility. At the end of their life cycles, the facilities would be closed with an engineered barrier that would extend over an additional 1.6 hectares (4 acres) of previously disturbed land, as further described below. As with any ground-disturbing activity, denuded surface soils and unconsolidated sediments in excavations and graded areas would be subject to wind and water erosion if left exposed over an extended period of time. Adherence to standard best management practices for soil erosion and sediment control during construction would minimize soil erosion and loss. During the 3-year construction period for each of the facilities, temporary seeding, mulching, and the use of geotextile covers and similar best management practices would be employed to minimize soil erosion in disturbed areas. After construction, the previously disturbed areas would not be subject to long-term soil erosion because the areas would either lie within the footprint of the completed structures or the temporarily disturbed areas would be revegetated.

Disposal facility operations through 2100 are not expected to have any additional direct impact on geology and soils. Operations of IDF-East and the proposed RPPDF would require the use of soil to cover each layer of emplaced waste. However, the soil would be derived from stockpiles excavated during facility construction. Following completion of disposal activities in IDF-East and the RPPDF, these engineered facilities would be closed with a modified RCRA Subtitle C barrier. The 2.7-meter-thick (9-foot-thick) engineered barrier would be composed of layers of topsoil in the upper part, which would support a mixed perennial grass ground cover, underlain by layers of sand, gravel, asphalt, and/or riprap in the lower part. Best management practices for soil erosion and sediment control would be employed during barrier construction, including watering to control fugitive dust. The final barriers would encompass approximately 63.9 hectares (158 acres), slightly larger than the footprints of the disposal facilities. During the 100-year postclosure care period for IDF-East and the RPPDF, sodium bentonite clay or grout would be required for completion of groundwater monitoring wells.

2.6 WATER RESOURCES

This section presents the potential direct, short-term impacts of implementing clean closure of the WMAs on water resources, encompassing surface water, the vadose zone, and groundwater. Potential short-term impacts of facility construction, operations, deactivation, and closure activities were analyzed over the active project phase for clean closure of each WMA, extending through the 100-year postclosure monitoring period.

The same construction, operations, deactivation, and closure activities would occur at each WMA, except no deep soil removal would occur at the BY tank farm (WMA B/BX/BY), the S Tank Farm (WMA S/SX), or the TY Tank Farm (WMA TX/TY).

Direct impacts of clean closure on surface water, the vadose zone, and groundwater would be similar in nature at all of the WMAs; any variability would be related to the intensity and duration of the activities conducted at each WMA. Generally, facility construction activities are not expected to have any direct impact on surface-water features, including the Columbia River, as there are no natural, perennial surface-water drainages on the Central Plateau of Hanford. While several manmade ponds and impoundments are located in the 200 Areas, including the two Treated Effluent Disposal Facility disposal ponds and the three Liquid Effluent Retention Facility impoundments adjacent to the 200-East Area, these ponds and impoundments would not be directly impacted by construction activities. In addition, no portion of the 200 Areas lies within a floodplain. Although the southwest corner of the 200-West Area is within the probable maximum flood zone of Cold Creek, no facilities would be constructed there under any of the clean closure activities for the WMAs.

All construction- and clean closure–related land disturbances, especially for new facility construction, would expose soils and sediments to possible erosion by infrequent, heavy rainfall or by wind. While unlikely to reach surface-water features, as discussed above, stormwater runoff from exposed areas could convey soil, sediments, and other pollutants (e.g., construction waste materials and spilled materials, such as petroleum, oils, and lubricants from construction equipment) from construction footprint and laydown areas. Nevertheless, appropriate soil erosion and sediment control measures, as well as spill prevention and waste management practices, would be employed to minimize suspended sediment, the transport of other deleterious materials, and any potential water quality impacts. Further, all construction and other ground-disturbing activities would be conducted in accordance with current National Pollutant Discharge Elimination System (NPDES) and state waste discharge general permits for stormwater discharges associated with construction activities, issued by the Washington State Department of Ecology. The NPDES permit specifically requires the development and implementation of a stormwater pollution prevention plan.

Once completed, new facilities required for WMA clean closure would incorporate appropriate stormwater management controls to collect, convey, and detain stormwater from buildings and other impervious surfaces so as to minimize the impacts of onsite hydrology and soil erosion. Hanford's NPDES Storm Water Multi Sector General Permit would cover stormwater discharges associated with industrial activity and, as necessary, stormwater discharges would be covered under state waste discharge permits for discharges to the ground.

Under normal operations associated with WMA clean closure, facility design combined with adherence to spill prevention and emergency response plans and procedures would help to ensure that involved hazardous substances, including spills, should they occur, do not reach soils or surfaces where they could be conveyed to surface water or groundwater. For construction, operations, deactivation, and closure activities, adherence to best management practices and other preventive measures under applicable permits and compliance plans would be coordinated by DOE with those measures in similar sitewide pollution prevention plans.

Projected impacts on water resources specific to implementation of clean closure at each of the WMAs are presented in Chapter 3 of this *Clean Closure Practicability Demonstration*.

There would be no direct discharge of effluents to either surface water or groundwater during construction, operations, and deactivation as a result of clean closure of the WMAs. Nonhazardous sanitary wastewater (sewage) would be managed via appropriate sanitary wastewater collection and treatment systems. During the early phases of new facility construction, it was assumed that portable toilet facilities would be provided for construction personnel, with collected waste disposed of at offsite contractor facilities, as is standard construction practice. During facility operations and deactivation, sanitary wastewater would be disposed of via the dedicated sanitary sewer or septic/drain-field system serving a particular facility.

Water would be required to support new facility construction, facility operations, and facility deactivation for clean closure of the WMAs. For each WMA, water would be required for WRF construction; replacement of underground transfer lines; and construction of tank upgrades, a new riser, a MRS and VBR system, the PPF, IDF-East, and the proposed RPPDF that will be located between the 200-East and 200-West Areas. Peak periods of water demands would occur during the years of operation of both Borrow Area C and the RPPDF. Total water demands, as well as peak water demands, are listed for all of the WMAs in Table 2–8. All utility demands, as well as water demands, are discussed in Section 2.2, Infrastructure.

Table 2-8 Waste Management Area Clean Closure Water Demands

Waste Management Area	Total Water Demand (million liters)	Peak Water Demand (million liters)	Peak Water Demand
A/AX	2,290	266	2094–2095
B/BX/BY	4,990	332	2043
C	1,120	92.3	2062–2069
S/SX	7,970	397	2038–2039
T	4,650	308	2098–2099
TX/TY	5,940	351	2062–2065
U	3,440	327	2035–2042

Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate. To convert liters to gallons, multiply by 0.26417.
Source: SAIC 2010.

2.7 ECOLOGICAL RESOURCES

Clean closure of any of the seven WMAs evaluated would involve land-disturbing activities associated with construction of an underground transfer line, WRF, HLW Debris Storage Facility, PPF, IDF, and the proposed RPPDF. Clean closure activities would also require the extraction of material from Borrow Area C. Each of these activities has the potential to disturb ecological resources. As detailed in Chapter 4 of the *Final TC & WM EIS* (DOE 2012), there would be no short-term impacts on wetlands or aquatic resources as a result of activities associated with WMA clean closure. However, terrestrial resources and threatened and endangered species could be impacted and are therefore addressed below.

For most facilities and activities, the area of potential habitat disturbed was determined by use of a scaling factor that adjusted the total land requirement for closing all Hanford tank farms (as reported in the *Final TC & WM EIS*) to a specific value for each WMA. However, this was not done for the WRF and PPF, as the minimum requirement to close a WMA is one facility. Also, it was not necessary to scale the length of the underground transfer line. Once the total land requirement was determined, the next step was to determine how much of that land had not been previously disturbed and whether it was sagebrush habitat. Sagebrush habitat was specifically addressed, as Washington State considers pristine shrub-steppe habitat to be a priority habitat because of its relative scarcity in the state and its importance to several state-listed wildlife species (WDFW 2007). Designation and characterization of priority habitat provide a basis for sound, defensible land management planning and assist in the management of regulated species. Sagebrush communities are also considered a Level III resource under the *Hanford Site Biological Resources Management Plan* (DOE 2001b). Biological resources are ranked from Level I to Level IV, with Level IV being the most significant in terms of the presence of threatened or endangered species, as well as rare, unique, or vanishing habitat. Impacts on Level III resources should be avoided or minimized; however, when avoidance and minimization are not possible, rectification or mitigation is recommended (DOE 2001b:4.7). With respect to threatened and endangered species, information developed for the *Final TC & WM EIS* (DOE 2012) (see Chapter 3, Section 3.2.4.7) was utilized to determine if any such species would be affected by the clean closure of any of the seven WMAs.

2.7.1 Terrestrial Resources

As noted in Section 2.1.1 (see Table 2–1), most of the land required for the clean closure of any of the seven WMAs evaluated is located between the 200-East and 200-West Areas and within Borrow Area C, all of which is undeveloped. Within the 200-East Area, nearly all of the land needed for construction required for clean closure of any of the seven WMAs is undeveloped, some of which is sagebrush habitat. Between the 200-East and 200-West Areas, all of the land needed for construction is sagebrush habitat, whereas, within the 200-West Area, all of the land needed for construction has been previously disturbed. The clean closure of one or more of the WMAs in the 200-East Area would result in the loss of 1.21 hectares (3 acres) of sagebrush habitat from construction of the underground transfer line; this loss would not be mitigable. Hanford guidance may require that the loss of other sagebrush habitat in the 200-East Area and between the 200-East and 200-West Areas be replaced at a ratio ranging from 1:1 to 3:1 (DOE 2003b:20, 21, 31). Specific measures to mitigate the loss of sagebrush habitat would be set forth in a mitigation action plan prior to construction.

As noted in the *Final TC & WM EIS* (see Chapter 3, Section 3.2.7.1), the two major plant communities present within Borrow Area C are cheatgrass-bluegrass (782 hectares [1,933 acres]) and needle-and-thread grass/Indian ricegrass (107 hectares [265 acres]). The latter represents an unusual and relatively pristine community type at Hanford; thus, it is considered a more highly valued community than the former. It is not possible to determine specific impacts of excavating Borrow Area C on ecological resources because the particular portion of the site from which geologic material would be excavated is unknown. To the extent that it is possible, the needle-and-thread grass/Indian ricegrass community should be avoided during excavation. A mitigation action plan would be developed prior to excavation.

2.7.2 Threatened and Endangered Species

Federally or state-listed threatened or endangered species have not been observed within, or in the immediate vicinity of, the 200 Areas or Borrow Area C; therefore, impacts on this group of plants and animals are not expected as a result of the clean closure of any of the seven WMAs. Both the Columbia and Yakima Rivers adjacent to Hanford have been designated as critical habitat for the bull trout. However, as there would be no short-term impacts on either river from construction or operation of new facilities associated with clean closure of any of the seven WMAs, designated critical habitat would not be adversely affected.

A number of state-listed, special status species observed within areas that would be disturbed by clean closure of any of the seven WMAs could be impacted by construction of the various required facilities. Three state-listed species were observed within areas that could be disturbed within the 200-East Area. The black-tailed jackrabbit (state candidate) and Piper's daisy (state sensitive) have been observed on or near the underground transfer line route, and the sage sparrow (state candidate) has been observed within the IDF vicinity. In addition, the loggerhead shrike (Federal species of concern and state candidate), black-tailed jackrabbit, sage sparrow, and crouching milkvetch (state watch) have all been observed between the 200-East and 200-West Areas where the HLW Debris Storage Facility, PPF, and the proposed RPPDF would be located. Finally, surveys have identified Piper's daisy, stalked-pod milkvetch (state watch), crouching milkvetch, and the long-billed curlew (state monitor) within the boundaries of Borrow Area C. No state-listed, special status species have been observed within areas to be disturbed within the 200-West Area. The operation of new facilities is not expected to impact any listed species.

Although mitigation would not be required for the state monitor and watch species, they should be considered during project planning. Impacts on state candidate and sensitive species, which are considered Level III resources under the *Hanford Site Biological Resources Management Plan*, require mitigation where impacts would occur. When avoidance and minimization are not possible or are insufficient, mitigation via rectification or compensation is recommended (DOE 2001b:4.9, 8.11). A comprehensive mitigation action plan, which would deal with the loss of state-listed species (as well as sagebrush habitat), would be developed prior to construction.

2.8 CULTURAL AND PALEONTOLOGICAL RESOURCES

2.8.1 Prehistoric Resources

White Bluffs Road, which was originally an American Indian trail but was also used by early settlers, passes from southwest to northeast across the 200-West Area (see Chapter 3,

Section 3.2.8.1.2, of the *Final TC & WM EIS* [DOE 2012]). A number of prehistoric artifacts were found in the northwestern portion of the 200-West Area and immediately east of the 200-East Area; however, there are no known prehistoric resources within the areas that would be affected by the clean closure of any of the seven WMAs. The survey and geology of these areas indicate that subsurface cultural deposits have little or no potential of being present. The *Hanford Cultural Resources Management Plan* (DOE 2003c) provides guidance for identifying, evaluating, recording, curating, and managing cultural resources. If any prehistoric resources were discovered during construction or excavation, procedures from the *Hanford Cultural Resources Management Plan* would be implemented.

2.8.2 Historic Resources

There would be no impacts on White Bluffs Road or on other known early historic artifacts within the 200-East or 200-West Area from construction or excavation required for clean closure of any of the seven WMAs. In addition to White Bluffs Road in the 200-West Area, historic resources have been found in the south-central part of the 200-East Area (see Chapter 3, Section 3.2.8.2.2, of the *Final TC & WM EIS*). Buildings associated with the Manhattan Project and Cold War era are found within both the 200-East and 200-West Areas; however, none of these structures would be affected. As is the case for prehistoric resources, if historic resources were discovered, procedures in place to properly identify, evaluate, record, curate, and manage the discovery site would be implemented.

2.8.3 American Indian Interests

As stated above, there are no known prehistoric resources that may be an American Indian interest within the affected areas required for the clean closure of any of the seven WMAs. Clean closure of any of the seven WMAs would impact undeveloped land between the 200-East and 200-West Areas (see Section 2.1.1). The conversion of this land to industrial use would be noticeably visible from nearby higher elevations, such as Gable Mountain and Gable Butte. The viewscape from these higher elevations is important to American Indians with cultural ties to Hanford. There would be little impact on the viewscape within the 200-East and 200-West Areas, as the areas are already highly industrialized.

Clean closure of any of the seven WMAs would also require excavation within Borrow Area C. This would also have an impact on the viewscape from Rattlesnake Mountain; however, upon completion of the work, excavations of Borrow Area C would be recontoured and revegetated, thus lessening the visual impact. Appropriate mitigation measures would be developed in consultation with area tribes.

2.8.4 Paleontological Resources

No paleontological resources have been discovered within the 200 Areas or Borrow Area C; therefore, clean closure of any of the seven WMAs would not impact such resources. However, if any paleontological resources were found during construction or excavation, procedures to properly manage the discovery site would be implemented.

2.9 SOCIOECONOMICS

The potential primary (direct) and secondary (indirect) impacts of WMA clean closure activities on employment, regional demographics, housing and community services, and local

transportation were analyzed. The potential primary impacts were identified by analyzing projected changes in employment (in terms of full-time equivalents [FTE]) and truck activity related to the clean closure implementation. The projected changes in employment and truck activity could impact the need for housing units, public services, and local transportation in the region.

When calculating workforce estimates, partial FTE employee quantities were rounded up to the nearest whole FTE. The resulting conservative workforce estimates represent the upper limit of workforce requirements. As shown in Table 2–9, for each type of activity (e.g., construction, operations, closure), a peak workforce estimate was calculated and the year(s) in which the peak occurred was noted. As each activity type may peak during different years, the totals do not add up because they represent different time periods.

The conversion factor used when calculating the number of trips per day from trips per year was 260 days worked in a year. In addition, the number of calculated truck trips associated with the various activities was rounded up to the nearest whole trip. Impacts of onsite truck trips, i.e., trips conducted solely onsite, are included in the onsite analysis. Impacts of the onsite portion of truck trips to or from the site are included in the offsite analysis.

Table 2-9 Waste Management Area Clean Closure Estimated Peak Workforce

Waste Management Area	Work Activity	Peak Year(s)	Workforce Peak (FTEs)
A/AX	Construction	2033–2034	1,260
	Operations	2038–2039	693
	Deactivation	2040–2041	36
	Closure	2101	724
	Total Onsite Workforce	**2033–2034**	**1,260**
B/BX/BY	Construction	2013	1,920
	Operations	2014–2017	1,880
	Deactivation	2015–2018	42
	Closure	2101	1,180
	Total Onsite Workforce	**2014**	**3,570**
C	Construction	2021–2023	1,320
	Operations	2024–2027	761
	Deactivation	2031–2033	38
	Closure	2101	93
	Total Onsite Workforce	**2021**	**1,330**
S/SX	Construction	2013	1,490
	Operations	2016–2017	1,680
	Deactivation	2040–2041	41
	Closure	2101	2,500
	Total Onsite Workforce	**2015**	**2,590**
T	Construction	2032–2034	1,270
	Operations	2038	1,850
	Deactivation	2042	41
	Closure	2101	1,610
	Total Onsite Workforce	**2038**	**1,850**
TX/TY	Construction	2023	2,470
	Operations	2026	1,460
	Deactivation	2028	39
	Closure	2101	1,970
	Total Onsite Workforce	**2026**	**2,490**
U	Construction	2013	1,590
	Operations	2016–2017	1,850
	Deactivation	2017–2018	41
	Closure	2101	1,090
	Total Onsite Workforce	**2015**	**2,800**

Key: FTE=full-time equivalent.

2.10 PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY – NORMAL OPERATIONS

Radiological impacts associated with clean closure of the WMAs would result from normal operations and could occur for unplanned events (accidents or intentional destructive acts). Results of the analysis are presented for the population within 80 kilometers (50 miles) of the 200-East and 200-West Areas, a maximally exposed individual (MEI), and workers.

Table 2–10 summarizes the impacts of normal operations on members of the public for clean closure of each of the WMAs. Members of the public would be exposed to radioactive materials emitted from facilities and activities associated with clean closure. For normal operations, the MEI is a hypothetical resident living along the Columbia River east-northeast of the 200 Areas. In addition to the resident MEI, impacts are also presented for an onsite MEI, a person not associated with DOE's Hanford activities who works on the site. The onsite MEI was determined to be a worker at the US Ecology Commercial Low-Level Radioactive Waste Disposal Site between the 200-East and 200-West Areas. Impacts on each receptor are estimated for the duration of the project, i.e., WMA clean closure, and for the year of maximum impact. The dominant source of normal operations emissions affecting the public would be the PPF.

Table 2–11 summarizes the impacts of normal operations on workers associated with the WMA clean closure activities and on noninvolved workers. Workers associated with clean closure activities would be exposed as a result of their proximity to the radiation sources resulting from tank waste and contaminated soils. A noninvolved worker is a Hanford worker at another facility who is exposed via air emission. As with the public exposures, the total project doses are strongly correlated with the volume of contaminated soil that would be excavated to accomplish clean closure.

Table 2–12 presents the impacts on members of the public and a noninvolved worker of unplanned events. These events, a seismically induced collapse of a waste tank dome and an intentionally initiated explosion in a waste tank, are considered applicable to any tank farm; the potential impacts are not evaluated on an individual WMA basis. For the seismically induced tank dome collapse, Table 2–12 shows the consequences (the impact if the event occurred) in terms of dose and the number of latent cancer fatalities (LCF) in the population or the risk of an LCF for an individual. Table 2–12 also shows the annual risk of an LCF when the probability (frequency) of an earthquake of sufficient magnitude to cause a tank dome collapse is taken into account. The consequences of the postulated intentional destructive act are also shown in Table 2–12. The impacts of this event, if it were to occur, would be about four times higher than those of the tank dome collapse accident. DOE conducts vulnerability assessments and risk analyses of facilities and equipment under its jurisdiction to evaluate the physical protection elements, technologies, and administrative controls needed to protect DOE assets. Physical and administrative access controls designed to protect against sabotage make this scenario an extremely unlikely event; the probability of this event occurring is not estimated.

Table 2-10 Waste Management Area Clean Closure Summary of Radiological Impacts of Normal Operations on the Public

	Waste Management Area						
	A/AX	B/BX/BY	C	S/SX	T	TX/TY	U
Offsite Population							
Project Total Impact							
Dose (person-rem)	5.3	8.6	0.64	19	12	14	7.9
LCFs[a]	0 (0.003)	0 (0.005)	0 (0.0004)	0 (0.01)	0 (0.007)	0 (0.009)	0 (0.005)
Maximum Annual Impact							
Dose (person-rem)	0.61	0.81	0.078	0.87	0.80	0.80	0.81
LCFs[a]	0 (0.0004)	0 (0.0005)	0 (0.00005)	0 (0.0005)	0 (0.0005)	0 (0.0005)	0 (0.0005)
Maximally Exposed Individual							
Project Total Impact							
Dose (millirem)	0.56	0.96	0.093	1.9	1.2	1.4	0.80
LCF risk[b]	0.0000003	0.0000006	0.00000006	0.000001	0.0000007	0.0000009	0.0000005
Maximum Annual Impact							
Dose (millirem)	0.063	0.084	0.0080	0.088	0.081	0.082	0.083
LCF risk[b]	0.00000004	0.00000005	0.000000005	0.00000005	0.00000005	0.00000005	0.00000005
Onsite Maximally Exposed Individual							
Project Total Impact							
Dose (millirem)	0.22	0.35	0.024	0.84	0.52	0.65	0.37
LCF risk[b]	0.0000001	0.0000002	0.00000001	0.0000005	0.0000003	0.0000004	0.0000002
Maximum Annual Impact							
Dose (millirem)	0.025	0.034	0.0032	0.039	0.035	0.036	0.035
LCF risk[b]	0.00000002	0.00000002	0.000000002	0.00000002	0.00000002	0.00000002	0.00000002

[a] The reported value is the number of LCFs projected to occur and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

[b] The reported value is the risk or probability of an LCF occurring in the individual.

Key: LCF=latent cancer fatality.

Table 2-11 Waste Management Area Clean Closure Summary of Radiological Impacts of Normal Operations on Workers

	Waste Management Area						
	A/AX	B/BX/BY	C	S/SX	T	TX/TY	U
Worker Population							
Project Total Impact							
Dose (person-rem)	310	1,600	450	33,000	4,400	32,000	1,300
LCFs[a]	0 (0.2)	1	0 (0.3)	20	3	19	0 (0.8)
Average Full-Time-Equivalent Worker							
Project Total Impact							
Dose (millirem)	3,600	8,400	3,800	270,000	30,000	200,000	9,700
LCF risk[b]	0.002	0.005	0.002	0.2	0.02	0.1	0.006
Average Annual Impact							
Dose (millirem)	89	130	95	3,500	760	3,900	240
LCF risk[b]	0.00005	0.00008	0.00006	0.002	0.0005	0.002	0.0001
Noninvolved Worker							
Maximum Annual Impact							
Dose (millirem)	0.21	0.28	0.027	0.34	0.30	0.31	0.30
LCF risk[b]	0.0000001	0.0000002	0.00000002	0.0000002	0.0000002	0.0000002	0.0000002

[a] The reported value is the number of LCFs projected to occur and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

[b] The reported value is the risk or probability of an LCF occurring in the individual.

Key: LCF=latent cancer fatality.

Table 2-12 Summary of Unplanned-Event Impacts – All Waste Management Areas

Event	Frequency (per year)		Offsite Population[a]	Maximally Exposed Individual	Noninvolved Worker
Accident: Seismically induced waste tank dome collapse – unmitigated	5×10^{-4}	Consequences (impact if the accident occurred)			
		Dose	1.3 person-rem	0.00021 rem	0.22 rem
		LCFs or LCF risk[b]	0 (8×10^{-4})	1×10^{-7}	1×10^{-4}
		Annual Risk (impact, including estimated frequency of the accident occurring)			
		Risk	4×10^{-7}	6×10^{-11}	7×10^{-8}
Intentional Destructive Act: Explosive device in underground waste tank	Not estimated	Consequences (impact if the accident occurred)			
		Dose	4.9 person-rem	0.00083 rem	0.88 rem
		LCFs or LCF risk[b]	0 (3×10^{-3})	5×10^{-7}	5×10^{-4}

[a] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

[b] For the population, the reported value is the number of LCFs projected to occur and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses. For an individual, the value is the risk of an LCF occurring.

Key: LCF=latent cancer fatality.

2.11 PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY – FACILITY ACCIDENTS

This section addresses potential impacts on workers and the public associated with tank-farm-related accidents. Radiological impacts of the postulated accident scenarios were quantified for an MEI living near Hanford, the offsite population living within 80 kilometers (50 miles) of the facility, and a noninvolved worker assumed to be 100 meters (110 yards) from the facility. Hazardous chemical impacts were also evaluated. For an involved worker, accident consequences were not quantified. While involved workers are expected to be near the Hanford tank farms during routine tank farm operations, their number and location relative to a postulated accident are unknown. In the event of an accident involving chemicals or radioactive materials, workers near an accident could be at risk of serious injury or fatality. Safety procedures, safety equipment, and protective barriers are typical features that would prevent or minimize worker impacts. Additionally, following initiation of accident/site emergency alarms, workers in adjacent areas would evacuate in accordance with the technical area and facility emergency operating procedures and training. Therefore, involved worker impacts are not discussed further.

There would be no radiological accidents associated with facility construction. Further, any hazardous chemical accidents associated with facility construction would be typical of those normally associated with industrial construction materials, hazards, and practices. Projected operational accident consequences are presented in the following sections. Details of the methodology for assessing the potential impacts on workers and the public associated with postulated accidents are presented in Appendix K, Section K.3, of the *Final TC & WM EIS* (DOE 2012).

2.11.1 Radiological Impacts of Airborne Releases

During tank farm operations, tank waste retrieval, or clean closure activities, reasonably foreseeable accidents that could occur include: 1) hydrogen burn in a waste storage tank; and (2) tank dome collapse. The accident selected to represent a severe accident is the seismically induced waste tank dome collapse. The consequences of a seismically induced waste tank dome collapse, if it were to occur, are shown in Table 2–13. The annual risks of LCFs for this accident, which were obtained by multiplying the consequences by the likelihood (frequency per year) that the accident would occur, are shown in Table 2–14.

Table 2-13 Clean Closure Radiological Consequences of Accidents

Accident	Maximally Exposed Individual		Offsite Population[a]		Noninvolved Worker	
	Dose (rem)	LCF[b]	Dose (person-rem)	LCF[c]	Dose (rem)	LCF[b]
Seismically induced waste tank dome collapse – unmitigated	0.00021	1×10^{-7}	1.3	0 (8×10^{-4})	0.22	1×10^{-4}

a Based on a population of 589,668 persons residing within 80 kilometers (50 miles) of the 200-West Area.

b Increased likelihood of latent cancer fatality for an individual, assuming the accident occurs.

c The reported value is the projected number of latent cancer fatalities (LCFs) among the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

Key: LCF=latent cancer fatality.

Table 2-14 Clean Closure Annual Cancer Risks from Accidents

Accident	Frequency (per year)	Risk of Latent Cancer Fatality		
		Maximally Exposed Individual[a]	Offsite Population[b, c]	Noninvolved Worker[a]
Seismically induced waste tank dome collapse – unmitigated	5×10^{-4}	6×10^{-11}	4×10^{-7}	7×10^{-8}

a Increased risk of a latent cancer fatality to the individual, taking into account the probability (frequency) of the accident.

b Based on a population of 589,668 persons residing within 80 kilometers (50 miles) of the 200-West Area.

c The reported value is the projected number of latent cancer fatalities (LCFs) among the population, based on the probability (frequency) of the accident occurring, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

2.11.2 Hazardous Chemical Impacts

Various hazardous chemicals exist in the waste tanks. Because the chemicals that exist in the tank waste are mixed with the radioactive material, any accident event is expected to release both hazardous chemicals and radioactive materials. Due to the quantity and nature of the radioactive material in the waste tanks, the human health consequences of an accidental release would be

dominated by the impacts of the radioactive components. Therefore, hazardous chemical human health impacts were not analyzed separately.

2.11.3 Intentional Destructive Acts

This section addresses potential impacts of intentional destructive acts at a tank farm. To protect against such actions, safeguards and security measures are employed at all DOE facilities. In accordance with DOE orders, DOE conducts vulnerability assessments and risk analyses of facilities and equipment under its jurisdiction to evaluate the physical protection elements, technologies, and administrative controls needed to protect DOE assets. DOE also protects against espionage, sabotage, and theft of radioactive, chemical, or biological materials; classified information and matter; nonnuclear weapon components; and critical technologies. Before startup of any new or substantially modified operations, DOE would conduct an indepth, site-specific safeguards and security inspection to ensure that existing programs satisfy DOE requirements. Any inadequacies would be resolved before startup of operations. Release scenarios and impacts resulting from intentional destructive acts may be similar to the accident scenarios analyzed. Additional scenarios representing intentional destructive acts that may not be represented by the accident analyses were also considered.

Explosive Device in Underground Waste Tank. It was postulated that intentionally initiated explosions occur that displace a large portion of the soil overburden, breach the tank dome, and disperse a portion of the tank waste into the atmosphere. In accordance with the recommendation from *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, Vol. 1, *Analysis of Experimental Data* (DOE Handbook 3010-94), the respirable release would be less than the trinitrotoluene-equivalent weight of the explosive charge. Analysis results indicate that the radiological impacts of an explosive device in an underground waste tank would be about four times greater than the impacts of the most severe accident scenario that involved the same inventory of radioactive material (seismically induced waste tank dome collapse). The offsite population dose was estimated to be 4.9 person-rem, with no (3×10^{-3}) resulting additional LCFs. The MEI dose would be 0.00083 rem, corresponding to an increased risk of an LCF of 5×10^{-7}. The noninvolved worker dose would be 0.88 rem, corresponding to an increased risk of an LCF of 5×10^{-4}.

2.12 PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY – TRANSPORTATION

Chapter 4, Section 4.1.12, of the *Final TC & WM EIS* (DOE 2012) summarizes the impacts associated with Tank Closure Alternative 6B, Base Case. Appendix H of the *TC & WM EIS* provides more detail regarding the methodology and assumptions used, as well as more-detailed results.

Transportation impacts are presented in terms of the following:

- Incident-free dose to workers (i.e., drivers) in person-rem and corresponding risk in terms of number of LCFs
- Incident-free dose to the public in person-rem and corresponding risk in terms of number of LCFs

- Accident risk in terms of LCFs due to the radioactive cargo
- Nonradiological risk associated directly with the accident and not the cargo, in terms of number of traffic accidents

For Tank Closure Alternative 6B, Base Case, no offsite shipments of radioactive wastes composed of removed infrastructure, equipment, or soils were projected. Only impacts associated with onsite transport were projected and estimated. These impacts would be associated with the transport of tank farm and ancillary equipment waste, both highly and lightly contaminated soils and grout, and radioactive waste associated with the PPF feed. To maximize the impacts for conservatism, it was assumed that radioactive wastes generated in the 200-East Area would be transported to the 200-West Area for disposal, and vice versa.

Nonradiological accident impacts (i.e., traffic fatalities) were determined for all radioactive and nonradioactive material and waste shipments. These impacts include offsite impacts because construction materials and hazardous wastes were assumed to be transported within the region.

Table 2–15 provides the radiological impacts associated with these transport activities on a WMA basis (shipments associated with transport of immobilizedHLW, ILAW , and melters are not included).

Table 2-15 Waste Management Area Clean Closure Risks of Transporting Radioactive Waste[a]

Waste Management Area	Number of Shipments	Incident-Free				Accident	
		Crew		Population			
		Dose (person-rem)	Risk (LCF)	Dose (person-rem)	Risk (LCF)	Radiological Risk (LCF)	Nonradiological Risk (Traffic Fatalities)
A/AX	18,200	21	0.013	1.1	0.00066	4.5×10^{-9}	0.0080
B/BX/BY	41,100	57	0.034	2.6	0.0015	1.6×10^{-8}	0.018
C	8,590	16	0.0095	0.6	0.00034	5.8×10^{-9}	0.0038
S/SX	63,500	69	0.042	3.8	0.0023	1.3×10^{-8}	0.028
T	39,400	43	0.026	2.4	0.0014	7.8×10^{-9}	0.017
TX/TY	51,100	57	0.034	3.1	0.0018	1.1×10^{-8}	0.023
U	28,600	33	0.020	1.7	0.0010	7.1×10^{-9}	0.013

[a] Shipments associated with transport of immobilized high-level radioactive waste, immobilized low-activity waste, and melters are not included.
Key: LCF=latent cancer fatality.

Table 2–16 summarizes the impacts of transporting nonradioactive feed and support materials required to construct new facilities, as well as materials required to immobilize, vitrify, or solidify the liquid waste and transport it to storage or burial locations. The construction materials considered are concrete, cement, sand/gravel/dirt, asphalt, steel, and piping. The materials required for waste solidification and transport include glass formers, fly ash, blast furnace slag, canisters, cylinders, and boxes. Transport of secondary wastes to onsite disposal areas is also included. The table shows the impacts in terms of total kilometers, accidents, and fatalities for each WMA.

Table 2-16 Waste Management Area Clean Closure Estimated Impacts of Construction and Operational Material Transport

Waste Management Area	Total Distance Traveled (million kilometers)	Number of Accidents	Number of Traffic Fatalities
A/AX	9.4	2	0.12
B/BX/BY	21.2	4	0.28
C	4.9	1	0.06
S/SX	29.4	6	0.38
T	18.2	4	0.24
TX/TY	24.2	5	0.32
U	13.5	3	0.18

Note: To convert kilometers to miles, multiply by 0.6214.

2.13 ENVIRONMENTAL JUSTICE

Per Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, DOE seeks to ensure that no group of people bear a disproportionate share of negative environmental consequences resulting from the actions associated with clean closure of WMA A/AX, B/BX/BY, C, S/SX, T, TX/TY, or U. This section addresses potential short-term impacts on minority, American Indian, Hispanic, or Latino, and low-income populations. Public access to Hanford is restricted, so the majority of impacts would be associated with onsite activities and would not affect populations residing offsite; thus the potential for environmental justice concerns is small. Resource areas that could potentially be impacted and that may also affect populations residing offsite comprise public and occupational health and safety, including normal operations and facility accidents, and air quality. These impacts were analyzed because of their potential for environmental justice concerns in the short term. Definitions of terms associated with environmental justice and a description of the analysis methodology used are included in Appendix J of the *Final TC & WM EIS* (DOE 2012).

Section 2.10 discusses short-term impacts on the public as a result of normal operations from clean closure of the WMAs. Radiological impacts of normal operations on minority, American Indian, Hispanic, or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model the four population group exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radiologically contaminated produce and animal products.

For purposes of evaluating the potential for disproportionately high and adverse impacts caused by radiological air emissions from normal operations, the total dose to an average individual of the minority, American Indian, Hispanic, or Latino, and low-income populations is compared to the total dose to an average individual of the remainder of the population. Table 2–17 summarizes the average individual total doses for the life of the project, i.e., clean closure, for each of the WMAs. There are no appreciable differences between average individual total doses. Therefore, clean closure of the WMAs would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Section 2.10 discusses radiological impacts on the offsite MEI at the far side of the Columbia River opposite Hanford. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation were evaluated. As a result of WMA C clean closure, the total dose received by an individual residing at the point of greatest impact along the reservation boundary would be the equivalent of less than approximately 2 percent of the total dose received by the MEI from the general population; for the other WMAs, less than approximately one-fifteenth. Therefore, clean closure of the WMAs would not pose disproportionately high and adverse impacts on the American Indian population due to normal operations.

Section 2.11 discusses radiological impacts of airborne releases from facility accidents hypothesized as a result of clean closure of the WMAs. Examination of the risks for each of the WMAs shows that there would be essentially no LCFs per year for the offsite population, including minority, American Indian, Hispanic, or Latino, and low-income populations. Therefore, clean closure of the WMAs would not pose disproportionately high and adverse impacts on the minority, American Indian, Hispanic, or Latino, or low-income populations due to accident consequences.

Air quality impacts resulting from clean closure of the WMAs are discussed in Section 2.4. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; as there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic, or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 2.12 discusses the potential human health risks from onsite waste transportation and transporting construction materials from onsite, local, or regional locations to Hanford. The impacts of transporting onsite waste and construction materials to Hanford due to clean closure of each of the WMAs would be very small. Therefore, clean closure of the WMAs would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

Table 2-17 Waste Management Area Clean Closure Average Individual Total Dose from Radioactive Air Emissions over the Life of the Project

Subset Population	Individual Average Dose (millirem)	
	Subset Population	Remainder of Population
Waste Management Area A/AX		
Minority	0.0081	0.010
American Indian	0.0049	0.0094
Hispanic or Latino	0.0078	0.010
Low-income	0.0079	0.0097
Waste Management Area B/BX/BY		
Minority	0.013	0.017
American Indian	0.0080	0.015
Hispanic or Latino	0.013	0.017
Low-income	0.013	0.016
Waste Management Area C		
Minority	0.0010	0.0013
American Indian	0.00058	0.0012
Hispanic or Latino	0.0010	0.0013
Low-income	0.0010	0.0012
Waste Management Area S/SX		
Minority	0.028	0.037
American Indian	0.017	0.033
Hispanic or Latino	0.027	0.036
Low-income	0.028	0.034
Waste Management Area T		
Minority	0.017	0.023
American Indian	0.011	0.020
Hispanic or Latino	0.017	0.023
Low-income	0.017	0.021
Waste Management Area TX/TY		
Minority	0.022	0.028
American Indian	0.013	0.025
Hispanic or Latino	0.021	0.028
Low-income	0.021	0.026
Waste Management Area U		
Minority	0.012	0.016
American Indian	0.0073	0.014
Hispanic or Latino	0.012	0.015
Low-income	0.012	0.014

2.14 WASTE MANAGEMENT

This section evaluates the impacts of waste generation on the waste management infrastructure at Hanford as a result of clean closure of the WMAs. The inventories are divided into primary waste and secondary waste. This section also evaluates the impacts of waste generation associated with the construction, operations, deactivation, and closure of the waste management facilities. Table 2–18 provides the estimated waste volumes resulting from clean closure of the WMAs.

Primary Waste

As a result of clean closure of the WMAs, HLW associated with tank farm removal would be generated and stored on site in shielded boxes. Storage of this HLW is expected to result in no releases to the environment; it would require ongoing facility maintenance and monitoring. In addition, the PPF melters would become a waste stream following service. The retired PPF melters used in processing soils contaminated by past tank leaks would be disposed of onsite in an IDF.

Secondary Waste

Secondary waste would be produced as a result of clean closure of the WMAs. This secondary waste could include LLW, including closure waste; MLLW, including closure waste; mixed transuranic (TRU) waste; hazardous waste; nonhazardous waste; and PPF glass, another form of secondary waste.

The secondary LLW (e.g., personal protective equipment, tools, filters, empty containers) would be generated during routine operations and the administrative control period. LLW is typically not treated or only minimally treated (e.g., compacted) before disposal. Therefore, this waste treatment would cause no impacts on the Hanford waste management system. The LLW would be sent directly to disposal. Therefore, long-term storage facilities would not be required.

The secondary MLLW (e.g., personal protective equipment, tools, job waste, soil [in the case of clean closure activities]) would be generated during operations, deactivation, and closure. Through a combination of on- and offsite capabilities, secondary MLLW would be treated to meet RCRA land-disposal-restriction treatment standards prior to disposal.

PPF glass waste canisters generated from the treatment of the soils in the PPF are also included as MLLW. The process would generate a liquid waste stream that has had the radionuclides and chemicals removed from the soils. A melter cell would be installed in the PPF to process this liquid waste into a PPF glass suitable for onsite disposal. This waste would be disposed of as MLLW onsite in an IDF.

An IDF would be constructed and operated for the disposal of tank waste and all other LLW and MLLW. The proposed RPPDF would be constructed and operated for the disposal of equipment and soils that would result from clean closure activities. IDF and RPPDF operations would be completed in 2100. The IDF and RPPDF would be covered with engineered modified RCRA Subtitle C barriers to reduce water infiltration and potential for intrusion. A 100-year postclosure care period would follow.

Secondary mixed TRU waste (e.g.,\ equipment, tools, filters, empty containers) would be generated during waste retrieval and operations of tanks and treatment facilities. It is expected that TRU waste would be disposed of at the Waste Isolation Pilot Plant.

Table 2-18 Waste Management Area Clean Closure Waste Generation Volumes (4 pages)

Waste Type	Project Phase					Peak Annual Generation		Total Waste Volume to IDF(s)/RPPDF
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Waste Volume/Year	
Waste Management Area A/AX								
Primary Waste								
Other HLW	N/A	N/A	N/A	22,600	22,600	2077–2088	1,890	N/A
PPF melters	N/A	N/A	N/A	157	157	various	123	157 (IDF)
Secondary Waste								
PPF glass	N/A	N/A	N/A	128	128	2089–2096	16	128 (IDF)
Low-level radioactive	N/A	179	93	5,850	6,120	2097–2099	723	6,120 (IDF)
Low-level radioactive (closure)[a]	N/A	N/A	N/A	679	679	2097–2099	226	679 (RPPDF)
Mixed low-level radioactive	N/A	157	178	6,590	6,920	2097–2099	913	6,920 (IDF)
Mixed low-level radioactive (closure)[b]	N/A	N/A	N/A	183,000	183,000	2089–2096	22,190	183,000 (RPPDF)
TRU mixed	N/A	29	N/A	N/A	29	2038–2041	7	N/A
Hazardous[c]	31	78	0	79	189	2038–2041	20	N/A
Nonradioactive–nonhazardous[d]	N/A	N/A	16	175,000	175,000	2077–2088	13,000	N/A
Waste Management Area B/BX/BY								
Primary Waste								
Other HLW	N/A	N/A	N/A	90,500	90,500	2023–2034	5,280	N/A
PPF melters	N/A	N/A	N/A	235	235	various	123	235 (IDF)
Secondary Waste								
PPF glass	N/A	N/A	N/A	192	192	2035–2043	21	192 (IDF)
Low-level radioactive	N/A	690	359	14,500	15,600	2043	726	15,600 (IDF)
Low-level radioactive (closure)[a]	N/A	N/A	N/A	1,020	1,020	2043–2045	226	1,020 (RPPDF)
Mixed low-level radioactive	N/A	606	617	16,400	17,600	2043–2045	913	17,600 (IDF)
Mixed low-level radioactive (closure)[b]	N/A	N/A	N/A	296,000	296,000	2035–2042	33,400	296,000 (RPPDF)
TRU mixed	N/A	111	N/A	N/A	111	2014–2063	16	N/A
Hazardous[c]	119	302	N/A	123	544	2014	46	N/A
Nonradioactive–nonhazardous[d]	N/A	N/A	61	555,000	555,000	2031–2032	28,200	N/A

Table 2–18 Waste Management Area Clean Closure Waste Generation Volumes (4pages)

Waste Type	Project Phase					Peak Annual Generation		Total Waste Volume to IDF(s)/RPPDF
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Waste Volume/Year	
Waste Management Area C								
Primary Waste								
Other HLW	N/A	N/A	N/A	36,200	36,200	2050–2061	3,020	N/A
PPF melters	N/A	N/A	N/A	1.6	1.6	various	123	1.6 (IDF)
Secondary Waste								
PPF glass	N/A	N/A	N/A	2	2	2062–2069	0.2	2 (IDF)
Low-level radioactive	N/A	281	146	5,220	5,640	2070–2072	361	5,640 (IDF)
Low-level radioactive (closure)[a]	N/A	N/A	N/A	339	339	2070–2072	113	339 (RPPDF)
Mixed low-level radioactive	N/A	247	280	5,510	6,040	2070–2072	457	6,040 (IDF)
Mixed low-level radioactive (closure)[b]	N/A	N/A	N/A	12,100	12,100	2050–2061	747	12,100 (RPPDF)
TRU mixed	N/A	45	N/A	N/A	45	2028–2033	8	N/A
Hazardous[c]	49	123	N/A	29	201	2028–2033	21	N/A
Nonradioactive–nonhazardous[d]	N/A	N/A	25	249,000	249,000	2050–2061	20,700	N/A
Waste Management Area S/SX								
Primary Waste								
Other HLW	N/A	N/A	N/A	61,100	61,100	2023–2034	2,830	N/A
PPF melters	N/A	N/A	N/A	568	568	various	123	568 (IDF)
Secondary Waste								
PPF glass	N/A	N/A	N/A	464	464	2035–2056	21	464 (IDF)
Low-level radioactive	N/A	457	239	12,600	13,300	2035–2037	575	13,300 (IDF)
Low-level radioactive (closure)[a]	N/A	N/A	N/A	679	679	2043–2045 2089–2091	113	679 (RPPDF)
Mixed low-level radioactive	N/A	403	388	14,500	15,300	2100	656	15,300 (IDF)
Mixed low-level radioactive (closure)[b]	N/A	N/A	N/A	682,000	682,000	2035–2042	71,500	682,000 (RPPDF)
TRU mixed	N/A	72	N/A	N/A	72	2016–2091	14	N/A
Hazardous[c]	79	196	N/A	149	424	2016	38	N/A
Nonradioactive–nonhazardous[d]	N/A	N/A	41	494,000	494,000	2023–2034	19,400	N/A

Table 2–18 Waste Management Area Clean Closure Waste Generation Volumes *(4 pages)*

Waste Type	Project Phase					Peak Annual Generation		Total Waste Volume to IDF(s)/RPPDF
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Waste Volume/Year	
Waste Management Area T								
Primary Waste								
Other HLW	N/A	N/A	N/A	36,200	36,200	2077–2088	3,020	N/A
PPF melters	N/A	N/A	N/A	353	353	various	123	353 (IDF)
Secondary Waste								
PPF glass	N/A	N/A	N/A	288	288	2086–2099	21	288 (IDF)
Low-level radioactive	N/A	281	146	7,850	8,280	2097–2099	365	8,280 (IDF)
Low-level radioactive (closure)[a]	N/A	N/A	N/A	339	339	2097–2099	113	339 (RPPDF)
Mixed low-level radioactive	N/A	247	280	8,510	9,040	2097–2099	457	9,040 (IDF)
Mixed low-level radioactive (closure)[b]	N/A	N/A	N/A	428,000	428,000	2089–2096	47,300	428,000 (RPPDF)
TRU mixed	N/A	45	N/A	N/A	45	2038–2040	15	N/A
Hazardous[c]	49	123	N/A	88	260	2038–2040	41	N/A
Nonradioactive–nonhazardous[d]	N/A	N/A	25	295,000	295,000	2077–2088	20,700	N/A
Waste Management Area TX/TY								
Primary Waste								
Other HLW	N/A	N/A	N/A	170,000	170,000	2062–2069	14,500	N/A
PPF melters	N/A	N/A	N/A	431	431	various	123	431 (IDF)
Secondary Waste								
PPF glass	N/A	N/A	N/A	352	352	2062–2078	21	352 (IDF)
Low-level radioactive	N/A	409	213	11,600	12,200	2070–2072	723	12,200 (IDF)
Low-level radioactive (closure)[a]	N/A	N/A	N/A	679	679	2070–2072	226	679 (RPPDF)
Mixed low-level radioactive	N/A	359	372	12,700	13,400	2070–2072	913	13,400 (IDF)
Mixed low-level radioactive (closure)[b]	N/A	N/A	N/A	532,000	532,000	2062–2069	57,300	532,000 (RPPDF)
TRU mixed	N/A	66	N/A	N/A	66	2026 2028	8	N/A
Hazardous[c]	71	179	N/A	128	378	2026	23	N/A
Nonradioactive–nonhazardous[d]	N/A	N/A	36	431,000	431,000	2050–2061	31,100	N/A

Table 2–18 Waste Management Area Clean Closure Waste Generation Volumes *(4 pages)*

Waste Type	Project Phase					Peak Annual Generation		Total Waste Volume to IDF(s)/RPPDF
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Waste Volume/Year	
Waste Management Area U								
Primary Waste								
Other HLW	N/A	N/A	N/A	36,200	36,200	2023–2034	3,020	N/A
PPF melters	N/A	N/A	N/A	235	235	various	123	235 (IDF)
Secondary Waste								
PPF glass	N/A	N/A	N/A	192	192	2035–2043	21	192 (IDF)
Low-level radioactive	N/A	281	146	6,920	7,350	2043	365	7,350 (IDF)
Low-level radioactive (closure)[a]	N/A	N/A	N/A	339	339	2043–2045	113	339 (RPPDF)
Mixed low-level radioactive	N/A	247	280	7,460	7,990	2043–2045	457	7,990 (IDF)
Mixed low-level radioactive (closure)[b]	N/A	N/A	N/A	283,000	283,000	2035–2042	33,400	283,000 (RPPDF)
TRU mixed	N/A	45	N/A	N/A	45	2016–2017	15	N/A
Hazardous[c]	49	123	N/A	68	240	2016–2017	41	N/A
Nonradioactive–nonhazardous[d]	N/A	N/A	25	279,000	279,000	2023–2034	20,700	N/A

[a] Closure LLW is the waste from decontamination and decommissioning of the containment structure over the tank farms after soil removal is complete.

[b] Closure MLLW includes rubble, soil, and equipment removed during closure of the tank farms.

[c] Hazardous waste is accumulated on site for less than 90 days and then shipped to offsite commercial facilities for treatment and/or disposal.

[d] Nonhazardous solid waste is shipped to offsite commercial facilities for recycling, treatment, and disposal.

Note: All values are in cubic meters. To convert cubic meters to cubic feet, multiply by 35.315. Total may not equal the sum of the contributions due to rounding.

Key: HLW=high-level radioactive waste; IDF=Integrated Disposal Facility; LLW=low-level radioactive waste; MLLW=mixed low-level radioactive waste; N/A=not applicable; PPF=Preprocessing Facility; RPPDF=River Protection Project Disposal Facility; TRU=transuranic.

Hazardous waste is dangerous waste as defined in WAC 173-303. Hazardous waste generated during construction and operations would be packaged in U.S. Department of Transportation–approved containers and shipped offsite to permitted commercial recycling, treatment, and disposal facilities. Management of the additional waste generated would require additional planning, coordination, and establishment of satellite accumulation areas, but because the waste would be treated and disposed of at offsite commercial facilities, the additional waste load would have a minor impact at Hanford.

Any nonhazardous solid waste generated during facility construction, operations, deactivation, and closure would be packaged and transported in conformance with standard industrial practice. Solid waste such as office paper, metal cans, and plastic and glass bottles that can be recycled would be sent offsite for that purpose. The remaining nonhazardous solid waste would be sent for offsite disposal in a local landfill. This additional waste load would have only a minor impact on the handling and accumulation of nonhazardous solid waste at Hanford.

2.15 INDUSTRIAL SAFETY

Illness, injury, and death are possible outcomes of any industrial accident. The accepted standard for measuring the outcome of an industrial accident is the number of fatalities and the total recordable cases (TRC), that is the occurrence of illness or injury. A fatal occurrence is a work-related injury or illness that causes the death of the employee. TRCs include work-related illness or injury that results in loss of consciousness, restriction of work or motion, transfer to another job, a requirement for medical treatment beyond first aid, or death. This section addresses the total number of TRCs and potential fatalities associated with implementation of clean closure at each of the seven WMAs.

DOE and contractor TRC and fatality incident rates were obtained from the Computerized Accident/Incident Reporting System (CAIRS) (DOE 2007a, 2007b). The CAIRS database is used to collect and analyze DOE and DOE contractor reports of injuries, illnesses, and other accidents that occur during DOE operations. General industry data were obtained from information maintained by the U.S. Bureau of Labor Statistics (BLS 2008, 2009).

A number of occupational incident rates were available for use in estimating the industrial safety impacts of clean closure considered in this analysis. The rates vary between 1.3 and 6.7 incidents per 200,000 labor hours, as shown in Table 2–19. This table provides the four most relevant sources of data for this *Clean Closure Practicability Demonstration*: DOE Office of River Protection (ORP) data, Idaho Operations Office data, DOE and contractor data, and private industry data maintained by the U.S. Bureau of Labor Statistics.

Table 2-19 Total Recordable Cases and Fatality Incident Rates

Labor Category	Total Recordable Case Rate[a]	Fatality Rate[b]
DOE and contractor	1.88	0.26
Construction (DOE and contractor)	2.4	0.0
Operations/production (DOE and contractor)	1.3	0.0
DOE Office of River Protection	2.0	0.0
Idaho Operations Office	1.5	0.0
Private industry (BLS)	5.0	4.0
Construction (private industry) (BLS)	6.7	11.8

[a] Average illness and injury cases per 200,000 labor hours from 2001 through 2006.
[b] Average fatality rate per 200 million labor hours from 2001 through 2006.
Key: BLS=U.S. Bureau of Labor Statistics; DOE=U.S. Department of Energy.
Source: BLS 2008, 2009; DOE 2007a, 2007c.

The ORP TRC rate of 2.0 per 200,000 labor hours was selected as representative of the types of work associated with clean closure of the WMAs under consideration. It includes contributions from all labor categories (e.g., construction, operations, engineering) and is slightly higher than the 1.88 rate experienced by the DOE-wide facilities. The incident rate for private industry was deemed not representative of typical DOE project experience.

As ORP has not experienced a fatality during recent history, the DOE and contractor rate (for all labor categories) of 0.26 per 200 million labor hours was adopted as representative of fatal occurrences. The impacts of illness and injury can be calculated using the total project labor hours and the appropriate incident rate. The total labor hours were calculated from the scaled data sets (SAIC 2012). The subtotal for each type of activity (construction, operations, deactivation, and closure) is presented in Table 2–20.

Using the incident rates selected above and the projected labor hours obtained from the scaled data sets, the occupational safety impacts associated with each of the WMAs were calculated. These impacts were calculated by multiplying the total labor hours by the TRC rate and dividing by 200,000 (i.e., incidents per 200,000 labor hours).

The number of fatalities per year for an activity can be calculated by multiplying the projected number of labor hours for that activity by the selected fatality rate shown in Table 2–20 and dividing by 200 million. When the estimated number of fatalities per year is less than 1, no fatalities are expected. As shown in the table, the highest projected fatality rate as a result of WMA clean closure implementation is 0.1222 for WMA S/SX. All other projected fatality rates are lower than this; thus, no fatalities can be expected as a result of clean closure of any of the WMAs.

Using these incident rates and the projected labor hours, industrial safety impacts associated with clean closure of each of the WMAs were determined (see Table 2–20). There are inherent uncertainties in estimating the number of TRCs and fatalities associated with future activities. Currently, there are no weighting factors assigned to the phases of WMA clean closure implementation that allow for normalizing the risks for each WMA. Therefore, when averaging the rate over all phases, this approach can result in slightly higher values for project operation and closure phases and lower values for activities that have higher risk of injury and illness.

Table 2-20 Waste Management Area Clean Closure Industrial Safety Impacts

Waste Management Area	Labor Category	Million Labor Hours	Total Recordable Case Rate per 200,000 Labor Hours	Projected Total Recordable Cases	Fatality Rate per 200 Million Labor Hours	Projected Fatalities
A/AX	Construction	8.8	2.0	88.0	0.26	0.0114
	Operations	17.0	2.0	170.0	0.26	0.0221
	Deactivation	0.16	2.0	1.5	0.26	0.0002
	Closure	5.84	2.0	58.4	0.26	0.0076
	Total	31.8		317.9		0.0413
B/BX/BY	Construction	31.4	2.0	314.0	0.26	0.0408
	Operations	48.9	2.0	489.0	0.26	0.0636
	Deactivation	0.60	2.0	6.0	0.26	0.0008
	Closure	11.9	2.0	119.0	0.26	0.0155
	Total	92.8		928.0		0.1206
C	Construction	12.6	2.0	126.0	0.26	0.0164
	Operations	15.9	2.0	159.0	0.26	0.0207
	Deactivation	0.24	2.0	2.4	0.26	0.0003
	Closure	2.09	2.0	20.9	0.26	0.0027
	Total	30.8		308.3		0.0401
S/SX	Construction	22.7	2.0	227.0	0.26	0.0295
	Operations	51.1	2.0	511.0	0.26	0.0664
	Deactivation	0.40	2.0	4.0	0.26	0.0005
	Closure	19.8	2.0	198.0	0.26	0.0257
	Total	94.0		940.0		0.1222
T	Construction	14.0	2.0	140.0	0.26	0.0182
	Operations	31.5	2.0	315.0	0.26	0.0410
	Deactivation	0.24	2.0	2.4	0.26	0.0003
	Closure	12.4	2.0	124.0	0.26	0.0161
	Total	58.1		581.4		0.0756
TX/TY	Construction	19.7	2.0	197.0	0.26	0.0256
	Operations	42.2	2.0	422.0	0.26	0.0549
	Deactivation	0.36	2.0	3.5	0.26	0.0005
	Closure	15.7	2.0	157.0	0.26	0.0204
	Total	78.0		779.5		0.1013
U	Construction	13.5	2.0	135.0	0.26	0.0176
	Operations	26.2	2.0	262.0	0.26	0.0341
	Deactivation	0.24	2.0	2.5	0.26	0.0003
	Closure	8.87	2.0	88.7	0.26	0.0115
	Total	48.8		488.2		0.0635

Note: Projected fatalities are displayed to four decimal places to show at least one significant digit. All other values presented in the table have been rounded to no more than three significant digits. Totals may not equal the sum of the contributions due to rounding.

Source: Labor hours compiled from the scaled data sets (SAIC 2012).

As shown in Figure 2–1, the higher projected industrial safety impacts are associated with those WMAs that would require higher numbers of labor hours. Chapter 3 of this *Clean Closure Practicability Demonstration* presents a brief discussion of the TRC results for each of the WMAs. In all cases, the construction and operations phases account for the majority of the labor hours and TRCs. WMAs S/SX, T, and TX/TY resulted in the highest projected TRCs associated with clean closure activities. Deactivation activities for all WMAs required the fewest projected numbers of labor hours and small numbers of TRCs.

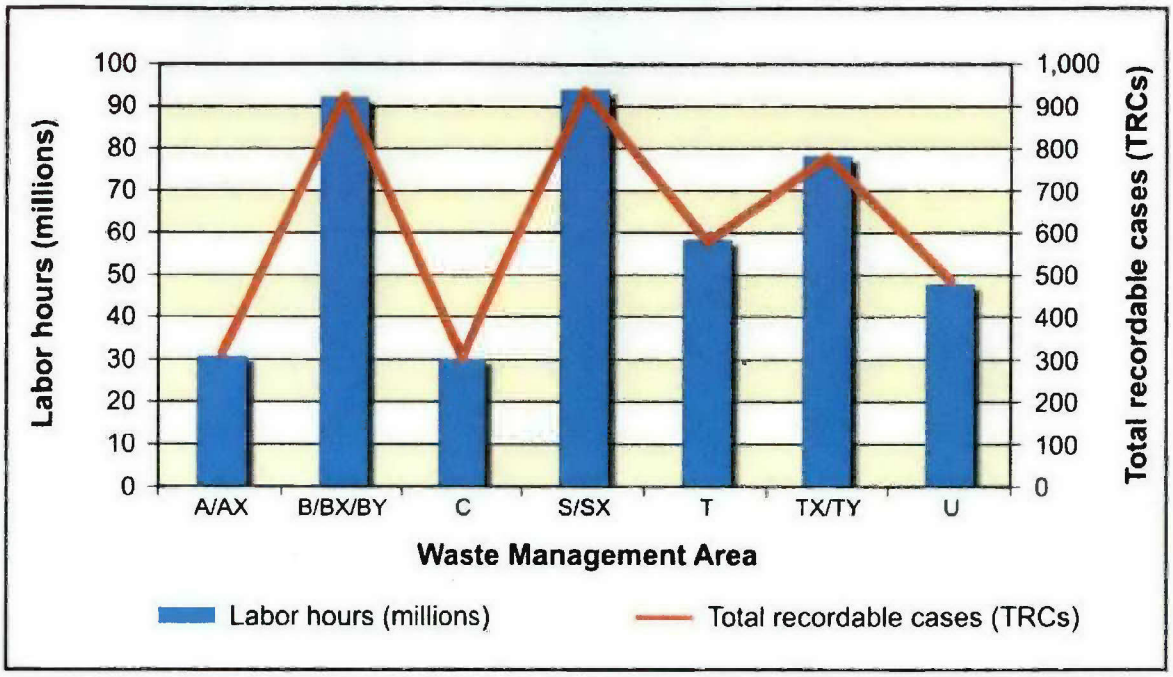

Figure 2-1 Waste Management Area Clean Closure Total Recordable Cases and Labor Hours

2.16 COST ANALYSIS

The following excerpt from the *Final TC & WM EIS* (DOE 2012), Chapter 2, Section 2.11, Cost of the Alternatives, provides insight into the development of the cost estimates for the alternatives, which served as the basis for the clean closure cost estimates for each of the WMAs analyzed under Tank Closure Alternative 6B (All Vitrification with Separations; Clean Closure), Base Case, and Waste Management Alternative 2 (Disposal in IDF, 200-East Area Only), Disposal Group 2.

> 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).[3] The costs were calculated using constant 2008 dollars. Because the alternatives cover a broad range of remediation and closure

[3] 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 usually available with a higher degree of certainty.

pathways, the estimates developed for the various alternatives span a wide range of potential costs.[4]

Each of the *TC & WM EIS* Tank Closure, Fast Flux Test Facility 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.** National Environmental Policy Act 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 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.** Except for the No Action Alternatives, each alternative includes durations for completing the waste retrieval and treatment, storage, and disposal components of the River Protection Project mission, as well as the deactivation and closure components, which vary among the alternatives. Cost estimates based on projecting current costs (i.e., 2008 dollars) 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 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.

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

- **Development and use of technologies.** Except for 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., contact-handled- and remote-handled-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 contributions 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.

Cost estimates for the clean closure of each of the WMAs are provided in Table 2–21. Specifically, the table provides the estimated potential costs of construction, operations, deactivation, closure, and disposal for the clean closure of each of the WMAs. The costs associated with on- or offsite disposal of the HLW shielded boxes are not included in the cost data, nor are the offsite-disposal costs for immobilized high-level radioactive waste. No credit was taken for cost-reducing actions such as waste volume reduction, alternative waste packaging, or use of alternative disposal sites.

Table 2-21 Waste Management Area Clean Closure Summary of Estimated Costs (millions of 2008 dollars)[a]

Work Element	Waste Management Area						
	A/AX	B/BX/BY	C	S/SX	T	TX/TY	U
Construction	423	1,632	665	1,088	665	967	665
Operations	665	2,565	1,045	1,710	1,045	1,520	1,045
Deactivation	15	57	23	38	23	34	23
Closure	1,453	2,654	666	3,235	1,913	2,716	1,486
Disposal	539	953	115	1,855	1,176	1,462	812
Total	**3,095**	**7,861**	**2,514**	**7,926**	**4,822**	**6,699**	**4,031**

[a] Estimates are costs to the Hanford Site only.
Source: DOE 2009.

Included in the construction costs are the costs to build or modify the SSTs within each WMA to support waste retrieval and the construction of interim storage facilities for HLW debris from the

clean closure of the SSTs. Operations costs include ongoing operations of the tank farms, retrieval of tank waste, and operations of Borrow Area C, the onsite pit used to supply sand, soil, and gravel for backfilling the tank farms after the SSTs are removed. Deactivation costs include deactivation of tank waste retrieval equipment and facilities.

Closure costs include the construction and deactivation of confinement structures over the tank farms required during tank removal and contaminated deep soil removal, as well as removal of the SSTs and ancillary equipment within the tank farms and the contaminated deep soils. The removed highly contaminated rubble, soil, and equipment that would be managed as HLW would be maintained in shielded storage boxes on site on covered concrete storage pads. Closure costs also include the construction, operations, and deactivation of the PPF, a soil-washing facility that would treat highly contaminated (non-HLW) soils. This treatment would result in: 1) washed soils, which would be packaged for onsite disposal in the proposed RPPDF; and 2) contaminated liquid waste streams, which would be treated in the PPF melter, producing a ILAW glass that would be disposed of in the IDF.

Disposal costs include the construction, operations, closure, and postclosure care of the IDF and RPPDF that are necessary for the clean closure of the SSTs within each WMA.

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Chapter 3
WASTE MANAGEMENT AREA CLEAN CLOSURE SHORT-TERM ENVIRONMENTAL CONSEQUENCES

As stated in Chapter 1, this Clean Closure Practicability Demonstration examines the potential short-term impacts on the existing natural and human environment and on human health of implementing clean closure of the 12 single-shell tank (SST) farms at the Hanford Site (Hanford) and disposal of the associated waste streams, as analyzed in the *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (TC & WM EIS)* (DOE 2012).

Chapter 2 of this *Clean Closure Practicability Demonstration* provides a summary overview of these potential human health and environmental impacts, presented by resource area or discipline: land resources, infrastructure, noise and vibration, air quality, geology and soils, water resources, ecological resources, cultural and paleontological resources, socioeconomics, existing human health risk, environmental justice, waste management, and industrial safety. The impacts discussion is followed by a summary cost analysis.

This chapter provides more-detailed analysis of the potential impacts of clean closure of the 12 SST farms, which are grouped into seven WMA, i.e., WMAs A/AX, B/BX/BY, C, S/SX, T, TX/TY, and U. The detailed impacts analysis is presented in this chapter by resource area or discipline for each of the seven WMAs; following each WMA's impacts presentation is a WMA-specific cost analysis of clean closure implementation.

3.1 WASTE MANAGEMENT AREA A/AX

WMA A/AX consists of two SST farms that store HLW that was generated primarily from the chemical processing of irradiated uranium reactor fuel at the Plutonium-Uranium Extraction (PUREX) Plant. Both of the tank farms consist of the following:

- SSTs of varying sizes
- Waste transfer lines
- Multiple dry wells around each SST used as leak detection systems
- Tank ancillary equipment

The A Tank Farm also includes laterals under the tanks that are used as additional leak detection systems.

WMA A/AX is located in the east-central portion of the 200-East Area near the PUREX Plant (see Figure 3–1).

A Tank Farm. The A Tank Farm consists of six 3.8-million-liter (1-million-gallon) (100-series) SSTs constructed between 1954 and 1955 to store waste that was generated primarily at the PUREX Plant, located about 914 meters (3,000 feet) south of the A Tank Farm. The SSTs are 23 meters (75 feet) in diameter and approximately 13.4 meters (44 feet) in height from base to dome and have a flat bottom. The tanks are constructed of a steel-reinforced concrete shell that

encompasses a steel plate liner and are connected with overflow lines but do not cascade. The tanks are below grade, and the sediment cover from the apex of the tank domes to the ground surface is 1.8 meters (6 feet). Because the A Tank Farm was designed to store boiling waste, the tank farm was underlain by laterals connected to caissons as a leak detection system (Connelly 2008).

All of the tanks in the A tank farm were removed from service in 1975 or 1980 except for tank 241-A-105, which was removed from service in 1963 (Wood et al. 2003). Three of the six tanks in the A tank farm (A-101, A-102, and A-106) are classified as sound and three (A-103, -104, and -105) as assumed leakers. Interim stabilization of the SSTs began in 1972 and has been completed (Williams 2001).

AX Tank Farm. The AX Tank Farm consists of four 3.8-million-liter (1-million-gallon) (100-series) SSTs constructed between 1963 and 1964 to store waste that was generated primarily at the PUREX Plant, located about 457 meters (1,500 feet) south-southwest of the AX tank farm. The SSTs in the AX Tank Farm are of the same type, dimensions, and configuration, including the sediment cover, as those in the A tank farm. The tanks in the AX farm include a grid of drain slots beneath the steel liner bottom and a leak detection well to collect potential leakage (Connelly 2008). The grids also served as an escape route for free water released from concrete grout during initial heating of the tank (Wood et al. 2003).

All of the tanks in the AX tank farm were removed from service during the late 1970s and 1980 (Wood et al. 2003). Two of the four tanks in the AX tank farm (AX-101 and AX-103) are classified as sound and two (AX-102 and AX-104) as assumed leakers. Interim stabilization of the SSTs began in 1972 and has been completed (Williams 2001).

Figure 3–1. General Location of Waste Management Area A/AX

3.1.1 Land Resources

3.1.1.1 Land Use

Clean closure of WMA A/AX would involve land-disturbing activities associated with construction of an underground transfer line, WRF, HLW Debris Storage Facility, PPF, IDF, and RPPDF. Closure activities would also require the extraction of material from Borrow Area C. For most facilities and activities, the acreage requirement was determined by use of a scaling factor that adjusted the total land requirement for closing all Hanford tank farms to a specific value for WMA A/AX. However, this was not done for the WRF and PPF, as the minimum requirement to close a WMA is one facility. Also, it was not necessary to scale the length of the underground transfer line.

WMA A/AX is located in the 200-East Area; however, not all activities associated with its closure would take place in this area. Thus, land also would be disturbed between the 200-East and 200-West Areas (for the HLW Debris Storage Area, PPF, and proposed RPPDF) and within Borrow Area C. Within the 200-East Area, a total of 4.37 hectares (10.8 acres) would be disturbed, nearly all of which (4.03 hectares [9.96 acres]) is undeveloped. Development within the area between the 200-East and 200-West Areas would require 25.0 hectares (61.7 acres), all of which is undeveloped. Disturbance within Borrow Area C would total 27.8 hectares (68.8 acres), all of which is also undeveloped. Thus, a total of 57.1 hectares (141 acres) would be required for closure of WMA A/AX, of which less than 0.4 hectares (1 acre) is currently developed.

3.1.1.2 Visual Resources

As noted above, a total of 57.1 hectares (141 acres), most of which is not currently developed, would be required for clean closure of WMA A/AX. Within the 200-East Area, development would have little impact on visual resources, as the area is already highly industrialized. However, the use of 25.0 hectares (61.7 acres) between the 200-East and 200-West Areas would impact visual resources, as most of this land is not developed. The conversion of this land to an industrial use would add noticeably to the overall developed nature of the area and would be visible from nearby higher elevations. The viewscape from these higher elevations is important to American Indians with cultural ties to Hanford. Clean closure activities would involve constructing containment structures over the WMA; however, these structures would be removed upon completion of clean closure activities. Although there would be an overall increase in the industrial appearance of the 200 Areas, the BLM Visual Resource Management Class IV rating would not change. Management activities within Class IV areas dominate the view and typically are the focus of viewer attention.

As noted above, 27.8 hectares (68.8 acres) within Borrow Area C would be excavated for the closure of WMA A/AX. Development of Borrow Area C would be readily visible from State Route 240 and Rattlesnake Mountain and would change the BLM visual resource management rating from Class II to Class IV. Management activities within Class II areas may be seen but should not dominate the view. Upon completion of WMA A/AX closure, excavations in Borrow Area C would be recontoured and revegetated, thereby lessening the visual impact.

3.1.2 Infrastructure

For clean closure of WMA A/AX, the highest total infrastructure demands for water, diesel fuel, and gasoline would occur with activities related to the operations of the proposed RPPDF, which would be located between the 200-East and 200-West Areas. Also, the placement of a modified RCRA Subtitle C barrier above the proposed RPPDF would also require large amounts of these utilities. The largest total amount of electricity usage would occur during deep soil removal from the A and AX Tank Farms and during tank and ancillary equipment removal from these areas.

Water would be required during construction for soil compaction, dust control, and possibly work surface and equipment washdown. Standard construction practices dictate that, at least initially, construction water would be trucked to construction locations on an as-needed basis for these uses until water supply and wastewater treatment utilities are in place. Concrete and grout would be produced in onsite batch plants, which would require large volumes of water. By comparison, relatively little water would be required to meet the potable and sanitary needs of the construction workforce. During operations, water would be required to support process makeup requirements and facility cooling, as well as the potable and sanitary needs of the operations workforce and other uses. To stabilize and partially decontaminate waste treatment, retrieval, and disposal facilities, water would also be used during facility deactivation activities; however, this requirement would be relatively small compared with those for construction and operational demands and for many closure activities, including construction of surface barriers.

Table 3–1 summarizes the projected utility infrastructure resource requirements for WMA A/AX clean closure.

Table 3–1. Waste Management Area A/AX Clean Closure Summary of Utility Infrastructure Requirements

Activity Phase	Electricity (million megawatt-hours)	Diesel Fuel[a]	Gasoline	Water
		(million liters)		
Peak (Year)	**10.6 (2089–2095)**	**24.0 (2101)**	**2.26 (2101)**	**267 (2094–2095)**
Construction	0.002	12.1	0.782	59.3
Operations	0.005	89.9	2.94	2,090
Deactivation	0.00[b]	0.08	0.101	0.00[b]
Closure	0.156	45.6	5.01	145
Total[c]	**0.163**	**147**	**8.83**	**2,290**

[a] Assumed to be inclusive of all Number 2 diesel fuel, including road diesel and heating fuel oil.
[b] Deactivation values of "0.00" reflect no demand for that utility.
[c] Totals may not equal the sum of the contributions due to rounding.
Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate. To convert liters to gallons, multiply by 0.26417.
Source: SAIC 2010.

3.1.1.1 Electricity

For clean closure of WMA A/AX, the peak annual electrical energy demand would occur from 2089 through 2095. The peak demand would be 10,600 megawatt-hours. This peak demand would remain well within the annual capacity of 1.74 million megawatt-hours (based on a peak load capacity of 199 megawatts) of the Hanford electric power transmission system.

3.1.1.2 Fuel

For clean closure of WMA A/AX, peak demands of 24 million liters (6.3 million gallons) of diesel fuel and 2.26 million liters (0.6 million gallons) of gasoline would both occur in 2101. Annualized liquid fuel consumption (diesel fuel and gasoline) of about 0.81 million liters (0.21 million gallons) would occur during the timespan of clean closure activities for WMA A/AX (2008 through 2202). Approximately 4.3 million liters (1.1 million gallons) of liquid fuels are currently used annually at Hanford.

3.1.1.3 Water

Peak annual water requirements in 2094 and 2095 of 267 million liters (71 million gallons) would be well within the 18,500-million-liter (4,890-million-gallon) annual capacity of the Hanford Export Water System.

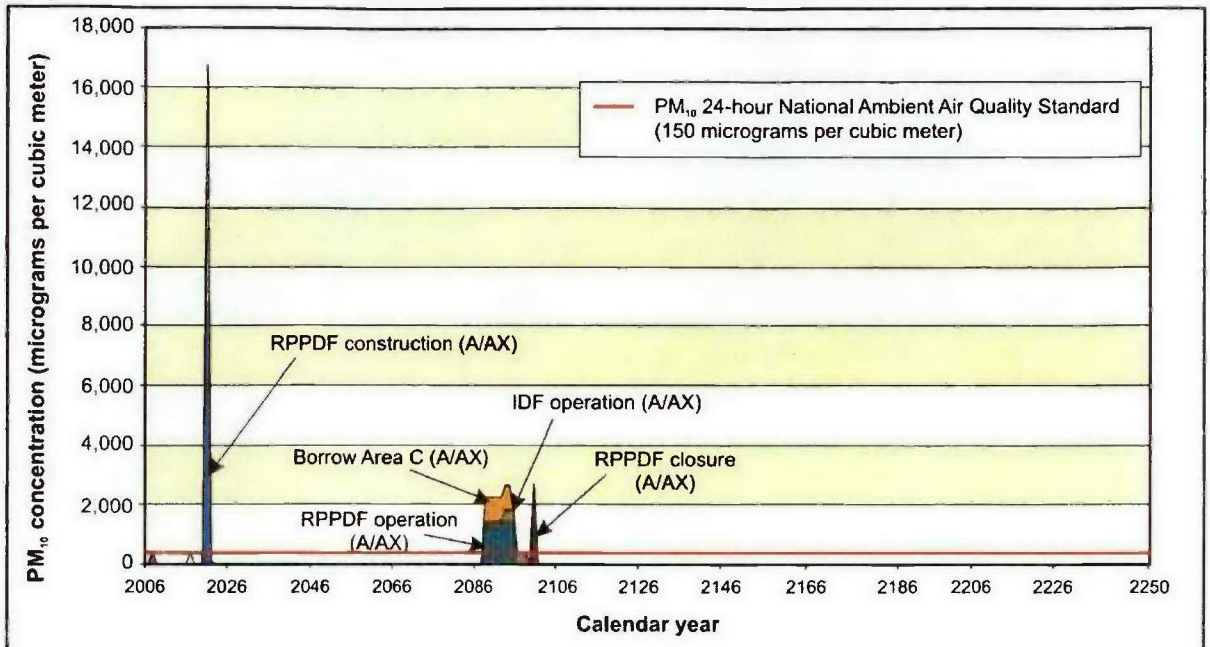
3.1.2 Noise and Vibration

Construction, operation, deactivation, and closure of facilities required for clean closure of WMA A/AX would result in minor noise impacts of employee vehicles, trucks, construction equipment and activity, generators, and process equipment. The offsite noise levels from activities associated with clean closure of WMA A/AX would be negligible due to the distance to the Hanford boundary.

Employee and truck traffic to deliver materials for various phases of activities would vary over the duration of the project. The highest number of employee trips is expected to occur from 2033 through 2034 (SAIC 2012). The increase in the number of employee vehicles and truck trips is expected to cause a minor increase in traffic noise levels along routes to the site. This increase in employee and truck traffic (discussed in Section 3.1.9) was compared with the existing average traffic volume of 30,000 to 40,000 vehicles per day (DOE 2012). For comparison purposes, the increase in traffic noise level can be estimated from the ratio of the projected traffic volume to the existing traffic volume.

3.1.3 Air Quality

Criteria pollutant concentrations that would result from WMA A/AX clean closure activities are presented in Table 3–2. Peak concentrations of all criteria pollutants except particulate matter (PM) would occur in 2101. Peak concentrations of PM would occur in 2021. The peak period concentrations for carbon monoxide, nitrogen dioxide, and sulfur dioxide would result primarily from closure of the proposed RPPDF. Peak period concentrations for PM would result from RPPDF construction. The maximum air quality impacts of PM_{10} [particulate matter with an aerodynamic diameter less than or equal to 10 micrometers] emissions would occur to the south at State Route 240. Figure 3–2 shows the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities to these concentrations.



Key: IDF=Integrated Disposal Facility; PM_{10} =particulate matter with an aerodynamic diameter less than or equal to 10 micrometers; RPPDF=River Protection Project Disposal Facility.

Figure 3-2 Waste Management Area A/AX Clean Closure PM_{10} Maximum 24-Hour Concentrations

Table 3-2 Waste Management Area A/AX Clean Closure Maximum Incremental Criteria Pollutant Concentrations

Pollutant and Averaging Period	Standard[a]	Maximum Modeled Increment
	(micrograms per cubic meter)	
Carbon Monoxide		
8-hour	10,000[b]	**41,200**
1-hour	40,000[b]	**267,000**
Nitrogen Dioxide		
Annual	100[b]	88.9
1-hour	188	**179,000**
PM_{10}[c]		
Annual	50[d]	**119**
24-hour	150[b]	**16,800**
$PM_{2.5}$		
Annual	15[d]	**119**
24-hour	35[b]	**16,800**
Sulfur Dioxide		
Annual	50[d]	0.176
24-hour	260[d]	24.5
3-hour	1,300[b]	120
1-hour	197[e]	**353**

[a] The more stringent of the Federal and Washington State standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (40 CFR 50), other than those for ozone, particulate matter, lead, and those based on annual averages, are not to be exceeded more than once per year. The 24-hour PM_{10} standard is attained when the expected number of days with a 24-hour average concentration above the standard is less than or equal to 1. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard. The annual $PM_{2.5}$ standard is met when the 3-year average of the annual means is less than or equal to the standard. The 24-hour $PM_{2.5}$ standard is met when the 3-year average of the 98th percentile 24-hour averages is less than or equal to the standard. The 1-hour nitrogen dioxide standard is met when the 3-year average 98th percentile of the daily maximum 1-hour average does not exceed the standard value.

[b] Federal and Washington State standard.

[c] The Federal standards for $PM_{2.5}$ are 15 micrograms per cubic meter annual average and 35 micrograms per cubic meter 24-hour average. No specific data for $PM_{2.5}$ were available, but for analysis purposes, concentrations were assumed to be the same as those of PM_{10}.

[d] Washington State standard.

[e] Federal standard.

Note: The National Ambient Air Quality Standards also include standards for lead and ozone. No sources of lead emissions have been identified for the activities evaluated. Washington State also has ambient standards for fluorides. Concentrations in **bold** text indicate potential exceedance of the standard.

Key: PM_n=particulate matter with an aerodynamic diameter less than or equal to *n* micrometers.

Source: Based on emissions data in SAIC 2012.

Maximum concentrations of carcinogenic and noncarcinogenic toxic pollutants are presented in Table 3–3. No impacts on the public due to projected nonradioactive toxic pollutant emissions are expected as a result of WMA A/AX clean closure activities. Hazardous chemical health effects on noninvolved workers are summarized in Tables 3–4 and 3–5.

Table 3-3 Waste Management Area A/AX Clean Closure Maximum Incremental Nonradioactive Toxic Chemical Concentrations

Pollutant	Averaging Period	Acceptable Source Impact Level[a]	Maximum Modeled Increment
		(micrograms per cubic meter)	
Ammonia	24-hour	70.8	20.0
Benzene	Annual	0.0345	0.0323
1,3-Butadiene	Annual	0.00588	0.000842
Formaldehyde	Annual	0.167	0.0278
Mercury	24-hour	0.09	0.00000491
Toluene	24-hour	5,000	31.2
Xylene	24-hour	(b)	9.27

[a] WAC 173-460.

[b] Not listed in WAC 173-460.

Note: To convert cubic meters to cubic feet, multiply by 35.315.

Source: Based on emissions data in SAIC 2012.

Table 3-4 Waste Management Area A/AX Clean Closure Nonradioactive Airborne Toxic Chemical Hazard Index for the Nearest Noninvolved Worker

Chemical	Hazard Quotient
Ammonia	1.14×10^{-1}
Mercury	2.14×10^{-5}
Toluene	1.89×10^{-3}
Xylene	2.84×10^{-2}
Hazard Index	1.44×10^{-1}

Source: Based on emissions data in SAIC 2012.

Table 3-5 Waste Management Area A/AX Clean Closure Nonradioactive Airborne Toxic Chemical Cancer Risk for the Nearest Noninvolved Worker

Chemical	Cancer Risk
Benzene	1.20×10^{-5}
1,3-Butadiene	1.30×10^{-6}
Formaldehyde	1.82×10^{-5}

Source: Based on emissions data in SAIC 2012.

3.1.4 Geology and Soils

Consumption of geologic resources (rock, minerals, and soils) to support facility construction, operations, and deactivation, as applicable, would constitute the major indirect impact on geologic and soil resources from implementation of clean closure of WMA A/AX and associated waste management activities, as summarized in Table 3–6. Varying quantities of geologic resources would be required for ongoing facility construction; upgrades to existing facilities, including the 200 Area tank farms; waste retrieval activities; and, most substantially, tank farm closure. Geologic resources, including relatively large volumes of gravel, sand, and silt, are available from the suprabasalt sediments and associated soils at Hanford. Rock, in the form of basalt, is also plentiful. As discussed in the *Environmental Assessment, Use of Existing Borrow Areas, Hanford Site, Richland, Washington* (DOE 2001a), a number of active gravel and sand pits and two rock quarries at Hanford have been identified for use in providing a continual supply of borrow materials for new facility construction, maintenance of existing facilities, and fill and capping material for remediation and other activities. Of the two active quarries on the site, quarry No. 2 (referred to as "Borrow Area C"), located due south of the 200-West Area just south of State Route 240, has large volumes of basalt and sand (DOE 2001a). This approximately 926.3-hectare (2,289-acre) borrow area has been designated as a source of materials such as rock riprap (basalt), aggregate (gravel and sand), and soil (silt and loam) that would be needed to support tank farm closure and supporting activities (DOE 2003a).

Table 3-6 Waste Management Area A/AX Clean Closure Major Geologic and Soil Resource Impact Indicators and Requirements

Construction Materials				Other Borrow Materials[a]				Closure-Specific Materials		
Concrete/ Grout	Cement[b]	Sand[b]	Gravel[b]	Rock/Basalt	Sand	Gravel	Soil (Specification Backfill)	Grout[c]	Cement	Sand[d]
64,500	13,600	31,500	29,500	0	245,000	125,000	4,210,000	970	120	470

[a] Resources for miscellaneous uses not exclusively tied to facility construction, operations, or closure, such as site grading and backfill for operations.

[b] Cement, sand, and gravel are components of concrete.

[c] Grout is composed of cement, sand, fly ash, and other materials.

[d] Principal component of grout that would be obtained from onsite deposits.

Note: Values have been rounded to no more than three significant figures. All values have are expressed in cubic meters. To convert cubic meters to cubic feet, multiply by 35.315.

3.1.5 Water Resources

All construction and closure related land disturbances, especially for new facility construction, would expose soils and sediments to possible erosion by infrequent, heavy rainfall or by wind.

While unlikely to reach surface water features, stormwater runoff from exposed areas could convey soil, sediments, and other pollutants (e.g., construction waste materials and spilled materials, such as petroleum, oils, and lubricants from construction equipment) from construction footprint and laydown areas. Nevertheless, appropriate soil erosion and sediment control measures, as well as spill prevention and waste management practices, would be employed to minimize suspended sediment, the transport of other deleterious materials, and any potential water-quality impacts. Further, all construction and other ground-disturbing activities would be conducted in accordance with current NPDES and state waste discharge general permits for stormwater discharges associated with construction activities, issued by the Ecology. The NPDES permit specifically requires the development and implementation of a stormwater pollution prevention plan.

Once completed, new facilities required for clean closure of WMA A/AX would incorporate appropriate stormwater management controls to collect, convey, and detain stormwater from buildings and other impervious surfaces so as to minimize the impacts of onsite hydrology and soil erosion. Hanford's NPDES Storm Water Multi-Sector General Permit would cover stormwater discharges associated with industrial activity and, as necessary, stormwater discharges would be covered under state waste discharge permits for discharges to the ground.

Under normal operations associated with WMA closure, facility design combined with adherence to spill prevention and emergency response plans and procedures would help to ensure that involved hazardous substances, including spills, should they occur, do not reach soils or surfaces where they could be conveyed to surface water or groundwater. For construction, operations, deactivation, and closure activities, adherence to best management practices and other preventive measures under applicable permits and compliance plans would be coordinated by the DOE with those measures in similar sitewide pollution prevention plans.

There would be no direct discharge of effluents to either surface water or groundwater during construction, operations, and deactivation as a result of WMA A/AX clean closure. Nonhazardous sanitary wastewater (sewage) would be managed via appropriate sanitary wastewater collection and treatment systems. During the early phases of new facility construction, it was assumed that portable toilet facilities would be provided for construction personnel, with collected waste disposed of at offsite contractor facilities, as is standard construction practice. During facility operations and deactivation, sanitary wastewater would be disposed of via the dedicated sanitary sewer or septic/drain-field system serving a particular facility.

Water would be required to support new facility construction, facility operations, and facility deactivation for WMA A/AX clean closure. Water would be required for WRF construction; replacement of underground transfer lines; and construction of tank upgrades, a new riser, a MRS, VBR system, the PPF, an IDF in the 200-East Area (IDF-East), and the proposed RPPDF that will be located between the 200-East and 200-West Areas. Total water demands have been conservatively estimated at 2,290 million liters (605 million gallons), with a peak demand of 266 million liters (70 million gallons). Peak periods of water demands would occur during years 2094 and 2095 as a result of Borrow Area C and RPPDF operation. All utility demands, as well as water demands, are discussed in Section 3.1.1, Infrastructure.

3.1.6 Ecological Resources

3.1.6.1 Terrestrial Resources

As noted in Section 3.1.1.1, a total of 29.3 hectares (72.5 acres) within the 200-East Area and between the 200-East and 200-West Areas would be disturbed by construction of the facilities required to clean-close WMA A/AX. Of this total, 4.37 hectares (10.8 acres) would be developed within the 200-East Area and 25.0 hectares (61.7 acres) between the 200-East and 200-West Areas. Within the 200-East Area, nearly all of the land needed for construction (4.03 hectares [9.96 acres]) is undeveloped, with 2.0 hectares (4.96 acres) being sagebrush habitat, while the entire 25.0 hectares (61.7 acres) required between the 200-East and 200-West Areas is sagebrush habitat. Late successional sagebrush habitat is considered a Level III resource under the *Hanford Site Biological Resources Management Plan* (DOE 2001b:4.11). The loss of 1.21 hectares (3 acres) of sagebrush habitat resulting from construction of the underground transfer line within the 200-East Area would not be mitigable; however, Hanford guidance may require the replacement of other sagebrush habitat at a ratio ranging from 1:1 to 3:1 (DOE 2003b:20, 21, 31). Specific measures to mitigate the loss of sagebrush habitat would be set forth in a mitigation action plan prior to construction.

The clean closure of WMA A/AX would require that 27.8 hectares (68.8 acres) of Borrow Area C be excavated to supply needed geologic material. The two major plant communities present within the area are cheatgrass-bluegrass (782 hectares [1,933 acres]) and needle-and-thread grass/Indian ricegrass (107 hectares [265 acres]) (DOE 2012). The latter represents an unusual and relatively pristine community type at Hanford; thus, it is considered a more highly valued community than the former. It is not possible to determine specific impacts of excavating Borrow Area C on ecological resources because the particular portion of the site from which geologic material would be excavated is unknown. To the extent that it is possible, the needle-and-thread grass/Indian ricegrass community should be avoided during excavation. A mitigation action plan would be developed prior to excavation.

3.1.6.2 Threatened and Endangered Species

Federally or state-listed threatened or endangered species have not been observed within, or in the immediate vicinity of, the 200 Areas or Borrow Area C; therefore, impacts on this group of plants and animals are not expected as a result of WMA A/AX clean closure. Both the Columbia and Yakima Rivers adjacent to Hanford have been designated as critical habitat for the bull trout. However, as there would be no short-term impacts on either river from construction or operation of new facilities associated with clean closure of WMA A/AX, designated critical habitat would not be adversely affected.

A number of state-listed, special status species observed within areas that would be disturbed by clean closure of WMA A/AX could be impacted by construction of the various required facilities. Three state-listed species were observed within areas that could be disturbed within the 200-East Area. The black-tailed jackrabbit (state candidate) and Piper's daisy (state sensitive) have been observed on or near the underground transfer line route, and the sage sparrow (state candidate) has been observed within the IDF vicinity. In addition, the loggerhead shrike (Federal species of concern and state candidate), black-tailed jackrabbit, sage sparrow, and crouching milkvetch (state watch) have all been observed between the 200-East and 200-West Areas where the HLW Debris Storage Facility, PPF, and the proposed RPPDF would

be located. Finally, surveys have identified Piper's daisy, stalked-pod milkvetch (state watch), crouching milkvetch, and the long-billed curlew (state monitor) within the boundaries of Borrow Area C. The operation of new facilities is not expected to impact any listed species.

Although mitigation would not be required for the state monitor and watch species, they should be considered during project planning. Impacts on state candidate and sensitive species, which are considered Level III resources under the *Hanford Site Biological Resources Management Plan*, require mitigation where impacts would occur. When avoidance and minimization are not possible or are insufficient, mitigation via rectification or compensation is recommended (DOE 2001b:4.9, 8.11). A comprehensive mitigation action plan, which would deal with the loss of state-listed species (as well as sagebrush habitat), would be developed prior to construction.

3.1.7 Cultural and Paleontological Resources

3.1.7.1 Prehistoric Resources

As noted in Section 3.1.1.1, clean closure of WMA A/AX would require a total of 57.1 hectares (141 acres), of which less than 0.4 hectares (1 acre), located in the 200-East Area, is currently developed. Land disturbance due to clean closure of WMA A/AX would involve the 200-East Area, land between the 200-East and 200-West Areas, and Borrow Area C. As noted in the *Final TC & WM EIS* (DOE 2012) (see Chapter 3, Section 3.2.8.1.2), White Bluffs Road, an important archaeological resource, is located in the southwest and northeast parts of the 200-West Area. Other prehistoric finds were discovered in the northwestern portion of the 200-West Area and immediately east of the 200-East Area. There are no known prehistoric resources within the areas that would be affected by the clean closure of WMA A/AX. The survey and geology of these areas indicate that subsurface cultural deposits have little or no potential of being present. The *Hanford Cultural Resources Management Plan* (DOE 2003c) provides guidance for identifying, evaluating, recording, curating, and managing cultural resources. If any prehistoric resources were discovered during construction or excavation, procedures from the *Hanford Cultural Resources Management Plan* would be implemented.

3.1.7.2 Historic Resources

Construction or excavation activities would not require land from the 200-West Area for the clean closure of WMA A/AX; therefore, White Bluffs Road, which is located within the 200-West Area, would not be affected. Buildings associated with the Manhattan Project and Cold War era are found within both the 200-East and 200-West Areas; however, none of these structures would be affected. There would be no impacts on other known early historic artifacts within the 200-East or 200-West Area because all such resources would be avoided. As is the case for prehistoric resources, if historic resources were discovered, procedures in place to properly identify, evaluate, record, curate, and manage the discovery site would be implemented.

3.1.7.3 American Indian Interests

As stated above, there are no known prehistoric resources that may be an American Indian interest within the affected areas required for the clean closure of WMA A/AX. Clean closure of WMA A/AX would impact 25.0 hectares (61.7 acres) of undeveloped land between the 200-East and 200-West Areas. The conversion of this land to industrial use would be noticeably visible from nearby higher elevations, such as Gable Mountain and Gable Butte. The viewscape from these higher elevations is important to American Indians with cultural ties to Hanford. There

would be little impact on the viewscape within the 200-East Area, as the area is already highly industrialized.

Clean closure of WMA A/AX would also require excavation of 27.8 hectares (68.8 acres) within Borrow Area C. This would also have an impact on the viewscape from Rattlesnake Mountain; however, upon completion of the work, excavations of Borrow Area C would be recontoured and revegetated, thus lessening the visual impact. Appropriate mitigation measures would be developed in consultation with area tribes.

3.1.7.4 Paleontological Resources

No paleontological resources have been discovered within the 200-East Area or Borrow Area C; therefore, clean closure of WMA A/AX would not impact such resources. However, if any paleontological resources were found during construction or excavation, procedures to properly manage the discovery site would be implemented.

3.1.8 Socioeconomics

3.1.8.1 Regional Economic Characteristics

For clean closure of WMA A/AX, as shown in Table 3–7, the peak workforce (1,260 FTE) would occur during construction activities at the site from 2033 through 2034. This estimate is approximately 0.6 percent of the projected labor force in the region of influence (ROI) (223,000 in 2034). For comparison, the approximately 10,000 people employed at Hanford in 2006 represented about 10 percent of overall employment with the Hanford ROI. As a result of this increase in employment, up to 940 additional indirect jobs (Perteet, Thomas/Lane, and SCM 2001) are projected for the peak years.

Table 3-7 Waste Management Area A/AX Clean Closure Workforce Estimates

Work Activity	Peak Year(s)	Workforce Peak (FTE)
Construction	2033–2034	1,260
Operations	2038–2039	693
Deactivation	2040–2041	36
Closure	2101	724
Total Onsite Workforce	**2033–2034**	**1,260**

Key: FTE=full-time equivalent.

A small spike in the workforce estimate in 2101 would be related to clean closure activities at the IDF and proposed RPPDF. Beginning in 2103, only 3 FTEs would be needed for postclosure care of the site. Implementing WMA A/AX clean closure activities could alter the economic characteristics of the region by increasing demands for goods and services in the Tri-Cities area due to increases in expenditures, income, and employment, both direct and indirect, at Hanford.

3.1.8.2 Demographic Characteristics

While clean closure of WMA A/AX would draw some workers from the local labor force, the short-term demand for construction workers could draw from outside the region. The in-

migrations of new workers and their families would increase the overall population within the Tri-Cities area and could alter the demographic characteristics of the region.

3.1.8.3 Housing and Community Services

Implementing clean closure of WMA A/AX could increase the demand for housing and could impact schools and other community services within the Hanford ROI. The demand for housing by construction workers would impact the cost and availability of houses and rental units. School enrollments would increase, and utilities and police and fire services may need to be expanded.

3.1.8.4 Local Transportation

In the area of transportation, estimates of the annual workforce show an impact on commuter traffic, regardless of whether workers are new to the community, because all the workers would use local roads to access the project site. Increased traffic from both higher employment and additional truck shipments would result in additional impacts on the local transportation system. The current roadway system has no additional capacity during the commute hours, so all workforce increases would impact the major commute routes. These impacts could include increased degradation of the roadways, increased congestion, and the need for increased maintenance of the roadways.

The projected increase in commuter traffic to the site would be due primarily to construction activities, peaking at an annual 1,260 FTEs in 2033 and 2034. Assuming an average of 1.25 persons per passenger vehicle (Malley 2007), this could represent up to 1,000 passenger vehicles per day during those peak years.

Both on- and offsite trucking would be at their highest in 2101 due to construction of the modified RCRA Subtitle C barriers. During the barrier construction, offsite truck trips would peak at 6,030 truck trips per year (approximately 23 truck trips per day), and onsite truck trips would peak at 70,900 trips per year (approximately 273 truck trips per day). Additionally, construction and operation of the proposed RPPDF would require a heavier period of truck use onsite, averaging over 19,000 truck trips per year (approximately 73 trips per day). For the majority of the rest of the time period (2024 through 2072 and after 2102), there would be less than one truck trip on or off site each day.

3.1.9 Public and Occupational Health and Safety – Normal Operations

Activities to clean-close WMA A/AX could result in radiological exposures to the public and workers. Radiological impacts are presented for three public receptors: the general population (approximately 560,000)[5] living within 80 kilometers (50 miles) of the Hanford 200 Areas, a MEI living near Hanford, and an onsite MEI. Impacts on the general population are evaluated for a residential scenario whereby people are exposed to radioactive materials emitted from project facilities. Radiological exposure occurs through inhalation, direct exposure to the radioactive plume and material deposited on the ground, and ingestion of contaminated products from animals raised locally and fruits and vegetables grown in a family garden (DOE 1995). The MEI is a hypothetical individual member of the public located at a position near the site

[5] The approximate population is based on populations of 542,324; 546,746; and 589,668 people residing within 80 kilometers (50 miles) of the WTP, 200-East Area, and 200-West Area, respectively, as described in the *Final TC & WM EIS* (DOE 2012).

boundary who would experience the highest impacts during normal operations. The MEI was determined to be a receptor on the east side of the Columbia River. Impacts on the offsite MEI are evaluated for a scenario that includes the same exposure pathways assumed for the general population, but with an increased amount of time spent outdoors and a higher rate of contaminated food consumption. Impacts on the onsite MEI, identified as a member of the public who works at the Columbia Generating Station, Laser Interferometer Gravitational-Wave Observatory (LIGO), or U.S. Ecology Commercial Low-Level Radioactive Waste Disposal Site (U.S. Ecology), would be from inhalation and exposure to the plume and material deposited on the ground. Doses are presented as total effective doses. Details of the assessment methodology for determining radiological exposure of workers and members of the public are presented in Appendix K of the *Final TC & WM EIS* (DOE 2012).

The radiological impacts on members of the public are presented in terms of impacts over the life of the project, that is WMA A/AX clean closure (the operational life of the project during which radioactive air emissions would occur), and peak annual impacts. Impacts over the life of the project are the total estimated radiation doses that would be incurred by members of the public over the duration of the activities to complete clean closure of the WMA. The peak annual impacts are the estimated annual radiation doses that would be incurred by members of the public during the year(s) of largest radiation dose.

In addition to members of the public, workers directly involved in the activities to clean-close the WMA and nearby noninvolved workers may receive radiation doses. Doses to an involved worker are calculated based on an FTE employee. It was assumed for the purposes of this dose evaluation that an FTE involved worker has a 2,080 hour work year. In practice, the number of workers who could receive a radiation dose may be larger than the number of FTEs assumed in this analysis, resulting in a smaller average dose per worker. A noninvolved worker is a person working at the site who is incidentally exposed due to the radioactive air emissions associated with tank farm management, tank waste retrieval, and clean closure activities. The potential dose to a noninvolved worker would result from exposure to, and inhalation of, radioactive contaminants released to the atmosphere from tank farm management, tank waste retrieval, and clean closure activities. In the 200-East Area, the noninvolved worker was assumed to be at the 242-A Evaporator, 1,090 meters (3,580 feet) north northwest of the 200-East Area source. In the 200-West Area, the noninvolved worker was assumed to be at the Environmental Restoration Disposal Facility (ERDF), about 950 meters (3,120 feet) east of the 200-West Area source. The impacts of radionuclide releases from construction, operations, deactivation, and cleanup of facilities directly related to tank farm management, tank waste retrieval, and clean closure of WMA A/AX were evaluated.

3.1.9.1 Radiological Impacts on the Public

Table 3–8 presents estimated doses to the general population and the MEI for activities associated with clean closure of WMA A/AX. Activities conducted at WMA A/AX that would generate radioactive air emissions would occur from 2016 through 2100. Due to the long timeframe involved, the doses over the life of the project may not be received by the same members of the population or the same MEI, but are presented as a measure of potential impacts to provide a basis for comparison with other WMAs.

Over the life of the project, the population within 80 kilometers (50 miles) of the 200 Areas would receive a cumulative dose of 5.3 person rem,[6] and the MEI would receive a cumulative dose of 0.56 millirem. Given the risk factor of 0.0006 latent cancer fatalities (LCF) per rem (DOE 2003d), no LCFs are expected in the general population as a result of these activities. There would be a probability of 3×10^{-7} (1 chance in 3.3 million) of the MEI developing an LCF, assuming the same MEI was exposed over the life of the project. Radioactive air emissions would result in a maximum annual population dose of 0.61 person rem and a maximum annual MEI dose of 0.063 millirem. The primary contributor to offsite doses would be fission products from processing contaminated tank farm soils through the PPF.

An onsite MEI who spends a normal workday at U.S. Ecology would receive a maximum annual dose of 0.025 millirem. The increased risk of an LCF from this dose would be 2×10^{-8} (1 chance in 50 million).

Table 3-8 Waste Management Area A/AX Clean Closure Public Health Impacts of Atmospheric Radionuclide Releases

Receptor	Facility	Impacts over Life of Project[a]		Peak Annual Impacts		
General population		Dose (person-rem)	Number of Latent Cancer Fatalities[b]	Year of Maximum Impact	Dose (person-rem per year)	Number of Latent Cancer Fatalities[b]
	200-East Area	2.8			0.31	
	200-West Area	2.5			0.31	
	Total	**5.3**	**0 (3×10^{-3})**	**2089**	**0.61**	**0 (4×10^{-4})**
Maximally exposed individual		Dose[c] (millirem)	Lifetime Risk of a Latent Cancer Fatality[d]	Year of Maximum Impact	Dose (millirem per year)	Lifetime Risk of a Latent Cancer Fatality[d]
	200-East Area	0.38			0.041	
	200-West Area	0.18			0.022	
	Total	**0.56**	**3×10^{-7}**	**2089**	**0.063**	**4×10^{-8}**
Onsite MEI	**Total**	**0.22**	**1×10^{-7}**	**2089**	**0.025**	**2×10^{-8}**

a Impacts accrued over the operational life of the project to clean-close Waste Management Area A/AX.

b The reported value is the projected number of latent cancer fatalities (LCF) among the population and is therefore presented as a whole number. The result, calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem), is shown in parentheses.

c Impacts are provided for assessment purposes. The life-of-project dose likely overestimates the dose that would be received by one individual person because the project could span approximately 85 years.

d Probability of an LCF in the MEI is calculated by converting the dose in millirem to rem (divide by 1,000), then multiplying the dose by the risk factor of 0.0006 LCFs per rem.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.
Key: MEI=maximally exposed individual.

3.1.9.2 Radiological Impacts on Workers

Table 3–9 presents dose and risk estimates for an involved FTE worker and a noninvolved FTE worker. The average annual FTE radiation worker dose would be 89 millirem, lower than the Administrative Control Level of 500 millirem. A radiation worker who received the average annual dose over the course of 40 years would receive a dose of 3,600 millirem, corresponding to a risk of 2×10^{-3} (1 chance in 500) of developing an LCF.

[6] Person-rem is 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.

Table 3-9 Waste Management Area A/AX Clean Closure Normal Operations Radiological Impacts on Workers

Receptor	Dose	Latent Cancer Fatality Risk[a]
Average Involved Full-Time-Equivalent Worker		
Average annual impact	89 millirem	5×10^{-5}
Impact over life of project[b]	3,600 millirem	2×10^{-3}
Life-of-Project Worker Population	310 person-rem	0 (2×10^{-1})
Noninvolved Worker (Year of Maximum Impact)		
At the 242-A Evaporator (2089)	0.075 millirem	5×10^{-8}
At the Environmental Restoration Disposal Facility (2089)	0.21 millirem	1×10^{-7}

[a] For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

[b] Impact over the life of the project is the average dose a full-time-equivalent radiation worker would receive working on this project. It is determined by multiplying the average annual dose by an assumed career length of 40 years.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

The total effective dose to the involved worker population from the 85 years of occupational exposure was estimated to be 310 person-rem. Given the risk factor of 0.0006 LCFs per person-rem, no LCFs are expected to result from the dose associated with tank farm operations, tank waste retrieval, and clean closure of WMA A/AX. Worker doses should be viewed in the context of the duration of the project and the DOE administrative controls employed that limit them. Due to the number of years required to complete clean closure, the dose over the life of the project would be distributed over multiple generations of workers. In addition, the worker dose would be limited to less than 5 rem total effective dose per year (10 CFR 835). This regulatory limit would be further constrained by the application of administrative controls. DOE Standard 1098-2008, *Radiological Control*, recommends that the annual dose not exceed 2 rem, unless explicitly authorized by DOE management (e.g., for emergency situations). Individual worker doses would be maintained as low as is reasonably achievable (ALARA) and generally be controlled at a level below 500 millirem (0.5 rem) per year.

Estimated doses and risks to the noninvolved workers at the 242-A Evaporator or the ERDF in the year of maximum impact are shown in Table 3–9. Doses to noninvolved workers would be a small fraction of the DOE recommended Administrative Control Level of 500 millirem per year.

3.1.10 Public and Occupational Health and Safety – Facility Accidents

This section addresses potential impacts on workers and the public associated with tank-farm-related accidents. Radiological impacts of the postulated accident scenarios were quantified for an MEI living near Hanford, the offsite population living within 80 kilometers (50 miles) of the facility, and a noninvolved worker assumed to be 100 meters (110 yards) from the facility. Hazardous chemical impacts were also evaluated. For an involved worker, accident consequences were not quantified. While involved workers are expected to be near the Hanford tank farms during routine tank farm operations, their number and location relative to a postulated accident are unknown. In the event of an accident involving chemicals or radioactive materials, workers near an accident could be at risk of serious injury or fatality. Safety procedures, safety equipment, and protective barriers are typical features that would prevent or minimize worker impacts. Additionally, following initiation of accident/site emergency alarms, workers in

adjacent areas would evacuate in accordance with the technical area and facility emergency operating procedures and training. Therefore, involved worker impacts are not discussed further.

There would be no radiological accidents associated with facility construction. Further, any hazardous chemical accidents associated with facility construction would be typical of those normally associated with industrial construction materials, hazards, and practices. Projected operational accident consequences are presented in the following sections. Details of the methodology for assessing the potential impacts on workers and the public associated with postulated accidents are presented in Appendix K, Section K.3, of the *Final TC & WM EIS* (DOE 2012).

3.1.10.1 Radiological Impacts of Airborne Releases

During tank farm operations, tank waste retrieval, or clean closure activities, reasonably foreseeable accidents that could occur include: 1) hydrogen burn in a waste storage tank; and 2) tank dome collapse. The accident selected to represent a severe accident is the seismically induced waste tank dome collapse. The consequences of a seismically induced waste tank dome collapse, if it were to occur, are shown in Table 3–10. The annual risks of LCFs for this accident, which were obtained by multiplying the consequences by the likelihood (frequency per year) that the accident would occur, are shown in Table 3–11.

Table 3-10 Waste Management Area A/AX Clean Closure Radiological Consequences of Accidents

Accident	Maximally Exposed Individual		Offsite Population[a]		Noninvolved Worker	
	Dose (rem)	LCF[b]	Dose (person-rem)	LCF[c]	Dose (rem)	LCF[b]
Seismically induced waste tank dome collapse – unmitigated	0.00021	1×10^{-7}	1.3	0 (8×10^{-4})	0.22	1×10^{-4}

[a] Based on a population of 589,668 persons residing within 80 kilometers (50 miles) of the 200-West Area.

[b] Increased likelihood of latent cancer fatality for an individual, assuming the accident occurs.

[c] The reported value is the projected number of latent cancer fatalities (LCF) among the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

Key: LCF=latent cancer fatality.

Table 3-11 Waste Management Area A/AX Clean Closure Annual Cancer Risks from Accidents

Accident	Frequency (per year)	Risk of Latent Cancer Fatality		
		Maximally Exposed Individual[a]	Offsite Population[b, c]	Noninvolved Worker[a]
Seismically induced waste tank dome collapse – unmitigated	5×10^{-4}	6×10^{-11}	4×10^{-7}	7×10^{-8}

[a] Increased risk of a latent cancer fatality to the individual, taking into account the probability (frequency) of the accident.

[b] Based on a population of 589,668 persons residing within 80 kilometers (50 miles) of the 200-West Area.

[c] The reported value is the projected number of latent cancer fatalities (LCF) among the population, based on the probability (frequency) of the accident occurring, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

3.1.10.2 Hazardous Chemical Impacts

Various hazardous chemicals exist in the waste tanks. Because the chemicals that exist in the tank waste are mixed with the radioactive material, any accident event is expected to release both hazardous chemicals and radioactive materials. Due to the quantity and nature of the radioactive material in the waste tanks, the human health consequences of an accidental release would be dominated by the impacts of the radioactive components. Therefore, hazardous chemical human health impacts were not analyzed separately.

3.1.10.3 Intentional Destructive Acts

This section addresses potential impacts of intentional destructive acts at a tank farm. To protect against such actions, safeguards and security measures are employed at all DOE facilities. In accordance with DOE Orders, DOE conducts vulnerability assessments and risk analyses of facilities and equipment under its jurisdiction to evaluate the physical protection elements, technologies, and administrative controls needed to protect DOE assets. DOE also protects against espionage, sabotage, and theft of radioactive, chemical, or biological materials; classified information and matter; nonnuclear weapon components; and critical technologies. Before startup of any new or substantially modified operations, DOE would conduct an indepth, site-specific safeguards and security inspection to ensure that existing programs satisfy DOE requirements. Any inadequacies would be resolved before startup of operations. Release scenarios and impacts resulting from intentional destructive acts may be similar to the accident scenarios analyzed. Additional scenarios representing intentional destructive acts that may not be represented by the accident analyses were also considered.

Explosive Device in Underground Waste Tank. It was postulated that intentionally initiated explosions occur that displace a large portion of the soil overburden, breach the tank dome, and disperse a portion of the tank waste into the atmosphere. In accordance with the recommendation from *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, Vol. 1, *Analysis of Experimental Data* (DOE Handbook 3010-94), the respirable release would be less than the trinitrotoluene (TNT) equivalent weight of the explosive charge. Analysis results indicate that the radiological impacts of an explosive device in an underground waste tank would be about four times greater than the impacts of the most severe accident scenario that involved the same inventory of radioactive material (seismically induced waste tank dome collapse). The offsite population dose was estimated to be 4.9 person-rem, with no (3×10^{-3}) resulting additional LCFs. The MEI dose would be 0.00083 rem, corresponding to an increased risk of an LCF of 5×10^{-7}. The noninvolved worker dose would be 0.88 rem, corresponding to an increased risk of an LCF of 5×10^{-4}.

3.1.11 Public and Occupational Health and Safety – Transportation

About 18,200 onsite shipments of radioactive waste would occur due to WMA A/AX clean closure activities. The dose to transportation workers from all transportation activities was estimated at about 21 person-rem; the dose to the public would be about 1.1 person-rem. Accordingly, incident-free transportation of radioactive material would result in zero (0.013) LCFs among transportation workers and 0 (0.00066) LCFs in the total affected population over the duration of transportation activities.

The estimated total transportation accident risks are a radiation dose risk to the population of about 7.5×10^{-6} person-rem, resulting in 4.5×10^{-9} LCFs, and traffic accidents resulting in zero (0.0080) fatalities.

The nonradiological impacts of transporting construction and operational material and radioactive and nonradioactive secondary waste would be 9.4 million kilometers (5.8 million miles) traveled, 2 accidents, and zero (0.12) fatalities over the entire period from construction through deactivation and closure.

3.1.12 Environmental Justice

Section 3.1.10 discusses short-term impacts on the public as a result of normal operations from clean closure of WMA A/AX. Radiological impacts of normal operations on minority, American Indian, Hispanic, or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model the four population group exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radiologically contaminated produce and animal products.

For purposes of evaluating the potential for disproportionately high and adverse impacts caused by radiological air emissions from normal operations, the total dose to an average individual of the minority, American Indian, Hispanic, or Latino, and low-income populations is compared to the total dose to an average individual of the remainder of the population. Table 3–12 summarizes the average individual total doses for the life of the project, i.e., clean closure of WMA A/AX. There are no appreciable differences between average individual total doses. Therefore, closure of this WMA would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Table 3-12 Waste Management Area A/AX Clean Closure Average Individual Total Dose from Radioactive Air Emissions over the Life of the Project

Subset Population	Individual Average Dose (millirem)	
	Subset Population	Remainder of Population
Minority	0.0081	0.010
American Indian	0.0049	0.0094
Hispanic or Latino	0.0078	0.010
Low-income	0.0079	0.0097

Section 3.1.10 discusses radiological impacts on the offsite MEI, who is located at the far side of the Columbia River opposite Hanford. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation were evaluated. As a result of WMA A/AX clean closure, the total dose received by an individual residing at the point of greatest impact along the reservation boundary would be the equivalent of less than approximately one-fifteenth of the total dose received by the MEI from the general population. Therefore, closure of WMA A/AX would not pose disproportionately high and adverse impacts on the American Indian population due to normal operations.

Section 3.1.11 discusses radiological impacts of airborne releases from facility accidents hypothesized as a result of WMA A/AX clean closure. Examination of the risks shows that there would be essentially no LCFs per year for the offsite population, including minority, American Indian, Hispanic, or Latino, and low-income populations. Therefore, clean closure of WMA A/AX would not pose disproportionately high and adverse impacts on the minority, American Indian, Hispanic, or Latino, or low-income populations due to accident consequences.

Air quality impacts resulting from WMA A/AX clean closure are discussed in Section 3.1.4. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; as there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic, or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 3.1.12 discusses the potential human health risks from onsite waste transportation and transporting construction materials from onsite, local, or regional locations to Hanford. The impacts of transporting onsite waste and construction materials to Hanford due to WMA A/AX clean closure would be very small. Therefore, clean closure of this WMA would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

3.1.13 Waste Management

Table 3–13 represents the estimated waste volumes generated as a result of WMA A/AX clean closure activities. These activities include clean closure of the A and AX tank farms in the 200-East Area following deactivation. Clean closure of the tank farms would encompass removal of highly and moderately contaminated tank and ancillary equipment, all of which would be managed as HLW.

Tank closure waste that is not managed as HLW would be disposed of in the proposed RPPDF, to be located between the 200-East and 200-West Areas. The RPPDF would be similar to the IDF.

Primary Waste

As shown in Table 3–13, the volume of PPF melters generated due to WMA A/AX clean closure would be 157 cubic meters (5,540 cubic feet). A total of 22,600 cubic meters (799,000 cubic feet) of additional HLW would also be generated and stored onsite in shielded boxes.

Secondary Waste

The estimated volume of mixed TRU waste, 29 cubic meters (1,020 cubic feet), as shown in Table 3–13, should not impact existing TRU waste treatment and storage facilities. LLW and MLLW volumes generated by tank closure would be 6,120 cubic meters (216,000 cubic feet) of LLW; 679 cubic meters (24,000 cubic feet) of closure LLW; and 6,920 cubic meters (245,000 cubic feet) of MLLW. LLW and MLLW would be disposed of in an IDF. No long-term storage capacity would be needed.

Table 3-13 Waste Management Area A/AX Clean Closure Waste Generation Volumes

Waste Type	Project Phase					Peak Annual Generation		Total Waste Volume to IDF(s)/RPPDF
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Waste Volume/Year	
Primary Waste								
Other high-level radioactive waste	N/A	N/A	N/A	22,600	22,600	2077–2088	1,890	N/A
Preprocessing Facility melters	N/A	N/A	N/A	157	157	various	123	157 (IDF)
Secondary Waste								
Preprocessing Facility glass	N/A	N/A	N/A	128	128	2089–2096	16	128 (IDF)
Low-level radioactive	N/A	179	93	5,850	6,120	2097–2099	723	6,120 (IDF)
Low-level radioactive (closure)[a]	N/A	N/A	N/A	679	679	2097–2099	226	679 (RPPDF)
Mixed low-level radioactive	N/A	157	178	6,590	6,920	2097–2099	913	6,920 (IDF)
Mixed low-level radioactive (closure)[b]	N/A	N/A	N/A	183,000	183,000	2089–2096	22,190	183,000 (RPPDF)
Transuranic mixed	N/A	29	N/A	N/A	29	2038–2041	7	N/A
Hazardous[c]	31	78	0	79	189	2038–2041	20	N/A
Nonradioactive–nonhazardous[d]	N/A	N/A	16	175,000	175,000	2077–2088	13,000	N/A

[a] Closure low-level radioactive waste is the waste from decontamination and decommissioning of the containment structure over the tank farms after soil removal is complete.

[b] Closure mixed low-level radioactive waste includes rubble, soil, and equipment removed during closure of the tank farms.

[c] Hazardous waste is accumulated on site for less than 90 days and then shipped to offsite commercial facilities for treatment and/or disposal.

[d] Nonhazardous solid waste is shipped to offsite commercial facilities for recycling, treatment, and disposal.

Note: All values are in cubic meters. To convert cubic meters to cubic feet, multiply by 35.315. Total may not equal the sum of the contributions due to rounding.

Key: IDF=Integrated Disposal Facility; N/A=not applicable; RPPDF=River Protection Project Disposal Facility.

Large quantities of MLLW would be generated by the removal of ancillary equipment and the excavation of contaminated soil from the tank farms. This large quantity of tank closure waste would include approximately 183,000 cubic meters (approximately 6.47 million cubic feet) of MLLW. This contaminated soil would be disposed of in the proposed RPPDF. PPF treatment of the soils would generate 128 cubic meters (4,520 cubic feet) of PPF glass. These canisters would be disposed of in an onsite IDF.

A total of 189 cubic meters (6,670 cubic feet) of hazardous waste would be generated during construction, operations, and closure activities required for WMA A/AX clean closure. The estimated volume of nonhazardous waste would be approximately 175,000 cubic meters (approximately 6.18 million cubic feet). This waste would be sent for offsite disposal in a local landfill. This additional waste load would have only a minor impact on the handling and accumulation of nonhazardous solid waste at Hanford.

3.1.14 Industrial Safety

Illness, injury, and death are possible outcomes of any industrial accident. The accepted standard for measuring the outcome of an industrial accident is the number of fatalities and the total recordable cases (TRC), that is the occurrence of illness or injury. A fatal occurrence is a work-related injury or illness that causes the death of the employee. TRCs include work-related illness or injury that results in loss of consciousness, restriction of work or motion, transfer to another job, a requirement for medical treatment beyond first aid, or death.

As ORP has not experienced a fatality during recent history, the DOE and contractor rate (for all labor categories) of 0.26 per 200 million labor hours was adopted as representative of fatal occurrences. The impacts of illness and injury can be calculated using the total project labor hours and the appropriate incident rate. The total labor hours were calculated from the scaled data sets (SAIC 2012). The subtotal for each type of activity (construction, operations, deactivation, and closure) for clean closure of WMA A/AX is presented in Table 3–14.

Table 3-14 Waste Management Area A/AX Clean Closure Industrial Safety Impacts

Labor Category	Million Labor Hours	Total Recordable Case Rate per 200,000 Labor Hours	Projected Total Recordable Cases	Fatality Rate per 200 Million Labor Hours	Projected Fatalities
Construction	8.8	2.0	88.0	0.26	0.0114
Operations	17.0	2.0	170.0	0.26	0.0221
Deactivation	0.16	2.0	1.5	0.26	0.0002
Closure	5.84	2.0	58.4	0.26	0.0076
Total	**31.8**		**317.9**		**0.0413**

Note: Projected fatalities are displayed to four decimal places to show at least one significant digit. All other values presented in the table have been rounded to no more than three significant digits. Totals may not equal the sum of the contributions due to rounding.
Source: Labor hours compiled from the scaled data sets (SAIC 2012).

Clean closure of WMA A/AX would require about 32 million labor hours for all four phases: construction, operations, deactivation, and closure. More than half of the labor hours, 17 million, would occur during the operations phase. It is projected that there would be 318 TRCs and no fatalities.

3.1.15 Cost Analysis

The cost estimates, in 2008 dollars, for construction, operations, deactivation, closure, and disposal activities required to clean-close WMA A/AX are provided in Table 3–15.

Table 3-15 Waste Management Area A/AX Clean Closure Summary of Estimated Costs (millions of 2008 dollars)

Construction	Operations	Deactivation	Closure	Disposal	Total
423	665	15	1,453	539	3,095

Note: Estimates are costs to the Hanford Site only.
Source: DOE 2009.

Included in the construction costs are the costs to build or modify the 10 SSTs at the A and AX Tank Farms to support waste retrieval and the construction of interim storage facilities for HLW debris from the clean closure of the SSTs. Operations costs include ongoing operations of the A and AX Tank Farms, retrieval of tank waste, and operations of Borrow Area C, the onsite pit used to supply sand, soil, and gravel for backfilling the tank farms after the SSTs are removed. Deactivation costs include deactivation of tank waste retrieval equipment and facilities.

Closure costs include the construction and deactivation of confinement structures over the tank farms required during tank removal and contaminated deep soil removal, as well as removal of the 10 SSTs and ancillary equipment within the tank farms and the contaminated deep soils. The removed highly contaminated rubble, soil, and equipment (RSE) that would be managed as HLW would be maintained in shielded storage boxes on site on covered concrete storage pads. Closure costs also include the construction, operations, and deactivation of the PPF, a soil-washing facility that would treat highly contaminated (non-HLW) soils. This treatment would result in: 1) washed soils, which would be packaged for onsite disposal in the proposed RPPDF; and 2) contaminated liquid waste streams, which would be treated in the PPF melter, producing a ILAW glass that would be disposed of in the IDF.

Disposal costs include the construction, operations, closure, and postclosure care of the IDF and RPPDF that are necessary for the clean closure of the 10 SSTs at the A and AX tank farms.

3.2 WASTE MANAGEMENT AREA B/BX/BY

WMA B/BX/BY consists of three SST farms that store HLW that was generated primarily from the chemical processing of irradiated uranium fuel. Each of the tank farms consists of the following:

- SSTs of varying sizes
- Waste transfer lines
- Leak detection systems
- Tank ancillary equipment

WMA B/BX/BY is located in the north-central 200-East Area of Hanford (Figure 3–3).

B Tank Farm. The B Tank Farm consists of twelve 2-million-liter (530,000-gallon) (100-series) and four 208,000-liter (55,000-gallon) (200-series) SSTs constructed between 1943 and 1944 that currently store waste that was generated primarily at the B Plant, located about 823 meters (2,700 feet) southeast of the B Tank Farm. The B Fank Farm is one of the original tank farm designs, along with the C, T, and U Tank Farms. The SSTs are constructed of a steel-reinforced concrete shell that encompasses a steel plate liner. The 100-series tanks are 23 meters (75 feet) in diameter and about 10 meters (33 feet) in height, while the 200-series tanks are 6 meters (20 feet) in diameter and about 8.4 meters (27.5 feet) in height (DOE 2000).

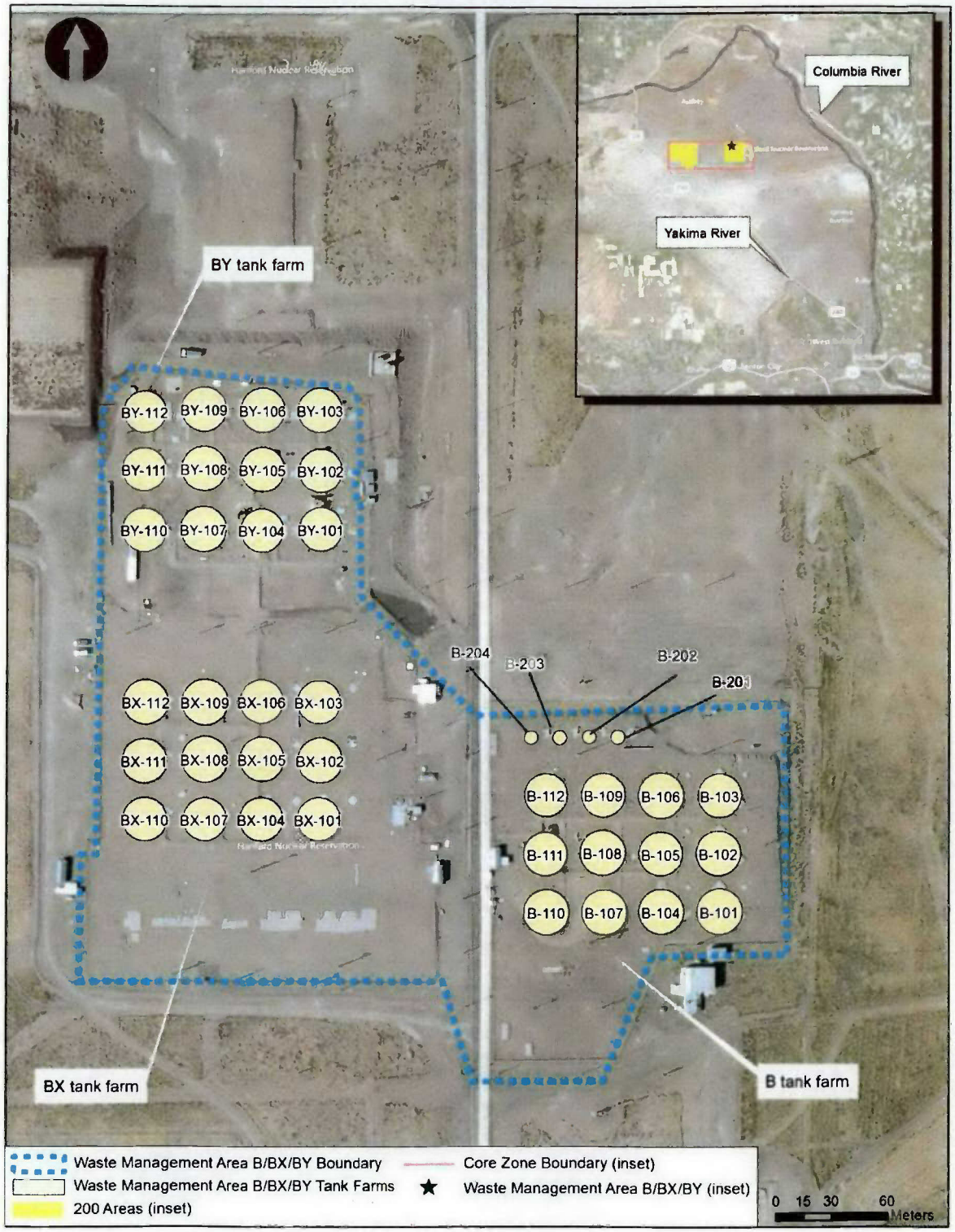


Figure 3-3 General Location of Waste Management Area B/BX/BY

Interbedded gravel, sand, and silt of the Hanford formation were excavated to a depth of about 12 meters (40 feet) during construction of the B tank farm, with the excavated materials used as backfill. Several inches of gravel were placed on top to provide protection and to retard vegetation growth that could bring subsurface contamination up to the ground surface. The 100-series tanks are sited at slightly different elevations, creating a gradient that allows liquids to flow from one tank to another as they are filled. They are arranged in four cascades, each consisting of a three-tank cascade series, with the receiving tank 0.3 meters (1 foot) lower than the feed tank. The 200-series tanks are sited at the same elevation and are connected by a series of tie lines that allow these tanks to overflow into one another and equalize waste volumes. Seven of the 100-series tanks and three of the 200-series tanks (B-101, B-103, B-105, B-107, B-110, B-111, B-112, B-201, B-203, and B-204) are estimated to have leaked a total of 204,000 liters (53,900 gallons) of liquid into the vadose zone sediments. All of the tanks in the B Tank Farm have been removed from service and are designated as stabilized. In addition, all of the tanks are designated to be in an intrusion prevention status, meaning that they have undergone measures to minimize the potential for addition of liquids to the tanks. None of the tanks are on the tank watch list for hazardous conditions (DOE 2000).

BX tank farm. The BX Tank Farm consists of twelve 100-series SSTs constructed in 1946 and 1947 that currently store HLW. This HLW was generated primarily at the B Plant, which is located about 914 meters (3,000 feet) south of the BX tank farm (DOE 1998a).

As with the B Tank Farm, sediments of the Hanford formation coarse-grained upper unit were excavated to a depth of about 12 meters (40 feet) during construction of the BX Tank Farm, with the excavated materials used as backfill. Several inches of gravel were again placed on top. The BX tanks are also sited at slightly different elevations and arranged in the same manner as those in the B tank farm. Five of the BX tanks (BX-101, BX-102, BX-108, BX-110, and BX-111) are assumed to have leaked approximately 274,000 liters (72,500 gallons) of liquid into the vadose zone sediments. All of the tanks in the BX Tank Farm have also been removed from service and are designated as stabilized. The ground surface is designated as controlled, clean, and stable, indicating that efforts have been made to remove hazardous conditions to promote a safe working environment (DOE 1998a).

BY tank farm. The BY Tank Farm was initially operated as a backup to the BX Tank Farm, and the tanks are connected to the end tanks of the BX Tank Farm: BX-103 to BY-101; BX-106 to BY-104; BX-109 to BY-107; and BX-112 to BY-110. The BY Tank Farm consists of second-generation tanks constructed between 1948 and 1949 and placed into service in 1950. The SSTs are basically the same design as the original T, U, B, and C tank designs, except the BY tanks have increased waste-volume capacity. Each BY tank, 23 meters (75 feet) in diameter and approximately 11.6 meters (38 feet) in height, with domed tops and concave bottoms, has a capacity of 2,869,000 liters (758,000 gallons). The BY Tank Farm includes 12 SSTs that currently store HLW. Tanks BY-101 through BY-106 stored B Plant metal waste after the BX farm tanks were full. Tanks BY-107 through BY-110 stored B Plant first-cycle waste and U Plant waste. Tanks BY-111 and BY-112 were used to store metal waste. Tanks BY-101, -103, and -111 received ferrocyanide waste from other BY tank transfers (DOE 1997a).

The BY tank farm excavation was constructed in sand and gravel sediments of the Hanford formation. These sediments occur from the ground surface to the top of basalt, which is at a

depth of about 7.9 meters (26 feet). The excavated materials were used as backfill around the completed tanks. The BY tanks are sited in the same manner as those in the B and BX tank farms. Five of these tanks (BY-103, -105, -106, -107, and -108) are assumed to have leaked approximately 159,000 liters (42,000 gallons) of liquid to the vadose zone sediments (DOE 1997a).

3.2.1 Land Resources

3.2.1.1 Land Use

Clean closure of WMA B/BX/BY would involve land-disturbing activities associated with construction of an underground transfer line, WRF, HLW Debris Storage Facility, PPF, IDF, and the proposed RPPDF. Closure activities would also require the extraction of material from Borrow Area C. For most facilities and activities, the acreage requirement was determined by use of a scaling factor that adjusted the total land requirement for closing all Hanford tank farms to a specific value for WMA B/BX/BY. However, this was not done for the WRF and PPF, as the minimum requirement to close a WMA is one facility. Also it was not necessary to scale the length of the underground transfer line.

WMA B/BX/BY is located in the 200-East Area; however, not all activities associated with its closure would take place in this area. Thus, land would also be disturbed between the 200-East and 200-West Areas (for the HLW Debris Storage Area, PPF, and proposed RPPDF) and within Borrow Area C. Within the 200-East Area, a total of 6.64 hectares (16.4 acres) would be disturbed, nearly all of which (6.31 hectares [15.6 acres]) is undeveloped. Development within the area between the 200-East and 200-West Areas would require 45.3 hectares (112 acres), all of which is undeveloped. Disturbance within Borrow Area C would total 107 hectares (265 acres), all of which is also undeveloped. Thus, a total of 159 hectares (393 acres) would be required for closure of WMA B/BX/BY, of which less than 0.4 hectares (1 acre) is currently developed.

3.2.1.2 Visual Resources

As noted above, a total of 159 hectares (393 acres), most of which is not currently developed, would be required for clean closure of WMA B/BX/BY. Within the 200-East Area, development would have little impact on visual resources, as the area is already highly industrialized. However, the use of 45.3 hectares (112 acres) between the 200-East and 200-West Areas would impact visual resources, as most of this land is not developed. The conversion of this land to an industrial use would add noticeably to the overall developed nature of the area and would be visible from nearby higher elevations. The viewscape from these higher elevations is important to American Indians with cultural ties to Hanford. Clean closure activities would involve constructing containment structures over the WMA; however, these structures would be removed upon completion of clean closure activities. Although there would be an overall increase in the industrial appearance of the 200 Areas, the BLM Visual Resource Management Class IV rating would not change. Management activities within Class IV areas dominate the view and typically are the focus of viewer attention.

As noted above, 107 hectares (265 acres) within Borrow Area C would be excavated for the closure of WMA B/BX/BY. Development of Borrow Area C would be readily visible from State

Route 240 and Rattlesnake Mountain and would change the BLM visual resource management rating from Class II to Class IV. Management activities within Class II areas may be seen but should not dominate the view. Upon completion of WMA B/BX/BY closure, excavations in Borrow Area C would be recontoured and revegetated, thereby lessening the visual impact.

3.2.2 Infrastructure

For clean closure of WMA B/BX/BY, the highest total amount of water, diesel, and gasoline usage would occur from operation of the proposed RPPDF and of Borrow Area C. The removal of tanks, ancillary equipment, and soils from the B Tank Farm would result in the highest total electricity demands. These activities would also generate a high demand for water, diesel, and gasoline.

Water would be required during construction for soil compaction, dust control, and possibly work surface and equipment washdown. Standard construction practices dictate that, at least initially, construction water would be trucked to construction locations on an as-needed basis for these uses until water supply and wastewater treatment utilities are in place. Concrete and grout would be produced in onsite batch plants, which would require large volumes of water. By comparison, relatively little water would be required to meet the potable and sanitary needs of the construction workforce. During operations, water would be required to support process makeup requirements and facility cooling, as well as the potable and sanitary needs of the operations workforce and other uses. To stabilize and partially decontaminate waste treatment, retrieval, and disposal facilities, water would also be used during facility deactivation activities; however, this requirement would be relatively small compared with those for construction and operational demands and for many closure activities, including construction of surface barriers.

Table 3–16 summarizes the projected utility infrastructure resource requirements for WMA B/BX/BY clean closure.

Table 3-16 Waste Management Area B/BX/BY Clean Closure Summary of Utility Infrastructure Requirements

Activity Phase	Electricity (million megawatt-hours)	Diesel Fuel[a]	Gasoline	Water
		(million liters)		
Peak (Year)	**0.017 (2035–2036)**	**39.2 (2101)**	**3.70 (2101)**	**333 (2043)**
Construction	0.009	29.1	2.93	98.7
Operations	0.018	180	5.58	4,620
Deactivation	0.00[b]	0.303	0.390	0.00[b]
Closure	0.395	94.3	7.99	269
Total[c]	**0.422**	**303**	**16.90**	**4,990**

a Assumed to be inclusive of all Number 2 diesel fuel, including road diesel and heating fuel oil.

b Deactivation values of "0.00" reflect no demand for that utility.

c Totals may not equal the sum of the contributions due to rounding.

Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate. To convert liters to gallons, multiply by 0.26417.

Source: SAIC 2010.

3.2.2.1 Electricity

For clean closure of WMA B/BX/BY, peak annual electrical energy demand in years 2035 and 2036 would be 17,270 megawatt-hours and would remain well within the annual capacity of 1.74 million megawatt-hours (based on a peak load capacity of 199 megawatts) of the Hanford electric power transmission system.

3.2.2.2 Fuel

Peak demands of about 39 million liters (10.3 million gallons) of diesel fuel and 3.7 million liters (1 million gallons) of gasoline would both occur in 2101. Annualized liquid fuel consumption (diesel fuel and gasoline) of about 1.64 million liters (0.4 million gallons) during the timespan of clean closure activities for WMA B/BX/BY (2008 through 2202) would be significantly less than the 4.3 million liters (1.1 million gallons) of liquid fuels currently used annually at Hanford.

3.2.2.3 Water

Peak annual water requirements of about 333 million liters (88 million gallons), occurring in 2043, would be well within the 18,500-million-liter (4,890-million-gallon) annual capacity of the Hanford Export Water System.

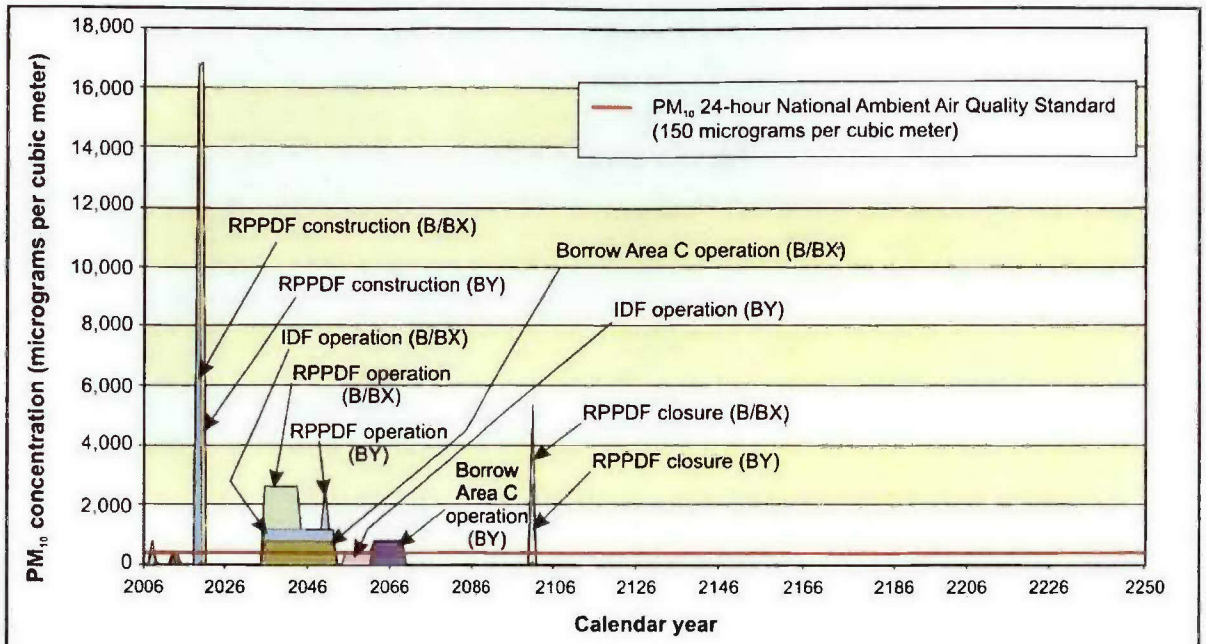
3.2.3 Noise and Vibration

Construction, operation, deactivation, and closure of facilities required for clean closure of WMA B/BX/BY would result in minor noise impacts of employee vehicles, trucks, construction equipment and activity, generators, and process equipment. The offsite noise levels from activities associated with clean closure of WMA B/BX/BY would be negligible due to the distance to the Hanford boundary.

Employee and truck traffic to deliver materials for various phases of activities would vary over the duration of the project. The highest number of employee trips is expected to occur in 2014 (SAIC 2012). The increase in the number of employee vehicles and truck trips is expected to cause a minor increase in traffic noise levels along routes to the site. This increase in employee and truck traffic (discussed in Section 3.2.9) was compared with the existing average traffic volume of 30,000 to 40,000 vehicles per day (DOE 2012). For comparison purposes, the increase in traffic noise level can be estimated from the ratio of the projected traffic volume to the existing traffic volume.

3.2.4 Air Quality

Criteria pollutant concentrations that would result from WMA B/BX/BY clean closure activities are presented in Table 3–17. Peak concentrations of all criteria pollutants except PM would occur in 2101. Peak concentrations of PM would occur in 2020. The peak period concentrations for carbon monoxide, nitrogen dioxide, and sulfur dioxide would result primarily from closure of the proposed RPPDF. Peak period concentrations for PM would result from RPPDF construction. The maximum air quality impacts of PM_{10} emissions would occur to the south at State Route 240. Figure 3–4 shows the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities to these concentrations.



Key: IDF=Integrated Disposal Facility; PM_{10} =particulate matter with an aerodynamic diameter less than or equal to 10 micrometers; RPPDF=River Protection Project Disposal Facility.

Figure 3-4 Waste Management Area B/BX/BY Clean Closure PM_{10} Maximum 24-Hour Concentrations

Table 3-17 Waste Management Area B/BX/BY Clean Closure Maximum Incremental Criteria Pollutant Concentrations

Pollutant and Averaging Period	Standard[a]	Maximum Modeled Increment
	(micrograms per cubic meter)	
Carbon Monoxide		
8-hour	10,000[b]	**82,300**
1-hour	40,000[b]	**514,000**
Nitrogen Dioxide		
Annual	100[b]	**178**
1-hour	188	**357,000**
PM_{10}[c]		
Annual	50[d]	**120**
24-hour	150[b]	**16,900**
$PM_{2.5}$		
Annual	15[d]	**120**
24-hour	35[b]	**16,900**
Sulfur Dioxide		
Annual	50[d]	0.352
24-hour	260[d]	48.9
3-hour	1,300[b]	240
1-hour	197[e]	**706**

[a] The more stringent of the Federal and Washington State standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (40 CFR 50), other than those for ozone, particulate matter, lead, and those based on annual averages, are not to be exceeded more than

once per year. The 24-hour PM_{10} standard is attained when the expected number of days with a 24-hour average concentration above the standard is less than or equal to 1. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard. The annual $PM_{2.5}$ standard is met when the 3-year average of the annual means is less than or equal to the standard. The 24-hour $PM_{2.5}$ standard is met when the 3-year average of the 98th percentile 24-hour averages is less than or equal to the standard. The 1-hour nitrogen dioxide standard is met when the 3-year average 98th percentile of the daily maximum 1-hour average does not exceed the standard value.

[b] Federal and Washington State standard.

[c] The Federal standards for $PM_{2.5}$ are 15 micrograms per cubic meter annual average and 35 micrograms per cubic meter 24-hour average. No specific data for $PM_{2.5}$ were available, but for analysis purposes, concentrations were assumed to be the same as those of PM_{10}.

[d] Washington State standard.

[e] Federal standard.

Note: The National Ambient Air Quality Standards also include standards for lead and ozone. No sources of lead emissions have been identified for the activities evaluated. Washington State also has ambient standards for fluorides. Concentrations in **bold** text indicate potential exceedance of the standard.
Key: PM_n=particulate matter with an aerodynamic diameter less than or equal to *n* micrometers.
Source: Based on emissions data in SAIC 2012.

Maximum concentrations of carcinogenic and noncarcinogenic toxic pollutants are presented in Table 3–18. No impacts on the public due to projected nonradioactive toxic pollutant emissions are expected as a result of WMA B/BX/BY clean closure activities. Hazardous chemical health effects on noninvolved workers are summarized in Tables 3–19 and 3–20.

Table 3-18 Waste Management Area B/BX/BY Clean Closure Maximum Incremental Nonradioactive Toxic Chemical Concentrations

Pollutant	Averaging Period	Acceptable Source Impact Level[a]	Maximum Modeled Increment
		(micrograms per cubic meter)	
Ammonia	24-hour	70.8	40.0
Benzene	Annual	0.0345	0.0646
1,3-Butadiene	Annual	0.00588	0.00168
Formaldehyde	Annual	0.167	0.0555
Mercury	24-hour	0.09	0.00000655
Toluene	24-hour	5,000	62.5
Xylene	24-hour	(b)	18.5

[a] WAC 173-460.

[b] Not listed in WAC 173-460.

Note: To convert cubic meters to cubic feet, multiply by 35.315.
Source: Based on emissions data in SAIC 2012.

Table 3-19 Waste Management Area B/BX/BY Clean Closure Nonradioactive Airborne Toxic Chemical Hazard Index for the Nearest Noninvolved Worker

Chemical	Hazard Quotient
Ammonia	2.25×10^{-1}
Mercury	2.86×10^{-5}
Toluene	3.70×10^{-3}
Xylene	5.56×10^{-2}
Hazard Index	2.84×10^{-1}

Source: Based on emissions data in SAIC 2012.

Table 3-20 Waste Management Area B/BX/BY Clean Closure Nonradioactive Airborne Toxic Chemical Cancer Risk for the Nearest Noninvolved Worker

Chemical	Cancer Risk
Benzene	2.36×10^{-5}
1,3-Butadiene	2.55×10^{-6}
Formaldehyde	3.59×10^{-5}

Source: Based on emissions data in SAIC 2012.

3.2.5 Geology and Soils

Consumption of geologic resources (rock, minerals, and soils) to support facility construction, operations, and deactivation, as applicable, would constitute the major indirect impact on geologic and soil resources from implementation of clean closure of WMA B/BX/BY and associated waste management activities, as summarized in Table 3–21. Varying quantities of geologic resources would be required for ongoing facility construction; upgrades to existing facilities, including the 200 Area tank farms; waste retrieval activities; and, most substantially, tank farm closure. Geologic resources, including relatively large volumes of gravel, sand, and silt, are available from the suprabasalt sediments and associated soils at Hanford. Rock, in the form of basalt, is also plentiful. As discussed in the *Environmental Assessment, Use of Existing Borrow Areas, Hanford Site, Richland, Washington* (DOE 2001a), a number of active gravel and sand pits and two rock quarries at Hanford have been identified for use in providing a continual supply of borrow materials for new facility construction, maintenance of existing facilities, and fill and capping material for remediation and other activities. Of the two active quarries on the site, quarry No. 2 (Borrow Area C), located due south of the 200-West Area just south of State Route 240, has large volumes of basalt and sand (DOE 2001a). This approximately 926.3-hectare (2,289-acre) borrow area has been designated as a source of materials such as rock riprap (basalt), aggregate (gravel and sand), and soil (silt and loam) that would be needed to support tank farm closure and supporting activities (DOE 2003a).

Table 3-21 Waste Management Area B/BX/BY Clean Closure Major Geologic and Soil Resource Impact Indicators and Requirements

Construction Materials				Other Borrow Materials[a]				Closure-Specific Materials		
Concrete/ Grout	Cement[b]	Sand[b]	Gravel[b]	Rock/ Basalt	Sand	Gravel	Soil (Specification Backfill)	Grout[c]	Cement	Sand[d]
188,000	41,700	91,300	97,800	0	388,000	206,000	7,970,000	1,640	190	770

[a] Resources for miscellaneous uses not exclusively tied to facility construction, operations, or closure, such as site grading and backfill for operations.

[b] Cement, sand, and gravel are components of concrete.

[c] Grout is composed of cement, sand, fly ash, and other materials.

[d] Principal component of grout that would be obtained from onsite deposits.

Note: Values have been rounded to no more than three significant figures. All values are expressed in cubic meters. To convert cubic meters to cubic feet, multiply by 35.315.

3.2.6 Water Resources

All construction and closure-related land disturbances, especially for new facility construction, would expose soils and sediments to possible erosion by infrequent, heavy rainfall or by wind. While unlikely to reach surface-water features, stormwater runoff from exposed areas could convey soil, sediments, and other pollutants (e.g., construction waste materials and spilled materials, such as petroleum, oils, and lubricants from construction equipment) from

construction footprint and laydown areas. Nevertheless, appropriate soil erosion and sediment control measures, as well as spill prevention and waste management practices, would be employed to minimize suspended sediment, the transport of other deleterious materials, and any potential water-quality impacts. Further, all construction and other ground-disturbing activities would be conducted in accordance with current NPDES and state waste discharge general permits for stormwater discharges associated with construction activities, issued by Ecology. The NPDES permit specifically requires the development and implementation of a stormwater pollution prevention plan.

Once completed, new facilities required for clean closure of WMA B/BX/BY would incorporate appropriate stormwater management controls to collect, convey, and detain stormwater from buildings and other impervious surfaces so as to minimize the impacts of onsite hydrology and soil erosion. Hanford's NPDES Storm Water Multi-Sector General Permit would cover stormwater discharges associated with industrial activity and, as necessary, stormwater discharges would be covered under state waste discharge permits for discharges to the ground.

Under normal operations associated with WMA closure, facility design combined with adherence to spill prevention and emergency response plans and procedures would help to ensure that involved hazardous substances, including spills, should they occur, do not reach soils or surfaces where they could be conveyed to surface water or groundwater. For construction, operations, deactivation, and closure activities, adherence to best management practices and other preventive measures under applicable permits and compliance plans would be coordinated by DOE with those measures in similar sitewide pollution prevention plans.

There would be no direct discharge of effluents to either surface water or groundwater during construction, operations, and deactivation as a result of WMA B/BX/BY clean closure. Nonhazardous sanitary wastewater (sewage) would be managed via appropriate sanitary wastewater collection and treatment systems. During the early phases of new facility construction, it was assumed that portable toilet facilities would be provided for construction personnel, with collected waste disposed of at offsite contractor facilities, as is standard construction practice. During facility operations and deactivation, sanitary wastewater would be disposed of via the dedicated sanitary sewer or septic/drain-field system serving a particular facility.

Water would be required to support new facility construction, facility operations, and facility deactivation for WMA B/BX/BY clean closure. Water would be required for WRF construction; replacement of underground transfer lines; and construction of tank upgrades, new risers, an MRS, a VBR system, the PPF, IDF-East, and the proposed RPPDF that will be located between the 200-East and 200-West Areas. Total water demands have been conservatively estimated at 4,990 million liters (1,320 million gallons), with a peak demand of 333 million liters (88 million gallons). Peak periods of water demands would occur during the year 2043 as a result of Borrow Area C and RPPDF operation. All utility demands, as well as water demands, are discussed in Section 3.2.2, Infrastructure.

3.2.7 Ecological Resources

3.2.7.1 Terrestrial Resources

As noted in Section 3.2.1.1, a total of 51.8 hectares (128 acres) within the 200-East Area and between the 200-East and 200-West Areas would be disturbed by construction of the facilities required to clean-close WMA B/BX/BY. Of this total, 6.64 hectares (16.4 acres) would be developed within the 200-East Area and 45.3 hectares (112 acres) between the 200-East and 200-West Areas. Within the 200-East Area, nearly all of the land needed for construction (6.31 hectares [15.6 acres]) is undeveloped, with 4.29 hectares (10.6 acres) being sagebrush habitat, while the entire 45.3 hectares (112 acres) required between the 200-East and 200-West Areas is sagebrush habitat. Late successional sagebrush habitat is considered a Level III resource under the *Hanford Site Biological Resources Management Plan* (DOE 2001b:4.11). The loss of 1.21 hectares (3 acres) of sagebrush habitat resulting from construction of the underground transfer line within the 200-East Area would not be mitigable; however, Hanford guidance may require the replacement of other sagebrush habitat at a ratio ranging from 1:1 to 3:1 (DOE 2003b:20, 21, 31). Specific measures to mitigate the loss of sagebrush habitat would be set forth in a mitigation action plan prior to construction.

The clean closure of WMA B/BX/BY would require that 107 hectares (256 acres) of Borrow Area C be excavated to supply needed geologic material. The two major plant communities within the area are cheatgrass-bluegrass (782 hectares [1,933 acres]) and needle-and-thread grass/Indian ricegrass (107 hectares [265 acres]) (DOE 2012). The latter represents an unusual and relatively pristine community type at Hanford; thus, it is considered a more highly valued community than the former. It is not possible to determine specific impacts of excavating Borrow Area C on ecological resources because the particular portion of the site from which geologic material would be excavated is unknown. To the extent that it is possible, the needle-and-thread grass/Indian ricegrass community should be avoided during excavation. A mitigation action plan would be developed prior to excavation.

3.2.7.2 Threatened and Endangered Species

Federally or state-listed threatened or endangered species have not been observed within, or in the immediate vicinity of, the 200 Areas or Borrow Area C; therefore, impacts on this group of plants and animals are not expected as a result of WMA B/BX/BY clean closure. Both the Columbia and Yakima Rivers adjacent to Hanford have been designated as critical habitat for the bull trout. However, as there would be no short-term impacts on either river from construction or operation of new facilities associated with clean closure of WMA B/BX/BY, designated critical habitat would not be adversely affected.

A number of state-listed, special status species observed within areas that would be disturbed by clean closure of WMA B/BX/BY could be impacted by construction of the various required facilities. Three state-listed species were observed within areas that could be disturbed within the 200-East Area. The black-tailed jackrabbit (state candidate) and Piper's daisy (state sensitive) have been observed on or near the underground transfer line route, and the sage sparrow (state candidate) has been observed within the IDF vicinity. In addition, the loggerhead shrike (Federal species of concern and state candidate), black-tailed jackrabbit, sage sparrow, and crouching milkvetch (state watch) have all been observed between the 200-East and

200-West Areas where the HLW Debris Storage Facility, PPF, and the proposed RPPDF would be located. Finally, surveys have identified Piper's daisy, stalked-pod milkvetch (state watch), crouching milkvetch, and the long-billed curlew (state monitor) within the boundaries of Borrow Area C. The operation of new facilities is not expected to impact any listed species.

Although mitigation would not be required for the state monitor and watch species, they should be considered during project planning. Impacts on state candidate and sensitive species, which are considered Level III resources under the *Hanford Site Biological Resources Management Plan*, require mitigation where impacts would occur. When avoidance and minimization are not possible or are insufficient, mitigation via rectification or compensation is recommended (DOE 2001b:4.9, 8.11). A comprehensive mitigation action plan, which would deal with the loss of state-listed species (as well as sagebrush habitat), would be developed prior to construction.

3.2.8 Cultural and Paleontological Resources

3.2.8.1 Prehistoric Resources

As noted in Section 3.2.1.1, clean closure of WMA B/BX/BY would require a total of 159 hectares (393 acres), of which less than 0.4 hectares (1 acre), located in the 200-East Area, is currently developed. Land disturbance due to clean closure of WMA B/BX/BY would involve the 200-East Area, land between the 200-East and 200-West Areas, and Borrow Area C. White Bluffs Road, an important archaeological resource, is located in the southwest and northeast parts of the 200-West Area. Other prehistoric finds were discovered in the northwestern portion of the 200-West Area and immediately east of the 200-East Area. There are no known prehistoric resources within the areas that would be affected by the clean closure of WMA B/BX/BY. The survey and geology of these areas indicate that subsurface cultural deposits have little or no potential of being present. The *Hanford Cultural Resources Management Plan* (DOE 2003c) provides guidance for identifying, evaluating, recording, curating, and managing cultural resources. If any prehistoric resources were discovered during construction or excavation, procedures from the *Hanford Cultural Resources Management Plan* would be implemented.

3.2.8.2 Historic Resources

Construction or excavation activities would not require land from the 200-West Area for the clean closure of WMA B/BX/BY; therefore, White Bluffs Road, which is located within the 200-West Area, would not be affected. Buildings associated with the Manhattan Project and Cold War era are found within both the 200-East and 200-West Areas; however, none of these structures would be affected. There would be no impacts on other known early historic artifacts within the 200-East or 200-West Area because all such resources would be avoided. As is the case for prehistoric resources, if historic resources were discovered, procedures in place to properly identify, evaluate, record, curate, and manage the discovery site would be implemented.

3.2.8.3 American Indian Interests

As stated above, there are no known prehistoric resources that may be an American Indian interest within the affected areas required for the clean closure of WMA B/BX/BY. Clean closure of WMA B/BX/BY would impact 45.3 hectares (112 acres) of undeveloped land between

the 200-East and 200-West Areas. The conversion of this land to industrial use would be noticeably visible from nearby higher elevations, such as Gable Mountain and Gable Butte. The viewscape from these higher elevations is important to American Indians with cultural ties to Hanford. There would be little impact on the viewscape within the 200-East Area, as the area is already highly industrialized.

Clean closure of WMA B/BX/BY would also require excavation of 107 hectares (265 acres) within Borrow Area C. This would also have an impact on the viewscape from Rattlesnake Mountain; however, upon completion of the work, excavations of Borrow Area C would be recontoured and revegetated, thus lessening the visual impact. Appropriate mitigation measures would be developed in consultation with area tribes.

3.2.8.4 Paleontological Resources

No paleontological resources have been discovered within the 200-East Area or Borrow Area C; therefore, clean closure of WMA B/BX/BY would not impact such resources. However, if any paleontological resources were found during construction or excavation, procedures to properly manage the discovery site would be implemented.

3.2.9 Socioeconomics

3.2.9.1 Regional Economic Characteristics

For clean closure of WMA B/BX/BY, as shown in Table 3–22, the peak workforce (3,570 FTEs) would occur in 2014. Construction and operation activities would dominate the years from 2013 through 2036, with several spikes in employment followed by sharp drops. The peak estimate is approximately 2.0 percent of the projected labor force in the ROI (175,000 in 2014), compared with 10 percent in 2006. The existence of these direct jobs is expected to result in the creation of another 2,670 indirect positions in the ROI during the peak year. An additional spike (1,180 FTEs) in the workforce estimate in 2101 would be dominated by clean closure activities at the proposed RPPDF. A small workforce (five FTEs) would be needed for postclosure care of the site beginning in 2103. Implementing WMA B/BX/BY clean closure activities could alter the economic characteristics of the region by increasing demands for goods and services in the Tri-Cities area due to increases in expenditures, income, and employment, both direct and indirect, at Hanford.

Table 3-22 Waste Management Area B/BX/BY Clean Closure Workforce Estimates

Work Activity	Peak Year(s)	Workforce Peak (FTE)
Construction	2013	1,920
Operations	2014–2017	1,880
Deactivation	2015–2018	42
Closure	2101	1,180
Total Onsite Workforce	**2014**	**3,570**

Key: FTE=full-time equivalent.

3.2.9.2 Demographic Characteristics

While the clean closure of WMA B/BX/BY would draw some workers from the local labor force, the demand for construction and operations workers would draw from outside the region.

The in-migrations of new workers and their families would increase the overall population within the Tri-Cities area and could alter the demographic characteristics of the region.

3.2.9.3 Housing and Community Services

Implementing clean closure of WMA B/BX/BY would increase the demand for housing and would impact schools and other community services within the Hanford ROI. The demand for housing by construction and operations workers would impact the cost and availability of houses and rental units. School enrollments would increase, and utilities and police and fire services may need to be expanded. After some peak employment periods, sharp drops in onsite employment might occur. These reductions could also reduce the number of indirect jobs in the region supporting Hanford activities. If these workers are unable to find employment in other industries, they could move out of the region, thereby reducing the overall regional population and decreasing the demand for housing and community services (Perteet, Thomas/Lane, and SCM 2001:3-4).

3.2.9.4 Local Transportation

Implementation of WMA B/BX/BY clean closure is expected to have an impact on the local transportation system, especially during the commute periods. The projected increase in commuter traffic to the site would be due primarily to construction and operations activities, peaking at an annual 3,570 FTEs in 2014. This could represent up to 2,850 passenger vehicles per day during the peak year. It is expected that this commuter traffic would impact the regionally established level of service (LOS), reducing it to below the minimum acceptable ("D") LOS.

The number of annual truck trips would peak in 2101 during construction of the modified RCRA Subtitle C barrier. During this construction, offsite trips would peak at 12,100 trips per year (approximately 46 truck trips per day). At the same time, the predicted onsite truck activity would peak at 119,000 truck trips per year (approximately 456 trips per day). For the majority of the rest of the time period (2070 through 2100 and after 2102), there would be less than 1 truck trip on or offsite each day.

3.2.10 Public and Occupational Health and Safety – Normal Operations

Activities to clean-close WMA B/BX/BY could result in radiological exposures to the public and workers. Radiological impacts are presented for three public receptors: the general population (approximately 560,000)[7] living within 80 kilometers (50 miles) of the Hanford 200 Areas, an MEI living near Hanford, and an onsite MEI. Impacts on the general population are evaluated for a residential scenario whereby people are exposed to radioactive materials emitted from project facilities. Radiological exposure occurs through inhalation, direct exposure to the radioactive plume and material deposited on the ground, and ingestion of contaminated products from animals raised locally and fruits and vegetables grown in a family garden (DOE 1995). The MEI is a hypothetical individual member of the public located at a position near the site boundary who would experience the highest impacts during normal operations. The MEI was determined to be a receptor on the east side of the Columbia River. Impacts on the offsite MEI

[7] The approximate population is based on populations of 542,324; 546,746; and 589,668 people residing within 80 kilometers (50 miles) of theWTP, 200-East Area, and 200-West Area, respectively, as described in the *Final TC & WM EIS* (DOE 2012).

are evaluated for a scenario that includes the same exposure pathways assumed for the general population, but with an increased amount of time spent outdoors and a higher rate of contaminated food consumption. Impacts on the onsite MEI, identified as a member of the public who works at the Columbia Generating Station, LIGO, or U.S. Ecology, would be from inhalation and exposure to the plume and material deposited on the ground. Doses are presented as total effective doses. Details of the assessment methodology for determining radiological exposure of workers and members of the public are presented in Appendix K of the *Final TC & WM EIS* (DOE 2012).

The radiological impacts on members of the public are presented in terms of impacts over the life of the project, that is WMA B/BX/BY clean closure (the operational life of the project during which radioactive air emissions would occur), and peak annual impacts. Impacts over the life of the project are the total estimated radiation doses that would be incurred by members of the public over the duration of the activities to complete clean closure of the WMA. The peak annual impacts are the estimated annual radiation doses that would be incurred by members of the public during the year(s) of largest radiation dose.

In addition to members of the public, workers directly involved in the activities to clean-close the WMA and nearby noninvolved workers may receive radiation doses. Doses to an involved worker are calculated based on an FTE employee. It was assumed for the purposes of this dose evaluation that an FTE involved worker has a 2,080 hour work year. In practice, the number of workers who could receive a radiation dose may be larger than the number of FTEs assumed in this analysis, resulting in a smaller average dose per worker. A noninvolved worker is a person working at the site who is incidentally exposed due to the radioactive air emissions associated with tank farm management, tank waste retrieval, and clean closure activities. The potential dose to a noninvolved worker would result from exposure to, and inhalation of, radioactive contaminants released to the atmosphere from tank farm management, tank waste retrieval, and clean closure activities. In the 200-East Area, the noninvolved worker was assumed to be at the 242-A Evaporator, 1,090 meters (3,580 feet) north northwest of the 200-East Area source. In the 200-West Area, the noninvolved worker was assumed to be at the ERDF, about 950 meters (3,120 feet) east of the 200-West Area source.

The impacts of radionuclide releases from construction, operations, deactivation, and cleanup of facilities directly related to tank farm management, tank waste retrieval, and clean closure of WMA B/BX/BY were evaluated.

3.2.10.1 Radiological Impacts on the Public

Table 3–23 presents estimated doses to the general population and the MEI for activities associated with clean closure of WMA B/BX/BY. Activities conducted at WMA B/BX/BY that would generate radioactive air emissions would occur from 2009 through 2100. Due to the long timeframe involved, the doses over the life of the project may not be received by the same members of the population or the same MEI, but are presented as a measure of potential impacts to provide a basis for comparison with other WMAs.

Table 3-23 Waste Management Area B/BX/BY Clean Closure Public Health Impacts of Atmospheric Radionuclide Releases

Receptor	Facility	Impacts over Life of Project[a]		Peak Annual Impacts		
General population		**Dose (person-rem)**	**Number of Latent Cancer Fatalities[b]**	**Year of Maximum Impact**	**Dose (person-rem per year)**	**Number of Latent Cancer Fatalities[b]**
	200-East Area	5.0			0.41	
	200-West Area	3.7			0.40	
	Total	**8.6**	**0 (5×10^{-3})**	**2035**	**0.81**	**0 (5×10^{-4})**
Maximally exposed individual		**Dose[c] (millirem)**	**Lifetime Risk of a Latent Cancer Fatality[d]**	**Year of Maximum Impact**	**Dose (millirem per year)**	**Lifetime Risk of a Latent Cancer Fatality[d]**
	200-East Area	0.69			0.054	
	200-West Area	0.27			0.030	
	Total	**0.96**	**6×10^{-7}**	**2035**	**0.084**	**5×10^{-8}**
Onsite MEI	**Total**	**0.35**	**2×10^{-7}**	**2035**	**0.034**	**2×10^{-8}**

a Impacts accrued over the operational life of the project to clean-close Waste Management Area B/BX/BY.

b The reported value is the projected number of latent cancer fatalities (LCF) among the population and is therefore presented as a whole number. The result, calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem), is shown in parentheses.

c Impacts are provided for assessment purposes. The life-of-project dose likely overestimates the dose that would be received by one individual person because the project could span approximately 92 years.

d Probability of an LCF in the MEI is calculated by converting the dose in millirem to rem (divide by 1,000), then multiplying the dose by the risk factor of 0.0006 LCFs per rem.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: MEI=maximally exposed individual.

Over the life of the project, the population within 80 kilometers (50 miles) of the 200 Areas would receive a cumulative dose of 8.6 person rem, and the MEI would receive a cumulative dose of 0.96 millirem. Given the risk factor of 0.0006 LCFs per rem (DOE 2003d), no LCFs are expected in the general population as a result of these activities. There would be a probability of 6×10^{-7} (1 chance in 1.6 million) of the MEI developing an LCF, assuming the same MEI was exposed over the life of the project. Radioactive air emissions would result in a maximum annual population dose of 0.81 person rem and a maximum annual MEI dose of 0.084 millirem. The primary contributor to offsite doses would be fission products from processing contaminated tank farm soils through the PPF.

An onsite MEI who spends a normal workday at U.S. Ecology would receive a maximum annual dose of 0.034 millirem. The increased risk of an LCF from this dose would be 2×10^{-8} (1 chance in 50 million).

3.2.10.2 Radiological Impacts on Workers

Table 3–24 presents dose and risk estimates for an involved FTE worker and a noninvolved FTE worker. The average annual FTE radiation worker dose would be 130 millirem, lower than the Administrative Control Level of 500 millirem. A radiation worker who received the average annual dose over the course of 40 years would receive a dose of 8,400 millirem, corresponding to a risk of 5×10^{-3} (1 chance in 200) of developing an LCF.

Table 3-24 Waste Management Area B/BX/BY Clean Closure Normal Operations Radiological Impacts on Workers

Receptor	Dose	Latent Cancer Fatality Risk[a]
Average Involved Full-Time-Equivalent Worker		
Average annual impact	130 millirem	8×10^{-5}
Impact over life of project[b]	8,400 millirem	5×10^{-3}
Life-of-Project Worker Population	1,600 person-rem	1
Noninvolved Worker (Year of Maximum Impact)		
At the 242-A Evaporator (2035)	0.10 millirem	6×10^{-8}
At the Environmental Restoration Disposal Facility (2035)	0.28 millirem	2×10^{-7}

[a] For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

[b] Impact over the life of the project is the average dose a full-time-equivalent radiation worker would receive working on this project. It is determined by multiplying the average annual dose by an assumed career length of 40 years.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

The total effective dose to the involved worker population from the 92 years of occupational exposure was estimated to be 1,600 person-rem. Given the risk factor of 0.0006 LCFs per person-rem, one LCF is expected to result from the dose associated with tank farm operations, tank waste retrieval, and clean closure of WMA B/BX/BY. Worker doses should be viewed in the context of the duration of the project and the DOE administrative controls employed that limit them. Due to the number of years required to complete clean closure, the dose over the life of the project would be distributed over multiple generations of workers. In addition, the worker dose would be limited to less than 5 rem total effective dose per year (10 CFR 835). This regulatory limit would be further constrained by the application of administrative controls. DOE Standard 1098-2008, *Radiological Control*, recommends that the annual dose not exceed 2 rem, unless explicitly authorized by DOE management (e.g., for emergency situations). Individual worker doses would be maintained ALARA and generally be controlled at a level below 500 millirem (0.5 rem) per year.

Estimated doses and risks to the noninvolved workers at the 242-A Evaporator or the ERDF in the year of maximum impact are shown in Table 3–24. Doses to noninvolved workers would be a small fraction of the DOE-recommended Administrative Control Level of 500 millirem per year.

3.2.11 Public and Occupational Health and Safety – Facility Accidents

This section addresses potential impacts on workers and the public associated with tank-farm-related accidents. Radiological impacts of the postulated accident scenarios were quantified for an MEI living near Hanford, the offsite population living within 80 kilometers (50 miles) of the facility, and a noninvolved worker assumed to be 100 meters (110 yards) from the facility. Hazardous chemical impacts were also evaluated. For an involved worker, accident consequences were not quantified. While involved workers are expected to be near the Hanford tank farms during routine tank farm operations, their number and location relative to a postulated accident are unknown. In the event of an accident involving chemicals or radioactive materials,

workers near an accident could be at risk of serious injury or fatality. Safety procedures, safety equipment, and protective barriers are typical features that would prevent or minimize worker impacts. Additionally, following initiation of accident/site emergency alarms, workers in adjacent areas would evacuate in accordance with the technical area and facility emergency operating procedures and training. Therefore, involved worker impacts are not discussed further.

There would be no radiological accidents associated with facility construction. Further, any hazardous chemical accidents associated with facility construction would be typical of those normally associated with industrial construction materials, hazards, and practices. Projected operational accident consequences are presented in the following sections. Details of the methodology for assessing the potential impacts on workers and the public associated with postulated accidents are presented in Appendix K, Section K.3, of the *Final TC & WM EIS* (DOE 2012).

3.2.11.1 Radiological Impacts of Airborne Releases

During tank farm operations, tank waste retrieval, or clean closure activities, reasonably foreseeable accidents that could occur include: 1) hydrogen burn in a waste storage tank; and 2) tank dome collapse. The accident selected to represent a severe accident is the seismically induced waste tank dome collapse. The consequences of a seismically induced waste tank dome collapse, if it were to occur, are shown in Table 3–25. The annual risks of LCFs for this accident, which were obtained by multiplying the consequences by the likelihood (frequency per year) that the accident would occur, are shown in Table 3–26.

Table 3-25 Waste Management Area B/BX/BY Clean Closure Radiological Consequences of Accidents

Accident	Maximally Exposed Individual		Offsite Population[a]		Noninvolved Worker	
	Dose (rem)	LCF[b]	Dose (person-rem)	LCF[c]	Dose (rem)	LCF[b]
Seismically induced waste tank dome collapse – unmitigated	0.00021	1×10^{-7}	1.3	0 (8×10^{-4})	0.22	1×10^{-4}

[a] Based on a population of 589,668 persons residing within 80 kilometers (50 miles) of the 200-West Area.

[b] Increased likelihood of latent cancer fatality for an individual, assuming the accident occurs.

[c] The reported value is the projected number of latent cancer fatalities (LCF) among the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

Key: LCF=latent cancer fatality.

Table 3-26 Waste Management Area B/BX/BY Clean Closure Annual Cancer Risks from Accidents

Accident	Frequency (per year)	Risk of Latent Cancer Fatality		
		Maximally Exposed Individual[a]	Offsite Population[b, c]	Noninvolved Worker[a]
Seismically induced waste tank dome collapse – unmitigated	5×10^{-4}	6×10^{-11}	4×10^{-7}	7×10^{-8}

a Increased risk of a latent cancer fatality to the individual, taking into account the probability (frequency) of the accident.

b Based on a population of 589,668 persons residing within 80 kilometers (50 miles) of the 200-West Area.

c The reported value is the projected number of latent cancer fatalities (LCF) among the population, based on the probability (frequency) of the accident occurring, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

3.2.11.2 Hazardous Chemical Impacts

Various hazardous chemicals exist in the waste tanks. Because the chemicals that exist in the tank waste are mixed with the radioactive material, any accident event is expected to release both hazardous chemicals and radioactive materials. Due to the quantity and nature of the radioactive material in the waste tanks, the human health consequences of an accidental release would be dominated by the impacts of the radioactive components. Therefore, hazardous chemical human health impacts were not analyzed separately.

3.2.11.3 Intentional Destructive Acts

This section addresses potential impacts of intentional destructive acts at a tank farm. To protect against such actions, safeguards and security measures are employed at all DOE facilities. In accordance with DOE Orders, DOE conducts vulnerability assessments and risk analyses of facilities and equipment under its jurisdiction to evaluate the physical protection elements, technologies, and administrative controls needed to protect DOE assets. DOE also protects against espionage, sabotage, and theft of radioactive, chemical, or biological materials; classified information and matter; nonnuclear weapon components; and critical technologies. Before startup of any new or substantially modified operations, DOE would conduct an indepth, site-specific safeguards and security inspection to ensure that existing programs satisfy DOE requirements. Any inadequacies would be resolved before startup of operations. Release scenarios and impacts resulting from intentional destructive acts may be similar to the accident scenarios analyzed. Additional scenarios representing intentional destructive acts that may not be represented by the accident analyses were also considered.

Explosive Device in Underground Waste Tank. It was postulated that intentionally initiated explosions occur that displace a large portion of the soil overburden, breach the tank dome, and disperse a portion of the tank waste into the atmosphere. In accordance with the recommendation from *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, Vol. 1, *Analysis of Experimental Data* (DOE Handbook 3010-94), the respirable release would be less than the TNT equivalent weight of the explosive charge. Analysis results indicate that the radiological impacts of an explosive device in an underground waste tank would be about four times greater than the impacts of the most severe accident scenario that involved the same inventory of radioactive material (seismically induced waste tank dome collapse). The offsite population dose was estimated to be 4.9 person-rem, with no

(3×10^{-3}) resulting additional LCFs. The MEI dose would be 0.00083 rem, corresponding to an increased risk of an LCF of 5×10^{-7}. The noninvolved worker dose would be 0.88 rem, corresponding to an increased risk of an LCF of 5×10^{-4}.

3.2.12 Public and Occupational Health and Safety – Transportation

About 41,100 onsite shipments of radioactive waste would occur due to WMA B/BX/BY clean closure activities. The dose to transportation workers from all transportation activities was estimated at about 57 person-rem; the dose to the public would be about 2.6 person-rem. Accordingly, incident-free transportation of radioactive material would result in zero (0.034) LCFs among transportation workers and zero (0.0015) LCFs in the total affected population over the duration of transportation activities.

The estimated total transportation accident risks are a radiation dose risk to the population of about 2.7×10^{-5} person-rem, resulting in 1.6×10^{-8} LCFs, and traffic accidents resulting in zero (0.018) fatalities.

The nonradiological impacts of transporting construction and operational material and radioactive and nonradioactive secondary waste would be 21.2 million kilometers (13.2 million miles) traveled, four accidents, and zero (0.28) fatalities over the entire period from construction through deactivation and closure.

3.2.13 Environmental Justice

Section 3.2.10 discusses short-term impacts on the public as a result of normal operations from clean closure of WMA B/BX/BY. Radiological impacts of normal operations on minority, American Indian, Hispanic, or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model the four population group exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radiologically contaminated produce and animal products.

For purposes of evaluating the potential for disproportionately high and adverse impacts caused by radiological air emissions from normal operations, the total dose to an average individual of the minority, American Indian, Hispanic, or Latino, and low-income populations is compared to the total dose to an average individual of the remainder of the population. Table 3–27 summarizes the average individual total doses for the life of the project that is clean closure of WMA B/BX/BY. There are no appreciable differences between average individual total doses. Therefore, closure of this WMA would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Table 3-27 Waste Management Area B/BX/BY Clean Closure Average Individual Total Dose from Radioactive Air Emissions over the Life of the Project

Subset Population	Individual Average Dose (millirem)	
	Subset Population	Remainder of Population
Minority	0.013	0.017
American Indian	0.0080	0.015
Hispanic or Latino	0.013	0.017
Low-income	0.013	0.016

Section 3.2.10 discusses radiological impacts on the offsite MEI, who is located at the far side of the Columbia River opposite Hanford. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation were evaluated. As a result of WMA B/BX/BY clean closure, the total dose received by an individual residing at the point of greatest impact along the reservation boundary would be the equivalent of less than approximately one-fifteenth of the total dose received by the MEI from the general population. Therefore, closure of WMA B/BX/BY would not pose disproportionately high and adverse impacts on the American Indian population due to normal operations.

Section 3.2.11 discusses radiological impacts of airborne releases from facility accidents hypothesized as a result of WMA B/BX/BY clean closure. Examination of the risks shows that there would be essentially no LCFs per year for the offsite population, including minority, American Indian, Hispanic, or Latino, and low-income populations. Therefore, clean closure of WMA B/BX/BY would not pose disproportionately high and adverse impacts on the minority, American Indian, Hispanic, or Latino, or low-income populations due to accident consequences.

Air quality impacts resulting from WMA B/BX/BY clean closure are discussed in Section 3.2.4. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; as there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic, or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 3.2.12 discusses the potential human health risks from onsite waste transportation and transporting construction materials from onsite, local, or regional locations to Hanford. The impacts of transporting onsite waste and construction materials to Hanford due to WMA B/BX/BY clean closure would be very small. Therefore, clean closure of this WMA would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

3.2.14 Waste Management

Table 3–28 represents the estimated waste volumes generated as a result of WMA B/BX/BY clean closure activities. These activities would include clean closure of the B, BX, and BY tank farms in the 200-East Area following deactivation. Clean closure of the tank farms would encompass removal of highly and moderately contaminated tank and ancillary equipment, all of which would be managed as HLW.

Tank closure waste that is not managed as HLW would be disposed of in the proposed RPPDF, to be located between the 200-East and 200-West Areas. The RPPDF would be similar to the IDF.

Primary Waste

As shown in Table 3–28, the volume of PPF melters generated due to WMA B/BX/BY clean closure would be 235 cubic meters (8,300 cubic feet). A total of 90,500 cubic meters (3.2 million cubic feet) of additional HLW would also be generated and stored on site in shielded boxes.

Secondary Waste

The estimated volume of mixed TRU waste, 111 cubic meters (3,920 cubic feet), as shown in Table 3–28, should not impact existing TRU waste treatment and storage facilities. LLW and MLLW volumes generated by tank closure would be 15,600 cubic meters (549,000 cubic feet) of LLW; 1,020 cubic meters (35,900 cubic feet) of closure LLW; and 17,600 cubic meters (622,000 cubic feet) of MLLW. LLW and MLLW would be disposed of in an IDF. No long-term storage capacity would be needed.

Large quantities of MLLW would be generated by the removal of ancillary equipment and the excavation of contaminated soil from the tank farms. This large quantity of tank closure waste would include approximately 296,000 cubic meters (approximately 10.5 million cubic feet) of MLLW. This contaminated soil would be disposed of in the proposed RPPDF. PPF treatment of the soils would generate 192 cubic meters (6,780 cubic feet) of PPF glass. These canisters would be disposed of in an onsite IDF.

Table 3-28 Waste Management Area B/BX/BY Clean Closure Waste Generation Volumes

Waste Type	Project Phase					Peak Annual Generation		Total Waste Volume to IDF(s)/RPPDF
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Waste Volume/Year	
Primary Waste								
Other high-level radioactive waste	N/A	N/A	N/A	90,500	90,500	2023–2034	5,280	N/A
Preprocessing Facility melters	N/A	N/A	N/A	235	235	Various	123	235 (IDF)
Secondary Waste								
Preprocessing Facility glass	N/A	N/A	N/A	192	192	2035–2043	21	192 (IDF)
Low-level radioactive	N/A	690	359	14,500	15,600	2043	726	15,600 (IDF)
Low-level radioactive (closure)[a]	N/A	N/A	N/A	1,020	1,020	2043–2045	226	1,020 (RPPDF)
Mixed low-level radioactive	N/A	606	617	16,400	17,600	2043–2045	913	17,600 (IDF)
Mixed low-level radioactive (closure)[b]	N/A	N/A	N/A	296,000	296,000	2035–2042	33,400	296,000 (RPPDF)
Transuranic mixed	N/A	111	N/A	N/A	111	2014–2063	16	N/A
Hazardous[c]	119	302	N/A	123	544	2014	46	N/A
Nonradioactive–nonhazardous[d]	N/A	N/A	61	555,000	555,000	2031–2032	28,200	N/A

[a] Closure low-level radioactive waste the waste from decontamination and decommissioning of the containment structure over the tank farms after soil removal is complete.

[b] Closure mixed low-level radioactive waste includes rubble, soil, and equipment removed during closure of the tank farms.

[c] Hazardous waste is accumulated on site for less than 90 days and then shipped to offsite commercial facilities for treatment and/or disposal.

[d] Nonhazardous solid waste is shipped to offsite commercial facilities for recycling, treatment, and disposal.

Note: All values are in cubic meters. To convert cubic meters to cubic feet, multiply by 35.315. Total may not equal the sum of the contributions due to rounding.

Key: IDF=Integrated Disposal Facility; N/A=not applicable; RPPDF=River Protection Project Disposal Facility.

A total of 544 cubic meters (19,200 cubic feet) of hazardous waste would be generated during construction, operations, and closure activities required for WMA B/BX/BY clean closure. The estimated volume of nonhazardous waste would be approximately 555,000 cubic meters (approximately 19.6 million cubic feet). This waste would be sent for offsite disposal in a local landfill. This additional waste load would have only a minor impact on the handling and accumulation of nonhazardous solid waste at Hanford.

3.2.15 Industrial Safety

Illness, injury, and death are possible outcomes of any industrial accident. The accepted standard for measuring the outcome of an industrial accident is the number of fatalities and TRCs (the occurrence of illness or injury). A fatal occurrence is a work-related injury or illness that causes the death of the employee. TRCs include work-related illness or injury that results in loss of consciousness, restriction of work or motion, transfer to another job, a requirement for medical treatment beyond first aid, or death.

As ORP has not experienced a fatality during recent history, the DOE and contractor rate (for all labor categories) of 0.26 per 200 million labor hours was adopted as representative of fatal occurrences. The impacts of illness and injury can be calculated using the total project labor hours and the appropriate incident rate. The total labor hours were calculated from the scaled data sets (SAIC 2012). The subtotal for each type of activity (construction, operations, deactivation, and closure) for clean closure of WMA B/BX/BY is presented in Table 3–29.

Table 3-29 Waste Management Area B/BX/BY Clean Closure Industrial Safety Impacts

Labor Category	Million Labor Hours	Total Recordable Case Rate per 200,000 Labor Hours	Projected Total Recordable Cases	Fatality Rate per 200 Million Labor Hours	Projected Fatalities
Construction	31.4	2.0	314.0	0.26	0.0408
Operations	48.9	2.0	489.0	0.26	0.0636
Deactivation	0.60	2.0	6.0	0.26	0.0008
Closure	11.9	2.0	119.0	0.26	0.0155
Total	**92.8**		**928.0**		**0.1206**

Note: Projected fatalities are displayed to four decimal places to show at least one significant digit. All other values presented in the table have been rounded to no more than three significant digits. Totals may not equal the sum of the contributions due to rounding.
Source: Labor hours compiled from the scaled data sets (SAIC 2012).

Clean closure of WMA B/BX/BY would require a total of approximately 93 million hours of labor to complete. Approximately 31 million hours would occur during the construction phase, and 49 million hours would be required for the operations phase. Projected impacts on worker safety due to closure of this WMA are 928 TRCs. A fatality as a result of an occupational accident is not expected.

3.2.16 Cost Analysis

The cost estimates, in 2008 dollars, for construction, operations, deactivation, closure, and disposal activities required to clean-close WMA B/BX/BY are provided in Table 3–30.

Table 3-30 Waste Management Area B/BX/BY Clean Closure Summary of Estimated Costs (millions of 2008 dollars)

Construction	Operations	Deactivation	Closure	Disposal	Total
1,632	2,565	57	2,654	953	7,861

Note: Estimates are costs to the Hanford Site only.
Source: DOE 2009.

Included in the construction costs are the costs to build or modify the 40 SSTs at the B, BX, and BY Tank Farms to support waste retrieval and the construction of interim storage facilities for HLW debris from the clean closure of the SSTs. Operations costs include ongoing operations of the B, BX, and BY Tank Farms, retrieval of tank waste, and operations of Borrow Area C, the onsite pit used to supply sand, soil, and gravel for backfilling the tank farms after the SSTs are removed. Deactivation costs include deactivation of tank waste retrieval equipment and facilities.

Closure costs include the construction and deactivation of confinement structures over the tank farms required during tank removal and contaminated deep soil removal, as well as removal of the 40 SSTs and ancillary equipment within the tank farms and the contaminated deep soils. The removed highly contaminated RSE that would be managed as HLW would be maintained in shielded storage boxes on site on covered concrete storage pads. Closure costs also include the construction, operations, and deactivation of the PPF, a soil-washing facility that would treat highly contaminated (non-HLW) soils. This treatment would result in: 1) washed soils, which would be packaged for onsite disposal in the proposed RPPDF; and 2) contaminated liquid waste streams, which would be treated in the PPF melter, producing a LAW glass that would be disposed of in the IDF.

Disposal costs include the construction, operations, closure, and postclosure care of the IDF and RPPDF that are necessary for the clean closure of the 40 SSTs at the B, BX, and BY tank farms.

3.3 WASTE MANAGEMENT AREA C

WMA C is composed of the C Tank Farm and is located in the northeast portion of the 200-East Area near the middle of the Central Plateau, north of 7th Avenue and west of Canton Avenue, covering approximately 4 hectares (9 acres) (see Figure 3–5). This WMA was constructed from 1944 through 1945, began operations in 1946, and is currently out of service pending completion of waste retrieval. WMA C consists of 16 SSTs—4 SSTs (200-series) that are 6 meters (20 feet) in diameter with a capacity of 208,000 liters (55,000 gallons) and 12 SSTs (100-series) that are 23 meters (75 feet) in diameter with a capacity of 2 million liters (530,000 gallons)—that store HLW generated by chemical processing of irradiated uranium fuel from the C Plant. All 16 tanks were constructed to the first-generation tank design; were designed for nonboiling waste with a temperature of less than 104 degrees Celsius (°C) (220 degrees Fahrenheit [°F]); and were constructed of a steel-reinforced concrete shell that encompasses a steel plate liner. The tanks are entirely below the ground surface and are covered with approximately 2.2 meters (7.3 feet) of backfill material (Brevick, Gaddis, and Johnson 1994a, 1994b). Ancillary equipment, including miscellaneous underground storage tanks, evaporators, evaporator tanks and vessels, pits, and transfer piping, is also contained within WMA C. These additional facilities were constructed from 1951 through 1952; approximately 13 kilometers (8 miles) of pipeline were constructed throughout the tank farm's operating life.

All of the tanks in WMA C were removed from service during the late 1970s and early 1980s (Brevick, Gaddis, and Johnson 1994a). Nine of the tanks are categorized as sound (C-102, C-103, C-104, C-105, C-106, C-107, C-108, C-109, and C-112), and seven are categorized as assumed leakers (C-101, C-110, C-111, C-201, C-202, C-203, and C-204) (Hanlon 2003).

Figure 3-5 General Location of Waste Management Area C

3.3.1 Land Resources

3.3.1.1 Land Use

Clean closure of WMA C would involve land-disturbing activities associated with construction of an underground transfer line, WRF, HLW Debris Storage Facility, PPF, IDF, and the proposed RPPDF. Closure activities would also require the extraction of material from Borrow Area C. For most facilities and activities, the acreage requirement was determined by use of a scaling factor that adjusted the total land requirement for closing all Hanford tank farms to a specific value for WMA C. However, this was not done for the WRF and PPF, as the minimum requirement to close a WMA is one facility. Also, it was not necessary to scale the length of the underground transfer line.

WMA C is located in the 200-East Area; however, not all activities associated with its closure would take place in this area. Thus, land would also be disturbed between the 200-East and 200-West Areas (for the HLW Debris Storage Area, PPF, and proposed RPPDF) and within Borrow Area C. Within the 200-East Area, a total of 4.82 hectares (11.9 acres) would be disturbed, nearly all of which (4.49 hectares [11.1 acres]) is undeveloped. Development within the area located between the 200-East and 200-West Areas would require 9.31 hectares (23.0 acres), all of which is undeveloped. Disturbance within Borrow Area C would total 43.7 hectares (108 acres), all of which is also undeveloped. Thus, a total of 57.9 hectares (143 acres) would be required for the closure of WMA C, of which less than 0.4 hectares (1 acre) is currently developed.

3.3.1.2 Visual Resources

As noted above, a total of 57.9 hectares (143 acres), most of which is not currently developed, would be required for clean closure of WMA C. Within the 200-East Area, development would have little impact on visual resources, as the area is already highly industrialized. However, the use of 9.31 hectares (23 acres) between the 200-East and 200-West Areas would impact visual resources, as most of this land is not developed. The conversion of this land to an industrial use would add to the overall developed nature of the area and would be visible from nearby higher elevations. The viewscape from these higher elevations is important to American Indians with cultural ties to Hanford. Clean closure activities would involve constructing containment structures over the WMA; however, these structures would be removed upon completion of clean closure activities. Although there would be an overall increase in the industrial appearance of the 200 Areas, the BLM Visual Resource Management Class IV rating would not change. Management activities within Class IV areas dominate the view and typically are the focus of viewer attention.

As noted above, 43.7 hectares (108 acres) within Borrow Area C would be excavated for the closure of WMA C. Development of Borrow Area C would be readily visible from State Route 240 and Rattlesnake Mountain and would change the BLM visual resource management rating from Class II to Class IV. Management activities within Class II areas may be seen but should not dominate the view. Upon completion of WMA C closure, excavations in Borrow Area C would be recontoured and revegetated, thereby lessening the visual impact.

3.3.2 Infrastructure

For clean closure of WMA C, operation of Borrow Area C would result in the largest total water and diesel fuel demands of any activity. This operation would also have a large total gasoline requirement. The largest total gasoline requirement of any activity to clean-close WMA C would occur during tank waste retrieval system construction. The removal of tanks, ancillary equipment, and soils from the C Tank Farm would generate the largest total electricity requirement due to WMA C clean closure.

Water would be required during construction for soil compaction, dust control, and possibly work surface and equipment washdown. Standard construction practices dictate that, at least initially, construction water would be trucked to construction locations on an as-needed basis for these uses until water supply and wastewater treatment utilities are in place. Concrete and grout would be produced in onsite batch plants, which would require large volumes of water. By comparison, relatively little water would be required to meet the potable and sanitary needs of the construction workforce. During operations, water would be required to support process makeup requirements and facility cooling, as well as the potable and sanitary needs of the operations workforce and other uses. To stabilize and partially decontaminate waste treatment, retrieval, and disposal facilities, water would also be used during facility deactivation activities; however, this requirement would be relatively small compared with those for construction and operational demands and for many closure activities, including construction of surface barriers.

Table 3–31 summarizes the projected utility infrastructure resource requirements for WMA C clean closure.

Table 3-31 Waste Management Area C Clean Closure Summary of Utility Infrastructure Requirements

Activity Phase	Electricity (million megawatt-hours)	Diesel Fuel[a]	Gasoline	Water
		(million liters)		
Peak (Year)	**0.008 (2050–2061)**	**3.03 (2101)**	**0.419 (2014)**	**92.4 (2062–2069)**
Construction	0.004	7.50	1.17	8.61
Operations	0.007	32.6	0.874	1,050
Deactivation	0.00[b]	0.123	0.159	0.00[b]
Closure	0.101	17.9	1.16	69.9
Total[c]	**0.112**	**58.2**	**3.37**	**1,130**

a Assumed to be inclusive of all Number 2 diesel fuel, including road diesel and heating fuel oil.

b Deactivation values of "0.00" reflect no demand for that utility.

c Totals may not equal the sum of the contributions due to rounding.

Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate. To convert liters to gallons, multiply by 0.26417.

Source: SAIC 2010.

3.3.2.1 Electricity

For clean closure of WMA C, the peak annual electrical energy demand would occur between 2050 and 2061 and would be 828 megawatt-hours. This peak amount would be well within the annual capacity of 1.74 million megawatt-hours (based on a peak load capacity of 199 megawatts) of the Hanford electric power transmission system.

3.3.2.2 Fuel

Peak demands of about 3 million liters (0.8 million gallons) of diesel fuel and 0.42 million liters (0.11 million gallons) of gasoline would occur in 2101 and 2014, respectively, due to WMA C clean closure. Annualized liquid fuel consumption (diesel fuel and gasoline) of about 0.31 million liters (0.08 million gallons) occurring during the timespan of clean closure activities for this WMA (2008 through 2202) would represent a small amount of the 4.3 million liters (1.1 million gallons) of liquid fuels currently used annually at Hanford.

3.3.2.3 Water

For clean closure of WMA C, peak annual water requirements of about 92.4 million liters (24.4 million gallons) would occur from 2062 through 2069. This peak amount would be well within the 18,500-million-liter (4,890-million-gallon) annual capacity of the Hanford Export Water System.

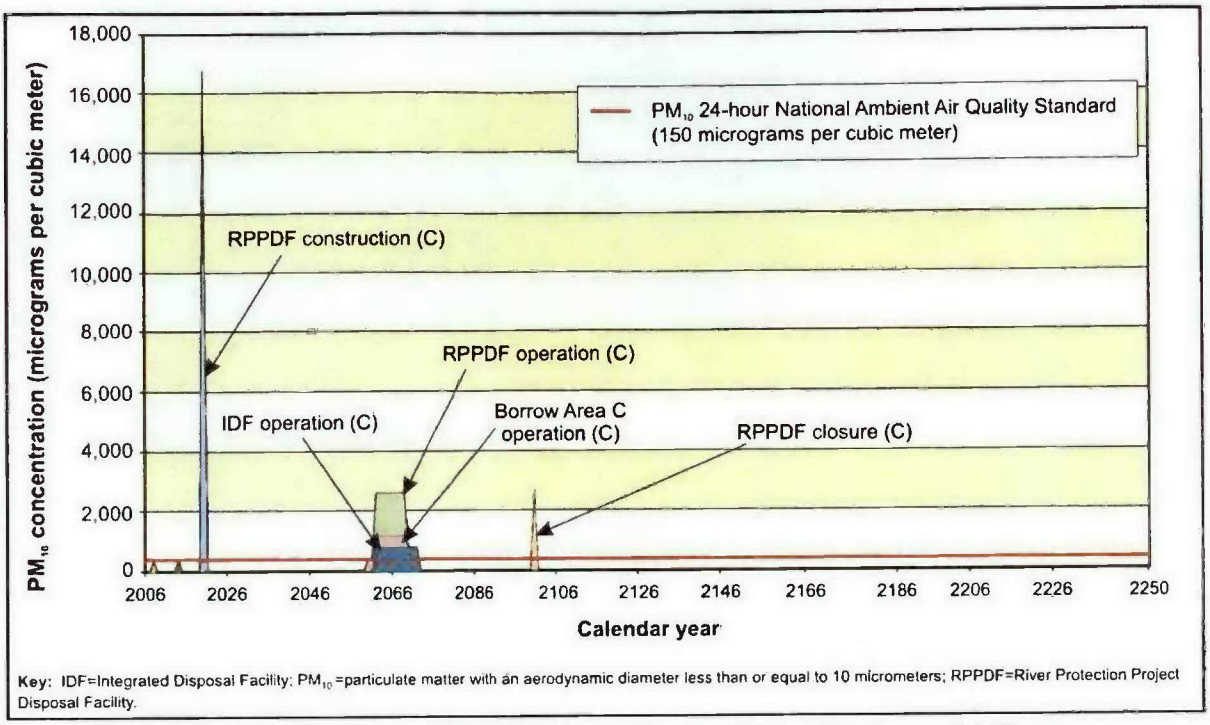
3.3.3 Noise and Vibration

Construction, operation, deactivation, and closure of facilities for clean closure of WMA C would result in minor noise impacts of employee vehicles, trucks, construction equipment and activity, generators, and process equipment. The offsite noise levels associated with WMA C clean closure activities would be negligible due to the distance to the Hanford boundary.

Employee and truck traffic to deliver materials for various phases of activities would vary over the duration of the project. The highest number of employee trips is expected to occur in 2021 (SAIC 2012). The increase in the number of employee vehicles and truck trips is expected to cause a minor increase in traffic noise levels along routes to the site. This increase in employee and truck traffic (discussed in Section 3.3.9) was compared with the existing average traffic volume of 30,000 to 40,000 vehicles per day (DOE 2012). For comparison purposes, the increase in traffic noise level can be estimated from the ratio of the projected traffic volume to the existing traffic volume.

3.3.4 Air Quality

Criteria pollutant concentrations that would result from activities for WMA C clean closure are presented in Table 3–32. Peak concentrations of all criteria pollutants except PM would occur in 2101. Peak concentrations of PM would occur in 2020. The peak period concentrations for carbon monoxide, nitrogen dioxide, and sulfur dioxide would result primarily from closure of the proposed RPPDF. Peak period concentrations for PM would result from RPPDF construction. The maximum air quality impacts of PM_{10} emissions would occur to the south at State Route 240. Figure 3–6 shows the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities to these concentrations.



Key: IDF=Integrated Disposal Facility; PM_{10}=particulate matter with an aerodynamic diameter less than or equal to 10 micrometers; RPPDF=River Protection Project Disposal Facility.

Figure 3-6 Waste Management Area C Clean Closure PM_{10} Maximum 24-Hour Concentrations

Table 3-32 Waste Management Area C Clean Closure Maximum Incremental Criteria Pollutant Concentrations

Pollutant and Averaging Period	Standard[a]	Maximum Modeled Increment
	(micrograms per cubic meter)	
Carbon Monoxide		
8-hour	10,000[b]	**41,200**
1-hour	40,000[b]	**257,000**
Nitrogen Dioxide		
Annual	100[b]	88.9
1-hour	188	**179,000**
PM_{10}[c]		
Annual	50[d]	**119**
24-hour	150[b]	**16,800**
$PM_{2.5}$		
Annual	15[d]	**119**
24-hour	35[b]	**16,800**
Sulfur Dioxide		
Annual	50[d]	0.176
24-hour	260[d]	24.5
3-hour	1,300[b]	120
1-hour	197[e]	**353**

[a] The more stringent of the Federal and Washington State standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (40 CFR 50), other than those for ozone, particulate matter, lead, and those based on annual averages, are not to be exceeded more than once per year. The 24-hour PM_{10} standard is attained when the expected number of days with a 24-hour average concentration above the standard is less than or equal to 1. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard. The annual $PM_{2.5}$ standard is met when the 3-year average of the annual means is less than or equal to the standard. The 24-hour $PM_{2.5}$ standard is met when the 3-year average of the 98th percentile 24-hour averages is less than or equal to the standard. The 1-hour nitrogen dioxide standard is met when the 3-year average 98th percentile of the daily maximum 1-hour average does not exceed the standard value.

[b] Federal and Washington State standard.

[c] The Federal standards for $PM_{2.5}$ are 15 micrograms per cubic meter annual average and 35 micrograms per cubic meter 24-hour average. No specific data for $PM_{2.5}$ were available, but for analysis purposes, concentrations were assumed to be the same as those of PM_{10}.

[d] Washington State standard.

[e] Federal standard.

Note: The National Ambient Air Quality Standards also include standards for lead and ozone. No sources of lead emissions have been identified for the activities evaluated. Washington State also has ambient standards for fluorides. Concentrations in **bold** text indicate potential exceedance of the standard.

Key: PM_n=particulate matter with an aerodynamic diameter less than or equal to *n* micrometers.

Source: Based on emissions data in SAIC 2012.

Maximum concentrations of carcinogenic and noncarcinogenic toxic pollutants are presented in Table 3–33. No impacts on the public due to projected nonradioactive toxic pollutant emissions are expected as a result of WMA C clean closure activities. Hazardous chemical health effects on noninvolved workers are summarized in Tables 3–34 and 3–35.

Table 3-33 Waste Management Area C Clean Closure Maximum Incremental Nonradioactive Toxic Chemical Concentrations

Pollutant	Averaging Period	Acceptable Source Impact Level[a]	Maximum Modeled Increment
		(micrograms per cubic meter)	
Ammonia	24-hour	70.8	20.0
Benzene	Annual	0.0345	0.0323
1,3-Butadiene	Annual	0.00588	0.000842
Formaldehyde	Annual	0.167	0.0278
Mercury	24-hour	0.09	0.0000000614
Toluene	24-hour	5,000	31.2
Xylene	24-hour	(b)	9.27

a WAC 173-460.

b Not listed in WAC 173-460.

Note: To convert cubic meters to cubic feet, multiply by 35.315.

Source: Based on emissions data in SAIC 2012.

Table 3-34 Waste Management Area C Clean Closure Nonradioactive Airborne Toxic Chemical Hazard Index for the Nearest Noninvolved Worker

Chemical	Hazard Quotient
Ammonia	1.13×10^{-1}
Mercury	2.68×10^{-7}
Toluene	1.89×10^{-3}
Xylene	2.84×10^{-2}
Hazard Index	1.44×10^{-1}

Source: Based on emissions data in SAIC 2012.

Table 3-35 Waste Management Area C Clean Closure Nonradioactive Airborne Toxic Chemical Cancer Risk for the Nearest Noninvolved Worker

Chemical	Cancer Risk
Benzene	1.20×10^{-5}
1,3-Butadiene	1.29×10^{-6}
Formaldehyde	1.82×10^{-5}

Source: Based on emissions data in SAIC 2012.

3.3.5 Geology and Soils

Consumption of geologic resources (rock, minerals, and soils) to support facility construction, operations, and deactivation, as applicable, would constitute the major indirect impact on geologic and soil resources from implementation of clean closure of WMA C and associated waste management activities, as summarized in Table 3–36. Varying quantities of geologic resources would be required for ongoing facility construction; upgrades to existing facilities, including the 200 Area tank farms; waste retrieval activities; and, most substantially, tank farm closure. Geologic resources, including relatively large volumes of gravel, sand, and silt, are available from the suprabasalt sediments and associated soils at Hanford. Rock, in the form of basalt, is also plentiful. As discussed in the *Environmental Assessment, Use of Existing Borrow Areas, Hanford Site, Richland, Washington* (DOE 2001a), a number of active gravel and sand pits and two rock quarries at Hanford have been identified for use in providing a continual supply of borrow materials for new facility construction, maintenance of existing facilities, and fill and capping material for remediation and other activities. Of the two active quarries on the

site, quarry No. 2 (Borrow Area C), located due south of the 200-West Area just south of State Route 240, has large volumes of basalt and sand (DOE 2001a). This approximately 926.3 hectare (2,289 acre) borrow area has been designated as a source of materials such as rock riprap (basalt), aggregate (gravel and sand), and soil (silt and loam) that would be needed to support tank farm closure and supporting activities (DOE 2003a).

Table 3-36 Waste Management Area C Clean Closure Major Geologic and Soil Resource Impact Indicators and Requirements

Construction Materials				Other Borrow Materials[a]				Closure-Specific Materials		
Concrete/ Grout	Cement[b]	Sand[b]	Gravel[b]	Rock/Basalt	Sand	Gravel	Soil (Specification Backfill)	Grout[c]	Cement	Sand[d]
61,500	14,800	29,800	37,300	0	22,900	16,700	1,190,000	120	15	60

[a] Resources for miscellaneous uses not exclusively tied to facility construction, operations, or closure, such as site grading and backfill for operations.

[b] Cement, sand, and gravel are components of concrete.

[c] Grout is composed of cement, sand, fly ash, and other materials.

[d] Principal component of grout that would be obtained from onsite deposits.

Note: Values have been rounded to no more than three significant figures. All values are expressed in cubic meters. To convert cubic meters to cubic feet, multiply by 35.315.

3.3.6 Water Resources

All construction and closure related land disturbances, especially for new facility construction, would expose soils and sediments to possible erosion by infrequent, heavy rainfall or by wind. While unlikely to reach surface-water features, stormwater runoff from exposed areas could convey soil, sediments, and other pollutants (e.g., construction waste materials and spilled materials, such as petroleum, oils, and lubricants from construction equipment) from construction footprint and laydown areas. Nevertheless, appropriate soil erosion and sediment control measures, as well as spill prevention and waste management practices, would be employed to minimize suspended sediment, the transport of other deleterious materials, and any potential water-quality impacts. Further, all construction and other ground-disturbing activities would be conducted in accordance with current NPDES and state waste discharge general permits for stormwater discharges associated with construction activities, issued by Ecology. The NPDES permit specifically requires the development and implementation of a stormwater pollution prevention plan.

Once completed, new facilities required for clean closure of WMA C would incorporate appropriate stormwater management controls to collect, convey, and detain stormwater from buildings and other impervious surfaces so as to minimize the impacts of onsite hydrology and soil erosion. Hanford's NPDES Storm Water Multi-Sector General Permit would cover stormwater discharges associated with industrial activity and, as necessary, stormwater discharges would be covered under state waste discharge permits for discharges to the ground.

Under normal operations associated with WMA closure, facility design combined with adherence to spill prevention and emergency response plans and procedures would help to ensure that involved hazardous substances, including spills, should they occur, do not reach soils or surfaces where they could be conveyed to surface water or groundwater. For construction, operations, deactivation, and closure activities, adherence to best management practices and

other preventive measures under applicable permits and compliance plans would be coordinated by DOE with those measures in similar sitewide pollution prevention plans.

There would be no direct discharge of effluents to either surface water or groundwater during construction, operations, and deactivation as a result of WMA C clean closure. Nonhazardous sanitary wastewater (sewage) would be managed via appropriate sanitary wastewater collection and treatment systems. During the early phases of new facility construction, it was assumed that portable toilet facilities would be provided for construction personnel, with collected waste disposed of at offsite contractor facilities, as is standard construction practice. During facility operations and deactivation, sanitary wastewater would be disposed of via the dedicated sanitary sewer or septic/drain-field system serving a particular facility.

Water would be required to support new facility construction, facility operations, and facility deactivation for WMA C clean closure. Water would be required for WRF construction; replacement of underground transfer lines; and construction of tank upgrades, a new riser, an MRS, a VBR system, the PPF, IDF-East, and the proposed RPPDF that will be located between the 200-East and 200-West Areas. Total water demands have been conservatively estimated at 1,120 million liters (296 million gallons), with a peak demand of 92.3 million liters (24 million gallons). Peak periods of water demands would occur during years 2062 through 2069 as a result of Borrow Area C and RPPDF operation. All utility demands, as well as water demands, are discussed in Section 3.3.2, Infrastructure.

3.3.7 Ecological Resources

3.3.7.1 Terrestrial Resources

As noted in Section 3.3.1.1, a total of 14.1 hectares (34.9 acres) within the 200-East Area and between the 200-East and 200-West Areas would be disturbed by construction of the facilities required to clean-close WMA C. Of this total, 4.82 hectares (11.9 acres) would be developed within the 200-East Area and 9.31 hectares (23 acres) between the 200-East and 200-West Areas. Within the 200-East Area, nearly all of the land needed for construction (4.49 hectares [11.1 acres]) is undeveloped, with 2.46 hectares (6.08 acres) being sagebrush habitat, while the entire 9.31 hectares (23 acres) required between the 200-East and 200-West Areas is sagebrush habitat. Late successional sagebrush habitat is considered a Level III resource under the *Hanford Site Biological Resources Management Plan* (DOE 2001b:4.11). The loss of 1.21 hectares (3 acres) of sagebrush habitat resulting from construction of the underground transfer line within the 200-East Area would not be mitigable; however, Hanford guidance may require the replacement of other sagebrush habitat at a ratio ranging from 1:1 to 3:1 (DOE 2003b:20, 21, 31). Specific measures to mitigate the loss of sagebrush habitat would be set forth in a mitigation action plan prior to construction.

The clean closure of WMA C would require that 43.7 hectares (108 acres) of Borrow Area C be excavated to supply needed geologic material. The two major plant communities present within the area are cheatgrass-bluegrass (782 hectares [1,933 acres]) and needle-and-thread grass/Indian ricegrass (107 hectares [265 acres]) (DOE 2012). The latter represents an unusual and relatively pristine community type at Hanford; thus, it is considered a more highly valued community than the former. It is not possible to determine specific impacts of excavating Borrow Area C on ecological resources because the particular portion of the site from which geologic material

would be excavated is unknown. To the extent that it is possible, the needle-and-thread grass/Indian ricegrass community should be avoided during excavation. A mitigation action plan would be developed prior to excavation.

3.3.7.2 Threatened and Endangered Species

Federally or state-listed threatened or endangered species have not been observed within, or in the immediate vicinity of, the 200 Areas or Borrow Area C; therefore, impacts on this group of plants and animals are not expected as a result of WMA C clean closure. Both the Columbia and Yakima Rivers adjacent to Hanford have been designated as critical habitat for the bull trout. However, as there would be no short-term impacts on either river from construction or operation of new facilities associated with clean closure of WMA C, designated critical habitat would not be adversely affected.

A number of state-listed, special status species observed within areas that would be disturbed by closure of WMA C could be impacted by construction of the various required facilities. Three state-listed species were observed within areas that could be disturbed within the 200-East Area. The black-tailed jackrabbit (state candidate) and Piper's daisy (state sensitive) have been observed on or near the underground transfer line route, and the sage sparrow (state candidate) has been observed within the IDF vicinity. In addition, the loggerhead shrike (Federal species of concern and state candidate), black-tailed jackrabbit, sage sparrow, and crouching milkvetch (state watch) have all been observed between the 200-East and 200-West Areas where the HLW Debris Storage Facility, PPF, and the proposed RPPDF would be located. Finally, surveys have identified Piper's daisy, stalked-pod milkvetch (state watch), crouching milkvetch, and the long-billed curlew (state monitor) within the boundaries of Borrow Area C. The operation of new facilities is not expected to impact any listed species.

Although mitigation would not be required for the state monitor and watch species, they should be considered during project planning. Impacts on state candidate and sensitive species, which are considered Level III resources under the *Hanford Site Biological Resources Management Plan*, require mitigation where impacts would occur. When avoidance and minimization are not possible or are insufficient, mitigation via rectification or compensation is recommended (DOE 2001b:4.9, 8.11). A comprehensive mitigation action plan, which would deal with the loss of state-listed species (as well as sagebrush habitat), would be developed prior to construction.

3.3.8 Cultural and Paleontological Resources

3.3.8.1 Prehistoric Resources

As noted in Section 3.3.1.1, clean closure of WMA C would require a total of 57.9 hectares (143 acres), of which less than 0.4 hectares (1 acre), located in the 200-East Area, is currently developed. Land disturbance due to clean closure of WMA C would involve the 200-East Area, land between the 200-East and 200-West Areas, and Borrow Area C. White Bluffs Road, an important archaeological resource, is located in the southwest and northeast parts of the 200-West Area. Other prehistoric finds were discovered in the northwestern portion of the 200-West Area and immediately east of the 200-East Area. There are no known prehistoric resources within the areas that would be affected by the clean closure of WMA C. The survey and geology of these areas indicate that subsurface cultural deposits have little or no potential of

being present. The *Hanford Cultural Resources Management Plan* (DOE 2003c) provides guidance for identifying, evaluating, recording, curating, and managing cultural resources. If any prehistoric resources were discovered during construction or excavation, procedures from the *Hanford Cultural Resources Management Plan* would be implemented.

3.3.8.2 Historic Resources

Construction or excavation activities would not require land from the 200-West Area for the clean closure of WMA C; therefore, White Bluffs Road, which is located within the 200-West Area, would not be affected. Buildings associated with the Manhattan Project and Cold War era are found within both the 200-East and 200-West Areas; however, none of these structures would be affected. There would be no impacts on other known early historic artifacts within the 200-East or 200-West Area because all such resources would be avoided. As is the case for prehistoric resources, if historic resources were discovered, procedures in place to properly identify, evaluate, record, curate, and manage the discovery site would be implemented.

3.3.8.3 American Indian Interests

As stated above, there are no known prehistoric resources that may be an American Indian interest within the affected areas required for the clean closure of WMA C. Clean closure of WMA C would impact 9.31 hectares (23 acres) of undeveloped land between the 200-East Area and 200-West Area. The conversion of this land to industrial use would be noticeably visible from nearby higher elevations, such as Gable Mountain and Gable Butte. The viewscape from these higher elevations is important to American Indians with cultural ties to Hanford. There would be little impact on the viewscape within the 200-East Area, as the area is already highly industrialized.

Clean closure of WMA C would also require excavation of 43.7 hectares (108 acres) within Borrow Area C. This would also have an impact on the viewscape from Rattlesnake Mountain; however, upon completion of the work, excavations of Borrow Area C would be recontoured and revegetated, thus lessening the visual impact. Appropriate mitigation measures would be developed in consultation with area tribes.

3.3.8.4 Paleontological Resources

No paleontological resources have been discovered within the 200-East Area or Borrow Area C; therefore, closure of WMA C would not impact such resources. However, if any paleontological resources were found during construction or excavation, procedures to properly manage the discovery site would be implemented.

3.3.9 Socioeconomics

3.3.9.1 Regional Economic Characteristics

For clean closure of WMA C, as shown in Table 3–37, the peak workforce of 1,330 FTEs in 2021 would occur mainly from construction activities. This estimate is approximately 0.7 percent of the projected labor force in the ROI (192,000 in 2021), compared with 10 percent in 2006. The existence of these direct jobs is expected to result in the creation of another 991 indirect positions in the ROI during the peak year. A small workforce (two FTEs)would be

needed for postclosure care of the site beginning in 2103. Implementing WMA C clean closure activities could alter the economic characteristics of the region by increasing demands for goods and services in the Tri-Cities area due to increases in expenditures, income, and employment, both direct and indirect, at Hanford.

Table 3-37 Waste Management Area C Clean Closure Workforce Estimates

Work Activity	Peak Year(s)	Workforce Peak (FTEs)
Construction	2021–2023	1,320
Operations	2024–2027	761
Deactivation	2031–2033	38
Closure	2101	93
Total Onsite Workforce	**2021**	**1,330**

Key: FTE=full-time equivalent.

3.3.9.2 Demographic Characteristics

While the clean closure of WMA C would draw some workers from the local labor force, the demand for construction workers could draw from outside the region. The in-migrations of new workers and their families would increase the overall population within the Tri-Cities area and could alter the demographic characteristics of the region.

3.3.9.3 Housing and Community Services

Implementing clean closure of WMA C could increase the demand for housing and would impact schools and other community services within the Hanford ROI. The demand for housing by construction workers would impact the cost and availability of houses and rental units. School enrollments would increase, and utilities and police and fire services may need to be expanded.

3.3.9.4 Local Transportation

Implementation of WMA C clean closure is expected to have an impact on the local transportation system, especially during the commute periods. The projected increase in commuter traffic to the site would be due primarily to construction activities, peaking at an annual 1,330 FTEs in 2021. This could represent up to 1,060 passenger vehicles per day during the peak year. It is expected that this commuter traffic would impact the regionally established LOS, reducing it to below the minimum acceptable ("D") LOS.

The predicted number of annual offsite truck trips is less than one truck trip per day due to WMA C clean closure activities except during a 6-year period from 2050 through 2055, where the peak would be two offsite trucks trips per day. Onsite truck traffic would peak during construction of the RCRA Subtitle C barrier in 2101 at 17,500 truck trips per year (approximately 67 truck trips per day). For the majority of the rest of the time period (2073 through 2100 and after 2102), there would be less than one truck trip on or off site each day.

3.3.10 Public and Occupational Health and Safety – Normal Operations

Activities to clean-close WMA C could result in radiological exposures to the public and workers. Radiological impacts are presented for three public receptors: the general population

(approximately 560,000)[8] living within 80 kilometers (50 miles) of the Hanford 200 Areas, an MEI living near Hanford, and an onsite MEI. Impacts on the general population are evaluated for a residential scenario whereby people are exposed to radioactive materials emitted from project facilities. Radiological exposure occurs through inhalation, direct exposure to the radioactive plume and material deposited on the ground, and ingestion of contaminated products from animals raised locally and fruits and vegetables grown in a family garden (DOE 1995). The MEI is a hypothetical individual member of the public located at a position near the site boundary who would experience the highest impacts during normal operations. The MEI was determined to be a receptor on the east side of the Columbia River. Impacts on the offsite MEI are evaluated for a scenario that includes the same exposure pathways assumed for the general population, but with an increased amount of time spent outdoors and a higher rate of contaminated food consumption. Impacts on the onsite MEI, identified as a member of the public who works at the Columbia Generating Station, LIGO, or U.S. Ecology, would be from inhalation and exposure to the plume and material deposited on the ground. Doses are presented as total effective doses. Details of the assessment methodology for determining radiological exposure of workers and members of the public are presented in Appendix K of the *Final TC & WM EIS* (DOE 2012).

The radiological impacts on members of the public are presented in terms of impacts over the life of the project, that is WMA C clean closure (the operational life of the project during which radioactive air emissions would occur), and peak annual impacts. Impacts over the life of the project are the total estimated radiation doses that would be incurred by members of the public over the duration of the activities to complete clean closure of the WMA. The peak annual impacts are the estimated annual radiation doses that would be incurred by members of the public during the year(s) of largest radiation dose.

In addition to members of the public, workers directly involved in the activities to clean-close the WMA and nearby noninvolved workers may receive radiation doses. Doses to an involved worker are calculated based on an FTE employee. It was assumed for the purposes of this dose evaluation that an FTE involved worker has a 2,080 hour work year. In practice, the number of workers who could receive a radiation dose may be larger than the number of FTEs assumed in this analysis, resulting in a smaller average dose per worker. A noninvolved worker is a person working at the site who is incidentally exposed due to the radioactive air emissions associated with tank farm management, tank waste retrieval, and clean closure activities. The potential dose to a noninvolved worker would result from exposure to, and inhalation of, radioactive contaminants released to the atmosphere from tank farm management, tank waste retrieval, and clean closure activities. In the 200-East Area, the noninvolved worker was assumed to be at the 242-A Evaporator, 1,090 meters (3,580 feet) north northwest of the 200-East Area source. In the 200-West Area, the noninvolved worker was assumed to be at the ERDF, about 950 meters (3,120 feet) east of the 200-West Area source.

The impacts of radionuclide releases from construction, operations, deactivation, and cleanup of facilities directly related to tank farm management, tank waste retrieval, and clean closure of WMA C were evaluated.

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[8] The approximate population is based on populations of 542,324; 546,746; and 589,668 people residing within 80 kilometers (50 miles) of theWTP, 200-East Area, and 200-West Area, respectively, as described in the *Final TC & WM EIS* (DOE 2012).

3.3.10.1 Radiological Impacts on the Public

Table 3–38 presents estimated doses to the general population and the MEI for clean closure activities associated with WMA C. Activities conducted at WMA C that would generate radioactive air emissions would occur from 2013 through 2100. Due to the long timeframe involved, the doses over the life of the project may not be received by the same members of the population or the same MEI, but are presented as a measure of potential impacts to provide a basis for comparison with other WMAs.

Table 3-38 Waste Management Area C Clean Closure Public Health Impacts of Atmospheric Radionuclide Releases

Receptor	Facility	Impacts over Life of Project[a]		Peak Annual Impacts		
General population		**Dose (person-rem)**	**Number of Latent Cancer Fatalities[b]**	**Year of Maximum Impact**	**Dose (person-rem per year)**	**Number of Latent Cancer Fatalities[b]**
	200-East Area	0.57			0.039	
	200-West Area	0.57			0.039	
	Total	**0.64**	**0 (4×10^{-4})**	**2100**	**0.078**	**0 (5×10^{-5})**
Maximally exposed individual		**Dose[c] (millirem)**	**Lifetime Risk of a Latent Cancer Fatality[d]**	**Year of Maximum Impact**	**Dose (millirem per year)**	**Lifetime Risk of a Latent Cancer Fatality[d]**
	200-East Area	0.88			0.041	
	200-West Area	0.0051			0.022	
	Total	**0.093**	**6×10^{-8}**	**2100**	**0.0080**	**5×10^{-9}**
Onsite MEI	**Total**	**0.024**	**1×10^{-8}**	**2100**	**0.0032**	**2×10^{-9}**

a Impacts accrued over the operational life of the project to clean-close Waste Management Area C.

b The reported value is the projected number of latent cancer fatalities (LCF) among the population and is therefore presented as a whole number. The result, calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem), is shown in parentheses.

c Impacts are provided for assessment purposes. The life-of-project dose likely overestimates the dose that would be received by one individual person because the project could span approximately 88 years.

d Probability of an LCF in the MEI is calculated by converting the dose in millirem to rem (divide by 1,000), then multiplying the dose by the risk factor of 0.0006 LCFs per rem.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: MEI=maximally exposed individual.

Over the life of the project, the population within 80 kilometers (50 miles) of the 200 Areas would receive a cumulative dose of 0.64 person rem, and the MEI would receive a cumulative dose of 0.093 millirem. Given the risk factor of 0.0006 LCFs per rem (DOE 2003d), no LCFs are expected in the general population as a result of these activities. There would be a probability of 6×10^{-8} (1 chance in 16 million) of the MEI developing an LCF, assuming the same MEI was exposed over the life of the project. Radioactive air emissions would result in a maximum annual population dose of 0.078 person rem and a maximum annual MEI dose of 0.0080 millirem. The primary contributor to offsite doses would be fission products from processing contaminated tank farm soils through the PPF.

An onsite MEI who spends a normal workday at U.S. Ecology would receive a maximum annual dose of 0.0032 millirem. The increased risk of an LCF from this dose would be 2×10^{-9} (1 chance in 500 million).

3.3.10.2 Radiological Impacts on Workers

Table 3–39 presents dose and risk estimates for an involved FTE worker and a noninvolved FTE worker. The average annual FTE radiation worker dose would be 95 millirem, lower than the Administrative Control Level of 500 millirem. A radiation worker who received the average annual dose over the course of 40 years would receive a dose of 3,800 millirem, corresponding to a risk of 2×10^{-3} (1 chance in 500) of developing an LCF.

Table 3-39 Waste Management Area C Clean Closure Normal Operations Radiological Impacts on Workers

Receptor	Dose	Latent Cancer Fatality Risk[a]
Average Involved Full-Time-Equivalent Worker		
Average annual impact	95 millirem	6×10^{-5}
Impact over life of project[b]	3,800 millirem	2×10^{-3}
Life-of-Project Worker Population	450 person-rem	0 (3×10^{-1})
Noninvolved Worker (Year of Maximum Impact)		
At the 242-A Evaporator (2100)	0.0092 millirem	6×10^{-9}
At the Environmental Restoration Disposal Facility (2100)	0.027 millirem	3×10^{-8}

[a] For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

[b] Impact over the life of the project is the average dose a full-time-equivalent radiation worker would receive working on this project. It is determined by multiplying the average annual dose by an assumed career length of 40 years.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

The total effective dose to the involved worker population from the 88 years of occupational exposure was estimated to be 450 person-rem. Given the risk factor of 0.0006 LCFs per person-rem, no LCFs are expected to result from the dose associated with tank farm operations, tank waste retrieval, and clean closure of WMA C. Worker doses should be viewed in the context of the duration of the project and the DOE administrative controls employed that limit them. Due to the number of years required to complete clean closure, the dose over the life of the project would be distributed over multiple generations of workers. In addition, worker dose would be limited to less than 5 rem total effective dose per year (10 CFR 835). This regulatory limit would be further constrained by the application of administrative controls. DOE Standard 1098-2008, *Radiological Control*, recommends that the annual dose not exceed 2 rem, unless explicitly authorized by DOE management (e.g., for emergency situations). Individual worker doses would be maintained ALARA and generally be controlled at a level below 500 millirem (0.5 rem) per year.

Estimated doses and risks to the noninvolved workers at the 242-A Evaporator or the ERDF in the year of maximum impact are shown in Table 3–39. Doses to noninvolved workers would be a small fraction of the DOE recommended Administrative Control Level of 500 millirem per year.

3.3.11 Public and Occupational Health and Safety – Facility Accidents

This section addresses potential impacts on workers and the public associated with tank-farm-related accidents. Radiological impacts of the postulated accident scenarios were quantified for an MEI living near Hanford, the offsite population living within 80 kilometers (50 miles) of the facility, and a noninvolved worker assumed to be 100 meters (110 yards) from the facility. Hazardous chemical impacts were also evaluated. For an involved worker, accident consequences were not quantified. While involved workers are expected to be near the Hanford tank farms during routine tank farm operations, their number and location relative to a postulated accident are unknown. In the event of an accident involving chemicals or radioactive materials, workers near an accident could be at risk of serious injury or fatality. Safety procedures, safety equipment, and protective barriers are typical features that would prevent or minimize worker impacts. Additionally, following initiation of accident/site emergency alarms, workers in adjacent areas would evacuate in accordance with the technical area and facility emergency operating procedures and training. Therefore, involved worker impacts are not discussed further.

There would be no radiological accidents associated with facility construction. Further, any hazardous chemical accidents associated with facility construction would be typical of those normally associated with industrial construction materials, hazards, and practices. Projected operational accident consequences are presented in the following sections. Details of the methodology for assessing the potential impacts on workers and the public associated with postulated accidents are presented in Appendix K, Section K.3, of the *Final TC & WM EIS* (DOE 2012).

3.3.11.1 Radiological Impacts of Airborne Releases

During tank farm operations, tank waste retrieval, or clean closure activities, reasonably foreseeable accidents that could occur include: 1) hydrogen burn in a waste storage tank; and 2) tank dome collapse. The accident selected to represent a severe accident is the seismically induced waste tank dome collapse. The consequences of a seismically induced waste tank dome collapse, if it were to occur, are shown in Table 3–40. The annual risks of LCFs for this accident, which were obtained by multiplying the consequences by the likelihood (frequency per year) that the accident would occur, are shown in Table 3–41.

Table 3-40 Waste Management Area C Clean Closure Radiological Consequences of Accidents

Accident	Maximally Exposed Individual		Offsite Population[a]		Noninvolved Worker	
	Dose (rem)	LCF[b]	Dose (person-rem)	LCF[c]	Dose (rem)	LCF[b]
Seismically induced waste tank dome collapse – unmitigated	0.00021	1×10^{-7}	1.3	0 (8×10^{-4})	0.22	1×10^{-4}

a Based on a population of 589,668 persons residing within 80 kilometers (50 miles) of the 200-West Area.

b Increased likelihood of latent cancer fatality for an individual, assuming the accident occurs.

c The reported value is the projected number of latent cancer fatalities (LCF) among the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

Key: LCF=latent cancer fatality.

Table 3-41 Waste Management Area C Clean Closure Annual Cancer Risks from Accidents

Accident	Frequency (per year)	Risk of Latent Cancer Fatality		
		Maximally Exposed Individual[a]	Offsite Population[b, c]	Noninvolved Worker[a]
Seismically induced waste tank dome collapse – unmitigated	5×10^{-4}	6×10^{-11}	4×10^{-7}	7×10^{-8}

a Increased risk of a latent cancer fatality to the individual, taking into account the probability (frequency) of the accident.

b Based on a population of 589,668 persons residing within 80 kilometers (50 miles) of the 200-West Area.

c The reported value is the projected number of latent cancer fatalities (LCF) among the population, based on the probability (frequency) of the accident occurring, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

3.3.11.2 Hazardous Chemical Impacts

Various hazardous chemicals exist in the waste tanks. Because the chemicals that exist in the tank waste are mixed with the radioactive material, any accident event is expected to release both hazardous chemicals and radioactive materials. Due to the quantity and nature of the radioactive material in the waste tanks, the human health consequences of an accidental release would be dominated by the impacts of the radioactive components. Therefore, hazardous chemical human health impacts were not analyzed separately.

3.3.11.3 Intentional Destructive Acts

This section addresses potential impacts of intentional destructive acts at a tank farm. To protect against such actions, safeguards and security measures are employed at all DOE facilities. In accordance with DOE Orders, DOE conducts vulnerability assessments and risk analyses of facilities and equipment under its jurisdiction to evaluate the physical protection elements, technologies, and administrative controls needed to protect DOE assets. DOE also protects against espionage, sabotage, and theft of radioactive, chemical, or biological materials; classified information and matter; nonnuclear weapon components; and critical technologies. Before startup of any new or substantially modified operations, DOE would conduct an indepth, site-specific safeguards and security inspection to ensure that existing programs satisfy DOE requirements. Any inadequacies would be resolved before startup of operations. Release scenarios and impacts resulting from intentional destructive acts may be similar to the accident scenarios analyzed. Additional scenarios representing intentional destructive acts that may not be represented by the accident analyses were also considered.

Explosive Device in Underground Waste Tank. It was postulated that intentionally initiated explosions occur that displace a large portion of the soil overburden, breach the tank dome, and disperse a portion of the tank waste into the atmosphere. In accordance with the recommendation from *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, Vol. 1, *Analysis of Experimental Data* (DOE Handbook 3010-94), the respirable release would be less than the TNT equivalent weight of the explosive charge. Analysis results indicate that the radiological impacts of an explosive device in an underground waste tank would be about four times greater than the impacts of the most severe accident scenario that involved the same inventory of radioactive material (seismically induced waste tank dome collapse). The offsite population dose was estimated to be 4.9 person-rem, with no

(3×10^{-3}) resulting additional LCFs. The MEI dose would be 0.00083 rem, corresponding to an increased risk of an LCF of 5×10^{-7}. The noninvolved worker dose would be 0.88 rem, corresponding to an increased risk of an LCF of 5×10^{-4}.

3.3.12 Public and Occupational Health and Safety – Transportation

About 8,590 onsite shipments of radioactive waste would occur due to WMA C clean closure activities. The dose to transportation workers from all transportation activities was estimated at about 16 person-rem; the dose to the public would be about 0.6 person-rem. Accordingly, incident-free transportation of radioactive material would result in zero (0.0095) LCFs among transportation workers and zero (0.00034) LCFs in the total affected population over the duration of transportation activities.

The estimated total transportation accident risks are a radiation dose risk to the population of about 9.7×10^{-6} person-rem, resulting in 5.8×10^{-9} LCFs, and traffic accidents resulting in zero (0.0038) fatalities.

The nonradiological impacts of transporting construction and operational material and radioactive and nonradioactive secondary waste would be 4.9 million kilometers (3.0 million miles) traveled, 1 accident, and 0 (0.06) fatalities over the entire period from construction through deactivation and closure.

3.3.13 Environmental Justice

Section 3.3.10 discusses short-term impacts on the public as a result of normal operations from clean closure of WMA C. Radiological impacts of normal operations on minority, American Indian, Hispanic, or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model the four population group exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radiologically contaminated produce and animal products.

For purposes of evaluating the potential for disproportionately high and adverse impacts caused by radiological air emissions from normal operations, the total dose to an average individual of the minority, American Indian, Hispanic, or Latino, and low-income populations is compared to the total dose to an average individual of the remainder of the population. Table 3–42 summarizes the average individual total doses for the life of the project, i.e., clean closure of WMA C. There are no appreciable differences between average individual total doses. Therefore, closure of this WMA would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Table 3-42 Waste Management Area C Clean Closure Average Individual Total Dose from Radioactive Air Emissions over the Life of the Project

Subset Population	Individual Average Dose (millirem)	
	Subset Population	Remainder of Population
Minority	0.0010	0.0013
American Indian	0.00058	0.0012
Hispanic or Latino	0.0010	0.0013
Low-income	0.0010	0.0012

Section 3.3.10 discusses radiological impacts on the offsite MEI, who is located at the far side of the Columbia River opposite Hanford. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation were evaluated. As a result of WMA C clean closure, the total dose received by an individual residing at the point of greatest impact along the reservation boundary would be the equivalent of less than approximately 2 percent of the total dose received by the MEI from the general population. Therefore, closure of WMA C would not pose disproportionately high and adverse impacts on the American Indian population due to normal operations.

Section 3.3.11 discusses radiological impacts of airborne releases from facility accidents hypothesized as a result of WMA C clean closure. Examination of the risks shows that there would be essentially no LCFs per year for the offsite population, including minority, American Indian, Hispanic, or Latino, and low-income populations. Therefore, clean closure of WMA C would not pose disproportionately high and adverse impacts on the minority, American Indian, Hispanic, or Latino, or low-income populations due to accident consequences.

Air quality impacts resulting from WMA C clean closure are discussed in Section 3.3.4. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; as there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic, or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 3.3.12 discusses the potential human health risks from onsite waste transportation and transporting construction materials from onsite, local, or regional locations to Hanford. The impacts of transporting onsite waste and construction materials to Hanford due to WMA C clean closure would be very small. Therefore, clean closure of this WMA would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

3.3.14 Waste Management

Table 3–43 represents the estimated waste volumes generated as a result of WMA C clean closure activities. These activities would include clean closure of the C tank farm in the 200-East Area following deactivation. Clean closure of the tank farm would encompass removal of highly and moderately contaminated tank and ancillary equipment, all of which would be managed as HLW.

Tank closure waste that is not managed as HLW would be disposed of in the proposed RPPDF, to be located between the 200-East and 200-West Areas. The RPPDF would be similar to the IDF.

As shown in Table 3–43, the volume of PPF melters generated due to WMA C clean closure would be 2 cubic meters (69 cubic feet). A total of 36,200 cubic meters (1.28 million cubic feet) of additional HLW would also be generated and stored on site in shielded boxes.

Secondary Waste

The estimated volume of mixed TRU waste, 45 cubic meters (1,600 cubic feet), as shown in Table 3–43, should not impact existing TRU waste treatment and storage facilities. LLW and MLLW volumes generated by tank closure would be 5,640 cubic meters (199,000 cubic feet) of LLW; 339 cubic meters (12,000 cubic feet) of closure LLW; and 6,040 cubic meters (213,000 cubic feet) of MLLW. LLW and MLLW would be disposed of in an IDF. No long term storage capacity would be needed.

Large quantities of MLLW would be generated by the removal of ancillary equipment and the excavation of contaminated soil from the tank farms. This large quantity of tank closure waste would include approximately 12,100 cubic meters (approximately 426,000 cubic feet) of MLLW. This contaminated soil would be disposed of in the proposed RPPDF. PPF treatment of the soils would generate 1.6 cubic meters (57 cubic feet) of PPF glass. These canisters would be disposed of in an onsite IDF.

A total of 201 cubic meters (7,090 cubic feet) of hazardous waste would be generated during construction, operations, and closure activities required for WMA C clean closure. The estimated volume of nonhazardous waste would be approximately 249,000 cubic meters (approximately 8.08 million cubic feet). This waste would be sent for offsite disposal in a local landfill. This additional waste load would have only a minor impact on the handling and accumulation of nonhazardous solid waste at Hanford.

Table 3-43 Waste Management Area C Clean Closure Waste Generation Volumes

Waste Type	Project Phase					Peak Annual Generation		Total Waste Volume to IDF(s)/RPPDF
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Waste Volume/Year	
Primary Waste								
Other high-level radioactive waste	N/A	N/A	N/A	36,200	36,200	2050–2061	3,020	N/A
Preprocessing Facility melters	N/A	N/A	N/A	1.6	1.6	Various	123	1.6 (IDF)
Secondary Waste								
Preprocessing Facility glass	N/A	N/A	N/A	2	2	2062–2069	0.2	2 (IDF)
Low-level radioactive	N/A	281	146	5,220	5,640	2070–2072	361	5,640 (IDF)
Low-level radioactive (closure)[a]	N/A	N/A	N/A	339	339	2070–2072	113	339 (RPPDF)
Mixed low-level radioactive	N/A	247	280	5,510	6,040	2070–2072	457	6,040 (IDF)
Mixed low-level radioactive (closure)[b]	N/A	N/A	N/A	12,100	12,100	2050–2061	747	12,100 (RPPDF)
Transuranic mixed	N/A	45	N/A	N/A	45	2028–2033	8	N/A
Hazardous[c]	49	123	N/A	29	201	2028–2003	21	N/A
Nonradioactive–nonhazardous[d]	N/A	N/A	25	249,000	249,000	2050–2061	20,700	N/A

[a] Closure low-level radioactive waste is the waste from decontamination and decommissioning of the containment structure over the tank farm after soil removal is complete.

[b] Closure mixed low-level radioactive waste includes rubble, soil, and equipment removed during closure of the tank farm.

[c] Hazardous waste is accumulated on site for less than 90 days and then shipped to offsite commercial facilities for treatment and/or disposal.

[d] Nonhazardous solid waste is shipped to offsite commercial facilities for recycling, treatment, and disposal.

Note: All values are in cubic meters. To convert cubic meters to cubic feet, multiply by 35.315. Total may not equal the sum of the contributions due to rounding.

Key: IDF=Integrated Disposal Facility; N/A=not applicable; PPF=Preprocessing Facility; RPPDF=River Protection Project Disposal Facility.

3.3.15 Industrial Safety

Illness, injury, and death are possible outcomes of any industrial accident. The accepted standard for measuring the outcome of an industrial accident is the number of fatalities and TRCs (the occurrence of illness or injury). A fatal occurrence is a work-related injury or illness that causes the death of the employee. TRCs include work-related illness or injury that results in loss of consciousness, restriction of work or motion, transfer to another job, a requirement for medical treatment beyond first aid, or death.

As ORP has not experienced a fatality during recent history, the DOE and contractor rate (for all labor categories) of 0.26 per 200 million labor hours was adopted as representative of fatal occurrences. The impacts of illness and injury can be calculated using the total project labor hours and the appropriate incident rate. The total labor hours were calculated from the scaled data sets (SAIC 2012). The subtotal for each type of activity (construction, operations, deactivation, and closure) for clean closure of WMA C is presented in Table 3–44.

Table 3-44 Waste Management Area C Clean Closure Industrial Safety Impacts

Labor Category	Million Labor Hours	Total Recordable Case Rate per 200,000 Labor Hours	Projected Total Recordable Cases	Fatality Rate per 200 Million Labor Hours	Projected Fatalities
Construction	12.6	2.0	126.0	0.26	0.0164
Operations	15.9	2.0	159.0	0.26	0.0207
Deactivation	0.24	2.0	2.4	0.26	0.0003
Closure	2.09	2.0	20.9	0.26	0.0027
Total	**30.8**		**308.3**		**0.0401**

Note: Projected fatalities are displayed to four decimal places to show at least one significant digit. All other values presented in the table have been rounded to no more than three significant digits. Totals may not equal the sum of the contributions due to rounding.
Source: Labor hours compiled from the scaled data sets (SAIC 2012).

The projected total impact of all phases of WMA C clean closure is 308 TRCs and no fatalities. A total of almost 31 million hours would be required for WMA C clean closure activities; 12.6 million hours for the construction phase, with 126 TRCs, and almost 16 million hours for the operations phase, with 159 TRCs.

3.3.16 Cost Analysis

The cost estimates, in 2008 dollars, for construction, operations, deactivation, closure, and disposal activities required to clean-close WMA C are provided in Table 3–45.

Table 3-45 Waste Management Area C Clean Closure Summary of Estimated Costs (millions of 2008 dollars)

Construction	Operations	Deactivation	Closure	Disposal	Total
665	1,045	23	666	115	2,514

Note: Estimates are costs to the Hanford Site only.
Source: DOE 2009.

Included in the construction costs are the costs to build or modify the 16 SSTs at the C tank farm to support waste retrieval and the construction of interim storage facilities for HLW debris from the clean closure of the SSTs. Operations costs include ongoing operations of the C tank farm,

retrieval of tank waste, and operations of Borrow Area C, the onsite pit used to supply sand, soil, and gravel for backfilling the tank farms after the SSTs are removed. Deactivation costs include deactivation of tank waste retrieval equipment and facilities.

Closure costs include the construction and deactivation of confinement structures over the tank farm required during tank removal and contaminated deep soil removal, as well as removal of the 16 SSTs and ancillary equipment within the tank farm and the contaminated deep soils. The removed highly contaminated RSE that would be managed as HLW would be maintained in shielded storage boxes on site on covered concrete storage pads. Closure costs also include the construction, operations, and deactivation of the PPF, a soil-washing facility that would treat highly contaminated (non-HLW) soils. This treatment would result in: 1) washed soils, which would be packaged for onsite disposal in the proposed RPPDF; and 2) contaminated liquid waste streams, which would be treated in the PPF melter, producing a LAW glass that would be disposed of in the IDF.

Disposal costs include the construction, operations, closure, and postclosure care of the IDF and RPPDF that are necessary for the clean closure of the 16 SSTs at the C tank farm.

3.4 WASTE MANAGEMENT AREA S/SX

WMA S/SX consists of two SST farms that store HLW from the processing of spent fuel rods in the Reduction-Oxidation (REDOX) Facility. Each of the tank farms consists of the following:

- SSTs of varying sizes
- Waste transfer lines
- Leak detection systems
- Tank ancillary equipment

WMA S/SX is located in the southern portion of the 200-West Area near the REDOX Facility (see Figure 3–7).

S Tank Farm. The S Tank Farm consists of twelve 2.9-million-liter (758,000-gallon) (100-series) SSTs constructed in 1950 and 1951. The SSTs are 23 meters (75 feet) in diameter and approximately 11.4 meters (37.3 feet) in height from base to dome, with curved-dish bottoms. The tanks are constructed of a steel-reinforced concrete shell that encompasses a steel plate liner and were designed with cascade overflow lines in a three-tank series to allow gravity flow of liquid waste between the tanks. The sediment cover from the apex of the tank domes to the ground surface is approximately 2.5 meters (8.1 feet). The S farm SSTs received REDOX Facility waste that self-boiled (CH2M HILL 2002).

One of the 12 tanks in the S farm (S-104) is classified as an assumed leaker. All of the tanks in the S farm were removed from service during the late 1970s and early 1980s (Johnson et al. 1999) and have since been interim-stabilized.

SX Tank Farm. The SX Tank Farm consists of fifteen 3.8-million-liter (1-million-gallon) (100-series) SSTs constructed in 1953 and 1954. The SSTs are 23 meters (75 feet) in diameter and approximately 13.4 meters (44 feet) in height from base to dome. The tanks are constructed of a steel-reinforced concrete shell that encompasses a steel plate liner. The sediment cover from the apex of the tank domes to the ground surface is approximately 1.8 meters (6 feet) (CH2M HILL 2002). The SX tanks were the first SSTs designed for self-boiling (self-concentrating) waste, with tanks 241-SX-105 and SX-107 through SX-115 designed to handle REDOX boiling HLW (Johnson et al. 1999). Like the tanks in the S farm, the SSTs were constructed with cascade overflow lines. However, these cascade lines were not used in the SX farm (CH2M HILL 2002).

Unlike the S tanks, the tanks in the SX Tank Farm were constructed with an orthogonal intersection of liner sidewall and bottom, which was a frequent locus of failure because of the stresses generated by self-boiling waste (Caggiano 1996). Ten of the 15 tanks (241-SX-104 and SX-107 through SX-115) in the SX farm are classified as assumed leakers; 9 of the 10 tanks operated as boiling-waste tanks (Johnson et al. 1999). All of the tanks in the SX farm were removed from service and have since been interim-stabilized.

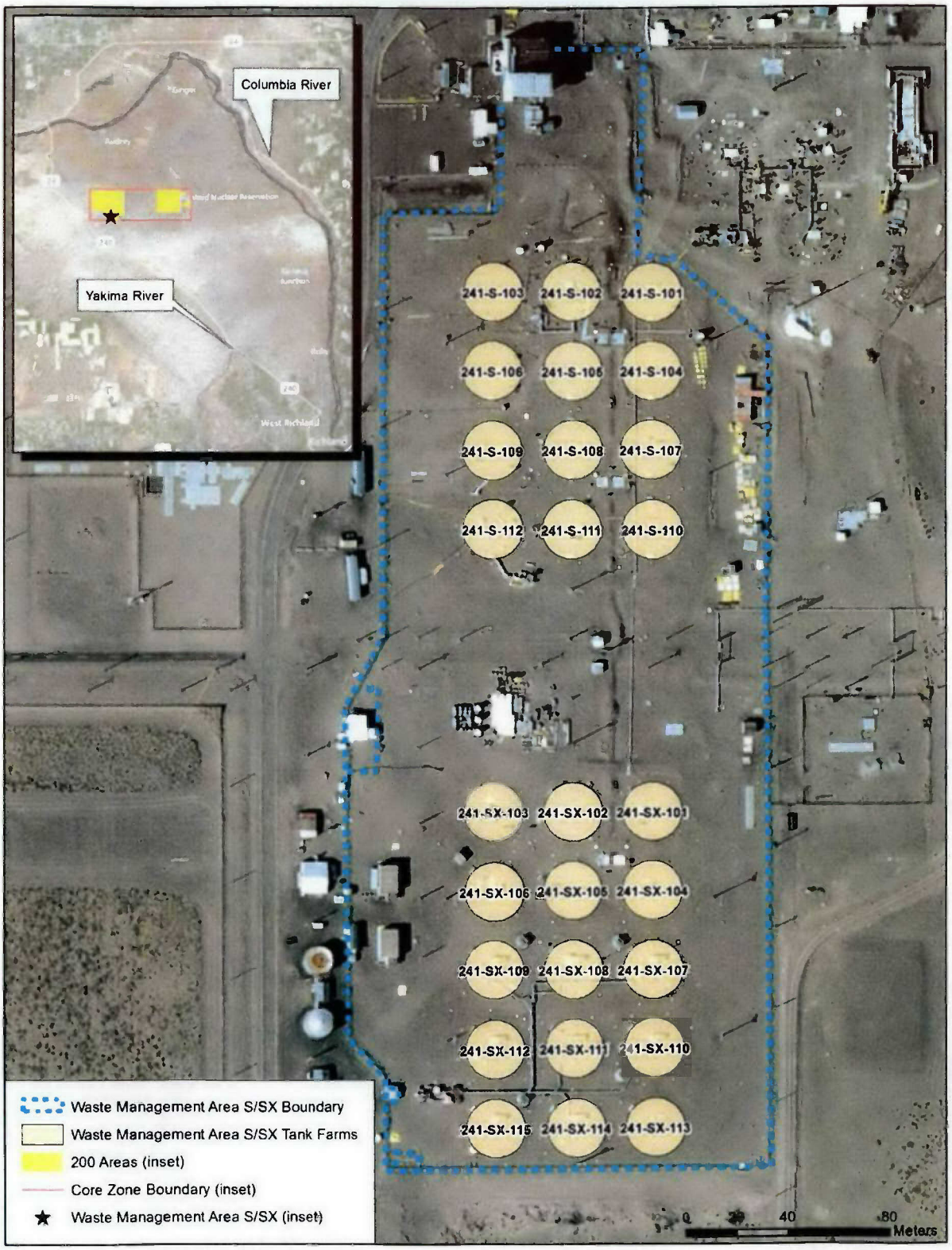


Figure 3-7 General Location of Waste Management Area S/SX

3.4.1 Land Resources

3.4.1.1 Land Use

Clean closure of WMA S/SX would involve land-disturbing activities associated with construction of an underground transfer line, WRF, HLW Debris Storage Facility, PPF, IDF, and the proposed RPPDF. Closure activities would also require the extraction of material from Borrow Area C. For most facilities and activities, the acreage requirement was determined by use of a scaling factor that adjusted the total land requirement for closing all Hanford tank farms (as reported in the *Final TC & WM EIS* [DOE 2012]) to a specific value for WMA S/SX. However, this was not done for the WRF and PPF, as the minimum requirement to close a WMA is one facility. Also, it was not necessary to scale the length of the underground transfer line.

WMA S/SX is located in the 200-West Area; however, not all activities associated with its closure would take place in this area. Thus, land would also be disturbed within the 200-East Area (for the IDF); between the 200-East and 200-West Areas (for the HLW Debris Storage Area, PPF, and RPPDF); and within Borrow Area C. Within the 200-West Area, a total of 3.46 hectares (8.54 acres) would be disturbed, all of which is developed. Within the 200-East Area, 2.04 hectares (5.04 acres) would be disturbed, none of which is developed. Development within the area between the 200-East and 200-West Areas would require 76.9 hectares (190 acres), all of which is undeveloped. Disturbance within Borrow Area C would total 71.6 hectares (177 acres), all of which is undeveloped. Thus, a total of 154 hectares (381 acres) would be required for closure of WMA S/SX, of which only 3.46 hectares (8.54 acres) is currently developed.

3.4.1.2 Visual Resources

As noted above, a total of 154 hectares (381 acres), most of which is not currently developed, would be required for clean closure of WMA S/SX. Within the 200-East and 200-West Areas, development would have little impact on visual resources, as these areas are already highly industrialized. However, the use of 76.9 hectares (190 acres) between the 200-East and 200-West Areas would impact visual resources, as this land is not developed. The conversion of this land to an industrial use would add noticeably to the overall developed nature of the area and would be visible from nearby higher elevations. The viewscape from these higher elevations is important to American Indians with cultural ties to Hanford. Clean closure activities would involve constructing containment structures over the WMA; however, these structures would be removed upon completion of clean closure activities. Although there would be an overall increase in the industrial appearance of the 200 Areas, the BLM Visual Resource Management Class IV rating would not change. Management activities within Class IV areas dominate the view and typically are the focus of viewer attention.

As noted above, 71.6 hectares (177 acres) within Borrow Area C would be excavated for the clean closure of WMA S/SX. Development of Borrow Area C would be readily visible from State Route 240 and Rattlesnake Mountain and would change the BLM visual resource management rating from Class II to Class IV. Management activities within Class II areas may be seen but should not dominate the view. Upon completion of WMA S/SX closure, excavations in Borrow Area C would be recontoured and revegetated, thereby lessening the visual impact.

3.4.2 Infrastructure

For clean closure of WMA S/SX, operation of the RPPDF would generate the highest total water and diesel fuel demand; deep soil removal, the highest total electricity and gasoline demand.

Water would be required during construction for soil compaction, dust control, and possibly work surface and equipment washdown. Standard construction practices dictate that, at least initially, construction water would be trucked to construction locations on an as-needed basis for these uses until water supply and wastewater treatment utilities are in place. Concrete and grout would be produced in onsite batch plants, which would require large volumes of water. By comparison, relatively little water would be required to meet the potable and sanitary needs of the construction workforce. During operations, water would be required to support process makeup requirements and facility cooling, as well as the potable and sanitary needs of the operations workforce and other uses. To stabilize and partially decontaminate waste treatment, retrieval, and disposal facilities, water would also be used during facility deactivation activities; however, this requirement would be relatively small compared with those for construction and operational demands and for many closure activities, including construction of surface barriers.

Table 3–46 summarizes the projected utility infrastructure resource requirements for WMA S/SX clean closure.

Table 3-46 Waste Management Area S/SX Clean Closure Summary of Utility Infrastructure Requirements

Activity Phase	Electricity (million megawatt-hours)	Diesel Fuel[a]	Gasoline	Water
		(million liters)		
Peak (Year)	**0.041 (2038–2039)**	**83.0 (2101)**	**7.82 (2101)**	**398 (2038–2039)**
Construction	0.006	38.3	2.05	204
Operations	0.013	314	10.5	7,390
Deactivation	0.00[b]	0.202	0.260	0.00[b]
Closure	0.563	153	13.9	384
Total[c]	**0.582**	**506**	**26.7**	**7,980**

[a] Assumed to be inclusive of all Number 2 diesel fuel, including road diesel and heating fuel oil.

[b] Deactivation values of "0.00" reflect no demand for that utility.

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

Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate. To convert liters to gallons, multiply by 0.26417.

Source: SAIC 2010.

3.4.2.1 Electricity

For clean closure of WMA S/SX, peak annual electrical energy demand in years 2038 and 2039 would be 41,310 megawatt-hours and would remain well within the annual capacity of 1.74 million megawatt-hours (based on a peak load capacity of 199 megawatts) of the Hanford electric power transmission system.

3.4.2.2 Fuel

Peak demands of about 83 million liters (22 million gallons) of diesel fuel and about 7.8 million liters (2.1 million gallons) of gasoline would both occur in 2101 due to clean closure of WMA S/SX. Annualized liquid fuel consumption (diesel fuel and gasoline) of about 1.34 million liters (0.35 million gallons) during the timespan of clean closure activities for this WMA (2008 through 2202) would be significantly less than the 4.3 million liters (1.1 million gallons) of liquid fuels currently used annually at Hanford.

3.4.2.3 Water

For clean closure of WMA S/SX, peak annual water requirements of about 398 million liters (105 million gallons) would occur in 2038 and 2039. This peak would be well within the 18,500-million-liter (4,890-million-gallon) annual capacity of the Hanford Export Water System.

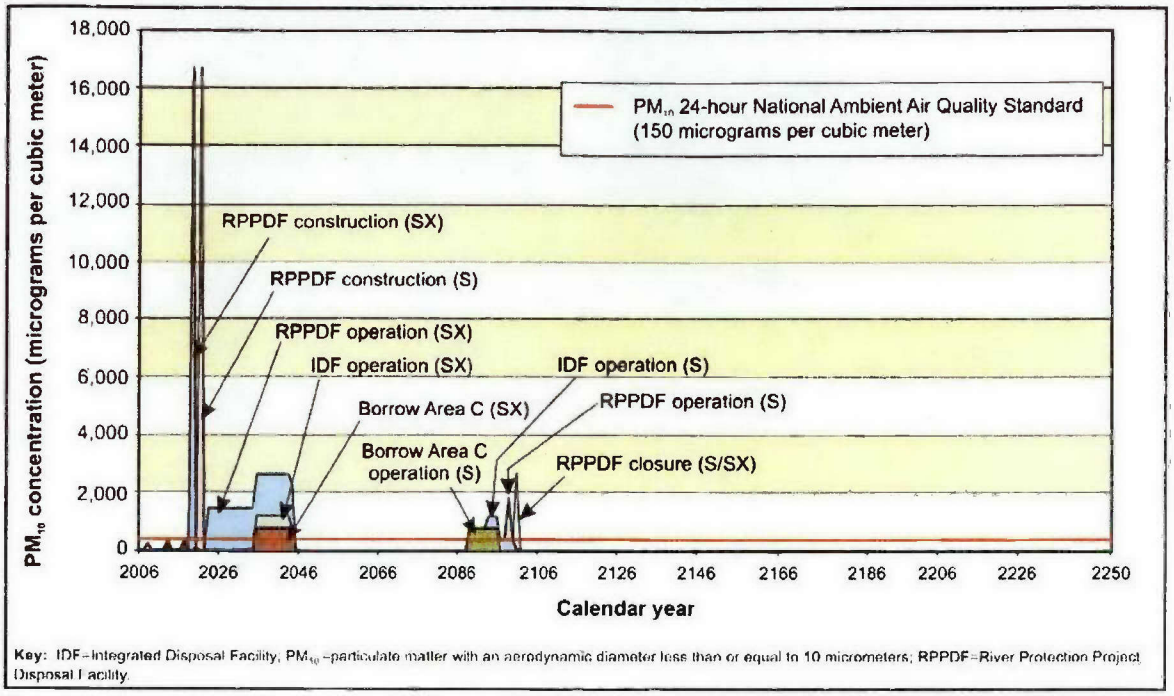
3.4.3 Noise and Vibration

Construction, operation, deactivation, and closure of facilities for clean closure of WMA S/SX would result in minor noise impacts of employee vehicles, trucks, construction equipment and activity, generators, and process equipment. The offsite noise levels from activities at the Waste Treatment and Immobilization Plant (WTP) and 200-East and 200-West Areas would be negligible due to the distance to the Hanford boundary.

Employee and truck traffic to deliver materials for various phases of activities would vary over the duration of the project. The highest number of employee trips is expected to occur in 2015 (SAIC 2012). The increase in the number of employee vehicles and truck trips is expected to cause a minor increase in traffic noise levels along routes to the site. This increase in employee and truck traffic (discussed in Section 3.4.9) was compared with the existing average traffic volume of 30,000 to 40,000 vehicles per day (DOE 2012). For comparison purposes, the increase in traffic noise level can be estimated from the ratio of the projected traffic volume to the existing traffic volume.

3.4.4 Air Quality

Criteria pollutant concentrations that would result from activities for WMA S/SX clean closure are presented in Table 3–47. Peak concentrations of all criteria pollutants except PM would occur in 2101. Peak concentrations of PM would occur in 2019. The peak period concentrations for carbon monoxide, nitrogen dioxide, and sulfur dioxide would result primarily from closure of the proposed RPPDF; for PM, from RPPDF construction. The maximum air quality impacts of PM_{10} emissions would occur to the south at State Route 240. Figure 3–8 shows the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities to these concentrations.



Key: IDF=Integrated Disposal Facility; PM_{10}=particulate matter with an aerodynamic diameter less than or equal to 10 micrometers; RPPDF=River Protection Project Disposal Facility.

Figure 3-8 Waste Management Area S/SX Clean Closure PM_{10} Maximum 24-Hour Concentrations

Table 3-47 Waste Management Area S/SX Clean Closure Maximum Incremental Criteria Pollutant Concentrations

Pollutant and Averaging Period	Standard[a]	Maximum Modeled Increment
	(micrograms per cubic meter)	
Carbon Monoxide		
8-hour	10,000[b]	**41,200**
1-hour	40,000[b]	**257,000**
Nitrogen Dioxide		
Annual	100[b]	88.9
1-hour	188	**179,000**
PM_{10}[c]		
Annual	50[d]	**119**
24-hour	150[b]	**16,800**
$PM_{2.5}$		
Annual	15[d]	**119**
24-hour	35[b]	**16,800**
Sulfur Dioxide		
Annual	50[d]	0.176
24-hour	260[d]	24.5
3-hour	1,300[b]	120
1-hour	197[e]	**353**

a The more stringent of the Federal and Washington State standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (40 CFR 50), other than those for ozone, particulate matter, lead, and those based on annual averages, are not to be exceeded more than once per year. The 24-hour PM_{10} standard is attained when the expected number of days with a 24-hour average concentration above the standard is less than or equal to 1. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard. The annual $PM_{2.5}$ standard is met when the 3-year average of the annual means is less than or equal to the standard. The 24-hour $PM_{2.5}$ standard is met when the 3-year average of the 98th percentile 24-hour averages is less than or equal to the standard. The 1-hour nitrogen dioxide standard is met when the 3-year average 98th percentile of the daily maximum 1-hour average does not exceed the standard value.

b Federal and Washington State standard.

c The Federal standards for $PM_{2.5}$ are 15 micrograms per cubic meter annual average and 35 micrograms per cubic meter 24-hour average. No specific data for $PM_{2.5}$ were available, but for analysis purposes, concentrations were assumed to be the same as those of PM_{10}.

d Washington State standard.

e Federal standard.

Note: The National Ambient Air Quality Standards also include standards for lead and ozone. No sources of lead emissions have been identified for the activities evaluated. Washington State also has ambient standards for fluorides. Concentrations in **bold** text indicate potential exceedance of the standard.

Key: PM_n=particulate matter with an aerodynamic diameter less than or equal to *n* micrometers.

Source: Based on emissions data in SAIC 2012.

Maximum concentrations of carcinogenic and noncarcinogenic toxic pollutants are presented in Table 3–48. No impacts on the public due to projected nonradioactive toxic pollutant emissions are expected as a result of WMA S/SX clean closure activities. Hazardous chemical health effects on noninvolved workers are summarized in Tables 3–49 and 3–50.

Table 3-48 Waste Management Area S/SX Clean Closure Maximum Incremental Nonradioactive Toxic Chemical Concentrations

Pollutant	Averaging Period	Acceptable Source Impact Level[a]	Maximum Modeled Increment
		(micrograms per cubic meter)	
Ammonia	24-hour	70.8	20.0
Benzene	Annual	0.0345	0.0323
1,3-Butadiene	Annual	0.00588	0.000842
Formaldehyde	Annual	0.167	0.0278
Mercury	24-hour	0.09	0.00000647
Toluene	24-hour	5,000	31.2
Xylene	24-hour	(b)	9.27

a WAC 173-460.

b Not listed in WAC 173-460.

Note: To convert cubic meters to cubic feet, multiply by 35.315.

Source: Based on emissions data in SAIC 2012.

Table 3-49 Waste Management Area S/SX Clean Closure Nonradioactive Airborne Toxic Chemical Hazard Index for the Nearest Noninvolved Worker

Chemical	Hazard Quotient
Ammonia	1.69×10^{-1}
Mercury	2.83×10^{-5}
Toluene	1.98×10^{-3}
Xylene	3.00×10^{-2}
Hazard Index	2.01×10^{-1}

Source: Based on emissions data in SAIC 2012.

Table 3-50 Waste Management Area S/SX Clean Closure Nonradioactive Airborne Toxic Chemical Cancer Risk for the Nearest Noninvolved Worker

Chemical	Cancer Risk
Benzene	1.38×10^{-5}
1,3-Butadiene	1.56×10^{-6}
Formaldehyde	2.18×10^{-5}

Source: Based on emissions data in SAIC 2012.

3.4.5 Geology and Soils

Consumption of geologic resources (rock, minerals, and soils) to support facility construction, operations, and deactivation, as applicable, would constitute the major indirect impact on geologic and soil resources from implementation of clean closure of WMA S/SX and associated waste management activities, as summarized in Table 3–51. Varying quantities of geologic resources would be required for ongoing facility construction; upgrades to existing facilities, including the 200 Area tank farms; waste retrieval activities; and, most substantially, tank farm closure. Geologic resources, including relatively large volumes of gravel, sand, and silt, are available from the suprabasalt sediments and associated soils at Hanford. Rock, in the form of basalt, is also plentiful. As discussed in the *Environmental Assessment, Use of Existing Borrow Areas, Hanford Site, Richland, Washington* (DOE 2001a), a number of active gravel and sand pits and two rock quarries at Hanford have been identified for use in providing a continual supply of borrow materials for new facility construction, maintenance of existing facilities, and fill and capping material for remediation and other activities. Of the two active quarries on the

site, quarry No. 2 (Borrow Area C), located due south of the 200-West Area just south of State Route 240, has large volumes of basalt and sand (DOE 2001a). This approximately 926.3-hectare (2,289-acre) borrow area has been designated as a source of materials such as rock riprap (basalt), aggregate (gravel and sand), and soil (silt and loam) that would be needed to support tank farm closure and supporting activities (DOE 2003a).

Table 3-51 Waste Management Area S/SX Clean Closure Major Geologic and Soil Resource Impact Indicators and Requirements

Construction Materials				Other Borrow Materials[a]				Closure-Specific Materials		
Concrete/ Grout	Cement[b]	Sand[b]	Gravel[b]	Rock/Basalt	Sand	Gravel	Soil (Specification Backfill)	Grout[c]	Cement	Sand[d]
192,000	38,600	93,300	79,300	0	852,000	431,000	11,000,000	3,360	400	1,640

a Resources for miscellaneous uses not exclusively tied to facility construction, operations, or closure, such as site grading and backfill for operations.

b Cement, sand, and gravel are components of concrete.

c Grout is composed of cement, sand, fly ash, and other materials.

d Principal component of grout that would be obtained from onsite deposits.

Note: Values have been rounded to no more than three significant figures. All values are expressed in cubic meters. To convert cubic meters to cubic feet, multiply by 35.315.

3.4.6 Water Resources

All construction and closure-related land disturbances, especially for new facility construction, would expose soils and sediments to possible erosion by infrequent, heavy rainfall or by wind. While unlikely to reach surface-water features, stormwater runoff from exposed areas could convey soil, sediments, and other pollutants (e.g., construction waste materials and spilled materials, such as petroleum, oils, and lubricants from construction equipment) from construction footprint and laydown areas. Nevertheless, appropriate soil erosion and sediment control measures, as well as spill prevention and waste management practices, would be employed to minimize suspended sediment, the transport of other deleterious materials, and any potential water-quality impacts. Further, all construction and other ground-disturbing activities would be conducted in accordance with current NPDES and state waste discharge general permits for stormwater discharges associated with construction activities, issued by Ecology. The NPDES permit specifically requires the development and implementation of a stormwater pollution prevention plan.

Once completed, new facilities required for clean closure of WMA S/SX would incorporate appropriate stormwater management controls to collect, convey, and detain stormwater from buildings and other impervious surfaces so as to minimize the impacts of onsite hydrology and soil erosion. Hanford's NPDES Storm Water Multi Sector General Permit would cover stormwater discharges associated with industrial activity and, as necessary, stormwater discharges would be covered under state waste discharge permits for discharges to the ground.

Under normal operations associated with WMA closure, facility design combined with adherence to spill prevention and emergency response plans and procedures would help to ensure that involved hazardous substances, including spills, should they occur, do not reach soils or surfaces where they could be conveyed to surface water or groundwater. For construction, operations, deactivation, and closure activities, adherence to best management practices and

other preventive measures under applicable permits and compliance plans would be coordinated by DOE with those measures in similar sitewide pollution prevention plans.

There would be no direct discharge of effluents to either surface water or groundwater during construction, operations, and deactivation as a result of WMA S/SX clean closure. Nonhazardous sanitary wastewater (sewage) would be managed via appropriate sanitary wastewater collection and treatment systems. During the early phases of new facility construction, it was assumed that portable toilet facilities would be provided for construction personnel, with collected waste disposed of at offsite contractor facilities, as is standard construction practice. During facility operations and deactivation, sanitary wastewater would be disposed of via the dedicated sanitary sewer or septic/drain-field system serving a particular facility.

Water would be required to support new facility construction, facility operations, and facility deactivation for WMA S/SX clean closure. Water would be required for WRF construction; replacement of underground transfer lines; and construction of tank upgrades, a new riser, an MRS, a VBR system, the PPF, IDF-East, and the proposed RPPDF that will be located between the 200-East and 200-West Areas. Total water demands have been conservatively estimated at 7,970 million liters (2,210 million gallons), with a peak water demand of 397 million liters (105 million gallons). Peak periods of water demands would occur during years 2038 through 2039 as a result of Borrow Area C and RPPDF operation. All utility demands, as well as water demands, are discussed in Section 3.4.2, Infrastructure.

3.4.7 Ecological Resources

3.4.7.1 Terrestrial Resources

As noted in Section 3.4.1.1, a total of 82.6 hectares (204 acres) within the 200-East Area, 200-West Area, and between the 200-East and 200-West Areas would be disturbed by construction of the facilities required to clean-close WMA S/SX. Of this total, 2.04 hectares (5.04 acres) would be developed within the 200-East Area, 3.46 hectares (8.54 acres) within the 200-West Area, and 76.9 hectares (190 acres) between the 200-East and 200-West Areas. Within the 200-East Area and between the 200-East and 200-West Areas, all of the land needed for construction is undeveloped sagebrush habitat, whereas within the 200-West Area, all of the land needed for construction has been previously disturbed. Late successional sagebrush habitat is considered a Level III resource under the *Hanford Site Biological Resources Management Plan* (DOE 2001b:4.11). Hanford guidance may require the replacement of sagebrush habitat at a ratio ranging from 1:1 to 3:1 (DOE 2003b:20, 21, 31). Specific measures to mitigate the loss of sagebrush habitat would be set forth in a mitigation action plan prior to construction.

The clean closure of WMA S/SX would require that 71.6 hectares (177 acres) of Borrow Area C be excavated to supply needed geologic material. The two major plant communities present within the area are cheatgrass-bluegrass (782 hectares [1,933 acres]) and needle-and-thread grass/Indian ricegrass (107 hectares [265 acres]) (DOE 2012). The latter represents an unusual and relatively pristine community type at Hanford; thus, it is considered a more highly valued community than the former. It is not possible to determine specific impacts of excavating Borrow Area C on ecological resources because the particular portion of the site from which geologic material would be excavated is unknown. To the extent that it is possible, the needle-

and-thread grass/Indian ricegrass community should be avoided during excavation. A mitigation action plan would be developed prior to excavation.

3.4.7.2 Threatened and Endangered Species

Federally or state-listed threatened or endangered species have not been observed within, or in the immediate vicinity of, the 200 Areas or Borrow Area C; therefore, impacts on this group of plants and animals are not expected as a result of WMA S/SX clean closure. Both the Columbia and Yakima Rivers adjacent to Hanford have been designated as critical habitat for the bull trout. However, as there would be no short-term impacts on either river from construction or operation of new facilities associated with clean closure of WMA S/SX, designated critical habitat would not be adversely affected.

A number of state-listed, special status species observed within areas that would be disturbed by clean closure of WMA S/SX could be impacted by construction of the various required facilities. One state-listed species, the sage sparrow (state candidate), was observed within IDF-East. In addition, the loggerhead shrike (Federal species of concern and state candidate), black-tailed jackrabbit (state candidate), sage sparrow, and crouching milkvetch (state watch) have all been observed between the 200-East and 200-West Areas where the HLW Debris Storage Facility, PPF, and the proposed RPPDF would be located. Finally, surveys have identified Piper's daisy (state sensitive), stalked-pod milkvetch (state watch), crouching milkvetch, and the long-billed curlew (state monitor) within the boundaries of Borrow Area C. No state-listed, special status species have been observed within areas to be disturbed within the 200-West Area. The operation of new facilities is not expected to impact any listed species.

Although mitigation would not be required for the state monitor and watch species, they should be considered during project planning. Impacts on state candidate and sensitive species, which are considered Level III resources under the *Hanford Site Biological Resources Management Plan*, require mitigation where impacts would occur. When avoidance and minimization are not possible or are insufficient, mitigation via rectification or compensation is recommended (DOE 2001b:4.9, 8.11). A comprehensive mitigation action plan, which would deal with the loss of state-listed species (as well as sagebrush habitat), would be developed prior to construction.

3.4.8 Cultural and Paleontological Resources

3.4.8.1 Prehistoric Resources

As noted in Section 3.4.1.1, clean closure of WMA S/SX would require a total of 154 hectares (381 acres), of which 3.46 hectares (8.54 acres), located in the 200-West Area, is currently developed. Land disturbance due to clean closure of WMA S/SX would involve the 200-East and 200-West Areas, land between the 200-East and 200-West Areas, and Borrow Area C. White Bluffs Road, an important archaeological resource, is located in the southwest and northeast parts of the 200-West Area. Other prehistoric finds were discovered in the northwestern portion of the 200-West Area and immediately east of the 200-East Area. There are no known prehistoric resources within the areas that would be affected by the clean closure of WMA S/SX. The survey and geology of the 200 Areas indicate that subsurface cultural deposits have little or no potential of being present. The *Hanford Cultural Resources Management Plan* (DOE 2003c) provides guidance for identifying, evaluating, recording,

curating, and managing cultural resources. If any prehistoric resources were discovered during construction or excavation, procedures from the *Hanford Cultural Resources Management Plan* would be implemented.

3.4.8.2 Historic Resources

There would be no impacts on White Bluffs Road or on other known early historic artifacts within the 200-East or 200-West Area from construction or excavation required for clean closure of WMA S/SX. In addition to White Bluffs Road in the 200-West Area, historic resources have been found in the south-central part of the 200-East Area. Buildings associated with the Manhattan Project and Cold War era are found within both the 200-East and 200-West Areas; however, none of these structures would be affected. As is the case for prehistoric resources, if historic resources were discovered, procedures in place to properly identify, evaluate, record, curate, and manage the discovery site would be implemented.

3.4.8.3 American Indian Interests

As stated above, there are no known prehistoric resources that may be an American Indian interest within the affected areas required for the clean closure of WMA S/SX. Clean closure of WMA S/SX would impact 76.9 hectares (190 acres) of undeveloped land between the 200-East and 200-West Areas. The conversion of this land to industrial use would be noticeably visible from nearby higher elevations, such as Gable Mountain and Gable Butte. The viewscape from these higher elevations is important to American Indians with cultural ties to Hanford. There would be little impact on the viewscape within the 200-East and 200-West Areas, as the areas are already highly industrialized.

Clean closure of WMA S/SX would also require excavation of 71.6 hectares (177 acres) within Borrow Area C. This would also have an impact on the viewscape from Rattlesnake Mountain; however, upon completion of the work, excavations of Borrow Area C would be recontoured and revegetated, thus lessening the visual impact. Appropriate mitigation measures would be developed in consultation with area tribes.

3.4.8.4 Paleontological Resources

No paleontological resources have been discovered within the 200 Areas or Borrow Area C; therefore, clean closure of WMA S/SX would not impact such resources. However, if any paleontological resources were found during construction or excavation, procedures to properly manage the discovery site would be implemented.

3.4.9 Socioeconomics

3.4.9.1 Regional Economic Characteristics

A peak workforce of 2,590 FTEs in 2015, as shown in Table 3–52, would be required for clean closure of WMA S/SX. Construction, operation, and closure activities would dominate the years from 2013 through 2041, with a few spikes in employment followed by sharp drops. The peak estimate is approximately 1.5 percent of the projected labor force in the ROI (178,000 in 2015), compared with 10 percent in 2006. The existence of these direct jobs is expected to result in the creation of another 1,930 indirect positions in the ROI during the peak year. An additional

estimated spike (2,500 FTEs) in the workforce in 2101 would be dominated by closure activities at the RPPDF. A small workforce (five FTEs)would be needed for postclosure care of the site beginning in 2103. Implementing WMA S/SX clean closure activities could alter the economic characteristics of the region by increasing demands for goods and services in the Tri-Cities area due to increases in expenditures, income, and employment, both direct and indirect, at Hanford.

Table 3-52 Waste Management Area S/SX Clean Closure Workforce Estimates

Work Activity	Peak Year(s)	Workforce Peak (FTEs)
Construction	2013	1,490
Operations	2016–2017	1,680
Deactivation	2040–2041	41
Closure	2101	2,500
Total Onsite Workforce	**2015**	**2,590**

Key: FTE=full-time equivalent.

3.4.9.2 Demographic Characteristics

While clean closure of WMA S/SX would draw some workers from the local labor force, the demand for construction and operations workers could draw from outside the region. The in-migrations of new workers and their families would increase the overall population within the Tri-Cities area and could alter the demographic characteristics of the region.

3.4.9.3 Housing and Community Services

Implementing clean closure of WMA S/SX would increase the demand for housing and would impact schools and other community services within the Hanford ROI. The demand for housing by construction and operations workers would impact the cost and availability of houses and rental units. School enrollments would increase, and utilities and police and fire services may need to be expanded.

The number of indirect jobs in the region supporting Hanford activities could be reduced by sharp drops in employment following spikes. If these workers are unable to find employment in other industries, they could move out of the region, thereby reducing the overall regional population and decreasing the demand for housing and community services.

3.4.9.4 Local Transportation

Implementation of WMA S/SX clean closure is expected to have an impact on the local transportation system, especially during the commute periods. The projected increase in commuter traffic to the site would be due primarily to construction and operations activities, peaking at an annual 2,590 FTEs in 2015. This could represent up to 2,070 passenger vehicles per day during the peak year. It is expected that this commuter traffic would impact the regionally established LOS, reducing it to below the minimum acceptable ("D") LOS.

The number of onsite annual truck trips would be the highest in 2101 during construction of the RCRA Subtitle C barrier. During this construction, onsite truck activity would peak at 221,000 truck trips per year (approximately 849 trips per day). Offsite trips would peak at 8,300 trips per year (approximately 32 truck trips per day). Additionally, RPPDF construction

and operations and SX tank farm and deep soil removal would require a heavier period of truck use onsite, averaging over 30,000 truck trips per year (approximately 115 trips per day).

3.4.10 Public and Occupational Health and Safety – Normal Operations

Activities to clean-close the S and SX Tank Farms could result in radiological exposures to the public and workers. Radiological impacts are presented for three public receptors: the general population (approximately 560,000)[9] living within 80 kilometers (50 miles) of the Hanford 200 Areas, an MEI living near Hanford, and an onsite MEI. Impacts on the general population are evaluated for a residential scenario whereby people are exposed to radioactive materials emitted from project facilities. Radiological exposure occurs through inhalation, direct exposure to the radioactive plume and material deposited on the ground, and ingestion of contaminated products from animals raised locally and fruits and vegetables grown in a family garden (DOE 1995). The MEI is a hypothetical individual member of the public located at a position near the site boundary who would experience the highest impacts during normal operations. The MEI was determined to be a receptor on the east side of the Columbia River. Impacts on the offsite MEI are evaluated for a scenario that includes the same exposure pathways assumed for the general population, but with an increased amount of time spent outdoors and a higher rate of contaminated food consumption. Impacts on the onsite MEI, identified as a member of the public who works at the Columbia Generating Station, LIGO, or U.S. Ecology, would be from inhalation and exposure to the plume and material deposited on the ground. Doses are presented as total effective doses. Details of the assessment methodology for determining radiological exposure of workers and members of the public are presented in Appendix K of the *Final TC & WM EIS* (DOE 2012).

The radiological impacts on members of the public are presented in terms of impacts over the life of the project, that is WMA S/SX clean closure (the operational life of the project during which radioactive air emissions would occur), and peak annual impacts. Impacts over the life of the project are the total estimated radiation doses that would be incurred by members of the public over the duration of the activities to complete clean closure of the WMA. The peak annual impacts are the estimated annual radiation doses that would be incurred by members of the public during the year(s) of largest radiation dose.

In addition to members of the public, workers directly involved in the activities to clean-close the WMA and nearby noninvolved workers may receive radiation doses. Doses to an involved worker are calculated based on an FTE employee. It was assumed for the purposes of this dose evaluation that an FTE involved worker has a 2,080-hour work year. In practice, the number of workers who could receive a radiation dose may be larger than the number of FTEs assumed in this analysis, resulting in a smaller average dose per worker. A noninvolved worker is a person working at the site who is incidentally exposed due to the radioactive air emissions associated with tank farm management, tank waste retrieval, and clean closure activities. The potential dose to a noninvolved worker would result from exposure to, and inhalation of, radioactive contaminants released to the atmosphere from tank farm management, tank waste retrieval, and clean closure activities. In the 200-East Area, the noninvolved worker was assumed to be at the 242-Evaporator, 1,090 meters (3,580 feet) north northwest of the 200-East Area source. In the

[9] The approximate population is based on populations of 542,324; 546,746; and 589,668 people residing within 80 kilometers (50 miles) of theWTP, 200-East Area, and 200-West Area, respectively, as described in the *Final TC & WM EIS* (DOE 2012).

200-West Area, the noninvolved worker was assumed to be at the ERDF, about 950 meters (3,120 feet) east of the 200-West Area source.

The impacts of radionuclide releases from construction, operations, deactivation, and cleanup of facilities directly related to tank farm management, tank waste retrieval, and clean closure of WMA S/SX were evaluated.

3.4.10.1 Radiological Impacts on the Public

Table 3–53 presents estimated doses to the general population and the MEI for clean closure activities associated with WMA S/SX. Activities conducted at WMA S/SX that would generate radioactive air emissions would occur from 2011 through 2100. Due to the long timeframe involved, the doses over the life of the project may not be received by the same members of the population or the same MEI, but are presented as a measure of potential impacts.

Table 3-53 Waste Management Area S/SX Clean Closure Public Health Impacts of Atmospheric Radionuclide Releases

Receptor	Facility	Impacts over Life of Project[a]		Peak Annual Impacts		
General population		Dose (person-rem)	Number of Latent Cancer Fatalities[b]	Year of Maximum Impact	Dose (person-rem per year)	Number of Latent Cancer Fatalities[b]
	200-East Area	8.7			0.39	
	200-West Area	9.9			0.48	
	Total	**19**	**0 (1×10^{-2})**	**2035**	**0.87**	**0 (5×10^{-4})**
Maximally exposed individual		Dose[c] (millirem)	Lifetime Risk of a Latent Cancer Fatality[d]	Year of Maximum Impact	Dose (millirem per year)	Lifetime Risk of a Latent Cancer Fatality[d]
	200-East Area	1.1			0.051	
	200-West Area	0.75			0.036	
	Total	**1.9**	**1×10^{-6}**	**2035**	**0.088**	**5×10^{-8}**
Onsite MEI	**Total**	**0.84**	**5×10^{-7}**	**2035**	**0.039**	**2×10^{-8}**

a Impacts accrued over the operational life of the project to clean-close Waste Management Areas S/SX.

b The reported value is the projected number of latent cancer fatalities (LCF) among the population and is therefore presented as a whole number. The result, calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem), is shown in parentheses.

c Impacts are provided for assessment purposes. The life-of-project dose likely overestimates the dose that would be received by one individual person because the project could span approximately 88 years.

d Probability of an LCF in the MEI is calculated by converting the dose in millirem to rem (divide by 1,000), then multiplying the dose by the risk factor of 0.0006 LCFs per rem.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.
Key: MEI=maximally exposed individual.

Over the life of the project, the population within 80 kilometers (50 miles) of the 200 Areas would receive a cumulative dose of 19 person-rem, and the MEI would receive a cumulative dose of 1.9 millirem. Given the risk factor of 0.0006 LCFs per rem (DOE 2003d), no LCFs are expected in the general population as a result of these activities. There would be a probability of 1×10^{-6} (1 chance in 1 million) of the MEI developing an LCF, assuming the same MEI was exposed over the life of the project. Radioactive air emissions would result in a maximum

annual population dose of 0.87 person-rem and a maximum annual MEI dose of 0.088 millirem. The primary contributor to offsite doses would be fission products from processing contaminated tank farm soils through the PPF.

An onsite MEI who spends a normal workday at U.S. Ecology would receive a maximum annual dose of 0.039 millirem. The increased risk of an LCF from this dose would be 2×10^{-8} (1 chance in 50 million).

3.4.10.2 Radiological Impacts on Workers

Table 3–54 presents dose and risk estimates for an involved FTE worker and a noninvolved FTE worker. The average annual FTE radiation worker dose would be 6,900 millirem, higher than the Administrative Control Level of 500 millirem. A radiation worker who received the average annual dose over the course of 40 years would receive a dose of 270,000 millirem, corresponding to a risk of 2×10^{-1} (1 chance in 5) of developing an LCF.

Table 3-54 Waste Management Area S/SX Clean Closure Normal Operations Radiological Impacts on Workers

Receptor	Dose	Latent Cancer Fatality Risk[a]
Average Involved Full-Time-Equivalent Worker		
Average annual impact	3,500 millirem	2×10^{-3}
Impact over life of project[b]	270,000 millirem	2×10^{-1}
Life-of-Project Worker Population	33,000 person-rem	20
Noninvolved Worker (Year of Maximum Impact)		
At the 242-A Evaporator (2035)	0.096 millirem	6×10^{-8}
At the Environmental Restoration Disposal Facility (2035)	0.34 millirem	2×10^{-7}

a For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

b Impact over the life of the project is the average dose a full-time-equivalent radiation worker would receive working on this project. It is determined by multiplying the average annual dose by an assumed career length of 40 years.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

The total effective dose to the involved worker population from the 90 years of occupational exposure was estimated to be 33,000 person-rem. Given the risk factor of 0.0006 LCFs per person-rem, 19 LCFs are expected to result from the dose associated with tank farm operations, tank waste retrieval, and clean closure of WMA S/SX. Worker doses should be viewed in the context of the duration of the project and the DOE administrative controls employed that limit them. Due to the number of years required to complete clean closure, the dose over the life of the project would be distributed over multiple generations of workers. In addition, worker dose would be limited to less than 5 rem total effective dose per year (10 CFR 835). This regulatory limit would be further constrained by the application of administrative controls. DOE Standard 1098-2008, Radiological Control, recommends that the annual dose not exceed 2 rem, unless explicitly authorized by DOE management (e.g., for emergency situations). Individual worker doses would be maintained ALARA and generally be controlled at a level below 500 millirem (0.5 rem) per year.

Estimated doses and risks to the noninvolved workers at the 242-A Evaporator or the ERDF in the year of maximum impact are shown in Table 3–54. Doses to noninvolved workers would be a small fraction of the DOE recommended Administrative Control Level of 500 millirem per year.

3.4.11 Public and Occupational Health and Safety – Facility Accidents

This section addresses potential impacts on workers and the public associated with tank-farm-related accidents. Radiological impacts of the postulated accident scenarios were quantified for an MEI living near Hanford, the offsite population living within 80 kilometers (50 miles) of the facility, and a noninvolved worker assumed to be 100 meters (110 yards) from the facility. Hazardous chemical impacts were also evaluated. For an involved worker, accident consequences were not quantified. While involved workers are expected to be near the Hanford tank farms during routine tank farm operations, their number and location relative to a postulated accident are unknown. In the event of an accident involving chemicals or radioactive materials, workers near an accident could be at risk of serious injury or fatality. Safety procedures, safety equipment, and protective barriers are typical features that would prevent or minimize worker impacts. Additionally, following initiation of accident/site emergency alarms, workers in adjacent areas would evacuate in accordance with the technical area and facility emergency operating procedures and training. Therefore, involved worker impacts are not discussed further.

There would be no radiological accidents associated with facility construction. Further, any hazardous chemical accidents associated with facility construction would be typical of those normally associated with industrial construction materials, hazards, and practices. Projected operational accident consequences are presented in the following sections. Details of the methodology for assessing the potential impacts on workers and the public associated with postulated accidents are presented in Appendix K, Section K.3, of the *Final TC & WM EIS* (DOE 2012).

3.4.11.1 Radiological Impacts of Airborne Releases

During tank farm operations, tank waste retrieval, or clean closure activities, reasonably foreseeable accidents that could occur include: 1) hydrogen burn in a waste storage tank; and 2) tank dome collapse. The accident selected to represent a severe accident is the seismically induced waste tank dome collapse. The consequences of a seismically induced waste tank dome collapse, if it were to occur, are shown in Table 3–55. The annual risks of LCFs for this accident, which were obtained by multiplying the consequences by the likelihood (frequency per year) that the accident would occur, are shown in Table 3–56.

Table 3-55 Waste Management Area S/SX Clean Closure Radiological Consequences of Accidents

Accident	Maximally Exposed Individual		Offsite Population[a]		Noninvolved Worker	
	Dose (rem)	LCF[b]	Dose (person-rem)	LCF[c]	Dose (rem)	LCF[b]
Seismically induced waste tank dome collapse – unmitigated	0.00021	1×10^{-7}	1.3	0 (8×10^{-4})	0.22	1×10^{-4}

a Based on a population of 589,668 persons residing within 80 kilometers (50 miles) of the 200-West Area.

b Increased likelihood of latent cancer fatality for an individual, assuming the accident occurs.

c The reported value is the projected number of latent cancer fatalities (LCF) among the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

Key: LCF=latent cancer fatality.

Table 3-56 Waste Management Area S/SX Clean Closure Annual Cancer Risks from Accidents

Accident	Frequency (per year)	Risk of Latent Cancer Fatality		
		Maximally Exposed Individual[a]	Offsite Population[b, c]	Noninvolved Worker[a]
Seismically induced waste tank dome collapse – unmitigated	5×10^{-4}	6×10^{-11}	4×10^{-7}	7×10^{-8}

a Increased risk of a latent cancer fatality to the individual, taking into account the probability (frequency) of the accident.

b Based on a population of 589,668 persons residing within 80 kilometers (50 miles) of the 200-West Area.

c The reported value is the projected number of latent cancer fatalities (LCF) among the population, based on the probability (frequency) of the accident occurring, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

3.4.11.2 Hazardous Chemical Impacts

Various hazardous chemicals exist in the waste tanks. Because the chemicals that exist in the tank waste are mixed with the radioactive material, any accident event is expected to release both hazardous chemicals and radioactive materials. Due to the quantity and nature of the radioactive material in the waste tanks, the human health consequences of an accidental release would be dominated by the impacts of the radioactive components. Therefore, hazardous chemical human health impacts were not analyzed separately.

3.4.11.3 Intentional Destructive Acts

This section addresses potential impacts of intentional destructive acts at a tank farm. To protect against such actions, safeguards and security measures are employed at all DOE facilities. In accordance with DOE Orders, DOE conducts vulnerability assessments and risk analyses of facilities and equipment under its jurisdiction to evaluate the physical protection elements, technologies, and administrative controls needed to protect DOE assets. DOE also protects against espionage, sabotage, and theft of radioactive, chemical, or biological materials; classified information and matter; nonnuclear weapon components; and critical technologies. Before startup of any new or substantially modified operations, DOE would conduct an in-depth, site-specific safeguards and security inspection to ensure that existing programs satisfy DOE requirements. Any inadequacies would be resolved before startup of operations. Release scenarios and impacts resulting from intentional destructive acts may be similar to the accident

scenarios analyzed. Additional scenarios representing intentional destructive acts that may not be represented by the accident analyses were also considered.

Explosive Device in Underground Waste Tank. It was postulated that intentionally initiated explosions occur that displace a large portion of the soil overburden, breach the tank dome, and disperse a portion of the tank waste into the atmosphere. In accordance with the recommendation from *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, Vol. 1, *Analysis of Experimental Data* (DOE Handbook 3010-94), the respirable release would be less than the TNT equivalent weight of the explosive charge. Analysis results indicate that the radiological impacts of an explosive device in an underground waste tank would be about four times greater than the impacts of the most severe accident scenario that involved the same inventory of radioactive material (seismically induced waste tank dome collapse). The offsite population dose was estimated to be 4.9 person-rem, with no (3×10^{-3}) resulting additional LCFs. The MEI dose would be 0.00083 rem, corresponding to an increased risk of an LCF of 5×10^{-7}. The noninvolved worker dose would be 0.88 rem, corresponding to an increased risk of an LCF of 5×10^{-4}.

3.4.12 Public and Occupational Health and Safety – Transportation

About 63,500 onsite shipments of radioactive waste would occur due to WMA S/SX clean closure activities. The dose to transportation workers from all transportation activities was estimated at about 69 person-rem; the dose to the public would be about 3.8 person-rem. Accordingly, incident-free transportation of radioactive material would result in zero (0.042) LCFs among transportation workers and zero (0.0023) LCFs in the total affected population over the duration of transportation activities.

The estimated total transportation accident risks are a radiation dose risk to the population of about 2.2×10^{-5} person-rem, resulting in 1.3×10^{-8} LCFs, and traffic accidents resulting in zero (0.028) fatalities.

The nonradiological impacts of transporting construction and operational material and radioactive and nonradioactive secondary waste would be 29.4 million kilometers (18.3 million miles) traveled, 6 accidents, and 0 (0.38) fatalities over the entire period from construction through deactivation and closure.

3.4.13 Environmental Justice

Section 3.4.10 discusses short-term impacts on the public as a result of normal operations from clean closure of WMA S/SX. Radiological impacts of normal operations on minority, American Indian, Hispanic, or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model the four population group exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radiologically contaminated produce and animal products.

For purposes of evaluating the potential for disproportionately high and adverse impacts caused by radiological air emissions from normal operations, the total dose to an average individual of

the minority, American Indian, Hispanic, or Latino, and low-income populations is compared to the total dose to an average individual of the remainder of the population. Table 3–57 summarizes the average individual total doses for the life of the project, i.e., clean closure of WMA S/SX. There are no appreciable differences between average individual total doses. Therefore, closure of this WMA would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Table 3-57 Waste Management Area S/SX Clean Closure Average Individual Total Dose from Radioactive Air Emissions over the Life of the Project

	Individual Average Dose (millirem)	
Subset Population	**Subset Population**	**Remainder of Population**
Minority	0.028	0.037
American Indian	0.017	0.033
Hispanic or Latino	0.027	0.036
Low-income	0.028	0.034

Section 3.4.10 discusses radiological impacts on the offsite MEI, who is located at the far side of the Columbia River opposite Hanford. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation were evaluated. As a result of WMA S/SX clean closure, the total dose received by an individual residing at the point of greatest impact along the reservation boundary would be the equivalent of less than approximately one-fifteenth of the total dose received by the MEI from the general population. Therefore, closure of WMA S/SX would not pose disproportionately high and adverse impacts on the American Indian population due to normal operations.

Section 3.4.11 discusses radiological impacts of airborne releases from facility accidents hypothesized as a result of WMA S/SX clean closure. Examination of the risks shows that there would be essentially no LCFs per year for the offsite population, including minority, American Indian, Hispanic, or Latino, and low-income populations. Therefore, clean closure of WMA S/SX would not pose disproportionately high and adverse impacts on the minority, American Indian, Hispanic, or Latino, or low-income populations due to accident consequences.

Air quality impacts resulting from WMA S/SX clean closure are discussed in Section 3.4.4. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; as there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic, or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 3.4.12 discusses the potential human health risks from onsite waste transportation and transporting construction materials from onsite, local, or regional locations to Hanford. The impacts of transporting onsite waste and construction materials to Hanford due to WMA S/SX clean closure would be very small. Therefore, clean closure of this WMA would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

3.4.14 Waste Management

Table 3–58 represents the estimated waste volumes generated as a result of WMA S/SX clean closure activities. These activities would include clean closure of the S and SX tank farms in the 200-East Area following deactivation. Clean closure of the tank farms would encompass removal of highly and moderately contaminated tank and ancillary equipment, all of which would be managed as HLW.

Tank closure waste that is not managed as HLW would be disposed of in the proposed RPPDF, to be located between the 200-East and 200-West Areas. The RPPDF would be similar to the IDF.

Primary Waste

As shown in Table 3–58, the volume of PPF melters generated due to WMA S/SX clean closure would be 568 cubic meters (20,100 cubic feet). A total of 61,100 cubic meters (2.16 million cubic feet) of additional HLW would also be generated and stored on site in shielded boxes.

Secondary Waste

The estimated volume of mixed TRU waste, 72 cubic meters (2,540 cubic feet), as shown in Table 3–58, should not impact existing TRU waste treatment and storage facilities. LLW and MLLW volumes generated by tank closure would be 13,300 cubic meters (469,000 cubic feet) of LLW; 679 cubic meters (24,000 cubic feet) of closure LLW; and 15,300 cubic meters (540,000 cubic feet) of MLLW. LLW and MLLW would be disposed of in an IDF. No long term storage capacity would be needed.

For clean closure of WMA S/SX, and all other WMAs, large quantities of MLLW would be generated by the removal of ancillary equipment and the excavation of contaminated soil from the tank farms. This large quantity of tank closure waste would include approximately 682,000 cubic meters (24.1 million cubic feet) of MLLW. This contaminated soil would be disposed of in the proposed RPPDF. PPF treatment of the soils would generate 464 cubic meters (16,400 cubic feet) of PPF glass. These canisters would be disposed of in an onsite IDF.

A total of 424 cubic meters (15,000 cubic feet) of hazardous waste would be generated during construction, operations, and closure activities required for WMA S/SX clean closure. The estimated volume of nonhazardous waste would be approximately 494,000 cubic meters (17.4 million cubic feet). This waste would be sent for offsite disposal in a local landfill. This additional waste load would have only a minor impact on the handling and accumulation of nonhazardous solid waste at Hanford.

Table 3-58 Waste Management Area S/SX Clean Closure Waste Generation Volumes

Waste Type	Project Phase					Peak Annual Generation		Total Waste Volume to IDF(s)/RPPDF
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Waste Volume/Year	
Primary Waste								
Other high-level radioactive waste	N/A	N/A	N/A	61,100	61,100	2023–2034	2,830	N/A
Preprocessing Facility melters	N/A	N/A	N/A	568	568	Various	123	568 (IDF)
Secondary Waste								
Preprocessing Facility glass	N/A	N/A	N/A	464	464	2035–2056	21	464 (IDF)
Low-level radioactive	N/A	457	239	12,600	13,300	2035–2037	575	13,300 (IDF)
Low-level radioactive (closure)[a]	N/A	N/A	N/A	679	679	2043–2045 2089–2091	113	679 (RPPDF)
Mixed low-level radioactive	N/A	403	388	14,500	15,300	2100	656	15,300 (IDF)
Mixed low-level radioactive (closure)[b]	N/A	N/A	N/A	682,000	682,000	2035–2042	71,500	682,000 (RPPDF)
Transuranic mixed	N/A	72	N/A	N/A	72	2016–2091	14	N/A
Hazardous[c]	79	196	N/A	149	424	2016	38	N/A
Nonradioactive–nonhazardous[d]	N/A	N/A	41	494,000	494,000	2023–2034	19,400	N/A

[a] Closure low-level radioactive waste is the waste from decontamination and decommissioning of the containment structure over the tank farm after soil removal is complete.

[b] Closure mixed low-level radioactive waste includes rubble, soil, and equipment removed during closure of the tank farm.

[c] Hazardous waste is accumulated on site for less than 90 days and then shipped to offsite commercial facilities for treatment and/or disposal.

[d] Nonhazardous solid waste is shipped to offsite commercial facilities for recycling, treatment, and disposal.

Note: All values are in cubic meters. To convert cubic meters to cubic feet, multiply by 35.315. Total may not equal the sum of the contributions due to rounding.

Key: IDF=Integrated Disposal Facility; N/A=not applicable; RPPDF=River Protection Project Disposal Facility.

3.4.15 Industrial Safety

Illness, injury, and death are possible outcomes of any industrial accident. The accepted standard for measuring the outcome of an industrial accident is the number of fatalities and TRCs (the occurrence of illness or injury). A fatal occurrence is a work-related injury or illness that causes the death of the employee. TRCs include work-related illness or injury that results in loss of consciousness, restriction of work or motion, transfer to another job, a requirement for medical treatment beyond first aid, or death.

As ORP has not experienced a fatality during recent history, the DOE and contractor rate (for all labor categories) of 0.26 per 200 million labor hours was adopted as representative of fatal occurrences. The impacts of illness and injury can be calculated using the total project labor hours and the appropriate incident rate. The total labor hours were calculated from the scaled data sets (SAIC 2012). The subtotal for each type of activity (construction, operations, deactivation, and closure) for clean closure of WMA S/SX is presented in Table 3–59.

Table 3-59 Waste Management Area S/SX Clean Closure Industrial Safety Impacts

Labor Category	Million Labor Hours	Total Recordable Case Rate per 200,000 Labor Hours	Projected Total Recordable Cases	Fatality Rate per 200 Million Labor Hours	Projected Fatalities
Construction	22.7	2.0	227.0	0.26	0.0295
Operations	51.1	2.0	511.0	0.26	0.0664
Deactivation	0.40	2.0	4.0	0.26	0.0005
Closure	19.8	2.0	198.0	0.26	0.0257
Total	**94.0**		**940.0**		**0.1222**

Note: Projected fatalities are displayed to four decimal places to show at least one significant digit. All other values presented in the table have been rounded to no more than three significant digits. Totals may not equal the sum of the contributions due to rounding.
Source: Labor hours compiled from the scaled data sets (SAIC 2012).

A total of 94 million labor hours would be required for clean closure of WMA S/SX during all phases, with construction requiring 22.7 million labor hours; operations, 51 million; and closure, almost 20 million. Given the selected TRC rates for illness and injury, 940 TRCs are expected: 227 during the construction phase, 511 during operations, and 198 during closure. No fatalities are expected during any phase of WMA S/SX clean closure activities.

3.4.16 Cost Analysis

The cost estimates, in 2008 dollars, for construction, operations, deactivation, closure, and disposal activities required to clean-close WMA S/SX are provided in Table 3–60.

Table 3-60 Waste Management Area S/SX Clean Closure Summary of Estimated Costs (millions of 2008 dollars)

Construction	Operations	Deactivation	Closure	Disposal	Total
1,088	1,710	38	3,235	1,855	7,926

Note: Estimates are costs to the Hanford Site only.
Source: DOE 2009.

Included in the construction costs are the costs to build or modify the 27 SSTs at the S and SX tank farms to support waste retrieval and the construction of interim storage facilities for HLW debris from the clean closure of the SSTs. Operations costs include ongoing operations of the S and SX Tank Farms, retrieval of tank waste, and operations of Borrow Area C, the onsite pit used to supply sand, soil, and gravel for backfilling the tank farms after the SSTs are removed. Deactivation costs include deactivation of tank waste retrieval equipment and facilities.

Closure costs include the construction and deactivation of confinement structures over the tank farms required during tank removal and contaminated deep soil removal, as well as removal of the 27 SSTs and ancillary equipment within the tank farms and the contaminated deep soils. The removed highly contaminated RSE that would be managed as HLW would be maintained in shielded storage boxes on site on covered concrete storage pads. Closure costs also include the construction, operations, and deactivation of the PPF, a soil-washing facility that would treat highly contaminated (non-HLW) soils. This treatment would result in: 1) washed soils, which would be packaged for onsite disposal in the proposed RPPDF; and 2) contaminated liquid waste streams, which would be treated in the PPF melter, producing a LAW glass that would be disposed of in the IDF.

Disposal costs include the construction, operations, closure, and postclosure care of the IDF and RPPDF that are necessary for the clean closure of the 27 SSTs at the S and SX Tank Farms.

3.5 WASTE MANAGEMENT AREA T

WMA T is composed of the T tank farm and is located in the northwestern portion of the 200-West Area of Hanford (see Figure 3–9). The T tank farm stores HLW that was generated primarily from the chemical processing of irradiated uranium fuel. The tank farm consists of the following:

- SSTs of varying sizes
- Waste transfer lines
- Leak detection systems
- Tank ancillary equipment

The T tank farm consists of twelve 2-million-liter (530,000-gallon) (100-series) and four 208,000-liter (55,000-gallon) (200-series) SSTs constructed between 1943 and 1944 that currently store a total of 7.02 million liters (1.86 million gallons) (*Final TC & WM EIS*, Appendix D, Table D–3) (DOE 2012) of waste that was generated primarily at the T Plant, located about 610 meters (2,000 feet) east of the T tank farm. The T tank farm is one of the original tank farm designs, along with the B, C, and U tank farms. The SSTs are constructed of a steel-reinforced concrete shell that encompasses a steel plate liner. The 100-series tanks are 23 meters (75 feet) in diameter and about 10 meters (33 feet) in height, while the 200-series tanks are 6 meters (20 feet) in diameter and about 8.4 meters (27.5 feet) in height (DOE 1999).

Interbedded gravel, sand, and silt of the Hanford formation were excavated to a depth of about 12 meters (40 feet) during construction of the T tank farm, with the excavated materials used as backfill. Several inches of gravel were placed on top to provide protection and to retard vegetation growth that could bring subsurface contamination up to the ground surface. The T tank farm is located at the bottom of a natural depression that historically tended to catch any

surface runoff and cause water to pond within the T tank farm. The tanks are sited at slightly different elevations, creating a gradient that allows liquids to flow from one tank to another as they are filled. They are arranged in four cascades, each consisting of a three-tank cascade series, with the receiving tank 0.3 meters (1 foot) lower than the feed tank (DOE 1999).

Seven of the 100-series tanks (T-101, T-103, T-106, T-107, T-108, T-109, and T-111) are estimated to have leaked a total volume of 509,000 liters (134,500 gallons) of liquid into the vadose zone sediments. Except for tank T-107, these estimates were based on the observed liquid-level decreases in these tanks. All of the tanks in the T tank farm have been removed from service and are designated as stabilized except for tanks T-104 and T-110, which are both designated as sound tanks. In addition, tanks T-102, T-103, T-105, T-106, T-108, T-109, T-112, and T-201 through T-204 are designated to be in an intrusion prevention status, meaning that they have undergone measures to minimize the potential for addition of liquids to the tanks. Tank T-110 is on the hydrogen (flammable gas) watch list because it is suspected of having a significant potential for hydrogen/flammable gas generation, entrapment, and release. The waste in this tank is monitored for trends of increasing temperature (DOE 1999).

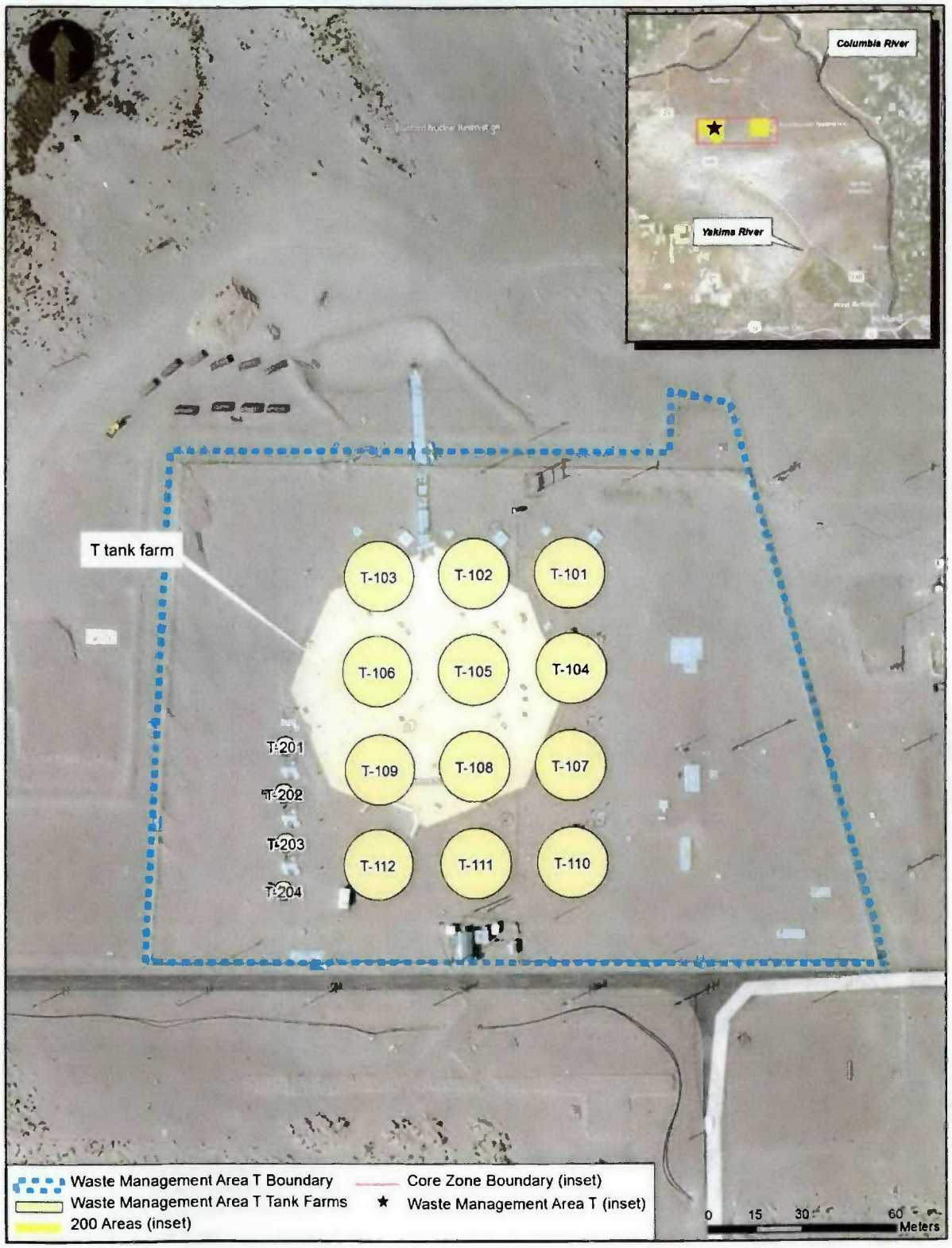


Figure 3-9 General Location of Waste Management Area T

3.5.1 Land Resources

3.5.1.1 Land Use

Clean closure of WMA T would involve land-disturbing activities associated with construction of an underground transfer line, WRF, HLW Debris Storage Facility, PPF, IDF, and the proposed RPPDF. Clean closure activities would also require the extraction of material from Borrow Area C. For most facilities and activities, the acreage requirement was determined by use of a scaling factor that adjusted the total land requirement for closing all Hanford tank farms (as reported in the *Final TC & WM EIS* [DOE 2012]) to a specific value for WMA T. However, this was not done for the WRF and PPF, as the minimum requirement to close a WMA is one facility. Also, it was not necessary to scale the length of the underground transfer line.

WMA T is located in the 200-West Area; however, not all activities associated with its closure would take place in this area. Thus, land would also be disturbed within the 200-East Area (for the IDF), between the 200-East and 200-West Areas (for the HLW Debris Storage Area, PPF, and proposed RPPDF), and within Borrow Area C. Within the 200-West Area, a total of 3.46 hectares (8.54 acres) would be disturbed, all of which is developed. Within the 200-East Area, 1.25 hectares (3.08 acres) would be disturbed, none of which is developed. Development within the area between the 200-East and 200-West Areas would require 49.4 hectares (122 acres), all of which is undeveloped. Disturbance within Borrow Area C would total 43.7 hectares (108 acres), all of which is also undeveloped. Thus, a total of 97.9 hectares (242 acres) would be required for closure of WMA T, of which only 3.46 hectares (8.54 acres) is currently developed.

3.5.1.2 Visual Resources

As noted above, a total of 97.9 hectares (242 acres), most of which is not currently developed, would be required for clean closure of WMA T. Within the 200-East and 200-West Areas, development would have little impact on visual resources, as these areas are already highly industrialized. However, the use of 49.4 hectares (122 acres) between the 200-East and 200-West Areas would impact visual resources, as this land is not developed. The conversion of this land to an industrial use would add to the overall developed nature of the area and would be visible from nearby higher elevations. The viewscape from these higher elevations is important to American Indians with cultural ties to Hanford. Clean closure activities would involve constructing containment structures over the WMA; however, these structures would be removed upon completion of clean closure activities. Although there would be an overall increase in the industrial appearance of the 200 Areas, the BLM Visual Resource Management Class IV rating would not change. Management activities within Class IV areas dominate the view and typically are the focus of viewer attention.

As noted above, 43.7 hectares (108 acres) within Borrow Area C would be excavated for the clean closure of WMA T. Development of Borrow Area C would be readily visible from State Route 240 and Rattlesnake Mountain and would change the BLM visual resource management rating from Class II to Class IV. Management activities within Class II areas may be seen but should not dominate the view. Upon completion of WMA T closure, excavations in Borrow Area C would be recontoured and revegetated, thereby lessening the visual impact.

3.5.2 Infrastructure

The largest total water, diesel fuel, and gasoline requirements due to clean closure of WMA T would occur with operation of the RPPDF, which will be located between the 200-East and 200-West Areas. Deep soil removal from the T Tank Farm would have the largest total electricity requirement. Removal of tanks, ancillary equipment, and soils would also require large amounts of electricity.

Water would be required during construction for soil compaction, dust control, and possibly work surface and equipment washdown. Standard construction practices dictate that, at least initially, construction water would be trucked to construction locations on an as-needed basis for these uses until water supply and wastewater treatment utilities are in place. Concrete and grout would be produced in onsite batch plants, which would require large volumes of water. By comparison, relatively little water would be required to meet the potable and sanitary needs of the construction workforce. During operations, water would be required to support process makeup requirements and facility cooling, as well as the potable and sanitary needs of the operations workforce and other uses. To stabilize and partially decontaminate waste treatment, retrieval, and disposal facilities, water would also be used during facility deactivation activities; however, this requirement would be relatively small compared with those for construction and operational demands and for many closure activities, including construction of surface barriers.

Table 3–61 summarizes the projected utility infrastructure resource requirements for WMA T clean closure.

Table 3-61 Waste Management Area T Clean Closure Summary of Utility Infrastructure Requirements

Activity Phase	Electricity (million megawatt-hours)	Diesel Fuel[a]	Gasoline	Water
		(million liters)		
Peak (Year)	**0.0413 (2038–2039)**	**83.0 (2101)**	**7.82 (2101)**	**398 (2038–2039)**
Construction	0.003	24.3	1.25	131
Operations	0.007	190	6.31	4,280
Deactivation	0.00[b]	0.123	0.159	0.00[b]
Closure	0.333	96.4	8.66	241
Total[c]	**0.344**	**311**	**16.3**	**4,650**

[a] Assumed to be inclusive of all Number 2 diesel fuel, including road diesel and heating fuel oil.

[b] Deactivation values of "0.00" reflect no demand for that utility.

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

Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate. To convert liters to gallons, multiply by 0.26417.

Source: SAIC 2010.

3.5.2.1 Electricity

For clean closure of WMA T, peak annual electrical energy demand would occur from 2089 through 2096. The peak amount would be about 25,000 megawatt-hours and would remain well within the annual capacity of 1.74 million megawatt-hours (based on a peak load capacity of 199 megawatts) of the Hanford electric power transmission system.

3.5.2.2 Fuel

For clean closure of WMA T, peak demands of about 53 million liters (14 million gallons) and about 5 million liters (1.3 million gallons) of gasoline would both occur in 2101. Annualized liquid fuel consumption (diesel fuel and gasoline) would be about 1.68 million liters (0.44 million gallons) during the timespan of clean closure activities for this WMA (2008 through 2202), significantly less than the 4.3 million liters (1.1 million gallons) of liquid fuels currently used annually at Hanford.

3.5.2.3 Water

Peak annual water requirements of about 309 million liters (82 million gallons) would occur during 2098 and 2099. This peak would be well below the annual capacity of the Hanford Export Water System of 18,500 million liters (4,890 million gallons).

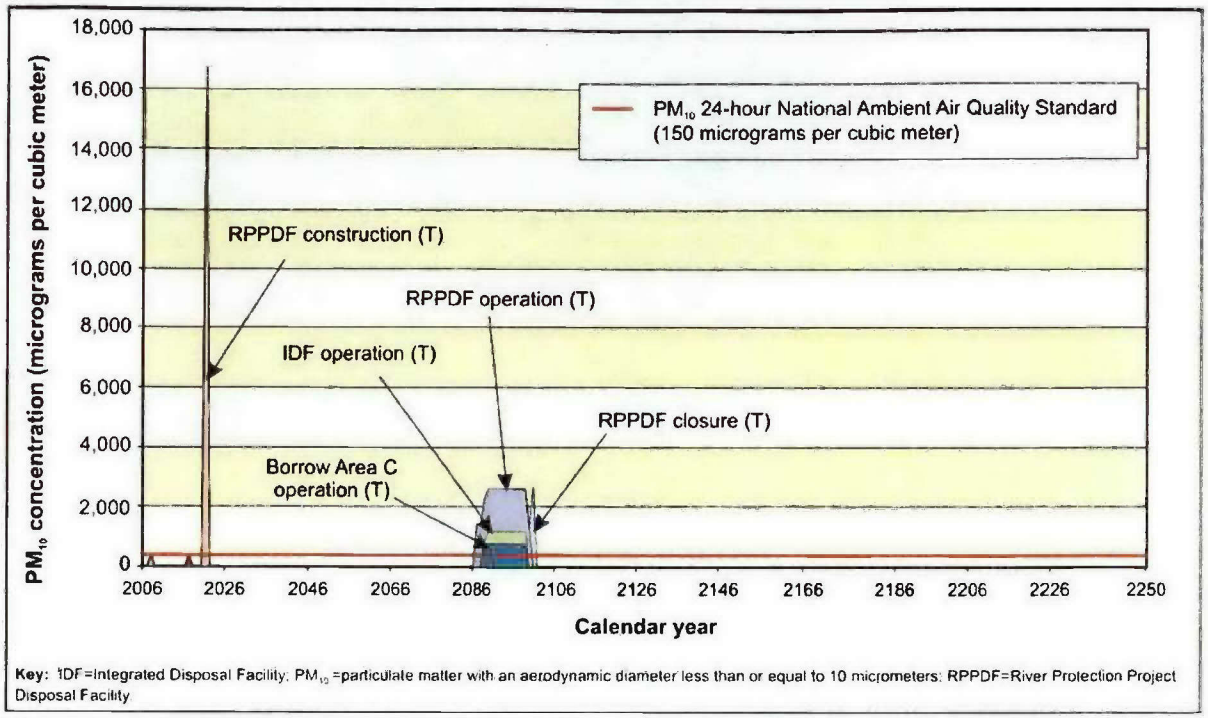
3.5.3 Noise and Vibration

Construction, operation, deactivation, and closure of facilities for clean closure of WMA T would result in minor noise impacts of employee vehicles, trucks, construction equipment and activity, generators, and process equipment. The offsite noise levels from activities at the WTP and 200-East and 200-West Areas would be negligible due to the distance to the Hanford boundary.

Employee and truck traffic to deliver materials for various phases of activities would vary over the duration of the project. The highest number of employee trips is expected to occur in 2038 (SAIC 2012). The increase in the number of employee vehicles and truck trips is expected to cause a minor increase in traffic noise levels along routes to the site. This increase in employee and truck traffic (discussed in Section 3.5.9) was compared with the existing average traffic volume of 30,000 to 40,000 vehicles per day (DOE 2012). For comparison purposes, the increase in traffic noise level can be estimated from the ratio of the projected traffic volume to the existing traffic volume.

3.5.4 Air Quality

Criteria pollutant concentrations that would result from activities for WMA T clean closure are presented in Table 3–62. Peak concentrations of all criteria pollutants except PM would occur in 2101. Peak concentrations of PM would occur in 2021. The peak period concentrations for carbon monoxide, nitrogen dioxide, and sulfur dioxide would result primarily from closure of the proposed RPPDF. Peak period concentrations for PM would result from RPPDF construction. The maximum air quality impacts of PM_{10} emissions would occur to the south at State Route 240. Figure 3–10 shows the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities to these concentrations.



Key: IDF=Integrated Disposal Facility; PM_{10}=particulate matter with an aerodynamic diameter less than or equal to 10 micrometers; RPPDF=River Protection Project Disposal Facility

Figure 3-10 Waste Management Area T Clean Closure PM_{10} Maximum 24-Hour Concentrations

Table 3-62 Waste Management Area T Clean Closure Maximum Incremental Criteria Pollutant Concentrations

Pollutant and Averaging Period	Standard[a]	Maximum Modeled Increment
	(micrograms per cubic meter)	
Carbon Monoxide		
8-hour	10,000[b]	**41,200**
1-hour	40,000[b]	**257,000**
Nitrogen Dioxide		
Annual	100[b]	88.9
1-hour	188	**179,000**
PM_{10}[c]		
Annual	50[d]	**119**
24-hour	150[b]	**16,800**
$PM_{2.5}$		
Annual	15[d]	**119**
24-hour	35[b]	**16,800**
Sulfur Dioxide		
Annual	50[d]	0.176
24-hour	260[d]	24.5
3-hour	1,300[b]	120
1-hour	197[e]	**353**

a The more stringent of the Federal and Washington State standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (40 CFR 50), other than those for ozone, particulate matter, lead, and those based on annual averages, are not to be exceeded more than once per year. The 24-hour PM_{10} standard is attained when the expected number of days with a 24-hour average concentration above the standard is less than or equal to 1. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard. The annual $PM_{2.5}$ standard is met when the 3-year average of the annual means is less than or equal to the standard. The 24-hour $PM_{2.5}$ standard is met when the 3-year average of the 98th percentile 24-hour averages is less than or equal to the standard. The 1-hour nitrogen dioxide standard is met when the 3-year average 98th percentile of the daily maximum 1-hour average does not exceed the standard value.

b Federal and Washington State standard.

c The Federal standards for $PM_{2.5}$ are 15 micrograms per cubic meter annual average and 35 micrograms per cubic meter 24-hour average. No specific data for $PM_{2.5}$ were available, but for analysis purposes, concentrations were assumed to be the same as those of PM_{10}.

d Washington State standard.

e Federal standard.

Note: The National Ambient Air Quality Standards also include standards for lead and ozone. No sources of lead emissions have been identified for the activities evaluated. Washington State also has ambient standards for fluorides. Concentrations in **bold** text indicate potential exceedance of the standard.

Key: PM_n=particulate matter with an aerodynamic diameter less than or equal to *n* micrometers.

Source: Based on emissions data in SAIC 2012.

Maximum concentrations of carcinogenic and noncarcinogenic toxic pollutants are presented in Table 3–63. No impacts on the public due to projected nonradioactive toxic pollutant emissions are expected as a result of WMA T clean closure activities. Hazardous chemical health effects on noninvolved workers are summarized in Tables 3–64 and 3–65.

Table 3-63 Waste Management Area T Clean Closure Maximum Incremental Nonradioactive Toxic Chemical Concentrations

Pollutant	Averaging Period	Acceptable Source Impact Level[a]	Maximum Modeled Increment
		(micrograms per cubic meter)	
Ammonia	24-hour	70.8	20.0
Benzene	Annual	0.0345	0.0323
1,3-Butadiene	Annual	0.00588	0.000842
Formaldehyde	Annual	0.167	0.0278
Mercury	24-hour	0.09	0.00000647
Toluene	24-hour	5,000	31.2
Xylene	24-hour	(b)	9.27

[a] WAC 173-460.
[b] Not listed in WAC 173-460.
Note: To convert cubic meters to cubic feet, multiply by 35.315.
Source: Based on emissions data in SAIC 2012.

Table 3-64 Waste Management Area T Clean Closure Nonradioactive Airborne Toxic Chemical Hazard Index for the Nearest Noninvolved Worker

Chemical	Hazard Quotient
Ammonia	1.14×10^{-1}
Mercury	2.76×10^{-5}
Toluene	1.89×10^{-3}
Xylene	2.85×10^{-2}
Hazard Index	1.44×10^{-1}

Source: Based on emissions data in SAIC 2012.

Table 3-65 Waste Management Area T Clean Closure Nonradioactive Airborne Toxic Chemical Cancer Risk for the Nearest Noninvolved Worker

Chemical	Cancer Risk
Benzene	1.20×10^{-5}
1,3-Butadiene	1.30×10^{-6}
Formaldehyde	1.83×10^{-5}

Source: Based on emissions data in SAIC 2012.

3.5.5 Geology and Soils

Consumption of geologic resources (rock, minerals, and soils) to support facility construction, operations, and deactivation, as applicable, would constitute the major indirect impact on geologic and soil resources from implementation of clean closure of WMA T and associated waste management activities, as summarized in Table 3–66. Varying quantities of geologic resources would be required for ongoing facility construction; upgrades to existing facilities, including the 200 Area tank farms; waste retrieval activities; and, most substantially, tank farm closure. Geologic resources, including relatively large volumes of gravel, sand, and silt, are available from the suprabasalt sediments and associated soils at Hanford. Rock, in the form of basalt, is also plentiful. As discussed in the *Environmental Assessment, Use of Existing Borrow*

Areas, Hanford Site, Richland, Washington (DOE 2001a), a number of active gravel and sand pits and two rock quarries at Hanford have been identified for use in providing a continual supply of borrow materials for new facility construction, maintenance of existing facilities, and fill and capping material for remediation and other activities. Of the two active quarries on the site, quarry No. 2 (Borrow Area C), located due south of the 200-West Area just south of State Route 240, has large volumes of basalt and sand (DOE 2001a). This approximately 926.3-hectare (2,289-acre) borrow area has been designated as a source of materials such as rock riprap (basalt), aggregate (gravel and sand), and soil (silt and loam) that would be needed to support tank farm closure and supporting activities (DOE 2003a).

Table 3-66 Waste Management Area T Clean Closure Major Geologic and Soil Resource Impact Indicators and Requirements

Construction Materials				Other Borrow Materials[a]				Closure-Specific Materials		
Concrete/ Grout	Cement[b]	Sand[b]	Gravel[b]	Rock/Basalt	Sand	Gravel	Soil (Specification Backfill)	Grout[c]	Cement	Sand[d]
119,000	23,600	57,500	48,000	0	547,000	277,000	9,100,000	2,160	260	1,050

[a] Resources for miscellaneous uses not exclusively tied to facility construction, operations, or closure, such as site grading and backfill for operations.

[b] Cement, sand, and gravel are components of concrete.

[c] Grout is composed of cement, sand, fly ash, and other materials.

[d] Principal component of grout that would be obtained from onsite deposits.

Note: Values have been rounded to no more than three significant figures. All values are expressed in cubic meters. To convert cubic meters to cubic feet, multiply by 35.315.

3.5.6 Water Resources

All construction and closure-related land disturbances, especially for new facility construction, would expose soils and sediments to possible erosion by infrequent, heavy rainfall or by wind. While unlikely to reach surface-water features, stormwater runoff from exposed areas could convey soil, sediments, and other pollutants (e.g., construction waste materials and spilled materials, such as petroleum, oils, and lubricants from construction equipment) from construction footprint and laydown areas. Nevertheless, appropriate soil erosion and sediment control measures, as well as spill prevention and waste management practices, would be employed to minimize suspended sediment, the transport of other deleterious materials, and any potential water-quality impacts. Further, all construction and other ground-disturbing activities would be conducted in accordance with current NPDES and state waste discharge general permits for stormwater discharges associated with construction activities, issued by Ecology. The NPDES permit specifically requires the development and implementation of a stormwater pollution prevention plan.

Once completed, new facilities required for clean closure of WMA T would incorporate appropriate stormwater management controls to collect, convey, and detain stormwater from buildings and other impervious surfaces so as to minimize the impacts of onsite hydrology and soil erosion. Hanford's NPDES Storm Water Multi-Sector General Permit would cover stormwater discharges associated with industrial activity and, as necessary, stormwater discharges would be covered under state waste discharge permits for discharges to the ground.

Under normal operations associated with WMA closure, facility design combined with adherence to spill prevention and emergency response plans and procedures would help to ensure that involved hazardous substances, including spills, should they occur, do not reach soils or surfaces where they could be conveyed to surface water or groundwater. For construction, operations, deactivation, and closure activities, adherence to best management practices and other preventive measures under applicable permits and compliance plans would be coordinated by DOE with those measures in similar sitewide pollution prevention plans.

There would be no direct discharge of effluents to either surface water or groundwater during construction, operations, and deactivation as a result of WMA T clean closure. Nonhazardous sanitary wastewater (sewage) would be managed via appropriate sanitary wastewater collection and treatment systems. During the early phases of new facility construction, it was assumed that portable toilet facilities would be provided for construction personnel, with collected waste disposed of at offsite contractor facilities, as is standard construction practice. During facility operations and deactivation, sanitary wastewater would be disposed of via the dedicated sanitary sewer or septic/drain-field system serving a particular facility.

Water would be required to support new facility construction, facility operations, and facility deactivation for WMA T clean closure. Water would be required for WRF construction; replacement of underground transfer lines; and construction of tank upgrades, a new riser, an MRS, a VBR system, the PPF, IDF-East, and the proposed RPPDF that will be located between the 200-East and 200-West Areas. Total water demands have been conservatively estimated at 4,650 million liters (1,230 million gallons), with a peak demand of 308 million liters (81 million gallons). Peak periods of water demands would occur during the years of operation of both Borrow Area C and the RPPDF. All utility demands, as well as water demands, are discussed in Section 3.5.2, Infrastructure.

3.5.7 Ecological Resources

3.5.7.1 Terrestrial Resources

As noted in Section 3.5.1.1, a total of 54.2 hectares (134 acres) within the 200-East Area, 200-West Area, and between the 200-East and 200-West Areas would be disturbed by construction of the facilities required to clean-close WMA T. Of this total, 1.25 hectares (3.08 acres) would be developed within the 200-East Area, 3.46 hectares (8.54 acres) within the 200-West Area, and 49.4 hectares (122 acres) between the 200-East and 200West Areas. Within the 200-East Area and between the 200-East and 200-West Areas, all of the land needed for construction is undeveloped sagebrush habitat, whereas within the 200-West Area, all of the land needed for construction has been previously disturbed. Late successional sagebrush habitat is considered a Level III resource under the *Hanford Site Biological Resources Management Plan* (DOE 2001b:4.11). Hanford guidance may require the replacement of sagebrush habitat at a ratio ranging from 1:1 to 3:1 (DOE 2003b:20, 21, 31). Specific measures to mitigate the loss of sagebrush habitat would be set forth in a mitigation action plan prior to construction.

The clean closure of WMA T would require that 43.7 hectares (108 acres) of Borrow Area C be excavated to supply needed geologic material. The two major plant communities present within the area are cheatgrass-bluegrass (782 hectares [1,933 acres]) and needle-and-thread grass/Indian ricegrass (107 hectares [265 acres]) (DOE 2012). The latter represents an unusual and relatively

pristine community type at Hanford; thus, it is considered a more highly valued community than the former. It is not possible to determine specific impacts of excavating Borrow Area C on ecological resources because the particular portion of the site from which geologic material would be excavated is unknown. To the extent that it is possible, the needle-and-thread grass/Indian ricegrass community should be avoided during excavation. A mitigation action plan would be developed prior to excavation.

3.5.7.2 Threatened and Endangered Species

Federally or state-listed threatened or endangered species have not been observed within, or in the immediate vicinity of, the 200 Areas or Borrow Area C; therefore, impacts on this group of plants and animals are not expected as a result of WMA T clean closure. Both the Columbia and Yakima Rivers adjacent to Hanford have been designated as critical habitat for the bull trout. However, as there would be no short-term impacts on either river from construction or operation of new facilities associated with clean closure of WMA T, designated critical habitat would not be adversely affected.

A number of state-listed, special status species observed within areas that would be disturbed by clean closure of WMA T could be impacted by construction of the various required facilities. One state-listed species, the sage sparrow (state candidate), was observed within IDF-East. In addition, the loggerhead shrike (Federal species of concern and state candidate), black-tailed jackrabbit (state candidate), sage sparrow, and crouching milkvetch (state watch) have all been observed between the 200-East and 200-West Areas where the HLW Debris Storage Facility, PPF, and the proposed RPPDF would be located. Finally, surveys have identified Piper's daisy (state sensitive), stalked-pod milkvetch (state watch), crouching milkvetch, and the long-billed curlew (state monitor) within the boundaries of Borrow Area C. No state-listed, special status species have been observed within areas to be disturbed within the 200-West Area. The operation of new facilities is not expected to impact any listed species.

Although mitigation would not be required for the state monitor and watch species, they should be considered during project planning. Impacts on state candidate and sensitive species, which are considered Level III resources under the *Hanford Site Biological Resources Management Plan*, require mitigation where impacts would occur. When avoidance and minimization are not possible or are insufficient, mitigation via rectification or compensation is recommended (DOE 2001b:4.9, 8.11). A comprehensive mitigation action plan, which would deal with the loss of state-listed species (as well as sagebrush habitat), would be developed prior to construction.

3.5.8 Cultural and Paleontological Resources

3.5.8.1 Prehistoric Resources

As noted in Section 3.5.1.1, clean closure of WMA T would require a total of 97.9 hectares (242 acres), of which 3.46 hectares (8.54 acres), located in the 200-West Area, is currently developed. Land disturbance due to clean closure of WMA T would involve the 200-East and 200-West Areas, land between the 200-East and 200-West Areas, and Borrow Area C. White Bluffs Road, an important archaeological resource, is located in the southwest and northeast parts of the 200-West Area. Other prehistoric finds were discovered in the northwestern portion of the 200-West Area and immediately east of the 200-East Area. There are no known

prehistoric resources within the areas that would be affected by the clean closure of WMA T. The survey and geology of these areas indicate that subsurface cultural deposits have little or no potential of being present. The *Hanford Cultural Resources Management Plan* (DOE 2003c) provides guidance for identifying, evaluating, recording, curating, and managing cultural resources. If any prehistoric resources were discovered during construction or excavation, procedures from the *Hanford Cultural Resources Management Plan* would be implemented.

3.5.8.2 Historic Resources

There would be no impacts on White Bluffs Road or on other known early historic artifacts within the 200-East or 200-West Area from construction or excavation required for clean closure of WMA T. In addition to White Bluffs Road in the 200-West Area, historic resources have been found in the south-central part of the 200-East Area. Buildings associated with the Manhattan Project and Cold War era are found within both the 200-East and 200-West Areas; however, none of these structures would be affected. As is the case for prehistoric resources, if historic resources were discovered, procedures in place to properly identify, evaluate, record, curate, and manage the discovery site would be implemented.

3.5.8.3 American Indian Interests

As stated above, there are no known prehistoric resources that may be an American Indian interest within the affected areas required for the clean closure of WMA T. Clean closure of WMA T would impact 49.4 hectares (122 acres) of undeveloped land between the 200-East and 200-West Areas. The conversion of his land to industrial use would be noticeably visible from nearby higher elevations, such as Gable Mountain and Gable Butte. The viewscape from these higher elevations is important to American Indians with cultural ties to Hanford. There would be little impact on the viewscape within the 200-East and 200-West Areas, as the areas are already highly industrialized.

Clean closure of WMA T would also require excavation of 43.7 hectares (108 acres) within Borrow Area C. This would also have an impact on the viewscape from Rattlesnake Mountain; however, upon completion of the work, excavations of Borrow Area C would be recontoured and revegetated, thus lessening the visual impact. Appropriate mitigation measures would be developed in consultation with area tribes.

3.5.8.4 Paleontological Resources

No paleontological resources have been discovered within the 200 Areas or Borrow Area C; therefore, clean closure of WMA T would not impact such resources. However, if any paleontological resources were found during construction or excavation, procedures to properly manage the discovery site would be implemented.

3.5.9 Socioeconomics

3.5.9.1 Regional Economic Characteristics

A workforce of 1,850 FTEs in 2038, as shown in Table 3–67, would be required for construction and operation activities and would be preceded by a construction activity spike (1,290 FTEs) in 2022. The peak estimate is approximately 0.8 percent of the projected labor force in the ROI

(232,000 in 2038), compared with 10 percent in 2006. The existence of these direct jobs is expected to result in the creation of another 1,380 indirect positions in the ROI during the peak year. An additional estimated spike (1,610 FTEs) in the workforce in 2101 would be dominated by closure activities at the RPPDF. A small workforce (five FTEs)would be needed for postclosure care of the site beginning in 2103. Implementing WMA T clean closure activities could alter the economic characteristics of the region by increasing demands for goods and services in the Tri-Cities area due to increases in expenditures, income, and employment, both direct and indirect, at Hanford.

Table 3-67 Waste Management Area T Clean Closure Workforce Estimates

Work Activity	Peak Year(s)	Workforce Peak (FTEs)
Construction	2032–2034	1,270
Operations	2038	1,850
Deactivation	2042	41
Closure	2101	1,610
Total Onsite Workforce	**2038**	**1,850**

Key: FTE=full-time equivalent.

3.5.9.2 Demographic Characteristics

While clean closure of WMA T would draw some workers from the local labor force, the demand for construction and operations workers could draw from outside the region. The in-migrations of new workers and their families would increase the overall population within the Tri-Cities area and could alter the demographic characteristics of the region.

3.5.9.3 Housing and Community Services

Implementing clean closure of WMA T would increase the demand for housing and would impact schools and other community services within the Hanford ROI. The demand for housing by construction and operations workers would impact the cost and availability of houses and rental units. School enrollments would increase, and utilities and police and fire services may need to be expanded.

After the early peak employment period (2022), a sharp drop in onsite employment might occur. This drop could also reduce the number of indirect jobs in the region supporting Hanford activities. If these workers are unable to find employment in other industries, they could move out of the region, thereby reducing the overall regional population and decreasing the demand for housing and community services.

3.5.9.4 Local Transportation

Implementation of WMA T clean closure is expected to have an impact on the local transportation system, especially during the commute periods. The projected increase in commuter traffic to the site would be due primarily to construction and operations activities, peaking at an annual 1,850 FTEs in 2038. This could represent up to 1,480 passenger vehicles per day during the peak year. It is expected that this commuter traffic would impact the regionally established LOS, reducing it below the minimum acceptable ("D") LOS.

The number of annual truck trips would peak in 2101 during construction of the RCRA Subtitle C barrier. During this construction, offsite trips would peak at 7,130 trips per year (approximately 27 truck trips per day). At the same time, the onsite truck activity would peak at 145,000 truck trips per year (approximately 559 trips per day). Additional onsite truck activity would occur during construction and operation of the RPPDF. After 2102, there would be less than 1 truck trip on or off site each day.

3.5.10 Public and Occupational Health and Safety – Normal Operations

Activities to clean-close the T Tank Farm could result in radiological exposures to the public and workers. Radiological impacts are presented for three public receptors: the general population (approximately 560,000)[10] living within 80 kilometers (50 miles) of the Hanford 200 Areas, an MEI living near Hanford, and an onsite MEI. Impacts on the general population are evaluated for a residential scenario whereby people are exposed to radioactive materials emitted from project facilities. Radiological exposure occurs through inhalation, direct exposure to the radioactive plume and material deposited on the ground, and ingestion of contaminated products from animals raised locally and fruits and vegetables grown in a family garden (DOE 1995). The MEI is a hypothetical individual member of the public located at a position near the site boundary who would experience the highest impacts during normal operations. The MEI was determined to be a receptor on the east side of the Columbia River. Impacts on the offsite MEI are evaluated for a scenario that includes the same exposure pathways assumed for the general population, but with an increased amount of time spent outdoors and a higher rate of contaminated food consumption. Impacts on the onsite MEI, identified as a member of the public who works at the Columbia Generating Station, LIGO, or U.S. Ecology, would be from inhalation and exposure to the plume and material deposited on the ground. Doses are presented as total effective doses. Details of the assessment methodology for determining radiological exposure of workers and members of the public are presented in Appendix K of the *Final TC & WM EIS* (DOE 2012).

The radiological impacts on members of the public are presented in terms of impacts over the life of the project, that is WMA T clean closure (the operational life of the project during which radioactive air emissions would occur), and peak annual impacts. Impacts over the life of the project are the total estimated radiation doses that would be incurred by members of the public over the duration of the activities to complete clean closure of the WMA. The peak annual impacts are the estimated annual radiation doses that would be incurred by members of the public during the year(s) of largest radiation dose.

In addition to members of the public, workers directly involved in the activities to clean-close the WMA and nearby noninvolved workers may receive radiation doses. Doses to an involved worker are calculated based on an FTE employee. It was assumed for the purposes of this dose evaluation that an FTE involved worker has a 2,080-hour work year. In practice, the number of workers who could receive a radiation dose may be larger than the number of FTEs assumed in this analysis, resulting in a smaller average dose per worker. A noninvolved worker is a person

[10] The approximate population is based on populations of 542,324; 546,746; and 589,668 people residing within 80 kilometers (50 miles) of the Waste Treatment and Immobilization Plant, 200-East Area, and 200-West Area, respectively, as described in the *Final TC & WM EIS* (DOE 2012).

working at the site who is incidentally exposed due to the radioactive air emissions associated with tank farm management, tank waste retrieval, and clean closure activities. The potential dose to a noninvolved worker would result from exposure to, and inhalation of, radioactive contaminants released to the atmosphere from tank farm management, tank waste retrieval, and clean closure activities. In the 200-East Area, the noninvolved worker was assumed to be at the 242-A Evaporator, 1,090 meters (3,580 feet) north-northwest of the 200-East Area source. In the 200-West Area, the noninvolved worker was assumed to be at the ERDF, about 950 meters (3,120 feet) east of the 200-West Area source.

The impacts of radionuclide releases from construction, operations, deactivation, and cleanup of facilities directly related to tank farm management, tank waste retrieval, and clean closure of WMA T were evaluated.

3.5.10.1 Radiological Impacts on the Public

Table 3–68 presents estimated doses to the general population and the MEI for clean closure activities associated with WMA T. Activities conducted at WMA T that would generate radioactive air emissions would occur from 2016 through 2100. Due to the long timeframe involved, the doses over the life of the project may not be received by the same members of the population or the same MEI, but are presented as a measure of potential impacts to provide a basis for comparison with other WMAs.

Table 3-68 Waste Management Area T Clean Closure Public Health Impacts of Atmospheric Radionuclide Releases

Receptor	Facility	Impacts over Life of Project[a]		Peak Annual Impacts		
General population		Dose (person-rem)	Number of Latent Cancer Fatalities[b]	Year of Maximum Impact	Dose (person-rem per year)	Number of Latent Cancer Fatalities[b]
	200-East Area	5.4			0.38	
	200-West Area	6.2			0.41	
	Total	**12**	**0 (7×10^{-3})**	**2086**	**0.80**	**0 (5×10^{-4})**
Maximally exposed individual		Dose[c] (millirem)	Lifetime Risk of a Latent Cancer Fatality[d]	Year of Maximum Impact	Dose (millirem per year)	Lifetime Risk of a Latent Cancer Fatality[d]
	200-East Area	0.71			0.050	
	200-West Area	0.46			0.031	
	Total	**1.2**	**7×10^{-7}**	**2086**	**0.081**	**5×10^{-8}**
Onsite MEI	**Total**	**0.52**	**3×10^{-7}**	**2086**	**0.035**	**2×10^{-8}**

a Impacts accrued over the operational life of the project to clean-close Waste Management Area T.

b The reported value is the projected number of latent cancer fatalities (LCF) among the population and is therefore presented as a whole number. The result, calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem), is shown in parentheses.

c Impacts are provided for assessment purposes. The life-of-project dose likely overestimates the dose that would be received by one individual person because the project could span approximately 88 years.

d Probability of an LCF in the MEI is calculated by converting the dose in millirem to rem (divide by 1,000), then multiplying the dose by the risk factor of 0.0006 LCFs per rem.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: MEI=maximally exposed individual.

Over the life of the project, the population within 80 kilometers (50 miles) of the 200 Areas would receive a cumulative dose of 12 person-rem, and the MEI would receive a cumulative dose of 1.2 millirem. Given the risk factor of 0.0006 LCFs per rem (DOE 2003d), no LCFs are expected in the general population as a result of these activities. There would be a probability of 7×10^{-7} (1 chance in 1.4 million) of the MEI developing an LCF, assuming the same MEI was exposed over the life of the project. Radioactive air emissions would result in a maximum annual population dose of 0.80 person-rem and a maximum annual MEI dose of 0.081 millirem. The primary contributor to offsite doses would be fission products from processing contaminated tank farm soils through the PPF.

An onsite MEI who spends a normal workday at U.S. Ecology would receive a maximum annual dose of 0.035 millirem. The increased risk of an LCF from this dose would be 2×10^{-8} (1 chance in 50 million).

3.5.10.2 Radiological Impacts on Workers

Table 3–69 presents dose and risk estimates for an involved FTE worker and a noninvolved FTE worker. The average annual FTE radiation worker dose would be 760 millirem, higher than the Administrative Control Level of 500 millirem. A radiation worker who received the average annual dose over the course of 40 years would receive a dose of 30,000 millirem, corresponding to a risk of 2×10^{-2} (1 chance in 50) of developing an LCF.

Table 3-69 Waste Management Area T Clean Closure Normal Operations Radiological Impacts on Workers

Receptor	Dose	Latent Cancer Fatality Risk[a]
Average Involved Full-Time-Equivalent Worker		
Average annual impact	760 millirem	5×10^{-4}
Impact over life of project[b]	30,000 millirem	2×10^{-2}
Life-of-Project Worker Population	4,400 person-rem	3
Noninvolved Worker (Year of Maximum Impact)		
At the 242-A Evaporator (2035)	0.093 millirem	6×10^{-8}
At the Environmental Restoration Disposal Facility (2035)	0.30 millirem	2×10^{-7}

[a] For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

[b] Impact over the life of the project is the average dose a full-time-equivalent radiation worker would receive working on this project. It is determined by multiplying the average annual dose by an assumed career length of 40 years.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

The total effective dose to the involved worker population from the 85 years of occupational exposure was estimated to be 4,400 person-rem. Given the risk factor of 0.0006 LCFs per person-rem, three LCFs are expected to result from the dose associated with tank farm operations, tank waste retrieval, and clean closure of WMA T. Worker doses should be viewed in the context of the duration of the project and the DOE administrative controls employed that limit them. Due to the number of years required to complete clean closure, the dose over the life of the project would be distributed over multiple generations of workers. In addition, worker

dose would be limited to less than 5 rem total effective dose per year (10 CFR 835). This regulatory limit would be further constrained by the application of administrative controls. DOE Standard 1098-2008, *Radiological Control*, recommends that the annual dose not exceed 2 rem, unless explicitly authorized by DOE management (e.g., for emergency situations). Individual worker doses would be maintained ALARA and generally be controlled at a level below 500 millirem (0.5 rem) per year.

Estimated doses and risks to the noninvolved workers at the 242-A Evaporator or the ERDF in the year of maximum impact are shown in Table 3–69. Doses to noninvolved workers would be a small fraction of the DOE recommended Administrative Control Level of 500 millirem per year.

3.5.11 Public and Occupational Health and Safety – Facility Accidents

This section addresses potential impacts on workers and the public associated with tank-farm-related accidents. Radiological impacts of the postulated accident scenarios were quantified for an MEI living near Hanford, the offsite population living within 80 kilometers (50 miles) of the facility, and a noninvolved worker assumed to be 100 meters (110 yards) from the facility. Hazardous chemical impacts were also evaluated. For an involved worker, accident consequences were not quantified. While involved workers are expected to be near the Hanford tank farms during routine tank farm operations, their number and location relative to a postulated accident are unknown. In the event of an accident involving chemicals or radioactive materials, workers near an accident could be at risk of serious injury or fatality. Safety procedures, safety equipment, and protective barriers are typical features that would prevent or minimize worker impacts. Additionally, following initiation of accident/site emergency alarms, workers in adjacent areas would evacuate in accordance with the technical area and facility emergency operating procedures and training. Therefore, involved worker impacts are not discussed further.

There would be no radiological accidents associated with facility construction. Further, any hazardous chemical accidents associated with facility construction would be typical of those normally associated with industrial construction materials, hazards, and practices. Projected operational accident consequences are presented in the following sections. Details of the methodology for assessing the potential impacts on workers and the public associated with postulated accidents are presented in Appendix K, Section K.3, of the *Final TC & WM EIS* (DOE 2012).

3.5.11.1 Radiological Impacts of Airborne Releases

During tank farm operations, tank waste retrieval, or clean closure activities, reasonably foreseeable accidents that could occur include: 1) hydrogen burn in a waste storage tank; and 2) tank dome collapse. The accident selected to represent a severe accident is the seismically induced waste tank dome collapse. The consequences of a seismically induced waste tank dome collapse, if it were to occur, are shown in Table 3–70. The annual risks of LCFs for this accident, which were obtained by multiplying the consequences by the likelihood (frequency per year) that the accident would occur, are shown in Table 3–71.

Table 3-70 Waste Management Area T Clean Closure Radiological Consequences of Accidents

Accident	Maximally Exposed Individual		Offsite Population[a]		Noninvolved Worker	
	Dose (rem)	LCF[b]	Dose (person-rem)	LCF[c]	Dose (rem)	LCF[b]
Seismically induced waste tank dome collapse – unmitigated	0.00021	1×10^{-7}	1.3	0 (8×10^{-4})	0.22	1×10^{-4}

a Based on a population of 589,668 persons residing within 80 kilometers (50 miles) of the 200-West Area.

b Increased likelihood of latent cancer fatality for an individual, assuming the accident occurs.

c The reported value is the projected number of latent cancer fatalities (LCF) among the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

Key: LCF=latent cancer fatality.

Table 3-71 Waste Management Area T Clean Closure Annual Cancer Risks from Accidents

Accident	Frequency (per year)	Risk of Latent Cancer Fatality		
		Maximally Exposed Individual[a]	Offsite Population[b, c]	Noninvolved Worker[a]
Seismically induced waste tank dome collapse – unmitigated	5×10^{-4}	6×10^{-11}	4×10^{-7}	7×10^{-8}

a Increased risk of a latent cancer fatality to the individual, taking into account the probability (frequency) of the accident.

b Based on a population of 589,668 persons residing within 80 kilometers (50 miles) of the 200-West Area.

c The reported value is the projected number of latent cancer fatalities (LCF) among the population, based on the probability (frequency) of the accident occurring, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

3.5.11.2 Hazardous Chemical Impacts

Various hazardous chemicals exist in the waste tanks. Because the chemicals that exist in the tank waste are mixed with the radioactive material, any accident event is expected to release both hazardous chemicals and radioactive materials. Due to the quantity and nature of the radioactive material in the waste tanks, the human health consequences of an accidental release would be dominated by the impacts of the radioactive components. Therefore, hazardous chemical human health impacts were not analyzed separately.

3.5.11.3 Intentional Destructive Acts

This section addresses potential impacts of intentional destructive acts at a tank farm. To protect against such actions, safeguards and security measures are employed at all DOE facilities. In accordance with DOE Orders, DOE conducts vulnerability assessments and risk analyses of facilities and equipment under its jurisdiction to evaluate the physical protection elements, technologies, and administrative controls needed to protect DOE assets. DOE also protects against espionage, sabotage, and theft of radioactive, chemical, or biological materials; classified information and matter; nonnuclear weapon components; and critical technologies. Before startup of any new or substantially modified operations, DOE would conduct an in-depth, site-specific safeguards and security inspection to ensure that existing programs satisfy DOE requirements. Any inadequacies would be resolved before startup of operations. Release scenarios and impacts resulting from intentional destructive acts may be similar to the accident

scenarios analyzed. Additional scenarios representing intentional destructive acts that may not be represented by the accident analyses were also considered.

Explosive Device in Underground Waste Tank. It was postulated that intentionally initiated explosions occur that displace a large portion of the soil overburden, breach the tank dome, and disperse a portion of the tank waste into the atmosphere. In accordance with the recommendation from *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, Vol. 1, *Analysis of Experimental Data* (DOE Handbook 3010-94), the respirable release would be less than the TNT equivalent weight of the explosive charge. Analysis results indicate that the radiological impacts of an explosive device in an underground waste tank would be about four times greater than the impacts of the most severe accident scenario that involved the same inventory of radioactive material (seismically induced waste tank dome collapse). The offsite population dose was estimated to be 4.9 person-rem, with no (3×10^{-3}) resulting additional LCFs. The MEI dose would be 0.00083 rem, corresponding to an increased risk of an LCF of 5×10^{-7}. The noninvolved worker dose would be 0.88 rem, corresponding to an increased risk of an LCF of 5×10^{-4}.

3.5.12 Public and Occupational Health and Safety – Transportation

About 39,400 onsite shipments of radioactive waste would occur due to WMA T clean closure activities. The dose to transportation workers from all transportation activities was estimated at about 43 person-rem; the dose to the public would be about 2.4 person-rem. Accordingly, incident-free transportation of radioactive material would result in zero (0.026) LCFs among transportation workers and zero (0.0014) LCFs in the total affected population over the duration of transportation activities.

The estimated total transportation accident risks are a radiation dose risk to the population of about 1.3×10^{-5} person-rem, resulting in 7.8×10^{-9} LCFs, and traffic accidents resulting in zero (0.017) fatalities.

The nonradiological impacts of transporting construction and operational material and radioactive and nonradioactive secondary waste would be 18.2 million kilometers (11.3 million miles) traveled, 4 accidents, and 0 (0.24) fatalities over the entire period from construction through deactivation and closure.

3.5.13 Environmental Justice

Section 3.5.10 discusses short-term impacts on the public as a result of normal operations from clean closure of WMA T. Radiological impacts of normal operations on minority, American Indian, Hispanic, or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model the four population group exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radiologically contaminated produce and animal products.

For purposes of evaluating the potential for disproportionately high and adverse impacts caused by radiological air emissions from normal operations, the total dose to an average individual of

the minority, American Indian, Hispanic, or Latino, and low-income populations is compared to the total dose to an average individual of the remainder of the population. Table 3–72 summarizes the average individual total doses for the life of the project, i.e., clean closure of WMA T. There are no appreciable differences between average individual total doses. Therefore, closure of this WMA would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Table 3-72 Waste Management Area T Clean Closure Average Individual Total Dose from Radioactive Air Emissions over the Life of the Project

Subset Population	Individual Average Dose (millirem)	
	Subset Population	Remainder of Population
Minority	0.017	0.023
American Indian	0.011	0.020
Hispanic or Latino	0.017	0.023
Low-income	0.017	0.021

Section 3.5.10 discusses radiological impacts on the offsite MEI, who is located at the far side of the Columbia River opposite Hanford. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation were evaluated. As a result of WMA T clean closure, the total dose received by an individual residing at the point of greatest impact along the reservation boundary would be the equivalent of less than approximately one-fifteenth of the total dose received by the MEI from the general population. Therefore, closure of WMA T would not pose disproportionately high and adverse impacts on the American Indian population due to normal operations.

Section 3.5.11 discusses radiological impacts of airborne releases from facility accidents hypothesized as a result of WMA T clean closure. Examination of the risks shows that there would be essentially no LCFs per year for the offsite population, including minority, American Indian, Hispanic, or Latino, and low-income populations. Therefore, clean closure of WMA T would not pose disproportionately high and adverse impacts on the minority, American Indian, Hispanic, or Latino, or low-income populations due to accident consequences.

Air quality impacts resulting from WMA T clean closure are discussed in Section 3.5.4. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; as there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic, or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 3.5.12 discusses the potential human health risks from onsite waste transportation and transporting construction materials from onsite, local, or regional locations to Hanford. The impacts of transporting onsite waste and construction materials to Hanford due to WMA T clean closure would be very small. Therefore, clean closure of this WMA would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

3.5.14 Waste Management

Table 3–73 represents the estimated waste volumes generated as a result of WMA T clean closure activities. These activities would include clean closure of the T tank farm in the 200-East area following deactivation. Clean closure of the tank farm would encompass removal of highly and moderately contaminated tank and ancillary equipment, all of which would be managed as HLW.

Tank closure waste that is not managed as HLW would be disposed of in the proposed RPPDF, to be located between the 200-East and 200-West Areas. The RPPDF would be similar to the IDF.

Primary Waste

As shown in Table 3–73, the volume of PPF melters generated due to WMA T clean closure would be 568 cubic meters (20,100 cubic feet). A total of 36,200 cubic meters (1.28 million cubic feet) of additional HLW would also be generated and stored on site in shielded boxes.

Secondary Waste

The estimated volume of mixed TRU waste, 45 cubic meters (1,600 cubic feet), as shown in Table 3–73, should not impact existing TRU waste treatment and storage facilities. LLW and MLLW volumes generated by tank closure would be 8,280 cubic meters (292,000 cubic feet) of LLW; 339 cubic meters (12,000 cubic feet) of closure LLW; and 9,040 cubic meters (319,000 cubic feet) of MLLW. LLW and MLLW would be disposed of in an IDF. No long-term storage capacity would be needed.

For clean closure of WMA T, and all other WMAs, large quantities of MLLW would be generated by the removal of ancillary equipment and the excavation of contaminated soil from the tank farms. This large quantity of tank closure waste would include approximately 428,000 cubic meters (15.1 million cubic feet) of MLLW. This contaminated soil would be disposed of in the proposed RPPDF. PPF treatment of the soils would generate 288 cubic meters (10,200 cubic feet) of PPF glass. These canisters would be disposed of in an onsite IDF.

A total of 260 cubic meters (9,170 cubic feet) of hazardous waste would be generated during construction, operations, and closure activities required for WMA T clean closure. The estimated volume of nonhazardous waste would be approximately 295,000 cubic meters (10.4 million cubic feet). This waste would be sent for offsite disposal in a local landfill. This additional waste load would have only a minor impact on the handling and accumulation of nonhazardous solid waste at Hanford.

Table 3-73 Waste Management Area T Clean Closure Waste Generation Volumes

Waste Type	Project Phase					Peak Annual Generation		Total Waste Volume to IDF(s)/RPPDF
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Waste Volume/Year	
Primary Waste								
Other high-level radioactive waste	N/A	N/A	N/A	36,200	36,200	2077–2088	3,020	N/A
Preprocessing Facility melters	N/A	N/A	N/A	353	353	Various	123	353 (IDF)
Secondary Waste								
Preprocessing Facility glass	N/A	N/A	N/A	288	288	2086–2099	21	288 (IDF)
Low-level radioactive	N/A	281	146	7,850	8,280	2097–2099	365	8,280 (IDF)
Low-level radioactive (closure)[a]	N/A	N/A	N/A	339	339	2097–2099	113	339 (RPPDF)
Mixed low-level radioactive	N/A	247	280	8,510	9,040	2097–2099	457	9,040 (IDF)
Mixed low-level radioactive (closure)[b]	N/A	N/A	N/A	428,000	428,000	2089–2096	47,300	428,000 (RPPDF)
Transuranic mixed	N/A	45	N/A	N/A	45	2038–2040	15	N/A
Hazardous[c]	49	123	N/A	88	260	2038–2040	41	N/A
Nonradioactive–nonhazardous[d]	N/A	N/A	25	295,000	295,000	2077–2088	20,700	N/A

[a] Closure low-level radioactive waste is the waste from decontamination and decommissioning of the containment structure over the tank farm after soil removal is complete.

[b] Closure mixed low-level radioactive waste includes rubble, soil, and equipment removed during closure of the tank farm.

[c] Hazardous waste is accumulated on site for less than 90 days and then shipped to offsite commercial facilities for treatment and/or disposal.

[d] Nonhazardous solid waste is shipped to offsite commercial facilities for recycling, treatment, and disposal.

Note: All values are in cubic meters. To convert cubic meters to cubic feet, multiply by 35.315. Total may not equal the sum of the contributions due to rounding.

Key: IDF=Integrated Disposal Facility; N/A=not applicable; RPPDF=River Protection Project Disposal Facility.

3.5.15 Industrial Safety

Illness, injury, and death are possible outcomes of any industrial accident. The accepted standard for measuring the outcome of an industrial accident is the number of fatalities and TRCs (the occurrence of illness or injury). A fatal occurrence is a work-related injury or illness that causes the death of the employee. TRCs include work-related illness or injury that results in loss of consciousness, restriction of work or motion, transfer to another job, a requirement for medical treatment beyond first aid, or death.

As ORP has not experienced a fatality during recent history, the DOE and contractor rate (for all labor categories) of 0.26 per 200 million labor hours was adopted as representative of fatal occurrences. The impacts of illness and injury can be calculated using the total project labor hours and the appropriate incident rate. The total labor hours were calculated from the scaled data sets (SAIC 2012). The subtotal for each type of activity (construction, operations, deactivation, and closure) for clean closure of WMA T is presented in Table 3–74.

Table 3-74 Waste Management Area T Clean Closure Industrial Safety Impacts

Labor Category	Million Labor Hours	Total Recordable Case Rate per 200,000 Labor Hours	Projected Total Recordable Cases	Fatality Rate per 200 Million Labor Hours	Projected Fatalities
Construction	14.0	2.0	140.0	0.26	0.0182
Operations	31.5	2.0	315.0	0.26	0.0410
Deactivation	0.24	2.0	2.4	0.26	0.0003
Closure	12.4	2.0	124.0	0.26	0.0161
Total	**58.1**		**581.4**		**0.0756**

Note: Projected fatalities are displayed to four decimal places to show at least one significant digit. All other values presented in the table have been rounded to no more than three significant digits. Totals may not equal the sum of the contributions due to rounding.
Source: Labor hours compiled from the scaled data sets (SAIC 2012).

For the clean closure of WMA T, a total of 58 million hours of labor would be required for all phases: 14 million labor hours for construction, 31.5 million for operations, and 12.4 million for closure. Given the selected incident rates for illness and injury, it is expected that 581 TRCs would occur, with 315 TRCs occurring during the operations phase, 140 during construction, and 124 during closure. No fatalities are projected.

3.5.16 Cost Analysis

The cost estimates, in 2008 dollars, for construction, operations, deactivation, closure, and disposal activities required to clean-close WMA T are provided in Table 3–75.

Table 3-75 Waste Management Area T Clean Closure Summary of Estimated Costs (millions of 2008 dollars)

Construction	Operations	Deactivation	Closure	Disposal	Total
665	1,045	23	1,913	1,176	4,822

Note: Estimates are costs to the Hanford Site only.
Source: DOE 2009.

Included in the construction costs are the costs to build or modify the 16 SSTs at the T tank farm to support waste retrieval and the construction of interim storage facilities for HLW debris from

the clean closure of the SSTs. Operations costs include ongoing operations of the T tank farm, retrieval of tank waste, and operations of Borrow Area C, the onsite pit used to supply sand, soil, and gravel for backfilling the tank farms after the SSTs are removed. Deactivation costs include deactivation of tank waste retrieval equipment and facilities.

Closure costs include the construction and deactivation of confinement structures over the tank farms required during tank removal and contaminated deep soil removal, as well as removal of the 16 SSTs and ancillary equipment within the tank farms and the contaminated deep soils. The removed highly contaminated RSE that would be managed as HLW would be maintained in shielded storage boxes on site on covered concrete storage pads. Closure costs also include the construction, operations, and deactivation of the PPF, a soil-washing facility that would treat highly contaminated (non-HLW) soils. This treatment would result in: 1) washed soils, which would be packaged for onsite disposal in the proposed RPPDF; and 2) contaminated liquid waste streams, which would be treated in the PPF melter, producing a LAW glass that would be disposed of in the IDF.

Disposal costs include the construction, operations, closure, and postclosure care of the IDF and RPPDF that are necessary for the clean closure of the 16 SSTs at the T tank farm.

3.6 WASTE MANAGEMENT AREA TX/TY

WMA TX/TY consists of two SST farms that store HLW that was generated primarily from the chemical processing of irradiated uranium fuel. Each of the tank farms consists of the following:

- SSTs of varying sizes
- Waste transfer lines
- Leak detection systems
- Tank ancillary equipment

WMA TX/TY is located in the northwestern portion of the 200-West Area of Hanford (see Figure 3–11).

TX Tank Farm. The TX Tank Farm consists of eighteen 2,869,000-liter (758,000-gallon) second-generation SSTs constructed in 1947 and 1948 that currently store a total volume of 24.6 million liters (6.5 million gallons) of waste (*Final TC & WM EIS*, Appendix D, Table D–3) (DOE 2012). The waste is HLW that was generated primarily at the T Plant, which is located northeast of the TX tank farm. The tanks are 23 meters (75 feet) in diameter and about 11.5 meters (38 feet) in height and are composed of a steel-reinforced concrete shell that encompasses a steel plate liner (DOE 1997b).

Sediments of the Hanford formation coarse-grained upper unit were excavated to a depth of about 15 meters (50 feet) during construction of the TX Tank Farm, with the excavated materials used as backfill. Several inches of gravel were placed on top to provide protection and to retard vegetation growth. The TX tanks are connected in three- and four-tank cascade series. The two sets of three-tank cascade series consist of tanks TX-113, TX-114, and TX-115 and TX-116, TX-117, and TX-118. The three sets of four-tank cascade series consist of tanks TX-101, -102, TX-103, and TX-104; tanks TX-105, TX-106, TX-107, and TX-108; and tanks TX-109, TX-110,

TX-111, and TX-112. The cascade tanks are arranged with each successive tank sited at a lower elevation (with the receiving tank 0.3 meters [1 foot] lower than the feed tank), creating a gradient that allows fluids to flow from one tank to another as they are filled (DOE 1997b).

Eight of the TX Farm Tanks (TX-105, TX-107, TX-110, TX-113, TX-114, TX-115, TX-116, and TX-117) are assumed to have leaked approximately 216,000 liters (57,000 gallons) of liquid into the vadose zone sediments. All of the tanks in the TX tank farm have been removed from service and are designated as stabilized. The ground surface is designated as controlled, clean, and stable, indicating efforts have been made to remove hazardous conditions to promote a safe working environment (DOE 1997b).

TY Tank Farm. The TY Tank Farm consists of six 2,869,000-liter (758,000-gallon) second-generation tanks constructed in 1951 and 1952 that currently store a total volume of 2.4 million liters (0.64 million gallons) of waste (*Final TC & WM EIS*, Appendix D, Table D–3) (DOE 2012). It is located north-northeast of the Plutonium Finishing Plant. The tanks are 23 meters (75 feet) in diameter and about 11.6 meters (38 feet) in height and are composed of a steel-reinforced concrete shell that encompasses a steel plate liner (DOE 1998b).

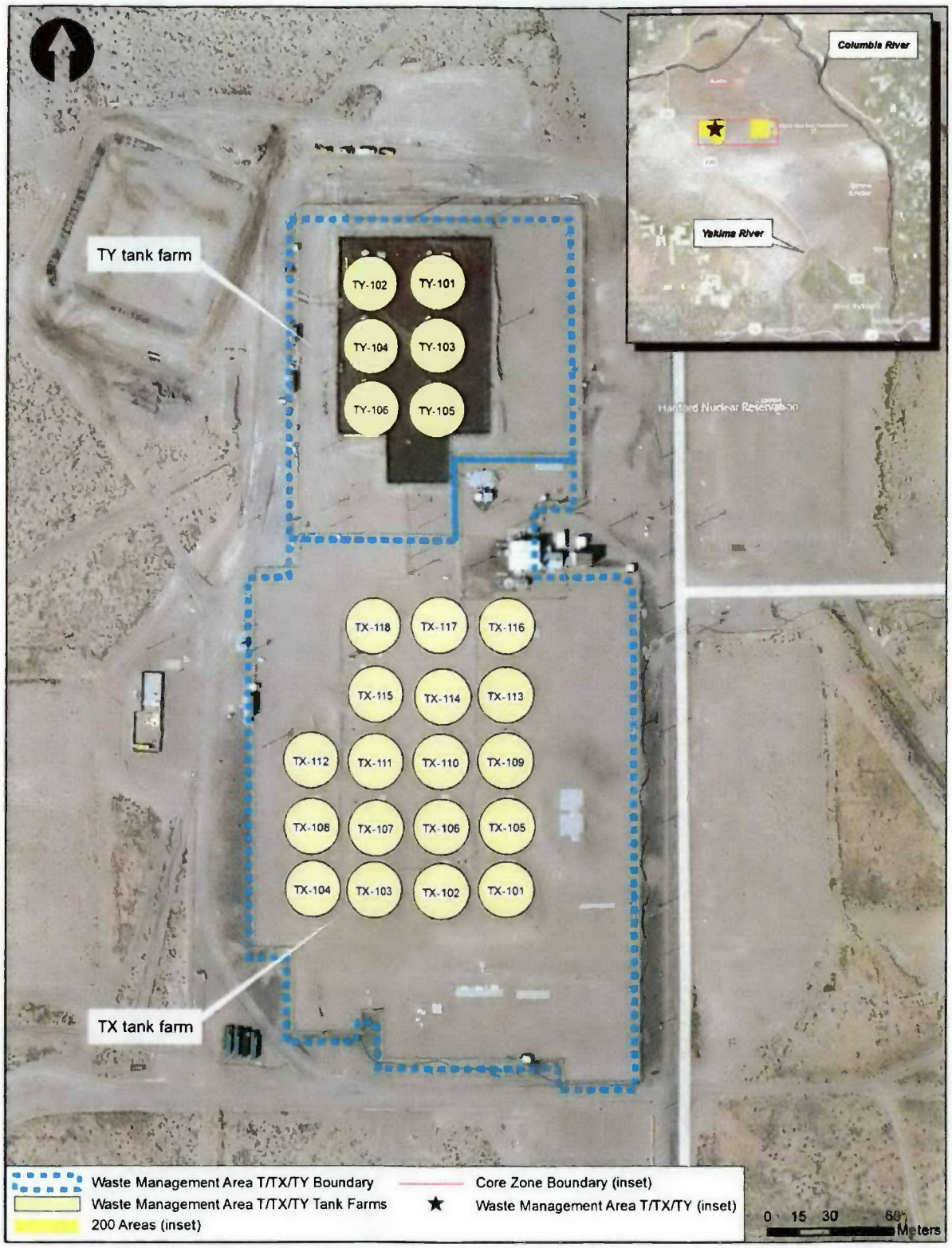


Figure 3-11 General Location of Waste Management Area TX/TY

Sediments of the Hanford formation coarse-grained upper unit were excavated to a depth of about 14 meters (45 feet) during construction of the TY tank farm, with the excavated materials used as backfill. Several inches of gravel were placed on top to provide protection and to retard vegetation growth. Five of these tanks (TY-101, TY-103, TY-104, TY-105, and TY-106) are assumed to have leaked approximately 230,000 liters (60,800 gallons) of liquid to the vadose zone sediments; only TY-102, which received waste until 1979, is designated as sound. All of the tanks in the TY Tank Farm have been removed from service and are designated as stabilized. Tank TY-104 is on the organics watch list, indicating that this tank has a small potential for an exothermic organic nitrate reaction. The wastes in this tank are monitored for temperature increases (DOE 1998b).

3.6.1 Land Resources

3.6.1.1 Land Use

Clean closure of WMA TX/TY would involve land-disturbing activities associated with construction of an underground transfer line, WRF, HLW Debris Storage Facility, PPF, IDF, and the proposed RPPDF. Clean closure activities would also require the extraction of material from Borrow Area C. For most facilities and activities, the acreage requirement was determined by use of a scaling factor that adjusted the total land requirement for closing all Hanford tank farms (as reported in the *Final TC & WM EIS* [DOE 2012]) to a specific value for WMA TX/TY. However, this was not done for the WRF and PPF, as the minimum requirement to close a WMA is one facility. Also, it was not necessary to scale the length of the underground transfer line.

WMA TX/TY is located in the 200-West Area; however, not all activities associated with its closure would take place in this area. Thus, land would also be disturbed within the 200-East Area (for the IDF), between the 200-East and 200-West Areas (for the HLW Debris Storage Area, PPF, and proposed RPPDF), and within Borrow Area C. Within the 200-West Area, a total of 3.46 hectares (8.54 acres) would be disturbed, all of which is developed. Within the 200-East Area, 1.81 hectares (4.48 acres) would be disturbed, none of which is developed. Development within the area between the 200-East and 200-West Areas would require 61.1 hectares (151 acres), all of which is undeveloped. Disturbance within Borrow Area C would total 63.5 hectares (157 acres), all of which is also undeveloped. Thus, a total of 130 hectares (321 acres) would be required for clean closure of WMA TX/TY, of which only 3.46 hectares (8.54 acres) is currently developed.

3.6.1.2 Visual Resources

As noted above, a total of 130 hectares (321 acres), most of which is not currently developed, would be required for clean closure of WMA TX/TY. Within the 200-East and 200-West Areas, development would have little impact on visual resources, as these areas are already highly industrialized. However, the use of 61.1 hectares (151 acres) between the 200-East and 200-West Areas would impact visual resources, as this land is not developed. The conversion of this land to an industrial use would add to the overall developed nature of the area and would be visible from nearby higher elevations. The viewscape from these higher elevations is important to American Indians with cultural ties to Hanford. Clean closure activities would involve constructing containment structures over the WMA; however, these structures would be removed upon completion of clean closure activities. Although there would be an overall increase in the industrial appearance of the 200 Areas, the BLM Visual Resource Management Class IV rating

would not change. Management activities within Class IV areas dominate the view and typically are the focus of viewer attention.

As noted above, 63.5 hectares (157 acres) within Borrow Area C would be excavated for the clean closure of WMA TX/TY. Development of Borrow Area C would be readily visible from State Route 240 and Rattlesnake Mountain and would change the BLM visual resource management rating from Class II to Class IV. Management activities within Class II areas may be seen but should not dominate the view. Upon completion of WMA TX/TY closure, excavations in Borrow Area C would be recontoured and revegetated, thereby lessening the visual impact.

3.6.2 Infrastructure

For WMA TX/TY clean closure, operations of the RPPDF, which will be located between the 200-East and 200-West Areas, would have the highest total demands for water, diesel fuel, and gasoline. Operation of Borrow Area C and placement of a modified RCRA Subtitle C barrier above the RPPDF would also generate high total water and fuel demands. Deep soil removal from the TX Tank Farm would have the highest total electricity requirement due to WMA TX/TY clean closure activities.

Water would be required during construction for soil compaction, dust control, and possibly work surface and equipment washdown. Standard construction practices dictate that, at least initially, construction water would be trucked to construction locations on an as-needed basis for these uses until water supply and wastewater treatment utilities are in place. Concrete and grout would be produced in onsite batch plants, which would require large volumes of water. By comparison, relatively little water would be required to meet the potable and sanitary needs of the construction workforce. During operations, water would be required to support process makeup requirements and facility cooling, as well as the potable and sanitary needs of the operations workforce and other uses. To stabilize and partially decontaminate waste treatment, retrieval, and disposal facilities, water would also be used during facility deactivation activities; however, this requirement would be relatively small compared with those for construction and operational demands and for many closure activities, including construction of surface barriers.

Table 3–76 summarizes the projected utility infrastructure resource requirements for WMA TX/TY clean closure.

Table 3-76 Waste Management Area TX/TY Clean Closure Summary of Utility Infrastructure Requirements

Activity Phase	Electricity (million megawatt-hours)	Diesel Fuel[a]	Gasoline	Water
		(million liters)		
Peak (Year)	**0.031 (2062–2065)**	**65.6 (2101)**	**6.17 (2101)**	**351 (2062–2065)**
Construction	0.005	31.3	1.81	161
Operations	0.011	240	7.91	5,470
Deactivation	0.00[b]	0.180	0.231	0.00[b]
Closure	0.445	123	11.2	313
Total[c]	**0.461**	**394**	**21.2**	**5,940**

[a] Assumed to be inclusive of all Number 2 diesel fuel, including road diesel and heating fuel oil.

[b] Deactivation values of "0.00" reflect no demand for that utility.

[c] Totals may not equal the sum of the contributions due to rounding.
Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate. To convert liters to gallons, multiply by 0.26417.
Source: SAIC 2010.

3.6.2.1 Electricity

For clean closure of WMA TX/TY, peak annual electrical energy demand in years 2062 through 2065 would be about 31,210 megawatt-hours and would remain well within the annual capacity of 1.74 million megawatt-hours (based on a peak load capacity of 199 megawatts) of the Hanford electric power transmission system.

3.6.2.2 Fuel

Peak demands of about 65.5 million liters (17.3 million gallons) of diesel fuel and 6.2 million liters (1.6 million gallons) of gasoline would both occur in 2101. Annualized liquid fuel consumption (diesel fuel and gasoline) would be about 2.13 million liters (0.6 million gallons) during the timespan of clean closure activities for this WMA (2008 through 2202), compared to the 4.3 million liters (1.1 million gallons) of liquid fuels currently used annually at Hanford.

3.6.2.3 Water

For clean closure of WMA TX/TY, peak annual water requirements of about 351 million liters (93 million gallons) would occur from 2062 through 2065. With an annual capacity of the Hanford Export Water System of 18,500 million liters (4,890 million gallons), this peak is well below capacity.

3.6.3 Noise and Vibration

Construction, operation, deactivation, and closure of facilities for clean closure of WMA TX/TY would result in minor noise impacts of employee vehicles, trucks, construction equipment and activity, generators, and process equipment. The offsite noise levels from activities at the WTP and 200-East and 200-West Areas would be negligible due to the distance to the Hanford boundary.

Employee and truck traffic to deliver materials for various phases of activities would vary over the duration of the project. The highest number of employee trips is expected to occur in 2026 (SAIC 2012). The increase in the number of employee vehicles and truck trips is expected to cause a minor increase in traffic noise levels along routes to the site. This increase in employee and truck traffic (discussed in Section 3.6.9) was compared with the existing average traffic volume of 30,000 to 40,000 vehicles per day (DOE 2012). For comparison purposes, the increase in traffic noise level can be estimated from the ratio of the projected traffic volume to the existing traffic volume.

3.6.4 Air Quality

Criteria pollutant concentrations that would result from activities for WMA TX/TY clean closure are presented in Table 3–77. Peak concentrations of all criteria pollutants except PM would occur in 2101. Peak concentrations of PM would occur in 2020. The peak period concentrations for carbon monoxide, nitrogen dioxide, and sulfur dioxide would result primarily from closure of the proposed RPPDF. Peak period concentrations for PM would result from RPPDF construction. The maximum air quality impacts of PM_{10} emissions would occur to the south at

State Route 240. Figure 3–12 shows the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities to these concentrations.

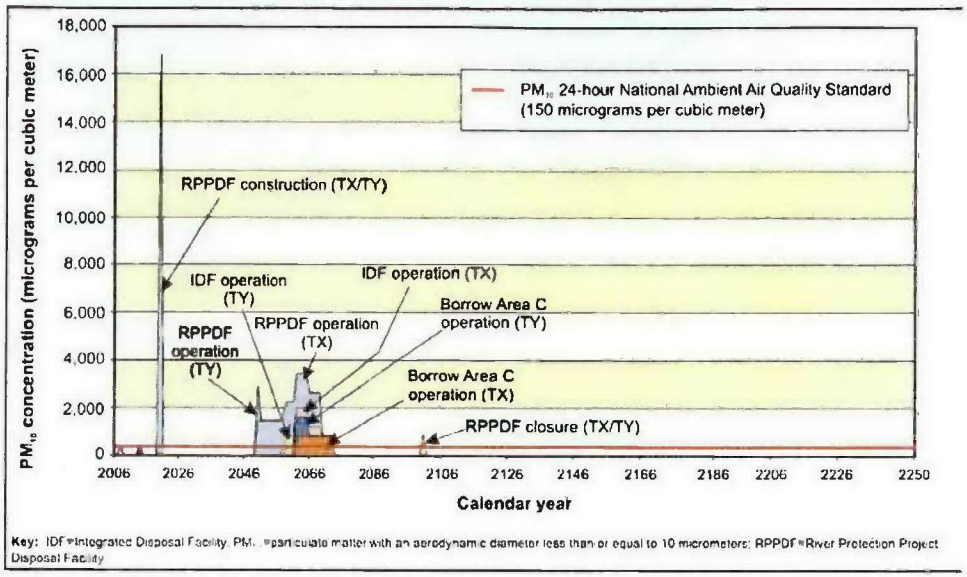


Figure 3-12 Waste Management Area TX/TY Clean Closure PM_{10} Maximum 24-Hour Concentrations

Table 3-77 Waste Management Area TX/TY Clean Closure Maximum Incremental Criteria Pollutant Concentrations

Pollutant and Averaging Period	Standard[a]	Maximum Modeled Increment
	(micrograms per cubic meter)	
Carbon Monoxide		
8-hour	10,000[b]	**41,200**
1-hour	40,000[b]	**257,000**
Nitrogen Dioxide		
Annual	100[b]	88.9
1-hour	188	**179,000**
PM_{10}[c]		
Annual	50[d]	**120**
24-hour	150[b]	**16,900**
$PM_{2.5}$		
Annual	15[d]	**120**
24-hour	35[b]	**16,900**
Sulfur Dioxide		
Annual	50[d]	0.176
24-hour	260[d]	24.5
3-hour	1,300[b]	120
1-hour	197[e]	**353**

a The more stringent of the Federal and Washington State standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (40 CFR 50), other than those for ozone, particulate matter, lead, and those based on annual averages, are not to be exceeded more than once per year. The 24-hour PM_{10} standard is attained when the expected number of days with a 24-hour average concentration above the standard is less than or equal to 1. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard. The annual $PM_{2.5}$ standard is met when the 3-year average of the annual means is less than or equal to the standard. The 24-hour $PM_{2.5}$ standard is met when the 3-year average of the 98th percentile 24-hour averages is less than or equal to the standard. The 1-hour nitrogen dioxide standard is met when the 3-year average 98th percentile of the daily maximum 1-hour average does not exceed the standard value.

b Federal and Washington State standard.

c The Federal standards for $PM_{2.5}$ are 15 micrograms per cubic meter annual average and 35 micrograms per cubic meter 24-hour average. No specific data for $PM_{2.5}$ were available, but for analysis purposes, concentrations were assumed to be the same as those of PM_{10}.

d Washington State standard.

e Federal standard.

Note: The National Ambient Air Quality Standards also include standards for lead and ozone. No sources of lead emissions have been identified for the activities evaluated. Washington State also has ambient standards for fluorides. Concentrations in **bold** text indicate potential exceedance of the standard.

Key: PM_n=particulate matter with an aerodynamic diameter less than or equal to *n* micrometers.

Source: Based on emissions data in SAIC 2012.

Maximum concentrations of carcinogenic and noncarcinogenic toxic pollutants are presented in Table 3–78. No impacts on the public due to projected nonradioactive toxic pollutant emissions are expected as a result of WMA TX/TY clean closure activities. Hazardous chemical health effects on noninvolved workers are summarized in Tables 3–79 and 3–80.

Table 3-78 Waste Management Area TX/TY Clean Closure Maximum Incremental Nonradioactive Toxic Chemical Concentrations

Pollutant	Averaging Period	Acceptable Source Impact Level[a]	Maximum Modeled Increment
		(micrograms per cubic meter)	
Ammonia	24-hour	70.8	20.0
Benzene	Annual	0.0345	0.0323
1,3-Butadiene	Annual	0.00588	0.000842
Formaldehyde	Annual	0.167	0.0278
Mercury	24-hour	0.09	0.00000635
Toluene	24-hour	5,000	31.2
Xylene	24-hour	(b)	9.27

[a] WAC 173-460.
[b] Not listed in WAC 173-460.
Note: To convert cubic meters to cubic feet, multiply by 35.315.
Source: Based on emissions data in SAIC 2012.

Table 3-79 Waste Management Area TX/TY Clean Closure Nonradioactive Airborne Toxic Chemical Hazard Index for the Nearest Noninvolved Worker

Chemical	Hazard Quotient
Ammonia	1.51×10^{-1}
Mercury	2.77×10^{-5}
Toluene	1.94×10^{-3}
Xylene	2.93×10^{-2}
Hazard Index	1.82×10^{-1}

Source: Based on emissions data in SAIC 2012.

Table 3-80 Waste Management Area TX/TY Clean Closure Nonradioactive Airborne Toxic Chemical Cancer Risk for the Nearest Noninvolved Worker

Chemical	Cancer Risk
Benzene	1.26×10^{-5}
1,3-Butadiene	1.38×10^{-6}
Formaldehyde	1.94×10^{-5}

Source: Based on emissions data in SAIC 2012.

3.6.5 Geology and Soils

Consumption of geologic resources (rock, minerals, and soils) to support facility construction, operations, and deactivation, as applicable, would constitute the major indirect impact on geologic and soil resources from implementation of clean closure of WMA TX/TY and associated waste management activities, as summarized in Table 3–81. Varying quantities of geologic resources would be required for ongoing facility construction; upgrades to existing facilities, including the 200 Area tank farms; waste retrieval activities; and, most substantially, tank farm closure. Geologic resources, including relatively large volumes of gravel, sand, and silt, are available from the suprabasalt sediments and associated soils at Hanford. Rock, in the form of basalt, is also plentiful. As discussed in the *Environmental Assessment, Use of Existing*

Borrow Areas, Hanford Site, Richland, Washington (DOE 2001a), a number of active gravel and sand pits and two rock quarries at Hanford have been identified for use in providing a continual supply of borrow materials for new facility construction, maintenance of existing facilities, and fill and capping material for remediation and other activities. Of the two active quarries on the site, quarry No. 2 (Borrow Area C), located due south of the 200-West Area just south of State Route 240, has large volumes of basalt and sand (DOE 2001a). This approximately 926.3-hectare (2,289-acre) borrow area has been designated as a source of materials such as rock riprap (basalt), aggregate (gravel and sand), and soil (silt and loam) that would be needed to support tank farm closure and supporting activities (DOE 2003a).

Table 3-81 Waste Management Area TX/TY Clean Closure Major Geologic and Soil Resource Impact Indicators and Requirements

Construction Materials				Other Borrow Materials[a]				Closure-Specific Materials		
Concrete/ Grout	Cement[b]	Sand[b]	Gravel[b]	Rock/Basalt	Sand	Gravel	Soil (Specification Backfill)	Grout[c]	Cement	Sand[d]
161,000	32,900	78,000	69,000	0	671,000	341,000	11,400,000	2,650	310	1,290

[a] Resources for miscellaneous uses not exclusively tied to facility construction, operations, or closure, such as site grading and backfill for operations.

[b] Cement, sand, and gravel are components of concrete.

[c] Grout is composed of cement, sand, fly ash, and other materials.

[d] Principal component of grout that would be obtained from onsite deposits.

Note: Values have been rounded to no more than three significant figures. All values are expressed in cubic meters. To convert cubic meters to cubic feet, multiply by 35.315.

3.6.6 Water Resources

All construction and closure-related land disturbances, especially for new facility construction, would expose soils and sediments to possible erosion by infrequent, heavy rainfall or by wind. While unlikely to reach surface-water features, stormwater runoff from exposed areas could convey soil, sediments, and other pollutants (e.g., construction waste materials and spilled materials, such as petroleum, oils, and lubricants from construction equipment) from construction footprint and laydown areas. Nevertheless, appropriate soil erosion and sediment control measures, as well as spill prevention and waste management practices, would be employed to minimize suspended sediment, the transport of other deleterious materials, and any potential water-quality impacts. Further, all construction and other ground-disturbing activities would be conducted in accordance with current NPDES and state waste discharge general permits for stormwater discharges associated with construction activities, issued by Ecology. The NPDES permit specifically requires the development and implementation of a stormwater pollution prevention plan.

Once completed, new facilities required for clean closure of WMA T would incorporate appropriate stormwater management controls to collect, convey, and detain stormwater from buildings and other impervious surfaces so as to minimize the impacts of onsite hydrology and soil erosion. Hanford's NPDES Storm Water Multi-Sector General Permit would cover stormwater discharges associated with industrial activity and, as necessary, stormwater discharges would be covered under state waste discharge permits for discharges to the ground.

Under normal operations associated with WMA closure, facility design combined with adherence to spill prevention and emergency response plans and procedures would help to ensure that involved hazardous substances, including spills, should they occur, do not reach soils or surfaces where they could be conveyed to surface water or groundwater. For construction, operations, deactivation, and closure activities, adherence to best management practices and other preventive measures under applicable permits and compliance plans would be coordinated by DOE with those measures in similar sitewide pollution prevention plans.

There would be no direct discharge of effluents to either surface water or groundwater during construction, operations, and deactivation as a result of WMA TX/TY clean closure. Nonhazardous sanitary wastewater (sewage) would be managed via appropriate sanitary wastewater collection and treatment systems. During the early phases of new facility construction, it was assumed that portable toilet facilities would be provided for construction personnel, with collected waste disposed of at offsite contractor facilities, as is standard construction practice. During facility operations and deactivation, sanitary wastewater would be disposed of via the dedicated sanitary sewer or septic/drain-field system serving a particular facility.

Water would be required to support new facility construction, facility operations, and facility deactivation for WMA TX/TY clean closure. Water would be required for WRF construction; replacement of underground transfer lines; and construction of tank upgrades, a new riser, an MRS, a VBR system, the PPF, IDF-East, and the proposed RPPDF that will be located between the 200-East and 200-West Areas. Total water demands have been conservatively estimated at 5,940 million liters (1,570 million gallons), with a peak demand of 351 million liters (93 million gallons). Peak periods of water demands would occur from 2062 through 2065, the years of operation of both Borrow Area C and the RPPDF. All utility demands, as well as water demands, are discussed in Section 3.6.2, Infrastructure.

3.6.7 Ecological Resources

3.6.7.1 Terrestrial Resources

As noted in Section 3.6.1.1, a total of 66.4 hectares (164 acres) within the 200-East Area, 200-West Area, and between the 200-East and 200-West Areas would be disturbed by construction of the facilities required to clean-close WMA TX/TY. Of this total, 1.81 hectares (4.48 acres) would be developed within the 200-East Area, 3.46 hectares (8.54 acres) within the 200-West Area, and 61.1 hectares (151 acres) between the 200-East and 200-West Areas. Within the 200-East Area and between the 200-East and 200-West Areas, all of the land needed for construction is undeveloped sagebrush habitat, whereas within the 200-West Area, all of the land needed for construction has been previously disturbed. Late successional sagebrush habitat is considered a Level III resource under the Hanford Site Biological Resources Management Plan (DOE 2001b:4.11). Hanford guidance may require the replacement of sagebrush habitat at a ratio ranging from 1:1 to 3:1 (DOE 2003b:20, 21, 31). Specific measures to mitigate the loss of sagebrush habitat would be set forth in a mitigation action plan prior to construction.

The clean closure of WMA TX/TY would require that 63.5 hectares (157 acres) of Borrow Area C be excavated to supply needed geologic material. The two major plant communities present within the area are cheatgrass-bluegrass (782 hectares [1,933 acres]) and needle-and-

thread grass/Indian ricegrass (107 hectares [265 acres]) (DOE 2012). The latter represents an unusual and relatively pristine community type at Hanford; thus, it is considered a more highly valued community than the former. It is not possible to determine specific impacts of excavating Borrow Area C on ecological resources because the particular portion of the site from which geologic material would be excavated is unknown. To the extent that it is possible, the needle-and-thread grass/Indian ricegrass community should be avoided during excavation. A mitigation action plan would be developed prior to excavation.

3.6.7.2 Threatened and Endangered Species

Federally or state-listed threatened or endangered species have not been observed within, or in the immediate vicinity of, the 200 Areas or Borrow Area C; therefore, impacts on this group of plants and animals are not expected as a result of WMA TX/TY clean closure. Both the Columbia and Yakima Rivers adjacent to Hanford have been designated as critical habitat for the bull trout. However, as there would be no short-term impacts on either river from construction or operation of new facilities associated with clean closure of WMA TX/TY, designated critical habitat would not be adversely affected.

A number of state-listed, special status species observed within areas that would be disturbed by clean closure of WMA TX/TY could be impacted by construction of the various required facilities. One state-listed species, the sage sparrow (state candidate), was observed within IDF-East. In addition, the loggerhead shrike (Federal species of concern and state candidate), black-tailed jackrabbit (state candidate), sage sparrow, and crouching milkvetch (state watch) have all been observed between the 200-East and 200-West Areas where the HLW Debris Storage Facility, PPF, and the proposed RPPDF would be located. Finally, surveys have identified Piper's daisy (state sensitive), stalked-pod milkvetch (state watch), crouching milkvetch, and the long-billed curlew (state monitor) within the boundaries of Borrow Area C. No state-listed, special status species have been observed within areas to be disturbed within the 200-West Area. The operation of new facilities is not expected to impact any listed species.

Although mitigation would not be required for the state monitor and watch species, they should be considered during project planning. Impacts on state candidate and sensitive species, which are considered Level III resources under the Hanford Site Biological Resources Management Plan, require mitigation where impacts would occur. When avoidance and minimization are not possible or are insufficient, mitigation via rectification or compensation is recommended (DOE 2001b:4.9, 8.11). A comprehensive mitigation action plan, which would deal with the loss of state-listed species (as well as sagebrush habitat), would be developed prior to construction.

3.6.8 Cultural and Paleontological Resources

3.6.8.1 Prehistoric Resources

As noted in Section 3.6.1.1, clean closure of WMA TX/TY would require a total of 130 hectares (321 acres), of which 3.46 hectares (8.54 acres), located in the 200-West Area, is currently developed. Land disturbance due to clean closure of WMA TX/TY would involve the 200-East and 200-West Areas, land between the 200-East and 200-West Areas, and Borrow Area C. White Bluffs Road, an important archaeological resource, is located in the southwest and northeast parts of the 200-West Area. Other prehistoric finds were discovered in the

northwestern portion of the 200-West Area and immediately east of the 200-East Area. There are no known prehistoric resources within the areas that would be affected by the clean closure of WMA TX/TY. The survey and geology of these areas indicate that subsurface cultural deposits have little or no potential of being present. The Hanford Cultural Resources Management Plan (DOE 2003c) provides guidance for identifying, evaluating, recording, curating, and managing cultural resources. If any prehistoric resources were discovered during construction or excavation, procedures from the Hanford Cultural Resources Management Plan would be implemented.

3.6.8.2 Historic Resources

There would be no impacts on White Bluffs Road or on other known early historic artifacts within the 200-East or 200-West Area from construction or excavation required for clean closure of WMA TX/TY. In addition to White Bluffs Road in the 200-West Area, historic resources have been found in the south-central part of the 200-East Area. Buildings associated with the Manhattan Project and Cold War era are found within both the 200-East and 200-West Areas; however, none of these structures would be affected. As is the case for prehistoric resources, if historic resources were discovered, procedures in place to properly identify, evaluate, record, curate, and manage the discovery site would be implemented.

3.6.8.3 American Indian Interests

As stated above, there are no known prehistoric resources that may be an American Indian interest within the affected areas required for the clean closure of WMA TX/TY. Clean closure of WMA TX/TY would impact 61.1 hectares (151 acres) of undeveloped land between the 200-East and 200-West Areas. The conversion of this land to industrial use would be noticeably visible from nearby higher elevations, such as Gable Mountain and Gable Butte. The viewscape from these higher elevations is important to American Indians with cultural ties to Hanford. There would be little impact on the viewscape within the 200-East and 200-West Areas, as the areas are already highly industrialized.

Clean closure of WMA TX/TY would also require excavation of 63.5 hectares (157 acres) within Borrow Area C. This would also have an impact on the viewscape from Rattlesnake Mountain; however, upon completion of the work, excavations of Borrow Area C would be recontoured and revegetated, thus lessening the visual impact. Appropriate mitigation measures would be developed in consultation with area tribes.

3.6.8.4 Paleontological Resources

No paleontological resources have been discovered within the 200 Areas or Borrow Area C; therefore, clean closure of WMA TX/TY would not impact such resources. However, if any paleontological resources were found during construction or excavation, procedures to properly manage the discovery site would be implemented.

3.6.9 Socioeconomics

3.6.9.1 Regional Economic Characteristics

A workforce of 2,490 FTEs in 2026, as shown in Table 3–82, would be required for construction and operation activities. This peak estimate is approximately 1.2 percent of the projected labor force in the ROI (204,000 in 2026), compared with 10 percent in 2006. The existence of these direct jobs is expected to result in the creation of another 1,860 indirect positions in the ROI during the peak year. An additional estimated spike (1,970 FTEs) in the workforce in 2101 would be dominated by closure activities at the RPPDF. A small (4 FTEs) workforce would be needed for postclosure care of the site beginning in 2103. Implementing WMA TX/TY clean closure activities could alter the economic characteristics of the region by increasing demands for goods and services in the Tri-Cities area due to increases in expenditures, income, and employment, both direct and indirect, at Hanford.

Table 3-82 Waste Management Area TX/TY Clean Closure Workforce Estimates

Work Activity	Peak Year(s)	Workforce Peak (FTEs)
Construction	2023	2,470
Operations	2026	1,460
Deactivation	2028	39
Closure	2101	1,970
Total Onsite Workforce	**2026**	**2,490**

Key: FTE=full-time equivalent.

3.6.9.2 Demographic Characteristics

While clean closure of WMA TX/TY would draw some workers from the local labor force, the demand for construction and operations workers could draw from outside the region. The in-migrations of new workers and their families would increase the overall population within the Tri-Cities area and could alter the demographic characteristics of the region.

3.6.9.3 Housing and Community Services

Implementing clean closure of WMA TX/TY would increase the demand for housing and would impact schools and other community services within the Hanford ROI. The demand for housing by construction and operations workers would impact the cost and availability of houses and rental units. School enrollments would increase, and utilities and police and fire services may need to be expanded.

3.6.9.4 Local Transportation

Implementation of WMA TX/TY clean closure is expected to have an impact on the local transportation system, especially during the commute periods. The projected increase in commuter traffic to the site would be due primarily to construction and operations activities, peaking at an annual 2,490 FTEs in 2026. This could represent up to 2,000 passenger vehicles per day during the peak year. It is expected that this commuter traffic would impact the regionally established LOS, reducing it below the minimum acceptable ("D") LOS.

For clean closure of WMA TX/TY, the number of onsite annual truck trips in 2101 during construction of the RCRA Subtitle C barrier would peak at 176,000 truck trips per year (approximately 677 trips per day). Offsite trips would peak at 7,660 trips per year

(approximately 29 truck trips per day). Additionally, construction and operation of the RPPDF and removal of tank farms TY and TX would require a heavier period of truck use onsite, averaging over 30,000 truck trips per year (approximately 115 trips per day).

3.6.10 Public and Occupational Health and Safety – Normal Operations

Activities to clean-close tank farms TX and TY could result in radiological exposures to the public and workers. Radiological impacts are presented for three public receptors: the general population (approximately 560,000)[11] living within 80 kilometers (50 miles) of the Hanford 200 Areas, an MEI living near Hanford, and an onsite MEI. Impacts on the general population are evaluated for a residential scenario whereby people are exposed to radioactive materials emitted from project facilities. Radiological exposure occurs through inhalation, direct exposure to the radioactive plume and material deposited on the ground, and ingestion of contaminated products from animals raised locally and fruits and vegetables grown in a family garden (DOE 1995). The MEI is a hypothetical individual member of the public located at a position near the site boundary who would experience the highest impacts during normal operations. The MEI was determined to be a receptor on the east side of the Columbia River. Impacts on the offsite MEI are evaluated for a scenario that includes the same exposure pathways assumed for the general population, but with an increased amount of time spent outdoors and a higher rate of contaminated food consumption. Impacts on the onsite MEI, identified as a member of the public who works at the Columbia Generating Station, LIGO, or U.S. Ecology, would be from inhalation and exposure to the plume and material deposited on the ground. Doses are presented as total effective doses. Details of the assessment methodology for determining radiological exposure of workers and members of the public are presented in Appendix K of the *Final TC & WM EIS* (DOE 2012).

The radiological impacts on members of the public are presented in terms of impacts over the life of the project, i.e., WMA TX/TY clean closure (the operational life of the project during which radioactive air emissions would occur), and peak annual impacts. Impacts over the life of the project are the total estimated radiation doses that would be incurred by members of the public over the duration of the activities to complete clean closure of the WMA. The peak annual impacts are the estimated annual radiation doses that would be incurred by members of the public during the year(s) of largest radiation dose.

In addition to members of the public, workers directly involved in the activities to clean-close the WMA and nearby noninvolved workers may receive radiation doses. Doses to an involved worker are calculated based on an FTE employee. It was assumed for the purposes of this dose evaluation that an FTE involved worker has a 2,080-hour work year. In practice, the number of workers who could receive a radiation dose may be larger than the number of FTEs assumed in this analysis, resulting in a smaller average dose per worker. A noninvolved worker is a person working at the site who is incidentally exposed due to the radioactive air emissions associated with tank farm management, tank waste retrieval, and clean closure activities. The potential dose to a noninvolved worker would result from exposure to, and inhalation of, radioactive contaminants released to the atmosphere from tank farm management, tank waste retrieval, and

[11] The approximate population is based on populations of 542,324; 546,746; and 589,668 people residing within 80 kilometers (50 miles) of the Waste Treatment and Immobilization Plant, 200-East Area, and 200-West Area, respectively, as described in the *Final TC & WM EIS* (DOE 2012).

clean closure activities. In the 200-East Area, the noninvolved worker was assumed to be at the 242-A Evaporator, 1,090 meters (3,580 feet) north-northwest of the 200-East Area source. In the 200-West Area, the noninvolved worker was assumed to be at the ERDF, about 950 meters (3,120 feet) east of the 200-West Area source.

The impacts of radionuclide releases from construction, operations, deactivation, and cleanup of facilities directly related to tank farm management, tank waste retrieval, and clean closure of WMA TX/TY were evaluated.

3.6.10.1 Radiological Impacts on the Public

Table 3–83 presents estimated doses to the general population and the MEI for clean closure activities associated with WMA TX/TY. Activities conducted at WMA TX/TY that would generate radioactive air emissions would occur from 2006 through 2101. Due to the long timeframe involved, the doses over the life of the project may not be received by the same members of the population or the same MEI, but are presented as a measure of potential impacts to provide a basis for comparison with other WMAs.

Table 3-83 Waste Management Area TX/TY Clean Closure Public Health Impacts of Atmospheric Radionuclide Releases

Receptor	Facility	Impacts over Life of Project[a]		Peak Annual Impacts		
General population		Dose (person-rem)	Number of Latent Cancer Fatalities[b]	Year of Maximum Impact	Dose (person-rem per year)	Number of Latent Cancer Fatalities[b]
	200-East Area	6.6			0.39	
	200-West Area	7.7			0.42	
	Total	**14**	**0 (9×10^{-3})**	**2062**	**0.80**	**0 (5×10^{-4})**
Maximally exposed individual		Dose[c] (millirem)	Lifetime Risk of a Latent Cancer Fatality[d]	Year of Maximum Impact	Dose (millirem per year)	Lifetime Risk of a Latent Cancer Fatality[d]
	200-East Area	0.86			0.051	
	200-West Area	0.58			0.031	
	Total	**1.4**	**9×10^{-7}**	**2062**	**0.082**	**5×10^{-8}**
Onsite MEI	**Total**	**0.65**	**4×10^{-7}**	**2062**	**0.036**	**2×10^{-8}**

[a] Impacts accrued over the operational life of the project to clean-close Waste Management Area TX/TY.

[b] The reported value is the projected number of latent cancer fatalities (LCF) among the population and is therefore presented as a whole number. The result, calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem), is shown in parentheses.

[c] Impacts are provided for assessment purposes. The life-of-project dose likely overestimates the dose that would be received by one individual person because the project could span approximately 88 years.

[d] Probability of an LCF in the MEI is calculated by converting the dose in millirem to rem (divide by 1,000), then multiplying the dose by the risk factor of 0.0006 LCFs per rem.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: MEI=maximally exposed individual.

Over the life of the project, the population within 80 kilometers (50 miles) of the 200 Areas would receive a cumulative dose of 14 person-rem, and the MEI would receive a cumulative dose of 1.4 millirem. Given the risk factor of 0.0006 LCFs per rem (DOE 2003d), no LCFs are expected in the general population as a result of these activities. There would be a probability of

9×10^{-7} (1 chance in 1.1 million) of the MEI developing an LCF, assuming the same MEI was exposed over the life of the project. Radioactive air emissions would result in a maximum annual population dose of 0.80 person-rem and a maximum annual MEI dose of 0.082 millirem. The primary contributor to offsite doses would be fission products from processing contaminated tank farm soils through the PPF.

An onsite MEI who spends a normal workday at U.S. Ecology would receive a maximum annual dose of 0.036 millirem. The increased risk of an LCF from this dose would be 2×10^{-8} (1 chance in 50 million).

3.6.10.2 Radiological Impacts on Workers

Table 3–84 presents dose and risk estimates for an involved FTE worker and a noninvolved FTE worker. The average annual FTE radiation worker dose would be 3,900 millirem, higher than the Administrative Control Level of 500 millirem. A radiation worker who received the average annual dose over the course of 40 years would receive a dose of 200,000 millirem, corresponding to a risk of 1×10^{-1} (1 chance in 10) of developing an LCF.

Table 3-84 Waste Management Area TX/TY Clean Closure Normal Operations Radiological Impacts on Workers

Receptor	Dose	Latent Cancer Fatality Risk[a]
Average Involved Full-Time-Equivalent Worker		
Average annual impact	3,900 millirem	2×10^{-3}
Impact over life of project[b]	200,000 millirem	1×10^{-1}
Life-of-Project Worker Population	32,000 person-rem	19
Noninvolved Worker (Year of Maximum Impact)		
At the 242-A Evaporator (2035)	0.094 millirem	6×10^{-8}
At the Environmental Restoration Disposal Facility (2035)	0.31 millirem	2×10^{-7}

a For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

b Impact over the life of the project is the average dose a full-time-equivalent radiation worker would receive working on this project. It is determined by multiplying the average annual dose by an assumed career length of 40 years.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

The total effective dose to the involved worker population from the 96 years of occupational exposure was estimated to be 32,000 person-rem. Given the risk factor of 0.0006 LCFs per person-rem, 19 LCFs are expected to result from the dose associated with tank farm operations, tank waste retrieval, and clean closure of WMA TX/TY. Worker doses should be viewed in the context of the duration of the project and the DOE administrative controls employed that limit them. Due to the number of years required to complete clean closure, the dose over the life of the project would be distributed over multiple generations of workers. In addition, worker dose would be limited to less than 5 rem total effective dose per year (10 CFR 835). This regulatory limit would be further constrained by the application of administrative controls. DOE Standard 1098-2008, *Radiological Control*, recommends that the annual dose not exceed 2 rem, unless explicitly authorized by DOE management (e.g., for emergency situations). Individual worker

doses would be maintained ALARA and generally be controlled at a level below 500 millirem (0.5 rem) per year.

Estimated doses and risks to the noninvolved workers at the 242-A Evaporator or the ERDF in the year of maximum impact are shown in Table 3–84. Doses to noninvolved workers would be a small fraction of the DOE recommended Administrative Control Level of 500 millirem per year.

3.6.11 Public and Occupational Health and Safety – Facility Accidents

This section addresses potential impacts on workers and the public associated with tank-farm-related accidents. Radiological impacts of the postulated accident scenarios were quantified for an MEI living near Hanford, the offsite population living within 80 kilometers (50 miles) of the facility, and a noninvolved worker assumed to be 100 meters (110 yards) from the facility. Hazardous chemical impacts were also evaluated. For an involved worker, accident consequences were not quantified. While involved workers are expected to be near the Hanford tank farms during routine tank farm operations, their number and location relative to a postulated accident are unknown. In the event of an accident involving chemicals or radioactive materials, workers near an accident could be at risk of serious injury or fatality. Safety procedures, safety equipment, and protective barriers are typical features that would prevent or minimize worker impacts. Additionally, following initiation of accident/site emergency alarms, workers in adjacent areas would evacuate in accordance with the technical area and facility emergency operating procedures and training. Therefore, involved worker impacts are not discussed further.

There would be no radiological accidents associated with facility construction. Further, any hazardous chemical accidents associated with facility construction would be typical of those normally associated with industrial construction materials, hazards, and practices. Projected operational accident consequences are presented in the following sections. Details of the methodology for assessing the potential impacts on workers and the public associated with postulated accidents are presented in Appendix K, Section K.3, of the *Final TC & WM EIS* (DOE 2012).

3.6.11.1 Radiological Impacts of Airborne Releases

During tank farm operations, tank waste retrieval, or clean closure activities, reasonably foreseeable accidents that could occur include: 1) hydrogen burn in a waste storage tank; and 2) tank dome collapse. The accident selected to represent a severe accident is the seismically induced waste tank dome collapse. The consequences of a seismically induced waste tank dome collapse, if it were to occur, are shown in Table 3–85. The annual risks of LCFs for this accident, which were obtained by multiplying the consequences by the likelihood (frequency per year) that the accident would occur, are shown in Table 3–86.

Table 3-85 Waste Management Area TX/TY Clean Closure Radiological Consequences of Accidents

Accident	Maximally Exposed Individual		Offsite Population[a]		Noninvolved Worker	
	Dose (rem)	LCF[b]	Dose (person-rem)	LCF[c]	Dose (rem)	LCF[b]
Seismically induced waste tank dome collapse – unmitigated	0.00021	1×10^{-7}	1.3	0 (8×10^{-4})	0.22	1×10^{-4}

a Based on a population of 589,668 persons residing within 80 kilometers (50 miles) of the 200-West Area.

b Increased likelihood of latent cancer fatality for an individual, assuming the accident occurs.

c The reported value is the projected number of latent cancer fatalities (LCF) among the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

Key: LCF=latent cancer fatality.

Table 3-86 Waste Management Area TX/TY Clean Closure Annual Cancer Risks from Accidents

Accident	Frequency (per year)	Risk of Latent Cancer Fatality		
		Maximally Exposed Individual[a]	Offsite Population[b, c]	Noninvolved Worker[a]
Seismically induced waste tank dome collapse – unmitigated	5×10^{-4}	6×10^{-11}	4×10^{-7}	7×10^{-8}

a Increased risk of a latent cancer fatality to the individual, taking into account the probability (frequency) of the accident.

b Based on a population of 589,668 persons residing within 80 kilometers (50 miles) of the 200-West Area.

c The reported value is the projected number of latent cancer fatalities (LCF) among the population, based on the probability (frequency) of the accident occurring, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

3.6.11.2 Hazardous Chemical Impacts

Various hazardous chemicals exist in the waste tanks. Because the chemicals that exist in the tank waste are mixed with the radioactive material, any accident event is expected to release both hazardous chemicals and radioactive materials. Due to the quantity and nature of the radioactive material in the waste tanks, the human health consequences of an accidental release would be dominated by the impacts of the radioactive components. Therefore, hazardous chemical human health impacts were not analyzed separately.

3.6.11.3 Intentional Destructive Acts

This section addresses potential impacts of intentional destructive acts at a tank farm. To protect against such actions, safeguards and security measures are employed at all DOE facilities. In accordance with DOE Orders, DOE conducts vulnerability assessments and risk analyses of facilities and equipment under its jurisdiction to evaluate the physical protection elements, technologies, and administrative controls needed to protect DOE assets. DOE also protects against espionage, sabotage, and theft of radioactive, chemical, or biological materials; classified information and matter; nonnuclear weapon components; and critical technologies. Before startup of any new or substantially modified operations, DOE would conduct an indepth, site-specific safeguards and security inspection to ensure that existing programs satisfy DOE requirements. Any inadequacies would be resolved before startup of operations. Release scenarios and impacts resulting from intentional destructive acts may be similar to the accident

scenarios analyzed. Additional scenarios representing intentional destructive acts that may not be represented by the accident analyses were also considered.

Explosive Device in Underground Waste Tank. It was postulated that intentionally initiated explosions occur that displace a large portion of the soil overburden, breach the tank dome, and disperse a portion of the tank waste into the atmosphere. In accordance with the recommendation from *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, Vol. 1, Analysis *of Experimental Data* (DOE Handbook 3010-94), the respirable release would be less than the TNT equivalent weight of the explosive charge. Analysis results indicate that the radiological impacts of an explosive device in an underground waste tank would be about four times greater than the impacts of the most severe accident scenario that involved the same inventory of radioactive material (seismically induced waste tank dome collapse). The offsite population dose was estimated to be 4.9 person-rem, with no (3×10^{-3}) resulting additional LCFs. The MEI dose would be 0.00083 rem, corresponding to an increased risk of an LCF of 5×10^{-7}. The noninvolved worker dose would be 0.88 rem, corresponding to an increased risk of an LCF of 5×10^{-4}.

3.6.12 Public and Occupational Health and Safety – Transportation

About 51,100 onsite shipments of radioactive waste would occur due to WMA TX/TY clean closure activities. The dose to transportation workers from all transportation activities was estimated at about 57 person-rem; the dose to the public would be about 3.1 person-rem. Accordingly, incident-free transportation of radioactive material would result in zero (0.034) LCFs among transportation workers and zero (0.0018) LCFs in the total affected population over the duration of transportation activities.

The estimated total transportation accident risks are a radiation dose risk to the population of about 1.8×10^{-5} person-rem, resulting in 1.1×10^{-8} LCFs, and traffic accidents resulting in zero (0.023) fatalities.

The nonradiological impacts of transporting construction and operational material and radioactive and nonradioactive secondary waste would be 24.2 million kilometers (15.0 million miles) traveled, 5 accidents, and 0 (0.32) fatalities over the entire period from construction through deactivation and closure.

3.6.13 Environmental Justice

Section 3.6.10 discusses short-term impacts on the public as a result of normal operations from clean closure of WMA TX/TY. Radiological impacts of normal operations on minority, American Indian, Hispanic, or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model the four population group exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radiologically contaminated produce and animal products.

For purposes of evaluating the potential for disproportionately high and adverse impacts caused by radiological air emissions from normal operations, the total dose to an average individual of

the minority, American Indian, Hispanic, or Latino, and low-income populations is compared to the total dose to an average individual of the remainder of the population. Table 3–87 summarizes the average individual total doses for the life of the project. There are no appreciable differences between average individual total doses. Therefore, closure of WMA TX/TY would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Table 3-87 Waste Management Area TX/TY Clean Closure Average Individual Total Dose from Radioactive Air Emissions over the Life of the Project

Subset Population	Individual Average Dose (millirem)	
	Subset Population	Remainder of Population
Minority	0.022	0.028
American Indian	0.013	0.025
Hispanic or Latino	0.021	0.028
Low-income	0.021	0.026

Section 3.6.10 discusses radiological impacts on the offsite MEI, who is located at the far side of the Columbia River opposite Hanford. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation were evaluated. As a result of WMA TX/TY clean closure, the total dose received by an individual residing at the point of greatest impact along the reservation boundary would be the equivalent of less than approximately one-fifteenth of the total dose received by the MEI from the general population. Therefore, closure of WMA TX/TY would not pose disproportionately high and adverse impacts on the American Indian population due to normal operations.

Section 3.6.11 discusses radiological impacts of airborne releases from facility accidents hypothesized as a result of WMA TX/TY clean closure. Examination of the risks shows that there would be essentially no LCFs per year for the offsite population, including minority, American Indian, Hispanic, or Latino, and low-income populations. Therefore, clean closure of WMA TX/TY would not pose disproportionately high and adverse impacts on the minority, American Indian, Hispanic, or Latino, or low-income populations due to accident consequences.

Air quality impacts resulting from WMA TX/TY clean closure are discussed in Section 3.6.4. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; as there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic, or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 3.6.12 discusses the potential human health risks from onsite waste transportation and transporting construction materials from onsite, local, or regional locations to Hanford. The impacts of transporting onsite waste and construction materials to Hanford due to WMA TX/TY clean closure would be very small. Therefore, clean closure of WMA TX/TY would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

3.6.14 Waste Management

Table 3–88 represents the estimated waste volumes generated as a result of WMA TX/TY clean closure activities. These activities would include clean closure of the TX and TY Tank Farms in the 200-East area following deactivation. Clean closure of the tank farms would encompass removal of highly and moderately contaminated tank and ancillary equipment, all of which would be managed as HLW.

Tank closure waste that is not managed as HLW would be disposed of in the proposed RPPDF, to be located between the 200-East and 200-West Areas. The RPPDF would be similar to the IDF.

Primary Waste

As shown in Table 3–88, the volume of PPF melters generated due to WMA TX/TY clean closure would be 431 cubic meters (15,200 cubic feet). A total of 170,000 cubic meters (6.0 million cubic feet) of additional HLW would also be generated and stored on site in shielded boxes.

Secondary Waste

The estimated volume of mixed TRU waste, 66 cubic meters (2,330 cubic feet), as shown in Table 3–88, should not impact existing TRU waste treatment and storage facilities. LLW and MLLW volumes generated by tank closure would be 12,200 cubic meters (431,000 cubic feet) of LLW; 679 cubic meters (24,000 cubic feet) of closure LLW; and 13,400 cubic meters (473,000 cubic feet) of MLLW. LLW and MLLW would be disposed of in an IDF. No long-term storage capacity would be needed.

For clean closure of WMA TX/TY, and all other WMAs, large quantities of MLLW would be generated by the removal of ancillary equipment and the excavation of contaminated soil from the tank farms. This large quantity of tank closure waste would include approximately 532,000 cubic meters (18.8 million cubic feet) of MLLW. This contaminated soil would be disposed of in the proposed RPPDF. PPF treatment of the soils would generate 352 cubic meters (12,400 cubic feet) of PPF glass. These canisters would be disposed of in an onsite IDF.

A total of 378 cubic meters (13,300 cubic feet) of hazardous waste would be generated during construction, operations, and closure activities required for WMA TX/TY clean closure. The estimated volume of nonhazardous waste would be approximately 431,000 cubic meters (15.2 million cubic feet). This waste would be sent for offsite disposal in a local landfill. This additional waste load would have only a minor impact on the handling and accumulation of nonhazardous solid waste at Hanford.

Table 3-88 Waste Management Area TX/TY Clean Closure Waste Generation Volumes

Waste Type	Project Phase					Peak Annual Generation		Total Waste Volume to IDF(s)/RPPDF
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Waste Volume/Year	
Primary Waste								
Other high-level radioactive waste	N/A	N/A	N/A	170,000	170,000	2062–2069	14,500	N/A
Preprocessing Facility melters	N/A	N/A	N/A	431	431	Various	123	431 (IDF)
Secondary Waste								
Preprocessing Facility glass	N/A	N/A	N/A	352	352	2062–2078	21	352 (IDF)
Low-level radioactive	N/A	409	213	11,600	12,200	2070–2072	723	12,200 (IDF)
Low-level radioactive (closure)[a]	N/A	N/A	N/A	679	679	2070–2072	226	679 (RPPDF)
Mixed low-level radioactive	N/A	359	372	12,700	13,400	2070–2072	913	13,400 (IDF)
Mixed low-level radioactive (closure)[b]	N/A	N/A	N/A	532,000	532,000	2062–2069	57,300	532,000 (RPPDF)
Transuranic mixed	N/A	66	N/A	N/A	66	2026 2028	8	N/A
Hazardous[c]	71	179	N/A	128	378	2026	23	N/A
Nonradioactive–nonhazardous[d]	N/A	N/A	36	431,000	431,000	2050–2061	31,100	N/A

[a] Closure low-level radioactive waste is the waste from decontamination and decommissioning of the containment structure over the tank farm after soil removal is complete.

[b] Closure mixed low-level radioactive waste includes rubble, soil, and equipment removed during closure of the tank farm.

[c] Hazardous waste is accumulated on site for less than 90 days and then shipped to offsite commercial facilities for treatment and/or disposal.

[d] Nonhazardous solid waste is shipped to offsite commercial facilities for recycling, treatment, and disposal.

Note: All values are in cubic meters. To convert cubic meters to cubic feet, multiply by 35.315. Total may not equal the sum of the contributions due to rounding.

Key: IDF=Integrated Disposal Facility; N/A=not applicable; RPPDF=River Protection Project Disposal Facility.

3.6.15 Industrial Safety

Illness, injury, and death are possible outcomes of any industrial accident. The accepted standard for measuring the outcome of an industrial accident is the number of fatalities and the TRCs (the occurrence of illness or injury). A fatal occurrence is a work-related injury or illness that causes the death of the employee. TRCs include work-related illness or injury that results in loss of consciousness, restriction of work or motion, transfer to another job, a requirement for medical treatment beyond first aid, or death.

As ORP has not experienced a fatality during recent history, the DOE and contractor rate (for all labor categories) of 0.26 per 200 million labor hours was adopted as representative of fatal occurrences. The impacts of illness and injury can be calculated using the total project labor hours and the appropriate incident rate. The total labor hours were calculated from the scaled data sets (SAIC 2012). The subtotal for each type of activity (construction, operations, deactivation, and closure) for clean closure of WMA TX/TY is presented in Table 3–89.

Table 3-89 Waste Management Area TX/TY Clean Closure Industrial Safety Impacts

Labor Category	Million Labor Hours	Total Recordable Case Rate per 200,000 Labor Hours	Projected Total Recordable Cases	Fatality Rate per 200 Million Labor Hours	Projected Fatalities
Construction	19.7	2.0	197.0	0.26	0.0256
Operations	42.2	2.0	422.0	0.26	0.0549
Deactivation	0.36	2.0	3.5	0.26	0.0005
Closure	15.7	2.0	157.0	0.26	0.0204
Total	**78.0**		**779.5**		**0.1013**

Note: Projected fatalities are displayed to four decimal places to show at least one significant digit. All other values presented in the table have been rounded to no more than three significant digits. Totals may not equal the sum of the contributions due to rounding.
Source: Labor hours compiled from the scaled data sets (SAIC 2012).

A total of 78 million hours of labor would be required to complete all phases of WMA TX/TX clean closure. Operations would require 42 million hours of labor; construction, almost 20 million; and closure, almost 16 million. Given the selected incident rates for illness and injury, it is expected that 780 TRCs would occur; no fatalities are projected. The TRC breakdown indicates that 422 TRCs would occur during operations, 197 during construction, and 157 during closure.

3.6.16 Cost Analysis

The cost estimates, in 2008 dollars, for construction, operations, deactivation, closure, and disposal activities required to clean-close WMA TX/TY are provided in Table 3–90.

Table 3-90 Waste Management Area TX/TY Clean Closure Summary of Estimated Costs (millions of 2008 dollars)

Construction	Operations	Deactivation	Closure	Disposal	Total
967	1,520	34	2,716	1,462	6,699

Note: Estimates are costs to the Hanford Site only.
Source: DOE 2009.

Included in the construction costs are the costs to build or modify the 24 SSTs at the TX and TY tank farms to support waste retrieval and the construction of interim storage facilities for

HLW debris from the clean closure of the SSTs. Operations costs include ongoing operations of the TX and TY tank farms, retrieval of tank waste, and operations of Borrow Area C, the onsite pit used to supply sand, soil, and gravel for backfilling the tank farms after the SSTs are removed. Deactivation costs include deactivation of tank waste retrieval equipment and facilities.

Closure costs include the construction and deactivation of confinement structures over the tank farms required during tank removal and contaminated deep soil removal, as well as removal of the 24 SSTs and ancillary equipment within the tank farms and the contaminated deep soils. The removed highly contaminated RSE that would be managed as HLW would be maintained in shielded storage boxes on site on covered concrete storage pads. Closure costs also include the construction, operations, and deactivation of the PPF, a soil-washing facility that would treat highly contaminated (non-HLW) soils. This treatment would result in: 1) washed soils, which would be packaged for onsite disposal in the proposed RPPDF; and 2) contaminated liquid waste streams, which would be treated in the PPF melter, producing a LAW glass that would be disposed of in the IDF.

Disposal costs include the construction, operations, closure, and postclosure care of the IDF and RPPDF that are necessary for the clean closure of the 24 SSTs at the TX and TY tank farms.

3.7 WASTE MANAGEMENT AREA U

WMA U is composed of the U Tank Farm and is located in the south-central portion of the 200-West Area near the U plant (see Figure 3–13). The U Tank Farm contains several types of wastes, including plutonium extraction metal waste, REDOX process waste, coating waste, decontamination waste from the bismuth phosphate process used to remove plutonium from irradiated fuel at the T and B Plants, and evaporator feed and bottoms waste. The U Tank Farm includes the following:

- SSTs of varying size
- Waste transfer lines
- Multiple drywells around each 100-series SST, used as leak detection systems
- Tank ancillary equipment

The U Tank Farm is one of the original tank farm designs, along with the B, C, and T Tank Farms. The U Tank Farm consists of 12 first-generation 2-million-liter (530,000-gallon) (100-series) and four 208,000-liter (55,000-gallon) (200-series) SSTs constructed in 1943 and 1944. The twelve 100-series tanks are 23 meters (75 feet) in diameter and approximately 10 meters (35 feet) in height from base to dome, with curved-dish bottoms. The four 200-series tanks are about 6 meters (20 feet) in diameter and 8 meters (26 feet) in height, also with curved-dish bottoms. The SSTs are constructed of a steel-reinforced concrete shell that encompasses a steel plate liner (DOE 1997c).

One large rectangular excavation about 12.8 meters (42 feet) deep was made for the construction and placement of all of the U tank farm SSTs. The original excavated material was uniformly backfilled around the tanks, and the tanks were covered with about 2.1 meters (7 feet) of backfill material (Brevick, Gaddis, and Johnson 1994a). Several inches of gravel were placed on top of

the backfilled sediments to provide protection and retard establishment of vegetation. The U tanks are sited at slightly different elevations, creating a gradient that allows liquids to flow from one tank to another as they are filled. The tanks are arranged in four cascades, each consisting of a three-tank cascade series, with the receiving tank 0.3 meters (1 foot) lower than the feed tank (DOE 1997c).

Most of the U Tank Farm SSTs were removed from service during the 1970s, with one tank removed in 1961 and one in 1980, and all have been interim-stabilized. Eight of the 100-series tanks are categorized as sound (U-102, U-103, U-105, U-106, U-107, U-108, U-109, and U-111). Three of these tanks (U-103, U-105, and U-107) are on both the hydrogen and organic salt watch lists, while U-106 and U-111 are on the organic salt watch list and U-108 and U-109 are on the hydrogen watch list. Four of the 100-series tanks are classified as leakers (U-101, U-104, U-110, and U-112). All four of the 200-series tanks are categorized as sound, with two of these tanks (U-203 and U-204) on the organic salt watch list (Connelly 2007).

Figure 3-13 General Location of Waste Management Area U

3.7.1 Land Resources

3.7.1.1 Land Use

Clean closure of WMA U would involve land-disturbing activities associated with construction of an underground transfer line, WRF, HLW Debris Storage Facility, PPF, IDF, and the proposed RPPDF. Clean closure activities would also require the extraction of material from Borrow Area C. For most facilities and activities, the acreage requirement was determined by use of a scaling factor that adjusted the total land requirement for closing all Hanford tank farms (as reported in the *Final TC & WM EIS* [DOE 2012]) to a specific value for WMA U. However, this was not done for the WRF and PPF, as the minimum requirement to close a WMA is one facility. Also, it was not necessary to scale the length of the underground transfer line.

WMA U is located in the 200-West Area; however, not all activities associated with its closure would take place in this area. Thus, land would also be disturbed within the 200-East Area (for the IDF), between the 200-East and 200-West Areas (for the HLW Debris Storage Area, PPF, and proposed RPPDF), and within Borrow Area C. Within the 200-West Area, a total of 3.46 hectares (8.54 acres) would be disturbed, all of which is developed. Within the 200-East Area, 1.25 hectares (3.08 acres) would be disturbed, none of which is developed. Development within the area between the 200-East and 200-West Areas would require 35.6 hectares (87.9 acres), all of which is undeveloped. Disturbance within Borrow Area C would total 43.7 hectares (108 acres), all of which is also undeveloped. Thus, a total of 84.2 hectares (208 acres) would be required for clean closure of WMA U, of which only 3.46 hectares (8.54 acres) is currently developed.

3.7.1.2 Visual Resources

As noted above, a total of 84.2 hectares (208 acres), most of which is not currently developed, would be required for clean closure of WMA U. Within the 200-East and 200-West Areas, development would have little impact on visual resources, as these areas are already highly industrialized. However, the use of 35.6 hectares (87.9 acres) between the 200-East and 200-West Areas would impact visual resources, as this land is currently not developed. The conversion of this land to an industrial use would add to the overall developed nature of the area and would be visible from nearby higher elevations. The viewscape from these higher elevations is important to American Indians with cultural ties to Hanford. Clean closure activities would involve constructing containment structures over the WMA; however, these structures would be removed upon completion of clean closure activities. Although there would be an overall increase in the industrial appearance of the 200 Areas, the BLM Visual Resource Management Class IV rating would not change. Management activities within Class IV areas dominate the view and typically are the focus of viewer attention.

As noted above, 43.7 hectares (108 acres) within Borrow Area C would be excavated for the clean closure of WMA U. Development of Borrow Area C would be readily visible from State Route 240 and Rattlesnake Mountain and would change the BLM visual resource management rating from Class II to Class IV. Management activities within Class II areas may be seen but should not dominate the view. Upon completion of WMA U closure, excavations in Borrow Area C would be recontoured and revegetated, thereby lessening the visual impact.

3.7.2 Infrastructure

For WMA U clean closure, activities related to the PPF and the RPPDF, which will be located between the 200-East and 200-West Areas, would have the highest total demands for water, diesel fuel, and gasoline. Operation of Borrow Area C would also generate high total water and fuel demands. Deep soil removal from the U Tank Farm and removal of tanks, ancillary equipment, and soils would result in the highest total electricity requirement due to WMA U clean closure activities.

Water would be required during construction for soil compaction, dust control, and possibly work surface and equipment washdown. Standard construction practices dictate that, at least initially, construction water would be trucked to construction locations on an as-needed basis for these uses until water supply and wastewater treatment utilities are in place. Concrete and grout would be produced in onsite batch plants, which would require large volumes of water. By comparison, relatively little water would be required to meet the potable and sanitary needs of the construction workforce. During operations, water would be required to support process makeup requirements and facility cooling, as well as the potable and sanitary needs of the operations workforce and other uses. To stabilize and partially decontaminate waste treatment, retrieval, and disposal facilities, water would also be used during facility deactivation activities; however, this requirement would be relatively small compared with those for construction and operational demands and for many closure activities, including construction of surface barriers.

Table 3–91 summarizes the projected utility infrastructure resource requirements for WMA U clean closure.

Table 3-91 Waste Management Area U Clean Closure Summary of Utility Infrastructure Requirements

Activity Phase	Electricity (million megawatt-hours)	Diesel Fuel[a]	Gasoline	Water
		(million liters)		
Peak (Year)	**0.016 (2035–2042)**	**36.0 (2101)**	**3.40 (2101)**	**327 (2035–2042)**
Construction	0.004	18.6	1.23	89.2
Operations	0.007	136	4.44	3,170
Deactivation	0.00[b]	0.123	0.159	0.00[b]
Closure	0.246	69.2	6.08	183
Total[c]	**0.257**	**224**	**11.90**	**3,450**

[a] Assumed to be inclusive of all Number 2 diesel fuel, including road diesel and heating fuel oil.

[b] Deactivation values of "0.00" reflect no demand for that utility.

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

Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate. To convert liters to gallons, multiply by 0.26417.

Source: SAIC 2010.

3.7.2.1 Electricity

For clean closure of WMA U, peak annual electrical energy demand of 16,390 megawatt-hours would occur from 2035 through 2042. This peak would be well within the annual capacity of 1.74 million megawatt-hours (based on a peak load capacity of 199 megawatts) of the Hanford electric power transmission system.

3.7.2.2 Fuel

For WMA U clean closure, peak demands of about 36 million liters (9.5 million gallons) of diesel fuel and 3.4 million liters (0.9 million gallons) of gasoline would both occur in 2101. Annualized liquid fuel consumption (diesel fuel and gasoline) would be about 1.21 million liters (0.32 million gallons) during the timespan of clean closure activities for this WMA (2008 through 2202), significantly less than the 4.3 million liters (1.1 million gallons) of liquid fuels currently used annually at Hanford.

3.7.2.3 Water

Peak annual water requirements of 327.4 million liters (86.5 million gallons) would occur from 2035 through 2042. This peak requirement would be well below the 18,500-million-liter (4,890-million-gallon) annual capacity of the Hanford Export Water System.

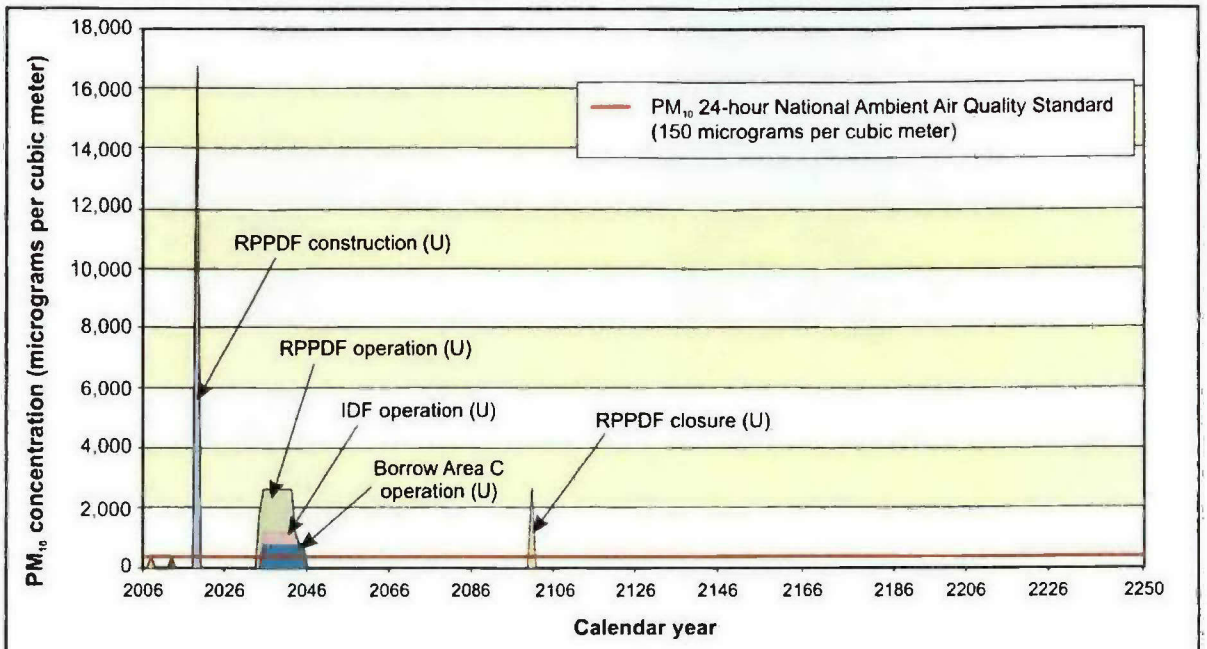
3.7.3 Noise and Vibration

Construction, operation, deactivation, and closure of facilities for clean closure of WMA U would result in minor noise impacts of employee vehicles, trucks, construction equipment and activity, generators, and process equipment. The offsite noise levels from activities at the WTP and 200-East and 200-West Areas would be negligible due to the distance to the Hanford boundary.

Employee and truck traffic to deliver materials for various phases of activities would vary over the duration of the project. The highest number of employee trips is expected to occur in 2015 (SAIC 2012). The increase in the number of employee vehicles and truck trips is expected to cause a minor increase in traffic noise levels along routes to the site. This increase in employee and truck traffic (discussed in Section 3.7.9) was compared with the existing average traffic volume of 30,000 to 40,000 vehicles per day (DOE 2012). For comparison purposes, the increase in traffic noise level can be estimated from the ratio of the projected traffic volume to the existing traffic volume.

3.7.4 Air Quality

Criteria pollutant concentrations that would result from activities for WMA U clean closure are presented in Table 3–92. Peak concentrations of all criteria pollutants except PM would occur in 2101. Peak concentrations of PM would occur in 2019. The peak period concentrations for carbon monoxide, nitrogen dioxide, and sulfur dioxide would result primarily from closure of the proposed RPPDF. Peak period concentrations for PM would result from RPPDF construction. The maximum air quality impacts of PM_{10} emissions would occur to the south at State Route 240. Figure 3–14 shows the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities to these concentrations.



Key: IDF=Integrated Disposal Facility; PM_{10}=particulate matter with an aerodynamic diameter less than or equal to 10 micrometers; RPPDF=River Protection Project Disposal Facility.

Figure 3-14 Waste Management Area U Clean Closure PM_{10} Maximum 24-Hour Concentrations

Table 3-92 Waste Management Area U Clean Closure Maximum Incremental Criteria Pollutant Concentrations

Pollutant and Averaging Period	Standard[a]	Maximum Modeled Increment
	(micrograms per cubic meter)	
Carbon Monoxide		
8-hour	10,000[b]	**41,200**
1-hour	40,000[b]	**257,000**
Nitrogen Dioxide		
Annual	100[b]	88.9
1-hour	188	**179,000**
PM_{10}[c]		
Annual	50[d]	**119**
24-hour	150[b]	**16,800**
$PM_{2.5}$		
Annual	15[d]	**119**
24-hour	35[b]	**16,800**
Sulfur Dioxide		
Annual	50[d]	0.176
24-hour	260[d]	24.5
3-hour	1,300[b]	120
1-hour	197[e]	**353**

a The more stringent of the Federal and Washington State standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (40 CFR 50), other than those for ozone, particulate matter, lead, and those based on annual averages, are not to be exceeded more than once per year. The 24-hour PM_{10} standard is attained when the expected number of days with a 24-hour average concentration above the standard is less than or equal to 1. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard. The annual $PM_{2.5}$ standard is met when the 3-year average of the annual means is less than or equal to the standard. The 24-hour $PM_{2.5}$ standard is met when the 3-year average of the 98th percentile 24-hour averages is less than or equal to the standard. The 1-hour nitrogen dioxide standard is met when the 3-year average 98th percentile of the daily maximum 1-hour average does not exceed the standard value.

b Federal and Washington State standard.

c The Federal standards for $PM_{2.5}$ are 15 micrograms per cubic meter annual average and 35 micrograms per cubic meter 24-hour average. No specific data for $PM_{2.5}$ were available, but for analysis purposes, concentrations were assumed to be the same as those of PM_{10}.

d Washington State standard.

e Federal standard.

Note: The National Ambient Air Quality Standards also include standards for lead and ozone. No sources of lead emissions have been identified for the activities evaluated. Washington State also has ambient standards for fluorides. Concentrations in **bold** text indicate potential exceedance of the standard.

Key: PM_n=particulate matter with an aerodynamic diameter less than or equal to *n* micrometers.

Source: Based on emissions data in SAIC 2012.

Maximum concentrations of carcinogenic and noncarcinogenic toxic pollutants are presented in Table 3–93. No impacts on the public due to projected nonradioactive toxic pollutant emissions are expected as a result of WMA U clean closure activities. Hazardous chemical health effects on noninvolved workers are summarized in Tables 3–94 and 3–95.

Table 3-93 Waste Management Area U Clean Closure Maximum Incremental Nonradioactive Toxic Chemical Concentrations

Pollutant	Averaging Period	Acceptable Source Impact Level[a]	Maximum Modeled Increment
		(micrograms per cubic meter)	
Ammonia	24-hour	70.8	20.0
Benzene	Annual	0.0345	0.0323
1,3-Butadiene	Annual	0.00588	0.000842
Formaldehyde	Annual	0.167	0.0278
Mercury	24-hour	0.09	0.00000655
Toluene	24-hour	5,000	31.2
Xylene	24-hour	(b)	9.27

[a] WAC 173-460.

[b] Not listed in WAC 173-460.

Note: To convert cubic meters to cubic feet, multiply by 35.315.

Source: Based on emissions data in SAIC 2012.

Table 3-94 Waste Management Area U Clean Closure Nonradioactive Airborne Toxic Chemical Hazard Index for the Nearest Noninvolved Worker

Chemical	Hazard Quotient
Ammonia	1.14×10^{-1}
Mercury	2.86×10^{-5}
Toluene	1.89×10^{-3}
Xylene	2.84×10^{-2}
Hazard Index	1.44×10^{-1}

Source: Based on emissions data in SAIC 2012.

Table 3-95 Waste Management Area U Clean Closure Nonradioactive Airborne Toxic Chemical Cancer Risk for the Nearest Noninvolved Worker

Chemical	Cancer Risk
Benzene	1.20×10^{-5}
1,3-Butadiene	1.30×10^{-6}
Formaldehyde	1.83×10^{-5}

Source: Based on emissions data in SAIC 2012.

3.7.5 Geology and Soils

Consumption of geologic resources (rock, minerals, and soils) to support facility construction, operations, and deactivation, as applicable, would constitute the major indirect impact on geologic and soil resources from implementation of clean closure of WMA U and associated waste management activities, as summarized in Table 3–96. Varying quantities of geologic resources would be required for ongoing facility construction; upgrades to existing facilities, including the 200 Area tank farms; waste retrieval activities; and, most substantially, tank farm closure. Geologic resources, including relatively large volumes of gravel, sand, and silt, are available from the suprabasalt sediments and associated soils at Hanford. Rock, in the form of

basalt, is also plentiful. As discussed in the *Environmental Assessment, Use of Existing Borrow Areas, Hanford Site, Richland, Washington* (DOE 2001a), a number of active gravel and sand pits and two rock quarries at Hanford have been identified for use in providing a continual supply of borrow materials for new facility construction, maintenance of existing facilities, and fill and capping material for remediation and other activities. Of the two active quarries on the site, quarry No. 2 (Borrow Area C), located due south of the 200-West Area just south of State Route 240, has large volumes of basalt and sand (DOE 2001a). This approximately 926.3-hectare (2,289-acre) borrow area has been designated as a source of materials such as rock riprap (basalt), aggregate (gravel and sand), and soil (silt and loam) that would be needed to support tank farm closure and supporting activities (DOE 2003a).

Table 3-96 Waste Management Area U Clean Closure Major Geologic and Soil Resource Impact Indicators and Requirements

Construction Materials				Other Borrow Materials[a]				Closure-Specific Materials		
Concrete/ Grout	Cement[b]	Sand[b]	Gravel[b]	Rock/Basalt	Sand	Gravel	Soil (Specification Backfill)	Grout[c]	Cement	Sand[d]
98,700	20,700	48,000	45,100	0	368,000	188,000	6,380,000	1,460	170	710

[a] Resources for miscellaneous uses not exclusively tied to facility construction, operations, or closure, such as site grading and backfill for operations.

[b] Cement, sand, and gravel are components of concrete.

[c] Grout is composed of cement, sand, fly ash, and other materials.

[d] Principal component of grout that would be obtained from onsite deposits.

Note: Values have been rounded to no more than three significant figures. All values are expressed in cubic meters. To convert cubic meters to cubic feet, multiply by 35.315.

3.7.6 Water Resources

All construction and closure-related land disturbances, especially for new facility construction, would expose soils and sediments to possible erosion by infrequent, heavy rainfall or by wind. While unlikely to reach surface-water features, stormwater runoff from exposed areas could convey soil, sediments, and other pollutants (e.g., construction waste materials and spilled materials, such as petroleum, oils, and lubricants from construction equipment) from construction footprint and laydown areas. Nevertheless, appropriate soil erosion and sediment control measures, as well as spill prevention and waste management practices, would be employed to minimize suspended sediment, the transport of other deleterious materials, and any potential water-quality impacts. Further, all construction and other ground-disturbing activities would be conducted in accordance with current NPDES and state waste discharge general permits for stormwater discharges associated with construction activities, issued by Ecology. The NPDES permit specifically requires the development and implementation of a stormwater pollution prevention plan.

Once completed, new facilities required for clean closure of WMA U would incorporate appropriate stormwater management controls to collect, convey, and detain stormwater from buildings and other impervious surfaces so as to minimize the impacts of onsite hydrology and soil erosion. Hanford's NPDES Storm Water Multi-Sector General Permit would cover stormwater discharges associated with industrial activity and, as necessary, stormwater discharges would be covered under state waste discharge permits for discharges to the ground.

Under normal operations associated with WMA closure, facility design combined with adherence to spill prevention and emergency response plans and procedures would help to ensure that involved hazardous substances, including spills, should they occur, do not reach soils or surfaces where they could be conveyed to surface water or groundwater. For construction, operations, deactivation, and closure activities, adherence to best management practices and other preventive measures under applicable permits and compliance plans would be coordinated by DOE with those measures in similar sitewide pollution prevention plans.

There would be no direct discharge of effluents to either surface water or groundwater during construction, operations, and deactivation as a result of WMA U clean closure. Nonhazardous sanitary wastewater (sewage) would be managed via appropriate sanitary wastewater collection and treatment systems. During the early phases of new facility construction, it was assumed that portable toilet facilities would be provided for construction personnel, with collected waste disposed of at offsite contractor facilities, as is standard construction practice. During facility operations and deactivation, sanitary wastewater would be disposed of via the dedicated sanitary sewer or septic/drain-field system serving a particular facility.

Water would be required to support new facility construction, facility operations, and facility deactivation for WMA U clean closure. Water would be required for WRF construction; replacement of underground transfer lines; and construction of tank upgrades, a new riser, an MRS, a VBR system, the PPF, IDF-East, and the proposed RPPDF that will be located between the 200-East and 200-West Areas. Total water demands have been conservatively estimated at 3,440 million liters (909 million gallons), with a peak demand of 327 million liters (86 million gallons). Peak periods of water demands would occur during years 2035 through 2042 as a result of operation of Borrow Area C and the RPPDF. All utility demands, as well as water demands, are discussed in Section 3.7.2, Infrastructure.

3.7.7 Ecological Resources

3.7.7.1 Terrestrial Resources

As noted in Section 3.7.1.1, a total of 40.3 hectares (99.5 acres) within the 200-East Area, 200-West Area, and between the 200-East and 200-West Areas would be disturbed by construction of the facilities required to clean-close WMA U. Of this total, 1.25 hectares (3.08 acres) would be developed within the 200-East Area, 3.46 hectares (8.54 acres) within the 200-West Area, and 35.6 hectares (87.9 acres) between the 200-East and 200-West Areas. Within the 200-East Area and between the 200-East and 200-West Areas, all of the land needed for construction is sagebrush habitat, whereas within the 200-West Area all of the land needed for construction has been previously disturbed. Late successional sagebrush habitat is considered a Level III resource under the *Hanford Site Biological Resources Management Plan* (DOE 2001b:4.11). Hanford guidance may require the replacement of sagebrush habitat at a ratio ranging from 1:1 to 3:1 (DOE 2003b:20, 21, 31). Specific measures to mitigate the loss of sagebrush habitat would be set forth in a mitigation action plan prior to construction.

The clean closure of WMA U would require that 43.7 hectares (108 acres) of Borrow Area C be excavated to supply needed geologic material. The two major plant communities present within the area are cheatgrass-bluegrass (782 hectares [1,933 acres]) and needle-and-thread grass/Indian ricegrass (107 hectares [265 acres]) (DOE 2012). The latter represents an unusual and relatively

pristine community type at Hanford; thus, it is considered a more highly valued community than the former. It is not possible to determine specific impacts of excavating Borrow Area C on ecological resources because the particular portion of the site from which geologic material would be excavated is unknown. To the extent that it is possible, the needle-and-thread grass/Indian ricegrass community should be avoided during excavation. A mitigation action plan would be developed prior to excavation.

3.7.7.2 Threatened and Endangered Species

Federally or state-listed threatened or endangered species have not been observed within, or in the immediate vicinity of, the 200 Areas or Borrow Area C; therefore, impacts on this group of plants and animals are not expected as a result of WMA U clean closure. Both the Columbia and Yakima Rivers adjacent to Hanford have been designated as critical habitat for the bull trout. However, as there would be no short-term impacts on either river from construction or operation of new facilities associated with clean closure of WMA U, designated critical habitat would not be adversely affected.

A number of state-listed, special status species observed within areas that would be disturbed by clean closure of WMA U could be impacted by construction of the various required facilities. One state-listed species, the sage sparrow (state candidate), was observed within IDF-East. In addition, the loggerhead shrike (Federal species of concern and state candidate), black-tailed jackrabbit (state candidate), sage sparrow, and crouching milkvetch (state watch) have all been observed between the 200-East and 200-West Areas where the HLW Debris Storage Facility, PPF, and the proposed RPPDF would be located. Finally, surveys have identified Piper's daisy (state sensitive), stalked-pod milkvetch (state watch), crouching milkvetch, and the long-billed curlew (state monitor) within the boundaries of Borrow Area C. No state-listed, special status species have been observed within areas to be disturbed within the 200-West Area. The operation of new facilities is not expected to impact any listed species.

Although mitigation would not be required for the state monitor and watch species, they should be considered during project planning. Impacts on state candidate and sensitive species, which are considered Level III resources under the *Hanford Site Biological Resources Management Plan*, require mitigation where impacts would occur. When avoidance and minimization are not possible or are insufficient, mitigation via rectification or compensation is recommended (DOE 2001b:4.9, 8.11). A comprehensive mitigation action plan, which would deal with the loss of state-listed species (as well as sagebrush habitat), would be developed prior to construction.

3.7.8 Cultural and Paleontological Resources

3.7.8.1 Prehistoric Resources

As noted in Section 3.7.1.1, clean closure of WMA U would require a total of 84.2 hectares (208 acres), of which 3.46 hectares (8.54 acres), located in the 200-West Area, is currently developed. Land disturbance due to closure of WMA U would involve the 200-East and 200-West Areas, land between the 200-East and 200-West Areas, and Borrow Area C. White Bluffs Road, an important archaeological resource, is located in the southwest and northeast parts of the 200-West Area. Other prehistoric finds were discovered in the northwestern portion of the 200-West Area and immediately east of the 200-East Area. There are no known

prehistoric resources within the areas that would be affected by the clean closure of WMA U. The survey and geology of these areas indicate that subsurface cultural deposits have little or no potential of being present. The Hanford Cultural Resources Management Plan (DOE 2003c) provides guidance for identifying, evaluating, recording, curating, and managing cultural resources. If any prehistoric resources were discovered during construction or excavation, procedures from the *Hanford Cultural Resources Management Plan* would be implemented.

3.7.8.2 Historic Resources

There would be no impacts on White Bluffs Road or on other known early historic artifacts within the 200-East or 200-West Area from construction or excavation required for clean closure of WMA U. In addition to White Bluffs Road in the 200-West Area, historic resources have been found in the south-central part of the 200-East Area. Buildings associated with the Manhattan Project and Cold War era are found within both the 200-East and 200-West Areas; however, none of these structures would be affected. As is the case for prehistoric resources, if historic resources were discovered, procedures in place to properly identify, evaluate, record, curate, and manage the discovery site would be implemented.

3.7.8.3 American Indian Interests

As stated above, there are no known prehistoric resources that may be an American Indian interest within the affected areas required for the clean closure of WMA U. Clean closure of WMA U would impact 35.6 hectares (87.9 acres) of undeveloped land between the 200-East and 200-West Areas. The conversion of this land to industrial use would be noticeably visible from nearby higher elevations, such as Gable Mountain and Gable Butte. The viewscape from these higher elevations is important to American Indians with cultural ties to Hanford. There would be little impact on the viewscape within the 200-East and 200-West Areas, as the areas are already highly industrialized.

Clean closure of WMA U would also require excavation of 43.7 hectares (108 acres) within Borrow Area C. This would also have an impact on the viewscape from Rattlesnake Mountain; however, upon completion of the work, excavations of Borrow Area C would be recontoured and revegetated, thus lessening the visual impact. Appropriate mitigation measures would be developed in consultation with area tribes.

3.7.8.4 Paleontological Resources

No paleontological resources have been discovered within the 200 Areas or Borrow Area C; therefore, clean closure of WMA U would not impact such resources. However, if any paleontological resources were found during construction or excavation, procedures to properly manage the discovery site would be implemented.

3.7.9 Socioeconomics

3.7.9.1 Regional Economic Characteristics

A workforce of 2,800 FTEs in 2015, as shown in Table 3–97, would be required for construction and operation activities. This peak estimate is approximately 1.6 percent of the projected labor force in the ROI (178,000 in 2015), compared with 10 percent in 2006. The existence of these

direct jobs is expected to result in the creation of another 2,090 indirect positions in the ROI during the peak year. A small (3 FTEs) workforce would be needed for postclosure care of the site beginning in 2103. Implementing WMA U clean closure activities could alter the economic characteristics of the region by increasing demands for goods and services in the Tri-Cities area due to increases in expenditures, income, and employment, both direct and indirect, at Hanford.

Table 3-97 Waste Management Area U Clean Closure Workforce Estimates

Work Activity	Peak Year(s)	Workforce Peak (FTEs)
Construction	2013	1,590
Operations	2016–2017	1,850
Deactivation	2017–2018	41
Closure	2101	1,090
Total Onsite Workforce	**2015**	**2,800**

Key: FTE=full-time equivalent.

3.7.9.2 Demographic Characteristics

While clean closure of WMA U would draw some workers from the local labor force, the demand for construction and operations workers could draw from outside the region. The in-migrations of new workers and their families would increase the overall population within the Tri-Cities area and could alter the demographic characteristics of the region.

3.7.9.3 Housing and Community Services

Implementing clean closure of WMA U would increase the demand for housing and would impact schools and other community services within the Hanford ROI. The demand for housing by construction and operations workers would impact the cost and availability of houses and rental units. School enrollments would increase, and utilities and police and fire services may need to be expanded.

3.7.9.4 Local Transportation

Implementation of WMA U clean closure is expected to have an impact on the local transportation system, especially during the commute periods. The projected increase in commuter traffic to the site would be due primarily to construction and operations activities, peaking at an annual 2,800 FTEs in 2015. This could represent up to 2,240 passenger vehicles per day during the peak year. It is expected that this commuter traffic would impact the regionally established LOS, reducing it below the minimum acceptable ("D") LOS.

The number of annual offsite truck trips would peak at 6,540 trips per year (approximately 25 truck trips per day) in 2101 during construction of the RCRA Subtitle C barrier. At the same time, the predicted onsite truck activity would peak at 101,000 truck trips per year (approximately 389 trips per day). For the majority of the rest of the time period (2046 through 2100 and after 2102), there would be less than one truck trip on or offsite each day.

3.7.10 Public and Occupational Health and Safety – Normal Operations

Activities to clean-close tank farm U could result in radiological exposures to the public and workers. Radiological impacts are presented for three public receptors: the general population (approximately 560,000)[12] living within 80 kilometers (50 miles) of the Hanford 200 Areas, an MEI living near Hanford, and an onsite MEI. Impacts on the general population are evaluated for a residential scenario whereby people are exposed to radioactive materials emitted from project facilities. Radiological exposure occurs through inhalation, direct exposure to the radioactive plume and material deposited on the ground, and ingestion of contaminated products from animals raised locally and fruits and vegetables grown in a family garden (DOE 1995). The MEI is a hypothetical individual member of the public located at a position near the site boundary who would experience the highest impacts during normal operations. The MEI was determined to be a receptor on the east side of the Columbia River. Impacts on the offsite MEI are evaluated for a scenario that includes the same exposure pathways assumed for the general population, but with an increased amount of time spent outdoors and a higher rate of contaminated food consumption. Impacts on the onsite MEI, identified as a member of the public who works at the Columbia Generating Station, LIGO, or U.S. Ecology, would be from inhalation and exposure to the plume and material deposited on the ground. Doses are presented as total effective doses. Details of the assessment methodology for determining radiological exposure of workers and members of the public are presented in Appendix K of the *Final TC & WM EIS* (DOE 2012).

The radiological impacts on members of the public are presented in terms of impacts over the life of the project, i.e., WMA U clean closure (the operational life of the project during which radioactive air emissions would occur), and peak annual impacts. Impacts over the life of the project are the total estimated radiation doses that would be incurred by members of the public over the duration of the activities to complete clean closure of the WMA. The peak annual impacts are the estimated annual radiation doses that would be incurred by members of the public during the year(s) of largest radiation dose.

In addition to members of the public, workers directly involved in the activities to clean-close the WMA and nearby noninvolved workers may receive radiation doses. Doses to an involved worker are calculated based on an FTE employee. It was assumed for the purposes of this dose evaluation that an FTE involved worker has a 2,080-hour work year. In practice, the number of workers who could receive a radiation dose may be larger than the number of FTEs assumed in this analysis, resulting in a smaller average dose per worker. A noninvolved worker is a person working at the site who is incidentally exposed due to the radioactive air emissions associated with tank farm management, tank waste retrieval, and clean closure activities. The potential dose to a noninvolved worker would result from exposure to, and inhalation of, radioactive contaminants released to the atmosphere from tank farm management, tank waste retrieval, and clean closure activities. In the 200-East Area, the noninvolved worker was assumed to be at the 242-A Evaporator, 1,090 meters (3,580 feet) north-northwest of the 200-East Area source. In the 200-West Area, the noninvolved worker was assumed to be at the ERDF, about 950 meters (3,120 feet) east of the 200-West Area source.

[12] The approximate population is based on populations of 542,324; 546,746; and 589,668 people residing within 80 kilometers (50 miles) of the Waste Treatment and Immobilization Plant, 200-East Area, and 200-West Area, respectively, as described in the *Final TC & WM EIS* (DOE 2012).

The impacts of radionuclide releases from construction, operations, deactivation, and cleanup of facilities directly related to tank farm management, tank waste retrieval, and clean closure of WMA U were evaluated.

3.7.10.1 Radiological Impacts on the Public

Table 3–98 presents estimated doses to the general population and the MEI for clean closure activities associated with WMA U. Activities conducted at WMA U that would generate radioactive air emissions would occur from 2011 through 2100. Due to the long timeframe involved, the doses over the life of the project may not be received by the same members of the population or the same MEI, but are presented as a measure of potential impacts to provide a basis for comparison with other WMAs.

Table 3-98 Waste Management Area U Clean Closure Public Health Impacts of Atmospheric Radionuclide Releases

Receptor	Facility	Impacts over Life of Project[a]		Peak Annual Impacts		
General population		Dose (person-rem)	Number of Latent Cancer Fatalities[b]	Year of Maximum Impact	Dose (person-rem per year)	Number of Latent Cancer Fatalities[b]
	200-East Area	3.6			0.40	
	200-West Area	4.3			0.42	
	Total	**7.9**	**0 (5×10^{-3})**	**2035**	**0.81**	**0 (5×10^{-4})**
Maximally exposed individual		Dose[c] (millirem)	Lifetime Risk of a Latent Cancer Fatality[d]	Year of Maximum Impact	Dose (millirem per year)	Lifetime Risk of a Latent Cancer Fatality[d]
	200-East Area	0.47			0.052	
	200-West Area	0.33			0.031	
	Total	**0.80**	**5×10^{-7}**	**2035**	**0.083**	**5×10^{-8}**
Onsite MEI	**Total**	**0.37**	**2×10^{-7}**	**2035**	**0.035**	**2×10^{-8}**

a Impacts accrued over the operational life of the project to clean-close Waste Management Area U.

b The reported value is the projected number of latent cancer fatalities (LCF) among the population and is therefore presented as a whole number. The result, calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem), is shown in parentheses.

c Impacts are provided for assessment purposes. The life-of-project dose likely overestimates the dose that would be received by one individual person because the project could span approximately 88 years.

d Probability of an LCF in the MEI is calculated by converting the dose in millirem to rem (divide by 1,000), then multiplying the dose by the risk factor of 0.0006 LCFs per rem.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: MEI=maximally exposed individual.

Over the life of the project, the population within 80 kilometers (50 miles) of the 200 Areas would receive a cumulative dose of 7.9 person-rem, and the MEI would receive a cumulative dose of 0.80 millirem. Given the risk factor of 0.0006 LCFs per rem (DOE 2003d), no LCFs are expected in the general population as a result of these activities. There would be a probability of 5×10^{-7} (1 chance in 2 million) of the MEI developing an LCF, assuming the same MEI was exposed over the life of the project. Radioactive air emissions would result in a maximum annual population dose of 0.81 person-rem and a maximum annual MEI dose of 0.083 millirem.

The primary contributor to offsite doses would be fission products from processing contaminated tank farm soils through the PPF.

An onsite MEI who spends a normal workday at U.S. Ecology would receive a maximum annual dose of 0.035 millirem. The increased risk of an LCF from this dose would be 2×10^{-8} (1 chance in 50 million).

3.7.10.2 Radiological Impacts on Workers

Table 3–99 presents dose and risk estimates for an involved FTE worker and a noninvolved FTE worker. The average annual FTE radiation worker dose would be 240 millirem, lower than the Administrative Control Level of 500 millirem. A radiation worker who received the average annual dose over the course of 40 years would receive a dose of 9,700 millirem, corresponding to a risk of 6×10^{-3} (1 chance in 170) of developing an LCF.

Table 3-99 Waste Management Area U Clean Closure Normal Operations Radiological Impacts on Workers

Receptor	Dose	Latent Cancer Fatality Risk[a]
Average Involved Full-Time-Equivalent Worker		
Average annual impact	240 millirem	1×10^{-4}
Impact over life of project[b]	9,700 millirem	6×10^{-3}
Life-of-Project Worker Population	1,300 person-rem	0 (8×10^{-1})
Noninvolved Worker (Year of Maximum Impact)		
At the 242-A Evaporator (2035)	0.095 millirem	6×10^{-8}
At the Environmental Restoration Disposal Facility (2035)	0.30 millirem	2×10^{-7}

[a] For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

[b] Impact over the life of the project is the average dose a full-time-equivalent radiation worker would receive working on this project. It is determined by multiplying the average annual dose by an assumed career length of 40 years.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

The total effective dose to the involved worker population from the 90 years of occupational exposure was estimated to be 1,300 person-rem. Given the risk factor of 0.0006 LCFs per person-rem, no LCFs are expected to result from the dose associated with tank farm operations, tank waste retrieval, and clean closure of WMA U. Worker doses should be viewed in the context of the duration of the project and the DOE administrative controls employed that limit them. Due to the number of years required to complete clean closure, the dose over the life of the project would be distributed over multiple generations of workers. In addition, worker dose would be limited to less than 5 rem total effective dose per year (10 CFR 835). This regulatory limit would be further constrained by the application of administrative controls. DOE Standard 1098-2008, *Radiological Control*, recommends that the annual dose not exceed 2 rem, unless explicitly authorized by DOE management (e.g., for emergency situations). Individual worker doses would be maintained ALARA and generally be controlled at a level below 500 millirem (0.5 rem) per year.

Estimated doses and risks to the noninvolved workers at the 242-A Evaporator or the ERDF in the year of maximum impact are shown in Table 3–99. Doses to noninvolved workers would be a small fraction of the DOE-recommended Administrative Control Level of 500 millirem per year.

3.7.11 Public and Occupational Health and Safety – Facility Accidents

This section addresses potential impacts on workers and the public associated with tank-farm-related accidents. Radiological impacts of the postulated accident scenarios were quantified for an MEI living near Hanford, the offsite population living within 80 kilometers (50 miles) of the facility, and a noninvolved worker assumed to be 100 meters (110 yards) from the facility. Hazardous chemical impacts were also evaluated. For an involved worker, accident consequences were not quantified. While involved workers are expected to be near the Hanford tank farms during routine tank farm operations, their number and location relative to a postulated accident are unknown. In the event of an accident involving chemicals or radioactive materials, workers near an accident could be at risk of serious injury or fatality. Safety procedures, safety equipment, and protective barriers are typical features that would prevent or minimize worker impacts. Additionally, following initiation of accident/site emergency alarms, workers in adjacent areas would evacuate in accordance with the technical area and facility emergency operating procedures and training. Therefore, involved worker impacts are not discussed further.

There would be no radiological accidents associated with facility construction. Further, any hazardous chemical accidents associated with facility construction would be typical of those normally associated with industrial construction materials, hazards, and practices. Projected operational accident consequences are presented in the following sections. Details of the methodology for assessing the potential impacts on workers and the public associated with postulated accidents are presented in Appendix K, Section K.3, of the *Final TC & WM EIS* (DOE 2012).

3.7.11.1 Radiological Impacts of Airborne Releases

During tank farm operations, tank waste retrieval, or clean closure activities, reasonably foreseeable accidents that could occur include: 1) hydrogen burn in a waste storage tank; and 2) tank dome collapse. The accident selected to represent a severe accident is the seismically induced waste tank dome collapse. The consequences of a seismically induced waste tank dome collapse, if it were to occur, are shown in Table 3–100. The annual risks of LCFs for this accident, which were obtained by multiplying the consequences by the likelihood (frequency per year) that the accident would occur, are shown in Table 3–101.

Table 3-100 Waste Management Area U Clean Closure Radiological Consequences of Accidents

Accident	Maximally Exposed Individual		Offsite Population[a]		Noninvolved Worker	
	Dose (rem)	LCF[b]	Dose (person-rem)	LCF[c]	Dose (rem)	LCF[b]
Seismically induced waste tank dome collapse – unmitigated	0.00021	1×10^{-7}	1.3	0 (8×10^{-4})	0.22	1×10^{-4}

a Based on a population of 589,668 persons residing within 80 kilometers (50 miles) of the 200-West Area.

b Increased likelihood of latent cancer fatality for an individual, assuming the accident occurs.

c The reported value is the projected number of latent cancer fatalities (LCF) among the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

Key: LCF=latent cancer fatality.

Table 3-101 Waste Management Area U Clean Closure Annual Cancer Risks from Accidents

Accident	Frequency (per year)	Risk of Latent Cancer Fatality		
		Maximally Exposed Individual[a]	Offsite Population[b, c]	Noninvolved Worker[a]
Seismically induced waste tank dome collapse – unmitigated	5×10^{-4}	6×10^{-11}	4×10^{-7}	7×10^{-8}

a Increased risk of a latent cancer fatality to the individual, taking into account the probability (frequency) of the accident.

b Based on a population of 589,668 persons residing within 80 kilometers (50 miles) of the 200-West Area.

c The reported value is the projected number of latent cancer fatalities (LCF) among the population, based on the probability (frequency) of the accident occurring, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

3.7.11.2 Hazardous Chemical Impacts

Various hazardous chemicals exist in the waste tanks. Because the chemicals that exist in the tank waste are mixed with the radioactive material, any accident event is expected to release both hazardous chemicals and radioactive materials. Due to the quantity and nature of the radioactive material in the waste tanks, the human health consequences of an accidental release would be dominated by the impacts of the radioactive components. Therefore, hazardous chemical human health impacts were not analyzed separately.

3.7.11.3 Intentional Destructive Acts

This section addresses potential impacts of intentional destructive acts at a tank farm. To protect against such actions, safeguards and security measures are employed at all DOE facilities. In accordance with DOE Orders, DOE conducts vulnerability assessments and risk analyses of facilities and equipment under its jurisdiction to evaluate the physical protection elements, technologies, and administrative controls needed to protect DOE assets. DOE also protects against espionage, sabotage, and theft of radioactive, chemical, or biological materials; classified information and matter; nonnuclear weapon components; and critical technologies. Before startup of any new or substantially modified operations, DOE would conduct an in-depth, site-specific safeguards and security inspection to ensure that existing programs satisfy DOE requirements. Any inadequacies would be resolved before startup of operations. Release scenarios and impacts resulting from intentional destructive acts may be similar to the accident scenarios analyzed. Additional scenarios representing intentional destructive acts that may not be represented by the accident analyses were also considered.

Explosive Device in Underground Waste Tank. It was postulated that intentionally initiated explosions occur that displace a large portion of the soil overburden, breach the tank dome, and disperse a portion of the tank waste into the atmosphere. In accordance with the recommendation from *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, Vol. 1, *Analysis of Experimental Data* (DOE Handbook 3010-94), the respirable release would be less than the TNT equivalent weight of the explosive charge. Analysis results indicate that the radiological impacts of an explosive device in an underground waste tank would be about four times greater than the impacts of the most severe accident scenario that involved the same inventory of radioactive material (seismically induced waste tank dome collapse). The offsite population dose was estimated to be 4.9 person-rem, with no (3×10^{-3}) resulting additional LCFs. The MEI dose would be 0.00083 rem, corresponding to an increased risk of an LCF of 5×10^{-7}. The noninvolved worker dose would be 0.88 rem, corresponding to an increased risk of an LCF of 5×10^{-4}.

3.7.12 Public and Occupational Health and Safety – Transportation

About 28,600 onsite shipments of radioactive waste would occur due to WMA U clean closure activities. The dose to transportation workers from all transportation activities was estimated at about 33 person-rem; the dose to the public would be about 1.7 person-rem. Accordingly, incident-free transportation of radioactive material would result in zero (0.020) LCFs among transportation workers and 0 (0.0010) LCFs in the total affected population over the duration of transportation activities.

The estimated total transportation accident risks are a radiation dose risk to the population of about 1.2×10^{-5} person-rem, resulting in 7.1×10^{-9} LCFs, and traffic accidents resulting in zero (0.013) fatalities.

The nonradiological impacts of transporting construction and operational material and radioactive and nonradioactive secondary waste would be 13.5 million kilometers (8.4 million miles) traveled, 3 accidents, and zero (0.18) fatalities over the entire period from construction through deactivation and closure.

3.7.13 Environmental Justice

Section 3.7.10 discusses short-term impacts on the public as a result of normal operations from clean closure of WMA U. Radiological impacts of normal operations on minority, American Indian, Hispanic, or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model the four population group exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radiologically contaminated produce and animal products.

For purposes of evaluating the potential for disproportionately high and adverse impacts caused by radiological air emissions from normal operations, the total dose to an average individual of the minority, American Indian, Hispanic, or Latino, and low-income populations is compared to the total dose to an average individual of the remainder of the population. Table 3–102

summarizes the average individual total doses for the life of the project. There are no appreciable differences between average individual total doses. Therefore, closure of this WMA would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Table 3-102 Waste Management Area U Clean Closure Average Individual Total Dose from Radioactive Air Emissions over the Life of the Project

Subset Population	Individual Average Dose (millirem)	
	Subset Population	Remainder of Population
Minority	0.012	0.016
American Indian	0.0073	0.014
Hispanic or Latino	0.012	0.015
Low-income	0.012	0.014

Section 3.7.10 discusses radiological impacts on the offsite MEI, who is located at the far side of the Columbia River opposite Hanford. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation were evaluated. As a result of WMA U clean closure, the total dose received by an individual residing at the point of greatest impact along the reservation boundary would be the equivalent of less than approximately one-fifteenth of the total dose received by the MEI from the general population. Therefore, closure of WMA U would not pose disproportionately high and adverse impacts on the American Indian population due to normal operations.

Section 3.7.11 discusses radiological impacts of airborne releases from facility accidents hypothesized as a result of WMA U clean closure. Examination of the risks shows that there would be essentially no LCFs per year for the offsite population, including minority, American Indian, Hispanic, or Latino, and low-income populations. Therefore, clean closure of WMA U would not pose disproportionately high and adverse impacts on the minority, American Indian, Hispanic, or Latino, or low-income populations due to accident consequences.

Air quality impacts resulting from WMA U clean closure are discussed in Section 3.7.4. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; as there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic, or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 3.7.12 discusses the potential human health risks from onsite waste transportation and transporting construction materials from onsite, local, or regional locations to Hanford. The impacts of transporting onsite waste and construction materials to Hanford due to WMA U clean closure would be very small. Therefore, clean closure of this WMA would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

3.7.14 Waste Management

Table 3–103 represents the estimated waste volumes generated as a result of WMA U clean closure activities. These activities include clean closure of the U tank farm in the 200-East Area following deactivation. Clean closure of the tank farm would encompass removal of highly and moderately contaminated tank and ancillary equipment, all of which would be managed as HLW.

Tank closure waste that is not managed as HLW would be disposed of in the proposed RPPDF, to be located between the 200-East and 200-West Areas. The RPPDF would be similar to the IDF.

Primary Waste

As shown in Table 3–103, the volume of PPF melters generated due to WMA U clean closure would be 235 cubic meters (8,300 cubic feet). A total of 36,200 cubic meters (1.28 million cubic feet) of additional HLW would also be generated and stored on site in shielded boxes.

Secondary Waste

The estimated volume of mixed TRU waste, 45 cubic meters (1,600 cubic feet), as shown in Table 3–103, should not impact existing TRU waste treatment and storage facilities. LLW and MLLW volumes generated by tank closure would be 7,350 cubic meters (260,000 cubic feet) of LLW; 339 cubic meters (12,000 cubic feet) of closure LLW; and 7,990 cubic meters (282,000 cubic feet) of MLLW. LLW and MLLW would be disposed of in an IDF. No long term storage capacity would be needed.

For clean closure of WMA U, and all other WMAs, large quantities of MLLW would be generated by the removal of ancillary equipment and the excavation of contaminated soil from the tank farms. This large quantity of tank closure waste would include approximately 283,000 cubic meters (9.99 million cubic feet) of MLLW. This contaminated soil would be disposed of in the proposed RPPDF. PPF treatment of the soils would generate 192 cubic meters (6,780 cubic feet) of PPF glass. These canisters would be disposed of in an onsite IDF.

A total of 240 cubic meters (8,460 cubic feet) of hazardous waste would be generated during construction, operations, and closure activities required for WMA U clean closure. The estimated volume of nonhazardous waste would be approximately 279,000 cubic meters (9.86 million cubic feet). This waste would be sent for offsite disposal in a local landfill. This additional waste load would have only a minor impact on the handling and accumulation of nonhazardous solid waste at Hanford.

Table 3-103 Waste Management Area U Clean Closure Waste Generation Volumes

Waste Type	Project Phase					Peak Annual Generation		Total Waste Volume to IDF(s)/RPPDF
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Waste Volume/Year	
Primary Waste								
Other high-level radioactive waste	N/A	N/A	N/A	36,200	36,200	2023–2034	3,020	N/A
Preprocessing Facility melters	N/A	N/A	N/A	235	235	Various	123	235 (IDF)
Secondary Waste								
Preprocessing Facility glass	N/A	N/A	N/A	192	192	2035–2043	21	192 (IDF)
Low-level radioactive	N/A	281	146	6,920	7,350	2043	365	7,350 (IDF)
Low-level radioactive (closure)[a]	N/A	N/A	N/A	339	339	2043–2045	113	339 (RPPDF)
Mixed low-level radioactive	N/A	247	280	7,460	7,990	2043–2045	457	7,990 (IDF)
Mixed low-level radioactive (closure)[b]	N/A	N/A	N/A	283,000	283,000	2035–2042	33,400	283,000 (RPPDF)
Transuranic mixed	N/A	45	N/A	N/A	45	2016–2017	15	N/A
Hazardous[c]	49	123	N/A	68	240	2016–2017	41	N/A
Nonradioactive–nonhazardous[d]	N/A	N/A	25	279,000	279,000	2023–2034	20,700	N/A

[a] Closure low-level radioactive waste is the waste from decontamination and decommissioning of the containment structure over the tank farm after soil removal is complete.

[b] Closure mixed low-level radioactive waste includes rubble, soil, and equipment removed during closure of the tank farm.

[c] Hazardous waste is accumulated on site for less than 90 days and then shipped to offsite commercial facilities for treatment and/or disposal.

[d] Nonhazardous solid waste is shipped to offsite commercial facilities for recycling, treatment, and disposal.

Note: All values are in cubic meters. To convert cubic meters to cubic feet, multiply by 35.315. Total may not equal the sum of the contributions due to rounding.

Key: IDF=Integrated Disposal Facility; N/A=not applicable; RPPDF=River Protection Project Disposal Facility.

3.7.15 Industrial Safety

Illness, injury, and death are possible outcomes of any industrial accident. The accepted standard for measuring the outcome of an industrial accident is the number of fatalities and the TRCs (the occurrence of illness or injury). A fatal occurrence is a work-related injury or illness that causes the death of the employee. TRCs include work-related death or illness or injury that results in loss of consciousness, restriction of work or motion, transfer to another job, a requirement for medical treatment beyond first aid, or death.

As ORP has not experienced a fatality during recent history, the DOE and contractor rate (for all labor categories) of 0.26 per 200 million labor hours was adopted as representative of fatal occurrences. The impacts of illness and injury can be calculated using the total project labor hours and the appropriate incident rate. The total labor hours were calculated from the scaled data sets (SAIC 2012). The subtotal for each type of activity (construction, operations, deactivation, and closure) for clean closure of WMA U is presented in Table 3–104.

Table 3-104 Waste Management Area U Clean Closure Industrial Safety Impacts

Labor Category	Million Labor Hours	Total Recordable Case Rate per 200,000 Labor Hours	Projected Total Recordable Cases	Fatality Rate per 200 Million Labor Hours	Projected Fatalities
Construction	19.7	2.0	197.0	0.26	0.0256
Operations	42.2	2.0	422.0	0.26	0.0549
Deactivation	0.36	2.0	3.5	0.26	0.0005
Closure	15.7	2.0	157.0	0.26	0.0204
Total	**78.0**		**779.5**		**0.1013**

Note: Projected fatalities are displayed to four decimal places to show at least one significant digit. All other values presented in the table have been rounded to no more than three significant digits. Totals may not equal the sum of the contributions due to rounding.
Source: Labor hours compiled from the scaled data sets (SAIC 2012).

For clean closure of WMA U, almost 49 million labor hours would be required to complete all phases. Operations would require 26 million labor hours; construction, 13.5 million. It is expected that work required to clean-close this WMA would result in approximately 488 TRCs; 262 TRCs are estimated due to operations and 135 due to construction. No fatalities are expected during any phase of the clean closure activities.

3.7.16 Cost Analysis

The cost estimates, in 2008 dollars, for construction, operations, deactivation, closure, and disposal activities required to clean-close WMA U are provided in Table 3–105.

Table 3-105 Waste Management Area U Clean Closure Summary of Estimated Costs (millions of 2008 dollars)

Construction	Operations	Deactivation	Closure	Disposal	Total
665	1,045	23	1,486	812	4,031

Note: Estimates are costs to the Hanford Site only.
Source: DOE 2009.

Included in the construction costs are the costs to build or modify the 16 SSTs at the U tank farm to support waste retrieval and the construction of interim storage facilities for HLW debris from

the clean closure of the SSTs. Operations costs include ongoing operations of the U tank farm, retrieval of tank waste, and operations of Borrow Area C, the onsite pit used to supply sand, soil, and gravel for backfilling the tank farms after the SSTs are removed. Deactivation costs include deactivation of tank waste retrieval equipment and facilities.

Closure costs include the construction and deactivation of confinement structures over the tank farms required during tank removal and contaminated deep soil removal, as well as removal of the 16 SSTs and ancillary equipment within the tank farms and the contaminated deep soils. The removed highly contaminated RSE that would be managed as HLW would be maintained in shielded storage boxes on site on covered concrete storage pads. Closure costs also include the construction, operations, and deactivation of the PPF, a soil-washing facility that would treat highly contaminated (non-HLW) soils. This treatment would result in: 1) washed soils, which would be packaged for onsite disposal in the proposed RPPDF; and 2) contaminated liquid waste streams, which would be treated in the PPF melter, producing a LAW glass that would be disposed of in the IDF.

Disposal costs include the construction, operations, closure, and postclosure care of the IDF and RPPDF that are necessary for the clean closure of the 16 SSTs at the U tank farm.

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CHAPTER 4
IMPRACTICABILITY DETERMINATION FOR CLEAN CLOSURE OF THE SINGLE-SHELL TANK SYSTEM

As previously discussed in Chapter 1 of this *Clean Closure Practicability Demonstration for the Single-Shell Tanks* the information in this plan can be used to demonstrate whether clean closure of any portion of the Hanford Site (Hanford) single-shell tank (SST) system is impracticable, as defined by Washington State regulations (WAC 173-340-200) and as demonstrated using the applicable procedures and criteria (WAC 173-340-360(3)(e) and (f)). The following conclusions can be drawn from this *Clean Closure Practicability Demonstration* regarding whether the costs of clean closure of the SST system are disproportionate to the benefits, based on the evaluation criteria (WAC 173-340-360(3)(f)).

4.1 DISPROPORTIONATE COST ANALYSIS (WAC 173-340-360(3)(e))

Clean closure of the SST system would provide the most protectiveness of human health and the environment in the long term; specifically, when addressing groundwater contamination and the potential groundwater pathways. However, the short-term impacts on human health and the environment associated with clean closure activities would be potentially more detrimental than retrieval of the waste from the tanks followed with landfill closure. Details to support this conclusion are provided in Section 4.2, below. In addition, the estimated overall cost associated with clean closure for the entire SST system is approximately $37 billion (in 2008 dollars). See Table 4–1 for the breakdown of cost by waste management area. In comparison, the estimated overall cost associated with landfill closure for the entire SST system is approximately $19 billion (in 2008 dollars), or approximately 50 percent of the estimated clean closure costs. See Table 4–2 for the breakdown of the landfill closure costs. Therefore, per the Disproportionate Cost Analysis Test (WAC 173-340-360(3)(e)(i)), DOE has determined that the costs associated with clean closure of the SST system would be disproportionate to the benefits.

Table 4-1 Waste Management Area Clean Closure Summary of Estimated Costs (millions of 2008 dollars)[a, b]

Work Element	Waste Management Area							Total
	A/AX	B/BX/BY	C	S/SX	T	TX/TY	U	
Construction	423	1,632	665	1,088	665	967	665	**6,104**
Operations	665	2,565	1,045	1,710	1,045	1,520	1,045	**9,595**
Deactivation	15	57	23	38	23	34	23	**214**
Closure	1,453	2,654	666	3,235	1,913	2,716	1,486	**14,124**
Disposal	539	953	115	1,855	1,176	1,462	812	**6,912**
Total	**3,095**	**7,861**	**2,514**	**7,926**	**4,822**	**6,699**	**4,031**	**36,949**

a Estimates are costs to the Hanford Site only.

b Based on the estimated costs for *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington* (DOE 2012) Tank Closure Alternative 6B: All Vitrification with Separations; Clean Closure (Base Case) and Waste Management Alternative 2: Disposal in IDF, 200-East Area Only, Disposal Group 2.

Source: DOE 2009.

Table 4-2 Waste Management Area Landfill Closure Summary of Estimated Total Costs (millions of 2008 dollars)[a, b]

Work Element	All Waste Management Areas
Construction	4,079
Operations	8,885
Deactivation	128
Closure	4,253
Disposal	1,691
Total	**19,036**

a Estimates are costs to the Hanford Site only.

b Based on the estimated costs for *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington* (DOE 2012) Tank Closure Alternative 2B: Expanded WTP Vitrification; Landfill Closure and Waste Management Alternative 2: Disposal in IDF, 200-East Area Only, Disposal Group 1.

Source: DOE 2009.

4.2 EVALUATION CRITERIA USED TO CONDUCT DISPROPORTIONATE COST ANALYSIS (WAC 173-340-360(3)(f))

(i) **Protectiveness** – Clean closure of the SST system would provide beneficial long-term impacts on groundwater. As discussed in the *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (TC & WM EIS)* (DOE 2012), the concentrations of iodine-129 and technetium-99 at the Core Zone Boundary would be reduced below their respective benchmark concentrations, but not until calendar year (CY) 2100. However, this reduction in the concentration of these constituents and associated lifetime radiological risk comes with a tradeoff in relation to potential short-term impacts. It is estimated that clean closure of the SST system could take approximately 50 more years to accomplish than landfill closure[13] to complete waste retrieval and treatment, tank and contaminated soil retrieval and treatment, and 100 years of postclosure care of the waste disposal facilities and administrative care of the waste storage facilities. Clean closure of the SST system would also have potential adverse short-term impacts compared with landfill closure related to the following:

- Total land commitments
- Electricity use
- Geologic resource requirements
- Sagebrush habitat
- Radiation worker population dose from normal operations
- LLW and MLLW generation volumes
- Total recordable cases

[13] Tank Closure Alternative 6B, Base Case, activities would occur from 2018 through 2099 PPF , or 82 years; Tank Closure Alternative 2B, from 2018 through 2045 RCRA barrier completion, or 28 years, for a difference of 54 additional years required for clean closure.

In terms of land resources, clean closure may allow future use of the tank farm areas;[14] however, it would require significant new, permanent land disturbance—approximately 60 percent more land use for new facilities to treat, store, and dispose of tank waste, including the tank structures themselves after they have been removed from the tank farms. In addition, geologic resource requirements (mainly for Borrow Area C material to backfill tank farm excavations) would increase significantly—over twice as much backfill material would be required to support clean closure compared with landfill closure.

Electricity use to support clean closure is estimated to be approximately 17 percent higher than that for landfill closure. Similarly, diesel fuel requirements for clean closure are estimated to be approximately 35 percent higher than those for landfill closure; gasoline, 68 percent; and water, 28 percent.

In terms of socioeconomic impacts, the peak daily commuter traffic resulting from clean closure activities would increase approximately 50 percent compared with that from landfill closure activities, as would the peak annual workforce. The worker population radiation dose (average annual impact) is estimated to be approximately four times higher as a result of clean closure than that from landfill closure due to expected exposures during tank and deep soil removal; latent cancer fatality risks would be five times higher.

In regard to generated volumes of LLW and MLLW, clean closure would generate approximately 60 percent more LLW and three times more MLLW than landfill closure.

Finally, projected total recordable cases, i.e., industrial accidents resulting in illness, injury, or death, associated with the implementation of the clean closure actions are estimated to be approximately 50 percent higher than those associated with landfill closure.

(ii) **Permanence** – Clean closure would reduce the mobility of the constituents in the vadose zone, as well as future groundwater contamination. As can be seen in Figure 4–1, the radiological risks to the drinking-water well user at the Core Zone Boundary would be significantly reduced under Tank Closure Alternative 6B: All Vitrification with Separations; Clean Closure, Base Case, after CY 2100 compared with those from landfill closure, which includes Tank Closure Alternative 2B: Expanded WTP Vitrification; Landfill Closure. However, this reduction in risk comes with a price. For example, a large volume of waste would be generated from excavation of the tanks, equipment, and contaminated soils from the vadose zone. As discussed above, the estimated volumes of LLW and MLLW from clean closure are 60 percent more and five times higher, respectively, than those from landfill closure. These newly generated wastes would be either immobilized or packaged for storage on site or, for most of the waste volume, disposed of on site in either the IDF or the proposed RPPDF. Thus, the wastes would remain on site and, while their mobility would be reduced, their toxicity would remain and they would still contribute a long-term risk that would be merely delayed.

[14] Although this analysis evaluates the tank farms, future use would also have to take into account some of the other CERCLA waste sites in the near vicinity of the tank farms.

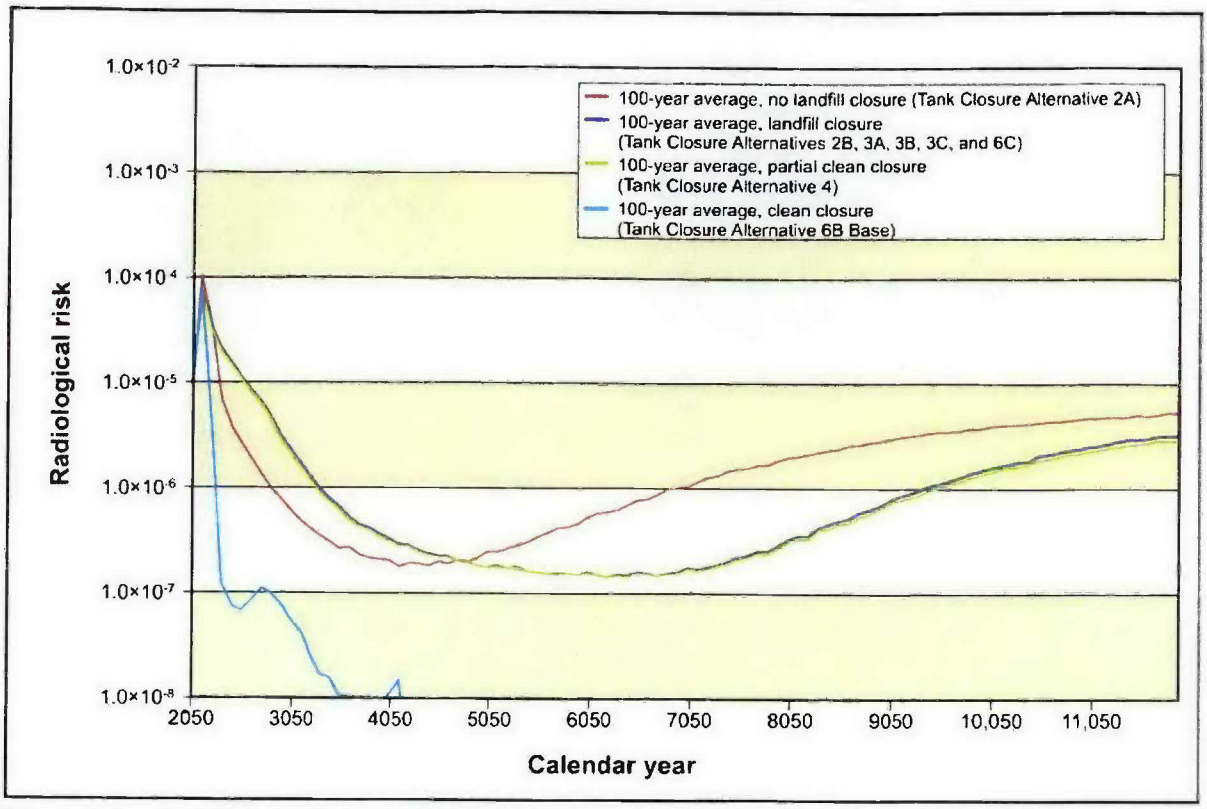

Figure 4-1 Lifetime Radiological Risk for the Drinking-Water Well User at the Core Zone Boundary Due to Past Leaks at Single-Shell Tank Farms

In addition, significantly more uncertainty exists regarding clean closure versus landfill closure in terms of technical feasibility and depth of excavation and soil exhumation. At a minimum, contaminated deep soil removal would include excavations to a depth of 20 meters (65 feet) below land surface. This excavation depth would be required 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. An effort of this scale in a radioactive environment has never been undertaken in the United States, and it is unclear whether this operation could be conducted with adequate consideration for worker safety. For these reasons and others, as discussed in the *Final TC & WM EIS* Summary, Section S.5.5.1, Closure of the SST System, "DOE believes that clean closure may not be a viable alternative" (DOE 2012).

It is also noted that DOE has experience and lessons learned with landfill closure at the DOE Savannah River Site in Aiken, South Carolina. At this site, DOE has successfully landfill-closed four high-level radioactive waste tanks by means similar to those analyzed for Tank Closure Alternative 2B, which includes landfill closure.

(iii) **Cost** – As discussed in Section 4.1, above, the estimated overall cost associated with clean closure for the entire SST system is approximately $37 billion (in 2008 dollars). In comparison, the estimated overall cost associated with landfill closure for the entire SST system is approximately $19 billion (in 2008 dollars). Therefore, the costs associated with clean closure of the SST system are considered disproportionate to the benefits.

(iv) **Effectiveness over the long term** – Clean closure would require the excavation of tanks and soils to remove the sources of potential continued contamination to the groundwater. The more highly contaminated soils would be treated in a new treatment facility the PPFto remove the constituents and immobilize them into a more stable waste form and then would be disposed of in an engineered, lined, and monitored disposal facility onsite (the IDF). The lightly contaminated soils would be packaged and disposed of in a new engineered, lined, and monitored disposal facility (the proposed RPPDF), also located onsite. The tanks and equipment would not be treated but would be packaged and stored on site in new storage facilities pending final disposition. These new storage facilities would be operated under institutional controls and monitoring. Currently, there is no disposal facility that can receive the moderately and highly contaminated packaged tanks and equipment.

Clean closure would reduce part of the risk posed by the waste streams by immobilizing the highly contaminated liquid waste stream in the new PPF, while the less contaminated wastes would be disposed of on site in the proposed RPPDF. However, even the immobilized, low-rate-of-release glass waste form, assumed to be identical to the WTP produced immobilized low-activity waste (ILAW) glass, would be disposed of onsite in the 200-East Area IDF and would be available for release, contributing to the radiological risk to the drinking-water well user. Figure 4–2 shows the 100-year average radiological risk under Tank Closure Alternative 2B, an estimate of the lifetime risks to the drinking-water well user from the disposal of ILAW glass and secondary waste, which would be similar to that from the PPF glass. As can be seen in the figure, the contribution from ILAW glass would be delayed until CY 5000 but then would increase significantly until leveling off in CY 9000.

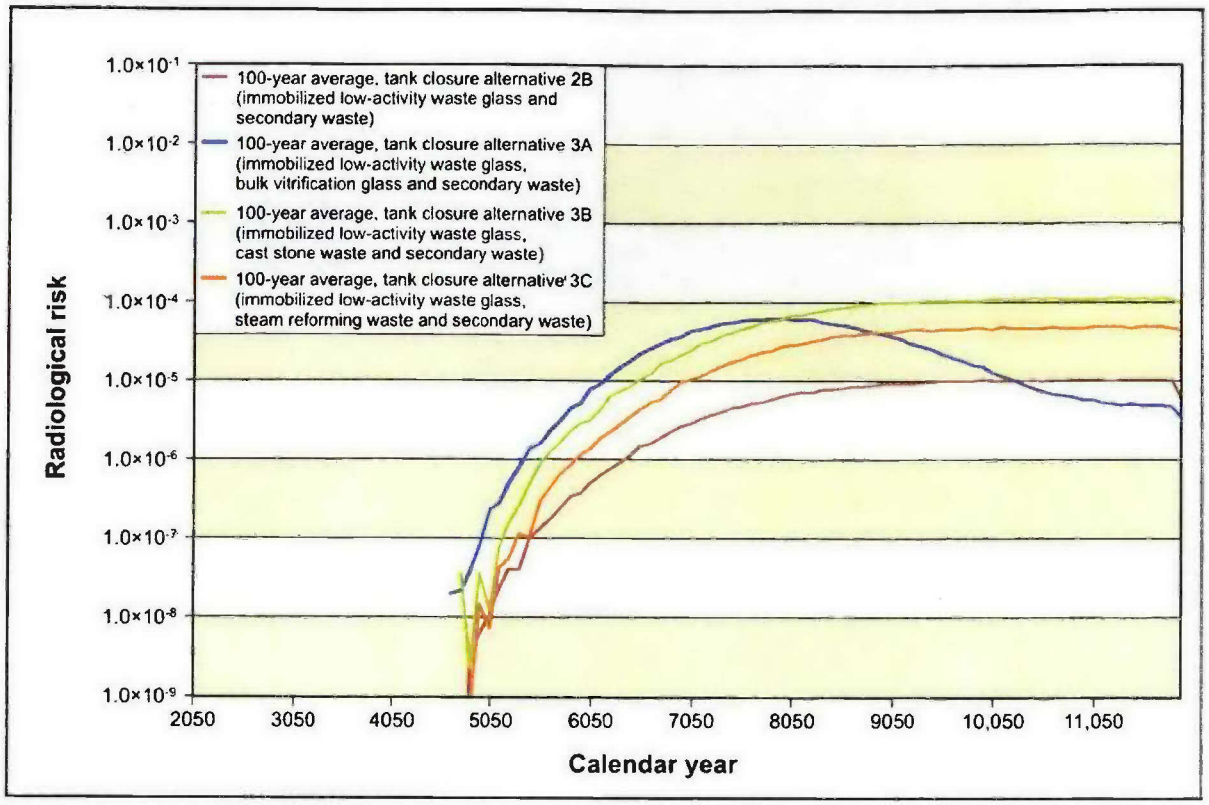

Figure 4-2 Lifetime Radiological Risk for the Drinking-Water Well User at the 200-East Area Integrated Disposal Facility Barrier Due to Tank Closure Treatment Process–Generated Waste Forms

(v) **Management of short term risks** – As stated in Chapter 2, assumptions were made that worker dose and emissions from tank farm excavations would be controlled using containment structures around and above the tank farms. In addition, it was assumed that the excavation could occur by mining the soil straight down, which would result in a smaller excavation footprint and a reduction in the amount of soils that would have to be excavated. Whether these technologies or procedures are technically viable is unknown at this time, and they are considered significant risks in terms of worker population dose, schedule, and costs. If the containment structures are not technically feasible, the release of radioactive emissions during excavation would increase, and the potential exposure to workers could increase. In all cases, DOE would ensure that workers are protected and would not receive exposure that would be detrimental to their health. If the assumption that the excavation footprint can be minimized by excavating soil straight downward is not correct, the amount of excavated soil produced in the more traditional methods would be significantly greater than what is projected here.

(vi) **Technical and administrative implementability** – As stated above, the significant uncertainty associated with 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 the 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 consideration for worker safety.

(vii) **Consideration of public concerns** – DOE included two alternatives that evaluated the clean closure of the SST farms. The clean closure alternatives considered for the SST system are represented by the Base and Option Cases of Tank Closure Alternatives 6A and 6B. For both Base Cases, the assumption is that the SST system would be cleaned to levels that would allow for unrestricted use, which would involve removal of the tanks, ancillary equipment, and soils beneath the tanks (contaminated as a result of past leaks) down to the water table. The two Option Cases represent this type of clean closure along with removal of soils beneath the tank farms (contaminated as a result of the contiguous cribs and trenches [ditches]). The analysis shows that removal of the contaminants from the vadose zone would not capture the contaminants that may have already reached the water table due to past practices, i.e., past leaks and infiltration from contiguous cribs and trenches (ditches).

DOE has received comments from certain stakeholders that support clean closure. These comments ask that DOE consider clean closure as an alternative to landfill closure. DOE has taken these comments into consideration and believes, based on the analysis in the *Final TC & WM EIS* and as stated in DOE's discussion on the Preferred Alternatives (see the Summary, Section S.7.1 [DOE 2012]), that "removal of the tank structures is technically infeasible and, due to both the depth of the contamination and the technical issues associated with removal of the tank structures, that it presents significant uncertainty in terms of worker exposure risk and waste generation volume."

4.3 REFERENCES

DOE (U.S. Department of Energy), 2009, *Central Plateau Cleanup Completion Strategy*, DOE/RL-2009-81, Rev. 0, Richland Operations Office, Richland, Washington, September.

DOE (U.S. Department of Energy), 2012, *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*, DOE/EIS-0391-F, Office of River Protection, Richland, Washington, November.

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WAC 173-340-200, Washington State Department of Ecology, "Model Toxics Control Act – Cleanup: Definitions," Olympia, Washington.

WAC 173-340-360, Washington State Department of Ecology, "Model Toxics Control Act – Cleanup: Selection of Cleanup Actions," Olympia, Washington.