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Supplement Analysis for the Tank Waste Remediation System

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ACRONYMS AND ABBREVIATIONS

BIO	Basis for Interim Operation
BNFL	BNFL, Inc. (American subsidiary of British Nuclear Fuels Limited)
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CSB	Canister Storage Building
DCRT	double-contained receiver tank
DOE	U.S. Department of Energy
DNFSB	Defense Nuclear Facility Safety Board
DST	double-shell tank
Ecology	Washington State Department of Ecology
EDTA	ethylenediaminetetraacetic acid
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ERPG	Emergency Response Planning Guidelines
FR	Federal Register
FSAR	Final Safety Analysis Report
FY	fiscal year
HI	hazard index
HLW	high-level waste
HTI	Hanford Tanks Initiative
ILCR	incremental lifetime cancer risk
ISC2	Industrial Source Complex Model
K_d	distribution coefficient
LAW	low-activity waste
LCF	latent cancer fatality
LLW	low-level waste
LMAES	Lockheed Martin Advanced Environmental Systems
MEI	maximally exposed individual
mrem	millirem
MUST	miscellaneous underground storage tank
MYWP	Multi-Year Work Plan
NEPA	National Environmental Policy Act
NRC	Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
PCB	polychlorinated biphenyl
PHMC	Project Hanford Management Contractor
PNNL	Pacific Northwest National Laboratory
PUREX	Plutonium-Uranium Extraction Plant
RCRA	Resource Conservation and Recovery Act
rem	roentgen equivalent man

ACRONYMS AND ABBREVIATIONS (cont'd)

revised inventory	global best-basis inventory
RfD	reference dose
RL	Richland Operations Office
ROD	Record of Decision
RPE	Retrieval Performance Evaluation
SA	Supplement Analysis
SNF	Spent Nuclear Fuel
SST	single-shell tank
Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order
TRU	transuranic
TSD	treatment, storage, and disposal
TWRS	Tank Waste Remediation System
URF	Unit Risk Factor
WAC	Washington Administrative Code
WMA	waste management area

Units of Radioactivity

Symbol	Name
Ci	curie
MCi	megacurie (1.0E+06 Ci)
mCi	millicurie (1.0E-03 Ci)
µCi	microcurie (1.0E-06 Ci)
nCi	nanocurie (1.0E-09 Ci)
pCi	picocurie (1.0E-12 Ci)

Radioactivity Units

Radioactivity is presented in radioactivity units. The Ci is the basic unit used to describe an amount of radioactivity. Concentrations of radioactivity generally are expressed in terms of curies or fractions of curies per unit mass, volume, and area. One curie is equivalent to 37 billion disintegrations per second, and is the quantity of any radionuclide that decays at a rate of 37 billion disintegrations per second. Disintegrations generally produce emissions of alpha or beta particles, gamma radiation, or combinations of these.

Radiation Dose Units

The amount of energy deposited by radiation in a living organism is the radiation dose. For humans, the radiation dose usually is reported as effective dose equivalent, expressed in terms of roentgen equivalent man (rem). For example, the average dose rate from natural sources (cosmic radiation, natural radioactivity in the earth, and other natural sources) is approximately 0.3 rem/year. This document reports radiation dose in millirem (mrem). One mrem is equal to one-thousandth of a rem. Therefore, 0.3 rem per year could be restated as 300 mrem/year or 3.0E-01 rem/year.

Units of Measure

The following shows the abbreviations for the units of measure used in this document.

Names and Symbols for Units of Measure

Length

Symbol	Name
cm	centimeter
ft	foot
in.	inch
km	kilometer
m	meter
mi	mile

Area

Symbol	Name
ha	hectare
ac	acre
km^2	square kilometer
mi^2	square mile
ft^2	square foot

Volume

Symbol	Name
cm^3	cubic centimeter
ft^3	cubic foot
gal.	gallon
L	liter
m^3	cubic meter
ppb	parts per billion
ppm	parts per million
yd^3	cubic yard

Mass

Symbol	Name
kg	kilogram
mg	milligram
lb	pound
mt	metric ton

Temperature

Symbol	Name
°C	degrees centigrade
°F	degrees Fahrenheit

READERS GUIDE

The following information is provided to help the reader understand the technical data and format of this SA. A list of acronyms and abbreviations can be found following the Table of Contents.

Reference Citations

Throughout the text of this document, reference citations are presented where information from the referenced document was used. These reference citations are contained within parentheses and provide a brief identification of the referenced document. This brief identification corresponds to the complete reference citation located on the reference list at the end of the document.

Scientific Notation

Scientific notation is used in this document to express very large or very small numbers. For example, the number one million could be written in scientific notation as 1.0E+06 or in traditional form as 1,000,000. Translating from scientific notation to the traditional number requires moving the decimal point either right or left from the number being multiplied by 10 to some power depending on the sign of the power (negative power move left or positive power move right).

Translating Scientific Notation

Example 1: 2.6E+06 = 2,600,000
Example 1 shows a positive power of six. To translate, move the decimal to the right six places adding zeros as necessary to achieve 2,600,000.

Example 2: 2.6E-07 = 0.00000026
Example 2 shows a negative power of seven. To translate, move the decimal to the left seven places adding zeros as necessary to achieve 0.00000026.

Chemical Elements and Radioactive Isotopes

Many chemical elements and radioactive isotopes are referenced in this document. Examples of the chemical elements are cesium, strontium, and uranium. For the most part, these elements are spelled out; however, these elements may be presented in tables and figures in this format: cesium-137 or Cs-137.

Units of Measure

The primary units of measure used in this SA are metric. However, the approximate equivalent in the U.S. Customary System of units is shown in parentheses directly following the use of a metric unit. For example, a distance presented as 10 meters (m) is followed by 33 feet (ft). This example would be presented in the text of the document as follows: 10 m (33 ft).

1.0 SUMMARY

This Supplement Analysis addresses the potential effect that new data and information developed since the preparation of the TWRS EIS may have on the environmental impacts presented in the EIS to support a determination of whether these new data warrant further NEPA analysis at this time.

The analysis demonstrates that the information developed since the preparation of the EIS has a small effect on the impacts calculated for the EIS, and that the changes in environmental impacts are bounded by the impacts presented in the TWRS EIS.

1.1 INTRODUCTION

The Tank Waste Remediation System (TWRS) program is a large and complex effort to remediate a large portion of the nation's high-level radioactive waste. It includes the remediation of approximately 210[1] million curies (Ci) in 200 million liters (L) (54 million gallons [gal.]) of liquid and solid waste that have been accumulating in underground storage tanks for more than 50 years. The TWRS program has four major components: 1) continued safe management of the tank waste; 2) remediation of the tank waste; 3) remediation of the tank farms after the tank waste has been removed (including any residual waste and contaminated soils from past tank leaks), a process called closure; and 4) decommissioning facilities to be constructed to remediate the waste. The U.S. Department of Energy (DOE) determined that sufficient information exists to address continued safe management of the waste and begin remediation of the waste. However, there is currently insufficient information to perform a complete evaluation of closure of the tank farms and decommissioning of facilities (62 Federal Register [FR] 8693).

In 1996, DOE and the Washington State Department of Ecology (Ecology) issued the TWRS Environmental Impact Statement (EIS), which assessed the full range of reasonable alternatives for continued safe management and remediation of the wastes. DOE subsequently issued a Record of Decision (ROD), which documented the selection of the Phased Implementation alternative. Ecology concurred in the selection of this alternative. The Phased Implementation alternative consists of 1) Phase I, the initial production phase, during which the efficiency and effectiveness of the processes selected to treat the waste will be verified by treating 6 to 13 percent of the well-characterized and readily retrievable waste; and 2) Phase II during which the majority of the waste will be treated. Waste will be retrieved from the tanks and separated into low-activity waste (LAW) and high-level waste (HLW). The LAW will be immobilized and disposed of onsite in near-surface vaults. The HLW will be vitrified (melted to form glass) and disposed of at a geologic repository.

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[1] Decayed to 12/31/99

DOE also decided to privatize certain aspects of the Phased Implementation alternative and in 1996 awarded contracts to BNFL, Inc. (BNFL) and Lockheed Martin Advanced Environmental Systems (LMAES) to perform initial planning and engineering for Phase I. DOE is now considering whether to authorize none, one, or two contractors to proceed with the construction and operation of Phase IB treatment plants. This decision is scheduled to be made no later than July 1998 in compliance with the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement). If DOE does not proceed with Phase IB with either contractor the Tri-Party Agreement provides for an alternate path for implementing tank waste retrieval and immobilization. For the alternate path, waste treatment facilities would be constructed and operated by the government with a 1 year delay in start of treatment facility operations. This alternate path is consistent with the Phased Implementation alternative.

The original Phased Implementation concept and the TWRS EIS describe Phase 1 treatment facilities as demonstration-scale facilities that would treat 6 to 13 percent of the waste over an operating period of approximately 10 years. During the Phase I design process it became apparent that the consideration of seismic and safety requirements would result in facilities that could be 1) operated for approximately 30 years; and 2) expanded to increase annual treatment capacity. While the treatment capacities of these facilities have not changed for Phase I, the potentially longer life and expansion capability makes them more representative of production facilities that could partially meet waste treatment needs during Phase II. Based on this information DOE currently refers to the Phase I demonstration phase treatment facilities as initial production facilities.

Remediation of the waste is complicated due to a lack of complete knowledge of the contents of the waste and the condition of some of the tanks, the lack of demonstrated effectiveness and efficiency of some of the complex processes to treat the waste, uncertainty in the regulatory classification of portions of the waste, and an incomplete understanding of how residual waste that may remain in the tanks after remediation, past leaks from the tanks, and other sources of contamination at the Hanford Site interrelate. One of the important challenges for DOE is to manage these uncertainties while making progress towards remediation. The analysis in the EIS demonstrated that it is necessary to proceed with remediation to ensure protection of human health and the environment.

DOE acknowledged in the EIS and ROD that there were a number of important uncertainties associated with proceeding with remediating the tank waste, and a report by the National Research Council entitled "The Hanford Tanks, Environmental Impacts and Policy Choices" also recognized and amplified these uncertainties. DOE selected the Phased Implementation alternative, in part, because it provides an opportunity to reduce technical uncertainties prior to making final commitments to critical elements of the remediation strategy.

DOE committed in the ROD to perform future National Environmental Policy Act (NEPA) analysis at key points in the remediation process to address the potential impacts that new information may have on the impacts presented in the EIS and to support an assessment of whether DOE's plans for remediating the tank waste are still pursuing the appropriate option for remediation or whether adjustments to the project needed to be made. This Supplement Analysis (SA) supports the first of these reevaluations and is one part of a comprehensive Authorization to Proceed process being conducted by DOE prior to proceeding with the next phase of the project. This SA addresses whether the new information substantially changes the environmental impacts presented in the TWRS EIS and whether further NEPA analysis is necessary at this time.

1.2 NEW DATA AND INFORMATION

The following is a summary of the substantive new data and information that have been developed since the preparation of the TWRS EIS.

Sources of substantive new information:

- Revised tank waste inventory
- New accident analysis documentation
- Emerging vadose zone transport data and analysis
- Revised engineering parameters
- Technology development activities.

Revised Tank Waste Inventory and Waste Characterization

Through 1997, tank waste has been sampled from 131 tanks to support safety analysis and waste characterization. In an effort to reduce uncertainty associated with the inventory of the tank waste and resolve differences among the many reported inventory values, DOE conducted a major reassessment of tank waste inventory based on key historical records and calculations of radionuclide isotope generation and decay and issued the Standard Inventories of Chemicals and Radionuclides in Hanford Site Wastes (Kupfer et al. 1997). DOE also sampled and issued inventory for the K Basins sludge, which will be disposed with the tank waste. There were a number of changes in the inventory, some of which have an effect on the impacts calculated in the TWRS EIS. These impacts are described in Section 1.3 and 4.0.

Accident Analysis

Since preparing the EIS, DOE issued the TWRS Basis for Interim Operations (BIO) (LMHC 1997a), which established a new authorization basis for the TWRS facilities and operations. The new information has different radiological and chemical risks than were presented in the TWRS EIS for the beyond-design-basis-earthquake scenario and accidents that could occur during routine operations.

New Vadose Zone Characterization Data

There are additional characterization data on the levels of contamination in the vadose zone (the unsaturated soils that underlie the tank waste above the groundwater). These data include spectral gamma logging of drywells, preliminary sampling results of extending a borehole (41-09-39) to the groundwater in the SX Tank Farm, studies on the mechanisms for the transport of contaminants through the vadose zone, and updated groundwater quality data. These new data show that certain contaminants (e.g., cesium [Cs]-137 and cobalt [Co]-60) from past tank leaks have moved faster through the vadose zone than previously expected and the highly mobile contaminants, such as technetium (Tc)-99, have reached the groundwater at certain tank farms. Contaminants that were previously expected to move rapidly through the vadose zone, such as Tc-99, appear to have been substantially unaffected by these new data, and some contaminants, such as uranium, may be moving slower than previously estimated.

Engineering Parameters

Throughout the duration of the project, data collection, bench-scale tests, and engineering studies will continuously be performed and will result in revised engineering parameters related to retrieval, treatment, and disposal. These efforts will reduce the uncertainty associated with certain aspects of the project and will result in changes to some of the impacts presented in the EIS. These data collected since the completion of the EIS include the following.

- The number of facilities required to support waste retrieval and transfer was reduced from five to three.
- There would be approximately 30 percent fewer containers of immobilized LAW.
- HLW volume projections have increased by approximately 10 percent.
- The conceptual design for the LAW disposal facility has changed from 66 closely spaced vaults to 19 widely spaced vaults.
- During Phase II HLW canisters will be stored in a facility similar to the Canister Storage Building (CSB).

Technology Development Activities

No new technologies within the DOE complex or at the Hanford Site have emerged that would replace the overall remediation program included in the Phased Implementation alternative. Most ongoing technology development activities are directed at improving the effectiveness and efficiency of the basic technologies previously selected at the Hanford Site or at other DOE sites. Most of the technologies included in the Phased Implementation alternative were also components of one or more of the other alternatives addressed in the EIS. Technology development activities are being conducted at the Hanford Site and throughout the DOE complex for many of the components of the Phased Implementation alternative and some of the components unique to other alternatives where technology needs have been identified. Technology development efforts have been reduced for technologies as they become commercially available. Most of these efforts are ongoing and have not yet produced definitive results that can be applied to the Hanford Site tank waste; however, they do offer the potential of improving the application of many technologies. The technology development activities include:

- The Hanford Tanks Initiative (HTI) project, which is testing the application of technologies for the removal of hard heels from the tanks, in situ characterization of tank waste, and developing criteria for tank waste retrieval and closure
- Testing of enhanced sludge washing and pulse jet mixer at Oak Ridge to facilitate waste retrieval and issuing an enhanced sludge washing report for the Hanford Site tank waste
- Testing of grout at the Savannah River Site to immobilize residual waste in the tanks

- Testing a technology that uses air bubbles to suspend solids and keep them suspended in slurries to promote waste transfers.

Tank Farm Safety

In response to the 1990 Public Law 101-510, Safety Measures for Waste Tanks at the Hanford Nuclear Reservation (also known as the Wyden Amendment), a program was created to identify tanks with potential safety problems and address specific tank safety issues. Safety issues associated with the tanks were grouped into four categories: flammable gas, ferrocyanide, high organic content, and high-heat generation. A total of 62 tanks have at one time been included on the Watchlist, with several tanks listed in more than one category. Technical evaluation has resulted in addressing the ferrocyanide, floating organic layer in tank 241-C-103, and criticality safety issues. Based on progress in addressing Watchlist safety issues to December 1997, there are currently 38 tanks on the Watchlist.

Revised Impacts

- Small change in short-term health impacts
- Small change in long-term health impacts
- Small change in groundwater impacts
- Increase in temporary and permanent land-use impacts
- Increase in shrub-steppe habitat disturbance
- Reduction in uncertainties for the demonstration phase.

Privatization Proposals

In October 1996, DOE evaluated the environmental impacts based on proposals to privatize portions of TWRS submitted by BNFL and LMAES on May 10, 1996. The evaluation was documented in a procurement-sensitive report prepared in response to the DOE procedures (10 Code of Federal Regulations [CFR] 1021.216). The data submitted in the May 10, 1996 proposals relative to potential environmental impacts were preliminary and based on preconceptual design concepts. This level of detail did not allow for the environmental data provided to be verified or the potential impacts to be quantified. The Environmental Reports submitted by LMAES and BNFL in September and October of 1997, respectively and supplemental data submitted in January of 1998 provide an increased level of detail corresponding to the design work that has been completed during Phase IA. This increased level of detail allows for a more quantitative evaluation of environmental impacts than was possible in the October 1996 evaluation; however, it has not changed the overall understanding of the impacts.

1.3 REVISED IMPACTS

Overall, the new data and information have a small effect on the impacts presented in the TWRS EIS. There are no areas of analysis where the revised impacts are substantially different or would change the relative relationship among the alternatives presented in the TWRS EIS.

Short-term impacts

Short-term human health risks remain essentially the same as presented in the TWRS EIS. There would be a 5 percent increase in the radiological risk from routine air emissions to the non-involved workers and the general public during operations due to the revised tank waste inventory. However, the total number of latent cancer fatalities (LCFs) for routine operations (three fatalities) would remain the same when rounded to the nearest whole number. Nearly all of the routine radiological risk would be to project workers during operations. There would be a 19 percent increase in the radiation exposures to the public during shipment of HLW to a geologic repository. However, the total number of fatalities (no fatalities) would remain the same when rounded to the nearest whole number. There would be no change in the estimated number of fatalities (four fatalities) from occupational accidents. The estimated number of fatalities from operational accidents (five fatalities) would be the same as presented in the TWRS EIS.

Based on the revised engineering estimates for the size of the treatment facilities, infrastructure upgrades, and LAW vaults, there would be 33 hectares (ha) (82 acres [ac]) of additional shrub-steppe habitat disturbed than was estimated for the TWRS EIS. This represents less than 1 percent of the shrub-steppe habitat remaining on the Central Plateau.

Long-term impacts
Based on the currently available information, the long-term impacts would be essentially the same as those presented in the TWRS EIS. The new information concerning the transport of contaminants in the vadose zone has resulted in revisions to Site computer models for estimating flow through the vadose zone for past leaks and, to a certain extent, refinements in models for tank waste leaks during retrieval. The leaching of residual waste that may be left in the tanks after closure and the immobilized waste in the LAW vaults will be largely unaffected by these new data because 1) the residual waste and immobilized LAW will be covered by a low-permeability earthen cover, which will reduce infiltration of water to very low levels so the leaching of residual waste into the vadose zone will be very slow; and 2) the chemistry and physical form of the residual waste and immobilized LAW will be substantially different from the past leaks.

The reasons why certain contaminants apparently move more rapidly than previously estimated and how deep into the vadose zone they will move at accelerated rates is still under investigation but may be due to 1) past single-shell tank (SST) leaks that were larger than previously estimated; 2) large surface releases from water lines and enhanced infiltration due to the removal of vegetation and installation of gravel around the tanks; 3) past leaks that were released over a small area or from a portion of the tank which tends to channel the releases and provide a larger hydraulic head to drive contamination downward more quickly; 4) enhanced mobility of certain contaminants, primarily Cs-137, due to the unique chemistry (e.g., high sodium concentration, high pH, and high temperature) of some past leaks; 5) enhanced mobility of certain contaminants, primarily Co-60, due to the presence of organic chelating agents in some previous leaks; and 6) preferential flow paths (e.g., clastic dikes) which could provide a mechanism for contaminants to move more quickly through the vadose zone.

There remains a substantial amount of uncertainty associated with which of these transport mechanisms are important in explaining the transport of past SST tank leaks. It is likely that all play a role at one or more tanks. Continuation of the ongoing field investigations are necessary to resolve the effect of these mechanisms on past tank leaks. All current information indicates that once in the groundwater the contaminants will be transported laterally at the previously anticipated rates. Contaminants such as Tc-99, Se-79, and ethylenediaminetetraacetic acid (EDTA) would be expected to move in the saturated zone at the velocity of the groundwater. Contaminants such as Cs-137 would not be readily transported away from the tanks by the groundwater but rather will be retarded by chemical interactions with the earthen materials that will essentially stop the migration of many contaminants (Serne et al. 1993). As discussed in the following section these mechanisms are expected to have a much reduced effect on future releases from the tanks.

Additional data are being obtained and evaluated (see Appendix A) to address these issues but it appears that the effects on the impacts presented in the TWRS EIS include the following.

- Past tank leaks will move faster through the vadose zone than previously estimated resulting in earlier arrival of contaminants in the groundwater. The concentrations of certain contaminants in the groundwater may be higher than previously estimated, and the concentration of other contaminants may be lower. Past tank leaks were not within the scope of the TWRS EIS but were addressed as part of the cumulative impacts of tank waste remediation with other Site groundwater impacts. Past tank leaks will be addressed in a future NEPA analysis on closure of the tank farms.
- The leaching of contaminants from the LAW vaults will be largely unaffected by the new information on transport mechanism.
- The leaching of residual waste that may be left in the tanks will likely be largely unaffected by this new information. Remediation of the residual waste was not within the scope of the TWRS EIS but will be addressed in a future NEPA analysis on closure of the tank farms.
- Leaks during retrieval would be affected by these new data and would likely result in earlier arrival times in the groundwater but in substantially the same concentration as previously estimated. All of the mechanisms that could accelerate transport of past leaks could also affect the rate of transport through the vadose zone of leaks during retrieval. However, the affect is likely to be less than the affect on past tank leaks. Nearly all of the waste to be retrieved during Phase IB would come from double-shell tanks (DSTs), which are not anticipated to leak during retrieval, so Phase IB activities would be largely unaffected by the new vadose zone data. Leaks during retrieval during Phase II could be affected by this new information, but additional characterization data and impact assessment will be necessary to assess the importance of these data.

This new information would not have an appreciable affect on the impacts presented in the TWRS EIS because all of the long-term risk and groundwater impacts result from the highly mobile contaminants such as Tc-99, uranium, and selenium (Se)-79, which were calculated to move with infiltrating water through the vadose zone and groundwater. The factors that accelerate transport through the vadose zone apparently would only result in slightly earlier first arrival times and not appreciably higher concentrations of contaminants in the groundwater. In addition, the TWRS EIS was sufficiently conservative in its calculation of impacts that the bounding analysis would capture any potential impacts from potentially accelerated transport.

The global best-basis inventory (revised inventory) for the tank waste would have a small impact on the concentrations of contaminants in the groundwater. Based on the bounding assessment in the TWRS EIS only the concentration of uranium-total would slightly exceed Federal Drinking Water Standards and this would not occur for approximately 5,000 years. The revised inventory also results in an exceedence of the Federal Drinking Water Standards, but the exceedence would be slightly smaller. The concentration of all contaminants entering the Columbia River would be within Federal Drinking Water Standards.

The potential long-term human health risk calculations result exclusively from the groundwater pathway (except for the intruder exposure scenario) and show the same trend as the groundwater impacts. The human health risks would be essentially the same as presented in the TWRS EIS.

The new information results in small changes to the land-use impacts. Although there would be an additional 45 ha (110 ac) used temporarily during remediation, all of this land would be within the 200 Area which is designated for waste management activities. There would be an additional 25 ha (62 ac) permanently used by the new configuration for the LAW vaults, but this too would be within the area designated for waste management activities. The amount and location of the area within the Hanford Site that would be need to be restricted from future use as a drinking water source would not change.

Regulatary Compliance

The new information did not change DOE's ability to meet regulatory requirements for the Phased Implementation alternative as presented in the EIS. All regulatory requirements would be met. The Nuclear Regulatory Commission (NRC) issued a conditional acceptance of the immobilized LAW waste as non-HLW.

Uncertainties

Progress has been made towards the reduction of a number of the uncertainties that are important to Phase IB, and activities have been initiated which will reduce the uncertainties associated with Phase II.

The inventory of the tank waste has been better defined through a detailed evaluation of records and characterization data and the issuance of a revised inventory. However, the revised inventory still has some inconsistencies that will be resolved in 1998. The revised inventory allows more accurate estimations for all aspects of the project.

There remain uncertainties about the effectiveness of technologies to retrieve waste but this is less important for Phase IB because nearly all of the waste would be retrieved from the DSTs with a high liquid content, which is more easily retrieved. Uncertainties have not been substantially reduced concerning leakage from SSTs during retrieval although this too is an issue that primarily impacts Phase II when most of the SSTs waste will be retrieved.

Progress has been made in verifying the effectiveness of enhanced sludge washing and defining the amount of glass formers that would be required to produce vitrified HLW which allows more accurate estimates of the amount of HLW that will be produced.

There remains uncertainty about the regulatory classification of residual waste that may be left in the tanks after remediation and whether the HLW would meet the acceptance criteria for the geologic repository. The Hanford Site's tank waste contains hazardous waste that must be treated and/or delisted prior to meeting repository waste acceptance criteria. If the residual waste is not classified as incidental waste it may need to be retrieved, or DOE would be required to demonstrate that disposal in place would be protective of human health and the environment. However, the NRC has given conditional acceptance that the immobilized LAW would not be classified as HLW, which reduces one major source of regulatory uncertainty.

There continues to be a large uncertainty surrounding past tank leaks and other non-TWRS sources of contamination and the impacts these sources of contamination may have on the overall site groundwater quality. This uncertainty is closely tried with decisions on how much waste to retrieve from the tanks and how to close the tank farms and is also important to the overall remediation of the Hanford Site. However, it is substantially less important to Phase IB which is not dependent on closure or Sitewide groundwater remediation decisions.

The understanding of long-term health effects associated with losses during retrieval, residual waste, and onsite and offsite disposal facilities remains an area of uncertainty. The TWRS EIS identified uncertainties in estimates and assumptions about tank waste inventories, waste composition, effectiveness of remediation technologies, and the consequences analyses, which included assumptions about waste source and release terms, future land uses, environmental transport parameters, the amount of waste retrieval, the end state of the tank farms, and relationships between exposure and risk. The understanding of these uncertainties is adequate for Phase IB activities because long-term risk is largely a function of retrieval losses from SSTs and residual waste following completion of SST retrieval, which are activities that will occur primarily during Phase II. However, additional information needs to be developed to reduce these uncertainties for Phase II.

The final location and costs for disposal for vitrified HLW from the TWRS program remains uncertain. Currently, Yucca Mountain is the only site being characterized as a geologic repository for HLW. The schedule for accepting waste and the costs associated with construction and operation of the geologic repository are preliminary. Additionally, the allocation of repository costs among defense waste sites has not been established. There is no new information developed since the TWRS EIS that would change the uncertainties associated with the TWRS planning for disposal of all HLW offsite at a geologic repository.

1.4 ENVIRONMENTAL SYNOPSIS OF THE PHASE IB PRIVATIZATION ENVIRONMENTAL REPORTS

In support of the review process for the TWRS program, DOE took the following actions in accordance with 10 CFR 1021 and commitments made in the TWRS EIS ROD and 1) required that each of the Privatization contractors submit an environmental report at the conclusion of Phase IA; 2) independently verified the accuracy of the environmental data and analyses, and prepared and considered a confidential environmental critique of each contractors environmental report; and 3) prepared an Environmental Synopsis (refer to Appendix D) based on the Environmental Critique. The confidential Environmental Critique discusses each of the contractors' treatment process along with proprietary data that cannot be made publicly available prior to authorizing contractors to proceed with Phase IB. DOE used the Environmental Critique to assess the need for additional National Environmental Policy Act (NEPA) analysis prior to authorizing one or both contractors to proceed with Phase IB.

Based on the review of the Environmental Reports and supplemental information provided by the Privatization contractors, the impacts of authorizing both contractors to proceed with Phase IB, assuming one contractor is authorized to proceed with a LAW/HLW facility and the second contractor is authorized to proceed with a LAW only facility, are within the bounds of the environmental impacts of the TWRS EIS or are not substantively different from the impacts presented in the EIS. Other options that would also be within the bounds of the environmental impacts presented in the TWRS EIS are proceeding with 1) two contractors that provide LAW only services; 2) one contractor to provide either LAW/HLW services or LAW only services; or 3) not authorizing either contractor to proceed. The final option may have NEPA implications depending on how DOE decides to proceed with waste retrieval and treatment. Specifically, as long as DOE maintains the underlying approach to waste retrieval and treatment and the alternate approach is evaluated and determined to be within the bounds of the TWRS ROD, DOE could choose to proceed with another contracting strategy for implementing waste retrieval and treatment.

2.0 INTRODUCTION

Tank Waste Remediation System
Decision Assessment Supplement Analysis
Purpose and Need

In 1996 DOE and Ecology issued the TWRS EIS, which addressed alternatives for the safe management and remediation of approximately 210 million Ci of radioactive, hazardous, and mixed waste stored in the 177 underground storage tanks in the 200 Areas of the Hanford Site (DOE 1996g). DOE subsequently issued a ROD, which documented the selection of the Phased Implementation alternative and the decision to privatize certain portions of the project (62 FR 8693). Ecology concurred in the selection of the Phased Implementation alternative. The waste will be separated into 1) LAW, which will be immobilized and disposed of onsite; and 2) HLW, which will be vitrified to form glass and disposed of at a geologic repository. The Phased Implementation alternative includes Phase IB production plants that will be used to verify that the treatment processes will function effectively in the Phase II production phase.

The TWRS project is very complex, and there are many technical uncertainties associated with the implementation of the Phased Implementation alternative. To address these uncertainties and ensure that data developed during the various phases of the project are incorporated into project planning, DOE committed in the ROD to perform future analysis at specific points in the program. These analyses are to assess 1) whether new data and information change the environmental and human health impacts of the Phased Implementation alternative; and 2) whether the new data and information support DOE's path forward for remediating the tank waste. DOE is currently evaluating proposals from Privatization companies and nearing a decision on how best to proceed with construction and operations of the demonstration phase of the project. This is one of the points in time at which DOE committed to evaluate these new data, and this NEPA SA was prepared to support this commitment. The SA is one component of a programmatic review of the TWRS path forward that DOE is conducting prior to proceeding with construction and operation of the Phase IB production plants.

2.1 THE TANK WASTE REMEDIATION SYSTEM PROGRAM

2.1.1 Tank Waste Generation History

From 1943 to 1989, the Hanford Site's principal mission was the production of weapons-grade plutonium (Figure 2.1.1). To produce plutonium, uranium metal was irradiated in a plutonium production reactor. The irradiated uranium metal, also known as spent fuel, was cooled and treated in a chemical separations or reprocessing plant, where plutonium was separated from uranium and many other radioactive by-products. The plutonium then was used for nuclear weapons production. The chemical separations processes resulted in large volumes of radioactive waste.

The Hanford Site processed approximately 100,000 metric tons (mt) (110,000 tons) of uranium and generated several hundred thousand metric tons of waste. The waste included high-level, transuranic (TRU), low-level, hazardous, and mixed waste (waste that includes both radioactive and hazardous waste).

For the HLW generated by the chemical reprocessing plants, waste management initially involved adding sodium hydroxide and calcium carbonate to make the acidic waste alkaline for storage in large underground tanks until a long-term disposal solution could be found. In the 1940's through the early 1960's, 149 SSTs with capacities of 210,000 L (55,000 gal.) to 3.8 million L (1 million gal.) were built to store HLW in a region near the center of the Hanford Site referred to as the 200 Areas.

During the 1950's waste was retrieved from some SSTs by sluicing and uranium was extracted from the waste. The waste stream from this extraction process, which included new chemical additions, was sent to the tanks for storage. Also, to free up tank space for large volumes of new waste generated by fuel reprocessing, chemicals were added to the tanks to settle radionuclides from the liquid waste to the bottom of the tanks. This left the upper liquid layer less radioactive allowing less-radioactive liquid to be pumped out of the tanks to shallow subsurface drainfields, referred to as cribs, where it percolated into the soil. Also, process changes resulted in higher concentrations of heat-generating Cs-137 and Sr-90 in the tanks. Heat generation in the tanks was addressed in the 1960's when SST waste was recovered and sent to B Plant to remove cesium and strontium from the waste. After removal of the cesium and strontium the liquid waste could be evaporated to lessen its chance of leaking out of the tanks.

The SSTs (Figure 2.1.2) were built with a design life of approximately 20 years. Leakage of waste from the SSTs to the underlying soil was suspected in 1956 and confirmed in 1959. By the late 1980's, 67 of the SSTs were known or suspected leakers, and an estimated 3.8 million L (1 million gal.) of tank waste had been released to the soil beneath the 200 Areas. To address concerns with the design of SSTs, the Hanford Site adopted a new DST design that included an outer steel shell to contain any leaks that occurred through the inner steel shell (Figure 2.1.3). The DST design provided for leak detection and recovery before waste could reach the surrounding soil.

Between 1968 and 1986, 28 DSTs with capacities of 3.8 million L (1 million gal.) to 4.4 million L (1.16 million gal.) were constructed in the 200 Areas. Most of the free-standing liquid contained in the SSTs has been pumped into DSTs; however, the remaining solids still contain liquids within the void spaces. Newly generated waste is stored in the DSTs. No leaks are known to have occurred from the DSTs.

Figure 2.1.1. Hanford Site Map

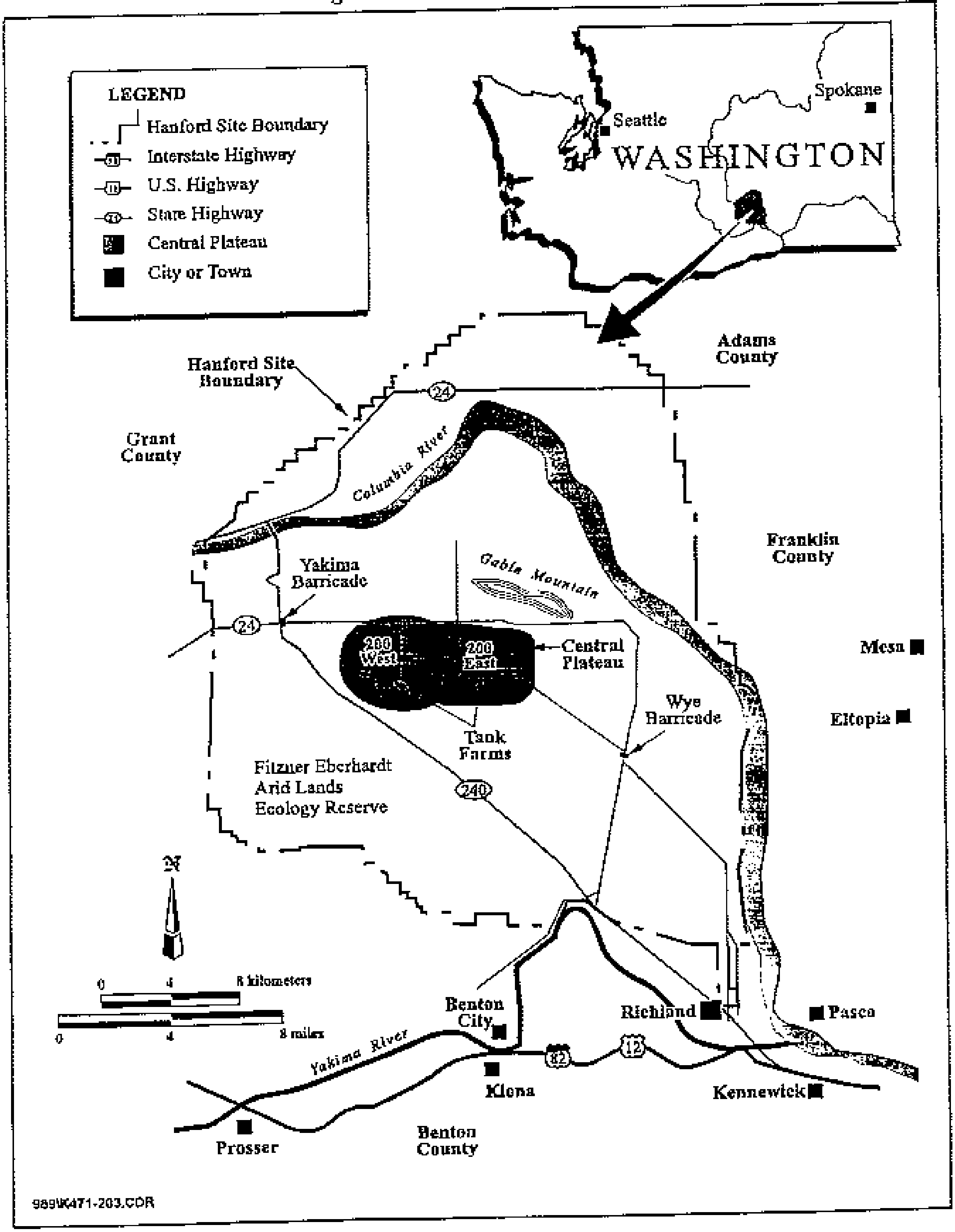
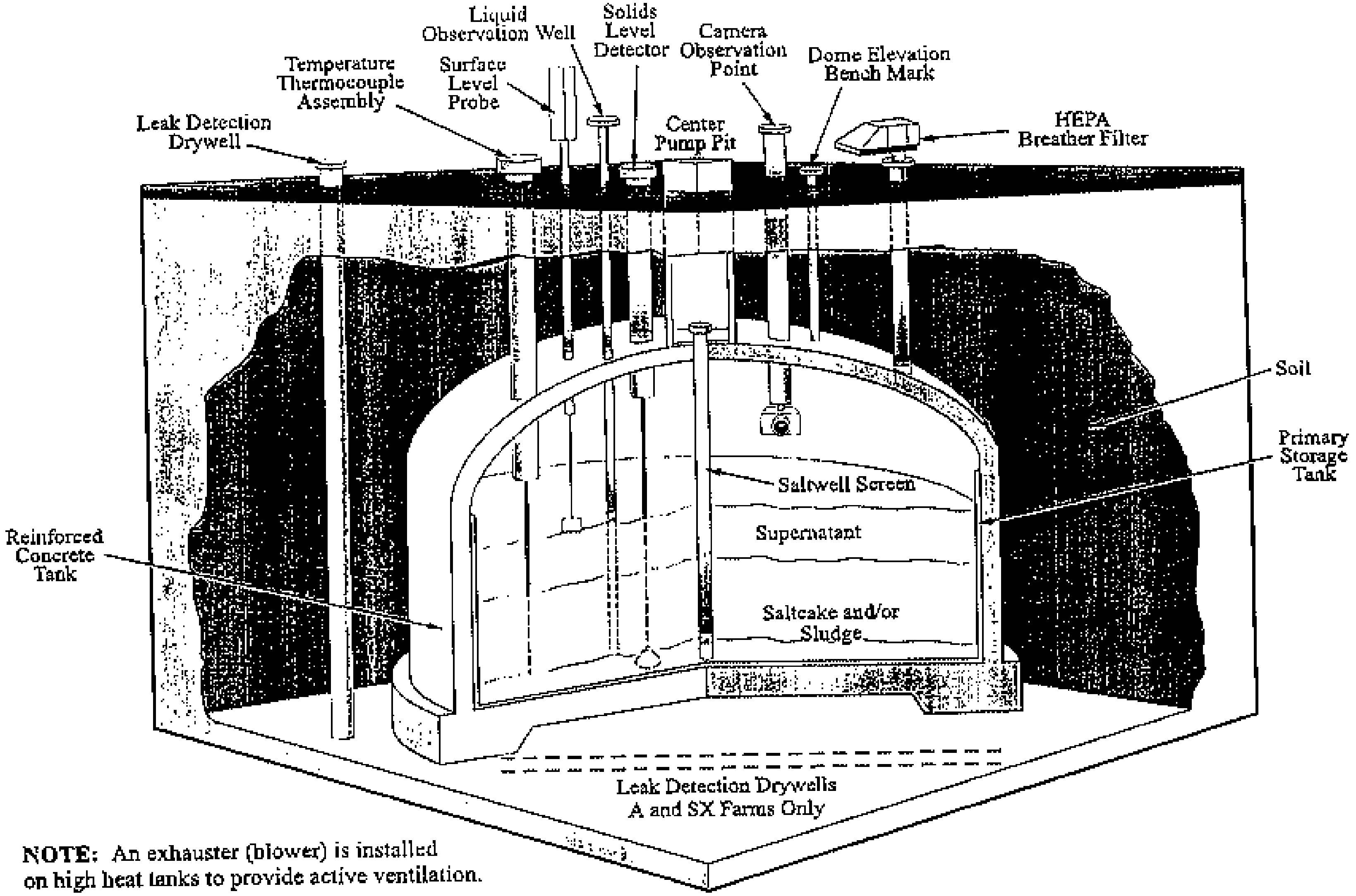


Figure 2.1.2. Single-Shell Tank Configuration

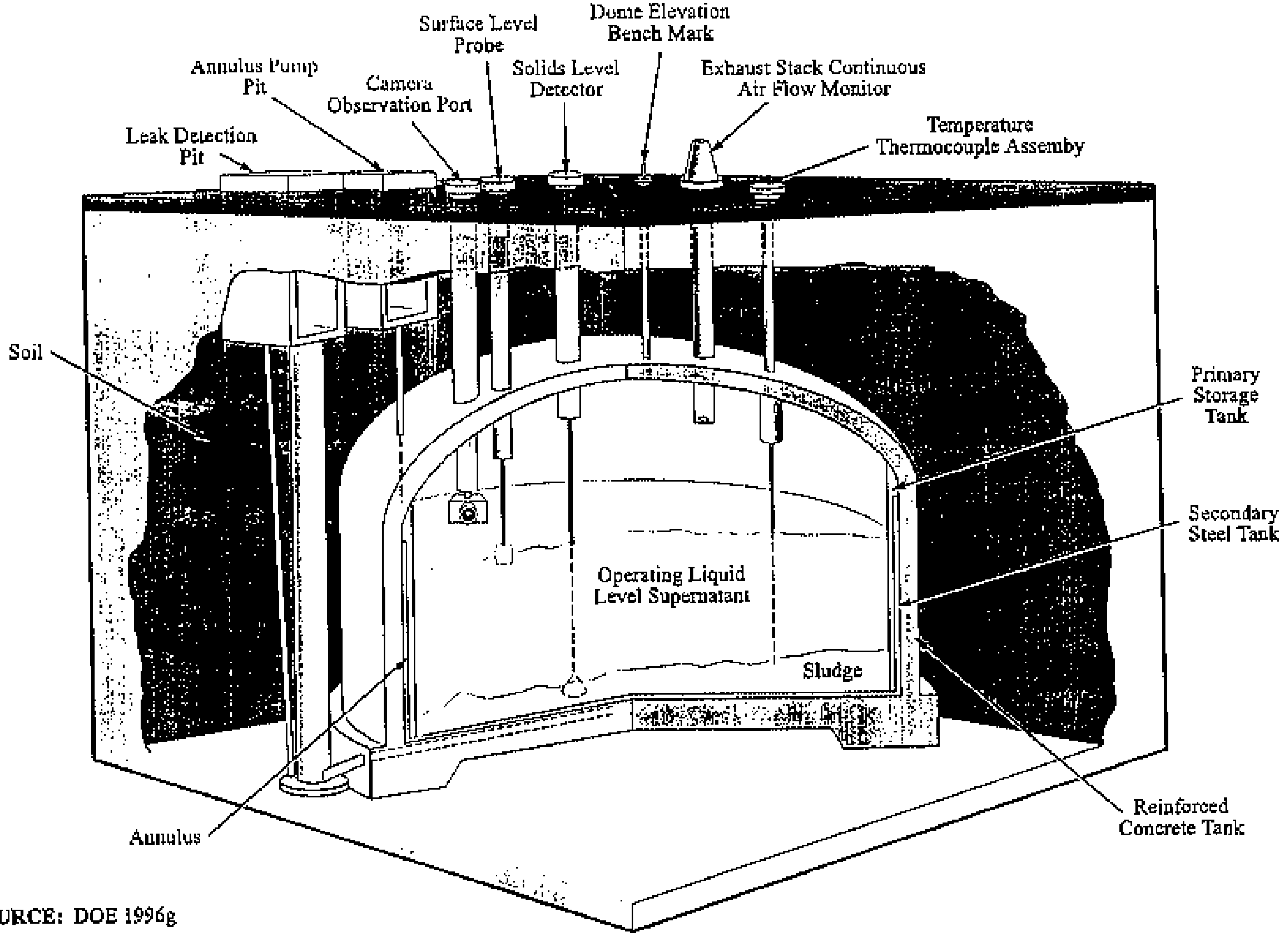


NOTE: An exhauster (blower) is installed on high heat tanks to provide active ventilation.

SOURCE: DOE 1996g

941/K471-53A.CDR

Figure 2.1.3. Double-Shell Tank General Configuration



SOURCE: DOE 1996g

941/K471-54A.CDR

Tanks were constructed in groups called tank farms (Figure 2.1.4). The current tank farm system consists of 177 large underground storage tanks in 18 tank farms that contain a total of 200 million L (54 million gal.) of liquid, sludge, and saltcake (generally a semi-solid crusty material).

There also are approximately 60 smaller active and inactive miscellaneous underground storage tank (MUSTs). Much of the waste in the inactive tanks has been removed or stabilized, and the remaining waste is similar to the waste in the DSTs and SSTs. The active tanks primarily are used to facilitate routine waste management transfers.

Additional waste planned for storage in the DSTs includes radioactive and hazardous waste from Hanford Site cleanup and decontamination activities including the cleanout of K Basin sludge.

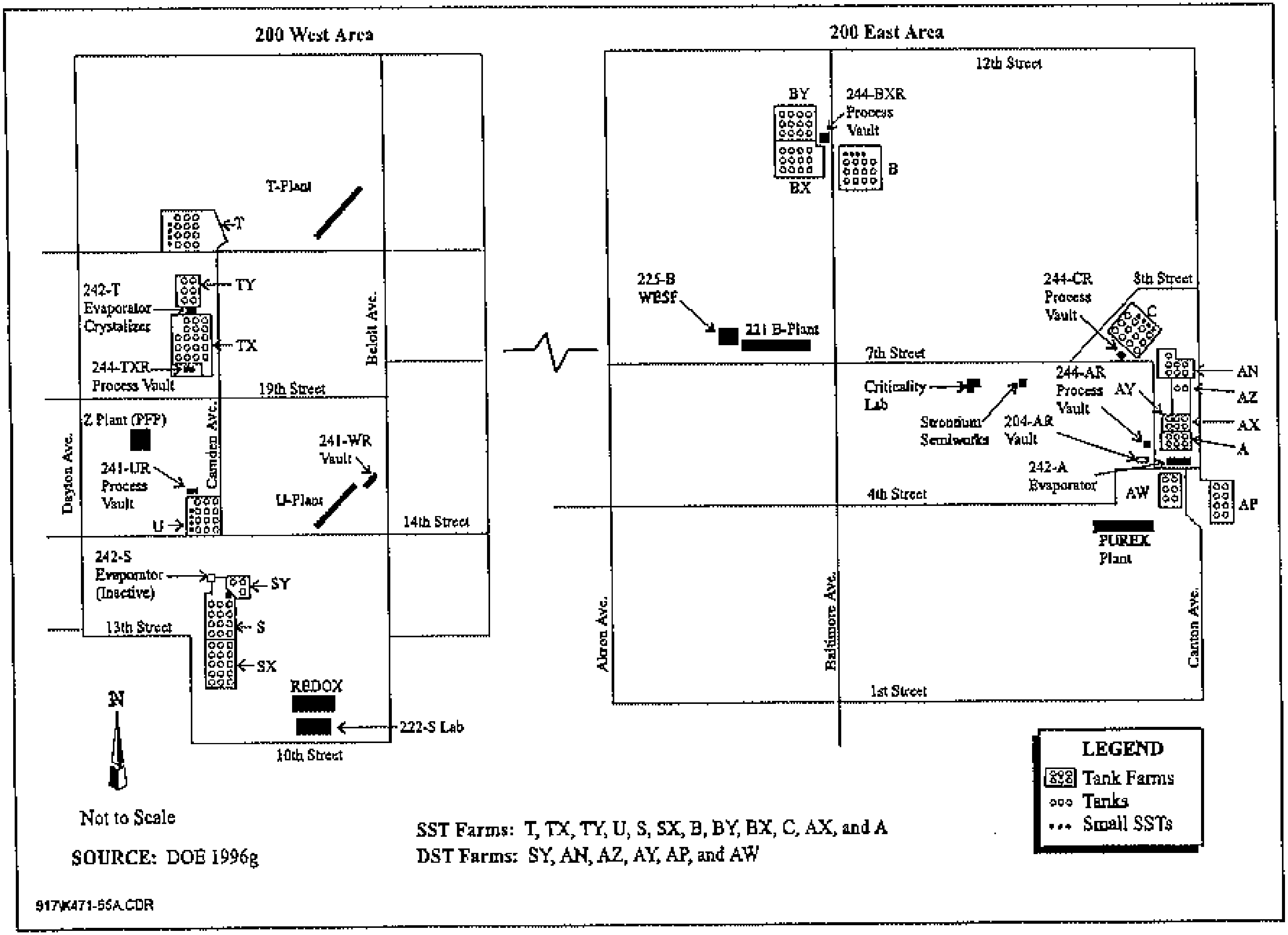
2.1.2 Tank Waste Regulatory History

In response to the continued accumulation of spent nuclear fuel, high-level radioactive waste, other hazardous wastes, and a growing public awareness and concern for public health and safety, Congress passed numerous laws to regulate the storage, treatment, and disposal of radioactive and hazardous waste including the Nuclear Waste Policy Act. The purpose of these laws was to establish a national policy and program that would provide reasonable assurance that the public and the environment would be adequately protected from the hazards posed by these wastes.

In 1974, Congress passed the Energy Reorganization Act, which authorized the NRC to regulate and license DOE facilities authorized for the express purpose of long-term storage of high-level radioactive waste that are not part of DOE's research and development program. The NRC established regulations for low-level radioactive waste that can be disposed of in land disposal sites (10 Code of Federal Regulations [CFR] Part 61), as well as radioactive waste requiring geologic disposal (10 CFR Part 60). The U.S. Environmental Protection Agency (EPA) was authorized to establish standards for managing and disposing of spent nuclear fuel, high-level waste, and TRU waste. These standards are contained in 40 CFR Part 194.

In addition to applicable laws and regulations, DOE has established a set of policies to guide DOE activities. It is DOE policy (DOE Order 5820.2A) that new and readily retrievable existing HLW would be processed into an immobilized form for disposal in a geologic repository. High-level waste that is not readily retrievable shall be evaluated for in-place stabilization or disposal in a potential geologic repository. DOE's policy for low-level waste (LLW) (DOE Order 5820.2A) is that LLW be disposed of at the site where it was generated, if practicable. If onsite disposal capacity is not available, the LLW shall be disposed of at an offsite disposal facility.

Figure 2.1.4. Tank Farm Locations in 200 East and 200 West Areas



Not to Scale

SOURCE: DOE 1996g

SST Farms: T, TX, TY, U, S, SX, B, BY, BX, C, AX, and A
DST Farms: SY, AN, AZ, AY, AP, and AW

917\K471-55A.CDR

With the passage of the Resource Conservation and Recovery Act (RCRA) of 1976, as amended by the Hazardous and Solid Waste Amendments of 1984 and the Federal Facility Compliance Act of 1992, the EPA and states were authorized to regulate hazardous and mixed waste generation, treatment, storage, and disposal (TSD). RCRA does not apply to Atomic Energy Act materials (source, special nuclear, and by-product material) but in 1987 the hazardous constituents in the mixed waste at DOE facilities was determined to be covered by RCRA regulations. The Federal Facility Compliance Act of 1992 amended RCRA to define mixed waste as waste that contains both hazardous waste and source, special, and by-product nuclear material. In November 1987, Ecology, the administrating agency for the State Hazardous Waste Management Act, was authorized by EPA to administer state statutes in lieu of the RCRA. These regulations established regulations for newly generated hazardous waste but as originally enacted did not address past waste disposal practices.

To address the cleanup of past hazardous and radioactive waste disposal sites, Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986. This law required Federal agencies to investigate and remediate releases of hazardous substances (including radioactive contaminants) from their facilities.

EPA, Ecology, and DOE issued the Tri-Party Agreement on May 15, 1989. The existing waste, as well as new waste added to the tank farms, is regulated by the Tri-Party Agreement's RCRA enforcement provisions. In 1994 DOE, Ecology, and EPA modified the Tri-Party Agreement to incorporate a new strategy for remediating the tank waste (Ecology et al. 1994). The revised technical strategy embodied in the Tri-Party Agreement addressed the need to manage and dispose of tank waste because the waste had an unacceptable potential for release to the environment and thereby posed a risk to human health and the environment. The risks include both urgent tank safety issues and longer-term risk.

Tri-Party Agreement

The Tri-Party Agreement is an enforceable agreement among DOE, Ecology, and EPA for achieving environmental compliance at the Hanford Site. The agreement accomplishes the following:

- Defines CERCLA cleanup provisions for past contamination
- Defines RCRA waste TSD requirements and corrective actions for uncontrolled releases to the environment
- Establishes responsibilities for each agency
- Provides a basis for budgeting
- Establishes enforceable milestones for achieving cleanup and regulatory compliance.

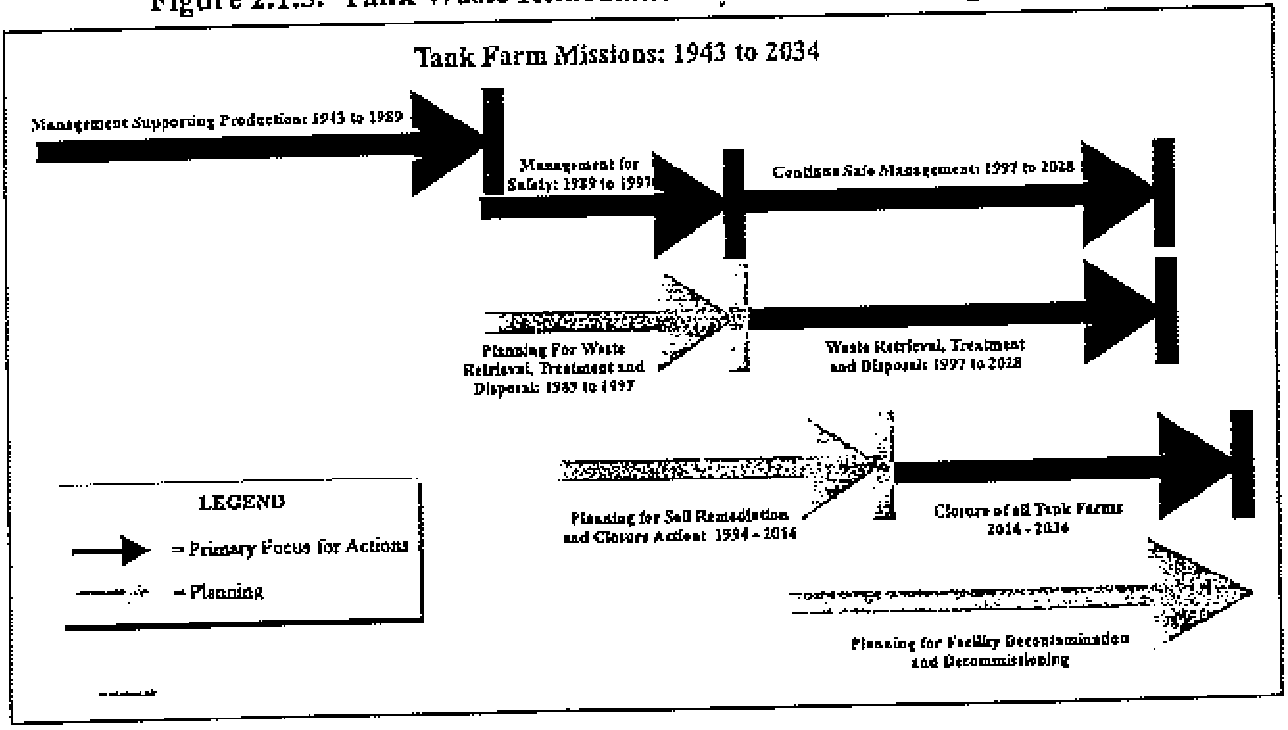
In 1996, the agencies issued changes to the Tri-Party Agreement to allow private companies to perform remediation of the tank waste in response to a DOE initiative to encourage industry to use innovative approaches to remediate the tank waste.

2.1.3 The Current Tank Waste Program

The overall TWRS program consists of four distinct activities: 1) safely managing the tank waste; 2) remediating the tank waste; 3) remediating the tanks, associated equipment, and contaminated soils (a process called closure); and 4) decommissioning facilities (Figure 2.1.5).

Safely managing the tank waste is a program that has been ongoing for many years and remediating the tank waste is the program that is nearing the construction and operations for the Phase IB production plants . DOE determined that decisions cannot be made at this time concerning closure of the tank farms because not enough information is known about past-practice releases from the tanks or technologies for remediating the tank farm system (59 FR 4052). However, DOE is collecting environmental data through the vadose zone characterization program and conducting technology development activities through HTI to support future decisions on how to close the tank farms. Emerging information on the rate of migration of past leaks from the tanks demonstrates that certain contaminants have moved faster than previously anticipated through the vadose zone to the groundwater. The cause of this is under investigation by DOE and likely results from several factors including larger volume leaks than previously estimated, changes in information on the mobility of contaminants in the upper layers of the vadose zone due to chemical processes, and physical properties of the subsurface soils (Section 4.3). This new information is important to the future assessment of measures to close the tank farms. Decommissioning is too far in the future to be addressed at this time because of a lack of information on what facilities will require decommissioning.

Figure 2.1.5. Tank Waste Remediation System Master Program Focus



In response to Public Law 101-510, Safety Measures for Waste Tanks at the Hanford Nuclear Reservation (also known as the Wyden Amendment) in 1990 a program was created to identify tanks with potential safety problems and address specific tank safety issues. Safety issues associated with the tanks were grouped into four categories: flammable gas, ferrocyanide, high organic content, and high-heat generation. A total of 62 tanks have at one time been included on the Watchlist, with several tanks listed in more than one category. The most tanks that have been on the Watchlist at any one time is 54. Technical evaluation has resulted in addressing the ferrocyanide, floating organic layer in tank 241-C-103, and criticality safety issues. Based on characterization data and analysis, DOE plans to close the flammable gas issue in 2000. The remaining Watchlist safety issues, organic hazards associated with organic solvents, organic complexants and high-heat, are also moving toward resolution. DOE plans to close the organic solvent issue in early 1998, the organic complexant issue in September 1998 and the high-heat issue in 1999. Based on progress in addressing Watchlist safety issues to December 1997, the number of Watchlist tanks now stands at 38 tanks.

Additionally, in 1997 DOE began implementing the TWRS BIO (LMHC 1997a). The BIO replaced the former TWRS Authorization Basis and provided TWRS with a single integrated safety basis to support tank farm operations rather than over 120 separate safety documents. The BIO provided detailed hazard analysis, bounding accident analysis, controls to prevent or mitigate accidents, and a process for evaluating proposed changes against the approved TWRS Authorization Basis. The BIO provides the Authorization Basis for TWRS until the Final Safety Analysis Report (FSAR) is approved and implemented.

Tank waste has been sampled from 131 tanks to support safety analysis and waste characterization. In 1997, based on the progress of the characterization program, the Tri-Party Agreement agencies renegotiated characterization milestones to revise the strategy for tank characterization. The original milestones required a set number of tanks to be sampled each year. However, the sampling efforts necessary to meet this requirement cannot be fully tied to the project's needs for tank waste information. The change removed the requirement for sampling a predetermined number of tanks, which increased sampling and analysis costs. The new approach links sampling and analysis activities directly to the projects' tank waste information needs.

In June 1997, DOE approved a NEPA SA for tank farm upgrades, Project W-314.This project includes capital improvements necessary for continued safe operation of existing DSTs, double-contained receiver tanks (DCRTs), and selected SSTs (DOE 1997b). The project includes replacing instrumentation and ventilation systems and upgrading electrical power systems. Most of the activities associated with the project involve replacing existing systems. In 1997, TWRS also completed construction of a 10 kilometers (km) (6.2 miles [mi]) cross-site transfer line that will allow the safe transfer of tank waste from DSTs in the 200 West Area to DSTs in the 200 East Area.

In 1996, DOE launched the HTI project to develop and deploy new technologies to support SST retrieval from leaking tanks and retrieval of hard-to-retrieve tank waste known as hard-heel waste. The three year technology development program also is evaluating tank retrieval criteria to determine potential leakage losses during retrieval and technologies for leak detection, mitigation, and monitoring. This program is supporting DOE's SST retrieval program, which is scheduled to begin retrieval of solid and liquid waste from SST C-106 in 1998.

2.1.4 Tank Waste Program Uncertainties

The TWRS program is one of the most complex and costly remediation programs in the country and involves a number of technical uncertainties, some of which can not be fully resolved until waste is actually processed. A major focus of the TWRS program is managing these uncertainties while making progress towards remediating the tank waste. DOE determined that the many years of research and development throughout the DOE complex have reduced the technical uncertainties to a manageable level and the risks associated with proceeding with remediation are less than the risks of future releases of contaminants to the groundwater and of accidents in unremediated tanks that are structurally deteriorating (62 FR 8693). A major accident, such as a tank dome collapse or fire initiated by a seismic event, could result in a significant loss of life and a major additional cost for remediation. DOE also determined that it is necessary to retrieve waste from the tanks to meet regulatory requirements, avoid long-term releases to the groundwater that could threaten human health and the environment, and reduce health impacts to inadvertent intruders into the waste if administrative control of the Site were to be lost (62 FR 8693).

However, DOE is concerned about the technical uncertainties associated with the program and the Phased Implementation alternative was selected, in part, because it provides an opportunity to reduce the technical uncertainties prior to making final commitments to a remediation strategy by learning from early phases of the program and from technology development activities. If necessary, mid-course corrections can be made to the program to apply the new information that is obtained. The responsibility and liability for resolving the uncertainties associated with the separation and treatment processes have been transferred to the Privatization contractors through DOE's Privatization initiative.

The uncertainties that have the potential to impact the course of the TWRS program were identified in the TWRS EIS and in the National Research Council report entitled "The Hanford Tanks: Environmental Impacts and Policy Choices" (NRC 1996). The following is a summary of these uncertainties.

- Waste Inventory
  The inventory of the tank waste is not completely understood. Complete records were not kept on the waste that was put into the tanks, how the waste was transferred between tanks, and the waste that was decanted off and discharged into shallow subsurface cribs for leaching into the soils. In addition, the waste is composed of many chemical and radiological elements and compounds that are constantly reacting to form new chemical

compounds. This results in an uncertain and continuously changing inventory of waste that adds a degree of complexity to the safe management, separations, and immobilization components of the project.

- Waste Retrieval and Transfer
  The efficiency and effectiveness of current methods (i.e., hydraulic sluicing) for retrieving waste from the tanks and how much liquid waste might be released to the environment during retrieval is uncertain. Sluicing is a process that involves adding water to the tanks and mixing it with the wastes to suspend particles so they can be pumped to the surface. Although hydraulic sluicing has been performed in the Hanford Site tanks its effectiveness in removing the hard pan (i.e., hard heel) in the bottom of the tanks has not been proven, and other technologies may be necessary to remove this waste. Also, hydraulic sluicing uses relatively large volumes of liquids and the amount of liquids that may be released through cracks in the SSTs is uncertain. There are 67 known or suspected leaking SSTs, and these and other tanks may leak liquids during retrieval. Using currently available leak detection and mitigation technology, it is estimated that a tank leak could not be detected before 15,200 L (4,000 gal.) has been released and not stopped for most tanks before approximately 30,400 L (8,000 gal.) had been released (WHC 1996e).

- Waste Treatment
  The processes for separating the waste into HLW and LAW and for vitrifying the HLW and immobilizing the LAW has not been performed on Hanford Site tank waste, and the efficiency and effectiveness of these processes are uncertain. The vitrified HLW must meet the waste form specifications for the national geologic repository, which are based on a high-quality borosilicate glass. Separations, immobilization, and vitrification of similar waste have been performed at other DOE sites and in Europe but they have not been performed at a production scale on the Hanford Site waste.

- Long-Term Health Effects
  The long-term health effects associated with losses during retrieval, residual wastes, and onsite and offsite disposal facilities are not fully understood. The TWRS EIS provided best estimate and bounding estimates for these long-term risks. These estimates of the risks vary considerably because of uncertainties associated with residual waste inventory, transport mechanisms through the vadose zone, separations processes, and future site uses. Because of this the TWRS EIS did not specify a level of retrieval that would be necessary to protect public health and safety or support decisions related to closure of the tank farms. The Tri-Party Agreement specifies an interim goal of no more than 10 cubic meters (m^3) (360 cubic feet [ft^3]) per tank of residual waste in the tanks, but this number is not based on estimates of potential health effects. This number may be more restrictive than necessary to be protective of public health and the environment or it may not be restrictive enough. This is not an issue that needs to be resolved for Phase IB but will be very important to resolve prior to Phase II and closure of the tank farms.

- Cumulative Impacts
  The relationship between remediation of the tank waste and remediation of other areas adjacent to the tanks, including past tank leaks, and the Hanford Site as a whole has not been established. There are many other sites within the 200 Areas and the Hanford Site that are releasing contaminants to the groundwater and require remediation. The impact of some of these sites on the groundwater is additive to the potential impacts of TWRS, and an understanding of these cumulative impacts is important in establishing cleanup goals.

- HLW Disposal
  The location and costs for disposal of the HLW generated from the treatment process have not been firmly established. The TWRS EIS used the Yucca Mountain Site as the planning basis for the final disposal location of the HLW because it is the only site that is being characterized for potential siting of the geologic repository. However, a final decision has not been made on the selection of this site.

- Regulations
  The regulations governing the disposal of radioactive, hazardous, and mixed waste have historically been subject to significant changes, and there is potential for future changes to occur, which could impact plans to remediate the tank waste. The final waste classifications of certain waste streams has not been determined, and these classifications may affect the remedial actions implemented.

- Costs
  The cost for the entire program has a degree of uncertainty relative to the uncertainty associated with the issues identified previously. Cost issues are being addressed within DOE's Programmatic Review Report (see Section 2.3) and are, therefore, not addressed in this SA.

DOE has and continues to implement actions to reduce these uncertainties. Section 5.0 contains a discussion of how the data developed since the preparation of the TWRS EIS have reduced these uncertainties and how the remaining uncertainties apply to the Phased Implementation alternative.

2.2 TWRS EIS AND ROD

In response to the aging condition of the tank waste and the applicable regulations identified earlier, DOE determined that it needed to make decisions in cooperation with Ecology on how to manage and dispose of the TWRS waste to reduce existing and potential future risks to the public, Site workers, and the environment. DOE determined that there is a need to address immediate and near-term safety and environmental issues posed by this waste to 1) minimize short-term risks to human health and the environment through ongoing safety programs; and 2) to implement long-term actions to safely manage and dispose of the tank waste and MUSTs to permanently reduce potential risks to human health and the environment (DOE 1996g). These long-term actions are also needed to ensure compliance with Federal and Washington State laws regulating the management and disposal of the waste.

Closure

Closure is a regulatory term for those activities involved in remediating the tank equipment, contaminated soil, and contaminated groundwater after the tank waste has been remediated.

Closure for the hazardous waste component would be performed under State Dangerous Waste Regulations (WAC 173-303). Closure of the radioactive component is assumed to be performed under DOE Orders, including DOE Order 5820.2A.

Closure alternatives were not part of the EIS but were interrelated with the decisions made concerning remediating the waste.

In the EIS closure as a landfill was included in all of the alternatives except the No Action and Long-Term Management alternatives so the alternatives could be meaningfully compared. The TWRS ROD made no decisions regarding closure or any decisions that would foreclose any closure options.

2.2.1 Description of Selected Alternative

In 1996, DOE published the TWRS EIS to address the disposition of the tank waste. The alternatives developed for evaluation in the TWRS EIS were for tank farm management and tank waste remediation activities. DOE evaluated the full range of reasonable alternatives and selected the Phased Implementation alternative. Because DOE selected the Phased Implementation alternative, the information in this SA concentrates on the potential affects that new information may have on the impacts and uncertainties associated with the Phased Implementation alternative. However, since there is potential for the new information to have a different impact on one of the other alternatives addressed in the EIS, a separate section (Section 4.21) is devoted to a discussion of the impact of this new information on the other alternatives.

DOE decided to privatize the implementation of certain portions of the Phased Implementation alternative and awarded contracts to teams led by LMAES and BNFL. The contracts required each contractor to submit an Environmental Report which provided information relative to the potential impacts that the Phase IB may have on the environment. The information in these reports is business sensitive and therefore can not be addressed in this SA, which will be publicly available. However, consistent with DOE's NEPA regulations (10 CFR Part 1021) DOE independently evaluated and verified the accuracy of the environmental data and analysis in accordance with 10 CFR Part 1021.216 and 10 CFR Part 1021.314, and used this information as appropriate, in the selection process for the Phase IB and to determine the potential need for further NEPA analysis. A synopsis of this independent evaluation and verification of the Environmental Reports has been prepared and made available in Appendix D. The synopsis does not contain any business-sensitive information. Section 4.0 of this Supplement Analysis includes a synopsis of the environmental impacts of the Phase IB Privatization Environmental Reports for each applicable category.

DOE determined that it was premature to make decisions on closure of the tank farms and decommissioning of the facilities constructed to treat the tank waste. Closure and decommissioning will be assessed in a future NEPA analysis. However, because these activities are interrelated with the remediation of the tank waste, information was provided in the TWRS EIS to provide the public and decision makers with an understanding of how the remediation of the tank waste is interrelated with these future decisions so the alternatives could be equitably compared. To address the relationship between tank waste remediation and closure of the tank farms a single and consistent method of closure was assumed for all alternatives. The closure method used for purposes of analysis was closure as a landfill, which includes placing an earthen surface barrier over the tanks after remediation is complete. Impacts that primarily are dependent on the type of closure that will be selected in the future include 1) releases to the groundwater from residual waste and the associated potential health effects; and 2) the amount and location of land and vegetation disturbances at potential earthen borrow sites.

In response to the need to support DOE's integrated approach to remediating the Central Plateau and the Hanford Site as a whole, DOE will prepare a future NEPA analysis to address tank farm closure and other issues associated with TWRS remediation. The analysis will address alternatives for closing the tank farms including disposition of the tanks and associated equipment, residual waste remaining after retrieval, and contaminated soils; resolution of emerging information concerning contamination of the vadose zone; and the integration of tank farm closure with the remediation of other Central Plateau areas.

To address decommissioning of the facilities constructed to remediate the tank waste, the cost, personnel requirements, and volume of contaminated and noncontaminated materials resulting from decommissioning were developed and analyzed in the TWRS EIS using general practice assumptions to show how tank waste remediation and decommissioning are interrelated. This provides an assessment of the relative environmental impacts of future decommissioning activities so that the alternatives can be meaningfully compared. DOE will conduct an appropriate NEPA review to support future decommissioning decisions.

The following describes the Phased Implementation alternative as it was assessed in the TWRS EIS. There have been some small changes to the alternative and these changes are described in Section 3.0. During Phases 1 and 2, continued operations of the tank farm system and actions to address safety and regulatory compliance issues would be performed and would include:

- Upgrading tank farm infrastructure, including waste transfer, instrumentation, ventilation, and electrical systems
- Monitoring tanks and equipment to support waste management and regulatory compliance requirements

Key Technical Terms

Earthen Barrier: A multi-layer cover consisting primarily of soil, sand, and rock up to 4.6 m (15 ft) thick that would be placed over waste that would remain onsite during closure of the tank farms and the LAW vaults. The purpose of the cover is to inhibit infiltration of water and human intrusion into the waste. This barrier is referred to as the Hanford Barrier.

Ex Situ: Ex situ describes operations or disposal that occurs out of the tanks.

Immobilization: A process (vitrification or a functionally equivalent process) used to stabilize waste so that contaminants are not readily leachable into groundwater.

Retrieval: Removal of liquid and solid waste from storage tanks.

Separations: Physical and chemical processes to separate tank waste into different waste types such as HLW and LAW.

Vitrification: A method of immobilizing waste by forming glass. This process involves adding materials to the waste and heating the waste until it melts. When the mixture cools, a glass is formed that is highly effective in inhibiting the leaching of contaminants.

- Combining compatible waste types, interim stabilization of SST waste, continuing waste characterization, transferring newly generated waste from ongoing Site activities to DSTs, operating the 242-A Evaporator and the Effluent Treatment Facility, and performing mitigative actions to resolve tank safety issues
- Using rail or tanker truck systems to transport waste to the tank farms
- Completing construction of and operating the new replacement cross-site transfer system to facilitate regulatory compliant waste transfers from 200 West to 200 East Area and continue operating the existing transfer pipeline system until the replacement system is operational
- Installing and operating an initial tank waste retrieval system to improve the capacity to consolidate DST waste and support mitigation of safety issues.

Phase 1 activities (Part A, development activities; Part B demonstration activities) would last for approximately 10 years and would include:

- Constructing facilities to produce immobilized LAW and vitrified HLW for future disposal
- Installing and operating tank retrieval systems to retrieve selected waste (primarily DST liquid waste) for separations and immobilization, and selected tank waste for HLW vitrification

- Transferring liquid waste feed to receiver tanks and transferring selected waste for HLW processing directly to the HLW facility
- Performing separations to remove selected radionuclides (e.g., cesium) from the LAW feed stream
- Storing separated HLW constituents (e.g., cesium) at the treatment facilities or in the CSB pending future HLW treatment
- Packaging the HLW in canisters for onsite interim storage and future shipment to a national geologic repository
- Returning a portion of the sludge, strontium, and TRU waste from separations processes to the DSTs for future retrieval and treatment during Phase 2
- Immobilizing the LAW and vitrifying HLW
- Transporting and storing the immobilized low and high activity wastes onsite pending disposal during Phase 2.

Phase 2 (full-scale production) activities would begin after completion of Phase 1, last for approximately 30 years and would include:

- Constructing facilities to immobilize LAW and vitrify HLW
- Installing and operating tank retrieval systems to retrieve waste from all SSTs, DSTs, and MUSTs
- Pretreating the waste by sludge washing and enhanced sludge washing followed by separations of the liquid and solids
- Performing separations to remove selected radionuclides from the waste feed stream and transferring the separated radionuclides to the HLW vitrification facility
- Vitrifying the HLW stream and immobilizing the LAW stream
- Packaging the HLW in canisters for onsite interim storage and future shipment to a national geologic repository
- Placing the immobilized LAW in containers and placing the containers in onsite near-surface disposal facilities
- Deactivating and decommissioning facilities following waste treatment.

DOE also would continue to characterize the tank waste and perform technology development activities to reduce uncertainties associated with remediation, evaluate emerging technologies, and resolve regulatory compliance issues.

The EIS also addressed alternatives for disposition of the 1,930 cesium and strontium capsules currently stored onsite; however, in the TWRS ROD DOE deferred a decision on the disposition of the capsules until commercial uses of the capsules have been evaluated. The capsules are not addressed in this SA because the data are not yet available concerning their disposition.

2.2.2 Record of Decision

After preparing the EIS, DOE published a ROD, which documented DOE's selection of the Phased Implementation alternative (62 FR 8693). Under the Phased Implementation alternative the tank waste would continue to be safely stored until the waste is retrieved from the tanks for treatment and disposal. DOE will remediate the tank waste by implementing a demonstration phase to verify that the treatment processes will function effectively and then by implementing a full-scale production phase. The LAW produced by processing will be immobilized and disposed of onsite in a near-surface-disposal facility near the current location of the tanks. The HLW will be vitrified and disposed of in a geologic repository. DOE selected the Phased Implementation alternative because it strikes an appropriate balance among the potential short- and long-term environmental impacts, stakeholder interests, regulatory requirements and agreements, costs, the ability to manage uncertainties, and recommendations from other interested parties.

DOE also decided to privatize certain portions of the Phased Implementation alternative to transfer a share of the responsibility, accountability, and liability for successful performance to industry. DOE awarded phased contracts to privatize certain portions of the TWRS Program to teams lead by LMAES and BNFL. The work includes two parts: Part IA and Part IB. Part IA consisted of preparing conceptual designs, environmental and regulatory reports, and other activities associated with the planning process for the construction and operation of facilities to treat tank waste. The completion date for Part IA contractor deliverables is January 24, 1998. In accordance with the Tri-Party Agreement, DOE has until no later than July 1998 to evaluate the deliverables and decide whether to authorize none, one, or both contractors to proceed with Part IB of the contract. During Part IB 6 to 13 percent of the total Hanford Site tank wastes will be processed during a 5- to 9-year period. Part IB will conclude with the completion of deactivating the treatment facilities. Part II, waste processing would follow Part I and would last approximately 20 years.

The TWRS Program for the safe management and remediation of the tank waste involves complex environmental, engineering, and policy issues that all have a degree of uncertainty associated with them. These uncertainties (see Section 2.1.4) were discussed in the TWRS EIS and were a major focus of a report prepared by the National Research Council entitled "The Hanford Tanks: Environmental Impacts and Policy Choices" (NRC 1996). DOE selected the Phased Implementation alternative, in part, because it provides the flexibility necessary to modify the TWRS program as new information is obtained through additional characterization activities, technology demonstrations, environmental and engineering assessments, and receipt of information from Privatization contractors. Although DOE determined that Privatization of the Phase Implementation alternative is the appropriate alternative to implement. DOE shares concerns about a number of uncertainties associated with the TWRS Program.

To address these concerns, DOE made a number of commitments in the TWRS EIS and ROD to perform future analysis. Specifically, DOE made the following commitments:

1. "DOE will conduct periodic independent scientific and technical expert reviews, which DOE believes are essential to the success of the TWRS program. Further, DOE intends to conduct

formal reevaluations of new information relevant to the tank waste remediation program at three key points over the next eight years under its NEPA regulations (10 CFR Part 1021.314), with an appropriate level of public involvement, to ensure that DOE stays on the correct course for managing and remediating the tank waste" (62 FR 8693).

2. "DOE will conduct these formal evaluations of the entire TWRS program at the following stages: 1) before proceeding into Privatization Phase I Part B (scheduled for no later than July 1998); 2) prior to the start of hot operations of Privatization Phase 1 Part B (scheduled for December 2002/December 2003); and 3) before deciding to proceed with Privatization Phase 2 (scheduled for December 2005)" (62 FR 8693).

3. "Potential impacts to shrub-steppe habitat and cultural resources will be among the factors considered in a NEPA analysis to support the site selection process for facilities and earthen borrow sites" (62 FR 8693).

4. "As the State {Washington State Department of Fish and Wildlife} requested, the Record of Decision commits to conducting a NEPA analysis for site selection of facilities" (62 FR 8693).

5. "DOE will also require selected offerers to submit further environmental information and analyses and will use the additional information, as appropriate, to assist in the NEPA compliance process, including a determination under 10 CFR Part 1021.314 of the potential need for a supplemental EIS" (62 FR 8693).

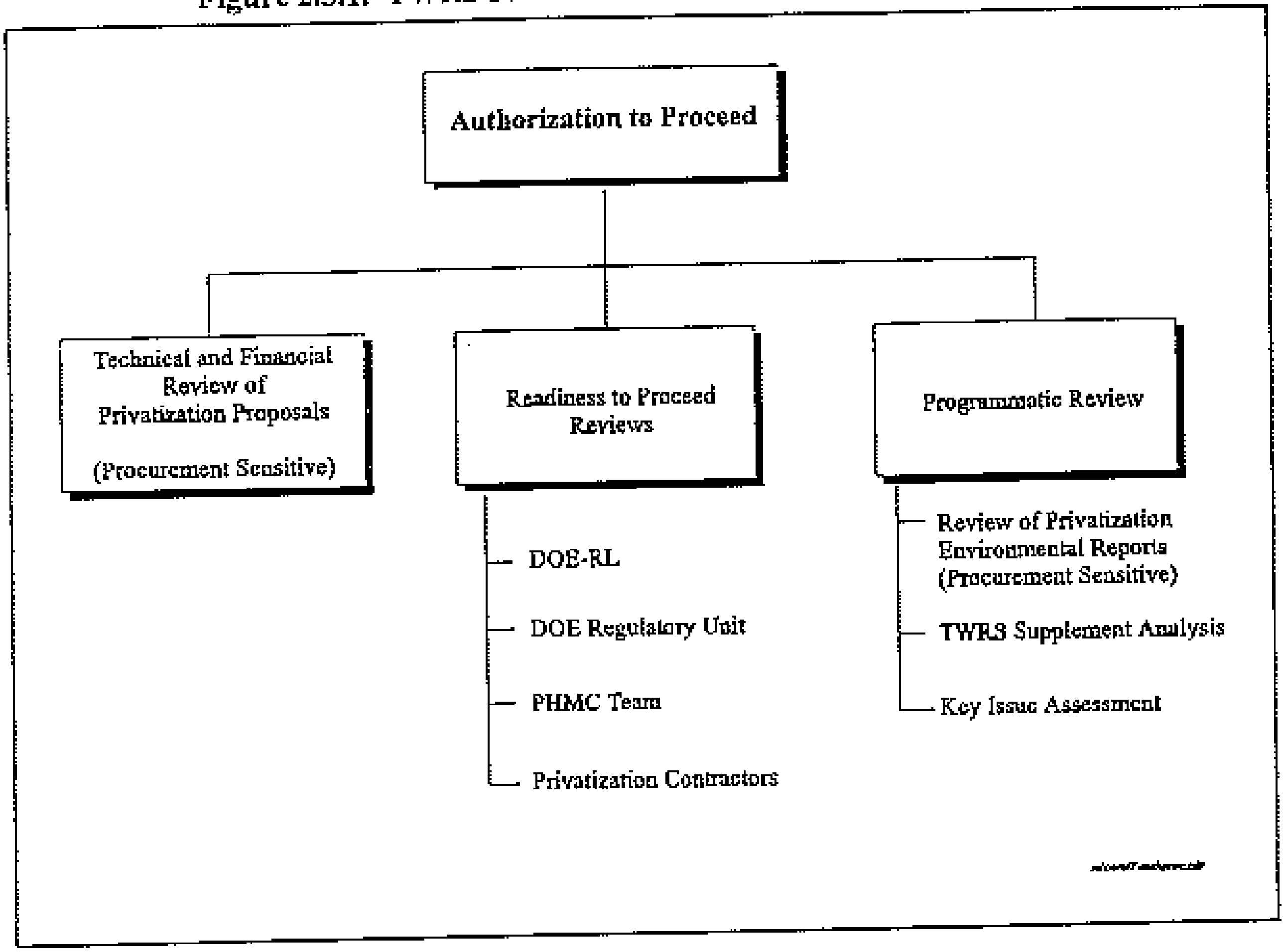
6. "DOE will independently evaluate and verify the accuracy of the environmental data and analyses and, as appropriate, use the information to help ensure the consideration of environmental factors in the selection process in accordance with 10 CFR Part 1021.216" (DOE 1996g).

2.3 THE TANK WASTE REMEDIATION SYSTEM SUPPLEMENT ANALYSIS

This SA was prepared to address the commitments identified in the previous section. This SA is one part of a comprehensive and detailed Authorization to Proceed process (Figure 2.3.1), which will include a comprehensive assessment of the key issues associated with proceeding with Phase IB. The Authorization to Proceed process includes the following:

- A comprehensive assessment of the proposals for Phase IB submitted by the Privatization contractors and an assessment of the options for proceeding with the next phase of the project. This includes a full assessment of the technical and financial aspects of each proposal.
- Formal Readiness to Proceed reviews by DOE-Richland Operations Office (RL), DOE Regulatory Unit, Project Hanford Management Contractor (PHMC), and Privatization contractors to ensure that all policies, plans, procedures, equipment, facilities, and personnel are in place and each organization is ready to meet their responsibilities for

Figure 2.3.1. TWRS Phase IB Authorization to Proceed Process



Phase 1B. This is a top-down review that assesses the readiness of each of the organizations relative to all of the key items that must be in place prior to proceeding.

- A Programmatic Review Process, which includes:
  - An assessment of the Environmental Reports submitted by the Privatization contractors to address EIS and ROD commitments 5 and 6 identified previously. This includes a review of the reports to verify the accuracy of this information and the preparation of a Critique (procurement sensitive) and Synopsis (non-procurement sensitive) consistent with DOE NEPA regulations (10 CFR Part 1021.216), which will provide an assessment of the potential impacts of the proposals.
  - This SA, which includes an assessment of new data and information developed since the preparation of the TWRS EIS.
  - A Key Issue Assessment, which includes comprehensive assessment of the key programmatic cost, technical, and financial issues that may affect DOE's decision to move forward with Phase 1B.

Consistent with 10 CFR Part 1021.314 and 40 CFR Part 1502, this SA was prepared to evaluate these new data and other information that have been generated since the preparation of the EIS to support DOE's Authorization to Proceed process and a determination by DOE on whether the potential environmental impacts, based on the new information, are bounded by the impacts presented in the TWRS EIS or whether a Supplemental EIS or other NEPA documentation is required.

To prepare this SA, the new data and information that have been generated since the preparation of the TWRS EIS were assembled. A list of engineering and environmental parameters that formed the basis of the impacts calculated for the TWRS EIS was developed, and any new data or information relative to the parameters were assembled for each of the environmental and engineering parameters (Section 3.0). For example, this new information included revised information on the inventory of chemical and radiological substances in the tank waste and new waste that is planned to be sent to the tanks for treatment, emerging information on the contamination in the vadose zone, the latest accident evaluations for the TWRS program, revisions to the tank characterization program, resolution of tank safety issues, information on technology development activities, and updated engineering information. All new data and information were assembled and placed in the Administrative Record for this SA.

The new data were compared against the data that were used as the basis for the analysis presented in the TWRS EIS and, where the new data are appreciably different than the data used to generate the EIS, the potential environmental impacts were reanalyzed to determine the change in the potential impacts for the Phased Implementation alternative. Consistent with NEPA guidance the level of detail of the analysis is dependent on the magnitude of the change in the data, the severity of potential environmental impacts, public controversy associated with the potential impact. The concerns and recommendations for the TWRS Program provided by the National Research Council and other interested parties were also considered. All environmental components are addressed, but in-depth analysis was performed only for the components which meet one of these criteria. A review was also performed to determine if the new information would affect the impacts calculated for the other alternatives addressed in the EIS differently than the Phased Implementation alternative. For each environmental component the methodology used to assess the impacts is briefly described and the changes in environmental impacts are presented.

The natural and human environment that could potentially be affected by the program to retrieve and treat the tank waste has been extensively studied and is described in a number of comprehensive reports including the 1) TWRS EIS, which contains an extensive discussion of the affected environment; 2) the Hanford Site 1996 Environmental Report (PNNL 1997a), which contains recent data and analysis of environmental impacts to the Hanford Site; 3) Hanford Site Environmental Policy Act Characterization (Neitzel et al. 1997); and 4) the TWRS Phase I Privatization Site Environmental Baseline and Characterization Plan (Chou et al. 1997), which assesses the existing environment at the proposed locations of the Privatization Phase IB facilities. These documents are hereby included by reference. The following is a summary from the TWRS EIS of the environment that could potentially be affected by the Phased Implementation alternative. New information and data concerning the affected environment that may have a substantive effect on the impacts calculated in the TWRS EIS are summarized in Section 3.0.

2.4 ENVIRONMENTAL SYNOPSIS ASSESSMENT

The Environmental Critique for Phase IB Privatization Proposals and the Synopsis of the Environmental Critique are one part of a comprehensive and detailed Authorization to Proceed process, which includes an assessment of the key issues associated with proceeding with Phase IB of the Phased Implementation alternative.

The Synopsis, provided in Appendix D, summarizes the Environmental Critique, which includes an independent evaluation and verification of the data and analysis submitted by the Privatization contractors for Phase IB. The Environmental Critique was used by DOE to determine 1) if there are any important differences in environmental impacts between the proposals submitted by the Privatization contractors that may affect the selection of none, one, or both of the contractors; and 2) if the potential environmental impacts of the proposals are bounded by impacts presented in the TWRS EIS or whether a supplemental EIS or other NEPA documentation is required prior to proceeding with implementation of the actions identified in the TWRS ROD. The Environmental Critique was a procurement-sensitive document and subject to all associated restrictions. The business sensitive information in the Synopsis was summarized at a level that will not compromise the procurement process.

To prepare the Environmental Synopsis, the data and information contained in the Environmental Reports, associated documents submitted by the contractors in response to inquiries from DOE or other Phase IA requirements, and the final Environmental Reports submitted to DOE in January 1998 were verified by checking calculations (when available), checking the data for reasonableness, and comparing the impacts presented in the Environmental Reports to the impacts presented in the TWRS EIS. All data presented in the Environmental Reports were then compared against the data that were used to generate the impacts presented in the TWRS EIS for Phase I of the Phased Implementation alternative and, where the data were different, the potential environmental impacts were analyzed to determine the changes in the potential impacts.
The level of detail of the analysis was based on the level of detail provided in the Environmental Reports, the magnitude of the changes in the data, the severity of the potential impacts, and the degree of public controversy associated with the potential impact.

Description of the Proposals

The proposals by the Privatization contractors contain confidential information and therefore are not available for review by the public and cannot be fully described nor the potential environmental impacts quantified in this synopsis. For this purpose a qualitative approach was used in the Synopsis when comparing the potential environmental impacts with the impacts estimated in the TWRS EIS. The descriptions of the proposals and the environmental impacts resulting from construction and operations have been quantified in an Environmental Critique for Phase IB Privatization prepared by DOE. The proposals are to construct and operate initial production facilities to separate and immobilize selected waste from the TWRS program. Both of the Privatization contractors would operate one existing DST as a waste receiver tank that would be used to stage waste prior to treatment. The proposals include interim storage of the processed high-level and LAW until such time as DOE verifies that the waste form meets performance specifications and accepts transfer of the waste. The proposals do not include current tank farm operations activities or the retrieval and transfer of waste from the tanks to receiver tanks (existing DSTs) that will be operated by the Privatization contractors. These activities will be performed by DOE. All waste processing for eventual disposal of LAW onsite and HLW offsite at a geologic repository must meet waste form performance specifications provided in the Request for Proposals.

Overview

Under the Privatization initiative private contractors would use private funding to design, build, operate, and own the facilities. In September 1996, DOE awarded contracts for Phase I to privatize certain portions of the TWRS program to teams lead by LMAES and BNFL. The contracts consisted of Phase IA and IB. Phase IA consisted of preparing technical, regulatory, business, and financial plans, and other activities (including the Environmental Reports) associated with the planning process for the construction and operation of facilities to treat tank waste. In accordance with the Tri-Party Agreement, DOE has until no later than July 1998 to evaluate the deliverables and decide whether to authorize none, one, or both contractors to proceed with Phase IB of the contract. During Phase IB the Privatization contractor(s) would process 6 to 13 percent of the tank waste over a 5- to 9-year period, and DOE would pay a fixed price per unit of product which meets DOE's specifications. Phase IB will conclude with the completion of deactivation of the treatment facilities.

Phase IB is an initial production period in which tank waste treatment services would be provided at fixed-unit prices. Four different waste feed streams (envelopes) are identified for Phase IB: three waste feed streams for pretreatment and immobilization of the resulting waste stream as LAW and one waste feed stream for vitrification as HLW. These waste feed streams are representative of the range of Hanford Site tank waste. The high-level constituents separated out during the separations processes would be vitrified with the HLW feed stream (envelope) or returned to DOE for treatment during Phase II. Waste processing would take place during an operating period of approximately 10 years during Phase IB. Following waste processing the initial production plants would be deactivated.

3.0 SUMMARY OF NEW INFORMATION

3.1 INTRODUCTION

This section summarizes the new data and information that have been developed since the preparation of the TWRS EIS. These new data and information form the basis of the analysis presented in this SA. To assemble the new data and information for analysis, a list of engineering and environmental parameters that formed the basis of the impacts calculated for the TWRS EIS was developed, and any new data or information relative to each of the environmental and engineering parameters were assembled. For example, the new information included the most recent inventory of chemical and radiological constituents in the tank waste and new waste that is planned to be sent to the tanks for treatment, emerging information on the contamination in the vadose zone, the latest accident evaluations for the TWRS program, information on technology development activities, updated engineering information, and new data in the Environmental Report, and supplement reports submitted by LMAES and BNFL. Section 3.2 identifies the information that bad the potential to substantively change the impacts presented in the TWRS EIS and Section 3.3 identifies resource areas where little or no new information is available to support analyzing changes in impacts.

3.2 ENGINEERING AND ENVIRONMENTAL INFORMATION

3.2.1 Waste Inventory

Tank Waste

The tank waste inventory used in the TWRS EIS was based on estimates developed using the best available information at the time of publication. The SST inventory estimate was based on normalized Track Radioactive Component data. The DST inventories were developed using tank sample data in combination with historical tank data. The TWRS EIS acknowledged that considerable uncertainty existed for the inventory data and that additional characterization and inventory evaluations were being conducted.

In an effort to reduce inventory uncertainties, resolve differences among the many reported inventory values, and provide a consistent and technically defensible inventory for all waste management and disposal activities, a task was initiated in fiscal year (FY) 1996 to establish a best-basis standard inventory for chemicals and radionuclides in the tank waste. In August 1997 the TWRS program released the first version of the "Standard Inventories of Chemicals and Radionuclides in Hanford Site Tank Wastes" (Kupfer et al. 1997), which provides a global best-basis (referred to as the revised inventory in this SA) inventory for 26 chemical and 46 radionuclide components. The revised inventory refers to the total inventory of chemical or radionuclide components currently stored in the tanks. Information used to establish global inventories originated from key historical records, various chemical flow sheets, and calculations for radionuclide isotope generation and decay. The revised inventory effort is ongoing and will provide updated inventory data through a controlled revision process as new characterization data and information become available. Although the revised inventory will be refined in the future, it is the best available inventory data and because of the methodology followed it provides a degree of refinement over the TWRS EIS inventory. The revised inventory is accepted as the inventory to be used for all TWRS activities.

Over the past twenty plus years more than seven different global tank waste inventory documents have been issued (Kupfer et al. 1997). Each of the inventory reports was based on the best available knowledge available at the time of publication. The different reports were based on different methodologies, different models, and to varying degrees available sampling data. The different inventory reports did not always provide inconsistent inventory values.

The methodology used to develop the revised inventory involved a thorough review of all pertinent information sources to identify errors, biases, inconsistencies, and missing information. The information sources included process flowsheets, waste transaction records, reactor fuel data, and essential material records. The chemical constituents and radionuclides are discussed individually and the technical basis for the inventory estimate along with reconciliation with previously reported inventories is provided. This methodology provides an inventory that serves as the single source of waste composition data for TWRS process flowsheet modeling work, safety analyses, risk assessments, and waste retrieval, treatment, and disposal system design.

Additionally, tank-by-tank inventory estimates have been developed using all available information, mainly sample analysis results, that provide a revised inventory for each of the 177 tanks (LMHC 1997b). There are some discrepancies between the cumulative tank-by-tank inventories and the revised inventory. A comparison of the revised inventory and the tank-by-tank inventory is provided in Section 5.1. There is an effort underway to reconcile the two inventories in FY 1998, which could include some adjustment of both the tank-by-tank and revised inventory estimates. This reconciliation will not be completed in time to support this SA. However, reconciliation of the two inventories is not expected to appreciably change the environmental impacts. If substantive changes in the inventory were to occur the effect of these changes on the impacts presented in the TWRS EIS would be reassessed.

Table 3.2.1 provides a comparison of the TWRS EIS inventory to the revised inventory for chemical and radiological constituents. The changes in potential environmental impacts that could occur from changes in inventory estimates are discussed in Section 4.0.

A number of constituents were included in the TWRS EIS inventory that are not reported in the revised inventory. The revised inventory estimate efforts were focused on a subset of chemicals and radionuclides of greatest concern to multiple data users. The TWRS EIS inventory for those constituents not reported in the revised inventory are assumed to be unchanged.

Table 3.2.1. Comparison of TWRS EIS Inventory and Revised Inventory

Constituent Name	Units (Decayed to 12/31/99)	TWRS EIS Inventory SSTs and DSTs	Revised Inventory	Delta Increase (positive) or Decrease (negative) from the TWRS EIS Inventory
Al	kg	2.1E+06	7.9E+06	5.8E+06
Bi	kg	2.6E+05	5.8E+05	3.2E+05
Ca	kg	1.5E+05	2.1E+05	6.4E+05
Ce	kg	2.4E+05	8.8E+03	-2.3E+05
Cl	kg	3.1E+05	5.0E+05	1.9E+05
TIC as CO_3	kg	N/R	4.8E+06	4.8E+06
Cr	kg	1.2E+05	7.9E+05	6.7E+05
F	kg	1.2E+06	1.4E+06	1.8E+05
Fe	kg	7.8E+05	1.2E+06	4.5E+05
Hg	kg	9.6E+02	2.1E+03	1.1E+03
K	kg	5.7E+05	4.8E+05	-8.5E+04
La	kg	2.1E+04	5.1E+04	3.0E+04
Mn	kg	1.5E+05	1.1E+05	-4.1E+04
Na	kg	6.9E+07	5.4E+07	-1.5E+07
Ni	kg	1.9E+05	1.1E+05	-7.8E+04
NO_2/NO_3[1]	kg	1.2E+08	8.6E+07	-3.4E+07
OH TOTAL	kg	7.8E+06	2.3E+07	1.5E+07
Pb	kg	5.2E+03	2.8E+05	2.7E+05
PO_4	kg	5.0E+06	6.0E+06	1.0E+06
Si	kg	5.3E+05	5.7E+05	3.9E+04
SO_4	kg	2.0E+06	5.0E+06	3.0E+06
Sr	kg	3.6E+04	3.1E+04	-4.7E+03
TOC	kg	1.5E+06	4.0E+06	2.5E+06
U	kg	1.4E+06	9.7E+05	-4.7E+05
Zr	kg	5.2E+02	4.4E+05	4.4E+05
Cd	kg	1.0E+04	8.2E+03	-1.8E+03
Ag	kg	1.7E+03	8.9E+03	7.2E+03
Th	kg	N/R	2.6E+04	N/A
W	kg	1.5E+04	1.6E+04	7.0E+02
Total Mass	kg	2.1E+08	2.0E+08	-2.0E+07
H-3	Ci	2.4E+03	2.4E+04	2.2E+04
C-14	Ci	5.3E+03	4.8E+03	-5.3E+02
Ni-59	Ci	5.0E+03	9.3E+02	-4.1E+03
Co-60	Ci	N/R[2]	5.6E+03	5.6E+03
Ni-63	Ci	2.7E+05	8.8E+04	-1.8E+05
Se-79	Ci	9.1E+02	7.7E+02	-1.4E+02
Sr-90	Ci	5.4E+07	6.2E+07	8.2E+06
Y-90	Ci	5.4E+07	6.2E+07	8.2E+06
Nb-93m	Ci	3.2E+03	2.0E+03	-1.2E+03
Zr-93	Ci	3.9E+03	3.6E+03	-3.1E+02

Table 3.2.1. Comparison of TWRS EIS Inventory and Revised Inventory (cont'd)

Constituent Name	Units (Decayed to 12/31/99)	TWRS EIS Inventory SSTs and DSTs	Revised Inventory	Delta Increase (positive) or Decrease (negative) from the TWRS EIS Inventory
Tc-99	Ci	3.2E+04	3.3E+04	5.0E+02
Ru-106	Ci	3.8E-02	1.7E+03	1.7E+03
Cd-113m	Ci	N/R[2]	1.3E+04	1.3E+04
Sb-125	Ci	N/R[2]	4.6E+04	4.6E+04
Sn-126	Ci	6.3E+02	1.2E+03	5.6E+02
I-129	Ci	3.8E+01	6.3E+01	2.5E+01
Cs-134	Ci	N/R[2]	1.2E+04	1.2E+04
Ba-137m	Ci	3.3E+07	3.8E+07	5.2E+06
Cs-137	Ci	3.5E+07	4.0E+07	5.5E+06
Sm-151	Ci	6.3E+05	2.6E+06	2.0E+06
Eu-152	Ci	N/R[2]	1.1E+03	1.1E+03
Eu-154	Ci	5.5E+04	9.1E+04	3.5E+04
Eu-155	Ci	N/R[2]	5.9E+04	5.9E+04
Ra-226	Ci	2.7E-07	6.3E-02	6.3E-02
Ac-227	Ci	2.2E-02	7.2E+01	7.2E+01
Ra-228	Ci	7.4E-14	3.7E+01	3.7E+01
Th-229	Ci	2.0E-05	1.8E+00	1.8E+00
Pa-231	Ci	3.8E-02	1.6E+02	1.6E+02
Th-232	Ci	6.4E-13	2.1E+00	2.1E+00
U-232	Ci	N/R[2]	1.2E+02	1.2E+02
U-233	Ci	1.2E-02	4.8E+02	4.8E+02
U-234	Ci	2.1E-01	3.5E+02	3.5E+02
U-235	Ci	2.1E+01	1.4E+01	-6.1E+00
U-236	Ci	2.9E-03	9.6E+00	9.6E+00
Np-237	Ci	7.0E+01	1.4E+02	7.1E+01
Pu-238	Ci	1.1E+03	2.6E+03	1.6E+03
U-238	Ci	4.8E+02	3.2E+02	-1.6E+02
Pu-239	Ci	2.6E+04	3.9E+04	1.3E+04
Pu-240	Ci	6.7E+03	8.9E+03	2.2E+03
Am-241	Ci	1.0E+05	6.9E+04	-3.4E+04
Pu-241	Ci	7.5E+04	1.7E+05	9.7E+04
Cm-242	Ci	5.7E+01	7.0E-03	-5.7E+01
Pu-242	Ci	4.3E-04	1.2E+00	1.2E+00
Am-243	Ci	3.3E+01	9.3E+00	-2.4E+01
Cm-243	Ci	N/R[2]	8.7E+00	8.7E+00
Cm-244	Ci	1.2E+02	1.9E+02	7.4E+01

Table 3.2.1. Comparison of TWRS EIS Inventory and Revised Inventory (cont'd)

Constituent Name	Units (Decayed to 12/31/99)	TWRS EIS Inventory SSTs and DSTs	Revised Inventory	Delta Increase (positive) or Decrease (negative) from the TWRS EIS Inventory
Radionuclide Total	Ci	1.8E+08	2.1E+08	2.9E+07

Notes:

[1] NO_2/NO_3 combined equals NO_3 inventory plus NO_2 inventory.

[2] Not included in inventory available for use in the TWRS EIS.

N/R = Not reported

N/A = Not applicable

Inventory decayed to 12/31/99

Future Waste Additions Included in this Supplement Analysis

The TWRS EIS identified the potential for relocating K Basins sludge to the DST's for storage and subsequent treatment with the tank waste. The current planning basis for the K Basins sludge includes chemical pretreatment of the sludge at the 100 K Area, followed by transfer of the sludge to the TWRS program for interim storage and treatment (LMHC 1997b). The proposed chemical pretreatment process would destroy polychlorinated biphenyls (PCBs) contained in the sludge before it would be transferred to the TWRS program. The analysis of potential environmental impacts addressed in Section 4.0 includes consideration of the bounding K Basins inventory.

The TWRS EIS included approximate inventories for select radionuclides (TWRS EIS Volume 2, Section A.2.4). Table 3.2.2 provides a comparison of the K Basins sludge inventory reported in the TWRS EIS and the latest nominal and bounding sludge inventory estimates (LMHC 1997b). Nominal inventories were developed using averaged concentrations and sludge volumes, and bounding inventories were developed using maximum concentrations and the upper limit of the estimated sludge volume. These sludges would be treated in the Phase 2 treatment plant and would increase the volume of vitrified HLW.

Table 3.2.2. K Basins Sludge Inventory Comparison

Constituent	Units	K Basins		
		TWRS EIS K Basins Inventory	Nominal K Basins Inventory	Bounding K Basins Inventory
Am-241	Ci	N/R	2,600	6,900
Bi-212	Ci	N/R	0	130
Ce-144/Pr	Ci	N/R	400	1,200
Cm-243/244	Ci	N/R	190	660
Co-60	Ci	N/R	1,100	2,500
Cs-134	Ci	N/R	340	790
Cs-137	Ci	970	103,000	270,000
Eu-152	Ci	N/R	11	45
Eu-154	Ci	N/R	960	2,400

Table 3.2.2. K Basins Sludge Inventory Comparison (cont'd)

Constituent	Units	K Basins		
		TWRS EIS K Basins Inventory	Nominal K Basins Inventory	Bounding K Basins Inventory
Eu-155	Ci	N/R	270	680
Nb-94	Ci	N/R	7.6	15
Np-237	Ci	N/R	0.54	1.4
Pu-238	Ci	N/R	970	2,500
Pu-239/240	Ci	260	2,900	7,300
Ra-226	Ci	N/R	250	730
Ru-106/Rh	Ci	N/R	430	1,200
Sb-126	Ci	N/R	530	1,300
Sr-90	Ci	1,300	81,000	220,000
Tl-208	Ci	N/R	63	410
Y-90	Ci	N/R	81,000 [1]	220,000 [1]
Pu-241	Ci	5,200	36,000	82,000
Ba-137m	Ci	N/R	98,000 [1]	270,000 [1]
Ag	kg	N/R	0.35	1.5
Al	kg	N/R	860	2,500
B	kg	N/R	3.9	31
Ba	kg	N/R	6.3	24
Be	kg	N/R	1.6	3.2
Ca	kg	N/R	250	1,400
Cd	kg	N/R	1.7	3.5
Cr	kg	N/R	18	82
Cu	kg	N/R	12	43
Fe	kg	N/R	4,900	21,000
K	kg	N/R	26	100
Mg	kg	N/R	42	200
Mn	kg	N/R	12	43
Na	kg	N/R	58	430
Pb	kg	N/R	9.7	45
Se	kg	N/R	3.5	13
Sm	kg	N/R	3.5	15
Tl	kg	N/R	6.9	31
Zn	kg	N/R	13	87
Zr	kg	N/R	990	1,900
U	kg	N/R	16,000	39,000

Notes:

N/R = Not reported

[1] Inventory ratioed from parent.

Inventories for most of the long-term risk radionuclides of concern that are mobile in the groundwater are not provided in the K Basins inventory estimate. There are substantial quantities of some actinides as compared to the TWRS EIS inventory. Only two of the radionuclides reported in Table 3.2.2, Np-237 and Ru-106/Rh, were considered mobile in the TWRS EIS. Additionally, inventory estimates are provided for bismuth (Bi)-212, cerium (Ce)-144, Co-60, Nb-94, and Tl-208, which were not evaluated in the TWRS EIS. The current planning basis includes transfer of the sludge to DST 241-AW-105 for storage. The sludge would be retrieved and vitrified during Phase 2. Based on the existing K Basin sludge inventory (e.g., prior to any pretreatment) and the glass composition used in the TWRS EIS, between 56 and 170 m^3 (2,000 to 6,000 ft^3) of HLW glass would be produced. This would result in an additional 20 to 40 days of operation for the Phase II HLW plant.

Based on the currently available information the K Basins sludge inventory would have little effect on long-term risk or groundwater quality. Three potential source terms were evaluated for long-term risk; leakage during retrieval, tank residuals, and releases from the LAW vaults. Since the K Basins sludge would be placed into a DST and no retrieval leakage is assumed to occur from the DSTs, there would be no change in the retrieval leakage source terms. A residual waste source term was evaluated in the TWRS EIS for each of the tanks, and the addition of the K Basins sludge into one of the DSTs would not appreciably change the overall residual waste source term. Finally, the K Basins sludge would not appreciably change the LAW vault source term because the waste separations and treatment process would result in most of the K Basins sludge ending up in the HLW treatment process.

MUSTs

Information has been provided that results in reallocating the MUSTs between the TWRS and other Site programs (LMHC 1997b). Two MUSTs, 216-TY-201 and 216-BY-201, identified in the TWRS EIS have been assigned to other programs. Two additional MUSTs, 240-S-302 and 241-T-302, have been assigned to the TWRS program. The total change in MUST waste volume based on new information is approximately 2,000 L (530 gal.) higher than reported in the TWRS EIS. This change is 0.4 percent of the MUST waste volume used in the TWRS EIS. As the project matures it is anticipated that the number of MUSTs within the TWRS program will fluctuate. The new information does not provide any detailed characterization data on MUST waste.

Other Waste

In the mid 1980's cesium and strontium was vitrified in the 300 Area. This vitrified material has recently been moved from the 324 Building in the 300 Area to the 200 Area where they are being stored on a storage pad. They are classified as special case waste. Because no decision has been made regarding the disposition of this waste it is not addressed in this SA.

3.2.2 Engineering

3.2.2.1 Tank Waste Management

The TWRS EIS included in the Phased Implementation alternative an evaluation of the operations necessary to maintain the tanks and associated facilities until they are no longer required for waste management. The operations that were considered components of routine tank farm operations were identified in Section 2.0.

In June 1997, an SA to the TWRS EIS was completed for Project W-314 (DOE 1997b). Project W-314 focused on capital improvements necessary for continued safe operation of existing DSTs, DCRTs, and selected SSTs. Portions of Project W-314 evaluated in the SA included replacing instrumentation and ventilation systems and upgrading electrical power systems. A determination was made that the upgrades to the tank farm ventilation, instrumentation, and electrical systems and planned upgrades to the waste transfer system proposed under Project W-314 did not pose potential environmental impacts that are substantially changed from those analyzed in the TWRS EIS.

In the TWRS EIS it was assumed under current tank farm operations that saltwell pumping would be completed on the Tri-Party Agreement schedule. Through 1997, DOE has completed saltwell pumping of 119 SSTs, including 63 of the 67 tanks, that are assumed to have leaked. In FY 1998 DOE plans to initiate saltwell pumping in three of the last four SSTs that are assumed to have leaked, and the fourth SST will be pumped in 1999. Saltwell pumping in two of the four tanks has already begun. Saltwell pumping of 13 non-leaking SSTs that was scheduled for FY 1998 has been delayed by approximately one year. The current Tri-Party Agreement milestone date for completion of SST interim stabilization by saltwell pumping in year 2000 has not been changed; however, current Site plans would complete saltwell pumping in 2003.

3.2.2.2 Waste Retrieval

TWRS EIS

Waste retrieval technologies for SSTs evaluated in detail in the TWRS EIS (Volume One, Section 3.4.6) included hydraulic sluicing and robotic arm-based retrieval systems. Hydraulic sluicing would use pressurized water and recycled tank liquid sprayed from a nozzle to dissolve, dislodge, and suspend the waste into a slurry, which would be pumped from the tank. Hydraulic sluicing was identified as the baseline retrieval technology and robotic arm-based systems would be used for cases where hydraulic sluicing could not achieve the required recovery, where sluicing would not be deployed because of leakage, or where sluicing was to be discontinued because of tank leakage. Robotic arm-based systems could use a number of end effectors for waste removal. Engineering data developed for the TWRS EIS were based on sluicing 110 SSTs and deploying robotic arm-based retrieval in 50 SSTs (11 SSTs were assumed to require both types of retrieval). A total of 24 sluicing systems and 12 arm-based systems with confinement structures were included in the impact analysis.

Waste retrieval technologies for DSTs evaluated in detail in the TWRS EIS (Volume One, Section 3.4.6) included slurry pumping using mixer pumps to break up and suspend solids into a slurry. This retrieval technique would be supplemented by hydraulic sluicing or robotic arm-based methods if required. A minimum of two and up to four mixer pumps were assumed to be used in the retrieval of DST waste. These mixer pumps were assumed to be permanently installed in each of the DSTs and were not moved from tank to tank.

Waste retrieval systems evaluated in the TWRS EIS (Volume One, Section 3.4.6) were assumed to be supported by four waste transfer annexes and a waste staging and sampling facility (five support facilities total). Each system would circulate sluicing liquid to the tanks as well as receive and accumulate slurry for batch transfer to the waste treatment facilities. The waste staging and sampling facility would accumulate waste in the 200 West Area for cross-site transfer to the 200 East Area.

In the TWRS EIS (Volume One, Section 3.4.10.7) one of the major areas of technology uncertainty related to meeting the interim Tri-Party Agreement goal of 99 percent or greater waste retrieval. As indicated in the EIS, this uncertainty was compounded by potential environmental impacts associated with waste retrieval from SSTs that are known or suspected to be leakers or that develop leaks during retrieval operations. To address these uncertainties the EIS adopted a number of assumptions that served to bound the potential human health and environmental impacts associated with waste retrieval. The following were among the assumptions.

- To bound short-term impacts associated with worker and public exposure to contaminants during routine retrieval operations and worker and public exposure during waste retrieval accidents, it was assumed that all tank waste inventory would be retrieved from all 177 tanks.
- To bound long-term impacts the EIS
  - Selected hydraulic sluicing as the baseline SST retrieval technology to provide conservative estimates of potential leak losses during retrieval operations.
  - Assumed that all 149 SSTs would develop leaks during retrieval and, on average, 15,000 L (4,000 gal.) of liquids would be released to the soil from each tank. This leakage volume was based on best available information for leakage volume at the time the TWRS EIS was prepared. The volume selected was intended to be a reasonably conservative value that would be applied to every SST. Additional discussion on the uncertainty associated with retrieval leakage volumes is provided in Section 5.2. Additionally, the concentration of contaminants in the leakage was assumed to be at or near saturation and not diluted by water additions during retrieval.
  - Identified several technologies that could be used if hydraulic sluicing were not able to remove sufficient waste to meet removal requirements or could not be deployed due to past tank leaks or leaks occurring during retrieval actions. Among the technologies were a robotic arm using sluicing liquids, alternate liquids including alkali and acid solutions instead of water, mechanical retrieval,

robotic crawler, and pneumatic retrieval. From among these technologies, DOE selected hydraulic sluicing and robotic arm-based retrieval for detailed analysis in the EIS. However, as indicated in the EIS, the other retrieval technologies could "be used to retrieve tank waste during any of the ex situ alternatives."

- For purposes of analysis hydraulic sluicing was assumed to be used on 110 of the 149 SSTs, robotic arm-based retrieval would be used in 50 SSTs, and 11 SSTs were assumed to use both types of retrieval.

The analysis presented in the EIS addressed retrieval technologies for use in the tanks other than hydraulic sluicing. The EIS addressed the HTI as a project designed to "reduce the uncertainties associated with waste retrieval by developing and demonstrating the technologies required to meet retrieval requirements" and that among the demonstrations would be deployment of technology to retrieve tank residuals from tank 241-C-106 and development of technologies and criteria to retrieve waste from known or assumed leaking SSTs.

New Information

The current planning for waste retrieval defined in the "Tank Waste Remediation System Operation and Utilization Plan" (Kirkbride et al. 1997) includes sluicing of SSTs and slurry pumping of DSTs. The Operations and Utilization Plan assumes that three waste retrieval facilities are required to support the waste retrieval and transfer function. This would reduce the number of support facilities required for waste retrieval and transfer from five to three, eliminating the Waste Staging and Sampling Facility in the 200 West Area and one of the Waste Transfer Annexes in the 200 East Area. The Operations and Utilization Plan assumption is based on routing the waste retrieved in the 200 West Area through the 241-SY Tank Farm and retrieving waste from the 241-A, -AX, and -C Tank Farms in 200 East Area directly into DST 241-AN-103.

Details on how the waste retrieval facilities might change based on reducing the number of facilities from five to three are not currently available to support a quantitative comparison. However, it is believed that reducing the number of retrieval support facilities from five to three would be expected to result in reduced resource and construction requirements. There are no new definitive data on waste retrieval that would indicate that the current basis for waste retrieval is appreciably different from the basis used in the TWRS EIS.

The current TWRS Multi-Year Work Plan (MYWP) is based on waste retrieval by two organizations (LMHC 1997b). The Site contractor retrieval project would retrieve waste from 36 SSTs and at least one MUST before the end of 2010. The Site contractor would also retrieve liquid waste from DSTs in support of Phase IB processing. The remaining tanks (SSTs and DSTs) would be retrieved by a private contractor beginning in 2010. This retrieval implementation strategy would not be expected to result in changes in environmental parameters.

Retrieval demonstrations are planned following hydraulic sluicing of tank 241-C-106 under the HTI project (LMHC 1997b). This project will use commercial technologies to demonstrate retrieval of hard heel from tank 241-C-106.

In January 1997, four vendors were awarded contracts to demonstrate the ability of their technologies to remove simulated tank wastes from the Hanford Site's tanks. The four companies completed testing of their equipment on simulated waste material in July 1997 and provided the Hanford Site with data on various waste removal strategies, decontamination techniques, equipment reliability, safety, and cost. These tests indicated that commercial technologies can be adopted for removal of hard-heel wastes and may reduce the potential for leakage during retrieval. Reports completed by each vendor addressed the following technologies:

- A wheeled vehicle and low pressure confined sluicer
- A multi-articulating hydraulic arm and medium pressure confined sluicer end effector
- A tracked foldable vehicle and a medium pressure water jet-based retrieval system
- A cable driven manipulator and high pressure water jet scarifier.

Information from these tests are being used by the Hanford Site to prepare performance specifications for the next phase of HTI work, tank 241-C-106 heel retrieval demonstration, which will call for construction of eqnipment that will do the actual retrieval of hard-to-remove waste from the first of the Hanford Site's SSTs following the completion of hydraulic sluicing operations. The Hanford Site plans to issue contracts in February 1998 that will require completion of conceptual design of retrieval systems by September 1998 when detailed design will begin, and deployment of the system in tank 241-C-106 in October 2000 (LMHC 1997b).

If successful, development and demonstration of these retrieval technologies would reduce the uncertainty associated with DOE's ability to retrieve waste from the SSTs. Additional discussion on planned waste retrieval demonstrations is provided in Section 5.0.

3.2.2.3 Pretreatment

TWRS EIS

The pretreatment or separations processes will separate the retrieved waste into HLW and LAW fractions prior to immobilization. Separations processes are used to minimize the volume of vitrified HLW (e.g., sludge washing) and remove specific constituents from the waste stream designated for LAW treatment (e.g., ion-exchange). The level of separations has an affect on both the short- and long-term risks. The number and type of separations processes controls the final inventory and volume of the HLW and LAW immobilized waste forms and impacts the construction and operation of the waste treatment facility.

The TWRS EIS Phased Implementation alternative included processes for separating the following constituents from the waste prior to immobilization as LAW:

- Entrained solids
- Cesium

- Strontium
- Technetium
- TRU.

The pretreatment of waste designated for HLW treatment included sludge washing and solid/liquid separations.

New Information

The Site contractor maintains the TWRS Process Flowsheet to develop retrieval sequencing and provide immobilized waste volume projections that incorporate the latest inventory and enhanced sludge washing data. The detailed Process Flowsheet is summarized in the TWRS Operation and Utilization Plan (Kirkbride et al. 1997), which states that although DOE would procure waste separations and immobilization services, there is no reason to believe that their chemical additions and sludge leaching/washing efficiencies would be substantively different from those determined by the Hanford Site's previous modeling and extensive sludge washing laboratory programs. New information on the efficiency of sludge washing and caustic leaching coupled with the new inventory results in revised volume projections for immobilized LAW and HLW. These revisions are discussed in Section 3.2.2.4.

The separations processes identified in the TWRS Operation and Utilization plan include:

- Sludge washing during retrieval
- Enhanced sludge washing using caustic to remove aluminum, chromium, phosphorus, sulfate, and sodium from the sludge
- Cesium removal from the LAW feed.

Chromium concentrations are limited in the HLW glass formulation to less than or equal to 0.5 percent to maintain glass quality (Kirkbride et al. 1997). The revised inventory for chromium increased by a factor of 6.5 over the inventory available for use in the TWRS EIS. This increase would be expected to result in a large increase in the projected volume of HLW glass. However, this volume increase was offset by a substantial improvement in the SST caustic leach factor for chromium. The leach factor (the fraction of water-insoluble component removed by caustic leaching) for chromium changed from 0.14 in 1996 to 0.78 in 1997 based on currently available data (LMHC 1997b). Laboratory tests of enhanced sludge washing conducted to date are representative of 75 percent of the SST sludge. Experimental tests and computer simulations have been completed for Phase IB. This change in the leach factor translates into a net increase in vitrified HLW on the order of 16 percent based on current data. Since the chromium inventory drives the volume of immobilized HLW the uncertainty in the chromium inventory estimate is important and remains to be quantified. These numbers represent an update of work in progress and are subject to change.

The Privatization contractors are responsible for developing the separations and pretreatment processes required to meet waste form specifications and volume limits. These processes may include additional separations aimed at other radionuclides. Specifically, separation of technetium, strontium, and TRU from some of the LAW feed envelopes would be required for the LAW to meet the defined product specification. These separations processes were evaluated in the TWRS EIS.

3.2.2.4 Immobilization

TWRS EIS

Vitrification was the baseline immobilization technology in the TWRS EIS for LAW and HLW. The LAW vitrification process was based on a uniform blend of tank waste with a 15 weight percent sodium oxide loading. It was also assumed that the molten LAW glass would be quenched in a water bath producing a cullet. Glass cullet was the assumed LAW form used in the TWRS EIS because it provided conservative values for waste volume and release rates. The void spaces between the individual pieces of glass cullet result in an overall increased waste volume for packaging and disposal of approximately 30 percent over glass monoliths. The waste loading value and waste form assumptions were selected to provide conservative volume projections for immobilized LAW and HLW. The HLW vitrification process was based on a borosilicate glass at a 20 weight percent waste oxides (excluding sodium and silica [31 weight percent including sodium and silica]) and a blending factor of 1.2 was applied to the total volume of HLW to accommodate inefficiencies in waste blending.

New Information

The TWRS Operation and Utilization Plans technical basis includes vitrification of both the LAW and HLW streams. The sodium oxide loading in the vitrified LAW is 20 weight percent (an increase from 15 weight percent) (Kirkbride et al. 1997). Additionally, the revised inventory of sodium is approximately 20 percent smaller than the inventory used in the TWRS EIS. The increased loading and smaller inventory resulted in a smaller vitrified LAW stream that could be expected to reduce the requirements for LAW vitrification during Phase II. The decrease in LAW glass translates into a reduction in Phase II LAW vitrification operations of approximately two years or a combined treatment capacity requirement of approximately 160 mt/day instead of 200 mt/day. A decision on the required LAW form, monolith or cullet, has not been made. Although there may be advantages to producing immobilized LAW in monoliths, the impacts presented in this SA are based on a glass cullet waste form to provide an appropriate level of conservatism to the assessment of impacts.

The HLW is assumed to be vitrified into a borosilicate glass. The TWRS Operation and Utilization plan is based on the Hanford Tank Waste Operations Simulator computer model (Kirkbride et al. 1997). This model uses tank retrieval sequences coupled with tank-by-tank inventories to allow direct prediction of immobilized HLW volumes without the use of blending factors. The Hanford Tank Waste Operations Simulator model provides a more sophisticated tool for estimating total immobilized HLW volume by using glass formulation ranges and reduces uncertainties in assessing disposal requirements. The HLW glass formulation ranges used in the TWRS process flowsheet simulation result in a waste loading in immobilized HLW of 37 percent (including sodium and silicon). Changes in inventory result in a projected increase of vitrified HLW from 14,000 m^3 to 16,000 m^3 (500,000 to 570,000 ft^3). This increase would translate into a slightly larger Phase II HLW treatment facility or approximately 1.4 additional years of HLW vitrification operations during Phase II. Alternately operation of the Phase IB HLW treatment facility could be extended. This change would result in higher operating resource requirements for HLW treatment of approximately 10 percent. The nominal fill volume of the HLW canisters in the TWRS EIS is 1.17 m^3 (41.3 ft^3) and is 1.08 m^3 (38.1 ft^3) in the TWRS Operations and Utilization Plan. These two changes result in a 19 percent increase in the number of HLW canisters.

Table 3.2.3 compares the immobilized waste forms, volumes, and constraints between the TWRS EIS and the current TWRS Operations and Utilization Plan.

Table 3.2.3. Comparison of Immobilized Waste Forms and Volumes

Component	TWRS EIS Phased Implementation Alternative		TWRS Operations and Utilization Plan [1]	
	LAW	HLW	LAW	HLW
Waste form	Vitrified, cullet	Vitrified, monolith	Vitrified, monolith [5]	Vitrified, monolith
Waste loading	15 wt. % sodium oxide	30 wt % waste oxides [4]	20 wt. % sodium oxide	37 wt % waste oxides [6]
Volume, m^3	350,000	14,000	200,000	16,000
Number of containers	140,000 [2]	12,200 [3]	96,000 [2]	14,500 [3]

Notes:

Monolith refers to a waste form resulting from a single pour of molten glass into a canister or container. Cullet refers to the small pieces of glass formed when molten glass is quenched in a water bath and the individual pieces of glass are placed into the disposal container. Assuming cullet as the immobilized LAW is more conservative from the standpoint of calculating environmental impacts.

[1] Includes both Phase 1 and Phase 2

[2] LAW containers = 2.6 m^3 standard Phase I containers

[3] HLW containers = 1.2 m^3 (4.6 m long) canister

[4] Equal to 20 wt % waste oxides less sodium and silica

[5] The calculation of impacts presented in this SA are based on cullet as the LAW waste form. The contract specification for Phase IB has radionuclide release rate limits that could impact the acceptability of cullet.

wt = weight

[6] Includes sodium and silica. The contract specification for Phase IB requires at least 25 weight percent waste oxides (excluding sodium and silica).

3.2.2.5 LAW Retrievable Disposal

The conceptual design for LAW retrievable disposal in the TWRS EIS consisted of steel containers (2.6 m^3 [92 ft^3]) placed inside of a 5,300 m^3 (187,167 ft^3) below grade engineered disposal vault. A total of 66 vaults were required for retrievable disposal of all the immobilized LAW. The LAW vaults were assumed to be constructed of reinforced concrete. It was assumed that during Phase IB the existing grout vaults would be modified to accommodate interim LAW storage.

A Conceptual Design Report for modifying the existing grout vaults to accommodate interim storage of immobilized LAW (Project W-465) provides additional information on the activities required to modify the existing grout vaults (LMHC 1997b). The grout vaults, with modifications for remote handling capability, would provide sufficient capacity for approximately three years of immobilized LAW production during Phase IB. This indicates that a portion of the LAW facility currently identified in the EIS as being constructed during Phase II, would be required during Phase IB.

Project W-465 would include demolishing the roof of each grout vault, constructing a pre-engineered building over the vaults, procuring waste package remote-handling cranes and shielded waste package transport vehicles, installing support utilities, and interfacing with adjacent infrastructure projects. The project would make minor changes to the existing control and change rooms.

The current conceptual designs for the LAW facility include the placement of steel containers containing vitrified LAW into engineered subsurface vaults (LMHC 1997b). The current vault concept is based on a 14,700 m^3 (519,123 ft^3) vault. The decrease in the current baseline volume projections for immobilized LAW volume and the larger disposal vault volume result in the current basis of a proposed 19 disposal vaults. The current plan also includes converting the interim LAW storage in the modified grout vaults into a permanent disposal facility. Converting the interim LAW storage in the modified grout vaults into a permanent disposal facility would have no appreciable change in impacts to short-term or long-term health effects.

The preconceptual design configuration of the LAW vaults includes a greater spacing between the individual vaults, which results in a larger facility footprint for the LAW facility (LMHC 1997b). The facility size increases from 11 ha (27 ac) as identified in the TWRS EIS to 36 ha (90 ac). The vault spacing used in the preconceptual design was based on excavation requirements for periodic vault construction and long-term performance considerations. This vault spacing could be reduced during facility design. The use of larger vaults combined with a lower volume of vitrified LAW would be expected to reduce the resource requirements for containers and vaults. Detailed engineering data are not currently available to support a quantitative comparison of resource requirements (e.g., cement, steel, etc.).

3.2.2.6 Interim Storage of HLW

The interim storage of immobilized HLW canisters evaluated in the TWRS EIS was based on placing the canisters in a large multi-purpose canister for interim onsite storage and transport to the geologic repository. The interim storage concept included placing the multi-purpose canisters on a reinforced concrete pad and placing a concrete shielding cover over each multi-purpose canister to reduce exposures. Adequate interim onsite storage was included to allow for storage of all of the projected HLW in the event there were delays in opening the geologic repository. Phase IB also included modification of the CSB for interim storage of vitrified HLW produced during Phase IB.

A preliminary conceptual design report has been completed that identifies Spent Nuclear Fuel (SNF) CSB modifications required to support interim storage of vitrified HLW and packaged cesium from Phase IB operations (LMHC 1997b).

The CSB was originally designed for the long-term storage of canisters containing vitrified HLW from the Hanford Waste Vitrification Project. Following the cancellation of the Hanford Waste Vitrification Project in 1992, the CSB design was modified to permit the staging and storage of N Reactor spent nuclear fuel, repackaged in multi-canister overpacks in the K Basins. However, K Basin SNF will not require the entire CSB storage capacity. Two of the three vaults in the CSB are available for storage of vitrified HLW canisters. The CSB would accommodate all immobilized HLW produced during Phase IB. The preliminary conceptual design report identifies the types of modifications required to support interim storage of materials from Phase IB operations; however, the detailed engineering data are not available to support detailed analysis of potential environmental impacts.

Recent delays in the Spent Nuclear Fuel program could delay the availability of the CSB for storage of HLW during Phase IB. If this were to occur the immobilized HLW could be packaged, placed on storage pads, and covered with shielding covers using the same interim storage concept described in the TWRS EIS. The impacts from this interim storage concept would be the same as described in the TWRS EIS.

The TWRS baseline planning assumption for interim storage of vitrified HLW canisters is for placement of canisters in a CSB or buildings similar in concept to the SNF CSB. Interim storage of all vitrified HLW would require the equivalent storage capacity of approximately 11 CSBs. Larger interim storage facilities are being considered, which would reduce the number of additional facilities required. Engineering data are not currently available to support a detailed comparison of resource data between the HLW interim storage concept used in the TWRS EIS and the current planning basis. In general it would be expected that interim storage of vitrified HLW in CSBs would involve higher construction requirements and lower land-use requirements compared to interim storage of vitrified HLW on concrete pads.

3.2.2.7 HLW Disposal

For purposes of analysis, the TWRS EIS assumed a geologic repository candidate site at Yucca Mountain, Nevada to be the final disposal site for all TWRS immobilized HLW. The TWRS EIS acknowledged the current legislation that limits the amount of spent fuel and HLW that can be placed in the first repository until a second repository is operating and that DOE will evaluate the need for a second repository no sooner than 2007.

The current baseline program planning basis includes final disposal of all TWRS HLW at the national geologic repository. DOE is continuing efforts to evaluate Yucca Mountain as a potential site for the national geological repository. DOE is currently preparing an EIS for a potential repository at Yucca Mountain.

There is no new information regarding the disposal of HLW that would affect the engineering data for disposal of HLW at the geologic repository.

3.2.2.8 Closure

Closure of the tanks and associated equipment and the remediation of contaminated soil and groundwater associated with leaks from the tanks was not within the scope of the TWRS EIS and therefore not within the scope of this SA. Closure as a landfill was assumed for all of the alternatives. The closure basis assumed for the EIS involved the following activities:

- SSTs and DSTs would be stabilized by filling with gravel
- MUSTs and ancillary equipment would be stabilized by filling with grout because of limited access for placement of gravel
- A Hanford Barrier would be constructed over SSTs, DSTs, and LAW vaults.

3.2.3 Accident Analysis

Since the release of the TWRS EIS, new information on potential radiological and chemical accidents during routine operations of the tank farm waste has been made available in the TWRS BIO (LMHC 1997a). New information in this document will change the radiological and chemical risk calculated in the TWRS EIS for the beyond-design-basis-earthquake scenario and accidents that could occur during routine operations. These changes are discussed in Section 4.13.

The TWRS BIO establishes an improved authorization basis for TWRS facilities and operations required for the storage of high-level radioactive waste (current and future tank waste). This basis for interim operation documents the basis for the conclusion that authorized TWRS facility operations can be conducted safely until approval of the TWRS FSAR and associated technical safety requirement document complying with the requirements of DOE 5480.23, Nuclear Safety Analysis Reports, and DOE 5480.22, Technical Safety Requirements. The TWRS FSAR is currently being prepared and upon completion will supersede the TWRS BIO.

3.2.4 New Groundwater Data and Information

3.2.4.1 New Vadose Information

New vadose zone information and data are summarized in this section. A more detailed discussion is provided in Appendix A, Vadose Zone and Groundwater.

Spectral Gamma Logging of Drywells at the Tank Farms

A program is currently underway to develop baseline gamma-specific radioisotope information in the vadose zone near the SSTs. This program builds on a previous one in which gross gamma data were collected as a means of leak detection from the SSTs. Both programs used the networks of drywells (i.e., wells that do not extend to groundwater) that are installed around each tank in each SST farm. Spectral gamma logging was completed in FY 1996 in drywells around the following tank farms: AX, S, TX, TY, and A. In the prior fiscal year, logging was completed at the SX Tank Farm (PNNL 1997a). In addition to logging existing drywells, two new drywells were installed in the SX Tank Farm, drywell Nos. 41-12-01 and 41-09-39, to depths of approximately 38 m (125 ft) and 39.6 m (130 ft) belowground surface, respectively, and logged.

Some of the first information from the logging program was generated from the SX Tank Farm. At the SX Tank Farm, spectral gamma logging in drywell No. 41-02-02 identified Cs-137 as deep as 42.6 m (140 ft) belowground surface. Other more mobile contaminants, including Tc-99 and chromium, were detected in RCRA groundwater monitoring wells and have subsequently been linked to sources within the SX Tank Farm. The new spectral gamma logging is consistent with the data that were available when the TWRS EIS was published. Appendix A contains additional details on the new spectral gamma logging data.

Preliminary Results of Sampling and Analysis from Extending Borehole 41-09-39 at the SX Tank Farm

DOE has extended borehole 41-09-39 from 40 m (130 ft) to the water table, which is located at a depth of approximately 64 m (210 ft). Preliminary data based on samples taken to a depth of 53 m (170 ft) are available from this work. The preliminary data available through December 1997 include moisture content; radioisotope analysis of selected samples for Tc-99, Sr-90, Cs-137, K-40, U-238, and Th-232; and chemical analysis of selected samples for NO_3. Cesium-137 was detected in the sediments at concentrations of approximately 1E+6 pCi/L from approximately 40 to 41 m (131 to 134 ft). From 40 to 41 m (131 to 134 ft) the concentration of Cs-137 decreases by over four orders of magnitude. The maximum concentration of Tc-99 is observed at a depth of 40.6 m (133 ft).

Information on Distribution Coefficients that Affect Contaminant Mobility

New direct measurements of the distribution coefficient (K_d) for tank waste and Hanford Site sediments will be completed with samples from the new borehole 41-09-39, currently being advanced at the SX Tank Farm; however, these data are not yet available. No other direct measurements have been performed. There are however some limited data on the distribution of some contaminants in the vadose zone and on tank waste contaminants that have reached the groundwater from which contaminant mobility can be qualitatively assessed. These data, combined with an assessment of previous work, have been used to develop inferences on tank waste contaminant mobility. The most comprehensive of these is that which has been developed for the Composite Analysis in response to Defense Nuclear Facility Safety Board (DNFSB) 94-02. The other effort is the development of Retrieval Performance Evaluation (RPE) criteria by the HTI project, which is focusing on retrieval criteria for one tank farm, the AX Tank Farm. Information from the RPE study also includes a literature review for 1) potential effect of high sodium concentrations and high pH in the waste; 2) potential effects of chelating agents; and 3) potential effects of colloidal processes.

Recharge of Precipitation at the Tank Farms

Since the TWRS EIS, no new recharge data have been acquired. However, reevaluation of the initial recharge rate has been undertaken. Two studies, the Composite Analysis and the RPE, have reevaluated the recharge rate inputs for their numerical simulations for four periods or activities. Both studies considered 1) the pre-tank construction period; 2) the current period, which spans the time from when the tanks were constructed until a barrier is placed over the tanks; 3) the period in which the barrier is functioning; and 4) the post-barrier period where the barrier has degraded and the tank farm has reverted back to the shrub-steppe type of ground cover with no additional recharge restriction from the barrier.

Potential Preferential Pathways

As noted in the TWRS EIS, the presence of relatively immobile contaminants at the SX Tank Farm at a depths greater than previously predictedare not fully understood. Reviews of the literature, additional measurements of contaminant concentrations in the vadose zone from spectral gamma logging, and the extension of one borehole are new information and data that provide some inferences on contaminant migration. Preferential flow paths can significantly impact the transport of contaminants in the vadose zone (Parlange et al. 1988). Different forms of potential preferential flow in the vadose zone at the Hanford Site include 1) fingering; 2) funnel flow; and 3) flow associated with clastic dikes or poorly sealed well borehole annular space. The magnitude of impact of these and other forms of preferential flow are still uncertain.

Sluicing Loss Characteristics

In the TWRS EIS, sluicing losses were assumed to leak over the full area at the base of the tank. Ongoing RPE studies have found that the tank area from which the leak occurs can affect the arrival time and peak concentration of contaminants to the water table. The RPE studies used a two-dimensional vadose flow and transport model and varied the area of tank base from which a past leak was assumed to occur.

3.2.4.2 Saturated Zone (Groundwater)

New data and information on the saturated zone have been collected from groundwater levels and concentrations of contaminants and other constituents in the groundwater. These data are summarized in the Hanford Site Groundwater Monitoring for Fiscal Year 1996 (PNNL 1997b) and the Hanford Site 1996 Environmental Report (PNNL 1997a). Additional interpretations of these data are provided in the individual draft RCRA reports on the tank waste management areas (WMAs).

Groundwater Levels

Groundwater level data are used to infer groundwater flow gradient direction and magnitude. The most recently published data on water levels are for June of 1996 (PNNL 1997b) in which groundwater levels were recorded from over 600 wells in the unconfined aquifer on the Site and in the immediately surrounding area. The most notable observation from these data is the continued trend of groundwater level decline in many areas of the Hanford Site.

Groundwater Quality

Much of the Hanford Site continues to be impacted by past releases of contaminants from many sources. The extent of this impact can be inferred by the distribution of tritium in the unconfined aquifer (Figure 3.2.1). For comparison purposes the Drinking Water Standard for tritium is 20,000 pCi/L. The 149 SSTs are grouped into 12 tank farms. These tank farms have been further grouped into RCRA WMAs as TSD units. The RCRA SST WMAs are classified as interim status under RCRA Part A.

New data associated with these WMAs are from groundwater sample analyses from up gradient and down gradient wells located at each of the WMAs (Hodges 1997; Johnson and Chou 1997). Based on these data, the following information has been developed:

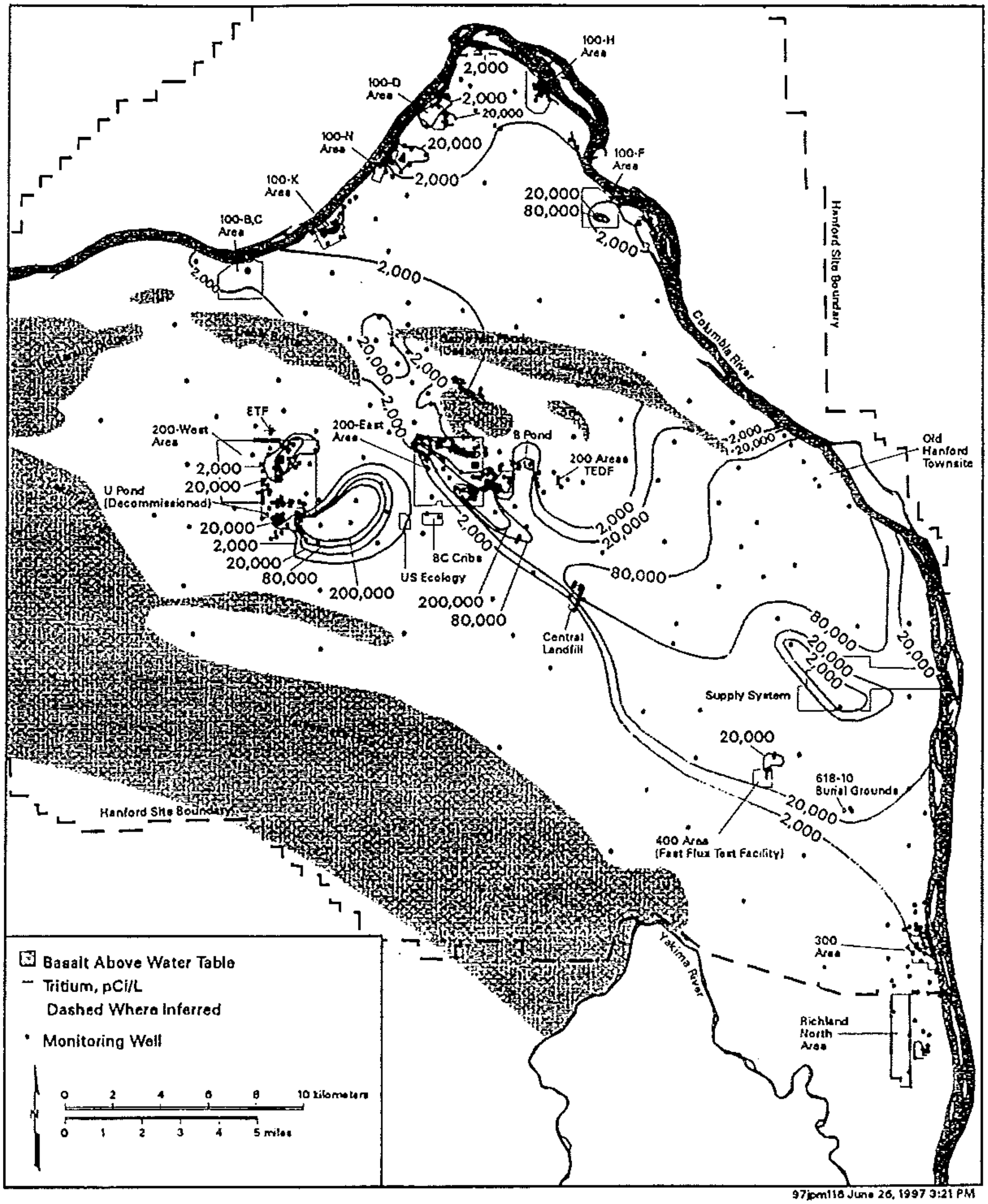
- Sources within the S-SX, T, and TX-TY WMAs such as past tank waste leaks are likely to have impacted groundwater as evidenced by the analytical results from down gradient well samples. Tc-99 and co-contaminants chromium, nitrate, and I-129 (TX-TY WMA only) are being detected in down gradient wells.

- Leaking water lines at the S-SX WMA are likely the cause of short-term transients in contaminant concentration that have been observed in several wells between 1986 and the present.

- More than one source location in the S-SX WMA is needed to explain historical as well as recent groundwater contamination. At least two and possibly three sources can explain the occurrences of Tc-99 transients observed in 1986 to 1987 and the more recent contaminant levels observed in wells 299-W23-15 and 299-W22-46. A short-term (i.e., approximately 2 years) transient Tc-99 spike was observed in well 299-W23-15 beginning in about January 1992. A 6-month transient Tc-99 spike was observed in well 299-W22-46 beginning in about January 1996. The spikes reached maximum values of 3,000 pCi/L and 2,750 pCi/L in wells 299-W23-15 and 299-W22-46, respectively, based on gross beta analysis, which is assumed to represent Tc-99.

- Compositional relationships between sodium/calcium and tritium/technetium ratios indicate information about origins and/or processes of groundwater source plumes for the S-SX, T, and TX-TY WMAs. These constituent ratios confirm that the Tc-99 and co-contaminants detected in down gradient well samples originated from these WMAs.

Figure 3.2.1. Distribution of Tritium in the Unconfined Aquifer, 1996



97jpml18 June 26, 1997 3:21 PM

Source: PNNL 1997a

3.2.5 New Technology Development

There are numerous technologies that could be used for remediating tanks waste. The viable technologies were evaluated in the TWRS EIS including technologies for waste retrieval, separations, and immobilization. For each of the main technology areas associated with the Phased Implementation alternative and other alternatives, a search was performed to determine if technology development efforts had resulted in new performance data or identified new technologies that would affect the alternatives analyzed in the TWRS EIS (LMHC 1997b, Jacobs 1997). The main technology areas associated with the Phased Implementation alternative include waste retrieval and transfer, pretreatment and separations processes, and immobilization. No new technologies that would change the overall approach to remediation or would support redefining the TWRS EIS alternatives were identified. However, new technologies being pursued that could potentially be incorporated into the TWRS program are described in Appendix C.

3.2.6 LMAES and BNFL Environmental Reports

Much of the data and information in the Environmental Reports and supplement reports relevant to addressing potential environmental impacts are based on the design and development work conducted by the Privatization contractors following the award of Phase IA. Some data and information appear to represent a level of detail beyond that provided in the TWRS EIS and reduce the data uncertainties associated with calculating the potential environmental impacts for Phase IB. However, the information provided in the Environmental Reports is based on preconceptual designs, and changes are likely to occur throughout the design process. Information and data that affect the analysis of potential environmental impacts may change as the design proceeds and additional testing is completed; however, major technology changes would not be expected.

Design changes have occurred during Phase IA conceptual design activities. Some of the processes described for organic destruction or removing specific isotopes have changed. In general, the treatment capacities of the proposed facilities have not changed. One of the larger changes relative to environmental impacts that has occurred during the Phase IA activities is the amount of land area required for constructing and operating the waste treatment facilities. The current land requirements have increased by over three and one-half times. The accidents evaluated in October 1996 were based on qualitative hazards analysis along with reasonable assumptions. The increased level of detail that is now available in the Environmental Reports and supplement reports results in a better understanding of accident scenarios and accident risks. The accident risks have increased as compared to those evaluated in the October 1996 evaluation.

The new data in the reports submitted by LMAES and BNFL have been evaluated and show increased impacts to the environment as compared to those estimated in the TWRS EIS Phase I. The environmental impacts that would exceed the impacts estimated in the TWRS EIS are as follows.

- The combined soil disturbance of the two proposals would be approximately two times greater than the soil disturbance estimated in the TWRS EIS.

- The combined air emissions during construction from the two proposals would exceed the TWRS EIS by as much as three times but would be within regulatory standards. Nitrogen oxides, sulfur oxides, and fugitive dust emissions during operations would exceed the TWRS EIS emissions by 135 times, 19 times, and six times, respectively but would be within regulatory standards.
- Total impacts to wildlife would be expected to be higher under the two proposals than the impacts estimated in the TWRS EIS because impacts to wildlife are largely a function of the total disturbance to previously undisturbed habitat.
- The total area that would be dedicated to waste management and treatment under the two proposals would be approximately 55 percent greater than the total area estimated in the TWRS EIS.

3.3 RESOURCES WITH LITTLE OR NO NEW INFORMATION

A review of new resource requirement information developed since the release of the TWRS EIS resulted in identifying the following resource areas where little or no new definitive information is available that would support a quantitative comparison of impacts (LMHC 1997b).

- Borrow site material quantities and disturbed area - The borrow pit disturbed area is a function of the volume of borrow required. Most of the borrow requirements are for facility construction during Phase 2 and for tank farm closure, and there have been no baseline changes that would affect the assumptions made in the EIS for Phase 2 or for tank farm closure. No new information is available that indicates new or alternative borrow pits would be used.
- Water resources - No new estimates have been done or baseline changes that would affect the estimates for water required.
- Energy resources - No new information is available to support recalculating total energy requirements.
- Construction materials - The material requirements for the construction of the Phase 1 and Phase 2 facilities are dependent on facility sizing and configuration assumptions. No new information is currently available that would change the basis used in the EIS for the number and size of waste treatment facilities.
- Process chemicals - There is no new information that would substantially change the separations and immobilization processes or the facility sizes evaluated in the EIS and therefore no new information is available to support revising the estimates for process chemical requirements.

The largest portion of these resource requirements would occur during the construction and operation of the full-scale waste treatment facilities during Phase 2. Changes in these resource requirements would be expected to occur as detailed information is developed during the conceptual design of Phase 1 and Phase 2 facilities. However, at the current time there is insufficient information available to warrant reevaluation of these resource requirements.

4.0 POTENTIAL ENVIRONMENTAL IMPACTS

This section describes the effect of new data and information on the potential human health and environmental impacts of the Phased Implementation alternative and, where appropriate, other alternatives considered in the TWRS EIS (Section 4.21). The section also includes a summary of cumulative impacts, regulatory compliance, mitigative measures, land use, energy and natural resource consumption and conservation, pollution prevention, and environmental justice.

A synopsis of the environmental impacts of the Phase IB Privatization Environmental Reports has been included in this section. The proposals by the Privatization contractors contain confidential information and therefore are not available for review by the public and cannot be fully described in the synopsis. For this purpose a qualitative approach was used when comparing the potential environmental impacts with the impacts estimated in the TWRS EIS. The description of the proposals and the environmental impacts resulting from construction and operations have been quantified in an environmental critique for Phase IB Privatization prepared by DOE.

4.1 GEOLOGY AND SOILS

4.1.1 Geology

Mineral resources (i.e., silt, sand, gravel, and rip rap) would be required to implement the Phased Implementation alternative. The amount of these resources required are shown in Table 4.1.1. This table shows the amount of mineral resources required for constructing 1) remediation facilities; and 2) remediation facilities and closing tank farms combined (total alternative). During remediation, the earthen materials primarily would be used to make concrete for constructing treatment facilities and LAW vaults. During closure the earthen materials would be used primarily for filling tanks and constructing earthen surface barriers over the tank farms and LAW vaults. Sand, silt, gravel, and rip rap are all readily available on and near the Hanford Site so there would be no substantive impact on the availability of these resources. New information concerning the size of the LAW retrievable disposal facility affects the amount of resources required for constructing surface covers and changes impacts on mineral resources and soil disturbances from those presented in the TWRS EIS. Changes in the Phase IB site construction and operations change the impacts on soil disturbances from those presented in the TWRS EIS.

Only small, localized changes in topography would result from constructing remediation facilities and earthen surface barriers over the LAW vaults and the tank farms during closure. No major drainage would be disturbed, and all facilities and earthen barriers would be constructed to conform with the surrounding terrain to promote drainage without causing increased erosion. The configuration of the treatment facilities and the LAW vaults has changed slightly but these changes would not have a substantive affect the on the topographic impacts presented in the TWRS EIS.

Table 4.1.1. Mineral Resources and Soil Impacts

Tank Waste Alternative		Mineral Resource in m^3 (yd^3)			Soil Disturbance[1] in ha (ac)	
		Sand and Gravel	Silt	Rip Rap	Temporary	Permanent
Phased Implementation	Remediation	1.2E+06 (1.6E+06)	N/R	N/R	200 (490)	38 (94)
	Total Alternative[2]	2.6E+06 (3.4E+06)	5.7E+05 (7.4E+05)	9.6E+05 (1.3E+06)	320 (790)	49 (120)
Revised Geology and Soil Impacts						
Phased Implementation	Remediation	1.2E+06 (1.6E+06)	N/R	N/R	200 (490)	38 (94)
	Total Alternative[2]	2.8E+06 (3.6E+06)	6.1E+06 (8.1E+06)	1.3E+06 (1.7E+06)	445 (1,100)	74 (180)

Notes:

[1] These estimates are based on closure of the tank farms by filling tanks and covering them with a Hanford Barrier. Numbers have been rounded to two significant digits.

[2] Total Alternative estimates include remediation and closure as landfill.

N/R = None required

The use of borrow sites as the source of earthen materials would cause topographic changes. Removing borrow materials from the borrow sites would cause topographic depressions, which would be recontoured to be compatible with the surrounding terrain and drainage systems. No new information has been developed concerning the location or configuration of borrow sites so there is no information available that would have a substantive affect on the impacts presented in the TWRS EIS.

4.1.2 Soils

Soils would be disturbed by the construction of remediation facilities and at borrow sites for earthen materials. Much of the soils in the areas which would be impacted by the construction and operation of remediation facilities has been disturbed. The most recent information concerning the location and configuration of the remediation facilities shows only minor changes in the amount of soils to be disturbed during remediation, as shown in Table 4.1.1. The changes are the result of increased estimates of land disturbance from conceptual engineering for the LAW vaults, waste transfer, and support facilities. Changes in the LAW facility also result in increased resource requirements from borrow sites and hence increased soil disturbances for constructing an earthen surface cover.

4.1.3 Soil Disturbance Synopsis of the Phase IB Privatization Environmental Report

The TWRS EIS assumes a total soil disturbance of up to 33 ha (82 ac). This would include facility footprints, trample zones around work areas, heavy equipment traffic areas, and material laydown areas. This area would include approximately 15 ha (37 ac) of previously disturbed area and 18 ha (45 ac) of area that has not been disturbed by prior Site construction and operations.

Because the facility footprint for both Privatization proposals are larger than the TWRS EIS, the total soil disturbance would be greater than the TWRS EIS. The combined soil disturbance of the two proposals would be approximately two times greater than the soil disturbance estimated in the TWRS EIS.

4.2 SURFACE WATER

4.2.1 Water Releases

The Phased Implementation alternative would generate liquid effluent; however, the effluent would not be discharged to surface waters and there would be no direct impacts to surface waters from the implementation of the alternative. Liquid currently in the tanks and liquid added to the tanks during waste retrieval activities ultimately would be removed and sent to an evaporator. Condensed water from the evaporator would be sent to the Effluent Treatment Facility in the 200 East Area. The water would be treated in the Effluent Treatment Facility with a variety of systems, including evaporation, to meet applicable regulatory standards. Ultimately the waste would be discharged, with most contaminants removed except tritium, from the Effluent Treatment Facility to the State-approved land disposal facility site, a subsurface drain field near the north-central part of the 200 West Area. The discharged water would move through the vadose zone into the groundwater where it would slowly flow towards and discharges to seeps along the Columbia River and directly into the Columbia River. An estimated 100 years would be required for any contaminants to reach the Columbia River where it would rapidly mix with the large volumes of water in the Columbia River. All levels of contaminants would meet the requirements of the approved permit.

Concern has been raised in the past about the amount of tritium that would be released from the land disposal facility. Since the preparation of the EIS, the specifications for the maximum amount of contaminants that can be sent to the Effluent Treatment Facility and the new revised inventory of the tanks have been developed. The maximum allowable concentration of tritium that can be sent to the Effluent Treatment Facility is 2.0E-06 Ci/L for each Phase IB and II facility. The estimated discharge rate for the Effluent Treatment Facility is 568 L/min (150 gal./min). The revised inventory data for the tank farms show 24,300 Ci of tritium in the tanks. Approximately one-half of the tritium would decay in the tanks prior to retrieval during the approximately 28-year schedule for Phase IB and II leaving 12,150 Ci to be disposed of. A portion of these 12,150 Ci would be released from evaporation and vitrification facilities prior to being sent to the Liquid Effluent Treatment Facility. To estimate an upper limit on the amount of tritium that would reach the Columbia River and determine if Federal Drinking Water Standards would be met, a calculation was performed assuming that the maximum allowable concentration (2.0E-06 Ci/L) was sent to the Effluent Treatment Facility continuously over a 28-year period, which is approximately the duration of Phase IB and II, at the maximum estimated discharge rate of the facility (568 L/min [150 gal./min]). Scaling from the previous modeling (Davis et al.1996), this bounding level of tritium discharge would result in a maximum concentration at seeps along the Columbia River of 2,700 pCi/L, which is well below the 20,000 pCi/L Federal Drinking Water Standard. Therefore, even though the amount of tritium in the tank waste has increased, Federal Drinking Water Standards would still be met.

The Phased Implementation alternative would result in contaminated liquids entering the groundwater as discussed in Section 4.3. Contaminants would enter the groundwater from 1) liquid losses during retrieval; 2) the residual waste left in the tanks following retrieval; and 3) the immobilized waste in the LAW vaults. Contaminants from past tank leaks would also migrate into the groundwater. Although these past-practice releases may have been large and may be important to future plans to close the tank farms and remediate the groundwater, they were not addressed in the TWRS EIS because there is not enough known about the amount of losses and their transport through the vadose zone to provide a meaningful comparison of alternatives for remediating the releases. These past practice releases will be the subject of a future NEPA analysis.

Some contaminants from losses during retrieval or leached from the residual waste or the LAW vaults may eventually enter the groundwater and discharge into the Columbia River through seeps and springs along the river bank or directly into the river bed where it intersects the groundwater. Once in the Columbia River the contaminants would rapidly mix with the large flows in the Columbia River due to turbulence of the river flow and the large volume of water in the river.

A calculation was performed for the Phased Implementation alternative using the revised inventory for the tank waste to assess the potential impacts on the Columbia River (Jacobs 1997). Table 4.2.1 shows the maximum concentration of the contaminants of concern for long-term risk in the Columbia River along with the reference Federal Drinking Water Standards. The analysis shows that for the Phased Implementation alternative the concentration of all contaminants would be well within Federal Drinking Water Standards.

Table 4.2.1. Concentration of Contaminants-of-Concern in the Columbia River for the Phased Implementation Alternative

Constituent	Revised Inventory (grams)	Federal Drinking Water Standards (mg/L)	Phased Implementation Alternative (mg/L)
NO_3	6.9E+10	45	7.0E-03
C-14	1,100	4.5E-07	1.0E-11
Tc-99	1.9E+06	5.3E-05	4.0E-08
I-129	3.6E+05	5.7E-06	7.0E-09
U (total)	9.7E+08	2.0E-02	6.0E-03

4.2.2 Surface Water Drainage Systems

The facilities for the Phased Implementation alternative would be constructed on relatively level and flat terrain. No major drainage features are present. Construction activities would result in slightly altered localized drainage patterns for the temporary construction areas and for the remediation facilities. The area around remediation facilities would be recontoured to conform with the surrounding drainage patterns. Small increases in surface water runoff during the infrequent heavy precipitation events or rapid snow melt would occur, but there would be no flooding of drainage systems. There is no new information that would result in a substantive change in the potential impacts to the surface water drainage systems from those presented in the TWRS EIS.

4.2.3 Water Quality Synopsis of the Phase IB Privatization Environmental Reports

The radioactive effluent generated in the TWRS EIS would be treated at the Effluent Treatment Facility prior to discharge. Both of the Privatization proposals included generating radioactive liquid effluent that would require treatment at the Effluent Treatment Facility. The generation of radioactive effluent for both proposals combined would not exceed the capacity of the Effluent Treatment Facility. There would be no liquid effluent discharged to surface waters, and thus there would be no direct impacts to any surface waters under the Privatization proposals.

4.3 GROUNDWATER

The groundwater is a pathway for potential releases during retrieval, residuals that may be left in tanks after retrieval, and immobilized waste in LAW vaults. Releases from the waste tanks and LAW vaults travel by advection downward through the vadose zone, intercept the unconfined aquifer (saturated zone), and move laterally to points of discharge along the Columbia River. In the TWRS EIS and in this discussion, the sources of the releases include retrieval losses from the waste tanks, residual waste in the tanks, and releases from the LAW vaults. Past leaks from the waste tanks were not addressed in detail in the TWRS EIS because not enough was known about their distribution and chemical and physical parameters. The discussion on impacts to the groundwater system is divided into 1) flow and contaminant transport through the vadose zone; and 2) flow and contaminant transport through the underlying saturated zone (groundwater). The impacts to the groundwater would be the presence of contaminants from tank waste and LAW vaults at concentrations that vary spatially and temporally in the unconfined aquifer.

4.3.1 Vadose Zone

The following is a summary of how data and information relative to the vadose zone may affect the TWRS EIS groundwater impact assessment. A detailed discussion is provided in Appendix A, Vadose Zone and Groundwater.

As discussed in Section 3.0 and 5.0, there remains a substantial amount of uncertainty associated with which vadose zone transport mechanisms are important in explaining the transport of past tank leaks. It is likely that all play a role at one or more SSTs. Continuation of the ongoing field investigations are necessary to resolve the affect of these mechanisms on past SST leaks. Current information indicates that once in the groundwater the contaminants will be transported laterally at the previously anticipated rates and the less mobile contaminants such as Cs-137 will not be transported away from the 200 Area by the groundwater but rather will be retarded by chemical reactions with the earthen materials that will essentially stop migration of many of the contaminants (Serne et al. 1993). As discussed in the following section these mechanisms would have a much reduced affect on future releases from the tanks.

The leaching of residual SST waste that may be left in the tanks after closure and the immobilized waste in the LAW vaults will be largely unaffected by these new data. This is because 1) the residual waste and immobilized LAW will be covered by a low-permeability earthen cover that will reduce infiltration of water to very low levels so the leaching of residual waste into the vadose zone will be very slow; and 2) the chemistry and physical form of the residual tank waste and immobilized LAW will be substantially different from the past tank leaks. These two factors prevent the transport mechanism described in Appendix A from substantively affecting the transport of the residuals tank waste and immobilized LAW.

Additional data are still being obtained and evaluated to address these issues but it appears that the effect on the impacts presented in the TWRS EIS includes the following:

- These data suggest that past SST tank leaks would move faster through the vadose zone than previously expected resulting in earlier arrival of contaminants in the groundwater. If this occurs, then the past leak contaminants would be more likely to move through the vadose zone and groundwater system prior to the contaminants from the tank waste remediation which reduces the potential for the impacts to occur at the same time and therefore reduces the cumulative impacts of past tank leaks and tank waste remediation (please refer to Appendix A for additional information).
- The leaching of contaminants from the LAW vaults will be largely unaffected by the transport mechanism discussed in Appendix A. The LAW will be immobilized into a glass form, and leaching will be controlled by the immobilized waste form and the low-permeability earthen cover placed over the LAW vaults. None of the mechanisms listed previously that may accelerate contaminant transport will be operative for the immobilized LAW.
- The leaching of residual waste that may be left in the tanks will be largely unaffected by much of this new information. Leaching will be controlled by a low-permeability earthen cover over the tank farms after closure. None of the mechanisms listed in Appendix A that may accelerate contaminant transport would have a substantive affect on the transport of contaminants from residual waste that contribute appreciably to risk.
- Leaks during waste retrieval would be affected by these new data and would likely result in earlier arrival times (Jacobs 1997) in the groundwater but in substantially the same concentration as estimated in the TWRS EIS.

This new information would not affect the impacts presented in the TWRS EIS because all of the long-term risk and groundwater impacts resulted from the highly mobile contaminants such as Tc-99, uranium-total, Se-79, and EDTA, which were calculated to move very rapidly through the vadose zone and groundwater so the factors that accelerate transport through the vadose zone would only result in slightly earlier times of arrival of the impacts and not appreciably higher concentrations of contaminants.

4.3.2 Saturated Zone (Groundwater)

The second half of the groundwater pathway is lateral contaminant transport through the unconfined aquifer flow from points of entry at the vadose zone/water table interface beneath the tank and LAW sources to the Columbia River. The unconfined aquifer is generally located in the unconsolidated to semiconsolidated Ringold and Hanford formations that overlie the basalt rock. The groundwater in the unconfined aquifer generally flows from the recharge areas near the western boundary of the Hanford Site toward the Columbia River, which is a discharge zone for the unconfined aquifer. The new data and information for the unconfined aquifer include 1) water levels at over 600 wells; 2) concentration of contaminants in the groundwater Sitewide including the areas around the tank farms; and 3) the revised inventory, which is also discussed in this section.

The following is a summary overview of how these new data and information may affect the groundwater impact assessment provided in the TWRS EIS. A detailed discussion is included in Appendix A. There are no notable changes to the groundwater flows direction from that used in the TWRS EIS that would cause a change to the TWRS EIS impact analysis. There are no notable changes to the groundwater contaminant concentrations that would cause a change to the TWRS EIS impact analysis.

The impacts presented in the TWRS EIS were amended for this SA to provide groundwater impact comparisons for the revised tank waste inventory to the TWRS EIS inventory for the selected years (2,500, 5,000, and 10,000 into the future for tank sources and 5,000, and 10,000 for LAW vaults). As shown in Tables 4.3.1 and 4.3.2, the only contaminants to exceed the Drinking Water Standards for tank waste releases for the revised inventory are U-238 and total

Table 4.3.1. Maximum Concentrations Calculated in Groundwater for the Phased Implementation Alternative (Tank Sources)

Constituent	Drinking Water Standard (mg/L)	2,500 Years		5,000 Years		10,000 Years	
		EIS (mg/L)	Revised (mg/L)	EIS (mg/L)	Revised (mg/L)	EIS (mg/L)	Revised (mg/L)
C-14	4.49E-07	3.4E-10	3.1E-10	6.8E-09	6.1E-09	2.0E-13	1.8E-13
I-129	5.68E-06	5.3E-08	8.7E-08	2.0E-06	3.3E-06	1.3E-10	2.1E-10
Tc-99	5.33E-05	3.8E-07	3.9E-07	1.5E-05	1.5E-05	1.5E-09	1.6E-09
U-233	N/A	7.0E-13	2.7E-08	2.3E-11	9.1E-07	0.0	0.0
U-234	N/A	2.4E-11	4.0E-08	1.4E-09	2.3E-06	0.0	0.0
U-235	N/A	7.4E-06	5.2E-06	5.8E-04	4.1E-04	7.2E-09	5.0E-09
U-236	N/A	4.6E-11	1.5E-07	6.6E-10	2.2E-06	0.0	0.0
U-237	N/A	0.0	0.0	0.0	0.0	0.0	0.0
U-238	N/A	1.1E-03	7.4E-04	8.9E-02*	6.0E-02*	1.0E-06	6.8E-07
Total U	0.02 (total)	1.1E-03	7.5E-04	8.9E-02*	6.0E-02*	1.0E-06	6.9E-07
NO_3- NO_2	45 (NO_3)	2.4E-02	1.7E-02	5.4E+00	4.0E+00	2.5E-04	1.8E-03

Notes:

N/A = Not applicable

EIS = TWRS EIS

* Calculated value exceeds Drinking Water Standard (40 CFR Part 141.16) based on a calculated dose equivalent of 4 mrem/year.

Table 4.3.2. Maximum Concentration Calculated in Groundwater for the Phased Implementation Total Alternative (LAW Vaults)

Constituent	Drinking Water Standard (mg/L)	5,000 Years		10,000 Years	
		EIS (mg/L)	Revised (mg/L)	EIS (mg/L)	Revised (mg/L)
Tc-99	5.3E-05	4.6E-06	2.7E-05	1.2E-05	1.2E-05
U-233	N/A	2.0E-13	7.9E-09	6.0E-13	2.4E-08
U-234	N/A	6.6E-12	1.1E-08	1.8E-11	2.9E-08
U-235	N/A	2.1E-06	1.4E-06	5.6E-06	3.9E-06
U-236	N/A	7.6E-12	2.5E-08	2.0E-11	6.8E-08
U-238	N/A	3.1E-04	2.1E-04	8.3E-04	5.6E-04
Total U	0.02 (total)	3.1E-04	2.1E-04	8.4E-04	5.6E-04

Notes:
N/A = Not applicable
EIS = TWRS EIS

uranium. In the TWRS EIS, U-238 was calculated to have exceeded the standard and thus so would total uranium. The potential uranium exceedance of the Drinking Water Standards is based on an assumed uranium K_d of zero. The emerging information on uranium mobility indicates that the K_d is likely 0.6 mL/g or greater and as such, would not likely exceed the Drinking Water Standards within the 10,000-year period of interest (Freshley 1997).
The mobility of uranium in the vadose zone and saturated zone is an area that continues to be researched. The uncertainty surrounding the uranium K_d is expected to be reduced as data from borehole 41-09-39 at the SX Tank Farm are assayed for uranium content.

4.3.3 Ground Water Synopsis of the Phase IB Privatization Environmental Reports

Potential impacts to groundwater would result from potential liquid losses during retrieval of tank waste, leaching of contaminates in the immobilized LAW vaults, and the leaching of residual waste that may be left in the tanks following retrieval. During Phase IB potential retrieval losses is a DOE function and is unaffected by either of the Privatization proposals. Each of the contractors would be responsible for operation and waste transfers from one DST to their respective facilities (tanks 241-AP-108 and 241-AP-106). Both contractors will construct pipelines with secondary containment for transfer of waste to the facility. Retrieval losses are not anticipated from these DSTs or waste transfer systems. The leaching of residuals from the LAW is unaffected by the Phase IB proposals as long as the waste form proposed by each contractor would meet the LAW performance specifications. Therefore, the Phase IB proposals by BNFL and LMAES would not impact groundwater. There is always the remote possibility for a spill to occur when waste is being transferred from the receiver tank to the process facilities, but it is anticipated that any such spills would be regulated by the remedial measures under RCRA, and it is assumed that if a spill did occur it would be remediated.

4.4 AIR QUALITY

Air pollutant emissions estimates were developed and air dispersion modeling was performed to analyze air quality impacts for the Phased Implementation alternative in the TWRS EIS. The analyses were conducted to compare the calculated impacts of potential criteria pollutant releases against National Ambient Air Quality Standards and Washington State Air Quality Standards, the calculated impacts of emissions of toxic and hazardous air pollutants against applicable Washington State regulations, and the calculated impacts of emissions of radionuclides against applicable Federal and Washington State standards.

Emission Sources

The emissions sources were from tank farms, evaporator, waste retrieval annexes, concrete batch plants, borrow sites, waste processing facilities construction, and waste processing facilities operations. There are currently no new data that would change the emission source parameters as presented in the TWRS EIS.

Emission Rates

In August 1997, the TWRS program issued a revised tank waste inventory and K Basins inventory, as described in Section 3.2.1. These new data result in a direct proportional change in the emissions evaluated in the TWRS EIS. The revised inventory, including the K Basin sludge, was compared against constituents of concern in the inventory used to calculate pollutant and radionuclide concentrations from air emissions evaluated in the TWRS EIS. Scaling factors were developed for estimating air concentrations based on the revised inventory data (Jacobs 1997). The scaling factors are shown in Table 4.4.1.

Table 4.4.1. Scaling Factors for Estimating Air Concentrations

Constituent	Scaling Factor
Pollutants	
No_x	7.3E-01
SO_x	2.5E+00
Radionuclides	
Am-241	7.3E-01
Cs-137	1.2E+00
Pu-239/240	1.8E+00
Pu-241	3.4E+00
Sr-90	1.2E+00
Tc-99	1.0E+00
C-14	9.0E-01
I-129	1.6E+00
Ru-106	7.6E+04
Sm-151	4.2E+00
Zr-93	9.2E-01

The radiological dose from the revised inventory results in an overall 36 percent increase in receptor dose for the maximally exposed individual (MEI) at the Site boundary.

Modeling

Version two of the EPA Industrial Source Complex Model (ISC2) (EPA 1992) was used for the air dispersion modeling in the TWRS EIS and this SA. ISC2 is capable of simulating emissions from diverse source types. ISC2 is a guideline air quality model (accepted by EPA for regulatory applications) and routinely is recommended for performing screening and refined analyses for remedial actions at RCRA and Superfund sites.

Receptors

Compliance with Washington State and Federal ambient air quality standards for nonradionuclide releases and compliance with Washington State ambient air quality standard for radionuclides were measured at the maximum receptor location at the Hanford Site boundary, along the Columbia River, and on State Route 240. Compliance with the Federal standard for radionuclide releases was measured at the nearest residence. There are no new data that would change the location of these receptors.

Results of Air Emission Modeling

The results of the modeling were compared with Washington State air quality standards or emission levels listed in the Washington Administrative Code (WAC) and with national primary and secondary Ambient Air Quality Standards listed in 40 CFR Part 50. The Washington Ambient Air Quality Standards are equal to or more stringent than the National Ambient Air Quality Standards, and thus compliance with the Washington Ambient Air Quality Standards results in compliance with the National Ambient Air Quality Standards.

New emissions concentrations were estimated by applying the scaling factors shown earlier to the concentrations calculated for the TWRS EIS. The results presented in Table 4.4.2 show no exceedances of Federal or State air quality standards for criteria pollutants or radionuclides.

The revised inventory data result in an increase in the sulfur oxide concentrations by 250 percent and an increase in the total radiological dose by 36 percent. Nitrogen oxide emission concentrations would be reduced to approximately 73 percent of the TWRS EIS estimates. Carbon monoxide and PM-10 emission concentrations would remain unchanged. Concentration of all contaminants would be within applicable standards.

Air Quality Synopsis of the Phase IB Privatization Environmental Report

Concentrations from particulate air emissions during construction estimated in the TWRS EIS would not exceed 87 micrograms/cubic meter ($\mu g/m^3$) during a 24-hour period from fugitive dust, 3.2 $\mu g/m^3$ during a 24-hour period from sulfur oxides, 800 $\mu g/m^3$ during a 8-hour period

Table 4.4.2. Comparison of the Calculated Maximum Concentration of Pollutants

Pollutant-Averaging Period	TWRS EIS $\mu g/m^3$		Revised Inventory $\mu g/m^3$		Standard $\mu g/m^3$	
	Construction	Operation	Construction	Operation	Federal	State
Sulfur Oxides						
1 Hour	7.6E+00	4.0E+00	N/C	9.8E+00	N/A	6.6E+03
3 Hours	6.9E+00	3.6E+00	N/C	8.8E+00	1.3E+03	N/A
24 Hours	3.1E+00	1.6E+00	N/C	3.9E+00	3.7E+02	2.6E+02
Annual	2.9E-02	2.0E-02	N/C	4.9E-02	8.0E+01	6.0E+01
Carbon Monoxide						
1 Hour	3.2E+03	4.8E+01	N/C	4.8E+01	4.0E+04	4.0E+04
8 Hour	2.3E+03	3.4E+01	N/C	3.4E+01	1.0E+04	1.0E+04
Nitrogen Oxides						
Annual	2.1E+00	1.2E-01	N/C	8.8E-02	1.0E+02	1.0E+02
PM - 10						
24 Hours	9.8E+01	7.5E-01	N/C	7.5E-01	1.5E+02	1.5E+02
Annual	1.1E+00	7.9E-03	N/C	7.9E-03	5.0E+01	5.0E+01
Total Radionuclide mrem/yr	1.1E-03 1.6E-03	7.7E-01[3] 9.2E-01[4]	1.5E-03 2.2E-03	1.1E+00 1.3E+00	1.0E+01[1] --	-- 2.5E+01[2]

Note:

[1] Maximum at nearest resident (Federal Standard)
[2] Maximum at any offsite receptor (State Standard)
[3] Misprint in TWRS EIS shows 4.0E-01
[4] Misprint in TWRS EIS shows 5.0E-01
N/C = No change

from carbon monoxide, and 1.3 $\mu g/m^3$ during an annual period from nitrogen oxides. Because the facility footprints for both proposals are larger than the TWRS EIS estimate, construction requirements would be greater and the air emissions would be greater than the TWRS EIS estimate. The combined air emissions during construction from the two proposals would exceed the TWRS EIS by as much as three times but would be within regulatory standards.

Concentrations from particulate air emissions during operations in the TWRS EIS estimate would not exceed 0.05 $\mu g/m^3$ during a 24-hour period from fugitive dust, 0.9 $\mu g/m^3$ during a 24-hour period from sulfur oxides, 27 $\mu g/m^3$ during a 8-hour period from carbon monoxide, and 0.01 $\mu g/m^3$ during an annual period from nitrogen oxides. Both proposals would exceed fugitive dust, sulfur oxide, and nitrogen oxide emission estimated in the TWRS EIS. The combined air emissions of these constituents during operations from the two proposals would exceed the TWRS EIS estimate by as much as 135 times for nitrogen oxides, six times for fugitive dust, and 19 times for sulfur oxides but would be well within regulatory standards. Additional emissions control technologies have been proposed that would result in operating emissions of carbon monoxide and radionuclides that would be below those estimated in the TWRS EIS. The TWRS EIS estimated that the combined air emissions of these constituents during operations from the two proposals would exceed those calculated in the EIS by two and one-half times.

4.5 BIOLOGICAL RESOURCES

To support a comparison of the relative impacts of each alternative, the impact analysis in the TWRS EIS focused on the biological resources of the specific land areas where activities are proposed under the various EIS alternatives. Most impacts would occur in the 200 Areas where TWRS waste is currently and projected to be stored and where waste TSD facilities would be located. Smaller impacts would be located at potential borrow sites where varying levels of borrow material would be secured to support facility construction and post-remediation tank farm activities. Biological and ecological impacts identified in the EIS included potential impacts under each alternative to vegetation and wildlife habitat, especially shrub-steppe habitat. Impacts assessed included impacts resulting from temporary disturbance of habitat to support construction and operation of facilities, permanent disturbances supporting post-remediation activities, impacts resulting from noise and transportation impacts that would disrupt wildlife, and potential impacts to biodiversity.

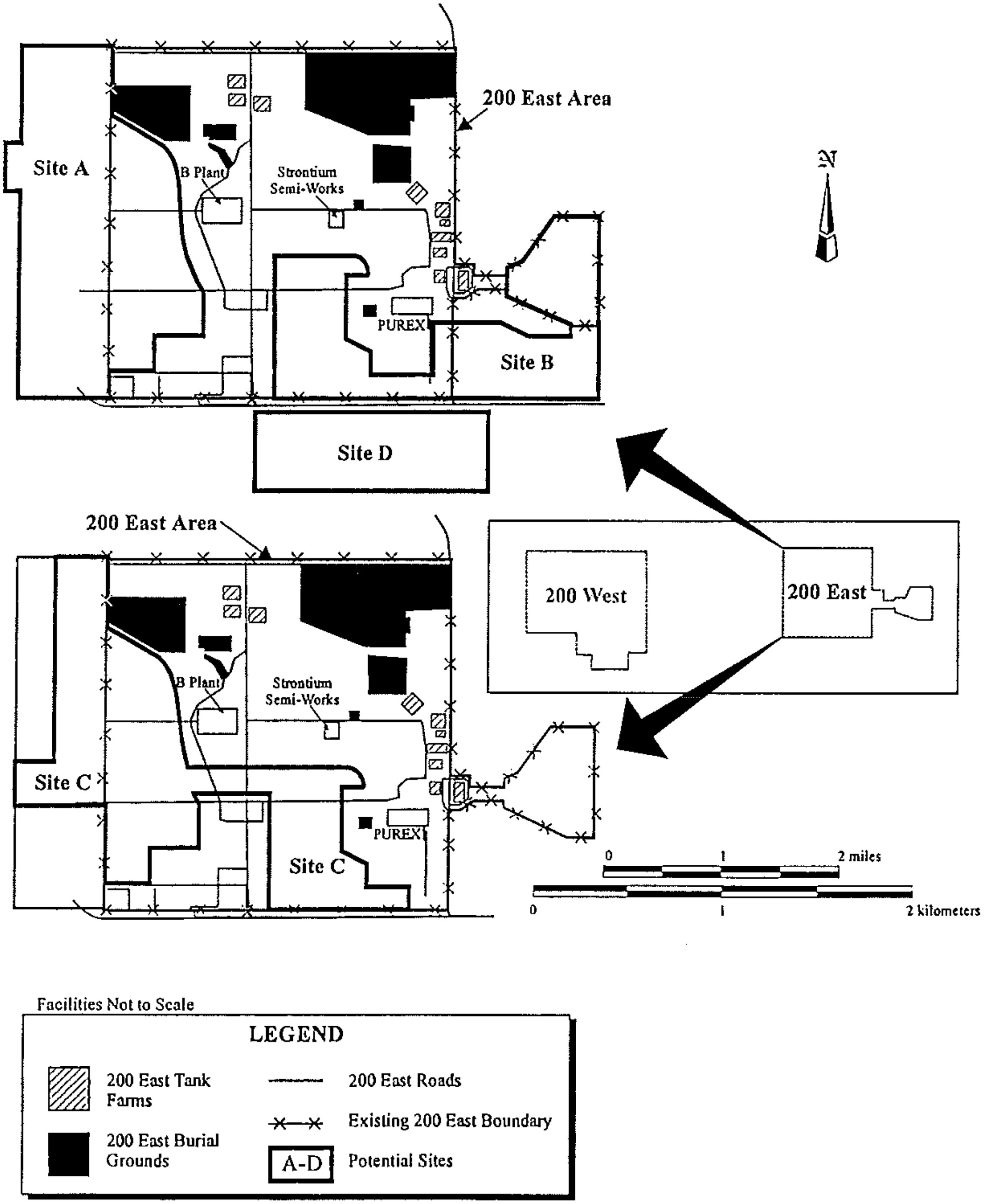
For the TWRS EIS analysis, the key issues were 1) whether the land areas proposed for use currently are undisturbed or whether they have been disturbed by past activities; 2) the extent of potential impacts on sensitive shrub-steppe habitat, which is considered a priority habitat by Washington State; and 3) potential impacts on plant and animal species of concern (those listed or candidates for listing by the Federal government or Washington State as threatened, endangered, and sensitive).

The potential site for construction and operation of the alternatives contained both undisturbed and disturbed land. For example, the tank farms and their immediate surrounding areas currently are heavily disturbed and thus have minimal native vegetative or wildlife habitat. The vitrification facility sites in the 200 East Area associated with the various alternatives contain currently disturbed land that is of minimal habitat value and undisturbed shrub-steppe that is considered valuable as vegetative and wildlife habitat. The analysis of potential impacts on species of concern focused on plant and animal species found in the Hanford Site's shrub-steppe habitat.

Where the Phased Implementation activities were proposed in areas that are partly disturbed and partly undisturbed habitat, vegetation and wildlife habitat impacts were calculated proportional to the current percentage of disturbed versus undisturbed land at the particular site. For example, if 30 ha (74 ac) were required at a site that currently is 50 percent disturbed, the habitat impact was calculated to be 15 ha (37 ac).

For the TWRS EIS, environmental impacts associated with siting of facilities were based on the results of two Site evaluation reports: 1) the TWRS complex site evaluation (WHC 1995a); and 2) the TWRS Privatization Phase IB site evaluation report (WHC 1996b). The TWRS complex site evaluation report considered four alternative sites in the 200 East Area to support construction and operation of full-scale waste treatment facilities (Figure 4.5.1). The evaluation ranked Site C highest based on evaluation of eight criteria. In conjunction with DOE's decision

Figure 4.5.1. Potential TWRS Complex Site Evaluation Locations



Source: DOE 1996g

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to consider a two-phased approach to implementing waste treatment, the Privatization Phase IB site evaluation report was completed. This report considered four alternative sites in the 200 East Area to support construction and operation of Phase IB facilities (Figure 4.5.2). The evaluation ranked Site 3 highest for Phase IB facilities based on the same eight criteria. The criteria used in both reports included the following.

Evaluation of a Site's Ability to Protect the Environment

- Cultural, Archeological, and Historical Sites
  The TWRS remediation site shall not have any areas of cultural, archeological, or historical significance that cannot be reasonably mitigated.

- Ecological
  The TWRS remediation site shall not have any areas of ecological impact that cannot be reasonably mitigated.

- Groundwater Protection
  The Columbia River shall be protected, and groundwater contamination will be dealt with realistically and forcefully. This issue concerns the ability of the Hanford Site to meet Federal, State, and local requirements for protecting groundwater. Factors include the 1) impact of previous Hanford Site practices (e.g., liquid effluent discharges, SST leaks, disposal actions) on groundwater under the Site; 2) hydrology of the Site; and 3) the impact of the Site on proposed future Hanford Site disposal operations (e.g., LAW disposal).

- Harm During Cleanup
  Establishing the TWRS complex (on the particular site) shall cause no irreparable harm to the environment.

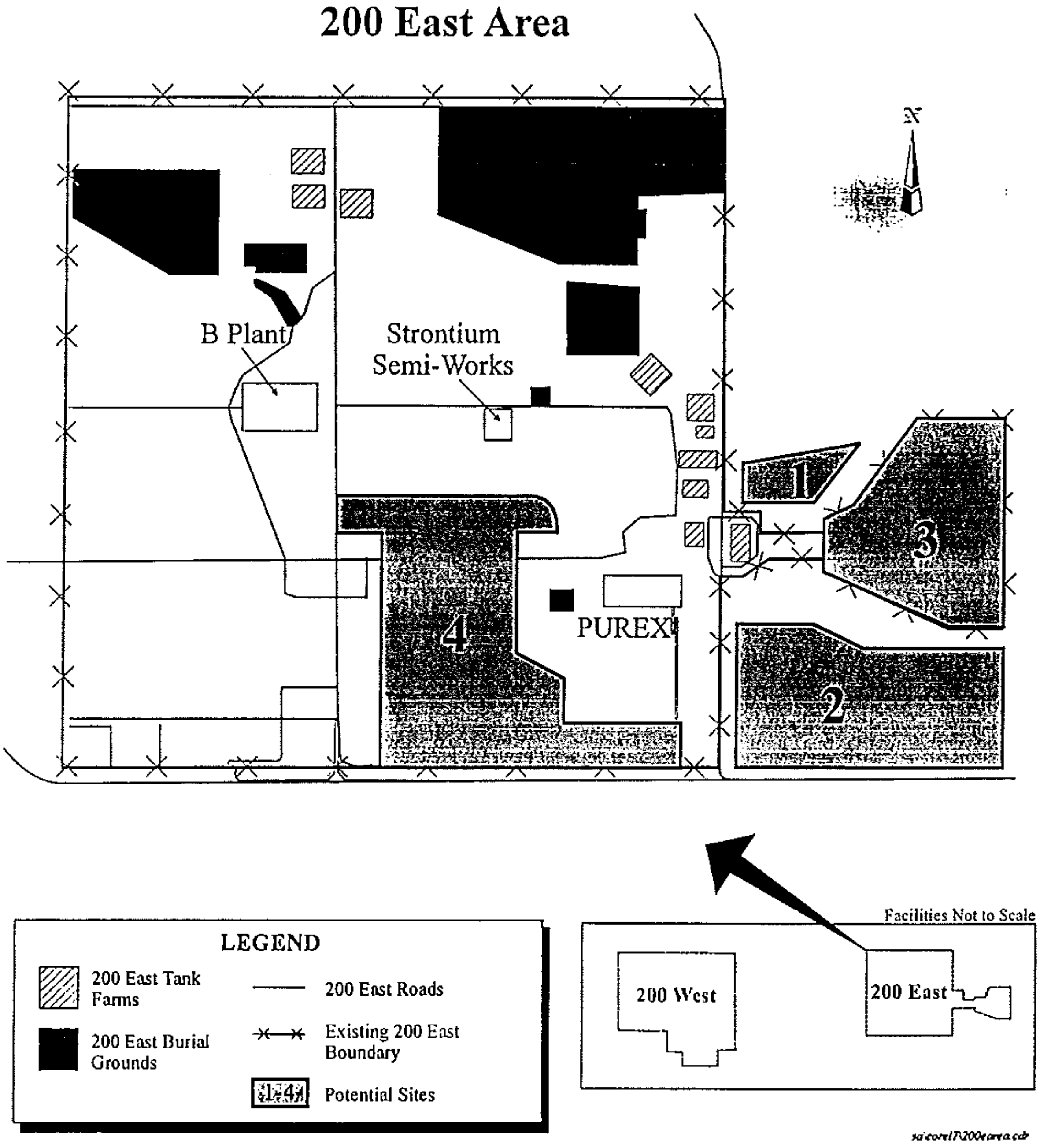
- Natural Resource Damage
  The TWRS remediation site shall minimize and avoid any impacts to natural resources.

Evaluation of a Site's Ability to Protect Public/Worker Health and Safety

- Transportation
  Waste will be transported safely, and measures will be taken to prepare for emergencies. The transportation of radioactive and hazardous waste and material through populated areas will be kept to a minimum.

- Exposures
  Exposures will be as low as reasonably achievable. The TWRS remediation site shall minimize the adverse impacts on the health and safety of personnel. The concept of reducing the exposure of workers to radiological and hazardous substances to as low as reasonably achievable principles will be considered.

Figure 4.5.2. Potential TWRS Phase 1 Evaluation Site Locations



Source: Adapted from WHC 1996k

- Accidents on the TWRS Complex
  The TWRS remediation site will minimize the effects of possible accidents at adjacent facilities on the TWRS complex.
- Accidents from the TWRS Complex
  The TWRS remediation site will minimize the effects of possible accidents at the TWRS complex and its associated facilities (e.g., transfer lines) on adjacent facilities.

Evaluation of a Site's Ability to Use the Central Plateau Wisely for Waste Management
Land-use planning for the TWRS remediation site should be in concert with and not conflict with other land-use planning documents.

Evaluation of a Site's Ability to Promote Local Economic Development
The TWRS remediation site will capture economic development opportunities locally by being conducive to Privatization of facilities.

Evaluation of a Site's Ability to Support the Tri-Party Agreement
The TWRS remediation site will support meeting the Tri-Party Agreement schedule and get on with cleanup to achieve substantive progress in a timely manner.

Evaluation of a Site's Ability to Consider Cost Impacts
The following cost impacts shall be considered.

- Construction Costs
  <u>Utilities</u>: The installation/upgrade costs of electricity, raw water, sanitary water, steam, and telecommunications. Existing and planned utilities will be considered.
  <u>Railroads</u>: The installation/upgrades costs of rail and roads.
  <u>Liquid Effluent Disposal</u>: The installation of liquid effluent disposal lines from the complex to the liquid effluent disposal system.
  <u>Sanitary Sewer</u>: The installation costs of a sanitary sewer to tie into the planned 200 East Area sanitary sewer system.
  <u>Storm Water Runoff</u>: The installation costs of a system to channel stormwater away from the site.
  <u>Construction Proximity</u>: The ability to locate temporary construction support facilities close to the facilities being constructed and the availability of adequate laydown and construction support areas.
  <u>Construction Commonality</u>: Maximize the use of common construction support needs (laydown areas, utilities, parking, batch plant, offices, shops, warehouse, and change rooms) between project or construction phases of multiple facilities of the same project.
  <u>Site Preparations</u>: Costs associated with earth-moving activities necessary to complete construction. Factors include topography, site irregularities, and finish grade elevation. The removal/relocation of existing structures are additional factors.

- Operating Costs
  Operating costs between the various sites shall be qualitatively assessed and shall include items such as facility and feed/waste transfer costs of flushing, diluting waste, concentrating diluted waste (evaporating waste to manage DST space), and line drain back.

Evaluation of a Site's Ability to Provide Flexibility
Provide flexibility in the following areas.

- Site Expansion
  Adequate expansion area should be available for future TWRS facility needs. Although the expansion area cannot be quantified at this point, more potential expansion area is preferable to less.
- Facility Relationships
  The TWRS remediation site should allow the interacting of process facilities to maximize use of common support facilities and utilities and facilitate flows (tank waste transfers, raw materials, effluent disposal, process waste streams) between process facilities and related operations.
- Compatibility
  The TWRS remediation site should be compatible with ongoing programs, current construction projects, and planned projects.
- Proximity
  The TWRS remediation site should possess the ability to 1) move the vitrified waste to HLW interim storage and subsequently to final storage offsite; and 2) retrieve LAW from onsite disposal for repackaging for offsite shipment.
- Contracting Flexibility
  The TWRS remediation site should be conducive to the use of innovative contracting concepts such as 1) fixed-price contracts for design, construction, startup, and initial operations; and 2) Privatization. Ease of access, interfaces with site operations, and the potential to encounter unforeseen conditions are to be considered.

Evaluation of a Site's Ability to Reduce Risks
Reduce risks (technical, regulatory, operational, construction, and planning) in the following areas.

- Hydraulics
  The potential for transfer line plugging should be minimized to the extent possible. Factors to be considered should include waste transfer system configuration (i.e., number of process pits), line traps, quantity of flush water after each transfer, line drain back to low point, number of low points in system, dilution requirements to mitigate plugging of transfer system, pumping requirements (to minimize the use of pump booster stations), and siphoning effect between the shipping location and the processing facilities.

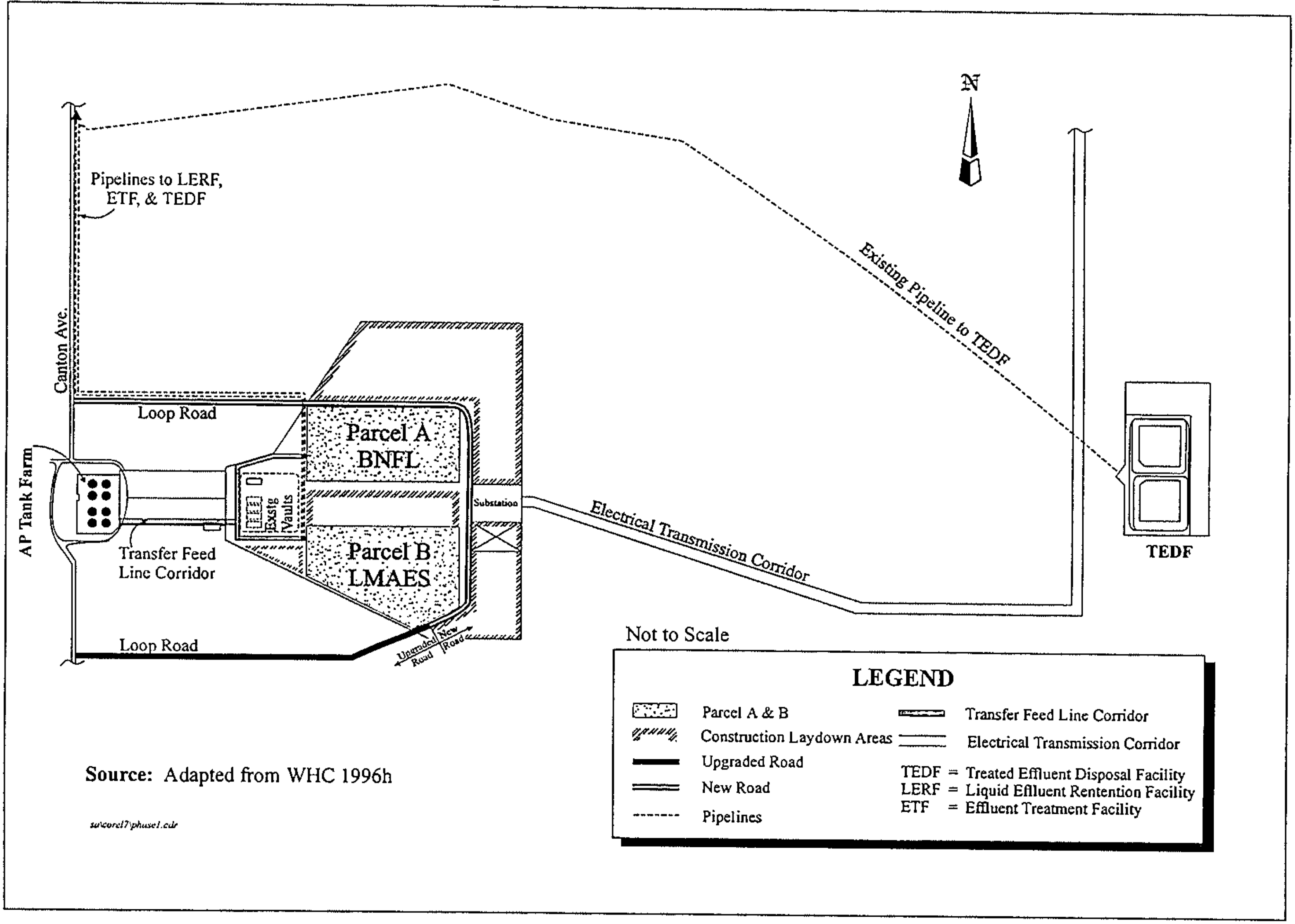
In essence, the inner tank/facility piping should be free draining (to the extent practical) to the transfer destination.

- Proximity to Existing Facilities
  The distance between the processing facilities for pretreatment/LAW treatment and HLW, and the DSTs existing in the 200 East Area (A Farm Complex) shall be kept to a practical minimum.
- Interferences and Contamination
  Minimize potential problems to be encountered during construction and operation due to existing above or belowground structures or radioactive/hazardous contamination.
- Seismic
  The distance to known earthquake faults shall be taken into consideration.
- Site Activities
  The impact on other Hanford Site activities and operating facilities during construction and operation should be kept to a minimum.
- Decontamination and Decommissioning
  The decontamination and decommissioning activities in the 200 East Area should be considered in siting the TWRS complex. This would include the decontamination and decommissioning impact of other facilities in the area on the TWRS complex and the ultimate decontamination and decommissioning of the TWRS complex.
- Design
  The need for new technology/design complexity should be minimized.

Because final site selection was not completed, the TWRS EIS for purposes of analysis a combination of Site B and C (Figure 4.5.1) was assumed to be representative of a site capable of accommodating the full-scale processing facilities, LAW disposal, and HLW temporary storage for Phase IB and II of the Phased Implementation alternative.

Based on the TWRS ROD and DOE's decision to proceed with consideration of two contractors to provide Phase IB waste treatment services, a series of studies were completed in 1996 to support siting and design of Phase IB facilities. These studies included the TWRS Privatization Phase I Master Site Plan (WHC 1996d) and engineering studies including analysis of roads and rail system modification (WHC 1996g), site development (WHC 1996h), raw and potable water service (WHC 1996i), and liquid effluent transfer systems (WHC 1996j). Each of the studies considered alternate scenarios for site development and evaluated the scenarios based on the planning criteria identified previously and contained in the TWRS Site Master Plan (Jacobs 1995). These criteria include potential environmental impacts, including impacts to previously undisturbed habitat. Based on the engineering studies, four conceptual design reports to support site development and infrastructure (i.e., electrical, effluent transfers, and roads) were prepared by LMHC (1997b). Conceptual deigns have refined the proposed facility siting (Figure 4.5.3) and are the basis of the analysis of impacts associated with Phase IB presented in this SA.

Figure 4.5.3. Phase 1 Site Location



Source: Adapted from WHC 1996h

To determine if new information developed since the completion of the TWRS EIS indicated changes in understanding of potential biological and ecological impacts a review of new data was completed (Jacobs 1997). The new data sources included Conceptual Design Reports associated with construction of TWRS Privatization Phase 1B facilities and associated infrastructure upgrades to provide the facilities with services (e.g., electrical) and to transfer waste to the plants and from the plants (LMHC 1997b), the TWRS Privatization Master Site Plan (WHC 1996d), preconceptual design information for LAW vaults to be constructed in the 200 Areas for disposal of immobilized LAW (LMHC 1997b), and a review of past biological reviews of the areas proposed for development during Phase IB TWRS Privatization (Brandt 1997).

Based on a review of the Conceptual Design Reports the following data regarding disturbances to biological and ecological resources, of the approximately 94 ha (230 ac) of total land that would be disturbed to support facility construction and operations during Phase IB of Privatization:

- Infrastructure projects (i.e., raw and potable water, liquid effluent transfer systems, and site development and roads to support Privatization Phase IB facilities would disturb approximately 4 ha (10 ac) of shrub-steppe habitat

- Electrical power system development would disturb approximately 1.9 ha (4.7 ac) of shrub-steppe habitat

- Site development (i.e., clearing and grading land to support Privatization Phase IB facility construction and operation) would disturb approximately 27 ha (68 ac) of shrub-steppe habitat.

Based on the preconceptual design for the LAW vaults, approximately 36 ha (90 ac) would be devoted to LAW vaults within the 200 East Area. This compares to an estimate of approximately 11 ha (27 ac) for the vaults for the Phased Implementation alternative in the TWRS EIS.

To address data gaps in land-use and habitat impact information required to complete a comparison of shrub-steppe habitat impacts under the EIS Phased Implementation alternative and impacts under the Privatization Phase IB, calculations were prepared based on engineering judgement. It was assumed that Privatization contractors would require borrow materials from an onsite pit, that the borrow material would be from Pit 30, and that each would require approximately one-half of the volume of borrow material estimated for the TWRS EIS Phased Implementation alternative. Also, no estimate was provided of the shrub-steppe habitat that would be disturbed associated with the construction of LAW vaults. To address this data gap it was assumed that impacts would occur at the same proportion as was used to calculate impact for Phase II facilities in the TWRS EIS.

Based on the data provided in the Conceptual Design Reports and Master Site Plan and these assumptions, a comparison with data used to perform impact calculations in the TWRS EIS for the Phased Implementation alternative was completed (Jacobs 1997). The results of the comparison are included in Table 4.5.1. Assuming DOE selects two contractors to provide Phase IB services, one to provide LAW and HLW services and the second providing only LAW services, with no changes in land-use needs by either contractor, impacts to shrub-steppe habitat would be approximately 45 percent or 16 ha (40 ac) greater than impacts calculated in the EIS for Phase IB (Figure 4.5.4). For the total alternative (Phase IB and Phase II) the total shrub-steppe habitat impacts would be 17 ha (42 ac) greater than the 99 ha (240 ac) calculated in the TWRS EIS for the Phased Implementation alternative. Of the 99 ha (240 ac) calculated in the TWRS EIS, 7 ha (17 ac) were assumed to be disturbed by construction of LAW vaults. The increase impacts under current plans compared the impacts under the Phased Implementation alternative represents less than a 1 percent impact of the remaining shrub-steppe habitat on the Central Plateau.

Table 4.5.1. Comparison of Shrub-Steppe Impacts - Changes from the TWRS EIS

Activity	Phased Implementation Alternative ha (ac)	Conceptual Design Report Estimate for Phase IB Impacts and LAW Preconceptual Design ha (ac)	Additional Impacts ha (ac)
Treatment Facilities (Phase 1)	18 (45)	27 (67)	9 (22)
Infrastructure (Phase 1)	1 (2.5)	8 (20)	7 (17)
LAW Disposal (Total Alternative)[1]	7 (17)	24 (60)	17 (42)
Total	26 (64)	60 (150)	33 (82)

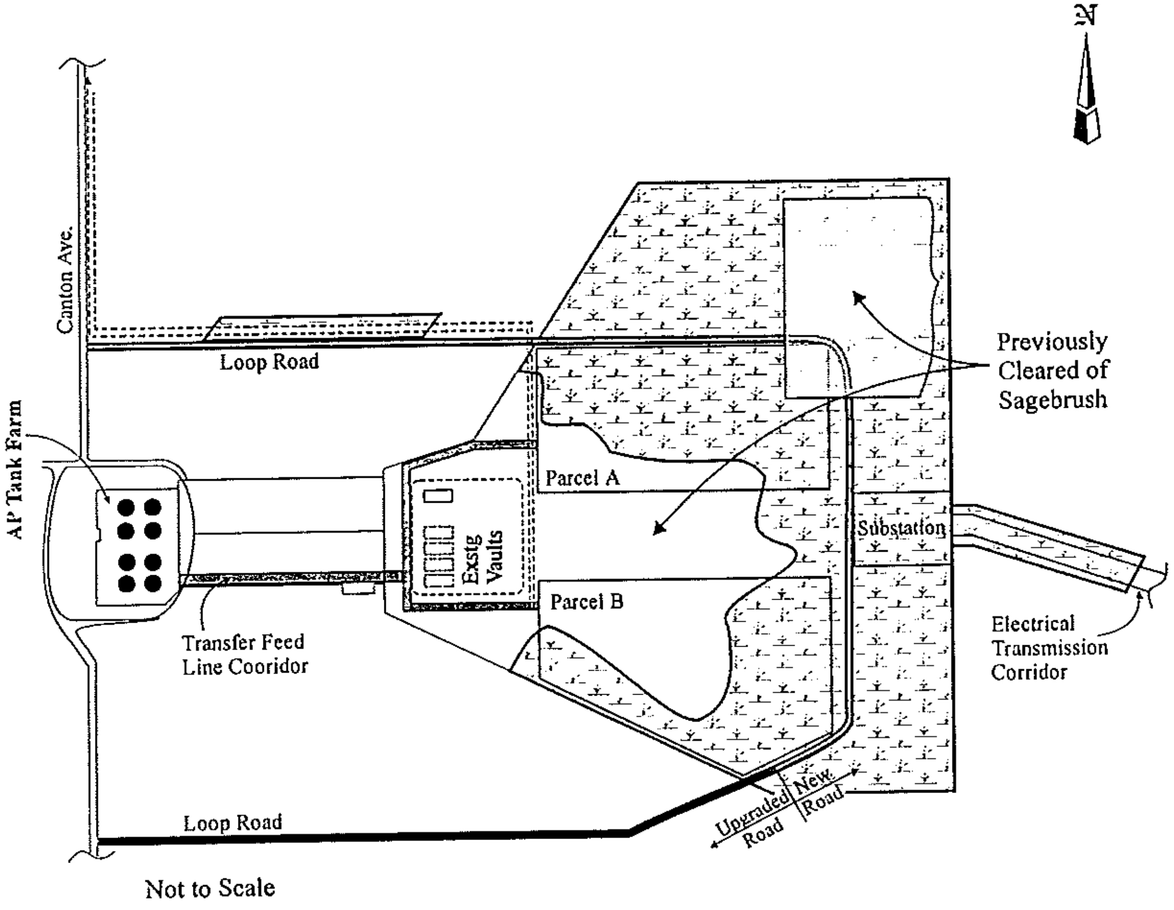
Notes:

[1] Potential increases in borrow materials to support increased size of LAW earthen cover not calculated because LAW design is preconceptual.

Impacts to biological and ecological resources associated with the shrub-steppe habitat would be similar to those identified in the TWRS EIS and would be greater in the same proportion as the area disturbed because ecological and biological impacts are proportional to the extent of disturbance. Thus, while the total impacts would be greater, based on the estimates provided in the new data, the overall impacts of the project represent a less than a fraction of 1 percent impact on the remaining shrub-steppe and shrub-steppe habitat on the Central Plateau.

In December 1997, a review of past ecological and biological surveys was completed by the Pacific Northwest National Laboratory (PNNL) on proposed Phase IB site development and infrastructure projects based on the Conceptual Design Reports (Brandt 1997). The PNNL report was completed to 1) summarize past ecological evaluations to determine the occurrence in the project area of plant and animal species listed as threatened, endangered, candidate, sensitive or monitor by the State of Washington, and species protected under the Migratory Bird Treaty Act; and 2) to evaluate the potential impacts of disturbance on priority habitats and protected plant and animal species identified in the surveys.

Figure 4.5.4. TWRS Phase 1 Site Habitat Impacts



Source: Adapted from WHC 1996h

LEGEND

▨	Shrubb-Steppe	------	Pipelines
▬	Upgraded Road	▭	Transfer Feed Line Corridor
═	New Road	═	Electrical Transmission Corridor

sd:cont17shrubb.cdr

No plant or animal species protected or considered for protection under the Federal Endangered Species Act or species listed by the State of Washington as endangered or threatened were observed during previous surveys. Federal (Peregrine falcon) and State (Ferruginous hawk and Sandhill crane, Dwarf evening primrose, and Loeflingia) threatened or endangered species have the potential to occur at or near the proposed sites. The report identified a number of species of concern including various plants and animals on the State sensitive, watch, or review list. The same plants and animals were also identified in the TWRS EIS. Similarly, the report and the TWRS EIS identified potential impacts to sagebrush-steppe habitat, which is designated as a priority habitat by the Washington State Department of Fish and Wildlife.

Ecological and Biological Impacts Synopsis of the Phase IB Privatization Environmental Reports

The TWRS EIS estimates that 62 percent of the area that would be used for construction and operation of Phase I facilities would disturb previously undisturbed shrub-steppe habitat. The total disturbance estimated in the TWRS EIS for Phase I activities was estimated to be 18 ha (45 ac). Because the facility footprint for both proposals are larger than the TWRS EIS the disturbance of previously undisturbed shrub-steppe habitat would be larger if both contracts are awarded for facilities as currently proposed. The combined shrub-steppe habitat disturbance of the two proposals would be approximately two times greater than that estimated in the TWRS EIS. Total impacts to wildlife would be expected to be higher under the two proposals than the impacts estimated in the TWRS EIS because impacts to wildlife are largely a function of the total disturbance to previously undisturbed habitat.

4.6 CULTURAL RESOURCES

The TWRS EIS analyzed the potential impacts of TWRS alternatives on prehistoric and historic sites. The approach used was to 1) define specific land areas that would be disturbed by construction and operation activities; and 2) identify any prehistoric or historic materials or sites at those locations that might be adversely impacted. Whether or not an area has been previously disturbed is an important variable in cultural resource impact analysis because areas previously disturbed are highly unlikely to have culturally or historically important resources. For the TWRS EIS, cultural resource surveys of the proposed sites for Phased Implementation Phase IB and Phase II facilities determined that there were no archaeological or historical sites in the potentially impacted area and thus there were "minimal potential" impacts to prehistoric and historic sites. The EIS analysis concluded that it is possible that the disturbed areas may contain cultural resources that were not identified in past surveys. Thus, additional cultural resource surveys would be conducted and TWRS construction would include procedures and monitoring activities to protect cultural resources encountered during construction.

As indicated in Section 4.5, the total area identified in Conceptual Design Reports and the Master Site Plan to support construction and operation of the TWRS Privatization Phase IB facilities is up to 45 percent or 16 ha (40 ac) greater than considered in the EIS and the total area for the total Phase Implementation alternative disturbance to previously undisturbed habitat is up to 20 percent or 33 ha (82 ac) greater than calculated for the TWRS EIS. The new areas include portions of the 200 East Area adjacent to the sites analyzed in the TWRS EIS and an electrical transmission corridor east and northeast of the TWRS EIS site. These areas also are unlikely to have prehistoric or historic materials. However, additional cultural resource surveys would be conducted, and TWRS construction would include procedures and monitoring activities to protect cultural resources encountered during construction.

In December 1997, a review of past cultural resource surveys was completed by the PNNL Cultural Resources Laboratory of proposed Phase IB site development and infrastructure projects based on the Conceptual Design Reports (Hale 1997). The letter report was completed to summarize past archaeological surveys to determine the occurrence in the project area of archaeological resources. The letter report documented that of the nine cultural resource surveys conducted within the proposed project area or within one-half mile of any potential project disturbances, no sites or finds were observed in areas potentially impacted by Phase IB activities, and one site and four isolated finds were observed within one-half mile of the Phase IB activities. These conclusions are consistent with the analysis provided in the TWRS EIS for the Phased Implementation alternative.

Cultural Resources Synopsis of the Phase IB Privatization Environmental Reports
In the TWRS EIS, cultural resource surveys of the potential site locations for facilities revealed no prehistoric material or sites. Because the total area to be disturbed under both Privatization proposals is greater than the TWRS EIS, the likelihood of impact to cultural resources would be greater. Visual impacts to Native American sacred sites (e.g., Gable Mountain, Gable Butte) would be greater under the two proposals than the TWRS EIS because the proposed structures and the total area to be disturbed would be larger. However, the increased disturbed area is not significant, and there would be a low probability of impacting archaeological sites.

4.7 SOCIOECONOMICS

The TWRS EIS analyzed the potential impacts to the socioeconomic environment associated with each of the alternatives in Volume One, Section 5.6. To support a comparison of the relative impacts of each alternative, the impact analysis focused on key indicators of the potentially impacted area including Hanford Site employment and the effects of Site employment levels on employment, population, taxable retail sales, and housing prices in the surrounding area. These impacts are addressed in more detail in Volume Five, Appendix H of the TWRS EIS. Based on the results of the socioeconomic modeling of the key indicators of socioeconomic impacts, analyses of potential impacts to public services and facilities (schools, police and fire protection, medical services, sanitary and solid waste disposal, and electricity, natural gas, and fuel oil) were completed. Socioeconomic impacts identified in the EIS were a direct function of the number of labor hours associated with each alternative. In other words, the more labor hours worked under each alternative the higher the level of impact on the key indicators of socioeconomic impacts.

To determine if new information developed since the completion of the TWRS EIS indicated changes in understanding of potential socioeconomic impacts, a review of new data was completed. Based on this review only one new data source was available that address potential impacts. The new data are the Hanford Site and Tri-Cities area employment for 1996 (Neitzel et al. 1997). In both cases employment levels were lower than those estimated in the EIS. For example, the EIS assumed the 1997 baseline employment at the Site would be 14,900 employees while the Site employment as of December 31, 1996, was approximately 13,400 (including enterprise company employment) or 1,500 employees fewer than estimated for 1997 in the TWRS EIS. The decline in Hanford Site and Tri-Cities area employment through June 1996 was documented in the TWRS EIS. As stated in the EIS, "because the same future baseline forecast was used to assess the impacts of all TWRS alternatives on the Tri-Cities total non-farm employment, population, taxable retail sales, and housing prices, the comparison of impacts among the TWRS alternatives would yield the same relative result" [if the baseline were to be based on lower employment figures for 1996 through 1997]. Currently there is no publicly available data that indicate a change in the employment estimates for the Phased Implementation alternative analyzed in the EIS. Because the overall Hanford Site employment and Tri-City area total employment are less than the estimates used in the EIS to calculate impacts, the absolute impacts of the Phased Implementation alternative would be less than those presented in the TWRS EIS.

Socioeconomic Impacts Synopsis of the Phase IB Privatization Environmental Reports
In the TWRS EIS, socioeconomic impacts were calculated to peak in 1999 based on a construction workforce of 3,300. All other impacts (e.g., area employment increase of 5,900 jobs, a housing price increase of 12.9 percent, and increases in demand for public services that would require additional police and fire personnel and school capacity) are a function of the size of the workforce employed under the alternative, the projected size of the Hanford Site workforce, and the size of the total nonfarm workforce in the Tri-Cities area. Individually, neither Privatization proposal would have peak construction employment greater than the TWRS EIS. The combined proposals would have total labor years that would exceed the total labor years in the TWRS EIS estimate by 5 percent. Therefore, when size of the construction workforce and duration of construction activities are considered, the two Privatization proposals would have impacts on the local economy that are similar to Phase I of the TWRS EIS.

The socioeconomic impacts during operations under Phase I of the TWRS EIS were based on an estimated total workforce of 580. The combined proposals would have total labor years that would exceed the total labor years in the TWRS EIS by 9 percent. Therefore, when the size of the operations workforce and duration of operation activities are considered, the two Privatization proposals would have impacts on the local economy that are similar to the estimate for Phase I of the TWRS EIS.

4.8 LAND USE

The TWRS EIS described the land-use impacts of the Phased Implementation alternative. Land-use impacts were addressed in terms of the compatibility of temporary and permanent land-use commitments under each alternative with past, present, and planned and potential future uses of the land and the surrounding area. Also addressed were potential conflicts with uses of land adjacent to the land that would be impacted under the alternative and unique land uses in proximity to the proposed TWRS sites, including the Hanford Reach of the Columbia River and the Fitzner Eberhardt Arid Land Ecology Reserve. Conflicts between the alternative and Federal, State, local, and Tribal Nation land-use policies, plans, and controls were described separately.

The EIS concluded that temporary and permanent proposed land-use commitments for the Phased Implementation alternative would be consistent with past and existing land uses for the 200 Areas, as well as with proposed use of the area as an exclusive-use WMA for Hanford Site waste disposal and environmental restoration programs. It also concluded that potential land-use commitments would not conflict with land uses in the area of the Hanford Site immediately surrounding the 200 Areas, recreational resources such as the Hanford Reach of the Columbia River, or the Fitzner Eberhardt Arid Land Ecology Reserve. Additionally, the EIS stated that temporary land-use commitments associated with use of potential borrow sites outside of the 200 Areas may conflict with future Site land-use plans. However, borrow sites identified in the EIS were used only to compare potential impacts associated with one closure scenario. According to the EIS, when a final closure plan is selected, borrow material needs may be much lower, and different onsite or offsite sources of borrow material may be selected to support closure activities. In August 1996, the Hanford Site published the Draft Hanford Remedial Action EIS and Comprehensive Land Use Plan (DOE 1996a), which addressed future Site uses, including the 200 Areas and the Central Plateau. The actions associated with implementing the EIS Phased Implementation alternative, as defined in the TWRS ROD, and actions associated with new data and information considered in this SA are consistent with the Draft Comprehensive Land Use Plan.

All major remediation activities associated with the Phased Implementation alternative would occur within the current boundaries of the 200 Areas. For more than 40 years, the 200 Areas have been used for industrial and waste management activities associated with the Hanford Site's past national defense mission and current waste management and environmental restoration cleanup mission. The 200 Areas consist of approximately 2,600 ha (6,400 ac). All proposed permanent land-use commitments identified in the TWRS EIS consisted of changes from existing waste management uses to waste disposal uses, which is consistent with the exclusive use for waste management designation for the Central Plateau including the 200 Areas.
The Phased Implementation alternative would result in temporary and permanent land-use commitments. Temporary land-use commitments would include currently undisturbed areas used for constructing and operating treatment facilities and construction activities associated with closure. Temporary land-use commitments would include facility footprints, parking lots, construction laydown areas, materials storage areas, facility assembly areas, new power line corridors, and areas used at the three potential borrow sites. Permanent land-use commitments would include areas that would be permanently committed to waste disposal. This would include the areas committed through the remedial phase of the alternatives, such as the tank farms and the LAW vaults associated with most of the ex situ alternatives. Permanent land-use commitments associated with the closure scenario would include the areas that would be covered

by the Hanford Barriers. The Phased Implementation alternative would require approximately 320 ha (790 ac) for temporary construction-related uses and 49 ha (120 ac) for permanent land uses.

To determine if new information developed since the completion of the TWRS EIS indicated changes in understanding of land-use impacts, a review of new data was completed. Based on this review only three new sources of data were available that address potential land-use impacts. These new data are the preconceptual design for the LAW vaults, the Conceptual Design Reports associated with construction of TWRS Privatization Phase IB facilities and associated infrastructure upgrades to provide the facilities with services (e.g., electrical) and to transfer waste to the plants and from the plants (LMHC 1997b), and the Master Site Plan for Phase IB of Privatization (WHC 1996d).

Based on a review of the LAW vaults preconceptual design and the Conceptual Design Reports the following data regarding land-use commitments were identified:

- Infrastructure projects (i.e., raw and potable water, liquid effluent transfer systems, and site development and roads) to support Privatization Phase IB facilities would disturb approximately 1 ha (2.5 ac).
- Electrical power system development would disturb approximately 1.9 ha (4.7 ac) for an electrical substation and a corridor 100 m (330 ft) wide by 11 km (7 mi) long.
- Site development (i.e., clearing and grading land to support Privatization Phase IB facility construction and operation) would disturb approximately 69 ha (171 ac).
- Existing grout vaults would be converted into low activity vaults (approximately 1 ha [2.5 ac]) and additional vaults would be constructed in the 200 East Area comprising an additional 36 ha (90 ac).

To address data gaps in land-use impact information required to complete a comparison of land-use impacts under the EIS Phased Implementation alternative and impacts under the Privatization Phase IB, calculations were prepared based on engineering judgement. Among the calculations required to address data gaps it was assumed that Privatization contractors would require borrow materials from an onsite pit, the borrow material would be from Pit 30, and each would require approximately one-half of the volume of borrow material estimated for the TWRS EIS Phased Implementation alternative. Additionally, it was assumed that areas between the grout vaults and the Phase IB Privatization facilities (4.7 ha [11.6 ac]) and between the two parcels allocated for Phase IB facilities would be unavailable for alternatives uses and hence would be temporarily allocated to waste remediation (1.9 ha [4.7 ac]).

Based on the data provided in the LAW vault preconceptual design and the Conceptual Design Reports and these assumptions, a comparison with data used to perform impact calculations in the TWRS EIS for the Phased Implementation alternative was completed. The results of the comparison are included in Table 4.8.1. Assuming DOE selects two contractors to provide Phase IB services, one to provide LAW and HLW services and the second providing only LAW services, with no changes in land use, the total land-use commitments for Phase IB activities would be 77 ha (190 ac) greater than impacts calculated in the EIS. The increase impacts under Privatization Phase IB and II compared the impacts under the total Phased Implementation alternative would result in an increase of 92 ha (230 ac) of land required to implement the alternative. Even with these increases, there is sufficient land in the space allocated for Phase IB activities to support the implementation of the alternative and the total amount of space required to implement the alternative represents an increase of from 12 percent of the 200 Areas to 16 percent of the 200 Areas for implementation of the alternative.

Table 4.8.1. Comparison of Changes in Land-Use Impacts

Activity[1]	Phased Implementation Alternative Estimate ha (ac)	Conceptual Design Report and Preconceptual LAW Design Estimate for Privatization Impacts ha (ac)
Phase 1		
Treatment Facilities	30 (74)	36 (90)
Construction	0	33 (82)
Infrastructure (electrical, roads, etc.)	2 (5)	39 (97)
LAW Vaults	0	1 (2.5)
Phase 2		
LAW Vaults	11 (27)	36 (90)
EIS Total Land-Use Estimate and the Revised Estimate[2]	320 (790)	412 (1,025)

Notes:

[1] Only includes components of the project where a change in land-use impacts has been identified.

[2] Potential increases in borrow material to support increased size of LAW vault earthen cover not calculated because LAW design is preconceptual. Total addresses impacts of Phase 1 and Phase 2.

Land Use Synopsis of the Phase IB Privatization Environmental Reports

Under the two Privatization proposals, there are no new land uses different from those analyzed in the TWRS EIS. All activities would be in areas designated for waste management and disposal under existing and planned Site land-use plans. However, the total area that would be dedicated to waste management and treatment under the two proposals would be approximately 55 percent greater than the total area estimated in the TWRS EIS.

4.9 VISUAL IMPACTS

The visual impacts from the Phased Implementation alternative would result from facilities associated with waste retrieval, processing, and storage. The Hanford landscape is characterized primarily by its broad plateau near the center of the Site. The visual setting provides sweeping vistas of the area broken up by more than a dozen large Hanford Site facilities (e.g., processing plants and nuclear reactors). The 200 Areas, where virtually all proposed facilities would be constructed, contain three large existing processing facilities as well as numerous multi-story support facilities. The facilities that would be constructed for the Phased Implementation alternative would be similar in size and appearance to the existing facilities. The primary visual impact would be from the approximately 46 m (150 ft) high stacks on each immobilization facility. The stacks occasionally would be visible from State Route 240, and under certain atmospheric conditions, plumes would be visible certain Site boundaries. No facilities would be visible from the Columbia River (DOE 1996g). There is no new information that would change the potential visual impacts from those described in the TWRS EIS.

Visual Resources Synopsis of the Phase IB Privatization Environmental Reports

In the TWRS EIS, visual impacts would primarily be from one stack on each vitrification facility. The stacks would be visible from State Route 240 and elevated locations that include sacred sites (e.g., Gable Mountain), and the plumes would be visible under some conditions from Site boundaries. Under the two Privatization proposals, visual impacts would be similar to those analyzed in the TWRS EIS because each proposal would result in one stack per facility during operations.

4.10 NOISE

Potential noise impacts would be minor. During both the construction and operation phases there would be some increase in noise levels onsite due to the operation of heavy equipment and offsite due to vehicular traffic along existing roadways. Construction noises would result from the operation of scrapers, loaders, bulldozers, graders, cranes, and trucks. Because of the remoteness and natural setting of the Site, noise impacts to resident wildlife species are of concern. Table 4.10.1 presents an analysis in which a scraper, bulldozer, and grader were assumed to operate at the same location to assess the upper limit of the impacts that are likely to occur. To place these noise levels in perspective, Table 4.10.1 also presents reference noise levels. The table shows there would be some short-term disturbance of noise-sensitive wildlife near the TWRS activities during construction. Construction noise levels would approach background levels at 600 m (2,000 ft). Noise levels during operations would be low and would result almost exclusively from traffic. There is no new information concerning potential noise impacts that substantively change the impacts presented in the TWRS EIS.

Table 4.10.1. Probable Bounding Case Cumulative Noise Impact During the Construction Phase (All Alternatives)

Equipment Type	Noise Level 15 m (dBA)	Cumulative Noise Level (dBA)		
		15 m (50 ft)	100 m (330 ft)	400 m (1,300 ft)
Scraper	88	90	74	62
Dozer	80			
Grader	85			

Notes:

dBA is decibels on the A scale, which adjusts noise levels to account for human hearing capabilities. These levels compare to a food blender (90 dBA), riding inside a car at 65 km/hr (40 mi/hr) (70 dBA), and normal speech (60 dBA).

Noise Synopsis of the Phase IB Privatization Proposals

In the TWRS EIS, noise impacts would primarily be from vehicular traffic along existing roadways and heavy equipment during the construction phase. Impacts would affect nearby animal populations resulting in displacement of wildlife within a maximum radius from the construction sites of approximately 800 m (2,600 ft) and workers in the immediate vicinity of the construction activities. Under the two Privatization proposals, noise impacts would be similar to those analyzed in the TWRS EIS. During operations, both proposals estimated that noise during operations would be within applicable regulatory standards for workplace conditions.

4.11 TRANSPORTATION

Impacts of the vehicular traffic associated with the traffic volume for each alternative was based on the number of people that would be commuting to and from work to support the TWRS activities including construction and operations. There are no new data for personnel requirements for any of the alternatives. However, baseline Hanford Site employment has declined to levels below those used in the TWRS EIS to calculate transportation impacts. Therefore, traffic impacts would remain unchanged or be somewhat less than those estimated in the TWRS EIS. The peak traffic flows would occur in the year 2010 and would result in extreme peak hour congestion (level of service F) on both Stevens Road at the 1100 Area and on Route 4 west of the Wye Barricade, which already experiences heavy congestion during morning and afternoon commuting. On Stevens Road the morning peak hour volume would be approximately 5,600 vehicles. On Route 4 the incremental TWRS traffic volume of 2,900 vehicles would produce peak hour traffic that would result in level of service F conditions. Congestion would begin to build in 2007 and would continue at high levels for several years after the 2010 peak.

4.12 ANTICIPATED HEALTH EFFECTS

Carcinogenic and noncarcinogenic adverse health effects on humans from exposure to radioactive and chemical contaminants associated with each of the following categories of risk were evaluated for the Phased Implementation alternative in the TWRS EIS.

- Remediation risk resulting from routine remediation activities, such as retrieving waste from tanks and waste treatment operations
- Post remediation risk, such as the risk resulting from residual contamination remaining after the completion of remediation activities
- Post remediation risk resulting from human intrusion directly into the residual tank waste remaining after remediation.

4.12.1 Remediation Risk

Radiological and chemical risks from routine emissions during remediation activities for the Phased Implementation alternative were evaluated for Hanford Site workers involved in remediation activities, Hanford Site workers not involved in remediation activities (noninvolved workers), the general public, and a MEI from each of the three population groups.

The radiological risk from exposure to radionuclides were expressed in terms of LCFs. The nonradiological risk from exposure to noncarcinogenic chemicals were measured against a hazard index (HI). The HI is defined as the summation of the hazard quotients (calculated dose divided by the reference dose [RfD]) for each chemical and for each route of exposure. The nonradiological risk from exposure to carcinogenic chemicals were expressed in terms of incremental lifetime cancer risk (ILCR).

The radiological and chemical risk was based on the air emissions and direct exposure from construction, continued operations (including tank farm and evaporator operations), retrieval, separations and treatment, storage and disposal, onsite transportation of waste, transportation of vitrified HLW, monitoring and maintenance, and closure and monitoring.

The new information that would change potential radiological and chemical risks analyzed in the TWRS EIS results from the revised inventory discussed in Sections 3.2.1. Scaling factors were developed and presented in Section 4.4 that would have a direct proportional change in the routine emissions and consequently the radiological and chemical risk.

New information includes converting the interim LAW storage in the modified grout vaults into a permanent disposal facility. Because the vitrified LAW that would remain disposed in the grout vaults would not be double handled (would not be transferred from interim storage to a disposal vault), exposure to the involved workers potentially would be reduced. However, the exposure from handling vitrified LAW is so low that there would be no appreciable health impacts from the grout vault mission change.

Radiological Risk

The radiological risk to the involved worker would result from occupational exposure to radiation. The historical dose to a Hanford Site tank farm worker has been 14 millirem (mrem)/year. This same dose was assumed for radiation workers during construction in radiation zones, tank farm operations, monitoring, maintenance, and closure activities. A dose of 200 mrem/year (the average zone worker exposure at Plutonium-Uranium Extraction Plant during 1986) was assumed for personnel operating evaporators, retrieval facilities, and pretreatment and vitrification facilities. The MEI worker dose was based on a Hanford Site administrative control level of 500 mrem/year.

The worker population LCF risk is dependent on the number of people in the population and the anticipated dose each individual would receive. Currently there is no new information that would change the number of workers or the anticipated dose they would receive. The worker LCF risk would remain unchanged at 6.0E-03 for the MEI worker and 3.27E+00 for the worker population.

The potential exposure to the noninvolved worker was based on inhaling respirable radiological contaminants, which would be released to the atmosphere (at ground level or through an elevated stack) from remediation activities during each year of operation. The noninvolved worker population was assumed to occupy the area from the Hanford Site boundary to within 100 m (330 ft) of the point of release. The MEI was assumed to be within 100 m (330 ft) from the point of release.

The general public would potentially receive an exposure from air emissions released to the environment during remediation activities and transported offsite by atmospheric dispersion during each year of operation. Routes of exposure would be from inhaling gaseous and particulate emissions and ingesting vegetables, meats, and milk products contaminated by airborne plumes. The general public population was assumed to occupy the area extending to an 80 km (50 mi) radius from the release point centered in the 200 Areas. The MEI was assumed to live on the Hanford Site boundary and raise and consume all of their own food.

A detailed description of the atmospheric transport parameters used to calculate the radiological dose for the noninvolved worker and general public is contained in the TWRS EIS. Currently there are no new data that would change the atmospheric transport parameters. The revised inventory data would increase the dose from the radiological emissions and consequently the radiological risk by 5 percent (Jacobs 1997). Increasing the radiological risk calculated in the TWRS EIS by 5 percent would result in LCF risks shown in Table 4.12.1.

Table 4.12.1. Risk from Radiological Emissions During Routine Operations

Receptor	Routine Operations Risk	
	TWRS EIS LCF Risk	Revised LCF Risk
MEI involved worker	6.0E-03	Unchanged
MEI noninvolved worker	9.6E-07	1.0E-06
MEI general public	2.4E-06	2.6E-06
Involved worker population	3.3E+00	Unchanged
Noninvolved worker population	9.0E-04	9.5E-04
General public population	1.9E-01	2.0E-01

Notes:
MEI = Maximally exposed individual
LCF = Latent cancer fatality

The vitrified HLW would be shipped to a geologic repository assumed to be located 2,100 km (1,300 mi) offsite by a dedicated train of 10 railcars per train. The revised inventory data would not have an appreciable change on the direct exposure received by the onsite and offsite population. There is new information presented in Section 3.2.2.4 that shows the number of containers of vitrified HLW would increase by 19 percent (from 12,200 to 14,500 canisters). This corresponds to an increase in trips to the repository and consequently an increase in risk of 19 percent to persons living along the transportation route. Increasing the radiological risk calculated in the TWRS EIS by 19 percent would result in the LCF risk shown in Table 4.12.2.

Table 4.12.2. Vitrified HLW Transportation Risk

Receptor	Vitrified HLW Transportation Risk	
	TWRS EIS LCF Risk	Revised LCF Risk
Onsite population	3.1E-04	3.6E-04
Offsite population	3.2E-03	3.8E-03

Notes:

LCF = Latent cancer fatality

The radiological risk to the involved worker population and MEI worker risk remained unchanged from the risks calculated in the TWRS EIS. For the non-involved worker and the general public the risk from routine air emissions exposure and from HLW shipments to a geologic repository increased by 5 and 19 percent, respectively. However, for the non-involved worker and general public population there were no LCFs calculated in the TWRS EIS, and despite the increased risk based on the revised inventory there are no LCFs calculated in the SA. In both cases there was no appreciable change in the overall risk to workers or the public.

Nonradiological Chemical Risk

The chemical hazard evaluation in the TWRS EIS estimated inhalation intakes for identified chemical emissions and evaluated potential ILCR and noncarcinogenic health hazards using chemical-specific cancer slope factors and RfDs, respectively. The revised inventory data would not have an appreciable change on the health impacts from chemical exposures from those calculated in the TWRS EIS because there were only small decreases in the chemical inventory. The chemical health risk would remain unchanged as presented in Table 4.12.3.

Table 4.12.3. TWRS EIS Risk from Chemical Emissions

Receptor	TWRS EIS	
	Chemical Hazard	Chemical ILCR
MEI involved worker	3.1E-01	2.5E-06
MEI noninvolved worker	1.3E-01	1.1E-06
MEI general public	7.5E-05	6.3E-10

Notes:

MEI = Maximally exposed individual
ILCR = Incremental lifetime cancer risk

Anticipated Health Effects Synopsis of the Phase IB Privatization Proposals

Occupational radiation exposures are routine exposures received from working in proximity to radioactive sources. Exposures are closely monitored, and the radiation dose a worker may receive is limited by law and Hanford Site and contractor administrative controls. The total number of potential latent cancer fatalities estimated in the TWRS EIS (excluding tank farm operations) would be 0.3. This was based on 3,300 person-years and 2.00E-01 rem/person-year. The 2.00E-01 rem/person-year was the average whole body deep exposure to operational personnel at the Plutonium-Uranium Extraction (PUREX) Plant during 1986. The latent cancer fatalities were based on a dose-to-risk conversion factor of 4.0E-04 latent cancer fatalities/rem. The two proposals would each require fewer radiation workers than the TWRS EIS and would result in lower exposure rates; therefore, there would be fewer latent cancer fatalities for each proposal. The combined proposals would have a larger number of radiation workers, but the combined proposals would have 40 percent fewer latent cancer fatalities than presented in the TWRS EIS because of the lower exposure rate. There would be no offsite health affects resulting from routine operation from either the TWRS EIS alternative or either of the proposals or the combined proposals.

4.12.2 Long-Term Anticipated Health Effects

The TWRS EIS analyzed anticipated health effects to potential future Hanford Site users from potential liquid losses during retrieval, residual waste that may be left in the tanks, and immobilized waste disposed of onsite in LAW vaults. The methodology used in calculating the long-term health effects for the SA is based on the methodology used in the TWRS EIS. The only new information concerning potential long-term health risks is the revised tank waste inventory. The groundwater concentration files from the TWRS EIS were scaled using the revised tank waste inventory data (i.e., revised inventory). Contaminant-specific scaling factors were developed for the retrieval leakage, residual waste, and LAW vault sources depending on the fate of the contaminants during the waste retrieval and immobilization processes. For example, increases in I-129 would be expected to result in increased air emissions, retrieval losses, and residual inventory but would not be expected to affect risks from waste in the LAW vaults.

The concentration points from the groundwater modeling calculated for each constituent of concern for the TWRS EIS Phased Implementation alternative were used for calculating the health effects for the SA. These concentrations are multiplied by the ratio of the revised inventory (Section 3.0) to the TWRS EIS inventory to generate the concentration grids for the SA. Table 4.12.4 presents the scaling factors used to calculate contaminant concentration in the groundwater.

The post-remediation contamination sources for this analysis consists of tanks residuals, leakage during retrieval, and immobilized waste in LAW vaults. This analysis assumes that changes in the long-term health effects are due to inventory changes between the TWRS EIS inventory and the revised inventory. The new information that includes converting the interim LAW storage in the modified grout vaults into a permanent disposal facility would have no appreciable long-term health impacts.

Table 4.12.4. Source-Term Scaling Factors for the Long-Term Health Effects

Constituents	Unit	TWRS EIS Inventory	Revised Inventory	Scaling Factor for Retrieval and Residuals	Scaling Factor for LAW Vaults
Bi	kg	2.6E+05	5.8E+05	2.20	-
Ca	kg	1.5E+05	2.1E+05	1.43	-
Ce	kg	2.4E+05	8.8E+03	0.04	-
Cl	kg	3.1E+05	5.0E+05	1.59	-
Cr	kg	1.2E+05	7.9E+05	6.54	-
Fe	kg	7.8E+05	1.2E+06	1.58	-
Hg	kg	9.6E+05	2.1E+03	2.19	-
Ni	kg	1.9E+05	1.1E+05	0.59	-
NO_2/NO_3	kg	1.2E+08	8.6E+07	0.73	-
SO_4	kg	2.1E+06	5.0E+06	2.45	-
U	kg	1.4E+06	9.7E+05	36.13	0.69
W	kg	1.5E+04	1.6E+04	1.06	-
C-14	Ci	5.3E+03	4.8E+03	0.90	-
Ni-63	Ci	2.7E+05	8.8E+04	0.33	-
Se-79	Ci	9.1E+02	7.7E+02	0.85	-
Tc-99	Ci	3.2E+04	3.3E+04	1.02	1.02
Ru-106	Ci	3.8E-02	1.7E+03	44,500	-
I-129	Ci	3.8E+01	6.3E+01	1.64	-
Np-237	Ci	7.0E+01	1.4E+02	2.02	2.02
Pa-231	Ci	3.8E-02	1.6E+02	4,100	4,100
U-233	Ci	1.2E-02	4.8E+02	39,338	39,338
U-234	Ci	2.1E-01	3.5E+02	1,632	1.632
U-235	Ci	2.7E+01	1.5E+01	0.70	0.70
U-236	Ci	2.9E-03	9.6E+00	3323	3323
U-238	Ci	4.8E+02	3.2E+02	0.67	0.67

Transport of contaminants from source locations through the vadose zone and groundwater is assumed to be the same as described in the TWRS EIS. Section 4.3 discusses the potential affect of the emerging data on groundwater modeling performed for the EIS. Groundwater modeling estimated that contaminants released from tanks would not reach groundwater during the first 500 years from these two sources. During the later time periods of interest (i.e., 2,500, 5,000, and 10,000 years from the present) modeling estimated that contaminants with K_d of 0 released from tanks would be present in the groundwater beneath the Hanford Site. The contaminants with a K_d of 0 released from the LAW vaults would be present in the groundwater beneath the Hanford Site during the later two time periods of interest (5,000 and 10,000 years).

Total cancer risk and hazard indices were calculated for the receptors as addressed in the TWRS EIS (i.e., Native American, Residential Farmer, Industrial Worker, and Recreational Shoreline User). The Unit Risk Factor (URF) for these receptors are the same as those presented in the TWRS EIS.

The calculated total cancer risk and hazard indices for bounding and nominal cases for all receptors at years up to 5,000 and 10,000 years from present are presented in Table 4.12.5. The cancer risk and hazard indices from TWRS EIS are also presented in the same table for comparison purposes. For the bounding and nominal case the cancer risk and hazard indices for the periods of 2,500, 5,000, and 10,000 years from the present time are very similar. In general, the cancer risk and hazard indices are slightly lower in the SA than in the TWRS EIS. The slight decrease in total risk is due to reduced inventory of some constituents such as Se-79, Ni-63, and U-238. The increase in Tc-99, Np-237, and other uranium isotopes (U-233, U-234, and U-236) inventories is offset by the decrease in the others. Uranium-233, U-234, and U-236 do not have a large impact on the risk values and remain as minor contributors to long-term health risks.

Table 4.12.5. Long-Term Anticipated Health Effects Comparison for the TWRS EIS Phased Implementation Alternative and Supplement Analysis

Risk/ Hazard	Year	Receptors	Bounding		Nominal	
			TWRS EIS	Supplement Analysis	TWRS EIS	Supplement Analysis
Risk	2,500	Native American	1.2E-04	1.1E-04	2.6E-05	1.1E-05
		Residential Farmer	9.6E-06	8.9E-06	1.9E-06	1.6E-06
		Industrial Worker	3.0E-06	3.1E-06	7.2E-08	6.6E-08
		Recreational User	2.7E-07	3.0E-08	1.1E-08	1.4E-09
	5,000	Native American	4.3E-03	3.7E-03	7.1E-04	3.3E-04
		Residential Farmer	3.4E-04	2.9E-04	2.0E-05	3.2E-05
		Industrial Worker	1.0E-04	1.0E-04	2.6E-06	5.6E-06
		Recreational User	9.6E-06	2.2E-06	2.6E-07	2.4E-07
	10,000	Native American	6.9E-04	2.7E-04	6.2E-04	5.2E-04
		Residential Farmer	6.8E-05	2.1E-05	40E-05	4.8E-05
		Industrial Worker	7.4E-06	6.2E-06	6.2E-06	1.2E-05
		Recreational User	7.8E-07	2.3E-07	6.0E-07	4.4E-07
Hazard Index	2,500	Native American	7.2E-01	6.6E-01	6.0E-01	4.4E-01
		Residential Farmer	1.2E-01	1.2E-01	1.1E-01	8.1E-02
		Industrial Worker	1.1E-04	1.0E-04	9.1E-05	6.6E-05
		Recreational User	1.6E-05	2.4E-06	1.2E-05	1.2E-06
	5,000	Native American	3.4E+03	1.1E+02	3.4E+03	2.5E+01
		Residential Farmer	6.1E+02	2.1E+01	6.1E+02	4.6E+00
		Industrial Worker	6.5E-01	1.7E-02	6.5E-01	3.8E-03
		Recreational User	8.9E-02	2.9E-04	8.9E-02	8.1E-05
	10,000	Native American	7.7E-03	4.8E-03	5.7E-03	7.9E-04
		Residential Farmer	1.6E-03	8.9E-04	2.2E-03	2.4E-04
		Industrial Worker	3.7E-04	2.5E-04	4.7E-04	1.8E-04
		Recreational User	4.9E-05	1.4E-05	6.3E-05	7.9E-06

The portion of the risk values presented in Table 4.12.5 from the immobilized LAW is calculated based on cullet as the immobilized waste form. In this SA and in the TWRS EIS, the immobilized LAW was assumed to be quenched into glass cullets and placed into containers, and the containers of cullet would be placed into onsite near-surface vaults for retrievable disposal. Use of monolithic pours into the disposal containers would reduce the surface area to volume ratio and slow the contaminant release rate. This lower release rate would result in lower contaminant concentrations in the groundwater and lower risks after 5,000 years from the present when the immobilized LAW vaults were the major contributors to risk.

Long-Term Environmental Impact Synopsis of the Phase IB Privatization Environmental Reports

The proposals do not include disposal of either LAW or HLW, which DOE would dispose of. The following discussion provides a general assessment of the potential long-term impacts (i.e., of disposal) if each of the proposals were implemented through Phase I and II.

Both proposals would generate stabilized LAW to be disposed of onsite by DOE in LAW vaults. The total volume of LAW to be disposed of onsite would be less than or similar to the volume estimated for the TWRS EIS. The waste forms for each of the proposals would be at least of comparable quality to that of the glass used for analysis in the TWRS EIS and meet or exceed the leachability requirements of the contracts. The leachability requirements of the contracts for the LAW were designed to ensure that all groundwater protection standards would be met.

The TWRS EIS bounding analysis showed very small contributions of contaminants to the groundwater from the LAW vaults. All releases would meet groundwater standards and result in long-term heath risks of two orders of magnitude less than the releases of tank residuals (the one percent of the waste assumed to remain in the tanks following retrieval). The maximum long-term risk from the vaults calculated for the LAW in the TWRS EIS was approximately 3 in 1 million for an onsite residential farmer. The two proposals would result in risks of less than 3 in 1 million. With the information available, the two proposals would result in similar long-term risks from the LAW vaults, and these risks would be very small.

Under both proposals, the HLW would be a borosilicate glass. Both proposals would produce the same amount of glass for disposal by DOE. The TWRS EIS analysis showed that less than one latent cancer fatality from routine exposures and potential transportation accidents to workers and the public would result from transporting all HLW to a geologic repository. Both proposals would result in the same impacts from the disposal of HLW, and they would be the same as those presented in the TWRS EIS--less than one latent cancer fatality.

4.12.3 Intruder Scenario

The intruder scenario is calculated using total inventories from the TWRS EIS and revised inventory. The same methodology used to calculate intruder risk was used for the TWRS EIS and SA tank residual waste. This methodology differs slightly from the methodology used in the TWRS EIS to conserve computational resources while providing comparable results.

Table 4.12.6 presents the calculated risk for the post-driller scenario for each constituents and their percentage of the contribution to the total risk. The LCF of 8.2E-05 for TWRS EIS increases to 1.6E-04 for the SA by a factor of two. The major contributors to the total risk for the TWRS EIS are Tc-99 (77 percent), Np-237 (7 percent), U-238 (6 percent), and C-14 (5 percent). The major contributors to the total risk for the SA are Pa-231 (44 percent), Tc-99 (39 percent), Np-237 (7 percent), and U-233, U-238, and C-14 (2 percent each).

Table 4.12.6. The Intruder Risk

Constituents	TWRS EIS		Supplement Analysis	
	Risk	Percent	Risk	Percent
C-14	3.8E-06	4.7	3.5E-06	2.1
Ni-63	3.0E-06	3.7	9.9E-07	0.6
Se-79	1.2E-07	0.1	1.0E-07	0
Tc-99	6.3E-05	77.1	6.4E-05	39.2
Ru-106	1.5E-39	0	6.5E-35	0
I-129	2.9E-07	0.3	4.8E-07	0.3
Np-237	5.8E-06	7.1	1.2E-05	7.2
Pa-231	1.8E-08	0	7.2E-05	44.0
U-233	1.1E-01	0	4.2E-06	2.6
U-234	1.6E-09	0	2.6E-06	1.6
U-235	6.5E-07	0.8	4.6E-07	0.3
U-236	2.0E-11	0	6.7E-08	0
U-238	5.2E-06	6.3	3.5E-06	2.1
Total	8.2E-05		1.6E-04	

4.13 ACCIDENTS

The analysis included nonradiological/nontoxicological occupational and transportation risks and risks from radiological and toxicological accidents resulting from current tank farm operations and construction and operations of pretreatment, treatment, and storage and disposal facilities that would support Phased Implementation

New information includes converting the interim LAW storage in the modified grout vaults into a permanent disposal facility. The change in the grout vault mission would have no appreciable change in the health impacts resulting from accidents. The number of construction and operation workers required for the change would remain approximately the same. There would be no introduction of radiological or chemical accidents that would exceed the bounding accidents evaluated in the TWRS EIS.

Nonradiological Nontoxicological Occupational Risk

Nonradiological and nontoxicological occupational risks included injuries, illnesses, and fatalities from construction and operation accidents common to the workplace such as falls, cuts, and operator-machine impacts. The risk associated with an accident was defined as the product of the probability of an accident occurring and the consequence of the accident. Occupational types of accidents would largely be a function of the number of person-years of labor required to complete the total activities.

There are currently no new data that would change the labor requirements to support construction and operations from those used in the TWRS EIS. Therefore, the risk from construction and operations would remain the same as presented in the TWRS EIS follows:

- Construction total recordable cases of injuries and illnesses = 4,200
- Construction lost workdays from injuries and illnesses = 1,100
- Fatalities during construction = 1.4
- Operations total recordable cases of injuries and illnesses = 1,900
- Operations lost workdays from injuries and illnesses = 940
- Fatalities during operations = 2.7.

Nonradiological Nontoxicological Transportation Risks

Nonradiological and nontoxicological transportation accidents analyzed in the TWRS EIS included transportation of materials by truck and rail and transportation of employees to and from work. The risk from material transport would largely be a function of the amount of construction and operating materials transported to the Hanford Site by truck and rail and the amount of vitrified HLW transported from the Hanford Site to a geologic repository. The repository was assumed to be located 2,100 km (1,300 mi) offsite, and the vitrified HLW would be transported by a dedicated train of 10 railcars per train. The risk from employees driving to and from work would be a function of the number of employees. Each employee was assumed to work 260 days of the year and drive 140 km (87 mi) round trip with 1.4 passengers per vehicle.

There is currently no new information concerning the labor requirements to support construction and operations for the Phased Implementation alternative; therefore, the risk from employee traffic accidents would remain the same at 2,500 injuries and 3.1 fatalities.

There is currently no new information concerning the amount of materials to be transported to the Hanford Site to support the Phased Implementation alternative; therefore, the risk would remain at 11 injuries and 0.54 fatalities. New information presented in Section 3.2.2.4 shows that the number of containers of vitrified HLW would increase by 19 percent (from 12,200 to 14,500 canisters). This corresponds to a 19 percent increase in trips to the repository; therefore, the transportation risk from transporting vitrified waste to the repository would increase from 4.0 injuries and 2.1 fatalities to 4.8 injuries and 2.5 fatalities. In both cases the increased risk results in increase in injuries and fatalities of less than 1, thus, the increases are not substantially different than those calculated in the TWRS EIS.

Radiological And Toxicological Accidents

The potential exists for accidents to result in radiological and toxicological exposures during routine operations and retrieval of tank waste, the vitrification operations of tank waste, and the transportation of vitrified HLW to a geological repository. The risk associated with a potential radiological release is expressed as the probability or the number of LCF given the occurrence and consequences of an operation or transportation accident. The risk associated with a potential chemical release is determined by comparing the chemical concentrations that a MEI would be exposed to with the American Industrial Hygiene Agency Emergency Response Planning Guidelines (ERPGs). ERPGs are maximum airborne concentrations below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing the following effects.

- ERPG-1 - Mild transient adverse health effects or perceiving a clearly defined objectionable odor.
- ERPG-2 - Irreversible or other serious health effects, or symptoms that could impair ability to take protective action.
- ERPG-3 - Irreversible or life-threatening health effects could result from exposures exceeding one hour.

The revised inventory for the tank waste is discussed in Section 3.2.1 and will have a direct proportional change in the risk from transportation accident.

Bounding and nominal consequences from accidents were evaluated in the TWRS EIS to provide a risk range. The bounding and nominal consequences were based on a bounding inventory and a nominal inventory. The bounding inventory was based on the development of a 100 percent inventory composite. This could be thought of as a single tank containing the highest activity concentration for each nuclide found in historical tank contents estimates and prior individual tank analyses. This maximum sample activity composite grouping means the highest radioactivity concentration for each radionuclide is combined to define a hypothetical "highest concentration" inventory used to bound the accidents. For the bounding consequences evaluated in the TWRS EIS the 90 percentile of the "highest concentration" inventory was assumed. The nominal consequences were based on a less conservative approach. Total radionuclide inventories were calculated based on the complete operating history of all of the Hanford Site production reactors. Reduction factors were then applied to the total inventories to account for plutonium and uranium extracted from the waste sent to the tanks. Reduction factors also were applied to cesium and strontium, which also were extracted from the waste. The bounding and nominal inventories used to calculate accidents evaluated in the TWRS EIS were compared to the revised inventory. The revised inventory is bounded by the highest concentration composite inventory used in the TWRS EIS. However, the revised inventory exceeds the nominal inventory used in the TWRS EIS by 18 percent.

Operational Radiological and Toxicological Accidents

Each phase of the various operations associated with Phased Implementation alternative was assessed for potential accidents. From the spectrum of accidents identified in a hazards analysis, dominant accident scenarios were selected for further analysis in the TWRS EIS to determine the LCF risk and chemical risk. The radiological and chemical accidents evaluated in the TWRS EIS are summarized as follows:

- The continued operations (tank waste transfers) accident analyzed in the TWRS EIS was a spray release scenario in which a jumper was mispositioned and pin hole leaks developed at both ends of the jumper resulting in a pressurized spray release of tank waste when the cover block was not covering the jumper pit. The LCF risk and chemical risk given the occurrence of the accident (probability of 3.0E-01), as evaluated in the TWRS EIS is summarized in Table 4.13.1. For comparison the LCF risk and chemical risk based on the revised inventory are also included in Table 4.13.1.

Table 4.13.1. LCF Risk and Chemical Risk from Tank Waste Transfer Accident - Spray Release From Jumper Pit

Receptor	TWRS EIS				Revised Inventory	
	Nominal Scenario		Bounding Scenario			
	LCF Risk	Chemical Risk	LCF Risk	Chemical Risk	LCF Risk	Chemical Risk
MEI involved worker	4.7E-02	ERPG-3	1.0E+00	Lethal rad. dose	5.5E-02	ERPG-3
MEI noninvolved worker	7.7E-03	ERPG-1	1.0E+00	ERPG-2	9.1E-03	ERPG-1
MEI general public	4.2E-05	<ERPG-1	9.6E-04	<ERPG-1	5.0E-05	<ERPG-1
Involved worker population	4.7E-01	ERPG-3	1.0E+01	Lethal rad. dose	5.5E-01	ERPG-3
Noninvolved worker population	2.9E-01	ERPG-3	6.6E+00	ERPG-2	3.4E-01	ERPG-3
General public population	8.9E-02	<ERPG-1	2.0E+00	<ERPG-1	1.1E-01	<ERPG-1

Notes:

ERPG = Emergency Response Planning Guidelines
LCF = Latent cancer fatality
MEI = Maximally exposed individual

- The continued operations (waste storage tanks) accident analyzed in the TWRS EIS was a hydrogen deflagration scenario that could occur from the ignition of hydrogen gas generated in the tank resulting in HEPA filter failure and an unfiltered radiological release to the atmosphere. The LCF risk and chemical risk, given the occurrence of the accident (probability of 2.2E-01), as evaluated in the TWRS EIS is summarized in Table 4.13.2. For comparison the LCF risk and chemical risk based on the revised inventory are also included in Table 4.13.2.

Table 4.13.2. LCF Risk and Chemical Risk from Hydrogen Deflagration in Waste Storage Tanks

Receptor	TWRS EIS				Revised Inventory	
	Nominal Scenario		Bounding Scenario			
	LCF Risk	Chemical Risk	LCF Risk	Chemical Risk	LCF Risk	Chemical Risk
MEI involved worker	3.1E-02	ERPG-3	1.0E+00	Lethal rad. dose	3.7E-02	ERPG-3
MEI noninvolved worker	3.8E-03	ERPG-3	1.0E+00	ERPG-3	4.5E-03	ERPG-3
MEI general public	1.1E-05	<ERPG-1	2.1E-03	<ERPG-1	1.3E-05	<ERPG-1
Involved worker population	3.1E-01	ERPG-3	1.0E+01	Lethal rad. dose	3.7E-01	ERPG-3
Noninvolved worker population	5.3E-02	ERPG-1	9.9E+00	ERPG-3	6.3E-02	ERPG-1
General public population	1.0E-02	<ERPG-1	1.9E+00	<ERPG-1	1.2E-02	<ERPG-1

Notes:

ERPG = Emergency Response Planning Guidelines
LCF = Latent cancer fatality
MEI = Maximally exposed individual

- The retrieval accident analyzed in the TWRS EIS was a ventilation heater failure that could occur due to an electrical fault resulting in humid air plugging the HEPA filter and filter blow out. . The LCF risk and chemical risk given the occurrence of the accident (probability of 2.7E-04) is summarized in Table 4.13.3. For comparison the LCF risk and chemical risk based on the revised inventory are also included in Table 4.13.3.

Table 4.13.3. LCF Risk and Chemical Risk from Loss of HEPA Filter During Retrieval

Receptor	TWRS EIS				Revised Inventory	
	Nominal Scenario		Bounding Scenario			
	LCF Risk	Chemical Risk	LCF Risk	Chemical Risk	LCF Risk	Chemical Risk
MEI involved worker	3.9E-02	ERPG-2	1.0E+00	Lethal rad. dose	4.6E-02	ERPG-2
MEI noninvolved worker	1.3E-04	ERPG-3	1.7E-02	ERPG 3	1.5E-04	ERPG-3
MEI general public	6.9E-07	<ERPG-1	4.6E-05	<ERPG-1	8.1E-07	<ERPG-1
Involved worker population	3.9E-01	ERPG-2	1.0E+01	Lethal rad. dose	4.6E-01	ERPG-2
Noninvolved worker population	5.5E-03	ERPG-1	3.7E-01	ERPG-2	6.5E-03	ERPG-1
General public population	1.0E-03	<ERPG-1	6.9E-02	<ERPG-1	1.2E-03	<ERPG-1

Notes:

ERPG = Emergency Response Planning Guidelines
HEPA = High-efficiency particulate air
LCF = Latent cancer fatality
MEI = Maximally exposed individual

- The pretreatment accident analyzed in the TWRS EIS was a line break that could occur within a ventilated vault because of an earthquake, resulting in a pressurized spray release. The LCF risk and chemical risk given the occurrence of the accident (probability of 2.0E-02) is summarized in Table 4.13.4. For comparison the LCF risk and chemical risk based on the revised inventory are also included in Table 4.13.4.

Table 4.13.4. LCF Risk and Chemical Risk from Line Break During Pretreatment

Receptor	TWRS EIS				Revised Inventory	
	Nominal Scenario		Bounding Scenario			
	LCF Risk	Chemical Risk	LCF Risk	Chemical Risk	LCF Risk	Chemical Risk
MEI involved worker	7.4E-04	<ERPG-1	2.8E-03	<ERPG-1	8.7E-04	<ERPG-1
MEI noninvolved worker	1.1E-05	<ERPG-1	4.2E-05	<ERPG-1	1.3E-05	<ERPG-1
MEI general public	6.0E-08	<ERPG-1	2.3E-07	<ERPG-1	7.1E-08	<ERPG-1
Involved worker population	7.4E-03	<ERPG-1	2.8E-02	<ERPG-1	8.7E-03	<ERPG-1
Noninvolved worker population	4.1E-04	<ERPG-1	1.6E-03	<ERPG-1	4.8E-04	<ERPG-1
General public population	1.3E-04	<ERPG-1	4.8E-04	<ERPG-1	1.5E-04	<ERPG-1

Notes:

ERPG = Emergency Response Planning Guidelines
LCF = Latent cancer fatality
MEI = Maximally exposed individual

- The treatment accident analyzed in the TWRS EIS was a canister of vitrified HLW dropped because of mechanical failure or human error in the HLW vitrification facility. The LCF risk and chemical risk given the occurrence of the accident (probability of 1.0E+00) is summarized in Table 4.13.5. For comparison the LCF risk and chemical risk based on the revised inventory are also included in Table 4.13.5.

Table 4.13.5. LCF Risk and Chemical Risk from Dropped Canister of Vitrified HLW

Receptor	TWRS EIS				Revised Inventory	
	Nominal Scenario		Bounding Scenario			
	LCF Risk	Chemical Risk	LCF Risk	Chemical Risk	LCF Risk	Chemical Risk
MEI involved worker	1.8E-11	<ERPG-1	1.1E-08	<ERPG-1	2.1E-11	<ERPG-1
MEI noninvolved worker	2.7E-13	<ERPG-1	1.6E-10	<ERPG-1	3.2E-13	<ERPG-1
MEI general public	5.0E-16	<ERPG-1	3.0E-13	<ERPG-1	5.9E-16	<ERPG-1
Involved worker population	1.8E-10	<ERPG-1	1.1E-07	<ERPG-1	2.1E-10	<ERPG-1
Noninvolved worker population	1.0E-11	<ERPG-1	6.1E-09	<ERPG-1	1.2E-11	<ERPG-1
General public population	1.1E-12	<ERPG-1	6.7E-10	<ERPG-1	1.3E-12	<ERPG-1

Notes:

ERPG = Emergency Response Planning Guidelines
HLW = High-level waste
LCF = Latent cancer fatality
MEI = Maximally exposed individual

- The beyond-design-basis accident analyzed in the TWRS EIS was a tank dome collapse resulting from a beyond-design-basis earthquake. The LCF risk and chemical risk, given the occurrence of the accident (probability of 4.3E-03) as evaluated in the TWRS EIS is summarized in Table 4.13.6. For comparison the LCF risk and chemical risk based on the revised inventory are also included in Table 4.13.6.

Table 4.13.6. LCF Risk and Chemical Risk from Beyond-Design-Basis-Earthquake Scenario

Receptor	TWRS EIS				Revised Inventory	
	Nominal Scenario		Bounding Scenario			
	LCF Risk	Chemical Risk	LCF Risk	Chemical Risk	LCF Risk	Chemical Risk
MEI involved worker	9.7E-02	ERPG-3	1.0E+00	Lethal rad. dose	1.1E-01	ERPG-3
MEI noninvolved worker	2.3E-02	ERPG-3	1.0E+00	ERPG-3	2.7E-02	ERPG-3
MEI general public	3.5E-05	<ERPG-1	2.4E-03	ERPG-2	4.1E-05	<ERPG-1
Involved worker population	9.7E-01	ERPG-3	1.0E+01	Lethal rad. dose	1.1E+00	ERPG-3
Noninvolved worker population	1.6E-01	ERPG-3	1.1E+01	ERPG-3	1.9E-01	ERPG-3
General public population	3.1E-02	<ERPG-1	2.1E+00	<ERPG-1	3.7E-02	<ERPG-1

Notes:
ERPG = Emergency Response Planning Guidelines
LCF = Latent cancer fatality
MEI = Maximally exposed individual

K Basins Inventory

Accidents associated with the bounding K Basins inventory after it has been treated (if the K Basins inventory were put into one tank) would result in estimated consequences approximately two to four times more severe than the accidents evaluated in the TWRS EIS assuming that all other parameters (such as the amount of material released) are the same. This is due to the high concentration of Am-241, Pu-239, and Pu-240 in the K Basin sludge. However, the K Basins inventory would involve only one tank and consist of less waste to transfer through the transfer lines and treat as compared to the rest of the tank farm. Therefore, the probability of the accident would decrease proportionately by at least one order-of-magnitude. The point estimate risk (consequences x probability of the accident) for K Basins tank inventory accidents would not exceed the point estimate risk of accidents evaluated in the TWRS EIS.

TWRS BIO

Since the release of the TWRS EIS, new information on potential radiological accidents during routine operations of the tank farm waste has been made available. The new information is contained in the TWRS BIO, which establishes operational and institutional measures to mitigate risks associated with the TWRS program. The three bounding accidents analyzed in the TWRS

EIS were also analyzed in the TWRS BIO (spray release from valve pit, flammable gas deflagration in waste storage tank, and a seismic event). A comparison of the dose consequences for these accidents as analyzed in the two documents is presented in Table 4.13.7. The accident parameters are compared in detail in Tables B.1, B.2, and B.3 of Appendix B. The analysis in the TWRS EIS was carried out to show the radiological LCF risk to the MEI involved worker, MEI noninvolved worker, and MEI general public receptors as well as the population for each receptor. It also included a probabilistic evaluation in which the probabilities of the postulated accidents were quantified. In contrast the analysis in the TWRS BIO analyzed accidents resulting in radiological doses and chemical hazards to an MEI onsite (noninvolved worker) receptor and an MEI offsite (general public) receptor. The analysis was not carried out to include a calculation of the LCF risk from the postulated accidents, and the annual frequency of the accidents was not quantified but addressed qualitatively as frequency categories. Therefore only the dose consequences and chemical hazard to the MEI noninvolved worker and MEI general public in the TWRS EIS are listed in Table 4.13.7 for comparison with the TWRS BIO.

One of the important differences between the TWRS EIS and the TWRS BIO is the purpose in which the two documents serve. The consequences presented in the TWRS BIO result from the worst-case scenarios based on extreme parameters. The worst-case scenarios are used to determine the hazard classification and the safety classification. Consistent with NEPA guidance, the TWRS EIS and this SA evaluate reasonably foreseeable accidents, not worst-case accidents. Although the EIS accident analysis and the BIO have differences in their purposes and it should not be expected that they would produce the same results, the information on the BIO is presented 1) because the BIO represents new information; 2) to confirm that the EIS addressed the appropriate accidents; and 3) to allow a comparison of the results of the EIS and BIO.

Table 4.13.7. TWRS EIS Bounding Accidents Compared to TWRS BIO

Receptor	TWRS EIS		TWRS BIO	
	Radiological Consequences (CEDE)	Chemical Consequences	Radiological Consequences (CEDE)	Chemical Consequences
Spray Release From Valve Pit Scenario				
MEI Onsite	4.4E+02	ERPG-2	1.5E+04	ERPG-1
MEI Offsite	1.9E+00	ERPG-1	2.1E+01	<ERPG-1
Flammable Gas Deflagration in Waste Storage Tank Scenario				
MEI Onsite	1.8E+03	ERPG-3	6.5E+02	ERPG-1
MEI Offsite	4.3E+00	<ERPG-1	5.7E-01	<ERPG-1
Seismic Event				
MEI Onsite	1.9E+03	ERPG-3	1.6E+04	ERPG-1
MEI Offsite	4.7E+00	ERPG-2	2.2E+01	<ERPG-1

Notes:
CEDE = Committed effective dose equivalent

The spray release from a valve pit scenario analyzed in the TWRS BIO resulted in a higher dose than was analyzed for the same scenario in the TWRS EIS. The higher dose in the TWRS BIO is attributed to higher (worst case) volume of tank waste released in the spray and worst-case inventories representing a higher unit liter dose based on 33 percent solids and 67 percent liquids from the Aging Waste Facility compared to 30 percent solids and 70 percent liquids from the SSTs used in the TWRS EIS. Toxicological consequences in the TWRS BIO were frequency dependent, which resulted in lower ERPG levels. The MEI onsite would be ERPG-1 and the MEI offsite would be less than ERPG-1 in the TWRS EIS if the ERPGs were adjusted for frequency dependency.

The flammable gas deflagration in a waste storage tank scenario analyzed in the TWRS EIS resulted in a higher dose than was analyzed for the same scenario in the TWRS BIO. The higher dose analyzed in the TWRS EIS is attributed to a higher unit liter dose based on DST solids compared to SST solids used in the TWRS BIO analysis. Toxicological consequences in the TWRS BIO were frequency dependent, which resulted in lower ERPG levels. The MEI onsite would be ERPG-2 and the MEI offsite would be less than ERPG-1 in the TWRS EIS if the ERPGs were adjusted for frequency dependency.

The TWRS BIO did not analyze a beyond-design-basis earthquake, but because the risk of the design-basis-earthquake in the TWRS BIO was greater than the beyond-design-basis earthquake analyzed in the TWRS EIS, it is included in this report for comparison. The higher doses analyzed in the TWRS BIO are attributed to higher volumes of tank waste released from a breached pipe, jumper, or valve during a waste transfer when the lines are under pressure. Since the power is not lost as a result of the earthquake, the spray leak is assumed to continue unabated for 24 hours. The beyond-design-basis earthquake analyzed in the TWRS EIS assumed loss of power due to the magnitude of the earthquake. Toxicological consequences in the TWRS BIO were frequency dependent, which resulted in lower ERPG levels. The MEI onsite would be ERPG-2 and the MEI offsite would be ERPG-1 in the TWRS EIS if the ERPGs were adjusted for frequency dependency.

Transportation Radiological and Toxicological Accidents

The radiological risk from accidents while transporting residual SST waste and MUST waste to the processing facilities for vitrification was analyzed in the TWRS EIS. The revised inventory was compared against constituents of concern in the inventory used to calculate transportation accident dose consequences in the TWRS EIS. A scaling factor of 1.15 for constituents of concern for HLW was developed for estimating radiological risk based on the revised inventory data (Jacobs 1997). The LCF risk calculated in the TWRS EIS for the MEI worker and MEI general public was 7.2E-04 and 3.8E-06, respectively. Based on the revised inventory the LCF risk would increase by 15 percent resulting in a LCF risk of 8.3E-04 and 4.4E-06, respectively.

The radiological risk from accidents while transporting vitrified HLW by rail to a geological repository was analyzed in the TWRS EIS. The LCF risk calculated in the TWRS EIS for the integrated population and urban population was 3.1E-05 and 8.5E-07, respectively. Based on the revised inventory the consequences would increase by three percent, and the probability of the accident (resulting from the increased number of trips) would increase by 19 percent. This would result in an increased LCF risk to the integrated population and urban population of 3.8E-05 and 1.0E-06, respectively.

The chemical risk from accidents while transporting chemicals to the Hanford Site to support the pretreatment and vitrification processes was analyzed in the TWRS EIS. The MEI onsite or MEI offsite (the accident could occur onsite or offsite) chemical risk would be ERPG-3 given the probability of occurrence of the accident. There is currently no new information that would change the chemical risk.

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Occupational Accidents - Occupational accidents cause injuries or fatalities to project workers from events such as falls from ladders or twisted ankles that occur at rates that can be statistically estimated. The number and severity of accidents depend on the type of activity and the number of labor hours spent performing the activities. Construction activities have the highest accident rates. The number of occupational fatalities calculated to occur for the TWRS EIS alternative (not including tank farm operations) would be less than one and the two proposals individually and combined would result in less than one fatality. The potential fatalities from tank farm operations are excluded from the Phased Implementation alternative to provide a direct comparison with the proposals because neither proposal would involve management of tank farm operations by the contractors.

Operational Accidents - The bounding operational accident during pretreatment/treatment for the two proposals would be a tank waste spray release. The latent cancer fatality point estimate risk evaluated in the TWRS EIS would be as much as 180 times greater than the spray release accident evaluated in either of the proposals.

4.14 REGULATORY COMPLIANCE

In the TWRS EIS, DOE described Federal and Washington State regulations potentially applicable to TWRS EIS alternatives, regulatory issues affecting the ability to implement the alternatives, and the ability of the alternatives to enable DOE to comply with applicable regulations. To determine if new information developed since the completion of the TWRS EIS indicated changes in understanding of the ability to implement the alternatives, a review of new data was completed. This review included assessing the changes in impacts discussed elsewhere in Section 4.0 of this document and new information regarding Federal and Washington State regulations and regulatory issues affecting the ability to implement the alternatives. Based on this review it was determined that none of the changes in impacts discussed elsewhere in Section 4.0 change the conclusions reached in the EIS regarding the ability of the TWRS EIS alternatives to comply with applicable Federal and State regulations. However, subsequent to publication of the TWRS EIS, four regulatory developments have occurred that 1) affect how regulations are applied to the Privatization strategy for implementation of the Phased

Implementation alternative; 2) diminish regulatory uncertainty associated with the immobilized LAW; and 3) increase regulatory uncertainty associated with application of hazardous waste regulations to tank waste.

Changes in Safety Regulatory Oversight

In response to the Policy for Radiological, Nuclear, and Process Safety Regulation of TWRS Contractors signed by the Under Secretary of Energy on July 3, 1996, a new organization was established within DOE-RL to provide a regulatory environment that would permit the demonstration phase (defined as Phase I) of TWRS Privatization activities to occur on a timely, predictable, and stable basis. The new organization is known as the Office of Radiological, Nuclear, and Process Safety Regulation for TWRS Privatization contractors, or the Regulatory Unit, and was created on September 19, 1996. It is DOE's policy that TWRS privatized contractor activities be regulated in a manner that ensures adequate radiological, nuclear, and process safety by applying regulatory concepts and principles consistent with those of the NRC. Implementing the new regulatory approach does not change the regulations applicable to the Phased Implementation alternative identified in the TWRS EIS. It does, however, provide a change in regulatory authority from that which is described in the TWRS EIS.

On January 29, 1997, the NRC and DOE entered into a Memorandum of Understanding (MOU) to establish the basis for cooperation and mutual support during Phase I activities (MOU 1997). DOE's regulatory program is structured to facilitate, pending the legislative changes necessary to permit such an activity, the possible transition of regulatory responsibilities from DOE to the NRC at the start of the full-scale operations phase (defined as Phase II). During Phase II DOE is responsible for implementing the TWRS Privatization regulatory program. The MOU does not apply to the Phase II activities.

For its regulation of the Privatization contractors, DOE will rely substantially on its nuclear safety rules (10 CFR 830, 10 CFR 834, and 10 CFR 835) and on the application of fundamental principles of radiological, nuclear, and process safety. The Regulatory Unit will draw heavily upon the concepts and principles established from the experiences of the commercial nuclear community, including the reactor sector, and the chemical industry.

While the formal incorporation of process safety into DOE's safety regulatory program enhances the importance of process safety within DOE's responsibility for ensuring adequate safety, it in no way replaces the authority of the Occupational Safety and Health Administration (OSHA) for process safety regulation nor relieves the contractor from the obligation to conform with OSHA regulations. The Regulatory Unit will formally and fully regulate radiological and nuclear safety but will only provide regulatory oversight with regard to process safety the scope of which is specified in 29 CFR Part 1910; the Regulatory Unit will not be responsible for enforcement actions associated with process safety violations. OSHA will be responsible for all enforcement actions with regard to process safety.

Contractually, the contractor must follow a DOE-specified, structured process to identify the set of subordinate standards and requirements that, when properly implemented, will provide adequate safety, comply with legal requirements, and conform to the stipulated top-level safety standards and principles. Consistent with meeting legal requirements, the contractor will have significant responsibility and flexibility for identifying its standards and requirements within the context of 1) the contractor's specific technology and processes; 2) the work to be performed; 3) the character and magnitude of the radiological, nuclear, and chemical hazards involved; and 4) the selected means of mitigating the hazards.

Development of DOE Order 435.1 to Replace DOE Order 5820.2A

In the TWRS EIS it was noted that DOE was in the process of streamlining its system of regulating waste management, treatment, and disposal. This effort includes revision of DOE Orders. Among the DOE Orders being revised is DOE Order 5820.2A, which provides the framework for DOE management and disposal of HLW, LLW and TRU waste, decontamination and decommissioning of facilities, and closure of radioactive waste sites. Subsequent to publication of the TWRS EIS, DOE issued draft DOE Order 435.1, which when finalized will replace DOE Order 5820.2A, the DOE Order used in the regulatory compliance analysis presented in the TWRS EIS. Most issues associated with the regulatory analysis presented in the EIS would be unaffected by the new Order. Specifically, the draft Order requires compliance with applicable Federal, State, and local laws and regulations (e.g., Clean Water Act, Clean Air Act, RCRA, State Dangerous Waste Regulations, and applicable Executive Orders and other DOE Directives (e.g., DOE Orders 5400.1 and 5400.5).

Because these applicable laws, regulations, Executive Orders, and DOE Directives were the basis of the EIS analysis of the ability of the EIS alternatives to comply with regulatory requirements, the draft Order does not change the analysis in the EIS. Additionally, the draft Order does not change DOE's policy regarding the disposal of HLW, TRU, or LLW. However, it specifically addresses disposal of incidental waste. The draft Order's discussion of incidental waste disposal is consistent with the discussion in the TWRS EIS. The new Order does contain one area of potential impact on the TWRS program associated with potential revision in the development of Performance Assessments and the requirement for DOE facilities to perform Composite Analysis. In both cases the potential changes do not impact the EIS analysis but may affect the design of disposal facilities (i.e., LAW vaults) and closure of the tank farms, an issue outside of the scope of the EIS and this SA.

Reduction of Regulatory Uncertainty Associated with Classification of the Immobilized LAW Waste Stream

The TWRS EIS addressed regulatory uncertainties associated with classifying the immobilized LAW waste stream that could impact storage and disposal of the immobilized LAW waste stream from all alternatives involving a separations and treatment process that produced a LAW and a HLW waste stream. In the discussion DOE indicated that current planning assumptions, based on previous consultation with the NRC, were that the immobilized LAW waste stream would not be classified as HLW and could then be disposed of onsite in near surface disposal facilities. For purposes of analysis in the TWRS EIS it was assumed that the immobilized LAW waste stream would be incidental waste and be able to be disposed of onsite in near surface facilities. If the NRC did not concur, and classified the waste as HLW there would have been substantive regulatory barriers to implementing several of the EIS alternatives, including the Phased Implementation alternative.

In November 1996, DOE submitted a request to the NRC to address the classification of the Hanford immobilized LAW fraction (DOE 1996d). DOE's request was based on data provided in two reports; the Technical Basis for Classification of the Low-Activity Waste Fraction From Hanford Site Tanks (WHC 1996c) and the Hanford Low-Level Tank Waste Interim Performance Assessment (WHC 1996a). This DOE request addressed the three changes in management strategy that occurred subsequent to the NRC acceptance of the previous strategy defined at 58 FR 12344.

In June 1997, the NRC responded to the DOE request in a letter that addresses the immobilized LAW fraction from the treatment facility (NRC 1997) . The NRC informed DOE that:

- "Low-Activity Waste (LAW) meets the incidental waste classification criteria specified in the March 2, 1993 letter from R. Bernero, NRC to J. Lytle, U.S. Department of Energy."
- "The staff's preliminary finding is a provisional agreement that the LAW portion of the Hanford tank waste planned for removal from the tanks and disposed onsite is incidental waste and is, therefore, not subject to NRC licensing authority."
- "Approximately 8.5 MCi of activity will remain in the LAW fraction, which corresponds to about 2% of the estimated 422 MCi generated at the Hanford Site (base on a December 31, 1999, decay date)." Early discussions of the criteria for incidental wastes were based, in part, on percentage removal (e.g., if 90 percent were removed, the remaining fraction might be incidental waste) and, as this statement reflects, percentage removal is still a secondary consideration.
- "The DOE [Performance Assessment] was performed to the requirements of DOE Order 5820.2A, "Radioactive Waste Management," September 26, 1988. This Order is similar to the 10 CFR Part 61 performance objectives."

The determination by the NRC regarding classification of the immobilized LAW diminishes one substantial area of regulatory uncertainty. This issue remains one that DOE will need to continue to address because the NRC indicated that it would need to review the final LAW Performance Assessment and other data regarding implementation of the waste treatment and disposal system before making a final determination regarding classification of the immobilized LAW.
Also, DOE is revising DOE Order 5820.2A, and it is uncertain if the requirements of the new order will also mirror 10 CFR Part 61 performance objectives.

Hanford Sitewide Polychlorinated Biphenyls Management Strategy
In September 1997, DOE established a working group to develop an integrated Sitewide management strategy for PCBs and related Toxic Substance Control Act contaminants (Wagoner 1997). The working group was formed in response to the discovery of PCBs at a number of locations throughout the Hanford Site, including K Basins sludges. The goal of the working group is to develop a Sitewide management strategy that could include a compliance agreement with EPA. For the TWRS program this issue of Toxic Substance Control Act poses new regulatory uncertainties. If Toxic Substance Control Act waste is determined to be present in tank waste, TWRS facilities for waste management and treatment could be subject to regulation under Toxic Substance Control Act, adding additional requirements for waste management and treatment beyond those imposed under RCRA.

4.15 RELATIONSHIP BETWEEN SHORT-TERM USES OF THE ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

In the TWRS EIS, short-term was considered to be the construction and operation phases (scheduled to be completed by 2028) and the monitoring and maintenance phase that would continue throughout the 100-year institutional control period. Most short-term environmental impacts would occur during the construction and operations phases of each alternative. In the EIS, long-term referred to the period after the end of the 100-year institutional control period. The TWRS EIS presented the analysis of the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity.

The EIS concluded that for the Phased Implementation alternative, there would be increased air emissions and noise, solid and liquid waste generation, and increased risk of accidents and illness, primarily to workers involved with implementing the alternatives compared to not performing remedial action. Implementing the alternative would consume both natural and human-made resources (e.g., fuels, concrete, steel, and chemicals), but none of the alternatives would be expected to cause shortages or price increases as a result of their resource consumption. Over the short-term, land areas would be committed that would affect biological resources. With respect to effluents, emissions, and land requirements, not performing remediation would have few short-term natural environment impacts because there would be low levels of activity during both construction and operation.

In terms of the human environment, the Phased Implementation alternative would increase expenditure of Federal funds in the Tri-Cities resulting in increased employment and economic activity associated with these expenditures compared to not performing remedial action. The Phased Implementation alternative would have short-term impacts on the human environment because it would cause short-term fluctuations in employment, population, and associated impacts on public services.

The long-term impacts on the natural environment of the Phased Implementation alternative are due in large part to how much waste remained on the Hanford Site after the alternatives were fully implemented, and how much of the remaining waste had been immobilized or left untreated. Future decisions on the ultimate closure of the tank farms that were beyond the scope of the EIS would have an effect on long-term impact issues. The long-term impacts of the alternative also must be considered in the context of decisions to be made concerning other contamination in the 200 Areas that is unrelated to the waste tanks or capsules, such as from the large 200 Areas processing facilities. Regardless of which alternative were implemented, the vicinity of the tank farms and proposed tank waste treatment facilities still would be contaminated. This would affect long-term health risks and future land uses of the 200 Areas, which would be the primary areas of long-term impacts.

Not remediating tank waste would result in long-term health risk impacts because contaminants would be released from the tanks into the groundwater at levels that would exceed drinking water standards and pose substantial health risks to future Site users compared to remediating the tank waste. Future users of the Hanford Site lands (Native Americans, residential farmers, workers, or recreational users) would experience increased health risks over a time period extending thousands of years into the future. Finally, not remediating tank waste would pose risks to down river users of the Columbia River while the Phased Implementation alternative would not pose similar risks.

Based on a review of the new data presented previously in Section 4.0 of this SA there were marginal increases in short-term impacts to air quality, human health risks, and habitat disturbance. Air impacts remained below regulatory standards and the habitat impacts represent a small percentage of the total shrub-steppe habitat in the Central Plateau. Additionally, while the long-term health impacts increased under the Phased Implementation alternative, due to changes in the tank waste inventory (i.e, revised inventory), similarly proposed increases in health affects would occur if the waste were not remediated and the Phased Implementation alternative would still result in a substantial decrease in long-term risk to human health and the environment.

4.16 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The Phased Implementation alternative would involve the irreversible and irretrievable commitment of land, energy, materials, and financial resources. Table 4.16.1 presents a summary of resource commitments.

Resource Requirements Synopsis of the Phase IB Privatization Environmental Reports

In the TWRS EIS, Phase I of the Phased Implementation alternative includes resource requirements for constructing one LAW vitrification facility and one LAW and HLW combined vitrification facility. A comparison of the construction resource requirements was made by comparing facility footprints and facility types. Currently both Privatization proposals included facility footprints that are larger than the 12,000 square meter (129,000 square foot) facility footprint estimated in the TWRS EIS. If both contractors are authorized to proceed with

Table 4.16.1. Irreversible and Irretrievable Commitment of Resources - Phased Implementation

Component	TWRS EIS	New Data	Revised Calculation
Land permanently committed (hectares)	4.9E+01	LAW vaults will require 36 ha (89 ac) (up from 11 ha [27 ac]).[1]	7.4E+01
Sand/gravel/silt/rip rap (cubic meters)	4.1E+06	New data include earthen materials required to construct a surface barrier over the increased immobilized LAW vaults.	1.02E+07
Steel (metric tons)	3.0E+05	No change.	3.0E+05
Stainless and alloy steel (metric tons)	3.8E+04	No change.	3.8E+04
Concrete (cubic meters)	1.1E+06	No change.	1.1E+06
Total water usage (cubic meters)	1.9E+07	No change.	1.9E+07
Electric power (GWh)	1.1E+04	No change.	1.1E+04
Gasoline (cubic meters)	1.1E+04	No change.	1.1E+04
Diesel (cubic meters)	1.1E+05	No change.	1.1E+05
Kerosene (cubic meters)	6.5E+04	No change.	6.5E+04
Process chemicals (metric tons)	9.8E+05	No change.	9.8E+05

Notes:

[1] LMHC 1997b

facilities as currently proposed the total facilities would be approximately three times the size of the TWRS EIS facility. Based on facility footprints and data provided by the vendors, the construction resource requirements are expected to be proportionately greater than those identified for the TWRS EIS Phase I alternative.

A comparison of the operating resource requirements was made by comparing the amount of waste treated in the TWRS EIS to the amount of waste processed under each of the Privatization proposals. The combined amount of process chemicals and glass formers required to treat the waste that would be produced under the two proposals would exceed the 180,000 metric tons required in the TWRS EIS by approximately three times. Both proposals would use electricity as the energy source for high-level vitrification and low-activity immobilization. This results in higher electrical usage than the 1,700 gigawatt hours estimated for the TWRS EIS, which assumed kerosene as the energy source for LAW immobilization. Electrical demand for the two proposals combined would be approximately two times greater than the demand estimated for the TWRS EIS. However, the combined energy usage of the two contractors would be within available resources.

4.17 POLLUTION PREVENTION

Consistent with overall national policy (e.g., the Pollution Prevention Act of 1990) and specific DOE guidance (DOE Order 5400.1), Hanford Site programs are directed to incorporate pollution prevention into their planning and implementation activities. This includes reducing the quantity and toxicity of hazardous, radioactive, mixed, and sanitary waste generated at the Hanford Site;

incorporating waste recycle and reuse into program planning and implementation; and conserving resources and energy. There are currently no new data that would change the pollution prevention planning and prevention activities presented in the TWRS EIS.

4.18 ENVIRONMENTAL JUSTICE

For each of the areas of technical analysis presented in the TWRS EIS a review of impacts to the human and natural environment was conducted to determine if any potentially disproportionate and adverse impacts on minority populations or low-income populations would occur.
The review included potential impacts on land use, socioeconomics (e.g., employment, housing prices, public facilities, and services), water quality, air quality, health effects, accidents, and biological and cultural resources. For each of the areas of analysis, impacts were reviewed to determine if there were any potential disproportionate and adverse impacts to the surrounding population that would occur due to construction, routine operations, or accident conditions. If an adverse impact was identified, a determination was made as to whether minority populations or low-income populations would be disproportionately affected.

For the purposes of the TWRS EIS, disproportionate impacts were defined as impacts that would affect minority and Native American populations or low-income populations at levels appreciably greater than their effects on nonminority populations or non-low-income populations. Adverse impacts were defined as negative changes to the existing conditions in the natural environment (e.g., land, air, water, wildlife, vegetation) or in the human environment (e.g., employment, health, land use).

During consultation with affected Tribal Nations on the TWRS EIS, representatives of the Yakama Indian Nation and the Confederated Tribes of the Umatilla Indian Reservation expressed the view that impacts associated with all of the alternatives may adversely impact the cultural values of affected Tribal Nations to the extent that they involve disturbance or destruction of ecological and biological resources, alter land forms, or pose a noise or visual impact to sacred sites. The level of impact to cultural values associated with natural resources would be proportional to the amount of land disturbed under each alternative.

The TWRS EIS identified two areas of potentially disproportionate and adverse impacts on minority and Native American populations or low-income populations. These impacts include 1) potential increases in housing prices that could adversely impact access to affordable housing by low-income populations; and 2) continued restrictions on access to portions of the 200 Areas that could restrict access to the 200 Areas by all individuals. Access restrictions also would apply to the Confederated Tribes and Bands of the Yakama Indian Nation and the Confederated Tribes of the Umatilla Indian Reservation. The Tribes have expressed an interest in access to and unrestricted use of the Hanford Site.

A review of new data and impacts analysis presented in Section 4.0 of this SA was conducted to determine if any potentially disproportionate and adverse impacts on minority populations or low-income populations would occur. In one area of concern to affected Tribal Nations there were increases in impacts. For the Phased Implementation alternative the amount of land that would be disturbed and the amount of shrub-steppe habitat that would be disturbed by construction and operation of the treatment facilities, based on the new data available since completion of the TWRS EIS, would increase by approximately 20 percent (33 ha [82 ac]). The increase in impacts compared to the impacts under the Phased Implementation alternative in the TWRS EIS represents less than a 1 percent impact on the remaining shrub steppe and shrub-steppe habitat on the Central Plateau.

4.19 MITIGATION MEASURES

In the TWRS EIS measures to mitigate potential impacts of the Phased Implementation alternative were addressed for 1) measures to prevent or mitigate environmental impacts; and 2) additional measures that could further reduce or mitigate potential environmental impacts described previously in other portions of the TWRS EIS if deemed necessary. The EIS focused on measures to mitigate potential impacts during remediation and indicated that future NEPA documentation would specifically address in detail impacts and mitigation of post-remediation tank closure where, for example, most of the impacts of borrow site activities would occur.

To determine if new information developed since the completion of the TWRS EIS resulted in changes in potential impacts of the Phased Implementation alternative and hence potential changes in mitigative measures, a review of new data and of impact analysis presented in Section 4.0 of this SA was conducted. This was completed to determine if any changes in impacts requiring changes in the mitigative measures identified in the TWRS EIS would occur.

The review of the impact analysis based on new information identified three potential changes in impacts that would potentially require development of new mitigative measures. Impacts for soil, water, air, biological and ecological resources, cultural resources, socioeconomics, land use, and long-term human health were within the bounds established in the EIS or the changes in impacts were not substantively different than the impacts presented in the EIS. Changes in impacts that could potentially require mitigation include changes in the inventory of the LAW resulting from the revised inventory and changes in the K Basins sludge inventory and siting of Phase 1 facilities. New potential mitigative measures were also identified for traffic during construction.

One implication of the revised inventory that may require mitigation is the increased inventory of some long-lived radionuclides in the immobilized LAW that will be disposed of onsite in vaults. In the TWRS EIS, the immobilized LAW was assumed to be quenched into glass cullets and placed into containers and the containers of cullet would be placed into onsite near-surface vaults for retrievable disposal. The LAW vaults, when filled, would be covered with an earthen barrier to minimize infiltration of water. However, over a long period of time the barrier would lose its effectiveness and water would enter the vaults, and eventually the vaults and containers would lose their effectiveness in preventing water from interacting with the cullet. Slowly, water interacting with the cullet would begin a process of leaching of contaminants into the soils beneath the vaults where they would eventually migrate to groundwater. To mitigate this effect, in light of higher inventories of some long-lived radionuclides in the immobilized LAW, a monolithic pour could be used instead of a cullet. Use of a monolithic pour into 1.2 m · 1.2 m · 1.8 m (4 ft · 4 ft · 6 ft) containers would result in reducing the surface area to volume ratio by a factor of 136 from 600 m^{-1} under ideal conditions (i.e., no cracking) to 4.4 m^{-1} resulting in less surface area exposed to infiltrating water, slowing the leaching process (Jacobs 1997). By slowing the leaching process, releases from the immobilized LAW would occur at a latter time and over a longer period of time resulting in lower concentrations of contaminants in the groundwater. An additional benefit of the monolithic pour waste form is that it would require fewer canisters and thus fewer vaults. This would mitigate the increase in space allocated for LAW vaults in the new data (27 ha [67 ac]) compared to the space allocated in the TWRS EIS (11 ha [27 ac]).

For developing tank farm accidents in the TWRS EIS, a 100 percent inventory composite was developed. This could be thought of as a single tank containing the highest activity concentration for each nuclide found in historical tank contents estimates and prior individual tank analyses. This maximum sample activity composite grouping means the highest radioactivity concentration for each radionuclide is combined to define a hypothetical "highest concentration" inventory, which provides a safety envelope used to bound the accidents. The TWRS BIO and TWRS FSAR (the TWRS FSAR is in preparation) safety analyses use a similar methodology for their safety envelope that bounds their accidents. If the contents of an existing tank were removed and replaced with new waste (e.g., K Basin sludge, other Hanford Site cleanup waste) or mixed with these other new wastes, the tank inventory could potentially exceed the hypothetical inventory used to bound the accidents. An evaluation of the waste prior to being added to the tank farm inventory would determine if the waste could exceed the safety envelope. If the waste would exceed the safety envelope the waste could be conditioned before it is put in a single tank or mixed with waste in other tanks with compatible waste mitigating the potential to exceed the safety envelope. Additionally, the safety envelope could be reevaluated and revised to allow storage of the new waste in the tank farms.

Subsequent to the publication of the Final TWRS EIS, DOE published a series of draft documents on biological resource management of the Hanford Site (DOE 1996b, c, f). These documents provide programmatic guidance and a strategy for managing biological and ecological resources for the Site. In the TWRS EIS discussion of mitigative measures, DOE indicated that DOE was in the process of developing these documents and that when published they would provide a framework for the development of the TWRS Mitigation Action Plan so that TWRS mitigation of biological and ecological impacts would be performed "in compliance with the Sitewide biological management plan."

The calculation of impacts in the EIS was based on a representative location for process facilities. The representative location was chosen from three similar locations that were considered in a preliminary site selection process. The preliminary site selection process was discussed in the TWRS EIS. A preliminary site evaluation report was prepared for TWRS facilities in 1995 (WHC 1995a) and a Privatization Phase 1 site evaluation was completed in December 1995 and modified in early 1996 (WHC 1996k). Subsequent to publication of the Final TWRS EIS, DOE awarded Privatization Phase IA contracts to two companies and in the contract awards identified to sites for the location of Phase 1 treatment plants to be used in developing conceptual designs during Phase IA. These sites corresponded to the site evaluated in the TWRS EIS as the representative site for Phased Implementation Phase I facilities (DOE 1996g).

Based on identification of the Privatization Phase 1 sites and the Conceptual Design Reports for development of Privatization Phase 1 sites discussed in Section 4.5, specific information is available regarding impacts to biological and ecological resources. Following siting to minimize or avoid impacts to shrub-steppe habitat, the development for Privatization Phase 1 will result in unavoidable disturbance to approximately 33 ha (82 ac) of previously undisturbed shrub-steppe habitat. DOE developed a TWRS EIS Mitigation Action Plan to address replacement or compensation for the unavoidable impacts as required under the Sitewide plan for management of biological and ecological resources. Development of the Mitigation Action Plan involved consulting with natural resource agencies and Tribal Nations. Approval of the Mitigation Action Plan is scheduled to occur concurrent with this SA and to precede the May 1998 authorization to proceed with Phase IB activities.

Based on pre-conceptual designs for LAW vaults the amount of land committed to LAW vaults would increase from the 11 ha (27 ac) to 36 ha (90 ac). This increase in land commitment could be mitigated by constructing fewer and larger vaults. This would lessen the amount of land by decreasing space required between a larger number of vaults.

In the TWRS EIS potential mitigative measures were identified for the increase in traffic associated with construction of Phase IB facilities. This traffic will result in lessening the quality of service on key public roads and result in accidents and fatalities for employees commuting to and from the 200 Areas each day. While the overall impact of the construction traffic has been somewhat lessened by lower than expected levels of total Hanford Site employment, the traffic remains an adverse impact that may require mitigation. The EIS indicated a number of potential mitigative measures to reduce the volume or timing of traffic or to modify key roads leading to the 200 Area to address this impact. Since the completion of the EIS, conceptual designs have been completed for Phase 1 facilities. These designs indicate that traffic to and from the plants will be routed along existing roads that will be modified or extended to accommodate construction and operations needs of the facilities. To address this potential area of concern for traffic, DOE will conduct a traffic study in FY 1999 to determine if planned road modifications will adequately mitigate construction cycle impacts. Should additional measures be required, options include modification to traffic patterns using lights, limiting traffic on segments of roads to traffic associated with the construction of one or the other of the facilities, use of remote parking lots and shuttle bus service during construction, and widening Route 4 by adding a rush hour lane.

4.20 CUMULATIVE IMPACTS

The TWRS EIS described potential cumulative impacts associated with implementing the TWRS alternatives and other actions at the Hanford Site in Volume One, Section 5.13 of the TWRS EIS. The TWRS impacts addressed in the cumulative impacts analysis included the impacts of both remediation of the tank waste and subsequent closure of the tank farms. The TWRS EIS identified other actions that could impact the Hanford Site and, when possible, provided a quantitative discussion, where possible, of the potential cumulative impacts of the TWRS alternatives and the other actions. The NEPA implementing regulations define a cumulative impact as the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes other such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR Part 1508.7).

The TWRS EIS analysis demonstrated that the post-remediation risk of the TWRS alternatives would be strongly influenced by the type and form of waste remaining in the tanks or on the Hanford Site following remediation, the amount of time and labor that would be needed to accomplish the alternative, and the environmental disturbance that would take place during the work, including permanent disturbance or long-term resource commitment. These factors were comprehensively analyzed and discussed throughout Volume One, Section 5.0 of the EIS for each resource for each of the TWRS alternatives. For purposes of discussing the potential cumulative impacts, the TWRS alternative having the highest potential cumulative impacts were drawn from the comprehensive discussion and presented in combination with the other past, present, and reasonably foreseeable sources of impact. Thus the upper bound of the reasonably foreseeable potential cumulative impacts was presented.

Actions at the Hanford Site that would have quantifiable environmental impacts that would be cumulative with TWRS actions include the Hanford Site waste management and remedial action programs, the Environmental Restoration and Disposal Facility, the management of spent nuclear fuel stored in the K Basins, the US Ecology Site, and the replacement cross-site transfer system. While these activities would occur in the same general time frame as the EIS alternatives, little quantifiable cumulative impacts of the TWRS alternatives and other projects would be expected. Among the cumulative impacts that would occur would be impacts to land use and biological resources, human health, air quality, groundwater quality, and socioeconomics. For each of these impacts the TWRS EIS presented information regarding the potential cumulative impacts of the TWRS EIS alternatives and these other actions. Table 4.20.1 summarizes the actions that pose potential cumulative impacts with TWRS EIS alternatives and the impacts that may be cumulative.

Table 4.20.1. Cumulative Impacts of Other Projects and TWRS Alternatives

	Impact Category				
Project	Land Use and Habitat	Health Risks	Air Quality	Groundwater Quality	Socioeconomics
Hanford Remedial Action	Yes	Yes	Yes	Yes	Yes
Environmental Restoration and Disposal Facility	Yes	Yes	Yes	No	Yes
K Basin	Yes	No	No	No	Yes
Safe Interim Storage of Tank Waste	Yes	No	No	No	No
Waste Management Program	Yes	Yes	Yes	Yes	Yes

Notes:
No = Impact not cumulative with TWRS alternatives.
Yes = Potential cumulative impact with TWRS alternatives.

To determine if new information developed since the completion of the TWRS EIS indicated changes in understanding of potential cumulative impacts, a review of new data was completed. This review included reviewing new data regarding the impacts associated with the TWRS EIS alternatives, as discussed in previous sections of this SA, and information regarding other Hanford Site actions with potential cumulative impacts.

Land Use and Habitat

To address cumulative land-use and habitat impacts the TWRS EIS considered past Hanford Site land use and habitat uses (1944 through 1994), current operations, and future operations that would occur concurrent with 27 years of operations of the Phased Implementation alternative. The cumulative impacts are presented in Table 4.20.2. Table 4.20.2 documents that past operations had impacted 8,700 ha (21,500 ac) of land at the Hanford Site. Potential future actions would impact an additional 2,154 ha (5,340 ac), including 1,016 ha (2,515 ac) of previously undisturbed habitat. This estimate of future impacts included 320 ha (790 ac) of land commitments and 220 ha (540 ac) of habitat disturbance under the Phased Implementation alternative. Based on the new data the land-use impacts of the Phased Implementation alternative would increase by 125 ha (310 ac) and habitat disturbance would increase by 70 ha (173 ac). The overall impact of this change on land-use and habitat disturbance would be small, resulting in an approximately 4 percent increase in the total new land-use commitments above baseline conditions in 1996 and less than a 1 percent increase in the total Hanford Site land-use impacts.

Table 4.20.2. Cumulative Land-Use and Habitat Impacts

Source of Impact	Total Land Use ha (ac)	Habitat Impacts[1] ha (ac)
Hanford Remedial Action Program[2]	1,138 (2,812)	462 (1,153)
Environmental Restoration Disposal Facility[2]	590 (1,475)	314 (773)
Decommissioning Eight Surplus Reactors	6 (15)	6[3] (15)
Management of Spent Nuclear Fuel from K Basins	3.5 (9)	3.5 (9)
Safe Interim Storage of Hanford Tank Waste	30 (74)	9 (22)
TWRS alternative (Phased Implementation)[2]	320 (790)	220 (540)
TWRS Phased Implementation (based on new data)	445 (1,100)	290 (718)
Programmatic Waste Management	72 (180)	7 (18)
Baseline - Previously Disturbed	8,700 (21,500)	No Data
Cumulative Total (TWRS EIS)	10,854 (26,840)	1,016 (2,575)

Notes:

[1] Shrub-steppe unless otherwise noted.

[2] Highest impact alternative.

[3] Not specified as shrub-steppe in data source.

Health Risks

To address cumulative health risks the TWRS EIS considered past Hanford Site operations (1944 through 1994), current operations, and future operations that would occur concurrent with 27 years of operations of the Phased Implementation alternative. Based on this analysis the EIS estimated that the cumulative health affects for Hanford Site operations was 100,659 person-roentgen equivalent man (rem) resulting in 50 LCFs. Of this total the Phased Implementation alternative would contribute 388 person-rem and 0.2 LCFs or 0.4 percent of the cumulative impact. Based on the new data presented in this SA regarding waste inventory, the estimate of the Phased Implementation alternative dose has been revised upward to 473 person-rem and the cumulative Hanford Site dose was increased by the same amount to 100,744 person-rem with no change in the estimate of LCFs (for purposes of analysis in the EIS, each 2,000 person-rem was assumed to result in one LCF). The change in the Phased Implementation alternative dose represented an approximately 18 percent increase for the alternative and a less then 0.01 increase in the Hanford Site cumulative impact. It is important to note that the waste inventory change that caused the increase in impacts from the Phased Implementation alternative would have similarly impacted all other alternatives that would retrieve and treat the tank waste.

Air Quality

To address cumulative impacts of the Phased Implementation alternative and other ongoing and planned Site operations air emissions from construction and operations of all actions that could reasonably be expected to overlap were calculated, totaled, and compared to Washington State air quality standards for four contaminants. The Phased Implementation alternative was selected for comparison purposes. Impacts are presented in Table 4.20.3. As the table demonstrates, all four contaminants have similar or lower values compared to the data presented in the TWRS EIS.

Table 4.20.3. Cumulative Air Quality Impacts

Sources	Maximum Average Concentration ($\mu g/m^3$)			
	Particulate (PM-10)	Nitrogen Oxides (NO_X)	Sulfur Oxides (SO_X)	Carbon Monoxide (CO)
Hanford Site Baseline	3	3	19	3
Hanford Remedial Action	43	40	5	26
Environmental Restoration Disposal Facility	33	Negligible	Negligible	Negligible
TWRS alternative (maximum value from all alternatives)	98	2.2	27	2,500
TWRS Phased Implementation alternative (Revised calculation)	98	2.1	3.9	2,334
TWRS EIS Total	177	45	51	2,529
TWRS Phased Implementation alternative (Total based on revised calculations)	177	45	28	2,529
Standard [1]	150 (24 hour)	100 (Annual)	365 (24 hour)	10,000 (8 hour)

Notes:

[1] Washington State standards

Groundwater Quality

To address cumulative groundwater impacts and associated long-term health impacts, the TWRS EIS analyzed contaminants in the vadose zone in the 200 Areas that are primarily associated with past waste disposal practices using engineered structures such as cribs, drains, septic tanks and associated drain fields, and reverse wells (wells that do not penetrate to groundwater); percolation from ponds, ditches, and trenches such as B Pond and U Pond; solid waste burial in backfilled trenches; and unplanned releases such as leaks from SSTs. In addition the EIS considered the US Ecology Low-Level Radioactive Waste Disposal Facility located southwest of the 200 East Area, which is estimated to contain about 2.2 million curies of radioactive waste in backfilled trenches. Reasonably foreseeable additions to contaminants in the vadose zone also included future waste disposal at the 200 Area and US Ecology solid waste burial grounds and the placement of remediation waste in the Environmental Restoration Disposal Facility.

Cumulative radionuclide concentrations that could occur in the groundwater from a potential combination of contamination from past disposal practices, currently anticipated future waste disposal, and the contamination from the Phased Implementation alternative were discussed in Volume Four, Section F.4.5. Peak groundwater concentrations from the various potential sources could occur at different times and different locations. However, to maximize the potential cumulative impacts, the peak concentrations of the past and reasonably foreseeable future sources were assumed to combine with the peak concentrations from the Phased Implementation alternative. This resulted in a conservative bounding of the maximum potential cumulative groundwater impact for each TWRS alternative.

Subsequent to the publication of the TWRS EIS new sources of information have been and continue to be developed by DOE that could affect the cumulative impacts of TWRS EIS alternatives. These sources of new information were discussed previously in Sections 4.3 and 4.13. There is a large uncertainty associated with past tank leaks and other non-TWRS sources in the 200 Area and the potential cumulative impacts of these sources on existing and future groundwater quality. The uncertainty on cumulative impacts includes definition of the various source terms (e.g., volume and characteristics of waste) and contaminant transport parameters that affect migration from disposal sites to the groundwater.

Definition of the source terms is largely dependant on how well past activities were documented. Some improvements in the estimated inventory of past waste disposal have been achieved by the revised tank waste inventory and the Composite Analysis studies in response to the DNFSB comment 94-02 of 200 Area LLW disposal sites. The preliminary results of these efforts indicate that for the source terms included in the TWRS EIS cumulative analysis, other than the revised inventory:

- There have been no changes in the inventory for Environmental Restoration Disposal Facility and the US Ecology sites that would change cumulative impacts. The US Ecology site as well as the LLW Burial Grounds are undergoing environmental impact assessments that include consideration of expanded disposal of LLW and other contaminants. However, these assessments are in early stages, and no definitive data exist to support changes in the TWRS EIS analysis.
- Changes in inventory for past tank leaks and past practice solid waste disposal tended to revise the inventory to lower levels than used in the EIS analysis, and therefore the EIS analysis bounds the potential impacts associated with these sources
- Changes in past-practice liquid disposal which substantially increase the inventory would not affect the calculation of cumulative impacts because these release would have migrated well ahead of the other sources, including Phased Implementation retrieval losses, residual tank waste, and LAW vaults, and hence the impacts would not be additive.

Data from Site programs such as the spectral gamma logging of drywells surrounding the tank farms, the preliminary data from deepening borehole 41-09-39 at the SX Tank Farm, work performed as a part of the Composite Analysis, and some of the RPE studies are all coming together into a refined conceptualization of contaminant transport. These refinements serve to reduce the uncertainty in contaminant transport and indicate the assumptions made in the TWRS EIS regarding contaminant transport for cumulative impacts are still bounding. In the TWRS EIS, it was assumed that past-practice liquid waste disposal resulted in only near-term impacts. It was concluded that the cumulative impacts of this waste disposal activity would be very low for the Phased Implementation alternative and the new information and data do not change this conclusion.

In the TWRS EIS, a bounding approach to past tank leaks was taken that assumed that impacts from past tank leaks would be additive with future groundwater impacts from tanks if no waste retrieval and remediation were to be implemented. This assumption puts the impacts from past tank leaks out in time where they would be additive to the impacts from implementing the Phased Implementation alternative. Available information suggests the approach is still bounding because if anything, the impacts from past leaks are occurring sooner than would be calculated using the TWRS EIS assumption and thus would be less likely to be additive to the impacts associated with implementing the Phased Implementation alternative.

For the past-practice solid waste disposal sites, the solid low-level radioactive waste disposal in the 200 West burial grounds, and solid low-level radioactive waste disposed in the US Ecology Burial Grounds a bounding approach was taken that assumed the contaminants from these sites would be additive with tank waste that was disposed of in the tanks with a gravel fill and a cap. The new data and information suggest this approach is still bounding.

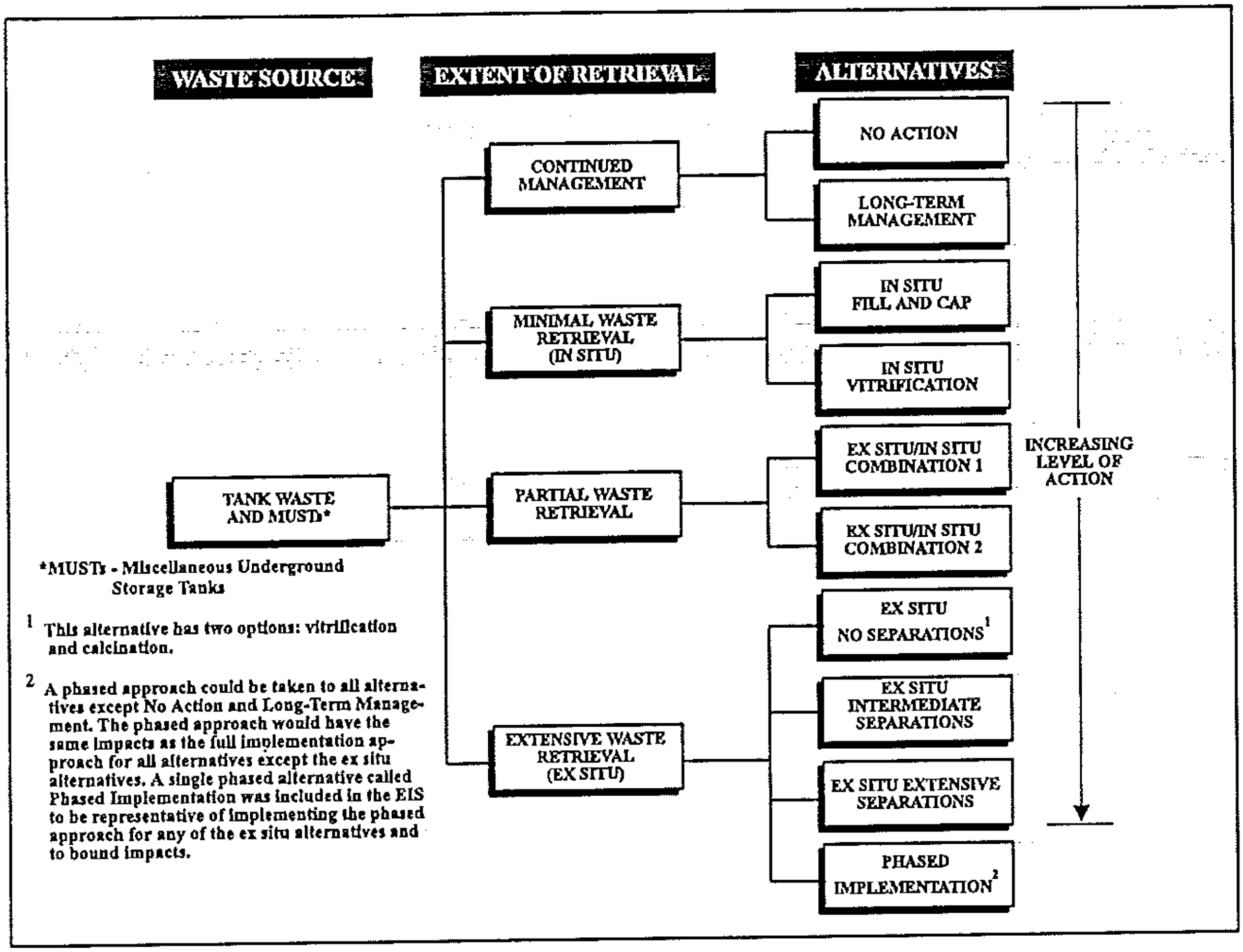
Socioeconomics
Based on the review of new data presented in Section 4.8 there is not a basis for revising TWRS EIS alternatives calculations of socioeconomic impacts. Therefore, there is no basis for change in the calculation of cumulative impacts. However, as noted in Section 4.8, the overall Hanford Site and Tri-Cities area employment has declined from the baseline levels presented in the TWRS EIS and used to calculate the impacts of the Phased Implementation alternative on housing costs, taxes, and local services (e.g., fire, police, schools). The decline in Site and area employment would have a comparable affect on the calculations of impacts presented in the EIS for the Phased Implementation alternative and would tend to lessen the adverse impacts in a comparable manner.

4.21 OTHER ALTERNATIVES ADDRESSED IN THE TWRS EIS

4.21.1 Other EIS Alternatives

A wide variety of potential alternatives and combinations of alternatives existed for treating and disposing of the tank waste. One of the challenges for DOE and Ecology was to develop a range of reasonable alternatives for detailed analysis and presentation in the TWRS EIS. The alternatives presented in the EIS were chosen to be representative of the many possible variations of the alternatives. The EIS contains an analysis of the full range of reasonable alternatives for management and disposal of the TWRS waste. The continued safe management of the tank farms is included in all of the alternatives. The tank waste alternatives were grouped into four major categories depending on the extent of waste retrieval as shown in Figure 4.21.1. The alternatives are summarized in Table 4.21.1.

Figure 4.21.1. Tank Waste Alternatives



*MUSTs - Miscellaneous Underground Storage Tanks

[1] This alternative has two options: vitrification and calcination.

[2] A phased approach could be taken to all alternatives except No Action and Long-Term Management. The phased approach would have the same impacts as the full implementation approach for all alternatives except the ex situ alternatives. A single phased alternative called Phased Implementation was included in the EIS to be representative of implementing the phased approach for any of the ex situ alternatives and to bound impacts.

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All of the TWRS EIS alternatives included the continuation of on-going activities to safely manage the tank waste, including removing liquid waste from SSTs and operating the existing 242-A Evaporator to concentrate waste and provide additional tank storage capacity and waste management flexibility; additional characterization of the waste; maintaining tank safety activities, such as operating waste mixer pumps and transferring waste between the tanks; and other associated monitoring, maintenance, security, and regulatory compliance activities.

All of the alternatives except the No Action alternative included upgrades to the tank farm waste transfer system, which involve the construction of buried waste transfer pipelines and replacement of transfer lines that are not regulatorily compliant. Also under all of the alternatives DOE would continue its policy of continually evaluating the issues associated with the TWRS and its path forward as additional tank characterization data and process knowledge are obtained.

Table 4.21.1. Summary of Tank Waste Alternatives [1]

Alternative (Time Frame) [2]	Key Features
No Action (1997 to 2097)	• Continue existing operations and maintenance (such as continued removal of saltwell liquid from SSTs). • No new waste retrieval, treatment, or disposal actions.
Long-Term Management (1997 to 2097)	• Continue existing operations and maintenance (such as continued removal of saltwell liquid from SSTs). • Upgrade tank farm inter- and intra-waste transfer system. • Replace all DSTs starting in 2035 and again in 2085. • Transfer the DST waste to new tanks.
In Situ Fill and Cap (1997 to 2029)	• Evaporate liquid from DST waste. • Fill SSTs and DSTs with gravel, and place a thick earthen cover over the tanks. • Dispose of waste onsite in the tanks.
In Situ Vitrification (1997 to 2033)	• Evaporate liquid from DST waste. • Vitrify waste in SSTs and DSTs in place, and place a thick earthen cover over the tanks. • Dispose of waste onsite.
Ex Situ/In Situ Combination 1 (1997 to 2040)	• Retrieve approximately 50 percent of the waste from SSTs and DSTs (based on the degree of risk posed to human health and the environment). • Dispose of waste remaining in tanks in place as under the In Situ Fill and Cap alternative. • Separate retrieved waste into high-level and LAW streams (use sludge washing, caustic leaching, and ion exchange). • Vitrify waste streams in separate facilities. • Dispose of LAW onsite in near-surface vaults. • Store HLW onsite for up to 50 years pending availability of a geologic repository. • Dispose of HLW offsite at a geologic repository.
Ex Situ/In Situ Combination 2 (1997 to 2040)	• Retrieve approximately 30 percent of the waste from SSTs and DSTs (based on the degree of risk posed to human health and the environment). • Dispose of waste remaining in tanks in place as under the In Situ Fill and Cap alternative. • Separate retrieved waste into HLW and LAW streams (use sludge washing, caustic leaching, and ion exchange). • Vitrify waste streams in separate facilities. • Dispose of LAW onsite in near-surface vaults. • Store HLW onsite for up to 50 years pending availability of a geologic repository. • Dispose of HLW offsite at a geologic repository.
Ex Situ No Separations (1997 to 2040)	• Retrieve all waste practicable (assumed to be 99 percent) from all SSTs and DSTs. • Vitrify or calcine all retrieved waste. • Store HLW onsite for up to 50 years pending availability of a geologic repository. • Dispose of all waste offsite at a geologic repository.
Ex Situ Intermediate Separations (1997 to 2040)	• Retrieve all waste practicable (assumed to be 99 percent) from all SSTs and DSTs. • Separate waste into HLW and LAW streams (use sludge washing, caustic leaching, and ion exchange). • Vitrify waste streams in separate facilities. • Dispose of LAW onsite in near-surface vaults. • Store HLW onsite for up to 50 years pending availability of a geologic repository. • Dispose of HLW offsite at a geologic repository.
Ex Situ Extensive Separations (1997 to 2032)	• Retrieve all waste practicable (assumed to be 99 percent) from all SSTs and DSTs. • Separate tank waste into HLW and LAW streams (use ion exchange, caustic and acid dissolution, and sorption and solvent extraction). • Vitrify waste streams in separate facilities.

Table 4.21.1 Summary of Tank Waste Alternatives[1] (cont'd)

Alternative (Time Frame)[2]	Key Features
Phased Implementation (Phase 1: 1997 to 2012) (Phase 2: 2004 to 2040) Selected Alternative	Phase 1: • Construct two LAW separations and immobilization demonstration facilities (one facility would include HLW vitrification). • Operate facilities for up to 10 years and treat up to approximately 76 million L (19 million gal.) of the tank waste volume. • Store treated waste onsite pending development of an onsite disposal facility for immobilized LAW and availability of a geologic repository for disposal of immobilized HLW. Phase 2: • Construct and operate two combined LAW separations and immobilization facilities and one HLW vitrification facility. • Retrieve all waste practicable (assumed to be 99 percent) from all SSTs and DSTs. • Separate tank waste into HLW and LAW streams (use sludge washing, caustic leaching, ion exchange, and other separations as required). • Store HLW onsite for up to 50 years pending availability of a geologic repository. • Dispose of HLW offsite at a geologic repository. • Dispose of LAW onsite in near-surface vaults.

Notes:

[1] Impacts as shown in the EIS included a representative closure scenario (closure as landfill) to provide a meaningful comparison of alternatives. This closure scenario consisted of placing an earthen barrier over the tanks and low-activity waste vaults.

[2] Time frames shown are through closure or following transport of HLW offsite, which ever is later, and do not include post-closure monitoring.

The following discusses the effect that the new information described in Section 3.0 may have on the impacts presented in the TWRS EIS for the alternatives that were not selected by DOE.

4.21.2 Continued Management Alternatives

All of the alternatives analyzed in the TWRS EIS included the continuation of routine operations and maintenance activities required for safe storage of the waste. New information on potential radiological accidents during routine tank farm operations has been developed. This information includes the TWRS BIO and revised inventory for the tank waste. This information will change the radiological and chemical risk calculated in the TWRS EIS for the beyond-design- basis earthquake scenario and accidents that could occur during routine operations. These changes are discussed for the Phased Implementation alternative in Section 4.13 and would affect the continued management alternatives in a similar manner. The higher radiological dose from a tank dome collapse resulting from a beyond-design-basis earthquake would have the greatest effect on the risks for the No Action and Long-Term Management alternatives because of the higher accident probability associated with extending current tank farm operations over a long period of time.

Changes in the waste inventory described in Section 3.2.1 would change the long-term risk for the continued management alternatives. The changes in anticipated long-term risk were not calculated for this SA; however, it would be expected that changes in long-term risk would follow the same trend as described for the Phased Implementation alternative in Section 4.12.2. Similar to the changes in the long-term risk calculated for the Phased Implementation alternative, the inventory changes would be expected to result in risk levels that are similar to those provided in the EIS. The calculations performed for the Phased Implementation alternative indicated that the net effect on long-term risk from changes in the inventory of contaminants modeled with a K_d of 0 was small. Because contaminants modeled with a $K_d = 1$ reached the groundwater under the continued management alternatives and the inventory of some contaminants with a $K_d = 1$ increased substantially, the long-term risk would be expected to increase. The increase is due to the increased inventory of Pa-231.

Increased inventory of the actinides identified in Section 3.2 would be expected to result in higher risks to hypothetical intruder under the post-remediation intruder scenario. This new inventory information would increase the intruder risks for all of the alternatives but would have the greatest effect on the long-term management and in situ disposal alternatives.

4.21.3 In Situ Disposal Alternatives

The In Situ Fill and Cap and In Situ Vitrification alternative impacts would be affected by the new accident information during the continued operations stage of each alternative. These changes would be similar to those described for the Phased Implementation alternative in Section 4.13.

No new information has been identified relative to the in situ disposal alternatives that would affect the engineering data relative to the remedial activities that would be required to implement these alternatives. Therefore, no new information is available that would change the potential short-term impacts for the In Situ Fill and Cap alternative from those described in the TWRS EIS. Changes in the waste inventory would change the routine emissions impacts for the In Situ Vitrification alternative. The revised inventory for I-129 described in Section 3.2 is approximately 64 percent higher than the TWRS EIS inventory. Iodine is volatile at the high temperatures that would occur during in situ vitrification, and in the TWRS EIS all of the I-129 was assumed to be released in the off-gas.

Changes in the waste inventory described in Section 3.2.1 would change the long-term risk for the in situ disposal alternatives. The changes in anticipated long-term risk and impacts to the vadose zone and groundwater were not calculated for this SA; however, it would be expected that changes in groundwater contaminant concentrations and associated long-term risk would be small and would follow the same trend as described for the Phased Implementation alternative in Section 4.12.2.

4.21.4 Partial Waste Retrieval Alternatives

The partial waste retrieval alternative impacts would be affected by the new accident information during the continued operations stage of each alternative. These changes would be similar to those described for the Phased Implementation alternative in Section 4.13.

The partial waste retrieval alternatives evaluated in the TWRS EIS were developed to assess the impacts that would result if a combination of two or more of the tank waste alternatives were selected for implementation. The Ex Situ/In Situ Combination 1 and 2 alternatives represented a combination of the In Situ Fill and Cap and Ex Situ Intermediate Separations alternatives. The tanks were evaluated on a tank-by-tank basis to determine the appropriate remediation method based on the contents of the tanks. The TWRS EIS acknowledged that a wide variety of potential combination of alternates could be developed and criteria that could be used to select a combination of alternatives for implementation. The two ex situ/in situ combination alternatives were intended to represent a variety of potential alternative combinations that could be developed to remediate the tank waste.

Since the publication of the EIS, the revised tank-by-tank inventory has been developed. The tank-by-tank inventory would be expected to result in selecting different tanks and potentially different numbers of tanks for retrieval using the EIS methodology.

Changes in the groundwater environmental impacts associated long-term risk for the ex situ portion of the combination alternatives based on new information would be expected to follow the same type of trends identified for the Phased Implementation alternative.

4.21.5 Extensive Waste Retrieval Alternatives

The extensive waste retrieval alternatives would be affected by the new accident information during the continued operations stage of each alternative. These changes would be similar to those described for the Phased Implementation alternative in Section 4.13.

Following DOE's decision to implement the Phased Implementation alternative using a privatized contracting strategy, development of other alternatives was discontinued. Therefore, no new engineering data are available for the other alternatives and the short-term impacts from construction, and operations of the waste treatment facilities described for the extensive retrieval alternatives would not be changed from those presented in the TWRS EIS. Many of the technologies that were identified for the extensive waste retrieval alternatives are common to the Phased Implementation alternative. Where common technologies are employed the changes in potential environmental impacts resulting from new information would be the same for the extensive waste retrieval alternatives as those described for the Phased Implementation alternative. A partial list of common technologies includes the following:

- Waste retrieval and transfer
- Waste separations processes
- Vitrification technologies.

The new inventory information provided by the revised inventory is described in Section 3.2 and would affect the long-term risks from all of the extensive retrieval alternatives. Changes in long-term impacts from new inventory information as it relates to potential tank leakage during retrieval and from residual waste left in the tanks following retrieval would be the same for all extensive retrieval alternatives. Changes in long-term impacts from new inventory information as it relates to the immobilized LAW vaults would be expected to follow similar trends as those described for the Phased Implementation alternative in Section 4.3. For example, the revised inventory for Np-237 is approximately 100 percent higher than in the TWRS EIS inventory. This would be expected to result in higher Np-237 inventories in the potential retrieval leaks, tank residuals, and immobilized LAW vaults (for extensive retrieval alternatives that include HLW and LAW separations). The relative change in impacts for all of the extensive retrieval alternatives would be expected to be similar to those calculated for the Phased Implementation alternative in Section 4.0.

Each of the alternatives involving waste retrieval and separations into a HLW and LAW waste stream followed by immobilization would experience increases in the HLW volume resulting from the revised waste inventory. The increases would be proportionate to those experienced by the Phased Implementation alternative. The increase in HLW volume would be approximately 15 percent under each of these alternatives except for the Ex Situ Extensive Separations alternative. The impact on HLW waste volume under this alternative would be somewhat less because the alternative includes acid dissolution of chromium. The Ex Situ No Separations alternative would not have an increase in vitrified (or calcine) waste volume because the large volume of waste under this alternative could accommodate the increase in chromium inventory.

4.22 STAKEHOLDER AND TRIBAL NATION INVOLVEMENT

Throughout the Phase IA process DOE has periodically consulted with stakeholders and Tribal Nations regarding the progress of the Privatization initiative. These consultations have taken the form of briefings for the Hanford Advisory Board and its committees, responses to Hanford Advisory Board consensus advice, and briefings for other stakeholder organizations such as the meetings with the Yakama Indian Nation, Confederated Tribes of the Umatilla Indian Reservation, and the Nez Perce Tribe. With the submission of the Privatization contractor Environmental Reports in September 1997 and the proposals in January 1998 DOE has conducted additional consultations regarding the potential environmental impacts evaluated in this Supplement Analysis and associated with the siting and mitigation of impacts associated with construction and operation of the facilities with representatives of regulatory agencies, stakeholders, and Tribal Nations including:

- Ecology
- Washington State Department of Fish and Wildlife
- U.S. Fish and Wildlife Service
- U.S. Bureaue of Land Management
- Oregon Department of Energy
- Hanford Advisory Board and its committees
- Yakama Indian Nation
- Confederated Tribes of the Umatilla Indian Reservation
- Nez Perce Tribe

In addition to these consultations, this Supplement Analysis and the Environmental Synopsis will be distributed to regulatory agencies, the Hanford Advisory Board, and Tribal Nations and placed on the DOE Hanford Home Page. Copies of both documents will be placed in the DOE Reading Rooms in Richland, Seattle, and Spokane, Washington and in Portland, Oregon. The public will be notified of the availability of the Supplement Analysis and the Environmental Synopsis from DOE or at DOE Reading Rooms through advertisements in area newspapers.

5.0 UNCERTAINTIES

Remediating the TWRS waste is a very complex and costly remediation program and involves a number of technical uncertainties, some of which will not be resolved until waste retrieval, transfer, and treatment operations have been demonstrated. Technical uncertainties are being reduced through technical analysis, characterization, modeling, and bench-scale experiments. However, these uncertainties will not be fully resolved until sufficient quantities of the varying waste types are retrieved from the tanks and immobilized in the waste treatment facilities. The Phased Implementation alternative allows DOE to implement waste treatment on a demonstration scale to reduce uncertainties prior to initiating full-scale remediation efforts. By performing Phase I of the Phased Implementation alternative and proceeding with other technology development projects and tank waste characterization, the uncertainties associated with the tank waste program will be reduced further.

The TWRS EIS identified several sources of uncertainty involved with calculating the impacts associated with implementing the tank waste alternatives, including characteristics of the waste and the performance characteristics of the waste retrieval, separations, and immobilization technologies. The methodology used to address uncertainties in the impact calculations was to calculate bounding and nominal impacts. Bounding impacts were calculated using conservative assumptions and represent reasonable maximum impacts that are likely to occur. Nominal impacts were based on less conservative assumptions (i.e., assumptions that resulted in higher environmental impacts) and were intended to represent average impacts that are likely to occur. For example, the nominal case defined for assessing long-term impacts in the TWRS EIS involved 1) reducing the concentration of contaminants in retrieval leakage to account for addition of water during sluicing; 2) reducing the inventory of C-14, Tc-99, and I-129 in the residual waste to account for higher solubility of these constituents in the retrieval liquid; and 3) the K_d of Np-237 was revised from 0 to 1. This nominal case represented an average or most likely scenario using nominal type assumptions for a limited number of parameters. The nominal and bounding cases also illustrate that given the uncertainties involved with calculating the impacts, presenting a risk range is more appropriate than providing a single point estimate.

Broader technical and programmatic uncertainties were also identified in the TWRS EIS that included 1) the effectiveness of the waste retrieval system and how much liquid might leak from the tanks during retrieval; 2) how effectively waste from multiple tanks can be blended to meet final waste specifications; and 3) the effectiveness of the processes for separating the waste into LAW and HLW.

Uncertainties were identified as one of the principal findings in the National Research Council's report, The Hanford Tanks, Environmental Impacts and Policy Choices (NRC 1996). DOE did consider the conclusions and recommendations in the National Research Council report in the preparation of the TWRS ROD. The National Research Council identified uncertainties in the areas of technology, costs, performance, regulatory environment, future land use, and health and environmental risks.

DOE is pursuing initiatives to gather additional information, and if successful these initiatives will reduce uncertainties in the TWRS program. These initiatives include:

- The HTI project, which has been initiated as a first step in developing waste retrieval and tank closure criteria by providing data on characterization of tank residuals and removal of tank hard heel, as well as technologies for waste retrieval, technologies for removing tank residuals, and developing risk based performance criteria for closing tanks
- Completion of the tank waste characterization program, which should provide data relative to tank waste safety issues and the contents of the tanks
- Determination of the level of contamination in the vadose zone
- Development of a comprehensive plan to integrate tank waste remediation with tank farm closure and other remediation activities related with the TWRS program
- Integration of TWRS program implementation with the plans for developing a national repository for HLW
- Demonstrations of the efficiency and effectiveness of retrieval sluicing technology to support the tank waste remediation activities
- Demonstrations of various tank waste separations and treatment processes.

This section will identify how new data developed since the preparation of the TWRS EIS have reduced these uncertainties and how the remaining uncertainties affect Phase 1 of the Phased Implementation alternative. Technology development programs whose purpose is to reduce technical uncertainties will also be identified.

5.1 TANK WASTE INVENTORY

Tank waste inventory was identified in the TWRS EIS as an area of uncertainty. The inventory used was based on estimates developed using the best available information at the time of publication. This inventory was considered reasonably accurate from an overall inventory stand point but was considered less reliable on a tank-by-tank basis.

In an effort to reduce inventory uncertainties, resolve differences among the reported inventory values, and provide a consistent and technically defensible inventory basis for all waste management and disposal activities, a task was initiated in FY 1996 to establish a revised inventory for chemicals and radionuclides in Hanford Site tank waste. In August 1997 the TWRS program released the first version of the "Standard Inventories of Chemicals and Radionuclides in Hanford Site Tank Wastes" (Kupfer et al. 1997), which provides a revised inventory for 26 chemical and 46 radionuclide components.

There are two components of the revised inventory for the SSTs and DSTs. A revised inventory has been developed and represents an overall total inventory estimate for all tanks. Tank-by-tank inventory estimates have also been developed that provide a revised inventory for each of the 177 tanks LMHC 1997b. There are discrepancies for some constituents between the cumulative tank-by-tank inventory and the revised inventory. There is an effort underway to reconcile the two inventories in FY 1998, which could include some adjustment of both inventory estimates. The revised inventory used in assessing potential changes in environmental impacts in this SA represents the best available information; however, it is expected to change as new information becomes available. For example, the summation of the tank-by-tank inventory for Tc-99 is approximately 40 percent higher than the revised inventory (4.6E+04 Ci versus 3.3E+04 Ci). Resolution of this discrepancy could change one and/or both of these inventories. A comparison of the revised inventory to the summation of the tank-by-tank inventories is provided in Table 5.1.

There will always be some level of uncertainty with the tank inventory because of limitations on the number and the location where samples are taken. Characterization of the tank waste is necessary to satisfy a number of data needs including resolving safety issues, evaluating processes for pretreating and immobilizing the waste, and to address regulatory requirements. Sampling and analysis of tank waste is incomplete and as it continues will likely result in adjustments in the tank-by-tank and global best-basis inventories. Tank sampling and analysis efforts have been performed for approximately 131 of the 177 tanks. The tanks that have been sampled satisfy one or more but not all of the characterization data needs. Recent characterization efforts have been focused on resolution of safety issues, and as these issues are resolved data needs for waste treatment will be addressed. This change in focus for the tank waste characterization program was the subject of recent changes to the M-44 series of Tri-Party Agreement milestones.

One notable change is the order-of-magnitude increase in the tritium inventory. The majority of the tritium in the tanks is expected to be contained in the radioactive liquid effluent streams generated as secondary waste during waste treatment. Therefore, the majority of this inventory would be transferred to the existing Effluent Treatment Facility. This increase could potentially affect tritium concentrations in the groundwater. The total tritium inventory is uncertain and the revised tritium inventory is believed to be too large. Investigation revealed that the basis for the tritium inventory is mainly the Hanford defined waste model, which is known to be high because it does not account for the substantial tritium losses that occurred during fuel reprocessing. The tritium inventory has been targeted for review and refinement during 1998 and it is expected to go down (Watrous 1997).

Tank waste inventory uncertainties would not limit implementation of Phase IB because the waste feed envelopes have been defined. Relatively well characterized waste from DSTs would be retrieved during Phase I and this waste would be adjusted as necessary to meet the specifications before delivery to the Privatization contractors.

5.2 WASTE RETRIEVAL AND TRANSFER

The ability to effectively retrieve SST waste, achieve retrieval goals in terms of the amount of residual remaining in the tanks following retrieval, and the potential for leakage to occur during retrieval were identified in the TWRS EIS as areas of uncertainty. Additionally waste retrieval

Table 5.1. Revised Inventory Compared to Best-Basis Tank-by-Tank Inventory

Constituent Name	Units (Decayed to 12/31/93)	Revised Inventory	Tank-by-Tank Summary	Ratio of Revised Inventory to Tank-by-Tank Summary
Al	kg	7.9E+06	7.6E+06	1.03
Bi	kg	5.8E+05	6.2E+05	0.93
Ca	kg	2.1E+05	3.4E+05	0.64
Ce	kg	8.8E+03	0.00E+00	N/A
Cl	kg	5.0E+05	8.8E+05	0.57
TIC as CO_3	kg	4.8E+06	9.0E+06	0.54
Cr	kg	7.9E+05	6.6E+05	1.19
F	kg	1.4E+06	8.7E+05	1.57
Fe	kg	1.2E+06	1.4E+06	0.85
Hg	kg	2.1E+03	6.4E+03	0.33
K	kg	4.8E+05	8.1E+05	0.60
La	kg	5.1E+04	4.8E+04	1.05
Mn	kg	1.1E+05	2.0E+05	0.52
Na	kg	5.4E+07	4.7E+07	1.14
Ni	kg	1.1E+05	1.5E+05	0.73
NO_2/NO_3	kg	8.6E+07	6.4E+07	1.34
OH TOTAL	kg	2.3E+07	2.1E+07	1.10
Pb	kg	2.8E+05	8.5E+04	3.29
PO_4	kg	6.0E+06	1.6E+06	3.87
Si	kg	5.7E+05	1.1E+06	0.54
SO_4	kg	5.0E+06	1.3E+06	3.84
Sr	kg	3.1E+04	4.3E+04	0.73
TOC	kg	4.0E+06	1.8E+06	2.25
U	kg	9.7E+05	8.0E+05	1.20
Zr	kg	4.4E+05	4.2E+05	1.05
Cd	kg	8.2E+03	0.00E+00	N/A
Ag	kg	8.9E+03	0.00E+00	N/A
Th	kg	2.6E+04	0.00E+00	N/A
W	kg	1.6E+04	0.00E+00	N/A
H-3	Ci	3.4E+04	3.8E+04	0.90
C-14	Ci	4.8E+03	3.7E+03	1.29
Ni-59	Ci	9.3E+02	8.6E+02	1.08
Co-60	Ci	1.2E+04	2.1E+04	0.59
Ni-63	Ci	9.2E+04	8.5E+04	1.09
Se-79	Ci	7.7E+02	6.8E+02	1.14

Table 5.1. Revised Inventory Compared to Best-Basis Tank-by-Tank Inventory (cont'd)

Constituent Name	Units (Decayed to 12/31/93)	Revised Inventory	Tank-by-Tank Summary	Ratio of Revised Inventory to Tank-by-Tank Summary
Sr-90	Ci	7.2E+07	6.7E+07	1.07
Y-90	Ci	7.2E+07	6.7E+07	1.07
Nb-93m	Ci	2.7E+03	2.4E+03	1.10
Zr-93	Ci	3.6E+03	3.3E+03	1.09
Tc-99	Ci	3.3E+04	4.6E+04	0.71
Ru-106	Ci	1.0E+05	1.8E+05	0.57
Cd-113m	Ci	1.7E+04	1.6E+04	1.05
Sb-125	Ci	2.1E+05	2.5E+05	0.83
Sn-126	Ci	1.2E+03	1.1E+03	1.04
I-129	Ci	6.3E+01	8.1E+01	0.78
Cs-134	Ci	8.9E+04	8.7E+04	1.03
Ba-137m	Ci	4.4E+07	4.8E+07	0.91
Cs-137	Ci	4.6E+07	5.1E+07	0.91
Sm- 151	Ci	2.8E+06	2.5E+06	1.11
Eu-152	Ci	1.5E+03	1.4E+03	1.06
Eu-154	Ci	1.5E+05	1.8E+05	0.80
Eu-155	Ci	1.4E+05	2.0E+05	0.67
Ra-226	Ci	6.3E-02	5.7E-02	1.11
Ac-227	Ci	8.8E+01	8.7E+01	1.00
Ra-228	Ci	7.7E+01	7.5E+01	1.03
Th-229	Ci	1.8E+00	1.8E+00	1.02
Pa-231	Ci	1.6E+02	1.6E+02	1.00
Th-232	Ci	2.1E+00	4.2E+00	0.50
U-232	Ci	1.2E+02	2.5E+02	0.49
U-233	Ci	4.8E+02	9.7E+02	0.49
U-234	Ci	3.5E+02	8.3E+02	0.42
U-235	Ci	1.5E+01	3.6E+01	0.40
U-236	Ci	9.6E+00	1.5E+01	0.64
Np-237	Ci	1.4E+02	7.2E+02	0.20
Pu-238	Ci	2.8E+03	2.4E+03	1.16
U-238	Ci	3.2E+02	8.6E+02	0.37
Pu-239	Ci	3.9E+04	2.3E+04	1.73
Pu-240	Ci	8.9E+03	4.5E+03	2.00
Am-241	Ci	7.0E+04	1.5E+05	0.47
Pu-241	Ci	2.3E+05	1.6E+05	1.42

Table 5.1. Revised Inventory Compared to Best-Basis Tank-by-Tank Inventory (cont'd)

Constituent Name	Units (Decayed to 12/31/93)	Revised Inventory	Tank-by-Tank Summary	Ratio of Revised Inventory to Tank-by-Tank Summary
Cm-242	Ci	7.7E+01	7.4E+01	1.04
Pu-242	Ci	1.2E+00	7.7E-01	1.50
Am-243	Ci	9.3E+00	1.6E+01	0.59
Cm-243	Ci	1.0E+01	1.9E+02	0.05
Cm-244	Ci	2.4E+02	5.0E+02	0.49

Notes:
Ci decayed to 12/31/93

and transfer operations could result in the formation of colloids and gels, which could interfere with waste processing. Reducing these uncertainties is necessary before full-scale implementation of SST retrieval in Phase II.

No waste retrieval has been conducted since the TWRS EIS was released, so many of the uncertainties associated with retrieval remain. However, DOE has implemented a number of programs and technology development efforts aimed at reducing these uncertainties.

The HTI project was established to implement the August 1996, DOE and Ecology Memorandum of Understanding (MOU 1996). In the Memorandum, the agencies agreed to address the degree of waste removal that should be used as the basis for developing waste retrieval systems technology, retrieval systems engineering, and defining completion of retrieval operations. HTI was developed to address many of these uncertainties before full-scale retrieval operations were required. HTI's mission is to minimize the programmatic and technical uncertainties by employing appropriate technologies and methods to achieve the following:

- Retrieve difficult-to-remove hard-heel waste from a SST
- Establish retrieval performance criteria, including cost
- Characterize waste to measure compliance with retrieval performance criteria.

Retrieval demonstrations for hard-heel waste are planned under HTI following sluicing of tank 241-C-106 under HTI. This project will use commercial technologies to demonstrate retrieval of hard heel from tank 241-C-106. Additional development and testing of these retrieval systems is underway that will lead to selection of one retrieval system for deployment in tank 241-C-106 following sluicing operations. If successfully implemented, development and demonstration of these retrieval technologies would reduce the uncertainty associated with DOE's ability to retrieve waste from the SSTs.

Cold testing demonstrations of four prototype retrieval technologies were completed in August 1997 under the HTI project. These systems included two arm-based systems and two remote vehicle-based systems that employ commercial technologies. The demonstration tests involved breaking up and pumping out simulated waste from test tanks. Results from these demonstrations will be used to develop performance specifications for the next phase of heel retrieval development under HTI, which will result in the award of a performance-based contract for deployment in tank 241-C-106.

HTI retrieval system development and deployment in tank 241-C-106 is scheduled to begin in October 2000. If successfully completed this schedule would support the design and implementation of SST retrieval required to support Phase II retrieval operations. During Phase 1, waste retrieval will be from DSTs with limited waste from SSTs, such as tank 241-C-106; therefore, SST waste retrieval uncertainties have little affect on plans for Phase IB retrieval and treatment. However, to support waste processing in Phase II the Tri-Party Agreement requires SST waste retrieval to begin in 2003 and for up to 35 SSTs, including tank 241-C-106, to be retrieved prior to initiation of Phase II waste treatment in approximately 2012.
The remaining SSTs would be retrieved during Phase II with the final SST retrieval completed in 2018. The phased schedule for waste retrieval and treatment will support operational flexibility required to develop and deploy alternate retrieval technologies, such as those being evaluated under HTI, to address key areas of retrieval uncertainty identified in the EIS including retrieval of SST hard-heel waste, retrieval from known or suspected leaking SSTs, and retrieval from SSTs that develop leaks during retrieval operations.

Retrieval Leakage

There is considerable uncertainty in estimating the likelihood of a leak occurring during waste retrieval and quantifying the leakage volumes. The mechanisms by which leaks might occur are not fully understood. The most likely leak path is through many small cracks caused by stress corrosion cracking around welds in the carbon steel tank liner and subsequently out through the construction joint where the tank wall meets the base. The extent of stress corrosion cracking in the SST liners is unknown. A stress corrosion cracking model was developed by the Savannah River Project, which predicts whether stress corrosion cracking may occur based on the chemistry of the waste. This model provided inconclusive results when applied to the Hanford SSTs (LMHC 1997b). The concentrations of hydroxide and nitrate in the waste lie between the values for which cracking is either predicted to occur or not occur.

If a leak were to occur during sluicing the leakage volume would be expected to be 15 to 30 m^3 (4,000 to 8,000 gal.) based on historical leak rates and the assumption that sluicing would be stopped once a leak was detected. However, analyses have been conducted that have shown that if a leak occurred early in the sluicing process and went undetected that leakage of up to 150 m^3 (40,000 gal.) may occur (WHC 1996f). This upper bound is conservative and would be expected to be less because 1) the leakage rate is determined by the hydraulic head and the resistance of the cracks in the tank and the properties of the surrounding soil; 2) the hydraulic head will decrease as sluicing progresses and liquid is held up in the sludge by capillary forces; 3) the ability to detect tank leaks; 4) the tendency of solids in the sludge to plug leaks; and 5) the ability to quickly remove sluicing liquids from the tank.

The minimum tank leakage volumes are a function of the capability of the leak detection technology. The current baseline leak detection technology is the mass balance method, which is based on retrieval process data and tank level measurements. Analysis for this method has determined that the minimum volume of leakage that can be reliably detected and mitigated is approximately 30 m^3 (8,000 gal.). Using this methodology, which involves tracking the volumes of liquids and solids (soluble and insoluble) and using parameters such as temperature, surface level, and liquid thermal expansion coefficients. The current baseline detection and mitigation minimum leakage volume for SST retrieval operations is 30 m^3 (8,000 gal.).

The environmental impacts that would result from retrieval leakage would be a function of the number of tanks that leak, the leakage volumes, the contaminant concentrations in the volume leaked, the area over which the leak escapes the tank (i.e., is the leak a point source or is it distributed around the base of the tank), and the leak duration. There is a high level of uncertainty for each of these leakage-related parameters; however, planned activities to establish retrieval performance criteria and develop leak detection technologies will reduce these uncertainties. Retrieval leakage uncertainties are less important to the implementation of Phase IB because limited SST retrieval is planned during Phase IB; however, these uncertainties would need to be addressed prior to implementing full-scale SST waste retrieval during Phase II.

The retrieval leakage scenario analyzed in the TWRS EIS included the following:

- Each of the 149 SSTs were assumed to leak 15 m^3 (4,000 gal.) during retrieval operations. This is conservative because arm-based retrieval systems deploying confined sluicing or mechanical retrieval technologies were also assumed to be deployed in 50 SSTs.
- Contaminant masses released in the retrieval leak were calculated using a congruent dissolution model with nitrate at an empirically based solubility limit of 360 g/L as the limiting concentration. All other contaminants were assumed to be present at concentrations that were calculated based on the mass ratio of the individual contaminants to nitrate multiplied by the solubility limit of 360 g/L.

Best-estimate leakage inventories were recently estimated for the 241-AX Tank Farm in support the RPE being conducted by the HTI project. These estimates were based on leakage volumes of 30 m^3 (8,000 gal.) and 150 m^3 (40,000 gal.). The contaminant concentrations were calculated by calculating two cases for the volume of water that would have to be added to the tank during retrieval. These cases assumed that the tank contents would be uniformly mixed with a volume of water necessary to achieve a waste slurry with 5 molar sodium concentration or a 10 weight percent solids and the higher of these two volumes would be required for retrieval.
The contaminant concentrations in the leakage was then calculated by dividing the tank inventory by the retrieval volume (Jacobs 1997).

For comparison purposes the contaminant inventories associated with an 30 m^3 (8,000 gal.) leak from each SST were calculated based on the 5 molar sodium retrieval limit. The 5 molar sodium limit for waste retrieval is one of the constraints that will be used during retrieval to minimize the formation of solids during waste transfer. Another constraint would be the weight percent of solids in the retrieval liquids. The 5 molar sodium limit is intended to be one example of how retrieval leakage could be estimated. In practice the sodium concentration would likely be higher at the beginning of retrieval and lower near the end. These inventories were compared against the retrieval leakage inventories used in the TWRS EIS. The TWRS EIS methodology resulted in calculating higher contaminant inventories for some constituents even though the leakage volume was 15 m^3 (4,000 gal.) as compared to 30 m^3 (8,000 gal.). A comparison of these two retrieval leakage estimates are provided in Table 5.2.1 for selected radionuclides. The notable exception in this comparison is the calculated inventory of Tc-99.

Table 5.2.1. Comparison of Contaminant Inventories in Retrieval Leakage

Radionuclide	Units (Decayed to 12/31/99)	Retrieval Leakage Inventory, 30 m^3 (8,000 gal.)/SST, Revised Inventory, Retrieval Liquids Limited to 5 M Na	TWRS EIS Retrieval Leakage Inventory, 15 m^3 (4,000 gal.)/SST, TWRS EIS Inventory, Congruent Release Model
C-14	Ci	33	100
Ni-63	Ci	1,600	22,000
Se-79	Ci	9.1	25
Tc-99	Ci	500	230
I-129	Ci	0.52	0.35
Np-237	Ci	9.1	0.82
U-238	Ci	16	26

Tc-99 is one of the major contributors to long-term risk, and an increase in the leakage inventory of Tc-99 would be expected to increase predicted long-term health risks. The following issues relative to retrieval leakage must also be considered in evaluating the uncertainties in human health and environmental impacts posed by retrieval leakage.

- Assuming all SSTs would leak during retrieval is a bounding assumption.
- The leak detection and mitigation capability for some tanks would be lower than 30 m^3 (8,000 gal.). This would include the AX Tank Farm with leak detection provisions, and the SST Farms with horizontal laterals running beneath the tanks.
- DOE would reassess the SST retrieval program if detectable volumes of leakage (equal to or greater than 30 m^3 [8,000 gal]) were routinely observed during initial SST retrieval operations.
- Some SSTs are confirmed leakers and would not be amenable to hydraulic sluicing. Use of robotic arm-based sluicing, with lower volume of liquids, was identified as a potential retrieval technology for 50 SSTs. This technology has a lower potential for leakage losses.
- There is a wide variation in current tank-by-tank waste volumes and expected retrieval durations which would indicate a range in leakage potential.

- The minimum detectable leakage range is 15 m^3 (4,000 gal.) to 30 m^3 (8,000 gal.), therefore, assuming a volume of 30 m^3 (8,000 gal.) for all retrieval leakage would be conservative.
- Saltwell pumping should transfer additional liquids containing a high percentage of the soluble and mobile risk-based constituents of concern into the DSTs.
- The tank-by-tank variations in the inventory of risk-based constituents of concern would be expected to result in greater risks from retrieval leakage in some tanks than in other tanks.

The new data and planned retrieval demonstration activities are anticipated to reduce DOE's uncertainties associated with SST retrieval and identified additional data required to further reduce these uncertainties prior to full-scale SST retrieval under Phase II. These uncertainties do not influence Phase IB decisions to the same extent because most waste retrieval in Phase IB will be from DSTs.

Waste Transfer

The potential for formation of colloids and gels from aluminum- and phosphate-containing compounds was identified as a technical uncertainty by the National Research Council (NRC 1996). DOE has addressed this technical uncertainty and developed a baseline approach for waste transfer through the development of models to provide sludge washing and waste transfer parameters to preclude the formation of unwanted solids (Kirkbride et al. 1997).

The TWRS Operations and Utilization Plan addresses solid-liquid phase behavior of Phase IB supernates. All of the Phase IB waste feeds exist as near-saturated or saturated solutions. To avoid conditions where waste retrieval and transfer activities could result in formation of highly viscous slurries or precipitation of solids, the baseline approach includes concentration adjustments through water and chemical additions. This will ensure that unwanted phase changes in the waste do not occur. Thermodynamic modeling has been conducted to evaluate phase equilibria for aluminum-bearing salts and other species in waste solutions. This is done to evaluate the behavior of aluminum species during waste retrieval when dilution water is added to the waste.

The steps taken to gather information through characterization and chemical modeling will provide a better understanding of waste behavior and allow DOE to reduce this technical uncertainty by defining acceptable waste transfer specifications.

5.3 WASTE TREATMENT

Separations and immobilization processes have not been demonstrated on Hanford Site tank waste on the scale described for the demonstration- and full-scale phases of the Phased Implementation alternative. The technologies such as solid/liquid separations, ion-exchange, and vitrification described for this alternative have been used to treat waste from other DOE sites and in Europe, but they have not been used on a production scale to treat Hanford Site waste.

A lower than assumed efficiency for the separations processes could result in producing higher volumes of vitrified HLW and higher concentrations of some radionuclides in the immobilized LAW. For example, if the separations process for removing Tc-99 from the LAW feed stream were less efficient than assumed, the Tc-99 inventory in the LAW vaults along with the anticipated environmental impacts would be higher. Therefore, some level of uncertainty exists in implementing the Phased Implementation alternative.

Considerable progress has been made since the release of the TWRS EIS in reducing the uncertainties surrounding the enhanced sludge washing process (LMHC 1997b)). Enhanced sludge washing is a process where the tank sludges are washed with strong caustic solutions to remove components such as aluminum, chromium, phosphorus, and sodium from the sludges to reduce the volume of HLW glass produced. Experimental results from enhanced sludge washing tests on waste solids are used to 1) estimate the distribution of waste inventory during retrieval between liquid and solid phases; and 2) determine the extent to which certain waste components are removed during leaching. Progress included both experimental enhanced sludge washing tests and thermodynamic computer simulations of Phase 1 sludge pretreatment.

The volume of HLW glass produced remains limited by chromium; however, the recent increased inventory of chromium reported in the revised inventory did not translate into substantial increases in HLW glass volumes because of improved performance projections for the enhanced sludge washing process. The expected amount of chromium removed while water washing the waste solids during sluicing decreased from 59 to 35 percent. The overall mass-weighted caustic leach factor (i.e., the amount of chromium removed from the water washed solids) increased from 14 to 78 percent. This results in an overall increase in enhanced sludge washing performance from 65 to 85 percent for chromium removal [LMHC 1997b]). Although DOE plans to contract for waste treatment services, this work demonstrates the technical feasibility of using an enhanced sludge washing process to reduce the volume of vitrified HLW.

DOE's plans to privatize waste treatment shift many of the responsibilities for addressing technical uncertainties for separations and immobilization to the private contractors. Details of the BNFL or LMAES processes are not available through December 1997.

One uncertainty that remains to be addressed is the fate of Se-79 in the separations and immobilization process. The Interim Low-Level Waste Performance assessment (WHC 1996a), in an effort to be conservative, assumed that all of the Se-79 would end up in the immobilized LAW. The fate of Se-79 was not included in the waste treatment process flowsheet modeling conducted in support of the TWRS EIS, and therefore Se-79 was not included in the TWRS EIS LAW vault inventory. Both Se-79 and Tc-99 are considered mobile in the vadose zone and groundwater and have similar health effects. Because the inventory of Se-79 is approximately 2 percent of the Tc-99 inventory, including it in the LAW disposal vault inventory would not appreciably change the impacts.

5.4 LONG-TERM HEALTH EFFECTS

The understanding of long-term health effects associated with losses during retrieval, residual waste, and onsite and offsite disposal facilities remains as an area of uncertainty. The TWRS EIS identified uncertainty in the conclusions as a consequence of the uncertainty in two major areas: the descriptions of the alternatives, with their associated assumptions about tank waste inventories, composition, and remediation technologies; and the consequences analyses, which included assumptions about waste source and release terms, future land uses, environmental transport parameters, and relationships between exposure and risk. The understanding of these uncertainties is adequate for Phase I activities because long-term risk is largely a function of retrieval losses from SSTs and residual waste following completion of SST retrieval, which are activities that will occur primarily during Phase II. However, additional information needs to be developed to reduce these uncertainties for Phase II.

The TWRS EIS included a bounding and nominal analysis of long-term health effects to provide information on the potential long-term health effects using both conservative and best-estimate values for the release and transport of contaminants. Additionally, because of the uncertainties associated with waste, waste retrieval, the potential for leakage during retrieval, future site uses, and waste from other 200 Area sources, the level of retrieval required to protect public health and safety was not specified. The Tri-Party Agreement provides an interim retrieval goal of no more than 10 m^3 (360 ft^3) of waste left in the tanks as residual following waste retrieval operations. This retrieval goal is not based on potential health effects and may or may not be protective of human health and the environment. Due to the variability in the tank-by-tank inventory it is expected that a fixed residual waste volume would result in long-term risks that vary greatly on a tank-by-tank basis.

To reduce the uncertainties surrounding the level of retrieval required within the context of the end state of the tank farms and surrounding 200 Area waste, DOE implemented the HTI project to establish a process for developing retrieval performance criteria for the 241-AX Tank Farm. The RPE was implemented to support the HTI project and involves developing retrieval performance criteria by assessing the environmental impacts from a range of alternatives for retrieval and closure of the AX Tank Farm. The process used to develop this criteria could then serve as a tool to support tank-by-tank retrieval decisions. This process will consider impacts from all potential source terms within the tank farm. These source terms include past leaks and spills, residual waste remaining in the tanks after retrieval, potential leakage that could occur during waste retrieval, and waste contained in ancillary equipment.

In support of the RPE process the HTI project is developing a number of engineering studies for different tank closure alternatives. A range of retrieval and closure alternatives have been identified for evaluation that include:

- Clean closure alternatives that involve tank removal, in situ soil remediation, or soil excavation

- Landfill closure alternatives that include a range of residual waste volumes and a range of technologies for stabilization of the tanks, in situ remediation of contaminated soils, options for ancillary equipment, and surface barriers.

To reduce uncertainties associated with understanding the TWRS end state within the context of other 200 Area sources and the effect of that relationship on TWRS SST retrieval closure decisions, DOE has implemented the Composite Analysis. This analysis will provide an estimate of the allocation of end state risks among the various 200 Area sources, thus providing TWRS with information needed to refine SST retrieval decisions. Initial results from the Composite Analysis are anticipated to be publicly available in 1998.

5.4.1 Source Terms

Source terms refer to the waste inventory, which is the total quantity of the hazardous material, and to the release term, which is the time dependent release to environmental media such as soil, groundwater, and surface water under normal or accident conditions.

The long-term risk posed by the Phased Implementation alternative is due to contaminant releases associated with retrieval losses, tank residuals, and immobilized LAW vaults. The inventory associated with retrieval leaks, tank residuals, and LAW vaults is based on the current tank inventory along with assumptions for how much waste would be retrieved, the volume and concentration of contaminants leaked during retrieval, and how effective the separations and immobilization process would be for the LAW. The revised inventory would affect each of these source terms as discussed previously.

The revised tank waste inventory is based on reevaluation of the inventory basis including waste sample analysis and reduces uncertainties associated with the source term. As the TWRS program continues to refine waste inventory based on characterization to support resolution of safety issues and waste processing for Phase IB, uncertainty regarding source term will continue to be reduced.

5.4.2 Contaminant Transport

The new vadose zone and groundwater data have raised some new issues for consideration but generally serve to reduce the overall uncertainty in predicting contaminant transport.

The information presented in this section and elsewhere in this SA regarding contaminant transport in the vadose zone and groundwater demonstrate that while important new data have emerged, although reduced, the uncertainty remains substantial. Much of this uncertainty is uniquely associated with the past tank leaks (e.g., volume of leaks, chemistry, duration of leaks, relationship of tank leaks to large volume liquid release in surrounding facilities). These uncertainties are less important for contaminant migration under the Phased Implementation alternative because 1) leakage during SST retrieval actions would be monitored and mitigated; 2) the chemistry of SST waste lost during retrieval would be different (more dilute) than past releases due to the addition of water required for retrieval; 3) the leaching of waste remaining in

SSTs following retrieval would be controlled by the low-permeability earthen cover and would not be expected to be subject to chemically enhanced mobility to the same degree as past leaks; and 4) the leaching of immobilized waste disposed in the LAW vaults will be controlled by a low-permeability cover, the low corrosion rate of the immobilized waste form (i.e., glass), and the lack of chemically enhanced mobility. This does not diminish the need for new data regarding contaminant transport. Data are needed, as the TWRS EIS concluded, to support both near-term decisions regarding which retrieval technologies to deploy at specific SSTs (e.g., known or suspected leakers and tanks developing leaks during retrieval) and long-term decisions regarding remediation of tanks and surrounding soils associated with closure of the tank farms.

The Phased Implementation alternative was implemented, in part, because it allows DOE the flexibility to begin waste treatment while reducing key program uncertainties. Phase IB implementation (1997-2012) would not be substantially impacted by the uncertainty associated with contaminant transport because nearly all waste retrieval to support Phase 1 waste processing will be from DSTs. DSTs have not contributed to past tank leak losses and are unlikely to leak during retrieval actions.

The Phased Implementation alternative approach provides DOE with time needed to address contaminant transport uncertainty prior to Phase 2 retrieval of SSTs (currently scheduled to begin no earlier than 2003 with most tanks being retrieved between 2012 and 2018). DOE has implemented several efforts to address key areas of uncertainty associated with SST retrieval (e.g., retrieval technology development and demonstrations, vadose zone and groundwater characterization) and should have data needed to support tank-by-tank retrieval decisions within the time frames of existing TWRS planning.

As the TWRS EIS concluded, prior to selecting a closure strategy for tanks and surrounding contaminated soils, substantial new data are needed to reduce uncertainties to levels that can support informed consideration of alternative approaches to closure. This is DOE's long-term need for contaminant transport data. Tank farm closure can not begin until the waste is out of the tanks and, therefore, the first demonstration of closure is not scheduled to begin until 2012. However, data regarding contaminant transport for closure are interrelated with SST retrieval because retrieval losses and the volume of waste remaining in tanks will be important components of any closure analysis. Thus DOE is integrating data collection and analysis supporting SST retrieval and closure to ensure that retrieval decision are made within the context of closure requirements.

5.4.3 Exposure

Exposure scenarios developed to evaluate potential long-term health impacts are based on conservative assumptions for health-risk-based parameters. Some of the contributing parameters are lifestyle, diet, land-use patterns, exposure pathways, exposure frequency and duration, and biotransfer/bioaccumulation factors. Assessment of long-term health impacts is inherently uncertain because of uncertainties associated with the size and lifestyle of future populations, land uses, climate and technology over a 10,000-year period of time. The risk analysis performed for the TWRS EIS included multiple exposure scenarios that cover a wide spectrum of exposure pathways to bound, to the extent reasonable, future land-use and exposure scenarios. The likelihood that future exposure scenarios lie outside the range used in the TWRS EIS is small and it is possible that scenarios resulting in substantially less exposure could occur. No new data have been developed since the preparation of the TWRS EIS that would reduce the uncertainties associated with the long-term human health risk exposure scenarios.

5.5 RELATIONSHIP BETWEEN TWRS AND OTHER AREAS

5.5.1 Past Leaks

There continues to be a large uncertainty surrounding past tank leaks and the impacts of these leaks on the overall groundwater quality; however, this uncertainty continues to be reduced as additional data and information are collected. The spectral gamma data for the drywells that surround the tank farms, the preliminary data from deepening borehole 41-09-39 at the SX Tank Farm, work performed as a part of the Composite Analysis, and some of the RPE studies are all being applied to refine the conceptualization of past tank leaks and their potential impacts on groundwater quality.

The data seem to indicate that some past tank leaks can arrive at the water table within a few tens of years, depending on the leak characteristics. These arrival times are supported by the RPE studies (Jacobs 1998a,b). For these past leaks, the leaks themselves are a very large driving force for the relatively fast transport in the vadose zone. The contaminant transport is augmented by the enhanced recharge of approximately 10 cm/yr (4 in./yr) at the tank farms through bare sand and gravel covers that have been placed over the tanks plus other sources of water such as water line leaks at some tank farms. Other factors include the tank leak area and the potential affects of the tank leak chemistry (e.g., high pH and high sodium concentration) in the near-field.

Even though the past tank leaks were not considered in the TWRS EIS impact assessment, they were evaluated in the cumulative impacts section. In the TWRS EIS, a bounding approach to past tank leaks was taken that assumed the No Action alternative could be used as an analog to the occurrence of past tank leaks. Use of this analog puts the impacts from past tank leaks out in time where they would be additive to the impacts from implementing the Phased Implementation alternative. Available information suggests the approach is still bounding because if anything, the impacts from past leaks are occurring sooner than would be calculated using the No Action alternative and thus would be less likely to be additive to the impacts associated with implementing the Phased Implementation alternative.

5.5.2 Non-TWRS Sources in the 200 Area

There continues to be a large uncertainty surrounding other non-TWRS sources in the 200 Area and the potential cumulative impacts of these sources on the overall groundwater quality; however, this uncertainty has been reduced as additional data and information are collected. The uncertainty on cumulative impacts resides in two major areas: 1) definition of the source terms which includes the amount of waste disposed, when it was disposed, and in what form; and

2) how waste moves from its initial place of disposal, down through the vadose zone, and laterally in the groundwater.

The uncertainty in the first area, definition of the source terms, is largely dependant on how well past activities were documented. Some improvements in the estimated inventory of past waste disposal have been achieved by the Composite Analysis studies in response to the DNFSB 94-02. The preliminary results of these efforts are summarized in Section 4.20, Cumulative Impacts, and compared to the values available at the time the TWRS EIS was prepared. It is not likely that additional information, beyond what is developed by the Composite Analysis effort, will be obtained on the past waste disposal inventories and practices.

There is uncertainty in how some waste moves from its place of disposal to the groundwater but this uncertainty is being reduced though the implementation of Site programs such as the ongoing RPE studies, the Composite Analysis, groundwater monitoring and assessments, and a vadose zone characterization program (includes spectral gamma logging, borehole drilling, and laboratory testing). As discussed previously, the spectral gamma data for the drywells that surround the tank farms, the preliminary data from deepening borehole 41-09-39 at the SX Tank Farm, work performed as a part of the Composite Analysis, and some of the RPE studies are all coming together into a refined conceptualization of contaminant transport. These refinements serve to reduce the uncertainty in contaminant transport and indicate the assumptions made in the TWRS EIS regarding contaminant transport for cumulative impacts are still bounding.

In the TWRS EIS, a discussion was presented that showed the past-practice liquid waste disposal could be considered to result in only near-term impacts. It was concluded that the cumulative impacts of this waste disposal activity would be very low for the Phased Implementation alternative and the new information and data do not change this conclusion.

Concerning past waste tank leaks, the data seem to indicate that some past tank leaks can arrive at the water table within a few tens of years, depending on the leak volume and chemistry. In the TWRS EIS, a bounding approach to past tank leaks was taken that assumed the past leaks would be additive with contaminant migration from tank waste that would not be remediated. Use of this analog puts the impacts from past tank leaks out in time where they would be additive to the impacts from the Phased Implementation alternative, maximizing contaminant concentrations in the groundwater. Available information suggests the approach is still bounding because if anything, the impacts from past leaks are occurring sooner than would be calculated using a no waste remediation assumption and thus would be less likely to be additive to the impacts associated with implementing the Phased Implementation alternative.

For the past-practice solid waste disposal sites, the solid low-level radioactive waste disposal in the 200 West burial grounds, and the solid low-level radioactive waste disposed in the US Ecology Burial Grounds, a bounding approach was taken that assumed the tank waste would be disposed of in the tanks, filled with gravel and capped. The new data and information suggest this approach is still bounding.

5.6 HLW DISPOSAL

The final location and costs for disposal for vitrified HLW from the TWRS program remains an uncertainty. For purposes of analysis, the TWRS EIS assumed that all TWRS HLW sent offsite for disposal would be disposed of at the geologic repository candidate site at Yucca Mountain, Nevada. Currently, Yucca Mountain is the only site being characterized as a geologic repository for HLW. If selected as the site for development, it would be ready to accept HLW no sooner than 2015.

Since the TWRS EIS was finalized, DOE has initiated the preparation of an EIS to analyze the site-specific environmental impacts from construction, operation, and eventual closure of a geologic repository for SNF and HLW at Yucca Mountain. The schedule for accepting waste and the costs associated with construction and operation of the geologic repository are preliminary. Additionally, the allocation of repository costs among defense waste sites has not been established.

There is no new information available since the TWRS EIS that would change the uncertainties associated with the TWRS planning baseline for disposal of all HLW offsite at a geologic repository.

5.7 REGULATORY COMPLIANCE

In the TWRS EIS, DOE described the Federal and Washington State regulations potentially applicable to TWRS EIS alternatives. Following the publication of the TWRS EIS, four regulatory developments have occurred that 1) affect how applicable regulations will be applied for implementation of the Phased Implementation alternative; and 2) reduce the regulatory uncertainty associated with classification of the LAW waste stream. These regulatory developments are discussed in detail in Section 4.14.

One new area of regulatory uncertainty is associated with current Hanford Site efforts to develop a Sitewide PCB strategy to address Toxic Substance Control Act regulations. This effort is early in the process and will involve extensive discussions with EPA and Ecology. However, depending on the outcome of the effort, certain tanks and the process facilities could be required to meet Toxic Substance Control Act compliance requirements.

The RPE project that was established under HTI includes the evaluation of regulatory issues associated with tank farm retrieval and closure alternatives. This includes addressing regulatory requirements associated with TWRS waste retrieval system as it relates to 1) retrieval, treatment, and disposition of tank waste remaining in the tanks following retrieval of tank waste to the extent practicable; 2) removal, treatment, and disposition (i.e., end state or closure) of soils contaminated by past tank leaks during waste retrieval actions; and 3) removal, treatment, and disposition of the tanks and ancillary equipment (i.e., end state or closure).

This analysis is being conducted at the 241-AX Tank Farm using a systems approach that considers retrieval and closure of the entire tank farm system. This approach was identified by the National Research Council as a method that could reduce programmatic and regulatory uncertainties. The RPE will be completed in early 1999.

One area of uncertainty for disposal of the residual waste remaining in the tanks following retrieval is whether attainment of the 99 percent retrieval goal would result in a residual waste that could be classified by the NRC as non-HLW (i.e., incidental waste). DOE's Savannah River Site has taken closure actions for buried HLW tanks that include retrieval of waste to the extent practicable, immobilization of the residual waste using an engineered grout material, and tank stabilization using grout. The NRC is currently reviewing the technical basis for incidental waste classification for HLW tank in situ closure at the Savannah River Site. This review is expected to be completed in April 1998 and is likely to set a precedent for classification of the Hanford Site's residual tank waste (Jacobs 1997). The NRC did consider the classification of the TWRS LAW vitrified waste stream and preliminarily concluded that the immobilized LAW met criteria established for incidental waste, was not HLW and therefore not subject to NRC regulations, and hence the waste could be disposed of onsite in near surface facilities (Section 4.14). This preliminary determination reduces uncertainty identified in the TWRS EIS with disposal of immobilized LAW. However, uncertainties associated with in-place residual waste disposal are not affected by this determination.

5.8 DOE WASTE MANAGEMENT PLANNING

DOE continues to address complex-wide waste management issues to reduce spending in the short-term while reducing both economic and environmental liabilities in the long-term. These efforts include options for accelerating cleanup of DOE sites, thereby reducing the overall life-cycle costs while complying with applicable environmental and legal requirements. The efforts also include examining complex-wide integration. These efforts represent DOE's continuing need to consider programmatic approaches for managing remediation of hazardous and mixed waste in a cost-effective manner. At some future date, programmatic options may affect Hanford Site management of tank waste remediation (e.g., plant sizing, operations); however, no option that would impact the Hanford Site's tank waste has reached a level of maturity that would require reassessment of the Phased Implementation alternative.

6.0 DETERMINATION

The data and information that have been developed since the preparation of the TWRS EIS relative to the plans for remediating the tank waste have been assessed. This assessment was conducted to support a decision on whether the potential environmental impacts are bounded by the impacts presented in the TWRS EIS or whether a Supplemental EIS or other NEPA documentation is required.

Potential changes in environmental impacts from the new data and information were presented in Section 4.0, and the effect these new data and information have on the uncertainties associated with the TWRS program were presented in Section 5.0 of this document. The new data included a revised tank waste inventory, emerging information on the level of contamination in the vadose zone, revised assessments on the potential for and consequences of accidents associated with management of the tank waste, ongoing technology development activities, and other engineering data. The areas of potential environmental concern included air emissions, releases to the groundwater, health risks to Site workers and the public, loss of shrub-steppe habitat, and cumulative impacts. For each area of the environmental impacts associated with implementing the Phased Implementation alternative, the impacts were not substantially changed from the impacts presented in the TWRS EIS.

The changes in potential environmental impacts would be small in comparison to and are bounded by the impacts presented for the Phased Implementation alternative in the TWRS EIS. The Phased Implementation alternative does not pose potential environmental impacts that are substantially changed from those presented in the TWRS EIS, nor are there any significant new circumstances relevant to environmental concerns. Therefore, no additional NEPA analysis is required.

Signed in Richland, Washington, this 15th day of May 1998.

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APPENDIX A

VADOSE ZONE AND GROUNDWATER

A.1 NEW DATA AND INFORMATION

New groundwater data and information including those from the vadose zone and underlying saturated zone are discussed in this appendix. New vadose zone data and information are from 1) spectral gamma logging of drywells around the tank farms; 2) the extension of borehole 41-09-39 at the SX Tank Farm; 3) ongoing studies on contaminant mobility; 4) studies on recharge, 5) studies on potential preferential flow paths; and 6) studies on tank leak characteristics. New groundwater data and information are from 1) water level measurements; and 2) chemical and radiological analysis of groundwater samples. The new information on tank waste inventory is also discussed as it affects the calculated contaminant concentrations in the groundwater.

A.1.2 NEW VADOSE INFORMATION

The vadose zone is thick at the waste tank and low-activity waste (LAW) vault locations (i.e., from approximately 65 meters [m] [213 feet (ft)] to 85 m [279 ft]), is partially saturated, and combined with arid site conditions, retards contaminant migration to the underlying unconfined aquifer. In the Tank Waste Remediation System (TWRS) Environmental Impact Statement (EIS), the impact assessment for the Phased Implementation alternative relied on the Site-accepted conceptual model of the vadose zone, which included the geometry of each site (i.e., number and thickness of strata) where the releases would occur, the assumption that each strata was an isotropic and homogenous porous medium, that contaminant transport would be driven primarily by advection downward through the interstitial spaces of the various strata, that contaminant transport would be an isolinear process (i.e., independent of contaminant concentration), and that contaminant mobility as expressed by the distribution coefficient (K_d) parameter would remain constant in the various strata of the vadose zone. In addition to vadose zone-specific elements, the conceptual model includes recharge from precipitation, the area from which a release occurs, the release volume, and the release duration. The new data and information, in particular, the spectral gamma logging, Resource Conservation and Recovery Act (RCRA) groundwater quality monitoring assessment, and numerical parametric studies, provide data to refine the conceptual model. A summary of the re-assessment of these data and information relative to the vadose zone component of the TWRS EIS groundwater impact assessment is provided in this section, followed by a detailed discussion.

- New information on potential effects of vadose zone layer thicknesses are based on ongoing Retrieval Performance Evaluation (RPE) studies (Jacobs 1998a,b). These studies suggest that the TWRS EIS one-dimensional vadose simulations using generalized vadose zone layer thicknesses has little affect on calculated mass flux, compared to source-specific vadose zone layer thicknesses.

- New information from the RPE studies (Jacobs 1997) on vadose zone characteristics focus on the effects of anisotrophy and homogeneity and are based on numerical studies. These studies suggest that multi-dimensional simulations that incorporate natural formation anisotrophy and heterogeneities would better match contaminant distribution in the vadose zone but would not likely result in a faster travel time through the vadose zone to the water table or higher maximum contaminant concentrations at the water table compared to the TWRS EIS vadose simulations.

- New information on vadose zone flow paths characteristics focus on the effects of clastic dikes, drywells annular space, and to a limited extent on alternative flow paths including funnel flow and fingering. These studies suggest that vadose zone contaminant transport through clastic dikes and potentially poorly sealed drywell annular spaces have very little affect on contaminant time of first arrival or maximum contaminant concentration at the water table.

- New information on contaminant mobility in the vadose zone associated with source chemistry characteristics indicate that mobility of some contaminants is affected near the source. These studies suggest that there may be some basis for refining the vadose zone conceptual model to include a zone near the source where contaminant mobility is most affected by factors such as pH and sodium concentration. There is still much uncertainty related to these potential effects such as which contaminants are affected, how are they are affected (i.e., higher or lower mobility), the spatial extent of the effect, and the temporal extent of the effect. These studies suggest that vadose zone contaminant transport may be faster near the source for some contaminants (e.g., cesium [Cs]-137 and nickel [Ni]-63) and slower for others (e.g., uranium).

- New information on recharge of precipitation and other sources of water near the sources indicate there is little impact on the TWRS EIS for contaminant first arrival and maximum concentration at the water table. Water sources such as fire line leaks are a large source of uncertainty associated with the past tank leaks because of their effect on contaminant first arrival and concentration at the water table for past leaks.

- New information on tank leak characteristics (e.g., area from which leak occurs, leak duration, and leak volume) are based on numerical studies and indicate that contaminant first arrival at the water table from past leaks and, to a lesser extent from sluicing losses, may occur sooner that calculated in the TWRS EIS.

The data indicate that some past tank leaks can arrive at the water table within a few tens of years, depending on the leak volume, chemistry, and other characteristics. These arrival times are supported by the RPE studies (Jacobs 1997, 1998a,b). For these past leaks, the leaks themselves are a very large driving force for the relatively fast transport in the vadose zone. The contaminant transport is augmented by the enhanced recharge of approximately 10 centimeters (cm)/year (yr) (3.94 inches [in.]/yr) at the tank farms through bare sand and gravel covers that have been placed over the tanks plus other sources of water such as water line leaks at some tank farms. Other factors include the tank leak area and the potential effects of the tank leak chemistry (e.g., high pH and high sodium concentration) in the near-field.

Even though the past tank leaks were not within the scope of the TWRS EIS impact assessment, they were evaluated with respect to their potential cumulative impacts. In the TWRS EIS, a bounding approach to past tank leaks was taken that assumed the No Action alternative could be used as an analog to the occurrence of past tank leaks. Use of this analog puts the impacts from past tank leaks out in time where they would be additive to the impacts from implementing the Phased Implementation alternative. Available information suggests the approach is still bounding because if anything, the impacts from past leaks are occurring sooner than would be calculated using the No Action alternative and thus would be less likely to be additive to the impacts associated with implementing the Phased Implementation alternative.

The effect the new vadose zone data and information would have on the impacts presented in the TWRS EIS for leaks during retrieval, leaching of contaminants from residuals that may be left in the tanks, and leaching of contaminants from the immobilized waste in the LAW vaults for the conditions of the Phased Implementation alternative appears to be small. The effects of vadose zone layer thickness assumptions was shown to be small, the one-dimensional vadose model approach provided bounding results compared to multi-dimensional models, parametric analysis of the potential effects of clastic dikes and similar-type preferential flow paths indicate they would have very little affect on maximum concentrations of contaminants reaching the water table, potential chemically enhanced mobility would likely most affect past leaks, and recharge under current conditions are recharge from artificial sources such as fire line leaks would most affect past leaks with little impact to sluicing losses or residual releases. Tank leak characteristics would affect past leaks, resulting in a more rapid transit time if the tank leak were more localized and/or the volume of leak were larger than previously reported. These impacts to the groundwater would not coincide with the potential impacts from retrieval or tank residual releases associated with the Phased Implementation alternative. The same type of tank leak characteristics (e.g., tank leak area and volume) would also affect the potential retrieval loss impacts. However, the range of sluicing loss leak is more constrained that past leak values, a cap would be installed over the tanks after sluicing, which would slow contaminant transport in the vadose zone, and there remains much uncertainty regarding which and how many of the 149 single-shell tanks (SSTs) would leak during retrieval.

A.1.2.1 Vadose Zone Monitoring (Spectral Gamma Logging)

This section summarizes the data from spectral gamma logging of existing drywells at the single-shell tank (SST) farms and the two recently installed drywells at SX Tank Farm.

A program is currently underway to develop baseline gamma-specific radioisotope information in the upper vadose zone (i.e., ground surface to 43 m [140 ft]) near the SSTs. This program builds on a previous one in which gross gamma data were collected as a means of leak detection from the SSTs. Both programs used the networks of drywells that are installed around each tank in each SST tank farm. In FY 1995, logging was completed at the SX Tank Farm (PNNL 1997a). Spectral gamma logging was completed in FY 1996 in drywells around the following tank farms: AX, S, TX, TY, and A. In addition to logging existing drywells, two boreholes were installed in the SX Tank Farm, boreholes 41-12-01 and 41-09-39, to depths of approximately 38 m (125 ft) and 39.6 m (130 ft) below ground surface, respectively, and logged. The results of the spectral gamma logging program generally show a consistent pattern and are consistent with information incorporated in the TWRS EIS (DOE 1996a). That is, where tanks are known to have leaked, the predominant gamma-emitting contaminant in the vadose zone is Cs-137 and the location of maximum Cs-137 concentration is generally several tens of feet above the bottom of the drywell. Data from the U and BX (DOE 1997b,d) Tank Farms provide an exception to this generalization where the maximum concentration was detected near the bottom of the drywell. Other gamma-emitting contaminants have been detected but Cs-137 is the common element at all of the tank farms logged to date.

Some of the first information from the logging program was generated from the SX Tank Farm. At the SX Tank Farm, spectral gamma logging identified Cs-137 as deep as 42.6 m (140 ft) below ground surface. Other, more mobile contaminants including Tc-99 and chromium were detected in RCRA groundwater monitoring wells and have subsequently been linked to sources within the SX Tank Farm (Johnson and Chou 1997).

At the BY Tank Farm, spectral gamma logs of the 69 drywells around the 12 tanks indicated Cs-137 was the most abundant gamma-emitting contaminant in the vadose zone, detected throughout the lengths of several of the dry wells at concentrations that were generally less than 1 pCi/g but with maximum concentration of 180,000 pCi/g in one drywell. Cobalt (Co)-60 was detected at much lower concentrations (usually < 10 pCi/g), often near or at the bottom of the dry wells (PNNL 1997a).

The two new boreholes at the SX Tank Farm were installed using a percussion hammer drilling method to minimize potential cross contamination from drag down of contamination. These boreholes were logged after each 3 m (10 ft) of advance to quantify potential drag down. Borehole 41-12-01 passed through some Cs-137 contamination but did not intercept high levels of Cs-137 contamination in the vadose zone as was expected (PNNL 1997a). However, the successive logging of this borehole demonstrated drag down of contamination was occurring. Using drilling tools modified to mitigate the drag down observed in the first borehole, borehole 41-09-39, was subsequently installed about 1.7 m (5.6 ft) from an existing drywell (41-09-04) in which high levels of Cs-137 had been observed with the spectral gamma logging down to a depth of approximately 38 m (125 ft). This borehole did pass through high levels of Cs-137 and the modified tools were apparently successful in mitigating drag down during drilling as indicated by the successive 3 m (10 ft) interval logging data. Spectral gamma logging data from borehole 41-09-39 indicated the presence of Cs-137 in the formation to the total depth of the boring which was 39.6 m (130 ft). It was concluded that the cesium likely reached that depth via transport through the formation and not along the unsealed drywells that are nearby (PNNL 1997a).

Table A.1 shows the spectral gamma logging reports that have been released, their release dates, detected gamma-emitters, maximum depth of detection, and the depth of maximum concentration.

Table A.1. Summary of Spectral Gamma Logging Results [1]

Tank Farm/ Tank Summary	Date Completed	Gamma-Emitting Constituent	Maximum Depth of Detection (m)	Maximum Concentration Depth (m)[2]	Maximum Concentration (pCi/g)	Comments
SX	Sept. 1996	Cs-137, Co-60, Eu-152, Eu-154	43 (Cs-137) [Tank 102]	21-38 (Cs-137) [Tank 112]; 18-30 [Tank 109]; 21-27, 102-104 [Tank 109]	>8,000 (Cs-137) [Tank 112] >15,000 [Tank 109]	Saturated probe. Tank SX-102 is a possible leaker based on Cs in borehole 41-02-02.
BY	Feb. 1997	Cs-137, Co-60, Sb-125, Eu-154, Pa-234	44 (Cs-137)	8-14 (Cs-137)	180,000 (Cs-137)	Value calculated from gross-gamma data.
U	May 1997	Cs-137, Co-60, Eu-154, U-235, U-238	38 (Cs-137), 28 (U-238)	30-38 (Cs-137), 18-24 (U-238)	1,000 (Cs-137) 1,000 (U-238)	
AX	Aug. 1997	Cs-137, Co-60, Sb-125, Eu-154	30 (Cs-137 near tank AX-103)	2 (Cs-137)	1,435 near tank AX-104	
TX	Sept. 1997	Cs-137, Co-60, Sb-125, Eu-154, U-235, U-238	43	14 (Cs-137) 17-18 (Co-60) 22 (U-238)	>1,000 [Tank 114] 900 [Tank 107] 600 [Tank 105]	Maximum concentration was saturated log
BX-102	Sept. 1997	Cs-137, Co-60, Sb-125, Eu-154, U-235, U-238	70	70	>10,000	Maximum extent of borehole was 70 feet. Maximum concentration was saturated.
T-107	Aug. 1995	Cs-137	28	1	120	Minimum detection in boreholes
T-110	Aug. 1995	Cs-137	18	14	13	Minimum detection in boreholes

Notes:

[1] Source: DOE (1995a, 1995b, 1996b, 1996c, 1997a, 1997b, 1997c, 1997d, 1997e).
Greater than sign (>) indicates probe was saturated.
Unless noted, constituent of concern is Cs-137 for maximum depth and maximum concentration depth.

[2] Maximum depth of detection may be limited by well depth.

A.1.2.2 Data from Extending Borehole 41-09-39

The data that can be obtained from the spectral gamma logging of the drywells around the tank farms are limited to gamma-emitting radioisotopes such as Cs-137 that generally move slower than the long-lived, high-risk contaminants Tc-99, I-129, and Se-79. Also, data can only be obtained to the depth of the drywells, which do not penetrate the lower portion of the vadose zone. Thus, the U.S. Department of Energy (DOE) is extending borehole 41-09-39 from 39.6 m

(130 ft) to the water table, which is anticipated to be at approximately 64 m (210 ft). Preliminary data based on samples taken to a depth of 52.6 m (172.7 ft) are summarized in Table A.2.

A.1.2.3 Distribution Coefficient Values Assumed for Impact Analysis

New direct measurements of the K_d for tank waste and Hanford Site sediments will be completed with samples from the new borehole 41-09-39, currently being advanced at the SX Tank Farm; however, these data are not yet available. No other direct measurements have been performed. There are, however, some limited data on the K_ds of some contaminants in the vadose zone and on tank waste contaminants that have reached the groundwater from which contaminant mobility can be qualitatively assessed. These data, combined with an assessment of previous work, have been used to develop inferences on tank waste contaminant mobility. The most comprehensive of these is that which has been developed for the Composite Analysis in response to Defense Nuclear Facility Safety Board (DNFSB) 94-02 (Freshley 1997). The other effort is the RPE being prepared for the Hanford Tanks Initiative (HTI) (Jacobs 1997), which is focusing on retrieval criteria for one tank farm, the AX Tank Farm. This information from these efforts indicates that the bounding estimates adopted for the TWRS EIS are still bounding for the contaminants that are most important to long-term human health risk.

A.1.2.4 Preliminary Identification of Contaminants Most Responsible for the Long-term Human Health Impacts and Indicators of Past Tank Leaks

This section provides a discussion of the emerging information on contaminant mobility. The discussion includes 1) the contaminants most responsible for the long-term human health risk for the Phased Implementation alternative; and 2) contaminants that may be indicators of vadose zone contamination and past tank leaks.

A.1.2.3 Distribution Coefficient Values Assumed for Impact Analysis

New direct measurements of the K_d for tank waste and Hanford Site sediments will be completed with samples from the new borehole 41-09-39, currently being advanced at the SX Tank Farm; however, these data are not yet available. No other direct measurements have been performed. There are, however, some limited data on the K_ds of some contaminants in the vadose zone and on tank waste contaminants that have reached the groundwater from which contaminant mobility can be qualitatively assessed. These data, combined with an assessment of previous work, have been used to develop inferences on tank waste contaminant mobility. The most comprehensive of these is that which has been developed for the Composite Analysis in response to Defense Nuclear Facility Safety Board (DNFSB) 94-02 (Freshley 1997). The other effort is the RPE being prepared for the Hanford Tanks Initiative (HTI) (Jacobs 1997), which is focusing on retrieval criteria for one tank farm, the AX Tank Farm. This information from these efforts indicates that the bounding estimates adopted for the TWRS EIS are still bounding for the contaminants that are most important to long-term human health risk.

Table A.2. Summary of Preliminary Sample Analysis From SX Tank Farm Borehole 41-09-39[1]

Depth (ft)	Sample ID	M.C.[2] (%)	NO_3 (ppm)	Tc-99 (pCi/g)	Sr-90 (pCi/g)	Cs-137 (pCi/g)	K-40 (pCi/g)	U-238 (pCi/g)	Th-232 (pCi/g)
131.7	1B	13	NM	NM	NM	2.35E+06	<MDA[4]	<MDA	<MDA
131.7	1B-2	NM[3]	NM	NM	NM	NM	NM	NM	NM
131.7	C.O.[6]								
133.2	C.O.								
133.2	2D	35.6	NM	290	2.0	6.50E+04	2.98E+00	<MDA	<MDA
133.7	2C	18.3	NM	X[5]	X	3.15E+04	1.54E+01	<MDA	<MDA
133.7	2C-2	26.7	NM	NM	NM	1.47E+06	<MDA	<MDA	<MDA
134.2	2B	14.5	291	56	1.0	2.60E+03	5.04E+00	<MDA	1.37
134.7	2A	16	268	X	X	6.65E+01	1.33E+01	<MDA	1.39
134.7	C.O.								
135.2	C.O.								
135.2	3B	NM	362	86	3	NM	NM	NM	NM
135.9	3A	13.1	165	X	X	3.31E+03	<MDA	<MDA	<MDA
135.9	C.O								
137.0	C.O								
137.4	4C	10.9	12	NM	NM	<MDA	1.16E+01	7.76E-01	6.65E-01
138.0	4B	11.7	24	NM	NM	1.81E+01	<MDA	<MDA	<MDA
138.7	4A	16.1	NM	NM	NM	5.86E-01	1.04E+01	1.28	6.97E-02
138.7	C.O								
139.5	C.O								
139.9	5D	14.1	NM	NM	NM	4.14E+01	8.22E+00	1.37	4.56E-01
140.3	5C	14.5	9.9	NM	NM	1.76E+01	8.47E+00	1.15	5.73E-01
140.9	5B	12.6	3.7	NM	NM	7.81E+01	7.88E+00	6.76E-01	4.50E-01
141.5	5A	9.4	9.8	NM	NM	3.97E+00	9.85E+00	1.09	6.56E-01
141.9	C.O.								
141.9	6F	11	9.1	NM	NM	1.54E+02	1.24E+01	<MDA	<MDA
142.4	6E	9.6	14	NM	NM	2.96	9.75	1.53	1.42
143.3	6D	21.8	42	NM	NM	1.34E-01	1.43E+01	1.95	1.22
144.1	6C	26	58	NM	NM	1.74E+02	1.03E+01	<MDA	<MDA
144.7	6B	22.9	48	NM	NM	<MDA	1.23E+01	7.37E-01	9.83E-01
144.7	C.O.								
145.2	C.O.								

Table A.2. Summary of Preliminary Sample Analysis From SX Tank Farm Borehole 41-09-39[1] (cont'd)

Depth (ft)	Sample ID	M.C.[2] (%)	NO_3 (ppm)	Tc-99 (pCi/g)	Sr-90 (pCi/g)	Cs-137 (pCi/g)	K-40 (pCi/g)	U-238 (pCi/g)	Th-232 (pCi/g)
145.2	7E	8.7	12.1	NM	NM	4.57	1.05E+01	4.35E-01	5.44E-01
145.8	7D	9.5	13.1	NM	NM	2.19E-01	9.86	6.57E-01	5.48E-01
146.4	7C	11.2	15.3	NM	NM	4.45E+00	1.08E+01	4.45E-01	5.56E-01
146.4	7C-R	11.2	NM	NM	NM	<MDA	1.05E+01	5.56E-01	5.56E-01
148.0	C.O.								
148.3	C.O.								
148.3	8C	7.4	NM	NM	NM	2.19E+01	8.06	2.15E-01	5.37E-01
149.9	8B	9.7	NM	NM	NM	1.39E+01	1.12E+01	5.49E-01	7.68E-01
149.9	C.O.								
150.8	C.O.								
151.1	9C	12.8	NM	NM	NM	1.23E+03	<MDA	<MDA	<MDA
151.8	9B	NM	NM	NM	NM	NM	NM	NM	NM
152.8	9A	13.9	24	NM	NM	1.82E-01	9.91	7.97E-01	5.70E-01
152.8	C.O.								
152.9	C.O.								
152.9	10D	NM	NM	NM	NM	NM	NM	NM	NM
153.4	10C	13.6	48	NM	NM	7.95E-02	9.77	5.68E-01	6.82E-01
153.9	10B	14.7	49	5	0.5	<MDA	8.83	6.88E-01	8.03E-01
154.5	10A	19.6	33	X	X	2.39E-02	1.40E+01	<MDA	7.18E-01
154.5	C.O.								
155.1	11D	5.4	NM	NM	NM	1.84	4.30	<MDA	4.22E-01
155.4	11C	4.3	9.8	NM	NM	<MDA	4.1	3.13E-01	3.13E-01
155.9	11B	3.5	8.4	NM	NM	<MDA	4.64	2.38E-01	3.11E-01
156.4	11A	4.5	5.3	NM	NM	1.03E+01	4.70	3.14E-01	3.14E-01
156.4	C.O.								
156.8	C.O.								
156.8	12B	6.9	10.5	4	0.4	7.89E+01	5.53	<MDA	3.63E-01
157.1	12A	6.6	7.5	X	X	7.79E+01	6.05	<MDA	4.80E-01
157.1	C.O.								
157.2	C.O.								
157.2	13D	6.4	2	NM	NM	5.92E+01	6.04	<MDA	4.79E-01
157.7	13C	4	6.2	NM	NM	1.06E+01	6.26	3.12E-01	3.95E-01
158.2	13B	5.3	8	NM	NM	1.21	5.76	<MDA	2.84E-01

Table A.2. Summary of Preliminary Sample Analysis From SX Tank Farm Borehole 41-09-39[1] (cont'd)

Depth (ft)	Sample ID	M.C.[2] (%)	NO_3 (ppm)	Tc-99 (pCi/g)	Sr-90 (pCi/g)	Cs-137 (pCi/g)	K-40 (pCi/g)	U-238 (pCi/g)	Th-232 (pCi/g)
158.7	13A	NM	NM	NM	NM	NM	NM	NM	NM
158.7	C.O.								
159.0	C.O.								
159.0	14D	NM	NM	NM	NM	NM	NM	NM	NM
159.4	14C	5.9	NM	NM	NM	2.84	4.88	<MDA	3.07E-01
160.0	14B	5.8	NM	NM	NM	<MDA	7.84	4.76E-01	3.49E-01
160.6	14A	7.6	NM	NM	NM	<MDA	1.06E+01	3.23E-01	4.63E-01
160.6	C.O.								
162.3	C.O.								
162.3	16D	13.3	5.77	NM	NM	2.49	9.94	3.63E-01	4.01
162.8	16C	13.5	NM	NM	NM	2.61	9.27	3.52E-01	4.20
163.3	16B	4.1	5.4	NM	NM	4.75	6.46	4.58E-01	3.12
163.8	16A	4.4	2.83	NM	NM	<MDA	6.99	3.13E-01	1.77E-01
163.8	C.O.								
164.3	17D	4.91	NM	NM	NM	1.95	7.45	NM	NM
164.8	17C	3.56	0.3	NM	NM	9.63E-01	6.23	NM	NM
165.3	17B	5.27	7.6	<2.5	0.35	6.32E-02	7.36	NM	NM
165.8	17A	4.91	10.8	X	X	<MDA	8.11	NM	NM
165.8	C.O.								
166.1	C.O.								
166.1	18D	NM	NM	NM	NM	NM	NM	NM	NM
166.6	18C	9.7	NM	NM	NM	<MDA	8.39	NM	NM
167.1	18B	4.7	NM	NM	NM	<MDA	7.60	NM	NM
167.7	18A	4.7	NM	NM	NM	5.24E-01	7.47	NM	NM
167.7	C.O.								
169.2	C.O.								
169.2	20D	NM	NM	NM	NM	NM	NM	NM	NM
169.4	20C	NM	NM	NM	NM	NM	NM	NM	NM
169.7	20B	NM	NM	NM	NM	NM	NM	NM	NM
169.9	20A	4.3	NM	NM	NM	3.02E-01	5.16	2.09E-01	1.88E-01
169.9	C.O.								
171.3	C.O.								
171.3	22C	5.8	NM	NM	NM	5.18E-01	6.30	<MDA	2.22E-01

Table A.2. Summary of Preliminary Sample Analysis From SX Tank Farm Borehole 41-09-39 [1] (cont'd)

Depth (ft)	Sample ID	M.C.[2] (%)	NO_3 (ppm)	Tc-99 (pCi/g)	Sr-90 (pCi/g)	Cs-137 (pCi/g)	K-40 (pCi/g)	U-238 (pCi/g)	Th-232 (pCi/g)
172.0	22B	5.2	NM	NM	NM	4.42E-01	7.76	2.10E-01	2.21E-01
172.7	22A	NM	NM	NM	NM	NM	NM	NM	NM
172.7	C.O.								

Notes:

Source: Serne 1997

[1] Reported concentrations are on a dry weight basis.

[2] M.C. is the abbreviation for moisture content.

[3] NM is the abbreviation for not measured at present time. Analysis are ongoing and additional results will become available.

[4] MDA is the abbreviation for minimum detectable activity.

[5] The results reported for Tc-99 and Sr-90 are based on composite samples. The "X" indicates that fraction of sample was composited with the fraction in the column on which the analytical result is provided.

[6] C.O. is the abbreviation for clean out, which means that during the drilling process the hole was cleaned out and not sampled.

A.1.2.4 Preliminary Identification of Contaminants Most Responsible for the Long-term Human Health Impacts and Indicators of Past Tank Leaks

This section provides a discussion of the emerging information on contaminant mobility. The discussion includes 1) the contaminants most responsible for the long-term human health risk for the Phased Implementation alternative; and 2) contaminants that may be indicators of vadose zone contamination and past tank leaks.

The TWRS EIS groundwater impact analysis considered the impacts of all of the contaminants reported in the inventory for the waste tanks and LAW vault. The large number of contaminants were placed into four groups (i.e., K_d = 0, 1, 10, and 50 mL/g) based on their mobility in the vadose zone and groundwater. This approach is bounding and results in placing contaminants such as uranium which has a best-estimate K_d of 0.6 mL/g (Kaplan and Serne 1995) in the group of contaminants with zero K_d. A relatively small group of contaminants can be identified in the TWRS EIS as being responsible for more than 90 percent of the long-term human health risk for the Phased Implementation alternative. Likewise, new information developed for the interim low-level tank waste performance assessment (Mann et al. 1997) and RPE studies (Jacobs 1998a,b) have identified a similar group of contaminants.

Additional data from the spectral gamma log data from dry wells around the waste tanks have resulted in the identification of specific gamma-emitting radioisotopes that may be used as indicators of current vadose zone contamination associated with past waste tank leaks. The contaminant most frequently identified and with the greatest abundance is Cs-137. Cs-137 is included as an "indicator" parameter because of it abundance, even though it has a short half-life (30 years) and is nearly immobile in the natural groundwater system and is thus not a contaminant of concern for the groundwater pathway for any of the long-term human health risk scenarios. Table A.3 summarizes the contaminants most responsible for long-term human health risk from the TWRS EIS (DOE 1996a), interim low-level tank waste performance assessment

(Mann et al. 1997), and RPE (Jacobs 1998a,b) evaluations and indicator parameters. The TWRS EIS considered both potential releases from the waste tanks and the LAW vaults. The interim low-level tank waste performance assessment considered releases from the LAW vaults only. The RPE evaluations considered potential releases from the AX Tank Farm only.

Table A.3. Comparison of Parameters Most Responsible for Long-term Human Health Risk and Indicator Parameters for the TWRS EIS, RPE, and ILLW Studies

Contaminant	TWRS EIS[3]	RPE[2]	ILLW[1]
Relative to long-term human health risk			
Tc-99	X	X	X
Se-79	X	X	X
CN		X	N/A[2]
EDTA		X	N/A[2]
NO_3	X	X	N/A[2]
I-129	X	X	X
C-14	X	X	X
U Series	X	X	X
Np	X		X
Indicator contaminant			
Cs-137	X	X	

Notes:

[1] Mann et al. 1997

[2] Jacobs 1998a,b

[3] DOE 1996a

[4] Vitrified waste will not contain any organic compounds.

RPE = Retrieval Performance Evaluation

ILLW = Interim low-level waste performance assessment

A.1.2.5 Comparison of Distribution Coefficient Values Assumed in the TWRS EIS and Emerging Information

The emerging information on contaminant mobility from the Composite Analysis (Freshley 1997) effort and the RPE project (Jacobs 1997) are discussed in this section. This section provides a summary comparison between the TWRS EIS, the emerging information, and other relative Hanford Site related efforts published within the last 10 years. The distribution coefficients for the contaminants-of-concern and indicator parameters are provided in Table A.4. Only the TWRS EIS, the RPE study, and the draft Hanford Remedial Action (HRA) EIS consider non-radiological contaminants. The TWRS EIS and all of the recent programs except for the Composite Analysis and RPE have assumed that the distribution coefficient for a specific contaminant remained at the same value for both transport in the vadose zone and saturated zone. The Composite Analysis and RPE have differentiated the distribution coefficient values for several contaminants for zones within the vadose zone and saturated zone. The RPE studies have adopted a near-field/far-field assumption based on the observed movement of gamma-emitting contaminants at the SX Tank Farm. A pattern of relatively quick contaminant movement immediately following a tank leak event, after which there is very little if any

Table A.4. Comparison of Distribution Coefficients for Contaminants-of-Concern and Indicator Parameters Assumed from Recent Hanford Studies and Emerging Information

STUDY	Contaminant-of-concern a) or indicator parameter and distribution coefficient (mL/g)									
	Tc-99	Se-79	CN	EDTA	I-129	C-14	U	Np-231	Cs-137 c)	Ni-63
TWRS EIS (DOE 1996a)	0	0	0	0	0	0	0	0	50	1
Studies containing new information										
Draft Composite Analysis (Freshley 1997) d)	0 0 0	0 0 0	b)	b)	0 0 0.5	0 0 5	20 0.3 3	0.2 0.8 15	1.5 500 1500	0.2 50 300
Draft RPE (Jacobs 1997, 1998a,b) f)	0 0	0 0	0 0	0 0	0 0.6	0 0.6	0.6 0.6	e)	1 50	e)
Recent Hanford-related studies										
Surplus Reactors (DOE 1989)	0	g)	b)	b)	g)	0	0	g)	26	100
ERDF (Wood et al. 1995a)	0	g)	b)	b)	g)	0	0	2	100	100
200 East SWBG (Wood et al. 1996)	0	0	b)	b)	0	0	0	10	100	100
Draft HRA EIS (DOE 1996d)	0	0	0	0	0	0	0 to 250	0 to 500	30	12
US Ecology (Grant 1996)	0	g)	b)	b)	0	0	0	g)	g)	100

Notes:

a) The contaminants-of-concern are with respect to long-term human health risk.

b) These studies did not consider non-radiological contaminants.

c) Cs-137 is an indicator parameter.

d) The Composite Analysis has adopted three mobility zones. The top value, middle, and bottom values are the K_ds in the high impact, intermediate impact, and low impact zones, respectively.

e) These contaminants were not identified as contaminants-of-concern in the study and K_d values were not provided.

f) RPE has adopted two mobility zones. The top value and bottom values are the K_ds in the near-field and far-field zones, respectively.

g) Not reported.

discernable movement of the contaminant, can be inferred from the gross gamma and subsequent spectral gamma logs of dry wells surrounding the SX Tank Farm. This is an inferred pattern because there are many uncertainties associated with the past tank leaks as discussed in Section 5.5.1, such as precisely when the tank leaks occurred, the portion of the tank that was leaking, and the volume of the leak. This observation combined with the literature on the potential effects of high pH and high sodium concentration on the mobility of Cs-137 demonstrates that cesium mobility and near-field is faster than it has been observed in the far-field from laboratory experiments and then greatly diminishes after the initial movement. The depth of this initial movement at the SX Tank Farm is approximately 21.3 m (70 ft) below the base of the tank. The RPE study has adopted the zone from ground surface to approximately 36.6 m (120 ft) as the near-field zone (Jacobs 1997). The vadose zone below this depth and the underlying unconfined aquifer are termed the far-field.

The Composite Analysis program has taken a similar approach, except three zones are used instead of two. Immediately below the waste tanks is what is termed a high impact zone. Below this zone and extending to the water table is the intermediate impact zone. The unconfined aquifer is a no-impact zone.

The TWRS EIS, previous Hanford EISs, and performance assessments have all used the linear sorption isotherm model to represent the adsorption process. With this model, it is assumed that adsorption is fully reversible and the K_d is effectively used as a lumped parameter that includes the affect of many processes (e.g., sorption, adsorption, etc.) on contaminant mobility. New data from spectral gamma logging, groundwater monitoring results, and extension of borehole 41-09-39 at the SX Tank Farm can be used to make inferences on contaminant mobility. They have been important in developing the notion of a near-field condition as adopted by the RPE study (Jacobs 1997) and zones of high impact and intermediate impact as adopted by the Composite Analysis study (Freshley 1997). In this section the overall impact of these data on the TWRS EIS groundwater impact analysis are discussed followed by a discussion on the results of literature review into several of the underlying processes that can affect contaminant mobility.

The Composite Analysis and the RPE studies have developed some new information on contaminant K_d values. This information will soon be supplemented with data from analysis of samples collected from extending borehole 41-09-39 at the SX Tank Farm. These data, combined with the information on leak characteristics, have the largest affect on the impacts of past leaks and could account, in large part, for the relatively fast transport of some contaminants in the vadose zone. They have a much lesser impact on the impacts presented in the TWRS EIS for retrieval, from residuals that may be left in the tanks, and from the waste in the LAW vaults for the conditions of the Phased Implementation alternative.

The contaminants most responsible for the long-term human health risk identified in the TWRS EIS are technetium (Tc)-99, selenium (Se)-79, iodine (I)-129, carbon (C)-14, uranium, neptunium (Np)-231, protactinium (Pa)-231, CN, and nitrate (NO_3) ethylenediaminetetraacetic acid (EDTA). The contaminant K_d values proposed in these Composite Analysis and RPE studies are the same as was assumed for the TWRS EIS for Tc-99, Se-79, CN, NO_3, EDTA (the Composite Analysis only considers radiological contaminants); therefore, there would be no change in the impact assessment in the TWRS EIS for these contaminants.

For the contaminant I-129, both studies suggest increasing the K_d of I-129 from 0 to 0.5 or 0.6 mL/g in the saturated zone while maintaining it at zero in the vadose zone. There would be no change in first arrival at the water table as calculated in the TWRS EIS. Movement in the groundwater would be slowed and transport time from the source areas to the Columbia River would increase such that the mass that reaches the river would be less because of the longer time available for radioactive decay. Maximum concentrations in the groundwater were calculated to be less than the drinking water standard in the TWRS EIS. Compared to the TWRS EIS calculations, I-129 concentrations would be expected increase near the source areas on the 200 Area Plateau, based on the lower mobility of I-129 in the groundwater, and decrease near the Columbia River.

For the contaminant C-14, the Composite Analysis and RPE studies suggest increasing the K_d to 5 and 0.6 mL/g, respectively, in the saturated zone while maintaining it a zero in the vadose zone. The TWRS EIS held the K_d of C-14 at zero for both the vadose zone and groundwater. There would be no change in first arrival at the water table as calculated in the TWRS EIS. For the RPE value of 0.6 mL/g, the movement C-14 in the groundwater and the change in impact would be as described previously for I-129. For the Composite Analysis value of 5.0 mL/g, the transport of C-14 to the Columbia River would be greatly slowed such that it would likely not be detected off of the 200 Area Plateau.

In the TWRS EIS, K_d of uranium was conservatively set to zero in both the vadose zone and groundwater. Vadose zone simulations included in the TWRS EIS indicated that contaminants with a K_d of 0.125 mL/g do not reach the groundwater within the 10,000-year period of interest for the Phased Implementation alternative. The Composite Analysis indicates that the uranium K_d is more likely 20 mL/g in their "high impact" zone (Kaplan et al. 1996) 0.3 mL/g in the intermediate impact zone (Kaplan et al. 1996), and 3.0 mL/g in the groundwater (Kaplan and Serne 1995). With these K_ds, uranium would not reach the water table within the 10,000 period of interest. The same conclusion is drawn for the RPE proposed uranium K_d value of 0.6 mL/g in both the vadose zone and groundwater.

In the TWRS EIS, K_d of Np-231 set to zero in both the vadose zone and groundwater. The Composite Analysis is suggesting the Np-231 K_d is more likely 0.2 mL/g in their high impact zone, 0.8 mL/g in the intermediate impact zone, and 15.0 mL/g in the groundwater. With these K_ds, Np-231 would not reach the water table within the 10,000 period of interest, based on the simulation described previously for uranium. The RPE study does not consider Np-231. Neither the RPE nor the Composite Analysis provide information on the Pa-231 K_d.

A.1.2.5.1 Distribution Coefficient Information from the Composite Analysis

The purpose of the Composite Analysis is to estimate the projected cumulative impacts of all radioactive material in the ground that may interact with projected releases from an existing or planned (low-level waste) LLW disposal facility. The sources considered by the Composite Analysis include past waste tank leaks, potential losses from sluicing, and residuals in the waste tanks in addition to many non-TWRS sources such as cribs, ditches, and solid waste disposal sites. In the Composite Analysis, K_d values were assigned in an attempt to recognize the potential impacts of waste chemistry and background chemistry and included considering the concentrations of chelating agents, salts, and organic phases as well as pH.

The Composite Analysis developed waste categories to describe the major waste sources (Freshley 1997). There are three Composite Analysis waste categories that relate to tank waste. A description of these categories and example of the waste source are provided in Table A.5.

Table A.5. TWRS-Related Source Categories Adopted by the Composite Analysis

Category	Description	Examples/Comments
Very high salt/very basic pH	Tank wastes and wastes associated with small tanks, lines, pits, and boxes	Tank waste can contain chelators but the high pH tends to diminish impacts of organic chelators on K_d values
Chelates/high salts	Tank wastes with organic chelating or complexing agents	BY cribs, waste with Fe(II)CN [used to remove Cs] or EDTA additives [used to remove Sr]
Low organic/low salt/near neutral	Groundwater in the unconfined aquifer	Tank waste chemistry not affecting K_d.

Background chemistry is considered in the Composite Analysis to further categorized the distribution coefficients. The Composite Analysis uses three zones to represent changing geochemical conditions away from the source. These zone are 1) the high impact zone near the source in the vadose zone; 2) an intermediate impact zone away from the source, but still in the vadose zone; and 3) the groundwater zone. The Composite Analysis defines the high impact zone as strata where the geochemistry of the vadose zone is greatly impacted by the chemical composition of the waste source. The intermediate impact zone differs from the high impact zone in that the affect, if any, of the source-term pH on K_d values has disappeared; the effects of salts and organics, if present, continue to impact K_d values. The Composite Analysis applies the intermediate zone to the vadose zone before contaminants reach groundwater. The groundwater zone is defined as the zone where K_d values are not impacted by the chemical composition of the waste source. The background chemical composition of the groundwater zone is assumed to be greatly diluted and does not impact K_d values. The presence of chelates in the waste source is the only aqueous constituent that could influence K_d values in the groundwater zone.

To accommodate the different waste categories and K_d zones, K_d values had to be assigned to fill in a matrix of the three source types and three zones. The Composite Analysis uses five unique K_d categories (i.e., C, D, E, F, and G) for the three source categories and three impact zones. The K_d category matrix is provided in Table A.6.

Table A.6. TWRS-Related Source Categories and K_d Zones Adopted by the Composite Analysis

Source Category	Zone Category [1]		
	High Impact	Intermediate Impact	Groundwater
Very high salt/very basic	D	E	F
Chelates/high salts	G	G	C
Low organic/low salts/near neutral	F	F	F

Notes:

[1] Categories with similar letters have similar background chemistries and, therefore, similar K_d values.

The K_d values that the Composite Analysis is adopting for each of the C, D, E, F, and G Zone Categories are provided in Tables A.7 through A.11 as provided by Freshley (1997).

A.1.2.5.2 Related Information on Distribution Coefficients

Additional reviews of the literature related to several potential transport phenomena have been completed for the RPE studies (Jacobs 1997). These reviews have focused on the effects of high sodium and high pH in the tank waste, the effects of chelating agents and their persistence in tank waste environments, and the likelihood of colloid formation in the Hanford Site environment. The results of these reviews are discussed in the following text.

Potential Effect of High Sodium Concentrations and High pH in the Waste

In the vadose zone near the source of tank waste leaks, the extreme sodium concentrations and high pH typical of self-concentrated Reduction-Oxidation (REDOX) waste may affect cesium mobility and may have influences that persist to the limits of travel of waste-derived liquid. The mechanisms and the effects on cesium mobility near the source of past tank leaks are uncertain and not well understood. In the near field, the waste liquid is a highly alkaline sodium nitrate brine. Hanford Site sediments have a large ion-exchange capacity that is normally saturated with calcium and magnesium. As the waste liquid interacts with the sediments, sodium will be exchanged for calcium and magnesium, eventually resulting in a calcium-magnesium nitrate brine and sodium-saturated sediments. This trend has been noted in groundwater samples beneath some tank farms (Hodges 1997; Johnson and Chou 1997). In the near field, the waste may swamp the ion-exchange capacity of the sediments, resulting in sodium-saturated sediments in contact with a sodium nitrate brine. Experimental investigations of Cs-137 adsorption (summarized by Serne and Burke 1997) have shown that under "normal" conditions ($pH < 12$, ionic strength < 4 M), ion-exchange is the dominant process. The principal variables influencing the degree of adsorption are the concentrations of competing cations of similar size (e.g., potassium and ammonium), the pH, the ion-exchange capacity of the soil, and the total concentration of cesium (natural cesium + Cs-137). Distribution coefficients inferred from numerous batch and column experiments using representative liquors and soils average 4.9 mL/g (0.6 to 13.5 mL/g; Serne and Burke 1997, Table 4.1), indicating substantial retardation of cesium relative to fluid flow.

Table A.7. K_d Values Adopted by Composite Analysis (Category C — Far-Field Groundwater Impacted With Chelates or Ferrocyanide Complexing Agent)

Radio-nuclide	Conservative and (Best estimate) K_d Estimate (mL/g)	Range K_d Estimate (mL/g)	Justification/References[1]
Co	0 (0)	0 to 3	Likely complexed with EDTA and/or CN. Field data suggest that the Co-chelate complexed species exists and moves rapidly.
Sr, Pb, Ni, Sn	2 (4)	2 to 20	A Sr K_d of 0.4 mL/g has been measured in one Hanford Site soil (Soil P) and 1.5 mL/g in another Hanford Site soil (Soil S) in an aqueous system containing high concentrations of salts and medium to high concentrations of complexing agents, such as EDTA and HEDTA[1]. A slightly higher K_d value than these is likely to exist in the Hanford Site because the complexing agent concentrations will likely be appreciably lower. It is also anticipated that an appreciable amount of microbial degradation will occur to the organic complexes during its extended travel time to the far field.[2,3]
Pu	20 (40)	20 to >1,980	A Pu K_d of 21 mL/g has measured in one Hanford Site soil (Soil P) and 26 mL/g in another Hanford Site soil (Soil S) in an aqueous system containing high concentrations of salts and medium to high concentrations of complexing agents, such as EDTA and HEDTA[1]. A slightly higher K_d value than these is likely because the complexing agent concentrations will likely be appreciably lower and it is anticipated that an appreciable amount of microbial degradation will occur to the organic complexes during its extended travel time to the far field.
Np, Pa	2 (5)	2 to 15	A K_d of 8.7 mL/g has been measured for Np in one Hanford soil (Soil P) and 12 mL/g in another Hanford Site soil (Soil S) in an aqueous system containing high concentrations of salts and medium to high concentrations of complexing agents, such as EDTA and HEDTA[1]. Slightly higher K_d values than these are likely to exist because the complexing agent concentrations will likely be appreciably lower and it is anticipated that an appreciable amount of microbial degradation will occur to the organic complexes during its extended travel time to the far field.[2,3]
Ac, Am, Ce, Cm, Eu	10 (50)	10 to 500	A K_d of 5.6 mL/g has been measured for Am in one Hanford soil (soil P) and 10 mL/g in another Hanford soil (soil S) in an aqueous system containing high concentrations of salts and medium to high concentrations of complexing agents, such as EDTA and HEDTA[1]. Slightly higher K_d values than these are likely to exist because the complexing agent concentration will likely be appreciably lower and it is anticipated that an appreciable amount of microbial degradation will occur to the organic complexes during its extended travel time to the far field. Ac, Ce, and Cm also have +3 valance.[2,3]

Notes:

[1] Delegard and Barney 1983

[2] Serne et al. 1995

[3] Ames and Rai 1978

Table A.8. K_d Values Adopted by Composite Analysis (Category D — Very High Salt/Very Basic Groundwater)

Radio-nuclide	Conservative and (Best estimate) K_d Estimate (mL/g)	Range K_d Estimate (mL/g)	Justification/References
Tritium, Cl, Tc, I, Se, Ru, C	0 (0)	0 to 0.2	Tc, C, I, Se, and Cl are anionic. Tritium will move with water. Ru has often been suggested as being coincident with water in tank leak scenarios based on gamma borehole logging. Carbon as carbonate in high pH tank environments is insoluble and combines with alkaline earths. To account for insolubility a K_d value > 0 is appropriate but to keep C from getting stuck permanently in this source (high impact) zone the value must be set at 0.[1,2,3]
Ac, Am, Ce, Cm, Eu,	2 (5)	2 to 10	Estimated.[2,4]
Cs	1 (1.5)	1 to 25	Based on observations at T-106, Cs-137 seemed to peak at about 3 m (10 ft) below the base (elevation) of the tank and nitrate at about 24 m (79 ft). This implies an in situ Rf of about 8 or K_d in the range of 1 - 2 mL/g during the initial tank leak. The lack of cesium in groundwater beneath tanks suggests that the plume may not have arrived at the water table and more likely than not have a K_d that approaches the default value for neutral, high salt at greater distances from the source. Serne and Burke (1997)[5] measured a K_d of 26 mL/g for a simulated REDOX tank liquor. But the results are not consistent with inferred Cs migration using gamma borehole logging at the SX Tank Farm.[6]
Co, Ni, Nb, Np, Sn, Pa	0.1 (0.2)	0.1 to 4	Estimated.[4]
Sr, Ra	4 (10)	4 to 20	Sr is known to be rather insoluble in tank liquors and does not migrate through soils in tank liquor as rapidly as other cations.[4]
Th, Zr, Pb, Pu	5 (10)	5 to 100	Estimated.[2,4]
U	5 (20)	10 to 800	Kaplan et al. (1996)[7] reported U-K_d values increased from ~2 to >400 mL/g when the pH of a Hanford sediment/groundwater slurry increased from 8.3 to > 10.5. The extremely high K_d was attributed to U (co)precipitation either as uranium phases or as calcite phases. Over a 1,000 year period, it is anticipated that the solutions pH of any near field would eventually decrease. Thus, over time, the K_d values would be expected to decrease as the pH increased above ~10.5 and the uranium dissolved from the solid phase.

Notes:

[1] Ames and Rai 1978
[2] Thibault et al. 1990
[3] Martin 1996
[4] Ames and Serne 1991
[5] Serne and Burke 1997
[6] PNNL 1997b
[7] Kaplan et al. 1996

Table A.9. K_d Values Adopted by Composite Analysis (Category E - High Salt/Near Neutral pH Groundwater)

Radio-nuclide	Conservative and (Best estimate) K_d Estimate (mL/g)	Range K_d Estimate (mL/g)	Justification/References
^3H, Cl, Tc	0 (0)	0 to 0.1	Tc and Cl are anionic. Tritium will move with H_2O.
Ac, Am, Ce, Cm, Eu	100 (350)	280 to >1,200	Americium in a calcium- dominated system has K_d values >1,200 mL/g. In a sodium-dominated system, americium has a K_d value of 280 mL/g.[1]
C	0 (0)	0 to 10	Estimated.[9]
Co	50 (50)	222 to 4760	. In a sodium-dominated system K_c values are 1,060 to 4,760 mL/g[2] In a calcium-dominated system, K_d values are 790 to 1,360 mL/g.[2] Cobalt forms complexes, specially with organics.
Cs	64 (500)	64 to 1,360	. In a sodium-dominated system K_d values are 64 to 1,170 mL/g[2] In a calcium-dominated system, K^d values are 790 to 1,360 mL/g.[2] Cesium does not form complexes.
I	0 (0)	0 to 2	Anion. Estimated.[3,4]
Ni, Sn, Nb	30 (50)	3 to 40	Ni is similar to Co but adsorbs slightly less possibly because of moderate complexing. Estimated[3, 4]
Np, Pa	0.2 (0.8)	0.4 to 4	K_d values range from 0.4 to 4 mL/g. The dominant protactinium species is assumed to be PaO_2^+, NpO_2^+ is assumed to be a reasonable analog.[10]
Pb	20 (100)	20 to 1,000	Lead is a good absorber and it is insoluble. The K_d values were estimated.
Pu	5 (20)	5 to >98	>98 mL/g[5]
Ra, Sr	0.2 (0.5)	0.3 to 42	In a sodium-dominated system, K_d values range from 1.7 to 42 mL/g for strontium. In a calcium-dominated system K_d values range from 0.3 to 1.6 mL/g for strontium.
Ru	0 (1)	0 to 500	May form RuO_4^{2-} and/or anionic complexes with nitrates and nitrites. Estimate.[3, 6, 7]
Se	0 (0)	0 to 4	Anionic. Estimated[4]
Th, Zr	40 (50)	40 to 470	Sandy soil data, 40 to 470 mL/g for Th[8].
U	0 (0.3)	0 to 3	Anionic and neutral carbonate and hydroxide species. Estimated.[3,4]

Notes:

[1] Rousten et al. 1976
[2] Rouston et al. 1978
[3] Ames and Serne 1991
[4] Kaplan et al 1995
[5] Rhodes 1957b
[6] Aims and Rai 1978
[7] Barney 1978
[8] Sheppard et al. 1976
[9] Martin 1996
[10] Pourbaix 1996

Table A.10. K_d Values Adopted by Composite Analysis (Category F — Far-Field Groundwater not Impacted by Background Chemistry of Waste Source)

Radio-nuclide	Conservative and (Best estimate) K_d Estimate (mL/g)	Range K_d Estimate (mL/g)	Justification/References
^3H, Cl, Tc	0 (0)	-2.8 to 0.6	Tc exist predominantly as TcO_4^-. K_d values have been reported for Tc in Hanford sediments ranging from –2.8 to 0.6 mL/g for 15 observations with a median was 0.1 mL/g.[1] Later studies did not change this range but did decrease the median slightly to -0.1 mL/g.[2] Negative K_d values are physically possible and may not be an experimental artifact.[2] Tritium is expected to move along with water. Cl is expected to behave as a dissolved anionic species.
Ac, Am, Ce, Cm, Eu	100 (300)	67 to 1,330	Two ranges for K_d values for americium have been reported: 67 to >1,200 mL/g[3] and 125 to 833 mL/g.[4]
C	0.5 (5) (see justification)	0.5 to 1,000	Assumed dominant species: HCO_3^-. Three processes will be acting on C to take it out of solution: 1) adsorption onto the calcite surface, 2) volatilization as CO_2 gas, and 3) precipitation into the calcite structure. The latter process is largely irreversible, therefore it is not well represented by the K_d linear sorption isotherm model (K_d which includes the assumption that adsorption occurs as readily as desorption). Volatilization is entirely removed from the definition of the K_d. In systems that contain higher concentrations of carbonate minerals, such as the calcrete layer in the 200 West Area, an appreciably higher K_d should be used to account for the isotopic dilution/precipitation reaction that may occur, a K_d of 100 mL/g would be appropriate for such a system. Since most of the 100 and 200 Areas contain <1% carbonate, lower K_d values are warranted for these areas, such as 0.5 mL/g. K_d values of ^{14}C of >250 mL/g have been measured in calcite.[5] At the 100 K Area, the C-14 is widely distributed down gradient from a crib associated with reactor operations.[6, 7, 8, 9, 10] The range of K_d values was estimated.
Co	1,200 (1,200)	1,200 to 12,500	In a sodium-dominated system, the K_d values range from 1,290 to 2,120 mL/g.[11] In a calcium-dominated system, the K_d values range from 2,000 to 3,870 mL/g.[11] In the Hanford sediment/groundwater system, the K_d values range from 1,600 to 12,500 mL/g.[12]
Cs	540 (1,500)	540 to 3,180	In a sodium-dominated system, the K_d values range from 1,410 to 1,590 mL/g.[11] In the Hanford sediment/groundwater system, the K_d values range from 540 to 3,180 mL/g.[12]
I	0.3 (0.5)	0.2 to 15	A review of K_d values for I in Hanford sediments showed a range of 0.7 to 15 mL/g for 9 observations; median was 0.7 mL/g.[1] Later studies increased this range to 0.2 to 15 mL/g; the median was decreased to 0.3 mL/g.[7]

Table A.10. K_d Values Adopted by Composite Analysis (Category F — Far-Field Groundwater not Impacted by Background Chemistry of Waste Source) (cont'd)

Radio-nuclide	Conservative and (Best estimate) K_d Estimate (mL/g)	Range K_d Estimate (mL/g)	Justification/References
Ni, Sn, Nb	50 (300)	50 to 2,350	In the Hanford sediment/groundwater system, K_d values for nickel ranged from 440 to 2,350 mL/g.[12] In a broad range of sediments, including those from Hanford, K_d values for nickel ranged from 50 to 340 mL/g.[13]
Np, Pa	10 (15)	2.4 to 21.9	A review of Np K_d values for Hanford sediments showed range of 2.4 to 21.7 mL/g for 4 observations; median was 17.8 mL/g.[1] Later studies increased the K_d value slightly to 2.2 to 21.7 mL/g; the median was slightly lowered, 15 mL/g.[2]
Pb	2,000 (6,000)	13,000 to 79,000	In a system where the pH is 6 and there are no competing ions, the K_d values range from 13,000 to 79,000 mL/g.[14]
Pu	80 (200)	80 to >1,980	For plutonium (V, VI) where the pH is 4 to 12, the K_d values range from 80 to >1,980 mL/g.[15]
Ra, Sr	8 (20)	5 to 173	For a sodium-dominated system, the strontium K_d values range from 173 mL/g, and 49 to 50 mL/g.[11] For a calcium-dominated system, the strontium K_d values range from 8 to 13 mL/g, 5 to 19 mL/g[11], 5 to 120 mL/g[16], and 19.1 to 21.5 mL/g.[12] For a sodium-dominated system, where the pH is 7 to 11, the strontium K_d values range from 14.9 to 25.1 mL/g.[17]
Ru	10 (20)	10 to 1,000	Estimated[15,11]
Se	0 (0)	-3.44 to 0.78	In the Hanford groundwater/sediment system the K_d values ranged from -3.44 to 0.78 mL/g.[12]
Th, Zr	40 (1,000)	40 to >2,000	K_d values were estimated. For zirconium, when the pH is 6 to 12, the K_d values range from 90 to >2,000 mL/g.[15]

Table A.10. K_d Values Adopted by Composite Analysis (Category F — Far-Field Groundwater not Impacted by Background Chemistry of Waste Source) (cont'd)

Radio-nuclide	Conservative and (Best estimate) K_d Estimate (mL/g)	Range K_d Estimate (mL/g)	Justification/References
U	0.6 (3)	0.1 to 79.3	A review of Hanford sediment U-K_d values showed range of 0.1 to 79.3 mL/g for 13 observations; median was 0.6 mL/g.[1] Results from later studies support the range.[2] In all reported data, some U was adsorbed by Hanford sediments and >90% of the values were between 0.6 and 4 mL/g.

Notes:

[1] Kaplan and Serne 1995
[2] Kaplan et al. 1996
[3] Routson et al. 1976
[4] Sheppard et al. 1976
[5] Martin 1996
[6] Striegl and Armstrong 1990
[7] Garnier 1985
[8] Pourbaix 1966
[9] Mozeto et al. 1983
[10] Zhang et al. 1995
[11] Routson et al. 1978
[12] Serne et al. 1993
[13] Serne and Relyea 1983
[14] Rhodes et al. 1992
[15] Rhodes 1957b
[16] Rhodes 1957a. 17 Nelson 1959

Table A.11. K_d Values Adopted by Composite Analysis (Category G - High and Intermediate Impact Zone for Conditions of High Salt and Chelated Groundwater)

Radio-nuclide	Conservative and (Best) K_d Estimate (mL/g)	Range K_d Estimate (mL/g)	Justification/References
Tritium, Cl, Tc, C, Co, I, Se	0 (0)	0 to 0.5	Tc, I, Se, Cl are anions. Co forms an unusually strong complex with EDTA by virtue of unique chemical reactions, namely the Co(II) converts to Co(III) through an auto-oxidation process, and the Co(III) forms very strong complexes with the EDTA. Tritium is assumed to behave like water. The others do not complex with chelators and their low K_d is controlled by virtue of their anionic nature.[1]
Ac, Am, Ce, Cm, Eu	3 (3)	3 to 50	A K_d for americium of 5.6 mL/g has been measured in one Hanford soil (soil P) and 24 mL/g in another Hanford soil (soil S) in an aqueous system containing high concentrations of salts and high concentrations of complexing agents, such as EDTA and HEDTA.[2] Additionally, borehole data beneath 216-Z-1A Crib suggest that Am moves appreciably slower than carbon tetrachloride.[3] If carbon tetrachloride is considered a conservative tracer, then it would appear that Am behaves as if it has a non-zero K_d value, i.e., that it is retarded. Cm, Ce, and Eu have a +3 valence and were assumed to behave like Am.[1,2]
Cs	6 (10)	6 to 18	Based on column breakthrough curves using actual U recovery scavenged waste.[4] The lack of Cs in groundwater beneath cribs suggests it has not broken through and more likely than not has a K_d that approaches the default value for neutral, low organic, low salt (Table A.10).
Np, Pa	2 (5)	2 to 10	A K_d of 3.9 mL/g has been measured for Np in one Hanford soil (soil P) and 6.8 mL/g in another (soil S) using an aqueous system containing high concentrations of salts and high concentrations of complexing agents, such as EDTA and HEDTA [2]
U	0.2 (0.4)	0.2 to 3	Estimate[1,6]
Ra, Sr, Pb, Ru, Ni, Nb, Sn	0.4 (5)	0 to 30	A K_d of 0.02 mL/g has been measured for Sr in one Hanford soil (soil P) and 1.5 mL/g in another Hanford soil (soil S) in an aqueous system containing high concentrations of salts and high concentrations of complexing agents, such as EDTA and HEDTA.[2] These organic complexants are likely to be degraded by microbes over time, thereby converting the radionuclides into a more adsorbing species. Strontium is used as analogue because of its similar +2 valence.
Th, Zr, Pu	0.5 (3)	0.6 to 100	A K_d of 0.6 mL/g has been measured for Pu in one Hanford soil (soil P) and 2.6 mL/g in another (soil S) with an aqueous system containing high concentrations of salts and high concentrations of complexing agents, such as EDTA and HEDTA.[2] Additionally, borehole data beneath 216-Z-1A Crib suggest that Pu and Am move appreciably slower than carbon tetrachloride.[3] If carbon tetrachloride is considered a conservative tracer, then it would appear that both actinides behave as if they have non-zero K_d values.

Notes:

[1] Serne et al. 1995
[2] Delegard and Barney 1983
[3] Price et al. 1979
[4] Rhodes and Nelson 1957
[5] Pourbaix 1966
[6] Ames and Rai 1978

possible. By analogy with ferric iron (Fe^{3+}) and oxidized aluminum (Al^{3+}), which have similar charges and slightly smaller ionic radii, it is likely that the actinides would be present as a variety of hydroxide complexes rather than the bare cations typical of acidic conditions. Changes in the extent of chelation are more difficult to project. The chelating ligands are highly selective for multivalent cations, so high sodium concentrations may have only a small affect on the extent of chelation. Chelation may be somewhat reduced because of competition between the chelating ligands and hydroxide and carbonate for the cations, but the extent cannot be estimated in the absence of experimental data.

Degradation of organic chelating agents under the extreme conditions present in the tanks must also be considered. In the presence of oxidizers (nitrate and nitrite) at elevated temperatures and subject to intense radiation, these organic compounds will break apart to simpler ligands such as oxalate, with some acetate and formate, with eventual oxidation to carbonate. Tank wastes are typically high in carbonate, both as a result of organic degradation as well as uptake of atmospheric carbon dioxide. For the remaining organic species, a recent study (Carlson 1997) has shown that in many tanks, oxalate is the dominant form of organic carbon, typically accounting for 80 to 100 percent of the total organic carbon. This suggests that concentrations of the original organic ligands will be small, but measurements on a few tanks showed that their concentrations are still detectable. Additionally, many of the leaks occurred soon after wastes were placed in the tanks, when the organic ligands may have been only slightly degraded. Mobility of contaminants during the early phase of waste migration downward from a leak may have been strongly influenced by chelating agents, whereas later leakage would not be.

The fate of ferrocyanide under tank conditions is probably similar to that of the organic ligands, with carbon eventually becoming oxidized to carbonate and nitrogen becoming oxidized to nitrate or nitrite. Thus, this important complexer of cesium would also have likely contributed to cesium mobility during early leaks, but may no longer be important for later leaks or sluicing losses under the Phased Implementation alternative.

Potential Effects of Colloids

A likely consequence of the interaction of self-concentrated REDOX waste with soil underlying the tanks is the production of colloid-size alteration products, which could potentially disperse in the leaking solution and hence be advected to greater depths. This mechanism offers a potential explanation for the unanticipated mobility of Cs-137; any Cs-137 adsorbed to colloids would be transported as well, giving an effective distribution coefficient of zero. A key question is the stability of colloids under this scenario. Colloids are stable under conditions where the individual particles repel each other. Repulsive interactions are facilitated by low ionic strength, where compensation for surface charge extends a significant distance into the solution, allowing like-charged surfaces to repel each other. At higher ionic strength (often no more than 0.01 M), charge compensation occurs essentially at the surface, permitting particles to approach closely enough to stick together due to van der Waals forces. A competing affect is the influence of increasing sodium concentration, which tends to stabilize colloids in solution. As a result, much higher ionic strength is needed to induce flocculation in a sodium-dominated electrolyte than in a calcium or magnesium dominated electrolyte. Nevertheless, colloid transport in undiluted waste leaking from the tanks, with an ionic strength much greater than 0.01 m (probably 4 M or greater) appears to be highly unlikely.

Colloid stability under site-specific conditions for the Hanford Site has been investigated (McGraw and Kaplan 1997) to determine the potential for colloids to move in groundwater. Uncontaminated Hanford Site groundwater was estimated to have a pH of 8.1 and an ionic strength of 0.099 M. Clays, the predominant colloids in Hanford Site sediments, have a pH of zero charge near 4, so are negatively charged in Hanford Site groundwater; most other minerals have pHs of zero charge between 6 and 8 and would show a greater tendency to flocculate because of reduced electrostatic repulsion. Comparison with experimental data on colloids extracted from a Hanford Site soil over a range of pH, ionic strength, and relative abundance of sodium shows that Hanford Site groundwater will cause flocculation. The experimental data suggest that Hanford Site groundwater would need to be diluted by nearly an order of magnitude for colloids to be stable. This may occur in the vadose zone, particularly in areas of focused recharge such as between the tanks. Interactions with tank leakage would lead to higher ionic strength and higher sodium concentrations, but ionic-strength effects are overwhelming, further favoring flocculation.

The potential for a stable colloid to move through saturated and unsaturated systems has also been evaluated experimentally in columns using well washed sand (McGraw and Kaplan 1997). In saturated experiments, no significant differences in retention were observed for particles between 52 and 1,900 nm in diameter (the range of the experiment). In unsaturated column experiments using a Hanford Site-specific volumetric water content of 6 percent, particles 52 nm in diameter were mobile, whereas larger particles were increasingly retained within the column with increasing diameter. A semi-empirical model based on filtration theory for uncharged particles was used to assess qualitatively the fate of particles based on their size. This model predicts that particles less than 100 nm in diameter will be rapidly removed from the aqueous phase by diffusional processes, in which Brownian motion carries particles to grain surfaces, where they are subsequently immobilized by unspecified processes. Empirical observations of natural systems also suggest that particles less than 100 nm in diameter are rare; McGraw and Kaplan (1997) note that most field studies report colloid diameters of 100 to 500 nm.

Colloid transport in undiluted waste leaking from tanks at the Hanford Site is unlikely due to the high ionic strength of the tank waste liquid and the abundance of negatively charged minerals in the Hanford Site sediments, both of which would cause colloids to flocculate. This conclusion is supported by evaluations using Hanford Site specific conditions and experimentally using a semi-empirical model based on filtration theory.

A.1.2.6 Recharge

The net recharge to the unconfined aquifer beneath a tank farm from infiltrating precipitation is an important parameter for calculating groundwater impacts from past tank leaks, tank waste retrieval losses, and tank waste residuals (Jacobs 1998a). Most of the precipitation at the

Table A.12. Comparison of TWRS EIS Recharge Rates to Emerging Information for Various Activities or Periods

Activity or period	Recharge assumed in TWRS EIS (cm/yr)	Rates Assumed by the Composite Analysis and RPE (cm/yr)	Comments
Pre-Tank	N/A	0.5 (CA) 0.3 (RPE)	
Current Conditions (Graveled Surface)	5.0	7.5 (CA) 10.0 (RPE)	The Composite Analysis has adopted a rate of 7.5 cm/yr using a one-dimensional vadose zone model. RPE assumes 10.0 cm/yr using a two-dimensional vadose zone model.
During Retrieval	0.5	10.0	RPE makes no allowance for changes in recharge during retrieval.
Active Cap Hanford Barrier	0.05	0.05	
RCRA-Complaint Cap	N/A	0.1	
Partially Effective Cap: Hanford Barrier	0.1	N/A	RPE assumes recharge rate through the cap remains at design rate for the design life, after which time the rate transitions back to the pre-tank rate.
RCRA-Compliant Cap	N/A	N/A	
Post-cap	0.1	0.5 (CA) 0.3 (RPE)	TWRS EIS assumed cap degraded and recharge remained at the degraded value. RPE is assuming that at the end of the cap life, recharge returns to pre-tank levels of 0.3 cm/yr.

Notes:

Related RPE assumptions: 1) The transition time between pre-tank and current conditions recharge rate is 1 year and the change in recharge is linear over that period. 2) At the end of the cap design life, the transition period for recharge is to go from the cap design rate to 0.3 cm/yr (0.12 in/yr) is 10 years and change is linear over that period. 3) The Hanford Barrier has a design life of 1,000 years. 4) The RCRA-compliant cap has a design life of 500 years.

CA = Composite Analysis (Kincaid 1997)

RPE = Retrieval Performance Evaluation Criteria Assessment (Jacobs 1997)

Current Recharge Rates

Current recharge rates for a tank farm are for a sand and gravel surface with no vegetation. This is the type of condition that has assumed to prevail from the time of tank construction until a barrier is placed over the tanks. The proposed recharge rates for a tank farm under current conditions is 10 cm/yr and 7.5 cm/yr (3.94 in./yr to 2.95 in./yr) for the RPE and Composite Analysis studies, respectively. The RPE study has adopted a two-dimensional vadose zone flow and transport model whereas the Composite Analysis and TWRS EIS used a one-dimensional vadose zone flow and transport model. Compared to the two-dimensional model, the one-dimensional model is expected to result in higher simulated contaminant concentration values at the vadose zone/groundwater interface, thus selection of the recharge values from the lower end of the range for current conditions is appropriate when using a one-dimensional model. Several previous groundwater impact assessments involving contaminant transport through the vadose zone from a tank waste source used a constant annual recharge rate of 10 cm/yr (3.94 in./yr) to represent current conditions. Ten cm/yr (3.94 in./yr) is approximately 60 percent of the long-term annual precipitation (16.8 cm/yr [6.61 in./yr]) (Hoitink and Burk 1994), which corresponds to lysimeter data that represent tank farm conditions (Gee 1987; Gee et al. 1992).

Lysimeter data from the Field Lysimeter Test Facility (FLTF) show that the recharge rate ranges from 24 to 66 percent of the annual precipitation for years 1990 to 1994 for lysimeters with gravel over sand and bare vegetation conditions, which is typical of current tank farm ground conditions (Rockhold et al. 1995). This is equivalent to approximately 4 to 11.1 cm/yr (1.57 to 4.37 in./yr) of recharge based on the long-term annual precipitation rate of 16.8 cm/yr (6.61 in./yr) (Hoitink and Burk 1994). However, more recent lysimeter field measurements acquired during August 1995 to July 1996 from the Small-Tube Lysimeter Facility resulted in 10.89 cm/yr (4.29 in./yr) drainage, which is 66 percent of the actual precipitation over that period. These lysimeters were designed to simulate tank farm conditions on the 200 Area Plateau. When additional moisture was applied via irrigation, the percentage of drainage observed in the lysimeters increased to 75 percent (Fayer 1997). In a 3-year study at the FLTF, under ambient precipitation conditions a total of 592 mm (23.3. in.) of precipitation occurred from 1990 to 1993, of which 47 percent or 278 mm (10.94 in.) of recharge (drainage) was recorded (Fayer 1997). Enhanced precipitation (1,440 mm [56.69 in.]) during this same time span accounted for 62.5 percent recharge (900 mm [35.43 in.]). Waugh et al. (1991) reported that 50 percent of the annual precipitation has resulted in recharge at the STLF during the 1988 to 1989 time period.

Recharge Through a Barrier

The surface barrier for the Phased Implementation alternative was assumed to be the Hanford Barrier. In a recent study (Jacobs 1998a,b), the RPE project also considered a RCRA-compliant type barrier. The assumed recharge rates through these two types of surface barriers and their expected life are discussed in the following text.

Previous works have shown annual recharge rates of less than 0.5 mm/yr (0.02 in./yr) for Waste Management Units with a protective cover (i.e., Hanford Barrier) (Gee et al. 1996). The Hanford Barrier consists of ten layers for a total thickness of 4.5 m (14.8 ft.)to the base of the asphalt base course. The design life for the Hanford Barrier is 1,000 years. At the prototype site, no drainage has occurred from the soil surfaces (Gee 1996). The value of ≤0.5 mm/yr (0.02 in./yr) is supported by lysimeter data collected from the FLTF and STLF (Gee et al. 1992).

The RCRA-compliant barrier has a design life of 500 years. The entire RCRA-type barrier consists of 8 layers for a total thickness of 1.7 m (5.58 ft.) thick to the base of the asphalt base course. With a 1 m (3.28 ft.) silt loam cover, recharge is expected to be negligible (Gee et al. 1992). This is supported by lysimeter data from FLTF, the STLF, and Arid Lands Ecology site (Gee et al. 1992). The RPE study has assumed the recharge through this type of barrier would be 1 mm/yr (0.04 in.).

Post-Barrier Recharge

After deterioration of the Hanford Barrier and the RCRA-type barrier, recharge rates are anticipated to return to predevelopment conditions. Therefore, in the post-barrier period, recharge rates are assumed to be 3.0 mm/yr and 5.0 mm/yr (0.12 in./yr and 0.20 in./yr) for the RPE and Composite Analysis programs, respectively. These assumed values are within the range identified in previous studies for shrub-steppe ground cover with a silt-loam soil.

Comparison of Assumed Constant Recharge with Seasonally Varied Recharge

Assuming a constant recharge rate has been a simplifying assumption commonly used for Site calculations of contaminant mass flux through the vadose zone (DOE 1996a, Ward 1997, Wood et al. 1995a,b). Recharge rates actually vary on a number of scales including seasonally, yearly with climatic variations, and periodically with changes in ground cover from such occurrences as fires and construction. A recent numerical analysis by the RPE project compared an assumed constant recharge assumption with synthetic seasonal variation in recharge (Jacobs 1997).

On the 200 Area Plateau, approximately 42 percent of the annual precipitation occurs in the months of November, December, and January, when evaporation and transpiration are at a minimum. Previous works have indicated that maximum recharge from the surface occurs between February and April, depending on the amount of snowmelt, air temperatures, antecedent moisture conditions of the soil, and precipitation (Rockhold et al. 1990, Fayer 1997). It was noted in Gee et al. (1996) that recharge greatly increased when drainage peaking in February 1996 for the gravel and basalt sideslopes on the Hanford Barrier. This was in response to snowmelt and other winter precipitation. The appropriateness of assuming constant recharge instead of the more accurate seasonally varying recharge is tested with a two-dimensional transient flow and contaminant transport model of the vadose zone as reported in the following text.

The RPE evaluation developed a synthetic "typical" variable recharge scenario for comparison to constant recharge. Seasonal mean precipitation was obtained from Table 4.2 of Hoitink and Burk (1994). The precipitation data in the table span from the years 1946 to 1993. The values were normalized so that the cumulative recharge assuming seasonal variability would have the same volume as a constant 10 cm/yr (3.94 in./yr). The resulting values are 14.88 cm/yr (5.86 in./yr) for the winter period (December to February), 8.72 cm/yr (3.43 in./yr) for the spring period (March to May), 6.12 cm/yr 2.41 in./yr) for the summer period (June to August), and 10.32 cm/yr (4.06 in./yr) for the autumn period (September to November).

To test the effect of incorporating annually varying infiltrating recharge instead of a constant infiltrating recharge, a model with no clastic dikes, anisotropic unsaturated hydraulic conductivities, and a distribution coefficient of 0 mL/g (0 gal/lb) was run under two conditions. Under the first condition, the model was used to simulate a unit concentration for a waste tank over a 250-year period with a constant recharge rate of 10 cm/yr (3.94 in./yr). Under the second condition, all other inputs were the same except that the recharge rate was assumed to vary seasonally on a quarterly (3 month) basis during each year of the simulation. The annual variation in infiltrating recharge for each quarter of each year simulated was 14.88 cm/yr (5.86 in./yr) for the first 3 months, 8.72 cm/yr (3.43 in./yr) for the next 3 months, followed by 6.12 cm/yr (2.41 in./yr) (for the next 3 months, and finally 10.32 cm/yr (4.06 in./yr) for the last 3 months. These rates were calculated based on Hoitink and Burk (1994) such that when added over an annual time period, the total volume of infiltrating recharge would equal that produced in a year under conditions of constant 10 cm/yr (3.94 in./yr) infiltrating recharge. Both simulations used the subsurface conditions expected at the SX Tank Farm, located in the 200 West Area and the period of simulation was 200 years.

A comparison of the results of the two simulations indicates that there no discernible spatial or temporal impacts on the migration of contaminants. Plots of concentration at various times within time over the whole model domain (vadose zone), as well as graphs of time versus concentration at selected model elements, are identical under the two simulations. The plots of mass flux with time over the entire base of the model domain was identical.

A.1.2.7 Vadose Zone Geometry

There are no new data relative to the waste site geometries (layer thicknesses). The site geometry in the TWRS EIS was generalized to represent groups of tank farms. Recent analyses that focus on one tank farm, the AX Tank Farm, indicate that the resulting groundwater impacts are relatively insensitive to the site geometry (Jacobs 1998a), even if more specific data are used such as variable layer thicknesses. Thus, use of more specific waste site vadose zone geometry, in lieu of the generalized vadose zone geometry used in the TWRS EIS, would not appreciably change the impact assessment.

A.1.2.8 Vadose Zone Isotropy and Homogeneity

Field observations of contaminant plumes at the Hanford Site provide evidence of lateral migration suggesting anisotrophy of the effective hydraulic conductivity in subsurface sediments (Routson et al. 1979; Sisson and Lu 1984). Typically, anisotrophy is expected to be heterogeneous, that is, it varies within a given sediment layer as well as between different sediment layers. Under unsaturated conditions, some research suggests that anisotrophy may be moisture dependent (Yeh et al.1985a,b,c).

There are no new data on hydraulic conductivity anisotrophy ratios for sediments beneath the Hanford Site. Although anisotrophy ratios have not been measured directly in sediments at the Hanford Site, anisotrophy ratios for different Hanford Site sediment types have been estimated based on studies by Sisson and Lu (1984) and Lowe et al. (1993). Ongoing studies by RPE have investigated ranges of anisotrophy ratios numerically with a two-dimensional vadose zone models of the SX and AX Tank Farms (Jacobs 1997). Results of these studies indicate that anisotropic ratios (K_h/K_v) on the order of 3 to 10 provide better matches to observation vadose zone contamination based on the spectral gamma logging data than does the isotropic conditions or extreme anisotrophy ratios on the order of 30 to 100.

Previous work by Kline and Khaleel (1994) indicate that incorporating moisture dependent anisotrophy increases have resulted in good agreement with model-predicted horizontal spreading with field observations associated with investigation of the tank T-106 leak. These evaluations are somewhat hypothetical for the Hanford Site because of the lack of field data regarding moisture dependent anisotrophy.

The RPE studies (Jacobs 1997) that involved simulations of the SX Tank Farm also included coarse scale heterogeneities. Each lithologic unit was modeled as an anisotropic and homogeneous within the specific layer, while heterogeneity is introduced across different model layers, each with differing hydraulic conductivities and anisotrophy ratios. In contrast, Ward et al. (1997) examined the impact of finer scale heterogeneities by introducing both coarse and fine textured sediment lenses approximately 0.6 m (2 ft.) thick into larger lithologic units present beneath the SX Tank Farm. They found that these small-scale textural variations introduced into the model resulted in moisture content increases near the interface between fine and coarse textured lenses due to the formation of capillary breaks. Under unsaturated conditions, small-scale coarse lenses will impede downward fluid migration, resulting in shallower penetration of leaked fluids. Coarse layers would also cause increased lateral migration of contaminants under saturated conditions, further impeding the downward migration of leaked fluids.

Overall, these new studies suggest that anisotropic hydraulic conductivities and finer scale sediment heterogeneity may be operative at the Hanford Site and, if so, would be one of the processes that are responsible lateral migration of contaminants from tank leaks. This process would also tend to lower the peak concentration of contaminants reaching the water table, all other factors being equal. Results presented in the TWRS EIS reflect one-dimensional vadose simulations which cannot incorporate anisotropic hydraulic conductivity and associated lateral migration. TWRS EIS one-dimensional vadose simulations would therefore tend to results in a faster travel time through the vadose zone and higher maximum contaminant concentrations reaching the water table.

A.1.2.9 Vadose Zone Contaminant Pathways

As noted in the TWRS EIS, measurements of relatively immobile contaminants at the SX Tank Farm at a depth of 38 m (125 ft) below ground surface are not fully explained. Reviews of the literature, additional measurements of contaminant concentrations in the vadose from spectral gamma logging, and the extension of one borehole are new information and data that provide some inferences on contaminant migration. Under some conditions and at some sites preferential flow paths can significantly impact the transport of contaminants in the vadose zone (Parlange et al. 1988). The three different forms of potential preferential flow in the vadose zone at the Hanford Site are identified as 1) fingering; 2) funnel flow; and 3) flow associated with clastic dikes or poorly sealed well borehole annular space. The mechanisms of these potential flow paths are discussed in the following text. There is still some uncertainty associated with these type of flow paths at the Hanford Site, but the new information and data do not change the impact assessment presented in the TWRS EIS.

Fingering

Fingering is described as fingers of vertically oriented flow paths that are usually wetter and carry more water per unit area than the surrounding sediments during infiltration of water through the vadose zone. Initial moisture content, media heterogeneity, and the existence of large void spaces such as macropores and fractures all fundamentally affect the fingering process (Glass and Nichol 1996). Fingers can be instability or heterogeneity driven (Steenhuis et al. 1996). Instability driven fingers, due either to gravity or viscous forces, occur especially in sandy soils, with or without layers. Neglecting consideration of capillary forces, instability, and finger formation are predicted when downward water flux is less than the saturated conductivity of a porous medium. Capillary forces act to stabilize perturbations to a wetting front below a critical wavelength (Glass and Nicholl 1996). Infiltration through layered systems can occur where a layer of lower saturated hydraulic conductivity (K_s) overlies one with a higher K_s. Redistribution of moisture, following ponded infiltration within a single layer, and uniformly distributed water application to a single layer at a flux less than K_s by rainfall or irrigation have all been shown to induce fingering (Chen et al. 1995; Glass and Nicholl 1996).

Fingers, once formed, persist from one infiltration cycle to the next (Glass et al. 1988). If initial moisture contents are distributed non-uniformly, either temporally or spatially, due to variations of flow caused by instability, or by intermittent water supply, fingered flow in sandy soils is observed to combine with hysteresis to create a heterogenous permeability field. Subsequent events then follow preferential flow paths defined by these previous fingers leading to the formation of persisting conduits of flow and extreme variability in solute transport (Glass et al.1989; Glass and Nicholl 1996). These flow conduits can be destroyed by complete drying or artificially uniformizing the moisture content within the bottom layer by saturation and drainage (Glass et al. 1988).

Heterogeneity driven fingers are the result of media heterogeneity such as macro- or mesopores or uneven water application. Macropores in the topsoil will tend to supply water nonuniformly to the unstructured and macroporeless subsoil causing the formation of fingers below. Other structures within the soil profile such as clay lenses and rocks play a similar role of concentrating flow (Glass et al. 1988). Horizontal micro-layering will tend to stabilize fingered flow, while cross-bedding acts to concentrate and coalesce fingers (Glass and Nicholl 1996).

There is a concern that in the 200 Areas, it is possible the features that promote fingering may be present and active to some degree. If such is the case, it would be likely that the vertical extent of finger flow would be intermittent and of limited thickness because of the macro- and micro-layering with the sediments. According to Dr. Bob Glass of Sandia National Laboratories, who has extensively investigated fingering phenomenon in the laboratory and in the field, the following are factors in the development of fingering (Glass 1997).

- Pressure-versus-saturation curves should be sharp and uniform throughout the interval of interest
- Wide variations in lithology inhibit finger development

- Moisture content and flux should be low
- Wetability should be intermediate.

Based on his field experience in New Mexico with the Santa Fe Group sediments consisting of alluvial gravel, sand, and silt in a climate similar to that at the Hanford Site, Dr. Glass suggested that extensive fingering at the Hanford Site is unlikely. Other studies suggest that unstable flow, which is driven by gravity, should be negligible in porous media in many arid regions because of the dominance of capillary and adsorptive forces over gravity forces in these areas (Scanlon et al. 1995).

Funnel Flow

Funnel flow is a special case of instability based flow where inclined lenses of coarse sand act as capillary breaks, redirecting downward seeping water toward their lower edges, and focusing recharge into a series of columns in which the local flow rate is enhanced by a factor of 10 to 100 relative to a uniform flow field (Kung 1990). The applicability of this mechanism to the Hanford Site depends upon the presence of inclined coarse-grained units to redirect infiltration. Such layers have been interpreted from borehole samples beneath the SX Tank Farm (Ward et al. 1997). Simulation performed by Ward et al. (1997) suggests that funnel flow could play a role in enhancing lateral migration, but the extent to which it could enhance the vertical migration of tank wastes has not been addressed.

Flow in Clastic Dikes and Well Boreholes

Flow through clastic dikes and poorly sealed well annular spaces are both instances of preferential flow paths. The impact of such potential preferential flow depends on the location of the feature relative to leak sources and is also dependent on leak flow rate because is it is only when leak flow rates are sufficient to saturate the feature that they become transport pathways. At low leak volumes, clastic dikes may serve as flow impediments.

Ongoing RPE studies (Jacobs 1997) include numerical analysis of leaks from the SX and AX Tank Farms for cases with and without the potential presence of a clastic dike. As part of these studies, a thin vertical high conductivity zone was incorporated into a two-dimensional flow and transport model of the vadose zone. This feature could be used to represent either a clastic dike or conservatively, the poorly sealed annulus of one of the dry wells at the tank farm. The feature was located directly between two tanks to examine the effects on the migration of contaminants from the base of the tanks to the water table. The thin zone of high conductivity extended from the elevation of the base of the tanks to the water table.

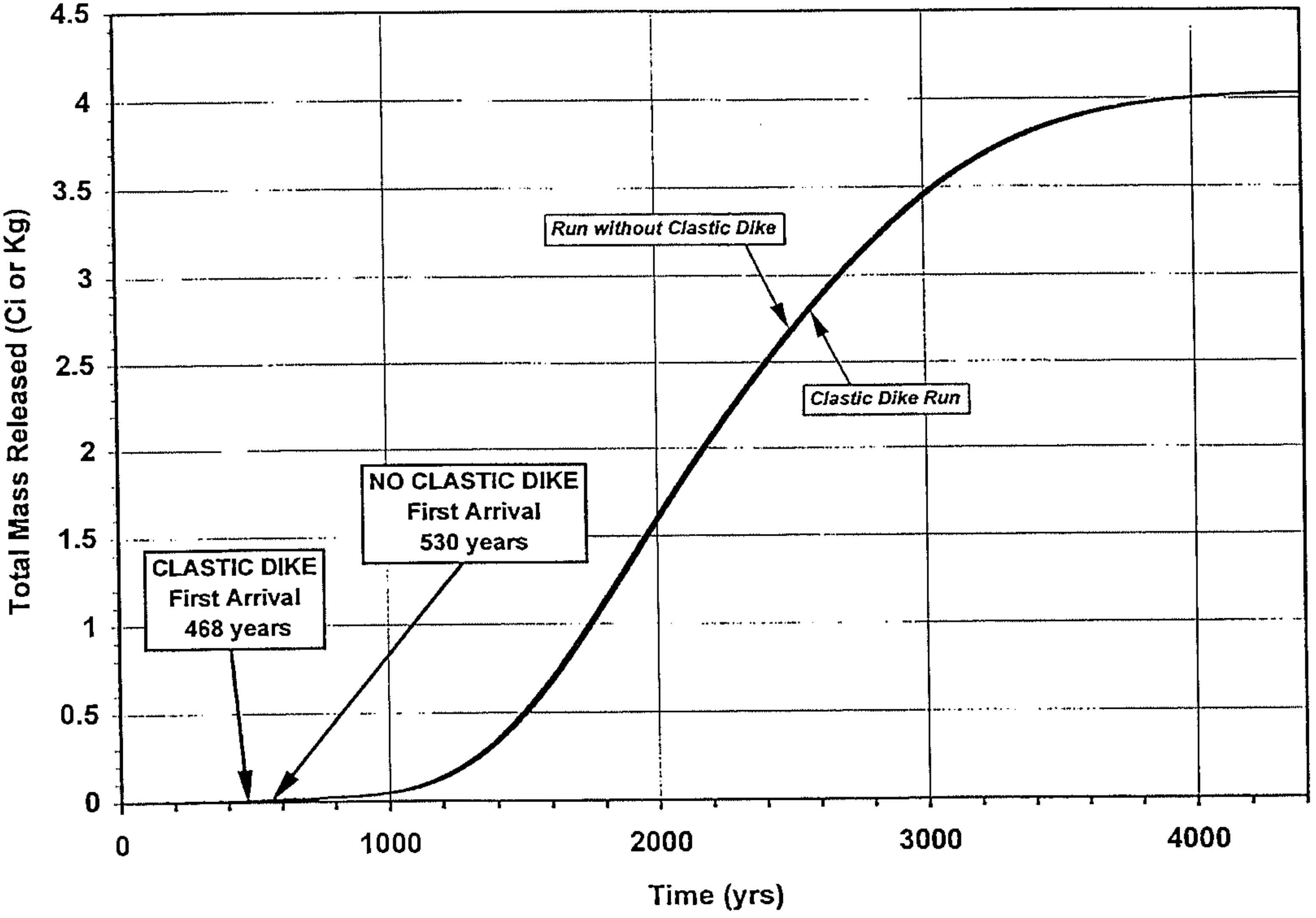
Results of two-dimensional vadose zone simulations of AX Tank Farm, sluicing leaks indicate that the presence of a clastic dikes resulted in a very small change (i.e., 60 years sooner for condition with clastic dike) in the time of contaminant first arrival and maximum contaminant concentration at the water table (Jacobs 1997). A comparison of the calculated results for a case with a clastic dike and without one is shown in Figure A.1. Plotted in this figure is the total cumulative mass as the mass reaches the water table for the two cases. The calculations are based on subsurface conditions at the AX Tank Farm, which is located in the 200 East Area, an assumed 30.3 m^3 (8,000 gal.) waste tank leak from one tank, a source concentration of 1 kg/m^3, and a zero K_d. A similar approach was taken for the SX Tank Farm, which is located in the 200 West Area (Jacobs 1997). For the SX Tank Farm simulations, subsurface conditions existing at the SX Tank Farm were used. Examination of sediment hydraulic characteristics beneath each of these sites indicates that, although most of the same stratigraphic formations underlie both sites, the thicknesses and relative juxtaposition of fine and coarse-grained layers within these formations is distinct at each tank farm. Subsurface conditions at the SX Tank Farm are, in general, representative of those of the other tank farms in the 200 West Area. Compared to those in 200 East Area, they are finer grained and have lower saturated hydraulic conductivities, resulting in the ability to cause perched water table conditions given the appropriate recharge events. Subsurface conditions at the AX Tank Farm can be used as representative of those in the 200 East Area. Based on the observation that representation of clastic dikes at both of these tank farms is inconsequential it is then reasonable to apply this conclusion to the other SSTs in both 200 East and 200 West Area.

Overall, results of calculations with clastic dikes represented in the simulations at the SX and AX Tank Farms indicate that clastic dikes, and to a lesser extent, drywell annular space pathways, do not affect contaminant first arrival or maximum concentration at the water table for a mobile contaminant (Jacobs 1997). They could play a role in explaining some of the deeper Cs-137 observed beneath the SX Tank Farm, but additional field data and analysis would be necessary to conclude that they may have more than a minor role.

A.1.2.10 Sluicing Loss Characteristics

In the TWRS EIS, sluicing losses were assumed to leak over the full area of the base of the tank. Ongoing RPE studies (Jacobs 1997) have found that tank area from which the leak occurs can affect the arrival time and peak concentration of contaminants to the water table. The RPE studies used a two-dimensional vadose flow and transport model of the SX Tank Farm and varied the area of tank base from which a past leak was assumed to occur. This parametric analysis also included varying the loss volume and leak duration. Results of simulations of different published leak volume estimates (Hanlon 1996; Agnew 1996) in sediments with isotropic hydraulic conductivities and zero distribution coefficients are depicted in Figure A.2. This figure illustrates the sensitivity of contaminant travel times to tank leak area and leak volume. Comparison of panel (B) and © in Figure A.2 illustrates the impact of halving the area over which the Agnew past leak volume is assumed to occur. Halving the area over which the leak loss occurs effectively doubles the loading rate (volume/time per area), causing the resulting solute plume to migrate more rapidly towards the water table. Changing assumptions concerning leak duration and leak volume have similar impacts as changes in leak area, when the other parameters are held constant. Panel (A) on Figure A.2 illustrates the depth of contamination if the Hanlon volume is assumed to be distributed over the full tank base.

Figure A.1. Cumulative Mass Released to Groundwater from Sluicing Losses
Comparison of Runs with and without a Clastic Dike



Source: Jacobs 1997

The new vadose zone information and data indicate that there are minimal changes to the TWRS impact analysis for potential releases from residuals that may be left in the tanks after retrieval and immobilized waste in the LAW vaults for the conditions of the Phased Implementation alternative.

New information on tank leak characteristics combined with assumed larger retrieval losses indicate that first arrival of mobile contaminants may be sooner that calculated in the TWRS EIS. There is still much uncertainty related to what the nominal tank leak area would be, how many of the 149 SSTs would leak during retrieval, and how much they would leak.

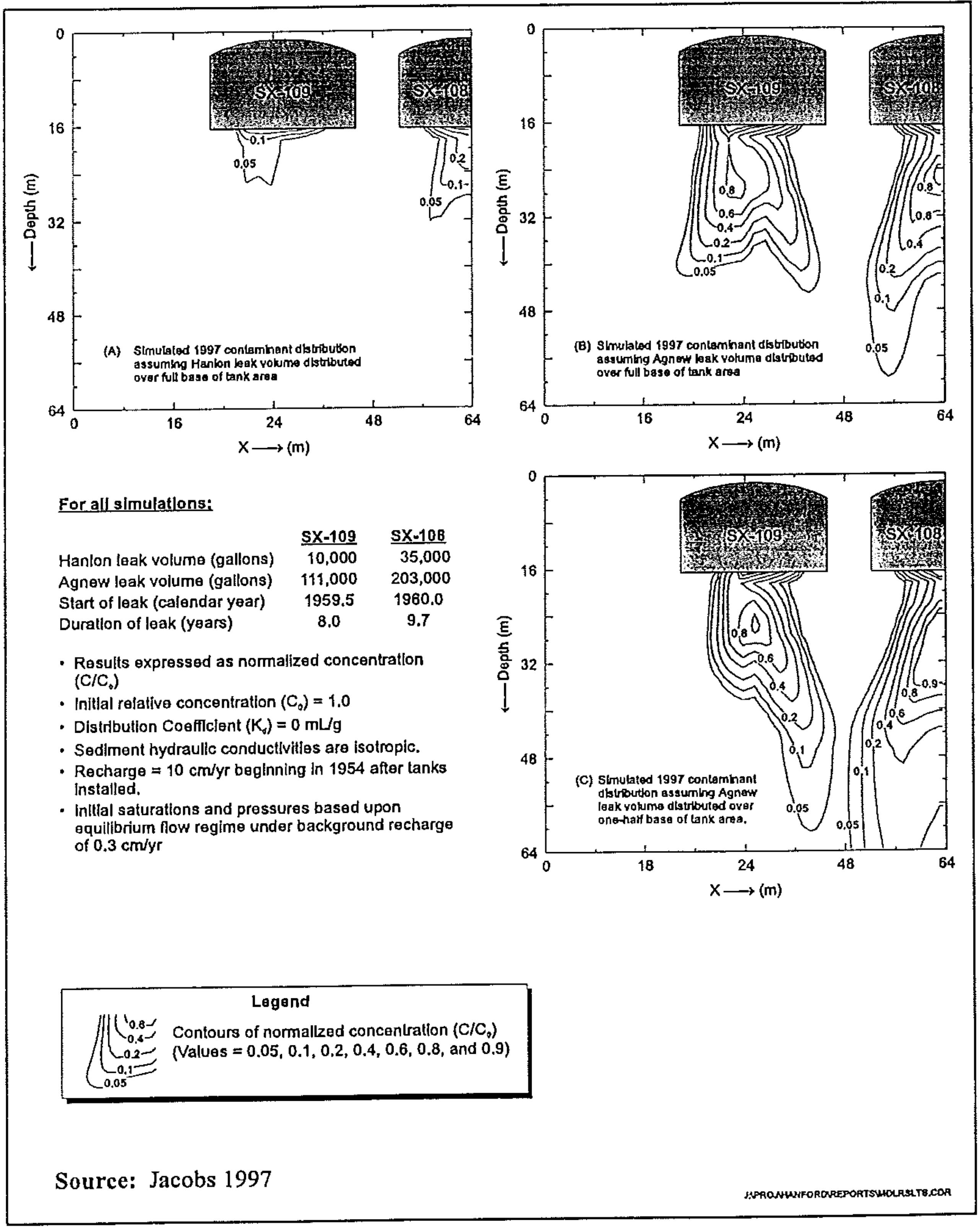
Overall, the largest change based on the new information and data is associated with past leaks from the waste tanks. Even though there continues to be a large uncertainty surrounding past tank leaks the data seem to indicate that some past tank leaks arrive at the water table within few tens of years, depending on the leak characteristics. These arrival times are supported by the RPE studies (Jacobs 1997, 1998a,b). For these past leaks, the leaks themselves are a very large driving force for the relatively fast transport in the vadose zone. The contaminant transport is augmented by the enhanced recharge of approximately 10 cm/yr (3.9 in./yr) at the tank farms through bare sand and gravel covers that have been placed over the tanks plus other sources of water such as water line leaks at some tank farms. Other factors include the tank leak area and the potential effects of the tank leak chemistry (e.g., high pH and high sodium concentration) in the near-field.

The past tank leaks were not within the scope of the TWRS EIS impact assessment; however, they were evaluated with respect to their potential cumulative with TWRS remediation impacts. In the TWRS EIS, a bounding approach to past tank leaks was taken that assumed the No Action alternative could be used as an analog to the occurrence of past tank leaks. Use of this analog puts the impacts from past tank leaks out in time where they would be additive to the impacts from implementing the Phased Implementation alternative. Available information suggests the approach is still bounding because if anything, the impacts from past leaks are occurring sooner than would be calculated using the No Action alternative and thus would be less likely to be additive to the impacts associated with implementing the Phased Implementation alternative.

A.1.3 SATURATED ZONE (GROUNDWATER)

The second part of the groundwater pathway is lateral contaminant transport through the unconfined aquifer flow from points of entry at the vadose zone/water table interface beneath the tank and LAW sources to the Columbia River. The unconfined aquifer is generally located in the unconsolidated to semiconsolidated Ringold and Hanford formations that overlie the basalt rock.

Figure A.2. Sensitivity of Contaminant Travel Time and Peak Concentration to Variation in Tank Leak Volume and Area



(A) Simulated 1997 contaminant distribution assuming Hanlon leak volume distributed over full base of tank area

(B) Simulated 1997 contaminant distribution assuming Agnew leak volume distributed over full base of tank area

(C) Simulated 1997 contaminant distribution assuming Agnew leak volume distributed over one-half base of tank area.

For all simulations:

	SX-109	SX-108
Hanlon leak volume (gallons)	10,000	35,000
Agnew leak volume (gallons)	111,000	203,000
Start of leak (calendar year)	1959.5	1960.0
Duration of leak (years)	8.0	9.7

- Results expressed as normalized concentration (C/C_o)
- Initial relative concentration (C_o) = 1.0
- Distribution Coefficient (K_d) = 0 mL/g
- Sediment hydraulic conductivities are isotropic.
- Recharge = 10 cm/yr beginning in 1954 after tanks installed.
- Initial saturations and pressures based upon equilibrium flow regime under background recharge of 0.3 cm/yr

Legend

Contours of normalized concentration (C/C_o) (Values = 0.05, 0.1, 0.2, 0.4, 0.6, 0.8, and 0.9)

Source: Jacobs 1997

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Groundwater in the unconfined aquifer generally flow from recharge areas the western boundary of the Hanford Site toward the Columbia River, which is a discharge zone for the unconfined aquifer. The new data and information for the unconfined aquifer include 1) water levels at over 600 wells; and 2) concentration of contaminants in the groundwater Sitewide including the areas around the tank farms. Other new information that affects the calculated TWRS contaminant concentrations is the revised inventory, which is also discussed in this section.

New data and information on the saturated zone have been collected from groundwater levels and concentrations of contaminants and other constituents in the groundwater. These data are summarized in two Site documents: Hanford Site Groundwater Monitoring for Fiscal Year 1996 (PNNL 1997b) and Hanford Site 1996 Environmental Report (PNNL 1997a). Additional interpretations of these data are provided in the individual RCRA reports on the tank WMAs.

A.1.3.1 Groundwater Levels

Groundwater level data are used to infer groundwater flow gradient direction and magnitude. The Ground-Water Surveillance Project (GWSP) produces maps annually based on water level measurements taken in June of each year. The most recently published data on water levels are for June of 1996 (PNNL 1997b) in which groundwater levels from over 600 wells in the unconfined aquifer on the Site and in the immediately surrounding area. The most notable observation from these data is the continued trend of groundwater level decline in many areas of the Hanford Site. This is illustrated in two figures. Figure A.3 shows the change in groundwater levels on the Site between 1979 and 1995. The most pronounced change is at the former location of U Pond, near the southern portion of the 200 West Area, where groundwater levels have declined approximately 6 m (19.68 ft.). Figure A.4 shows the changes in groundwater levels on the Site between 1995 and 1996. Again, the most pronounced change is at the former location of U Pond where groundwater levels have declined another 2 m (6.56 ft).

The water-table map for the unconfined aquifer is illustrated in Figure A.5. In the 200 West Area, the inferred groundwater flow direction from this figure is primarily to the east with a northeasterly component on the north side of the area. Groundwater levels in the 200 West Area are still affected by the remnants of the U Pond groundwater mound. Groundwater levels in the vicinity of the former U Pond remain approximately 10 m (32.81 ft.) above preoperational levels (PNNL 1997e). Gradients are relatively high in this area due to the mound and because of the low transmissivity of the aquifer in this area. The hydraulic gradient decreases quickly between the 200 West and 200 East Area in response to the increase of aquifer transmissivity. The water-table is relatively flat in the central portion of the 200 Area Plateau, including most of the 200 East Area. These data were provide in Section 5.2.4. There are no notable changes to the groundwater flows direction that were used in the TWRS EIS that would cause a change to the TWRS EIS impact analysis.

A.1.3.2 Groundwater Quality

Much of the Hanford Site continues to be impacted by past releases of contaminants from many sources. The extent of this impact can be inferred by the distribution of tritium in the unconfined aquifer (Figure A.6). Impacts to groundwater quality from TWRS sources have been evaluated and summarized in RCRA groundwater quality assessment reports which are summarized in the following (Hodges 1997; Johnson and Chou 1997).

The 149 SSTs are grouped into 12 tank farms. These tank farms have been further grouped into RCRA Waste Management Areas (WMAs) as Treatment, Storage and Disposal (TSD) units. The RCRA SST WMAs are classified as interim status under RCRA Part A and their groundwater monitoring status are provided in Table A.13.

New data associated with these WMA are from groundwater sample analyses from up gradient and down gradient wells located at each of the WMAs. Based on these data, the following information has been developed:

- Sources within the S-SX, T, and TX-TY WMAs such as past tank waste leaks are likely to have impacted groundwater as evidenced by the analytical results from down gradient well samples. And, Tc-99 and co-contaminants chromium, nitrate, and I-129 (TX-TY WMA only) are being detected in down gradient wells.

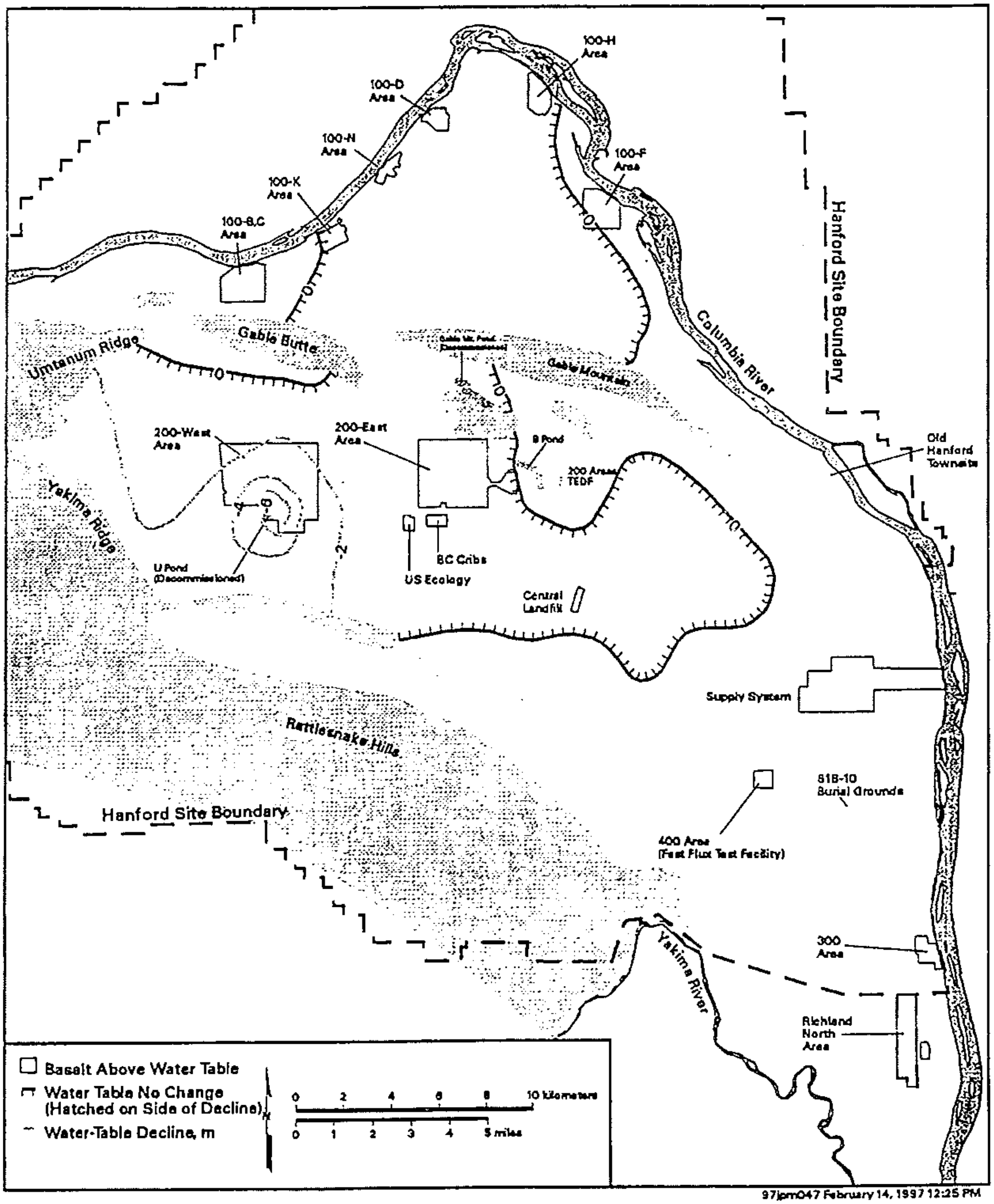
- Leaking water lines at the S-SX WMA are likely the cause of short-term transients in contaminant concentration that have been observed in several wells between 1986 and the present.

- More than one source location in the S-SX WMA is needed to explain historical as well as recent groundwater contamination. At least two, and possibly three, sources can explain the occurrences of Tc-99 transients observed in 1986-1987 and the more recent events observed in wells 299-W23-15 and 299-W22-46.

- Compositional relationships between sodium/calcium and tritium/technetium ratios indicate information about origins and/or processes of groundwater source plumes for the S-SX, T, and TX-TY WMAs. These constituent ratios confirm that the source was from these WMAs.

Site groundwater continues to be impacted by past disposal practices. The uncertainty around past waste tank leaks continues to be a factor in assessing groundwater contaminant concentrations. Mobile contaminants (e.g., Tc-99) associated with the past tank waste leaks are being detected in the groundwater in several of the RCRA groundwater monitoring wells (Hodges 1997; Johnson and Chou 1997). This is consistent with the new information on the potential past leak volume and tank leak area. Past tank waste leaks were not within the scope of the TWRS EIS because there were insufficient data on the volume of releases, current distribution of contaminants, and alternatives for remediation. Past tank leaks will be addressed, along with other issues associated with tank farm closure, in a future NEPA analysis. There are no notable changes to the groundwater contaminant concentrations that would cause a change to the TWRS EIS impact analysis.

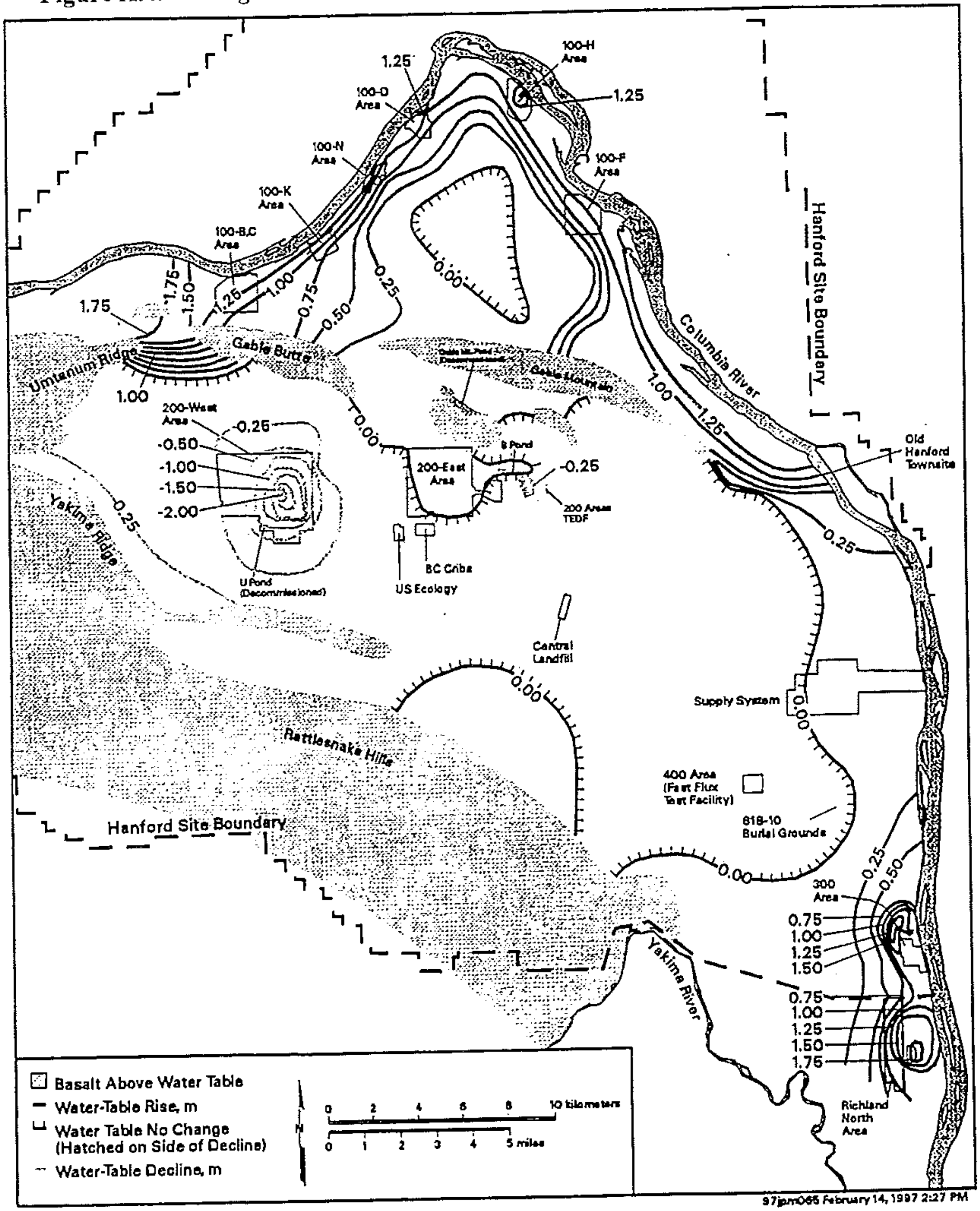
Figure A.3. Changes in Water-Table Elevations on the Hanford Site, 1979 - 1995



97jpm047 February 14, 1997 12:25 PM

Source: PNNL 1997b

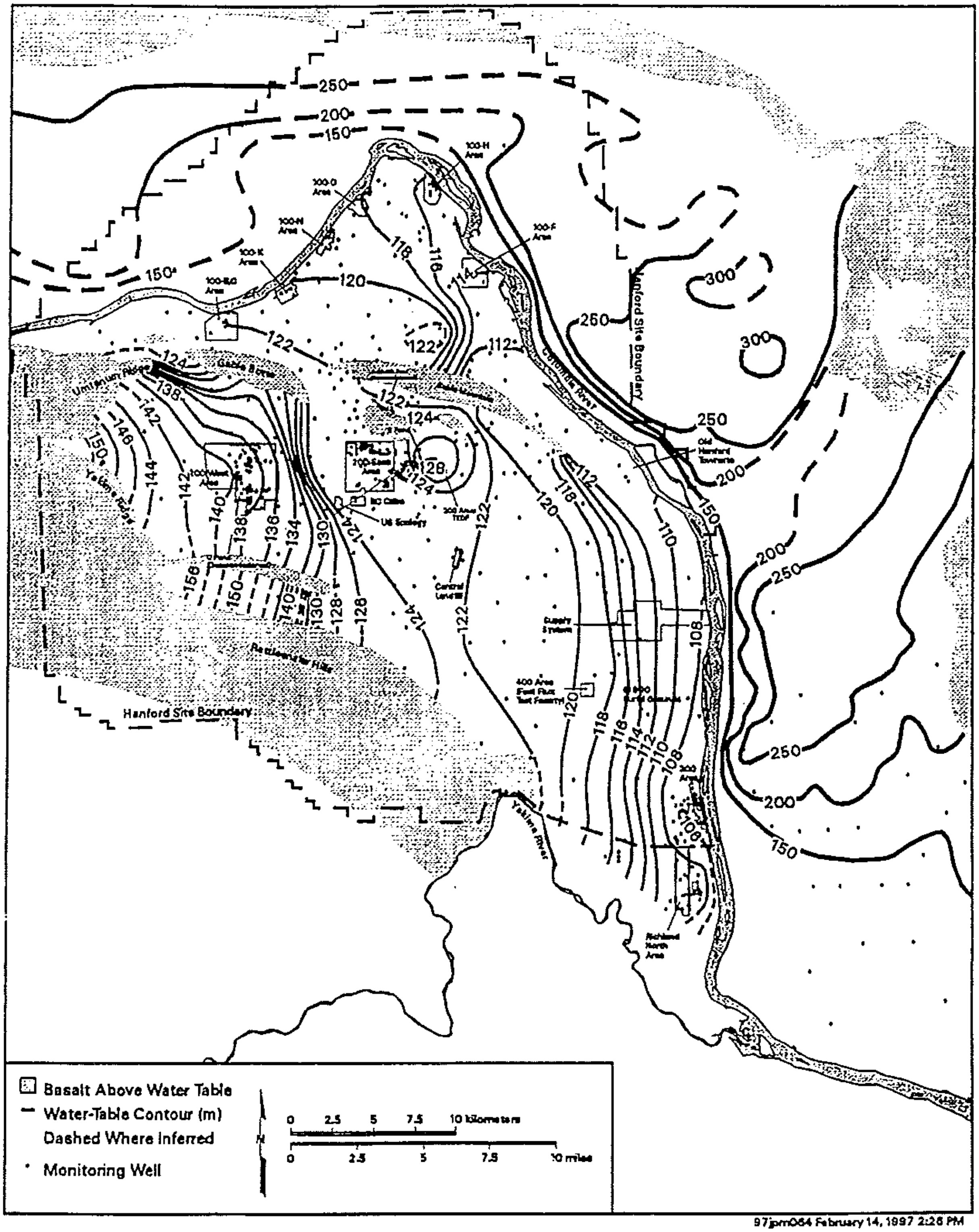
Figure A.4. Changes in Water-Table Elevations on the Hanford Site, 1995 - 1996



97jpm065 February 14, 1997 2:27 PM

Source: PNNL 1997b

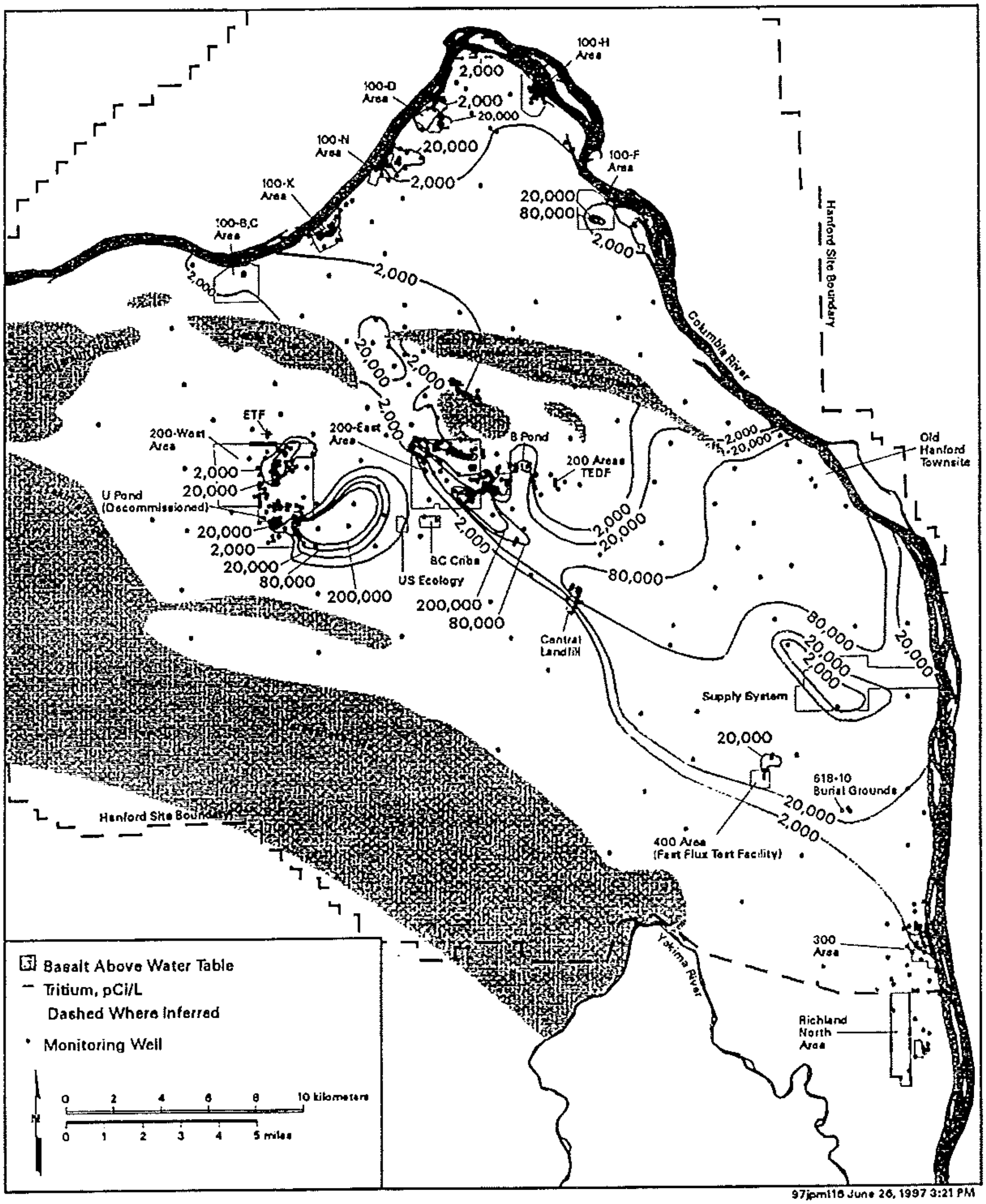
Figure A.5. Hanford Site and Outlying Areas Water-Table Map, June 1996



97jpm064 February 14, 1997 2:26 PM

Source: PNNL 1997b

Figure A.6. Distribution of Tritium in the Unconfined Aquifer, 1996



Source: PNNL 1997b

Table A.13. Single-Shell Tank Waste Management Areas (WMA) and Current Regulatory Status

Tank Farms Included Within a RCRA WMA	Status[1]	Regulatory Indicator Parameters and Contaminants of Concern Identified
A-AX (200 East)	Indicator Parameter Evaluation	Tc-99, Chromium (Cr), and Nickel (Ni). Cr and Ni detected are likely from stainless steel well casing.
B-BX-BY (200 West)	Groundwater Quality Assessment, 1996	Specific conductivity, nitrate (NO_3), chloride, Tc-99, and antimony (Sb)
C (200 East)	Indicator Parameter Evaluation	None
S-SX (200 West)	Groundwater Quality Assessment, 1995	Tc-99, NO_3, Cr, and Cs-137. Cs-137 attributed to particulate dust from casing screen zone.
T (200 West)	Groundwater Quality Assessment, 1993	Tc-99, Cr, tritium, and NO_3. Tritium source from surrounding cribs.
TX-TY (200 West)	Groundwater Quality Assessment, 1993	Tc-99, Cr, tritium, I-129, Co-60, and NO_3. Tritium source from surrounding cribs.
U (200 West)	Indicator Parameter Evaluation	pH, TOX, and Tc-99. All contaminants of concern from change in groundwater direction.

Source: PNNL 1997b.

[1] Indicator Parameter Evaluation status is when specific parameters (i.e., pH, specific conductance, total organic carbon, and total organic halogen) are used to determine if the facility is affecting groundwater quality. Groundwater Quality Assessment status is when the specific parameter threshold values have been exceeded and additional evaluation and sampling are required.

A.1.3.3 Revised Tank Waste and LAW Vault Inventory Affects on Groundwater Concentrations

The impacts presented in the TWRS EIS were amended for this Supplement Analysis to provide groundwater impact comparisons for the revised inventory to the previous TWRS EIS inventory for the selected years (2,500, 5,000, and 10,000 for tank sources and 5,000, and 10,000 for LAW vaults). As shown in Table A.14, the only contaminant to exceed the Drinking Water Standards for tank waste releases for the revised inventory is U-238. In the TWRS EIS, U-238 also was calculated to have exceeded the standard. The potential uranium exceedance of the standard is based on an assumed uranium K_d of zero. The emerging information on uranium mobility discussed previously indicates that the K_d is likely 0.6 mL/g or greater and as such, would not likely exceed the Drinking Water Standards within the 10,0000-year period of interest. For the LAW vaults, Tc-99 was the only constituent to exceed the standard for the revised inventory (Table A.15). In the TWRS EIS, Tc-99 was below the standard.

The calculated releases from the LAW vaults in the TWRS EIS were based on the assumption that the waste glass would be in the form of cullet disposed of in canisters. The current planning assumption for the waste glass has it in the form of a monolith that would be poured into canisters. A monolithic pour would result in a reduction in the contaminant release rate; compared to the TWRS EIS, all other factors being equal. This would reduce the impact to groundwater by lowering the maximum concentration and delaying the time of first arrival and of peak concentration in the groundwater. Contaminants in K_d group 2 (K_d = 1.0 mL/g) or above would not be expected to reach the water table in any event.

A.2 CONCLUSION

There are additional characterization data on the levels of contamination in the vadose zone. These data include spectral gamma logging of drywells, preliminary sampling results of extending a borehole (41-09-39) to the groundwater in the SX Tank Farm, studies on the mechanisms for the transport of contaminates through the vadose zone, and updated groundwater quality data. These new data show that certain contaminants (e.g., Cs-137 and Co-60) from past SST leaks have moved faster through the vadose zone than previously expected and that highly mobile contaminants, such as Tc-99, have reached the groundwater at certain tank farms. Contaminants that were previously expected to move rapidly through the vadose zone, such as Tc-99, appear to have been substantially unaffected by these new data and some contaminants, such as uranium, appear to be moving slower than previously expected.

The reasons why certain contaminants apparently move more rapidly than previously expected and how deep into the vadose zone they will move at accelerated rates is still under investigation. Some factors that may influence the rate of migration include 1) past leaks were larger than previously expected; 2) large surface releases from water line breaks and enhanced infiltration due to the removal of vegetation and installation of gravel around the tanks; 3) past leaks that leaked from a small portion of the tank which tends to channel the releases and provide a larger hydraulic head to drive contamination more quickly; 4) enhanced mobility of certain contaminants, primarily Cs-137, due to the unique chemistry (e.g., high sodium concentration, high pH, and high temperature) of some past SST leaks; 5) enhanced mobility of certain contaminants, primarily Co-60, due to the presence of organic chelating agents in some previous leaks; and 6) preferential flow paths (e.g., clastic dikes), which could provide an mechanism for contaminants to move more quickly through the vadose zone.

There remains a substantial amount of uncertainty associated with which of these transport mechanisms are important in explaining the transport of past tank leaks. It is likely that all play a role at one or more SSTs. Continuation of the ongoing field investigations are necessary to resolve the affect of these mechanisms on past SST leaks. All current information indicates that once in the groundwater the contaminants will be transported laterally at the previously anticipated rates and the less mobile contaminants such as Cs-137 and Co-60 will not be transported away from the 200 Area by the groundwater but rather will chemically bond with the earthen material and become fixed in place. As discussed in the following section these mechanisms would have a much reduced affect on future releases from the tanks.

This new information has resulted in revisions to site computer models for estimating flow through the vadose zone for past leaks and, to a certain extent, refinements in models for tank waste leaks during retrieval. The leaching of residual SST waste that may be left in the tanks after closure and the immobilized waste in the LAW vaults will be largely unaffected by these new data. This is because 1) the residual waste and immobilized LAW will be covered by a low permeability earthen cover that will reduce infiltration of water to very low levels so the leaching

Table A.14. Maximum Concentrations Calculated in Groundwater for the Phased Implementation Total Alternative (Tank Sources)

Constituent	Drinking Water Standard (mg/L)	2,500 years		5,000 years		10,000 years	
		EIS (mg/L)	Best-basis (mg/L)	EIS (mg/L)	Best-basis (mg/L)	EIS (mg/L)	Best-basis (mg/L)
C-14	4.49E-07	3.4E-10	3.1E-10	6.8E-09	6.1E-09	2.0E-13	1.8E-13
I-129	5.68E-06	5.3E-08	8.7E-08	2.0E-06	3.3E-06	1.3E-10	2.1E-10
Tc-99	5.33E-05	3.8E-07	3.9E-07	1.5E-05	1.5E-05	1.5E-09	1.6E-09
U-233	N/A	7.0E-13	2.7E-08	2.3E-11	9.1E-07	0.0	0.0
U-234	N/A	2.4E-11	4.0E-08	1.4E-09	2.3E-06	0.0	0.0
U-235	N/A	7.4E-06	5.2E-06	5.8E-04	4.1E-04	7.2E-09	5.0E-09
U-236	N/A	4.6E-11	1.5E-07	6.6E-10	2.2E-06	0.0	0.0
U-237	N/A	0.0	0.0	0.0	0.0	0.0	0.0
U-238	N/A	1.1E-03	7.4E-04	8.9E-02*	6.0E-02*	1.0E-06	6.8E-07
Total U	0.02 (total)	1.1E-03	7.5E-04	8.9E-02*	6.0E-02*	1.0E-06	6.9E-07
NO_3- NO_2	45 (NO_3)	2.4E-02	1.7E-02	5.4E+00	4.0E+00	2.5E-04	1.8E-03

Notes:

Best-basis = New global best-basis inventory
EIS = TWRS EIS
N/A = Not applicable
* Calculated value exceeds drinking water standard (40 CFR 141.16) based on a calculated dose equivalent of 4 mrem/year.

Table A.15. Maximum Concentration Calculated in Groundwater for the Phased Implementation Total Alternative (LAW Vaults)

Constituent	Drinking Water Standard (mg/L)	5,000 years		10,000 years	
		EIS (mg/L)	Best-basis (mg/L)	EIS (mg/L)	Best-basis (mg/L)
Tc-99	5.33E-05	4.6E-06	2.7E-05	1.2E-05	1.2E-05
U-233	N/A	2.0E-13	7.9E-09	6.0E-13	2.4E-08
U-234	N/A	6.6E-12	1.1E-08	1.8E-11	2.9E-08
U-235	N/A	2.1E-06	1.4E-06	5.6E-06	3.9E-06
U-236	N/A	7.6E-12	2.5E-08	2.0E-11	6.8E-08
U-238	N/A	3.1E-04	2.1E-04	8.3E-04	5.6E-04
U (total)	0.02 (total)	3.1E-04	2.1E-04	8.4E-04	5.6E-04

Notes:

Best-basis =New best-basis global inventory
EIS = TWRS EIS
N/A = Not applicable

of residual waste into the vadose zone will be very slow; and 2) the chemistry and physical form of the residual tank waste and immobilized LAW will be substantially different from the past tank leaks. These two factors prevent the transport mechanism described previously from substantively affecting the transport of the residuals tank waste and immobilized LAW waste.

Additional data are still being obtained and evaluated to address these issues, but it appears that the affect on the impacts presented in the TWRS EIS include:

- The data suggest that past SST tank leaks would move faster through the vadose zone than previously expected resulting in earlier arrival of contaminants in the groundwater. If this occurs, then the concentrations of certain contaminants in the groundwater may be higher than previously expected, and the concentration of other contaminants may be lower. Overall these past leak contaminants would be more likely to move through the vadose zone and groundwater system prior to the contaminants from the tank waste remediation which reduces the potential for the impacts to occur at the same time and therefore reduces the cumulative impacts of past tank leaks and tank waste remediation. The migration of highly mobile contaminants to groundwater from past tank leaks is already occurring. This is demonstrated at several SST farms based on RCRA groundwater quality assessments (Section A.1.3.2). Past, present, and near-term migration of past tank leaks to groundwater will proceed contaminants from TWRS remediation resulting in limited, cumulative impacts of past leaks and TWRS remediation activities. Past tank leaks were not within the scope of the TWRS EIS but were addressed as part of the cumulative impacts of tank waste remediation with other site groundwater impacts. Past tank leaks will be addressed in a future NEPA analysis on closure of the tank farms.

- The leaching of contaminants from the LAW vaults will be largely unaffected by the transport mechanism discussed previously. The LAW will be immobilized into a glass form, and leaching will be controlled by the immobilized waste form and the low permeability earthen cover placed over the LAW vaults. LAW vaults would have few of the characteristics that have resulted in contaminant migration from past SST leaks to groundwater. Past leak migration of past releases from the tanks appears to have been dominated by large volumes of liquids (Section A.1.2.10) and enhanced infiltration conditions (Section A.1.2.6). These conditions would not be present in the LAW vaults. The immobilize waste would be in a glass form encased in canisters. The canisters would be placed in dry vaults that would be covered by a low-permeability earthen barrier. Thus, even when the earthen barrier lost its effectiveness, infiltration would be at much lower levels than the current tank farm conditions. The lower levels of infiltration would also be interacting with a glass waste form resulting in the slow release of low levels of contaminants compared to the highly concentrated liquid waste releases associated with past SST leaks. Additionally, the chemistry of past leaks that contributed to enhanced mobility (e.g., high pH and sodium) would not exist for the LAW form. Finally, the LAW vaults will be located in an area that has not been impacted by past leaks or discharges of contaminated liquids. None of the mechanisms listed earlier that may accelerate contaminant transport will be operative for the immobilized LAW.

- The leaching of residual waste that may be left in the tanks will likely be largely unaffected by much of this new information. Leaching will be controlled by a low permeability earthen cover over the tank farms after closure. Tanks that experienced large leaks in the past may have a residual affect immediately beneath the tanks due to the chemistry of past leaks. This may enhance contaminant transport near the tank, but the effect will dissipate with depth and time. DSTs and SSTs that did not have past leaks with high sodium content, high pH, and high heat would not have this residual affect. None of the mechanisms listed earlier that may accelerate contaminant transport would have a substantive affect on the transport of contaminants from residual waste that contribute appreciably to risk. Similar to the immobilized waste form in the LAW, residual waste remaining in the tanks would have very different characteristics than past tank leaks. These differences would result in much slower migration of contaminants to groundwater than experienced under past tank leak conditions. The residual waste would consist of a dry, hard heel waste form. There would not be large volumes of liquids that could rapidly transport the contaminants deep into the vadose zone. The residual waste would be disposed of by filling the tanks with gravel and placing a low-permeability earthen barrier over the tanks. This would result in much lower levels of infiltration than the current tank farm conditions resulting in the slow release of low levels of contaminants compared to the highly concentrated liquid waste releases associated with past SST leaks (Section A.1.2.6). Additionally, past SST leaks consisted of large leakage volumes over relatively short periods of time and through a limited surface area of the tanks (A.1.2.10). Contaminant migration of residual tank waste under the Phased Implementation alternative would consist of leaching of low volumes of contaminants, over a long period of time, and over a wider area of the tank. These factors would further slow contaminant migration compared to past tank leaks. Remediation of the residual waste was not within the scope of the TWRS EIS but will be addressed in a future NEPA analysis on closure of the tank farms.

- Leaks during waste retrieval would be affected by these new data and would likely result in earlier arrival times in the groundwater but in substantially the same concentration as estimated in the TWRS EIS. Similar concentration levels are largely the result of recent analysis that has concluded that of the contaminants that contributed to long-term risk under the TWRS EIS, some contaminants (e.g., Tc-99 and I-129) are migrating at rates anticipated in the EIS while others may be migrating at rates slower than assumed in the EIS (e.g., uranium). Thus, the overall impact of faster vadose zone migration for some contaminants may be offset by slower migration of other contaminants resulting in groundwater contaminant concentration levels similar to those calculated in the EIS. All of the transport mechanism listed previously could affect the rate of transport through the vadose zone of leaks during retrieval. However, the affect on retrieval leakage is likely to be less than the affect on past tank leaks. Tanks that experienced large leaks in the past may have a residual affect immediately beneath the tanks due to the chemistry of past

> leaks. This may enhance contaminant transport near the tank but the effect will dissipate with depth and time. DSTs and SSTs that did not have past leaks with high sodium content, high pH, and high heat would not have this residual affect. It is important to note that nearly all of the waste to be retrieved during Phase IB of the Phased Implementation alternative would come from DSTs, which are not anticipated to leak during retrieval, so Phase IB activities would be largely unaffected by the new vadose zone data.

This new information would not affect the impacts presented in the TWRS EIS because all of the long-term risk and groundwater impacts resulted from the highly mobile contaminants such as Tc-99, uranium-total, Se-79, and EDTA, which were calculated to move very rapidly through the vadose zone and groundwater so the factors that accelerate transport through the vadose zone would only result in slightly earlier times of arrival of the impacts (Table A.11 and Figure A.1) and not appreciably higher concentrations of contaminants.

Also, the TWRS EIS was sufficiently conservative in its calculation of impacts that the bounding impacts would capture any potential impacts from accelerated contaminant transport in the vadose zone. Among the conservative assumptions in the TWRS EIS are 1) there would be no dilution of retrieval leaks from sluicing liquids; 2) all 149 SSTs would leak; 3) the rate of transport of all contaminants was grouped and contaminants were placed in the highest reasonable group; and 3) the inventory of waste that may remain in the tanks following retrieval was assumed to be one percent of the total tank waste, which does not take into account the preferential recovery of the highly soluble contaminants.

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APPENDIX B

COMPARISON OF TWRS EIS AND TWRS BIO ACCIDENTS

REVIEW OF ACCIDENT ANALYSES IN THE TWRS BASIS FOR INTERIM OPERATION AND COMPARISON TO THE TWRS EIS

The accident analyses in the Tank Waste Remediation System (TWRS) Basis for Interim Operation (BIO), HNF-SD-WM-BIO-001, Rev. 0 (LMHC 1997) was reviewed for comparison with the TWRS Environmental Impact Statement (EIS) (DOE 1996). The three bounding accidents analyzed in the TWRS EIS were also analyzed in the TWRS BIO (seismic event, spray release, and flammable gas deflagration). A comparison of the seismic event, spray release, and flammable gas deflagration evaluated in the two documents is presented in Tables B.1, B.2, and B.3 and shows that the TWRS BIO is bounding for the spray scenario and the TWRS BIO design basis earthquake bounds the TWRS EIS beyond design basis earthquake. The flammable gas deflagration scenario in the TWRS EIS bounds the flammable gas deflagration scenario in the TWRS BIO.

Table B.1. Spray Scenario (Cover Block Off)

Parameter	TWRS BIO, Rev. 0	TWRS EIS
Source term material	Aging Waste Facility	SST
Entrained solids	33 vol. %	30 vol. %
Leak length	5.1 cm (2 in.) long	0.035 cm (0.014 in.) pinhole
Crack width	0.011 cm (0.004 in.)	0.035 cm (0.014 in.) pinhole
Gauge pressure	300 psi	207 psi
*Total flow rate	9.2 L/min	0.027L/min · 2 = 0.054 L/min
Respirable release from spray	0.21 L/min (RF = 2. 3%)	0.054 L/min (RF = 100%)
Exposure duration onsite	12 hr	8 hr
Exposure duration offsite	24 hr	16 hr
Total volumetric respirable release for onsite	150 L (12 hr)	26 L (8 hr)
Total volumetric respirable release for offsite	300 L (24 hr)	52 L (16 hr)
Breathing rate onsite	3.3E-04 m^3/s	3.3E-04 m^3/s
Breathing rate offsite	2.7E-04 m^3/s	3.3E-04 m^3/s
X/Q onsite	99.5 percentile	99.5 percentile
X/Q offsite	99.5 percentile	99.5 percentile
Unit liter dose (rem/L)	5.6E+07 (AWF 33/67)	7.8E+06 [(SST 30/70), (70-yr CEDE)]
MEI onsite radiological dose (rem)	1.5E+04	4.4E+02
MEI offsite radiological dose (rem)	21	1.9

Table B.1. Spray Scenario (Cover Block Off) (cont'd)

Parameter	TWRS BIO, Rev. 0	TWRS EIS
MEI onsite toxicological exposure	4.6E+01 ERPG-1	5.4E+00 ERPG-2
MEI offsite toxicological exposure	2.4E-01 PEL-TWA	4.1E-04 ERPG-1
Annual frequency	1.0E+00 - 1.0E-02	1.1E-02 - 8.0E-03

Table B.2. Flammable Gas Deflagration Scenario

Parameter	TWRS BIO, Rev. 0	TWRS EIS
Failure mode	Unfiltered release, no dome collapse	Ventilation failure, no dome collapse
Source term	Ventilation system = 6.1E-03 L Headspace = 1.58E-01 L Entrainment = 2.46E+00 L Total = 2.63E+00 L	MAR = 5.0E+05 L ARF · RF = 6.5E-06 LPF = 0.75 Total = 2.4E+00
Breathing rate onsite	3.3E-04 m^3/s	3.3E-04 m^3/s
Breathing rate offsite	3.3E-04 m^3/s	3.3E-04 m^3/s
X/Q onsite	99.5 percentile	99.5 percentile
X/Q offsite	99.5 percentile	99.5 percentile
Unit liter dose - inhalation (rem/L)	SST solids (50 yr) = 2.2E+07	DST solids (70 yr) = 6.45E+07
MEI onsite radiological dose (rem)	650	1760
MEI offsite radiological dose (rem)	0.57	4.26
MEI onsite toxicological exposure	1.9E+02 ERPG-1	4.54E+02 ERPG-3
MEI offsite toxicological exposure	1.5E+00 PEL-TWA	4.92E-01 ERPG-1
Annual frequency	Unlikely (1.0E+00 - 1.0E-02)	7.2 E-03

Table B.3. Comparison of Seismic Analyses Between TWRS BIO and TWRS EIS

Parameter	TWRS BIO, Rev. 0 DBE (Bounding)	TWRS EIS BDBE (Bounding)
Peak horizontal ground acceleration	0.19 g	0.43 g
Failure mode	SST burn (no dome collapse) AWF spray (cover block off)	SST dome collapse
Onsite exposure source term (L)	Burn = 2.63 Spray = 150 (12h)	Dome collapse SST = 7.47
Offsite exposure source term (L)	Burn = 2.63 Spray = 300 (24h)	Dome collapse SST = 7.47
Breathing rate onsite (m^3/s)	3.3E-04	3.3E-04
Breathing rate offsite (m^3/s)	2.7E-04	3.3E-04
X/Q onsite (s/m^3)	99.5 percentile	99.5 percentile
X/Q offsite (s/m^3)	99.5 percentile	99.5 percentile
Unit liter dose (rem/L)	Burn SST (solids) = 2.3E+07 Spray AWF (33/67) = 5.6E+07	dc SST (solids) = 2.3E+07
MEI onsite radiological dose (rem)	Burn = 6.5E+02 Spray = 1.5E+04 Total = 1.6E+04	Dome collapse = 1.9E+03
MEI offsite radiological dose (rem)	Burn = 5.7E-01 Spray = 2.1E+01 Total = 2.2E+01	Dome collapse = 4.7E+00
MEI onsite toxicological exposure	1.9E+02 ERPG-1	Dome collapse = 2.2E+03 ERPG-3
MEI offsite toxicological exposure	1.5E+00 PEL-TWA	Dome collapse = 1.8E+00 ERPG-2
Annual exceedance frequency	1.0E-03/yr	1.4E-04/yr

Notes:

AWF = Aging waste farm
dc = Dome collapse
DST = Double-shell tank
EPRG = Emergency Response Planning Guidelines
MEI = Maximally exposed individual
SST = Single-shell tank
DBE = Design-basis earthquake
BDBE = Beyond-design-basis earthquake
EBA = Evaluation-basis accident

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APPENDIX C
NEW TECHNOLOGY DEVELOPMENT

INTRODUCTION

In support of the SA a technology review was conducted to identify any new information that might be applicable to the TWRS program (PHMC 1997). This new information could include new technologies or performance data resulting from the development and deployment of technologies on actual or simulated waste. A number of technology developments are underway at the Hanford Site and throughout the DOE complex aimed at improving the process of remediating HLW in buried tanks. Technology development activities are ongoing in most areas of the Phased Implementation alternative. The technical and programmatic reduction in uncertainty resulting from technology development is also discussed in Section 5.0.

The technology development activities taking place at the Hanford Site and throughout the DOE complex are mainly for technologies that are the same as or functionally equivalent to those evaluated in the TWRS EIS. For example, a number of technical reports were found that investigate cesium separation by ion exchange with different exchange media.

Technology development organizations within DOE are chartered with developing technologies for application to tank waste remediation. The goals of these organizations are to demonstrate, deploy, and provide performance data for tank waste retrieval systems, tank waste pretreatment and immobilization technologies, and technologies to support tank closure.

The key technology development efforts have been identified for 1998 that will facilitate tank waste remediation throughout the DOE complex. Demonstration of technologies at other sites can potentially provide valuable information for the Hanford Site. The technology development activities that are of interest to TWRS include the following activities listed by waste remediation function. The technologies that are identified throughout this section are intended to illustrate the types of activities being pursued and not provide an inclusive list of technologies.

Waste Mobilization and Retrieval

- Provide performance data for pulse jet mixer for the Bethel Valley Evaporator Service Tank at Oak Ridge National Laboratory. This technology uses pulsed jets to mix and suspend waste sludges and keep slurries suspended.
- Provide performance data for borehole miner at the Old Hydrofracture Facility Tank at Oak Ridge. This is an enhanced sluicing technology that includes an extendable nozzle design from the mining industry to direct high-pressure water to mobilize and slurry sludges so they can be pumped out of the tanks.
- Deploy saltcake retrieval equipment; complete hot demonstration at the Savannah River Site. This technology uses variable speed pumps and measured density gradients to remove salts proportional to their dissolution rate. It will be used to remove salts from the annulus of a Savannah River Site tank.
- Assemble and test heel retrieval equipment for tank 19 at the Savannah River Site. This tank contains a zeolite heel, and the technology demonstration will include deploying inexpensive off-the-shelf commercial equipment to dislodge and mix the tank heel. This equipment could be grouted in the tank during tank closure.

- Complete Pulsair® mixer and in-line solids monitor feature testing. This technology uses pulsed air bubbles to mobilize and keep slurries suspended.

Waste Pretreatment

- Complete fabrication of solid-liquid separation demonstration system for the Melton Valley Storage Tank at Oak Ridge. This system will us a cross-flow filtration system to perform solid-liquid separations. A similar, smaller scale system was used for a demonstration on Hanford Site waste. The new system will be larger and will provide additional performance data.
- Issue FY 1998 chromium leaching report for the Hanford Site waste. This report will update chromium leach data for the enhanced sludge washing of sludges based on laboratory tests performed throughout the year. This data will help refine volume projections for vitrified HLW.
- Prepare test model of saltcake dissolution for the Hanford Site. This task will support Phase 1 of the Phased Implementation alternative by defining waste concentration envelopes for transfer to the private contractors feed staging tanks. This will reduce the potential for precipitation of solids during waste transfers and in the feed staging tanks.
- Issue FY 1998 enhanced sludge washing report for the Hanford Site. This technology development effort will focus on waste chemistry and help define chemical envelopes to avoid conditions gels or solids would form.
- Issue FY 1998 leachate chemistry report for the Hanford Site. This effort includes modeling the mixing of leachates from sludge washing the Phase 1 HLW feed stock and the LAW feed to ensure conditions where the formation of unwanted solids or gels are avoided.

Waste Immobilization

- Complete technical report documenting expanded liquidus temperature data for Savannah River Site combined processing. This effort supports the coupled processing of sludge and saltcake in the HLW melter at Savannah River Site and supports optimization of waste loading. This effort is expected to be expanded to support waste loading optimization for the Hanford Site's HLW.
- Complete analysis of nonradioactive glasses for Hanford Site product acceptance criteria. This effort supports LAW processing for Phase 1 by supporting the approval of the waste product specifications for the glass.
- Complete grout/vitrification lifecycle cost analysis comparison for Oak Ridge consolidated wastes.

Tank Closure

- Complete Light Duty Utility Arm sampling campaign at Hanford Site tank AX-104.
- Deploy Light-Duty Utility Arm; retrieve HLW tank heel samples at Idaho National Engineering and Environmental Laboratory (INEEL).
- Complete cone penetrometer probe deployment at the Hanford Site.

- Establish grout specification and emplacement requirements for Gunite and Associated Tanks at Oak Ridge.

Many of the technologies identified for the Phased Implementation alternative have been applied at other DOE sites and in foreign countries. Technology development efforts are mainly oriented toward adapting technologies for application on the Hanford Site's tanks and waste types. The development and deployment of technologies for Hanford-specific applications reduces the uncertainties and provides performance data that can be used to refine TWRS program planning. In developing the engineering data for the TWRS EIS a conservative approach was used to bound the potential environmental impacts. Therefore, technology development could be used to refine a best estimate of the potential impacts but does not affect the bounding case. The exception to this would be if a particular technology was not suitable for application.

CHARACTERIZATION

A number of technologies are being developed that provide in situ characterization data both in the tanks and in the soils surrounding the tanks. These technologies involve different probes to collect different chemical and physical property data and are designed to be deployed using a cone penetrometer. The Raman probe has been developed to provide in situ characterization of organic and inorganic compounds. The Raman effect is the result of inelastic scattering of light off of molecular chemical species. A small fraction of the light interacts with the vibrational mode frequencies and generates the vibrational spectra or chemical fingerprint. This technology eliminates the need to take a physical sample of material for analysis. Other probes are being developed for deployment including a soil sampling device, a gamma probe, x-ray fluorescence probe, rheology sensors, magnetometer, and inclinometer. Development of these probes is currently underway and scheduled to be completed in time to support planned cold deployment in March 1998 (Jacobs 1997c).

The cone penetrometer platform was built in 1996 as a skid-mounted version of a commercially available truck mounted unit. For deployment in soils the cone penetrometer platform uses a hydraulic ram to force a small diameter pipe with a probe on the end into the soil. For deployment in the tanks the cone penetrometer platform would deploy the sensor through one of the tank risers. The platform is used to deploy characterization probes into tanks and soils.

Current plans include deployment of the cone penetrometer along with the new sensor technologies in the AX Tank Farm in August 1998 for the HTI project. Several of the sensor technologies will be combined into a multi-sensor probe that will serve as a screening tool to map contaminant levels of Cs-137 via the gamma probe and uranium via the x-ray fluorescence probe. This characterization data would be used in determining the nature and extent of contamination from past leaks and would support the development of retrieval performance criteria.

Characterization tools are also being developed for the light duty utility arm for deployment in the tanks. These tools include the waste hardness probe that will be used to measure waste depth and provide a qualitative measure of waste hardness and shear properties. The extended reach end effector, designed with a unique detachable and watertight sampler, has also been developed and demonstrated. The gripper end effector has been developed and demonstrated as a utility tool for retrieving small-scale debris and placing chemical probes deployed from adjacent risers to multiple locations on the waste surface.

Fluidic device sampling is being demonstrated at Savannah River in order to accommodate feed staging characterization needs for obtaining representative samples on a routine basis.

Waste retrieval and transfer technology development activities include the deployment of in tank retrieval systems at other DOE sites and prototype testing and demonstration of waste retrieval systems for the Hanford Site. The Hanford SST retrieval program plans to conduct a study to review retrieval technology options in 1998. This study will serve to identify new retrieval technology developments for potential application to the SSTs (PHMC 1997).

A Confined Sluicing End Effector and a scarifier were successfully deployed using the Modified Light Duty Utility Arm to retrieve waste from a tank at Oak Ridge National Laboratory during FY 1997. The Confined Sluicing End Effector is a sluicing-based technology that would require a lower volume of retrieval liquids during operation and would potentially reduce tank leakage. The scarifier is an end effector that can be used to aggressively clean inner tank surfaces and mobilize hardened waste and scale from the tank walls. During FY 1998 this system will be deployed in other Oak Ridge tanks.

The HTI project conducted cold testing of four prototype retrieval systems for the removal of hard-heel waste remaining in the tanks following sluicing. Two of the systems were robotic arm-based and two of the systems were vehicle based systems. Additional development of these systems is underway and one system will be selected for deployment in tank 241-C-106 following hydraulic sluicing. Successful deployment of these technologies would reduce the uncertainty regarding the amount of waste that can be technically and practically removed from the Hanford Site's SSTs.

Recent improvements in horizontal drilling technology have led to the potential use of close-coupled jet-grouted barriers to block the potential leakage from the side walls and bottoms of SSTs during waste retrieval operations.

PRETREATMENT

A number of separations technology development activities were identified during the technology review. These include bench-scale testing of cross-flow filters using sludge slurries from several Hanford Site tanks. Other technology development efforts included identifying or demonstrating processes for separating cesium, technetium, and strontium. Many of these development activities focus on development and performance of a specific type of ion exchange resin for removal of Cs, Tc, or Sr.

A study on acid-side processing of Hanford Site waste has been initiated as a joint effort between LMHC, the Tanks Focus Area (TFA), and INEEL. This strategic task supports the DOE complex-wide Environmental Management Integration Team's report recommending that alternative processes be considered for mortgage reduction.

WASTE IMMOBILIZATION, DISPOSAL, AND CLOSURE

No new technology developments were found during a review of the current state of information on technologies available for waste immobilization, disposal, or tank farm closure.

Optimization of problem constituents in HLW glass is being pursued in support of Phase 2, where wastes containing these constituents are targeted for processing.

However, subsequent to the completion of the TWRS EIS, tank 17 and tank 20 at the Savannah River Site have been closed using an engineered reducing grout to immobilize residual waste left in the tank following sluicing followed by stabilization of the remainder of the tank with grout.

OTHER TECHNOLOGIES

A review of the present state of the in situ vitrification technology revealed no new advances that would change the In Situ Vitrification alternative described in the TWRS EIS.

APPENDIX D
ENVIRONMENTAL SYNOPSIS FOR THE PHASE IB PRIVATIZATION REPORTS

ENVIRONMENTAL SYNOPSIS

Evaluation of Environmental Impacts of Environmental Reports Submitted by BNFL Inc. and Lockheed Martin Advanced Environmental Systems for Phase IB Privatization of the Tank Waste Remediation System at the Hanford Site, Richland, Washington

Prepared by
U.S. Department of Energy
Richland Operations Office

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1.0 INTRODUCTION

In 1996, the U.S. Department of Energy (DOE) and the Washington State Department of Ecology (Ecology) published the Tank Waste Remediation System (TWRS) Environmental Impact Statement (EIS), which addressed alternatives for the management and disposal of the radioactive, hazardous, and mixed waste currently or projected to be stored in 177 underground storage tanks and approximately 60 miscellaneous underground storage tanks in the Hanford Site tank farms. The EIS addressed the full range of alternatives for the safe management and remediation of the tank waste.

Subsequent to the preparation of the EIS, DOE published a Record of Decision (ROD), which documented DOE's selection of the Phased Implementation alternative. Under the Phased Implementation alternative the tank waste would continue to be safely stored until the waste is retrieved from the tanks for treatment and disposal by implementing Phase I to verify the efficiency and effectiveness of the treatment processes selected to treat the waste. Phase II would then be implemented during which the majority of the waste will be treated. The low-activity waste (LAW) produced by processing would be immobilized and disposed of onsite in a near-surface disposal facility near the current location of the tanks, and the high-level waste (HLW) would be vitrified and stored onsite pending disposal at the national geologic repository.

The TWRS EIS described the Phased Implementation alternative in terms of Phase 1 and Phase 2, which have been changed by the TWRS program to Phase I and Phase II. The Privatization contracts referred to the preparation and planning activities associated with construction and operation of the facilities to treat waste as Part IA. Proceeding with the construction and operations by the contractor(s) was referred as Part IB. Part IA and Part IB are now referred to by the TWRS program as Phase IA and Phase IB. For consistency, Phase I and Phase II and Phase IA and Phase IB designations are used throughout the remainder of this Environmental Synopsis.

The TWRS EIS Phased Implementation alternative consisted of Phase I treatment facilities that would treat 6 to 13 percent of the waste over an operating period of approximately 10 years. During the Phase I design process it became apparent that the consideration of seismic and safety requirements would result in facilities that could be 1) operated for approximately 30 years; and 2) expanded to increase annual treatment capacity. While the treatment capacities of these facilities have not changed for Phase I, the potentially longer life and expansion capability makes them more representative of production facilities that could partially meet waste treatment needs during Phase II. Based on this information DOE currently refers to the Phase I demonstration phase treatment facilities as initial production facilities.

DOE also decided to privatize certain portions of the Phased Implementation alternative to transfer a share of the responsibility, accountability, and liability for successful performance to industry and save costs. Under the Privatization initiative private contractors would use private funding to design, build, operate, and own the facilities. DOE awarded contracts for Phase IA to privatize certain portions of the TWRS program to teams lead by Lockheed Martin Advanced

Environmental Systems (LMAES) and BNFL Inc. (BNFL). Phase IA consisted of preparing technical, regulatory, business, and financial plans, and other activities (including Environmental Reports to document potential environmental impacts) associated with the planning process for the construction and operation of facilities to treat tank waste. In accordance with the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement), DOE has until no later than July 1998 to evaluate the deliverables and decide whether to authorize none, one, or both contractors to proceed with Part IB of the contract. During Phase IB the Privatization contractor(s) would process 6 to 13 percent of the tank waste over an operating period of approximately 10 years, and DOE would pay a fixed price per unit of product that meets DOE's specifications. Part IB will conclude with the completion of deactivation of the treatment facilities.

In support of the review process for the TWRS program, DOE took the following actions in accordance with 10 Code of Federal Regulations (CFR) 1021 and commitments made in the TWRS EIS ROD and 1) required that each of the Privatization contractors submit an Environmental Report at the conclusion of Phase IA; 2) independently verified the accuracy of the environmental data and analyses and prepared and considered a confidential Environmental Critique of the contractors' Environmental Reports; and 3) prepared this Environmental Synopsis based on the Environmental Critique. The confidential Environmental Critique discusses each of the contractors' treatment process along with proprietary data that cannot be made publicly available prior to authorizing one or both contractors to proceed with Phase IB. DOE will use the Environmental Critique to assess the need for additional National Environmental Policy Act (NEPA) analysis prior to proceeding with the next phase of the TWRS program.

2.0 ASSESSMENT METHODS

The Environmental Critique and this Synopsis of the Environmental Critique is one part of a comprehensive and detailed Authorization to Proceed process, which includes an assessment of the key issues associated with proceeding with Phase IB of the Phased Implementation alternative.

The Synopsis summarizes the Environmental Critique, which includes an independent evaluation and verification of the data and analysis submitted by the Privatization contractors for Phase IB. The Environmental Critique will be used by DOE to determine 1) if there are any important differences in environmental impacts between the proposals submitted by the Privatization contractors that may affect the selection of none, one, or both of the contractors; and 2) if the potential environmental impacts of the proposals are bounded by impacts presented in the TWRS EIS or whether a supplemental EIS or other NEPA documentation is required prior to proceeding with implementation of the actions identified in the TWRS ROD. The Environmental Critique is a procurement-sensitive document and subject to all associated restrictions. For this Synopsis, business-sensitive information has been summarized at a level that will not compromise the procurement process.

To prepare this Environmental Synopsis the data and information contained in the Environmental Reports, associated documents submitted by the contractors in response to inquiries from DOE or other Phase IA requirements, and the final Environmental Reports submitted to DOE in January 1998 were verified by checking calculations (when available), checking the data for reasonableness, and comparing the impacts presented in the Environmental Reports to the impacts presented in the TWRS EIS. All data presented in the Environmental Reports were then compared against the data that were used to generate the impacts presented in the TWRS EIS for Phase I of the Phased Implementation alternative, and where the data were different the potential environmental impacts were analyzed to determine the changes in the potential impacts. The level of detail of the analysis was based on the level of detail provided in the Environmental Reports, the magnitude of the changes in the data, the severity of the potential impacts, and the degree of public controversy associated with the potential impact.

3.0 DESCRIPTION OF THE PROPOSALS

The proposals by the Privatization contractors contain confidential information and therefore are not available for review by the public and cannot be fully described nor the potential environmental impacts quantified in this synopsis. For this purpose a qualitative approach was used in this Synopsis when comparing the potential environmental impacts with the impacts estimated in the TWRS EIS. The descriptions of the proposals and the environmental impacts resulting from construction and operations have been quantified in an Environmental Critique for Phase IB Privatization prepared by DOE. The proposals are to construct and operate initial production facilities to separate and immobilize selected waste from the TWRS program. Both of the Privatization contractors would operate one existing double-shell tank (DST) as a waste receiver tank, which would be used to stage waste prior to treatment. The proposals include interim storage of the processed HLW and LAW until such time as DOE verifies that the waste form meets performance specifications and accepts transfer of the waste. The proposals do not include current tank farm operations activities or the retrieval and transfer of waste from the tanks to receiver tanks (existing DSTs) that will be operated by the Privatization contractors. These activities will be performed by DOE. All waste processing for eventual disposal of LAW onsite and HLW offsite at a geologic repository must meet waste form performance specifications provided in the Request for Proposals.

3.1 OVERVIEW

Under the Privatization initiative private contractors would use private funding to design, build, operate, and own the facilities. In September 1996, DOE awarded contracts for Phase I to privatize certain portions of the TWRS program to teams lead by LMAES and BNFL. Phase IA consisted of preparing technical, regulatory, business, and financial plans, and other activities (including the Environmental Reports) associated with the planning process for the construction and operation of facilities to treat tank waste. In accordance with the Tri-Party Agreement, DOE has until no later than July 1998 to evaluate the deliverables and decide whether to authorize none, one, or both contractors to proceed with Phase IB of the contract. During Phase IB the Privatization contractor(s) would process 6 to 13 percent of the tank waste over a 5- to 9-year period, and DOE would pay a fixed price per unit of product that meets DOE's specifications. Phase IB will conclude with the completion of deactivation of the treatment facilities.

Phase IB is an initial production period in which tank waste treatment services would be provided at fixed-unit prices. Four different waste feed streams (envelopes) are identified for Phase IB: three waste feed streams for pretreatment and immobilization of the resulting waste stream as LAW and one waste feed stream for vitrification as HLW. These waste feed streams are representative of the range of Hanford Site tank waste. The high-level constituents separated out during the separations processes would be vitrified with the HLW feed stream (envelope) or returned to DOE for treatment during Phase II. Waste processing would take place during an operating period of approximately 10 years during Phase IB. Following waste processing the initial production plants would be deactivated.

4.0 POTENTIAL ENVIRONMENTAL IMPACTS

Resource Requirements

In the TWRS EIS, Phase I of the Phased Implementation alternative included resource requirements for constructing one LAW vitrification facility and one LAW and HLW combined vitrification facility. A comparison of the construction resource requirements was made by comparing facility footprints and facility types. Currently both Privatization proposals included facility footprints that are larger than the 12,000 square meter (129,000 square foot) facility footprint in the TWRS EIS. If both contractors are authorized to proceed with the facilities as currently proposed the two proposals combined would be approximately three times the size of the TWRS EIS Phased Implementation alternative facilities. Based on facility footprints and data provided by the contractors, the construction resource requirements are expected to be proportionately greater than those identified for the TWRS EIS alternative during Phase I.

A comparison of the operating resource requirements was made by comparing the amount of waste treated in the TWRS EIS to the amount of waste processed under each of the Privatization proposals. The combined amount of process chemicals and glass formers required to treat the waste that would be produced under the two proposals would exceed the 180,000 metric tons required in the TWRS EIS by approximately three times. Both proposals would use electricity as the energy source for HLW vitrification and LAW immobilization. This results in higher electrical usage than the 1,700 gigawatt hours estimated for the TWRS EIS, which assumed kerosene as the energy source for LAW immobilization. Electrical demand for the two proposals combined would be approximately two times greater than the demand estimated for the TWRS EIS. However, the combined energy usage of the two contractors would be within available resources.

Soil Disturbances

The TWRS EIS assumes a total soil disturbance of up to 33 hectares (ha) (82 acres [ac]). This would include facility footprints, trample zones around work areas, heavy equipment traffic areas, and material laydown areas. This area would include approximately 15 ha (37 ac) of previously disturbed area and 18 ha (45 ac) of area that has not been disturbed by prior Site construction and operations. Because the facility footprint for both proposals are larger than the TWRS EIS, the total soil disturbance would be greater than the TWRS EIS. The combined soil disturbance of the two proposals would be approximately two times greater than the soil disturbance estimated in the TWRS EIS.

Air Quality

Concentrations from particulate air emissions during construction in the TWRS EIS would not exceed 87 micrograms/cubic meter ($\mu g/m^3$) during a 24-hour period from fugitive dust, 3.2 $\mu g/m^3$ during a 24-hour period from sulfur oxides, 800 $\mu g/m^3$ during a 8-hour period from carbon monoxide, and 1.3 $\mu g/m^3$ during an annual period from nitrogen oxides. Because the facility footprint for both proposals is larger than the footprint for the facilities evaluated in the TWRS EIS, construction requirements and air emissions would be greater than those shown in the TWRS EIS. The combined air emissions during construction from the two proposals would exceed the TWRS EIS by as much as three times but would be within regulatory standards.

Concentrations from particulate air emissions during operations in the TWRS EIS would not exceed 0.05 $\mu g/m^3$ during a 24-hour period from fugitive dust, 0.9 $\mu g/m^3$ during a 24-hour period from sulfur oxides, 27 $\mu g/m^3$ during a 8-hour period from carbon monoxide, and 0.01 $\mu g/m^3$ during an annual period from nitrogen oxides. Both proposals would exceed the fugitive dust, sulfur oxide, and nitrogen oxide emission estimated in the TWRS EIS. The combined air emissions of these constituents during operations from the two proposals would exceed the TWRS EIS by as much as 135 times for nitrogen oxides, six times for fugitive dust, and 19 times for sulfur oxides but would be within regulatory standards. Additional emissions control technologies have been proposed that would result in operating emissions of carbon monoxide and radionuclides that would be below those estimated in the TWRS EIS. The TWRS EIS would exceed the combined air emissions of these constituents during operations from the two proposals by two and one-half times.

Water Quality

The radioactive effluent generated in the TWRS EIS would be treated at the Effluent Treatment Facility prior to discharge. Both of the Privatization proposals included generating radioactive liquid effluent that would require treatment at the Effluent Treatment Facility. The generation of radioactive effluent for both proposals combined would not exceed the capacity of the Effluent Treatment Facility. There would be no liquid effluent discharged to surface waters, and thus there would be no direct impacts to any surface waters under the Privatization proposals.

Potential impacts to groundwater would result from potential liquid losses during retrieval of tank waste, leaching of contaminates in the immobilized LAW vaults, and the leaching of residual waste that may be left in the tanks following retrieval. During Phase IB potential retrieval losses is a DOE function and is unaffected by either of the Privatization proposals. Each of the contractors would be responsible for operation and waste transfers from one DST to their respective facilities (tanks 241-AP-108 and 241-AP-106). Both contractors will construct pipelines with secondary containment for transfer of waste to their respective facilities.

Retrieval losses are not anticipated from these DSTs or waste transfer systems. The leaching of residuals from the LAW is unaffected by the Phase IB proposals as long as the waste form proposed by each contractor would meet the LAW performance specifications. Therefore, the Phase IB proposals by BNFL and LMAES would not impact groundwater. There is always the remote possibility for a spill to occur when waste is being transferred from the receiver tank to the process facilities, but it is anticipated that any such spills would be regulated by the remedial measures under RCRA, and it is assumed that if a spill did occur it would be remediated.

Ecological and Biological Impacts

The TWRS EIS estimates that 62 percent of the area that would be used for construction and operation of Phase I facilities would disturb previously undisturbed shrub-steppe habitat. The total disturbance calculated in the TWRS EIS for Phase I activities was estimated to be 18 ha (45 ac). Because the facility footprint for both proposals is larger than the TWRS EIS, the disturbance of previously undisturbed shrub-steppe habitat would be larger if both contractors are authorized to proceed with facilities as currently proposed. The combined shrub-steppe habitat disturbance of the two proposals would be approximately two times greater than that estimated in the TWRS EIS. Total impacts to wildlife would be expected to be higher under the two proposals than the impacts estimated in the TWRS EIS because impacts to wildlife are largely a function of the total disturbance to previously undisturbed habitat.

Cultural Resources

In the TWRS EIS cultural resource surveys of the potential site locations for facilities revealed no prehistoric material or sites. Because the total area to be disturbed under both Privatization proposals is greater than the TWRS EIS, the likelihood of impact to cultural resources would be greater. Visual impacts to Native American sacred sites (e.g., Gable Mountain, Gable Butte) would be greater under the two proposals than the TWRS EIS because the proposed structures and the total area to be disturbed would be larger. However, the increased disturbed area is not significant, and there would be a low probability of impacting archaeological sites.

Socioeconomic Impacts

In the TWRS EIS, socioeconomic impacts were calculated to peak in 1999 based on a construction workforce of 3,300. All other impacts (e.g., area employment increase of 5,900 jobs, a housing price increase of 12.9 percent, and increases in demand for public services that would require additional police and fire personnel and school capacity) are a function of the size of the workforce employed under the alternative, the projected size of the Hanford Site workforce, and the size of the total nonfarm workforce in the Tri-Cities area. Individually, neither Privatization proposal would have peak construction employment greater than the TWRS EIS. The combined proposals would have total labor years that would exceed the total labor years in the TWRS EIS by 5 percent. Therefore, when size of the construction workforce and duration of construction activities are considered, the two Privatization proposals would have impacts on the local economy that are similar to Phase I of the TWRS EIS.

The socioeconomic impacts during operations under Phase I of the TWRS EIS were based on an estimated total workforce of 580. The combined proposals would have total labor years that would exceed the total labor years in the TWRS EIS by 9 percent. Therefore, when size of the operations workforce and duration of operation activities are considered, the two Privatization proposals would have impacts on the local economy that are similar to Phase I of the TWRS EIS.

Land Use

Under the two Privatization proposals there are no new land uses different from those analyzed in the TWRS EIS. All activities would be in areas designated for waste management and disposal under existing and planned Site land-use plans. However, the total area that would be dedicated to waste management and treatment under the two proposals would be approximately 55 percent greater than the total area estimated in the TWRS EIS.

Visual Resources

In the TWRS EIS, visual impacts would primarily be from one stack on each vitrification facility. The stacks would be visible from State Route 240 and elevated locations that include sacred sites (e.g., Gable Mountain), and the plumes would be visible under some conditions from Site boundaries. Under the two Privatization proposals, visual impacts would be similar to those analyzed in the TWRS EIS because each proposal would result in one stack per facility during operations.

Noise

In the TWRS EIS noise impacts would primarily be from vehicular traffic along existing roadways and heavy equipment during the construction phase. Impacts would affect nearby animal populations resulting in displacement of wildlife within a maximum radius from the construction sites of approximately 800 meters (2,600 feet) and workers in the immediate vicinity of the construction activities. Under the two Privatization proposals noise impacts would be similar to those analyzed in the TWRS EIS. During operations both proposals estimated that noise during operations would be within applicable regulatory standards for workplace conditions.

Anticipated Health Effects

Occupational radiation exposures are routine exposures received from working in proximity to radioactive sources. Exposures are closely monitored, and the radiation dose a worker may receive is limited by law and Hanford Site and contractor administrative controls. The total number of potential latent cancer fatalities estimated in the TWRS EIS (excluding tank farm operations) would be 0.3. This was based on 3,300 person-years and 2.00E-01 rem/person-year. The 2.00E-01 rem/person-year was the average whole body deep exposure to operational personnel at the Plutonium-Uranium Extraction (PUREX) Plant during 1986. The latent cancer fatalities were based on a dose-to-risk conversion factor of 4.0E-04 latent cancer fatalities/rem. The two proposals would each require fewer radiation workers than the TWRS EIS and result in lower exposure rates; therefore, there would be fewer latent cancer fatalities for each proposal. The combined proposals would have a larger number of radiation workers, but the combined proposals would have 40 percent fewer latent cancer fatalities than presented in the TWRS EIS because of the lower exposure rate. There would be no offsite health affects resulting from routine operation from either the TWRS EIS alternative or either of the proposals or the combined proposals.

Accidents

Occupational Accidents - Occupational accidents cause injuries or fatalities to project workers from events such as falls from ladders or twisted ankles that occur at rates that can be statistically estimated. The number and severity of accidents depend on the type of activity and the number of labor hours spent performing the activities. Construction activities have the highest accident rates. The number of occupational fatalities calculated to occur for the TWRS EIS alternative (not including tank farm operations) would be less than one, and the two proposals individually and combined would result in less than one fatality. The potential fatalities from tank farm operations are excluded from the Phased Implementation alternative to provide a direct comparison with the proposals because neither proposal would involve management of tank farm operations by the contractors.

Operational Accidents - The bounding operational accident during pretreatment/treatment for the two proposals would be a tank waste spray release. The latent cancer fatality point estimate risk evaluated in the TWRS EIS would be as much as 180 times greater than the spray release accident evaluated in either of the proposals.

5.0 COMPARATIVE EVALUATION OF THE PROPOSALS

Because the proposals would not differ significantly with regard to their overall environmental impacts, they would not differ with respect to their potential for disproportionately high and adverse human health or environmental effects (see Executive Order 12898, 59 FR 7829, February 11, 1994). The environmental justice impacts from the two proposals would be approximately the same as the potential impacts described in the TWRS EIS.

6.0 LONG-TERM ENVIRONMENTAL IMPACTS

The proposals do not include disposal of either LAW or HLW, which DOE would dispose of. The following discussion provides a general assessment of the potential long-term impacts (i.e., of disposal) if each of the proposals were implemented through Phase I and II.

Both proposals would generate stabilized LAW to be disposed of onsite by DOE in LAW vaults. The total volume of LAW to be disposed of onsite would be less than or similar to the volume estimated for the TWRS EIS. The waste forms for each of the proposals would be at least of comparable quality to that of the glass used for analysis in the TWRS EIS and would meet or exceed the leachability requirements of the contracts. The leachability requirements of the contracts for the LAW were designed to ensure that all groundwater protection standards would be met.

The TWRS EIS bounding analysis showed very small contributions of contaminants to the groundwater from the LAW vaults. All releases would meet groundwater standards and would result in long-term heath risks of two orders of magnitude less than the releases of tank residuals (the one percent of the waste assumed to remain in the tanks following retrieval). The maximum long-term risk from the vaults calculated for the LAW in the TWRS EIS was approximately 3 in 1 million for an onsite residential farmer. With the information available, the two proposals would result in similar long-term risks from the LAW vaults, and these risks would be very small.

Under both proposals the HLW would be a borosilicate glass. Both proposals would produce the same amount of glass for disposal by DOE. The TWRS EIS analysis showed that less than one latent cancer fatality from routine exposures and potential transportation accidents to workers and the public would result from transporting all HLW to a geologic repository. Both proposals would result in the same impacts from the disposal of HLW, and they would be the same as those presented in the TWRS EIS--less than one latent cancer fatality.

7.0 PHASE II IMPACTS

The proposals do not contain information relative to Phase II so it is not possible to calculate potential impacts for Phase II. Based on engineering judgment and information provided in the proposals for Phase I, DOE expects that both of the proposals would result in similar environmental impacts, and these impacts would be less than or approximately the same as the impacts presented in the TWRS EIS for Phase II of the Phased Implementation alternative.

8.0 PERMITS, LICENSES, AND APPROVALS

Each of the proposals would require the same permits, licenses, and approvals as the TWRS EIS. These include:

- Modifications to the Hanford Site Dangerous Waste Permit (Washington Administrative Code [WAC] 173-303)
- Modification to the Sitewide Air Operating Permit (WAC 173-400, 173-460, 246-247, and 173-480, and 40 CFR Part 61)
- Modification to the Site National Pollution Discharge Elimination System Permit (WAC 173-303 and 40 CFR Part 122-136)
- A Sanitary Waste Discharge Permit (WAC 173-226)
- Notice of Construction (WAC 173-400, 173-460, and 246-247, and 40 CFR Part 61)
- Erosion and Sediment Control Plan (WAC 173-226).

9.0 SUMMARY

Based on the review of the Environmental Reports and supplemental information provided by the Privatization contractors, the impacts of authorizing both contractors to proceed with Phase IB, assuming one contractor is authorized to proceed with a LAW/HLW facility and the second contractor is authorized to proceed with a LAW only facility, are within the bounds of the environmental impacts of the TWRS EIS or are not substantively different from the impacts presented in the EIS. Other options that would also be within the bounds of the environmental impacts presented in the TWRS EIS are proceeding with 1) two contractors that provide LAW only services; 2) one contractor to provide either LAW/HLW services or LAW only services; or 3) not authorizing either contractor to proceed. The final option may have NEPA implications depending on how DOE decides to proceed with waste retrieval and treatment. Specifically, as long as DOE maintains the underlying approach to waste retrieval and treatment and the alternate approach is evaluated and determined to be within the bounds of the TWRS ROD, DOE could choose to proceed with another contracting strategy for implementing waste retrieval and treatment.