Washington State Department of Health

WASHINGTON STATE DEPARTMENT OF ECOLOGY

FINAL ENVIRONMENTAL IMPACT STATEMENT

DOH Publication 320-031

VOLUME I

COMMERCIAL LOW-LEVEL RADIOACTIVE WASTE DISPOSAL SITE
RICHLAND, WASHINGTON

May 28, 2004

Washington State Department of Health

WASHINGTON STATE DEPARTMENT OF ECOLOGY

May 14, 2004

To: Public Agencies and Persons with Interest in the Commercial Low-Level Radioactive Waste Disposal Site in Richland, Washington

This Final EIS is being issued in response to a February 14, 1997 State Environmental Protection Act (SEPA), Chapter 43.21C RCW, Determination of Significance. Both the Final EIS and the August 2000 Draft EIS were a joint effort by the Washington Department of Health (DOH) and the Washington Department of Ecology (Ecology). In response to comments on the Draft EIS, there were numerous updates and revisions made to the Final EIS. These include a recalibrated groundwater model, expanded radiological risk assessment, a more comprehensive description of past waste disposal, and the identification of three preferred alternatives. The three preferred alternatives identified in the Final EIS are:

1. Renew the US Ecology, Inc. Washington State radioactive materials license, with additional requirements, for operation of the commercial LLRW disposal site.

2. Amend Chapter 246-249 WAC (Washington Administrative Code), establishing an annual site limit of 100,000 cubic feet for diffuse Naturally Occurring or Accelerator Produced Radioactive Material (NARM) disposed at the commercial LLRW disposal site.

3. For site closure, construct a GeoSynthetic Cover in three phases, beginning in year 2005.

<u>Renew License</u>

The License Preferred Alternative would approve the US Ecology radioactive materials license application and would renew the license for an additional five years of operating the commercial LLRW disposal site. The benefits of renewing the license are: (1) confirms the state's commitment to the Northwest Compact; (2) provides in-state and regional generators with continued access to a regulated disposal site; and (3) provides revenues to local government. The EIS projected little or no health impact from continuing to operate the site through 2056. If the preferred alternative is selected, DOH will begin renewing the license, with additional requirements, within 60 days of issuance of the Final EIS.

Diffuse NARM

The Diffuse NARM Preferred Alternative would amend Chapter 246-249 WAC to establish an upper site limit of 100,000 cubic feet per year of diffuse NARM, with potential rollover on a case-by-case basis. The benefits of disposing of diffuse NARM at the commercial LLRW site are: (1) revenue for local government; (2) revenues that help offset disposal costs for LLRW generators; and (3) disposal access to 38 generators of diffuse NARM. The analysis in the EIS projects little or no health impact from a site limit of 100,000 cubic feet per year. If the preferred alternative is selected, DOH will begin rulemaking within 60 days of issuance of the Final EIS.

Site Closure

There are two preferred alternatives for site closure: the Cover Design Preferred Alternative; and the Cover Schedule Preferred Alternative. The EIS identifies the GeoSynthetic Cover as the preferred cover design. The benefits of the GeoSynthetic Cover are: (1) the cover is compliant with both radioactive and hazardous waste requirements for cover design; (2) projected post-closure doses for the GeoSynthetic Cover are less than the 25 millirem per year standard; and (3) an acceptable projected onsite dose.

The Preferred Cover Schedule is the "Close-As-You-Go" Schedule. The primary benefit of this alternative is a 100 millirem per year reduction in offsite doses as compared to the other schedule alternatives. The Close-As-You-Go Schedule would construct the cover in three phases. The first phase would begin constructing a low permeability cover over all existing waste (40 acres) no later than 2005. The second phase would begin in 2008 and would complete the cover over the first 40 acres. The third phase would be ongoing and would construct the final cover in planned phases, as waste is disposed. If these preferred alternatives are selected, US Ecology will begin work on the first phase of the cover within 60 days of issuance of the Final EIS.

The agencies will make a final decision on the proposed actions following a seven-day waiting period after the issuance of the EIS. For more information, please contact Nancy Darling, Project Manager, at (360) 236-3244, or e-mail her at nancy.darling@doh.wa.gov.

Sincerely,

Gary Robertson

Gary Robertson, Director
Office of Radiation Protection
Washington Department of Health

Mike Wilson, Program Manager
Nuclear Waste Program
Washington Department of Ecology

FACT SHEET

TITLE: Final Environmental Impact Statement for the Commercial Low-Level Radioactive Waste Disposal Site, Richland, Washington.

1. PROJECT DESCRIPTION

There are three proposed actions under consideration at the commercial low-level radioactive waste disposal site (commercial LLRW site). They are:

1. **License** - Approve or deny the US Ecology Washington State radioactive materials license (license) application for continued operation of the commercial LLRW site.

2. **Diffuse NARM** - Select an annual limit for disposal of diffuse NARM at the commercial LLRW site.

3. **Site Closure** - Approve a cover design and a cover schedule.

For each proposed action, there is a No Action Alternative and several reasonable alternatives evaluated in the EIS.

2. PROJECT PROPONENT

The Washington State Department of Health and the Washington State Department of Ecology are the project proponents for the three proposed actions.

3. DATE OF IMPLEMENTATION

Implementation on any of the proposed actions will commence following the seven-day waiting period after the EIS is issued.

4. LEAD AGENCIES

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5. REQUIRED LICENSES AND PERMITS

Radioactive Materials License WN-I019-2 – Issued to US Ecology, Inc. by Washington Department of Health

Site Use Permit G1004 issued to US Ecology by Washington Department of Ecology

Brokerage Permit B101 issued to US Ecology by Washington Department of Ecology

Radio License KNHU550 issued by Federal Communications Commission

6. AUTHORS AND PRINCIPAL CONTRIBUTORS

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Principal Contributors:

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Arthur S. Rood, K-Spar Inc.

Washington Department of Health; Office of Radiation Protection

Washington Department of Ecology; Nuclear Waste Program

7. DATE OF ISSUE

The EIS date of issue is June 30, 2004. The Final EIS may be posted on the Washington Department of Health and the Washington Department of Ecology websites prior to this date.

8. FURTHER REVIEW

Each proposed action will be subject to further review before implementation. Renewal of the license will be subject to the license amendment procedures; Diffuse NARM will be subject to rule adoption proceedings pursuant to the Administrative Procedures Act, RCW 34.05; and Site Closure will be subject to approval of engineering plans and specifications.

9. LOCATION OF TECHNICAL SUPPORT DOCUMENTS

Washington Department of Health
Office of Radiation Protection
7171 Cleanwater Lane, Bldg. 5
PO Box 47827
Olympia, WA 98504-7827

10. COST OF FINAL EIS

An initial copy of the Final EIS will be distributed, by request, at no cost. Additional copies may incur a cost.

READER'S GUIDE

The Commercial Low-Level Radioactive Waste Disposal Site Environmental Impact Statement (EIS), Volume I, provides three levels of detail to the reader. The Executive Summary, Chapter One, provides a summary of the proposed actions, potential impacts, and a description of the preferred alternatives.

Chapters two through six are the central body of the EIS and provide more detail on regulatory requirements, waste disposal history, proposed alternatives, public health impacts, affected environment, and other considerations. The shaded information at the end of each of the sections in chapters two through six provides a quick reference on the impacts of the preferred alternatives.

The Appendices provide the technical information on site operations (Appendix I), the Radiological Risk Assessment (Appendix II), and groundwater modeling (Appendices III and IV). Also included as Appendix V are the 1997 Scoping Comments for the Draft EIS.

The Executive Summary can be used as a stand-alone document without reading the other sections of the EIS. However, the central body of the EIS (chapters two through six) should not be read without also reading the Executive Summary. The Executive Summary contains information not presented elsewhere in the EIS.

The Responsiveness Summary, Volume II, addresses comments received during the Draft EIS public comment period. The public comment period for the August 2000 Draft EIS was from September 25, 2000 to November 30, 2000. Public hearings were held in Bellevue, Washington; Kennewick, Washington; and White Salmon, Washington. In response to public comments, the state made numerous changes to the Draft EIS. The Final EIS includes additional background information, several new alternatives, and a revised groundwater model.

There is no comment period for a Final EIS. The agencies may take action on the proposed actions after a seven-day waiting period following the issuance of the Final EIS.

New information or revisions in the Final EIS include:

- ***More Comprehensive Executive Summary***

The Executive Summary has been expanded to give the reader a more complete summary of the proposed actions and their potential impacts. A discussion of controversial issues and a description of the preferred alternatives have been added. The impact summary tables (Tables 1.A, 1.B, 1.C, and 1.D) were streamlined to only significant impacts.

- ***Revised Proposed Actions***

To be more consistent with the State Environmental Policy Act (SEPA), the state revised the three proposed actions to be more objective. For example, the proposed action in the Draft EIS for the license was "Renew the US Ecology License." The revised proposed action in the Final EIS is to "Make a Determination on the US Ecology License Application".

- ***Revised No Action Alternatives***

The state revised the No Action alternatives to be more true to the original intent of "no action". For example, in the Draft EIS, the License No Action Alternative was to deny the license. In the Final EIS, the License No Action Alternative is for the state to take no action on US Ecology's application and to leave the current license in timely renewal.

- ***Addition of New Alternative: Zero Diffuse NARM***

This new alternative bans all diffuse NARM from the commercial LLRW site, including diffuse NARM from Washington State.

- ***Filled Site Alternative Deleted***

The state deleted the Filled Site Alternative from all analyses except the Radiological Risk Assessment (Appendix II). This alternative was deleted because it is not viable at this time, due to legal restrictions on waste disposal. The Filled Site Alternative was kept in the Radiological Risk Assessment to provide an analysis of maximum waste volumes.

- ***More Comprehensive Description of Wastes***

Background information on past waste disposal was increased to include discussions of foreign waste, USDOE waste, free liquids, and TRU (transuranic) wastes.

- ***Update on MTCA Applicability***

An updated description of the applicability of MTCA was included in Section 2.2.2.

- ***Added Section on Cover Source Materials***

Information on impacts associated with procuring offsite materials for the cover designs is included in Section 4.3, Cover Construction Risk, and Section 6.4, Resource Commitments.

- ***Increased Information on Environmental Monitoring***

The environmental monitoring section was revised to include all environmental monitoring, including the annual environmental monitoring, the DOH confirmational monitoring program, and the US Ecology Site Investigation.

- ***Recalibrated Groundwater Model***

The groundwater modeling for radionuclides was recalibrated using vadose zone data from the US Ecology Site Investigation. The supporting analysis for the new modeling is in Appendix IV.

- ***Expanded and Revised Radiological Risk Assessment***

The Radiological Risk Assessment was revised using the new groundwater modeling. The point of compliance for the offsite resident remains at the boundary of the commercial LLRW site. An additional onsite intruder scenario and a Native American River Resident scenario were included. The Radiological Risk Assessment is attached to the Final EIS as Appendix II.

- ***Updated Description of Environment***

The descriptions of the environment have been updated to reference annual monitoring data, US Ecology Site Investigation data, and DOH confirmational data.

- ***Added Evaluation of Resource Commitments***

An evaluation of resources required for the construction of the cover design alternatives was included.

SUPPORTING DOCUMENTS

This section lists key supporting documents. Some of these documents are appendices to the EIS or are also listed in the reference section of the Final EIS.

Ahmad, Jamil, 2003, *Perpetual Care and Maintenance Surety Cost Analysis,* Washington Department of Health, Olympia, Washington.

Comprehensive Facility Investigation Richland LLRW Disposal Facility, Phase I and 2 Report, 1999, US Ecology, Inc.

Department of Ecology, EPA, and USDOE, 1989, *Hanford Federal Facility Agreement and Consent Order,* Document No. 89-10, as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Dunkelman, M., 1999, *Technical Evaluation Report for the 1996 US Ecology, Inc. Site Stabilization and Closure Plan for the Low-Level Radioactive Waste Disposal Facility, Richland, Washington,* Department of Health, Olympia, Washington.

NORM Task Force, 1993, *Recommendation on Chapter 246-249-080 WAC Regarding Large Volumes of NORM*, submitted to Washington State Department of Health, Olympia, Washington.

Rood, A.S., 2003, *Groundwater Concentrations and Drinking Water Doses with Uncertainty for the U.S. Ecology Low-Level Radioactive Waste Disposal Facility, Richland Washington,* K-Spar, Inc. Scientific Consulting, Rigby, Idaho.

Rood, A.S., 2003a, *FOLAT: A Model for Assessment of Leaching and Transport of Radionuclides in Unsaturated Porous Media*, K-Spar, Inc., Rigby, Idaho, December, 2002.

Thatcher, A.H., et al*,* 2003a*, DOH Radiological Risk Assessment for the Commercial Low-Level Radiological Waste Site,* Washington Department of Health, Olympia, Washington.

U.S. Department of Energy, 1993, *Hanford Federal Facility State of Washington Leased Land*, DOE/RL-93-76, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

US Ecology Site Environmental Review by the Joint Legislative Committee on Science and Technology, 1985, Olympia, Washington.

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ACRONYMS

Act	Low-Level Radioactive Waste Policy Act of 1985
AEA	Atomic Energy Act
AEC	Atomic Energy Commission
ALARA	As Low as Reasonably Achievable
Amendments Act	Low-Level Radioactive Waste Policy Act of 1985, Amended
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLUP	Comprehensive Land Use Plan
CNI	California Nuclear, Inc.
DEIS	Draft Environmental Impact Statement
DOH	Washington State Department of Health
DS	Determination of Significance
DUST	A Computer Code
ECB	Engineered Concrete Barriers
EIS	Environmental Impact Statement
EMS	Emergency Management Services
EPA	U.S. Environmental Protection Agency
FOLAT	A Computer Code
GWSCREEN	A Computer Code
HAEIF	Hanford Area Economic Investment Fund
HMS	Hanford Meteorological Station
ICRP	International Commission on Radiation Protection
JLC	Joint Legislative Committee
LLC	Limited Liability Company
LLRW	Low-Level Radioactive Waste
LNT	Linear No Threshold
MCL	Maximum Contaminant Level
MDC	Maximum Detectable Concentration
MEI	Maximally Exposed Individual
MOU	Memorandum of Understanding
MTCA	Model Toxics Control Act
N/A	Not Applicable
NARM	Naturally Occurring or Accelerator Produced Radioactive Material
NCRP	National Commission on Radiation Protection
NECO	Nuclear Engineering Company
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NRC	U.S. Nuclear Regulatory Commission
NUREG	Publications by the U.S. Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
PC&M	Perpetual Care and Maintenance
PNNL	Pacific Northwest National Laboratory (Formerly “PNL”)

RADTRAN	A Computer Code
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
SEPA	State Environmental Policy Act
SNM	Special Nuclear Material
TCE	Trichloroethene
TEDE	Total Effective Dose Equivalent
TLD	Thermoluminescent Dosimeter
TNC	The Nature Conservancy
TRU	Transuranic
TRV	Trojan Reactor Vessel
UNSAT-H	A Computer Code
US Ecology	US Ecology, Inc.
USDOE	U.S. Department of Energy
US DOT	U.S. Department of Transportation
WAC	Washington Administrative Code
WISHA	Washington Industrial Safety and Health Act
WUTC	Washington Utilities and Transportation Commission

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Washington State Library
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Eric Wieser, Nuclear Waste News

NOTE: Copies will be distributed to other interested persons upon request.

FOREWORD: RADIATION SOURCES AND RISK

This information is provided to help the reader understand ionizing radiation and its effects on health and the environment. Every individual is exposed to radiation on a daily basis. Sources of natural radiation include naturally occurring radioactive isotopes in the human body and in the earth's crust, naturally occurring radon gas, and cosmic radiation. In addition to these unavoidable exposures, individuals receive "voluntary" exposures to radiation when they agree to x-rays, certain medical treatments, and airplane travel. Some building materials also contribute to voluntary radiation exposures. Some people are exposed to other less common manmade sources of radiation. These may include living close to a nuclear power plant or a radioactive waste disposal site, working with radioactivity, or being affected by an accident involving radioactive materials. Some common radiation terms are defined below.

Terms Common to Radiation	
Name	**Definition**
Decay	The decrease in the amount of radioactive material with the passage of time.
Half-life	The amount of time for a given quantity of a specific radioactive material to decay to half the original activity.
Curie	Unit of measurement for the rate of radioactive decay.
Millirem (mrem)	Unit of measurement used to quantify an individual's dose of radiation exposure.

i. Radiation Doses

The amount of radiation an individual is exposed to is called a "dose" and is commonly measured in units of "millirem" (mrem). In this Environmental Impact Statement (EIS), unless specified otherwise, radiation doses are presented for the total effective dose equivalent (TEDE). The TEDE is the total dose, from the sum of both internal and external exposure. Internal exposure results from ingestion or inhalation of radioactive materials, while external exposure results from radiation emitted from a source external to the body.

The annual U.S. average background from natural sources is about 300 millirem per year. This includes 27 millirem from cosmic ray sources, 28 millirem from terrestrial sources, 39 millirem from internal sources, and 200 millirem from radon (NCRP 1987). Assuming a 70-year life span, an individual would receive an average lifetime cumulative dose of about 21,000 millirem.

The annual dose to different individuals from natural sources varies greatly, often depending on where the person lives. Variations of a factor of two from the average are common, and variations of a factor of ten are not rare. The range of an individual's annual dose extends from about 100 millirem per year to about 2000 millirem per year. An individual's dose may be greater due to exposure to manmade sources of radiation. Some examples of doses from manmade sources are listed below.

Average Radiation Dose	
Sources	**Average Dose**
X-ray	5-300 mrem
Nuclear Medicine	250-1500 mrem
Cross-Country Airplane Flight	4 mrem
Nuclear Industry Worker	1000-15,000 mrem average lifetime

ii. Radiation Risk

Risk from exposure to radiation is defined as the probability that a person will be harmed by radiation. Most commonly, radiation risk refers to the probability of death from cancer. It is well established that very high radiation doses of about 400,000 millirem are fatal. It is also established that doses greater than about 10,000 to 20,000 millirem, administered at high dose rates, may cause cancer. At the lower doses and lower dose rates typically received by members of the public and radiation workers, there is no direct evidence that radiation causes harm.

Because there is no direct evidence that lower doses of radiation are harmful, public health risks at these lower doses are estimated based on health effects measured at much higher doses. It is often assumed there is a linear relationship between dose and risk, and that there is no threshold below which risk does not exist. This assumption is known as the Linear No Threshold (LNT) model, and is similar to models used to predict risk from other cancer-causing agents.

RADIONUCLIDE NOMENCLATURE*

Symbol	Radionuclide	Half-Life	Symbol	Radionuclide	Half-Life
Ac-227	actinium-227	22 yr	Ni-59	nickel-59	7.6×10^4 yr
Am-241	americium-241	432 yr	Ni-63	nickel-63	100 yr
Ba-133	barium-133	7.2 yr	Pa-231	protactinium-231	3.3×10^4 yr
Bi-207	bismuth-207	30 yr	Pb-210	lead-210	22 yr
C-14	carbon-14	5730 yr	Pm-147	promethium-147	2.62 yr
Cd-113	cadmium-113	1.3×10^{15} yr	Pu-238	plutonium-238	88 yr
Cl-36	chlorine-36	3.0×10^5 yr	Pu-239	plutonium-239	2.4×10^4 yr
Cm-244	curium-244	18 yr	Pu-240	plutonium-240	6563 yr
Co-60	cobalt-60	5.3 yr	Pu-241	plutonium-241	14 yr
Cs-134	cesium-134	2.05 yr	Pu-242	plutonium-242	3.7×10^5 yr
Cs-137	cesium-137	30 yr	Ra-226	radium-226	1600 yr
Eu-152	europium-152	14 yr	Sb-125	antimony-125	2.8 yr
Eu-154	europium-154	8.6 yr	Sm-151	samarium-151	90 yr
Eu-155	europium-155	4.8 yr	Sr-90	strontium-90	29 yr
Fe-55	iron-55	2.7 yr	Tc-99	technetium-99	2.1×10^5 yr
H-3	hydrogen 3 (tritium)	12 yr	Th-230	thorium-230	7.5×10^4 yr
Hf-182	hafnium	9×10^6 yr	Th-232	thorium-232	1.4×10^{10} yr
I-129	iodine-129	1.6×10^7 yr	Tl-204	thallium-204	3.8 yr
K-40	potassium-40	1.3×10^9 yr	U-232	uranium-232	69 yr
Kr-85	krypton-85	10.76 yr	U-234	uranium-234	2.5×10^5 yr
Na-22	sodium-22	2.6 yr	U-235	uranium-235	7.0×10^8 yr
Nb-94	niobium-94	2.0×10^4 yr	U-238	uranium-238	4.5×10^9 yr

*Listing includes radionuclides discussed in this document.

1.0 EXECUTIVE SUMMARY

1.1 Purpose and Need

Washington State is host to one of the nation's three commercial low-level radioactive waste disposal sites (commercial LLRW site). The commercial LLRW site is located in Benton County and is approximately 23 miles northwest of Richland in eastern Washington. The site is located near the center of the 586-square mile United States Department of Energy (USDOE) Hanford Site, on approximately 100 acres of land leased to the state of Washington. Beginning in the 1940's, the primary mission at Hanford was to produce nuclear materials in support of national defense. The production of these materials resulted in contaminated soil and groundwater throughout Hanford and particularly in the area known as the central plateau. Since 1989, identification and cleanup of these sites has been USDOE's top priority at Hanford.

The commercial LLRW site has been in operation since 1965 and is operated by US Ecology, Inc. (US Ecology). The site is licensed to receive low-level radioactive waste (LLRW) and naturally occurring and accelerator-produced material (NARM). Disposal access is limited to 11 states by the Northwest Interstate Compact. Approximately 80% of the LLRW disposed at the site is from generators in Washington and Oregon.

Conventional shallow-land burial of packaged waste into unlined trenches is practiced at the commercial LLRW site. Types of waste disposed at the site since 1965 include unclassified radioactive waste (pre-1984), classified LLRW, NARM, non-radioactive hazardous waste, and mixed waste (radioactive waste having a hazardous component). All wastes, except LLRW and NARM, are no longer allowed for disposal.

The state decided to develop an environmental impact statement (EIS) for the commercial LLRW site based on three events. The first event occurred on May 15, 1996. In response to a civil suit filed by US Ecology, the Washington Department of Health (DOH) and US Ecology entered into a court ordered settlement agreement that required DOH to initiate rulemaking to amend WAC 246-249-080 to establish a 100,000 cubic feet per year site limit for diffuse NARM. Rulemaking has been deferred pending the completion of the Final EIS. The 100,000 cubic foot limit remains in effect today.

The second event also occurred in 1996. After extensive coordination with DOH and the Department of Ecology, US Ecology submitted the *1996 US Ecology, Inc. Site Stabilization and Closure Plan* for approval (US Ecology 1996). Closure decisions resulting from the EIS will be incorporated into the closure plan.

The third event occurred on January 7, 1997. US Ecology submitted an application to renew its operating license, which is required to be renewed every five years. Approval of the license application is pending the completion of the Final EIS.

In 1997, DOH and the Washington Department of Ecology (Department of Ecology) conducted a SEPA review to determine if the above three events could potentially result in significant adverse impacts. The state determined there was a potential for impacts, and work on the EIS began.

Figure 1.A: Hanford Site Location Map

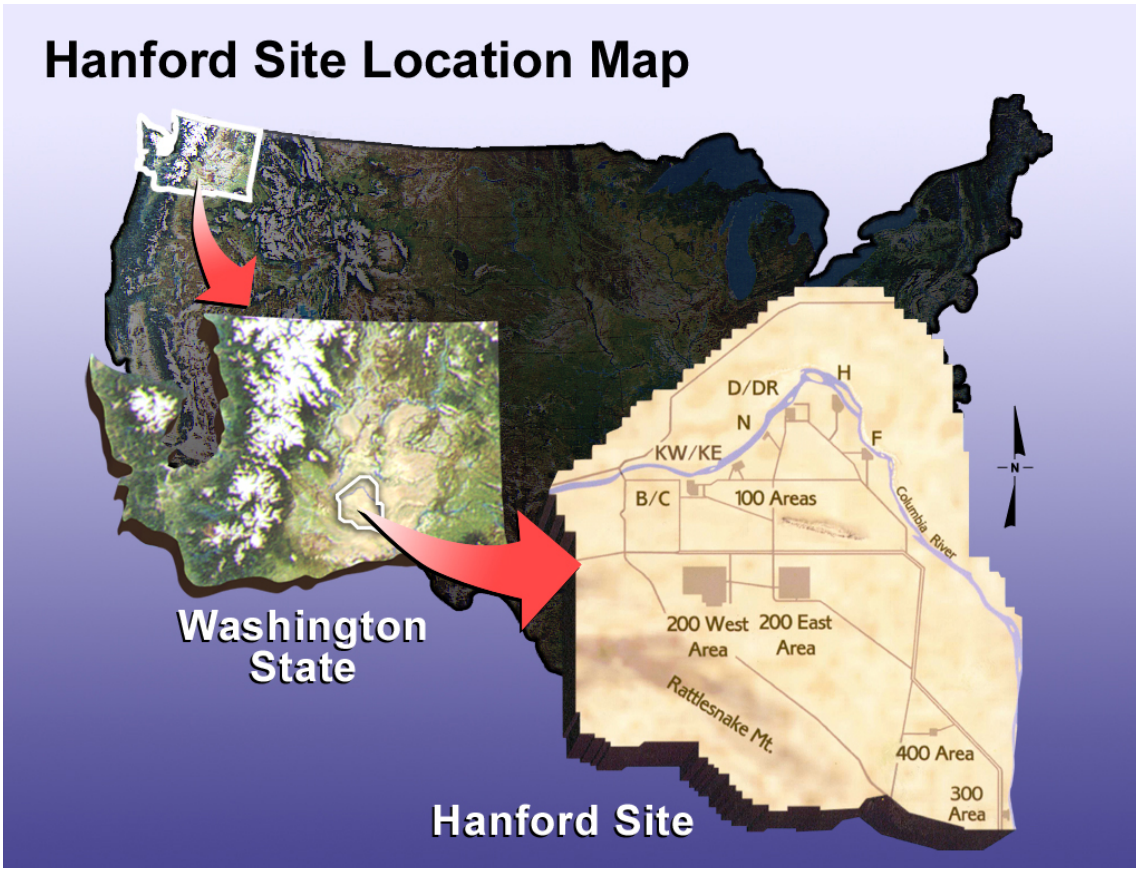
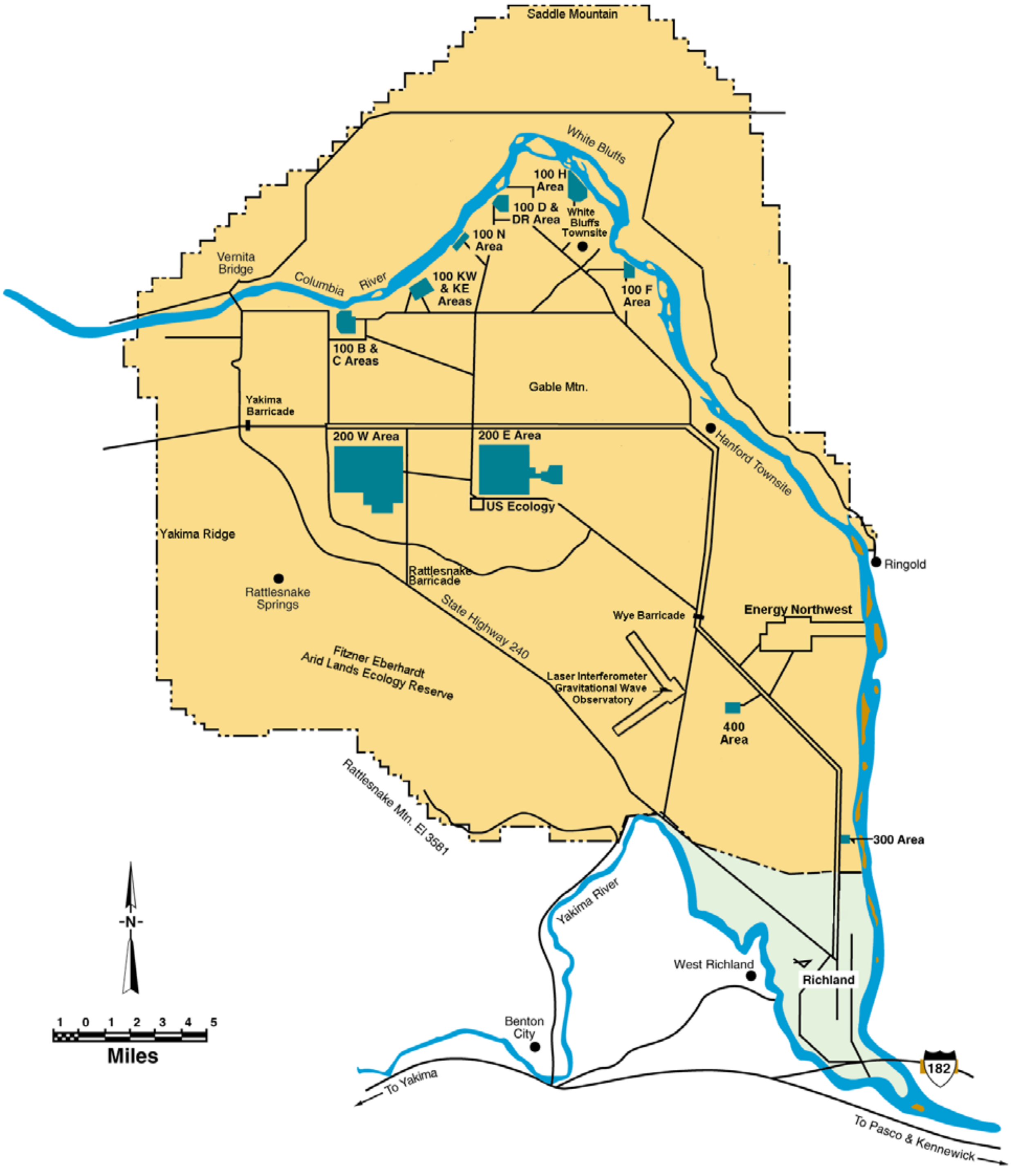


Figure 1.B: Map of Hanford



1.2 State Environmental Policy Act

The Washington State Environmental Policy Act, Chapter 43.21C RCW (Revised Code of Washington), requires an environmental review for actions potentially having a significant environmental impact. The purpose of an EIS is to disclose information to the public, tribes, project proponent, and government agencies on the benefits and impacts of the three proposed actions including any “significant unavoidable impacts”. According to SEPA, these are impacts that cannot or will not be mitigated. Although the three proposed actions have impacts both within and outside Washington State, the EIS focuses primarily on impacts within Washington.

A determination of significance (DS) was issued on February 14, 1997 (DOH 1997). As a result of the DS, DOH and the Washington Department of Ecology jointly prepared the EIS. Public scoping meetings were held in Seattle, Spokane, and Richland in the spring of 1997 (DOH 1998). The Draft EIS was issued on September 13, 2000.

1.3 Areas of Controversy

There are policy and technical issues relevant to the EIS where viewpoints may differ between members of the public, environmental groups, US Ecology, USDOE, the business community, Native Americans, and other interested parties. Some of these issues were addressed in the EIS but were likely not resolved to all parties’ satisfaction. The Department of Health and the Department of Ecology recognize these differences among interested parties and will continue to work with the public and other stakeholders to find acceptable solutions.

Import of Low-Level Radioactive Waste to Washington

The Northwest Interstate Compact (Northwest Compact) limits the amount of LLRW disposed at the site by limiting which states have access. Some stakeholders believe the state of Washington has already done its share in disposing of radioactive waste, and the commercial LLRW site should close or further limit the amount of waste accepted. Other stakeholders view the site as a regional asset. Please see Section 2.2 for more information on the legal, regulatory, and policy considerations that affect the import and management of LLRW in Washington.

Import of Diffuse NARM

In July 1995, DOH adopted amendments to WAC 246-249-080 that limited diffuse NARM generators to 1,000 cubic feet per year and established a site limit of 8,600 cubic feet per year. Prior to that time, there was no site limit for diffuse NARM. US Ecology filed a lawsuit against DOH, contesting the 8,600 cubic foot limit. The court entered an order staying both the individual and the site limit in the1995 amendment, imposed a 100,000 cubic foot site limit, and directed DOH to begin rulemaking to adopt a new site limit. The court-ordered limit of 100,000 cubic feet is in effect today. Please see Sections 1.6.2, 2.2, and 2.3.1.2 for more information on NARM.

Acceptance of Foreign Radioactive Waste

In August 2000, the commercial LLRW site accepted a shipment of discrete NARM waste from Spain. This waste was transported by air to Moses Lake and then by truck to the commercial site. Some groups have stated their opposition to importing foreign radioactive waste and are looking to the EIS to address this issue. At this time, neither the federal nor the state government has the authority to ban the importation of NARM (Department of Ecology 2000a). However, US Ecology has voluntarily agreed to not accept or solicit any other NARM shipments from foreign sources (US Ecology 2000). Please see Section 2.3.1.2.1 for further information on foreign NARM.

Adequacy of Emergency Services

The adequacy of emergency services for a radiological event, including training for first responders and hospitals, was noted in numerous comments received on the Draft EIS. Emergency management services (EMS) for radiological events in the Tri-City Area are well developed. There are three area hospitals specifically trained to deal with a catastrophic radiological event. All three hospitals maintain supplies and receive annual training on receiving and caring for patients from a radiological event.

Outside of the Tri-Cities, some statewide training is offered to first responders and hospitals, including training in radiological hazards that might be associated with a transportation accident. A 2003 EMS exercise carried out by local, state, and federal personnel showed that more training is necessary to help first responders and hospital personnel in the proper management of an incident involving radionuclides. A program to provide such training is currently in development by DOH. For more information on emergency response, please see Section 4.2.1.

Past Waste Disposal Practices

Numerous comments were submitted on the Draft EIS addressing the disposal of free liquids, transuranic (TRU) wastes, and hazardous wastes. The Final EIS addresses each of these wastes. The commercial LLRW site has never been licensed to dispose of free liquids. The 1985 US Ecology Site Environmental Review states that liquid wastes were either solidified or absorbed prior to disposal (JLC 1985).

The commercial LLRW site is licensed to dispose of TRU waste. The TRU waste disposed at the commercial LLRW site is much lower in concentration than the TRU waste disposed by USDOE at Hanford. In fact, the TRU waste disposed at the commercial LLRW site would not be defined as TRU by USDOE because of its lower concentration.

Unauthorized hazardous wastes were disposed at the commercial LLRW site from 1965 to June 1970. These wastes were disposed of in the “Chemical Trench” in the north-central portion of the site. Small amounts of hazardous waste, as a component of radiological waste, were authorized for disposal until October 1985. Disposal of these wastes ceased upon the adoption of RCRA. For more information on past hazardous waste disposal, see Section 2.3.

Disposal of Waste into Unlined Trenches

Lined trenches are used at hazardous waste and municipal landfills to provide secondary containment of waste. The purpose of secondary containment is to ensure that wastes do not leach out of their containers over an extended period of time. The most important time to have secondary containment is during the period that moisture has the opportunity to contact the waste and mobilize the contaminants. This period is primarily during operations when the trenches are open. Also important is the period of time, after closure, when antecedent moisture in the cover leaches into the trenches.

At the commercial LLRW site, approximately 98% of the waste activity is currently subject to secondary containment. Instead of trench liners, the site uses double containers or lining of individual containers to achieve secondary containment. Thick walled engineered concrete barriers (ECB) are an example of this type of containment. This type of secondary containment is preferred over trench liners for radioactive waste because it provides increased structural stability, eliminates the potential for contaminated leachate, and requires less post-closure maintenance.

The License Preferred Alternative would require all Class B and Class C waste to be overpacked in ECBs.[1] In addition, secondary containment would be required for Class A LLRW that contains any of the seven nuclides that may contribute to the hypothetical post-closure dose. These seven radionuclides are iodine 129 (I-129), technetium (Tc-99), uranium 238 (U-238), tritium (H-3), carbon 14 (C-14), uranium 234 (U-234), and plutonium 239 (Pu-239).

Reasons supporting the use of increased secondary containment at the commercial site include:

- Data indicating that a small, but mobile percentage of low-level waste has leached into the vadose zone.
- Data indicating that Tc-99, U-238, and H-3 are in the groundwater, and the commercial LLRW site has not been ruled out as a source.
- A hypothetical model predicting that seven radionuclides will contribute to a post-closure dose leaching to groundwater.
- A hypothetical model projecting that H-3 and I-129 will exceed a drinking water maximum contaminant level and State Groundwater Quality Standard at some time within 10,000 years after closure.

[1] Wastes that are too large for an ECB would be disposed of in a comparable secondary container.

- Inadvertent intruder doses that are close to or slightly exceed 100 millirem per year.

- Secondary containment is a standard practice at RCRA hazardous waste sites, USDOE hazardous waste sites, municipal solid waste sites, the Envirocare and Barnwell commercial LLRW disposal sites, and international LLRW sites.

- Strong public support for secondary containment.

- ALARA (Chapter 246-220 WAC) requires exposure to radionuclides to be maintained as low as reasonably achievable.

Applicability of Model Toxics Control Act (MTCA)

At this time, the Department of Ecology does not intend to regulate the radiation hazards of radionuclides subject to the 1954 federal Atomic Energy Act (AEA). Although MTCA includes radionuclides within its definition of "hazardous substances," a number of considerations affect the application of MTCA to the cleanup of radionuclides. There are legal questions concerning the application of MTCA to address those radionuclides regulated by the AEA (i.e., source, special nuclear, and byproduct materials as defined by the AEA). Federal courts have held that the AEA preempts state regulation of the radiation hazards of such materials, which may preclude the application of MTCA to remediate radiation risks. While the Department of Ecology does not concede any authority granted through MTCA, in light of these decisions, Ecology will focus its regulation under MTCA where its authority is clearest.

With respect to the non-radiological hazards of AEA-regulated radionuclides, as well as any hazards posed by other (non-AEA regulated radionuclides), the Department of Ecology may apply MTCA in the event data indicate releases of AEA-regulated radionuclides that pose a non-radiological hazard, or releases of any non-AEA regulated radionuclides. The Department of Ecology's decision will include consideration of the potential application of other authorities pursuant to WAC 173-340-310(5)(d)(iii).

Dose Versus Risk Cleanup Standards

Cleanup or closure standards for hazardous substances are most often risk-based, and for radionuclides are dose-based. For the commercial LLRW site, the state determined that the MTCA risk standards in Chapter 173-340 WAC were the most appropriate standards for hazardous substances. For radionuclides, the state determined that the dose standards in Chapter 246-250 WAC were the most appropriate.

The dose standard that is being used to regulate the site is 25 millirem per year plus ALARA (as low as reasonably achievable). The MTCA risk standard for hazardous substances is 1 additional cancer per 100,000 persons. A radiological dose standard based on a MTCA risk level would be approximately 1 or 2 millirem per year. This is significantly lower than the 25 millirem per year standard that is recognized by the national and international radiological communities as protective of public health. Radiological risk, although included in Section 4.4.7.3, Table 4.J, is not used for evaluating or comparing alternatives in the EIS.[2]

Protection of the Inadvertent Intruder

The inadvertent intruder is defined as a person who trespasses onto the commercial LLRW site unknowingly. There is no regulatory standard for protection of an inadvertent intruder at a closed commercial LLRW site. A dose of 500 millirem per year to a resident intruder was cited as a guidance level in the Draft EIS for the commercial LLRW site. This dose was based on the U.S. Nuclear Regulatory Commission (NRC) 1981 Draft EIS for 10 CFR (Code of Federal Regulations) Part 61. In the Final EIS for the commercial LLRW site, the guidance level has been revised to 100 millirem per year.

A guidance level of 100 millirem per year for the resident intruder was selected for two reasons. First, a 1993 NCRP (National Commission on Radiation Protection) Report states, “For continuous (or frequent) exposure, it is recommended that the annual effective dose not exceed 100 millirem” (NCRP 1993). The hypothetical resident intruder scenario assumes frequent exposure. Secondly, 100 millirem per year is consistent with the Radionuclide Cleanup Standards for Radioactive Material Licensed Sites, Chapter 246-246 WAC.

US Ecology Site Investigation

The results of the 1998 US Ecology Site Investigation were the subject of numerous comments submitted on the Draft EIS. The 1999 US Ecology Final Report reported the detection of hazardous contaminants and radionuclides in the vadose zone and groundwater. After further analysis of the data, US Ecology found numerous anomalies in the radionuclide results. These anomalies have led US Ecology to question the validity of the data and the use of the data in the groundwater model. The state agrees that these anomalies may exist; however, in the absence of other vadose zone data, the state used the site investigation data to recalibrate the groundwater model. Future vadose zone data will be used to further refine the groundwater modeling and predicted doses. For more information on environmental monitoring at the commercial LLRW site, please see Section 2.4.

Selecting Preferred Alternatives Without Further Investigation

Numerous comments on the Draft EIS expressed opposition to renewing the license and/or selecting a cover design without further site investigation. Comments from some

[2] Radionuclide risk is used to compare environmental justice impacts because environmental justice impacts have been historically compared in this manner.

stakeholders and members of the public stated that the source of the contaminants (commercial LLRW site or upgradient USDOE facilities) detected in groundwater and vadose zone should be clearly identified before any decisions are made on licensing or closure. The state considered these comments in determining whether or not to delay the EIS, and decided that the best course of action was to go forward with the EIS. If completion of the EIS were delayed, enhancements such as expanded secondary containment and construction of an interim cover would also be delayed. Instead of delaying the EIS until further investigation is complete, the state identified preferred alternatives that could be easily modified, if necessary, to incorporate changes that might result from future investigations. Please see Section 1.6 for a description of the preferred alternatives.

Groundwater Modeling

The groundwater model in the Draft EIS was criticized for not predicting the radionuclides detected in the vadose zone and groundwater during the 1998 US Ecology Site Investigation. In response to these comments, DOH recalibrated the groundwater model to the concentrations of Ni-63, Sr-90, Tc-99, Pu-239/240, and U-238 that were detected in the vadose zone. The new model incorporated effects of transient infiltration and historic waste disposal rates. The revised model determined there was a small fraction of LLRW that was moving with the rate of water. These results were used in the Radiological Risk Assessment to evaluate the cover designs and to project post-closure doses. For more information on the groundwater model, please see Section 4.4.6 and Appendix IV.

Cumulative Effects

Some stakeholders and members of the public believe the EIS should not go forward without a more thorough evaluation of cumulative effects. SEPA requires an EIS to include reasonable references to past projects and future expectations. The EIS references several USDOE documents that address cumulative effects, and includes statements as to the relative contribution of the commercial LLRW site. The number and diversity of facilities on the Hanford Site make a more thorough evaluation of cumulative effects beyond the scope of the EIS. For more information on cumulative effects, please see Section 6.7.

Risk from Non-Radioactive Hazardous Waste

A risk assessment on non-radioactive hazardous substances is not included in the Final EIS. A risk assessment will be completed by the Department of Ecology following the 2004 MTCA investigation. Results of the MTCA risk assessment will be used to determine if remedial actions, other than the presumptive remedy of a cover, will be necessary. This information will also be used, if necessary, to modify design of the final cover. For more information on risk from non-radioactive hazardous waste, please see Section 4.5.

1.4 Proposed Actions

The three proposed actions are:

1. **License** - Make a determination on the US Ecology Washington State radioactive materials license application for continued operation of the commercial LLRW site.

2. **Diffuse NARM** - Select an annual limit for disposal of diffuse NARM at the commercial LLRW site.

3. **Closure** - Approve a cover design and a cover schedule for closing the commercial LLRW site.

1.4.1 License

The EIS evaluates whether or not to relicense the Commercial LLRW Site for disposal of LLRW and NARM waste. The commercial site provides disposal capacity for both in-state and out-of-state generators of LLRW and NARM. Operation of the site allows the state to fulfill its commitments to the Northwest Compact and to support the fundamental state of Washington policy that supports shared responsibility among states for all types of waste management.

Washington State Radioactive Materials License WN-I019-2, issued by DOH to US Ecology, authorizes US Ecology to dispose of radioactive waste at the commercial LLRW site. The license must be renewed every five years. US Ecology submitted a relicensing application in 1997, but the state has delayed a decision on the license pending the completion of the EIS. This delay has placed the current license in a type of regulatory limbo called “timely renewal”. Timely renewal allows the current license to remain in effect while the state determines its best course of action on relicensing. During timely renewal, the state will make no major revisions to the license. Timely renewal will end when the state makes a determination on the relicensing application following the completion of the EIS.

1.4.2 Diffuse NARM

The EIS evaluates the impacts of disposing of diffuse NARM at the commercial LLRW site. The commercial LLRW site currently provides nation-wide access for disposal of diffuse NARM. Disposal of diffuse NARM at the commercial LLRW site generates revenues for local government and contributes to the viability of the site by helping to maintain reasonable disposal costs for LLRW generators. NARM is defined as “any naturally occurring or accelerator produced radioactive material except byproduct, source, or special nuclear material," and is either diffuse or discrete.[3] The Diffuse NARM alternatives evaluated in the EIS do not apply to discrete NARM. *Diffuse* NARM is low activity but large volume. *Discrete* NARM is high activity, but very low in volume. For more information on diffuse NARM, see Section 2.3.2.

1.4.3 Site Closure

The EIS evaluates the cover design and construction schedule for closing the site. The lease between the state and USDOE for the land the commercial LLRW site occupies expires on September 9, 2063. At that time or before, the site will be permanently closed. DOH has proposed the year 2056 as the latest possible year for disposal operations to cease and closure to begin.

Chapter 246-250 WAC requires the commercial LLRW site to have an approved closure plan. US Ecology submitted the first closure plan in 1983. Subsequent closure plans were submitted in 1987 and 1990. In each case, DOH required amendments to the plan. The most recent closure plan was submitted in 1996. An approved closure plan must address surety of funding, cover design, cover schedule, institutional controls, environmental monitoring, and any other remedial or administrative actions that may be required to safely close the site. An approved closure plan must also be able to demonstrate that hypothetical post-closure doses will be no higher than 25 millirem per year to any person living adjacent to the site.

1.5 Alternatives

SEPA requires that reasonable alternative actions be evaluated for each proposed action. A reasonable action is defined as an action that could feasibly attain or approximate a proposal's objectives, but at a lower environmental cost or decreased level of environmental degradation. Alternatives for each proposed action are described below.

1.5.1 License

License Alternatives

No Action Alternative: Current license remains in timely renewal

Alternative 1: Renew US Ecology license with additional operating requirements

Alternative 2: Deny license application

[3] In the past, the acronym "NORM" was used to define naturally occurring radioactive material, and the term "NARM" was used to define naturally accelerated radioactive material. DOH uses the term "NARM" to describe both types of waste.

License No Action Alternative – Timely Renewal. This alternative is referred to as the "Timely Renewal Alternative." Under this alternative, DOH would take no final action on US Ecology's license renewal application. Chapter 246-235 WAC states that if a complete license renewal application is filed in a timely manner, the current license will not expire until the state makes a final determination on the application. US Ecology filed a complete license renewal application in 1997. Under this alternative, the license would remain indefinitely in timely renewal. During this period, DOH would make no significant revisions to the existing license provisions.

Renew License. This alternative is referred to as the "Renew License Alternative." This alternative renews the license with additional operational requirements. Additional requirements include:

- Additional secondary containment requirements
- Additional requirements for discrete NARM
- License limits for selected radionuclides

Table 3.A includes the entire list of recommended new license requirements.

The impacts of renewing the license are evaluated for both for the five-year license renewal period and also for the maximum operating period through 2056.

Deny License. Under this alternative**,** DOH would deny the license renewal application. Denying the application means the state must either find a new operator, or close the site. For evaluating this alternative, the state assumes that denying the license would result in closing the site.[4]

Closing the site means that the states of Washington, Oregon, Alaska, Hawaii, Idaho, Montana, Utah, Wyoming, Nevada, Colorado, and New Mexico would need to find an alternative disposal site. At this time, some but not all of the regional LLRW and NARM waste could be disposed at the commercial sites in Clive, Utah, and Barnwell, South Carolina.

[4] There is the chance that the state could deny the license, open the license up to a competitive bid, and then issue a license to another interested party. If so, the impacts of this alternative would be similar to the Renew License Alternative.

1.5.2 Diffuse NARM Alternatives

Diffuse NARM Alternatives
No Action Alternative: 100,000 cubic feet per year limit with automatic rollover
Alternative 1: Adopt 100,000 cubic feet per year limit – case-by-case rollover
Alternative 2: Adopt 36,700 cubic feet per year limit – case-by-case rollover
Alternative 3: Adopt 8,600 cubic feet per year limit – no rollover
Alternative 4: Adopt zero cubic feet per year limit

Diffuse NARM No Action. DOH would take no action on amending Chapter 246-249 WAC, and would continue to operate under the current court-ordered diffuse NARM limit of 100,000 cubic feet per year plus *automatic* rollover. This alternative is in conflict with the current settlement agreement that directs DOH to begin rulemaking for adopting a diffuse NARM site limit.

Diffuse NARM – 100,000 cubic feet per year; rollover allowed on a case-by-case basis. DOH would amend Chapter 246-249 and adopt the court-ordered site limit of 100,000 cubic feet per year for diffuse NARM. This alternative differs from the No Action Alternative by requiring rule adoption and allowing rollover volumes on a case-by-case basis. Rollover equals 100,000 cubic feet minus the volume of diffuse NARM disposed in a given year. For example, if 10,000 cubic feet of diffuse NARM were disposed in a given year, the rollover amount for that year would be 90,000.

Under this alternative and all alternatives, including case-by-case rollover, US Ecology could request DOH to allow disposal of diffuse NARM above the site limit but not to exceed the cumulative rollover amount. The cumulative rollover amount equals the rollover volumes from previous years. For example, the site limit over ten years is 100,000 cubic feet per year, or 1,000,000 cubic feet. If a cumulative total of only 50,000 cubic feet of diffuse NARM had been disposed in the first nine years, the site operator could request authorization to dispose of 950,000 cubic feet in the tenth year. There is no limit on the cumulative rollover total the site operator could request. The rollover request submitted by the site operator would include an analysis of impacts from transporting and disposing of the diffuse NARM. DOH would approve, modify, or deny the request based on public health.

The current site limit of 100,000 cubic feet is much higher than present annual disposal rates. In 2002, the site received less than 4700 cubic feet of diffuse NARM – approximately five truckloads. If fully realized, the proposed limit of 100,000 cubic feet per year of diffuse NARM could potentially result in 120 truckloads of diffuse NARM per year.

Diffuse NARM – 8,600 cubic feet per year; no rollover. DOH would petition the court to remove the stay on chapter 246-249 WAC, thus reinstating the site limit of 8,600 cubic feet per year, and the individual generator limit of 1,000 cubic feet per year.

Diffuse NARM – 36,700 cubic feet per year; case-by-case rollover. DOH would amend Chapter 246-249 WAC to adopt a diffuse NARM site limit of 36,700 cubic feet per year with case-by-case rollover. This limit is tied to past disposal rates based on the five-year period of 1992-1996.

Diffuse NARM – Zero cubic feet per year. DOH would amend Chapter 246-249 WAC to adopt a diffuse NARM limit of zero cubic feet per year, thereby banning all diffuse NARM from the commercial LLRW site. This would include banning disposal of diffuse NARM from Washington State.

1.5.3 Site Closure

The EIS evaluates two aspects of closing the commercial LLRW site: cover design and the cover schedule. The selected cover design and the selected cover schedule will be incorporated into a final closure plan. These two actions were chosen for evaluation because of their importance in the overall closure plan. Other components needed to close the site include institutional controls, environmental monitoring, and perpetual care and maintenance. These other components were not evaluated in the EIS because they were assumed to be similar throughout all the alternatives. All components of closure will be included in the final closure plan for the commercial LLRW site.

The EIS does not evaluate the impacts of developing a borrow site. The state is planning to obtain the majority of cover materials from an offsite vendor. If it is necessary to develop a borrow site for these materials, a separate EIS will be completed at that time.

1.5.3.1 Cover Design Alternatives

Cover Design Alternatives

Cover Design No Action: Site Soils Cover

Cover Design Alternative 1: US Ecology Cover

Cover Design Alternative 2: Homogenous Cover

Cover Design Alternative 3: Enhanced Cover

- Asphalt Cover
- GeoSynthetic Cover
- Bentonite Cover

Cover Design No Action. The No Action Alternative means that DOH would take no action on approving a final cover design for the commercial LLRW site. The absence of an approved cover design means that a final closure plan cannot be completed. Without an approved closure plan, the current practice of covering filled trenches with 8 to 11 feet of site soils would continue, and this would be the only cover. This alternative would not meet the requirements needed for an approved closure plan under Chapter 246-250 WAC. Inevitably, the license application could not be renewed without an approved closure plan.

US Ecology Cover. The US Ecology Cover design was included in the US Ecology 1996 Closure Plan. The US Ecology Cover is a 16-foot thick multi-layer cover that includes a 36-inch surface silt loam layer and a low permeability bentonite layer. This cover was designed in coordination with DOH and the Department of Ecology.

Homogenous Cover. The Homogenous Cover is a 16-foot thick soil cover with a 60-inch surface silt loam layer. This cover does not include a low permeability barrier and is similar in design to the cover selected by US Ecology to close the Beatty, Nevada commercial LLRW disposal site.

Enhanced Cover. The enhanced cover alternative includes three different designs. All three include a 60-inch silt loam layer and a low permeability barrier. The covers differ by the type of low permeability barrier. The three design variations are:

- **Asphalt Cover –** contains a 12-inch asphalt barrier
- **GeoSynthetic Cover –** contains a geotextile clay layer
- **Bentonite Cover –** contains a 12-inch bentonite barrier

1.5.3.2 Cover Schedule Alternatives

Cover Schedule Alternatives
No Action Cover: No Early Construction
Cover Schedule Alternative 1: US Ecology Schedule
Cover Schedule Alternative 2: Prototype Schedule
Cover Schedule Alternative 3: Close-As-You-Go Schedule

No Action Cover Schedule. The No Action Schedule means there would be no action taken to construct a cover before final closure. With this schedule, all cover construction would begin in 2056 or when operations cease, whichever is earlier.

US Ecology Schedule. This alternative is included in the US Ecology Closure Plan and was developed in coordination with DOH and the Department of Ecology. The US

Ecology Schedule would construct a final cover over trenches 1-7 and the Chemical Trench, beginning in 2005. The cover would be constructed over the remainder of the trenches in 2056, or when operations cease, whichever is earlier. Trenches 1-7 and the Chemical Trench were selected for immediate closure because they are the oldest trenches and have the most potential to release radionuclides and non-radioactive chemicals.

Prototype Schedule. The Prototype Schedule would construct the final cover over two trenches (to be selected) in 2005. The cover would be constructed over the remainder of the trenches in 2056, or when operations cease, whichever is earlier. This alternative allows the state to study the performance and reliability of a specific cover design before committing to that design for the entire site.

Close-As-You-Go Schedule. The Close-As-You-Go Schedule would permanently close the site in three phases. This schedule works best with the US Ecology Proposed Cover or one of the other multi-layer covers. With this alternative, the state would start the first construction phase no later than 2005. The first phase would construct a low permeability cover over all existing waste (40 acres). In the first phase, only the bottom layers of the cover design, up to and including any impermeable barrier, would be constructed. The second phase would begin in 2008, following the completion of the 2004 MTCA investigation. The second phase would complete the final cover over the first 40 acres by constructing the upper layers over the first phase construction. The second phase would be delayed until after the MTCA investigation so that results from the MTCA investigation could be used to modify the cover design, if necessary. Any modifications to the cover would not require the first phase cover to be removed. The third phase is ongoing and would construct the final cover in planned phases as waste is disposed.

1.6 Preferred Alternatives

The state has identified a preferred alternative for each of the three proposed actions. State decision-makers will use the EIS, along with other available information, to determine the best course of action for each of the proposed actions.

1.6.1 License Preferred Alternative

The state has identified the Renew License Alternative as the preferred license alternative. This alternative would renew the US Ecology license with the additional requirements listed in Table 3.A.

The EIS does not identify the Timely Renewal License Alternative as preferred because this alternative would keep the site operating but would restrict the Department of Health's ability to make significant revisions to the license. The EIS also does not identify the Deny License Alternative as preferred because the state determined that the benefits of continuing to operate the site were greater than the projected impacts. These benefits and impacts are summarized below.

The benefits of renewing the license are: (1) reconfirms the state's commitment to the Northwest Compact; (2) provides in-state and regional generators continued access to a regulated disposal site; and (3) provides revenues to local government. There are 51 in-state generators of LLRW and 5 in-state generators of NARM that use the commercial LLRW site. Outside of Washington there are 108 generators of LLRW and 175 generators of NARM that use the site.

Renewing the license was predicted to result in no significant public health or environmental impacts for the five-year relicense period or if the site were operated through 2056. The Radiological Risk Assessment (Appendix II) found that additional waste disposal would not increase the hypothetical maximum doses predicted for the commercial site. There are three reasons why additional waste disposal would not increase the maximum hypothetical doses: (1) the radioactivity in the waste disposed over for the next 50 years of site operation is assumed to be small in comparison with the radioactivity in the waste disposed *prior* to 2005; (2) the assumed use of the Close-As-You-Go Schedule reduces the release of radionuclides into the vadose zone; and (3) the assumed burial of all new discrete NARM waste at 23 feet below grade reduces the dose from radon.

Additional operating requirements in this alternative include disposal of discrete NARM at 23 feet or deeper, new license limits for radionuclides predicted to contribute to a hypothetical post-closure dose (Ra-226, H-3, I-129, Tc-99, U-238, C-14, U-234, Pu-239), secondary containment for radionuclides in LLRW predicted to contribute to groundwater (H-3, I-129, Tc-99, U-238, C-14, U-234, Pu-239), and a comprehensive review of the environmental monitoring program.

Mitigation measures include closing the site with a low-permeability cover and use of the Close-As-You-Go Schedule.

1.6.2 Diffuse NARM Preferred Alternative

The state has identified a site limit of 100,000 cubic feet per year, with rollover on a case-by case basis, as the diffuse NARM preferred alternative. Under this alternative, DOH would revise Chapter 246-249 WAC to adopt the current court-ordered limit of 100,000 cubic feet per year.

The state did not include an *automatic rollover* provision with the preferred alternative because of the difficulty in analyzing all possible volume scenarios. The case-by-case rollover provision will require the site operator to submit a request to DOH for approval of any diffuse NARM volumes that exceed the 100,000 cubic foot site limit. The request will include an analysis of impacts, and DOH will approve, modify, or deny the request based on public health impacts.

The state did not identify the zero, 8,600, or 36,700 cubic foot alternatives as preferred because there was no public health justification to support restricting diffuse NARM to these volumes. The benefits and impacts of the 100,000 cubic foot per year alternative are summarized below.

The benefits of disposing of diffuse NARM at the commercial LLRW site are: (1) revenue for local government; (2) revenues that help offset disposal costs for LLRW generators; and (3) disposal access to 175 generators of diffuse and discrete NARM.

Disposal of 100,000 cubic feet per year of diffuse NARM was predicted to result in no significant public health or environmental impacts. The diffuse NARM already disposed at the commercial LLRW site is predicted to contribute 15 millirem per year to the hypothetical *onsite* dose and less than one millirem per year to the hypothetical *offsite* dose (assuming the GeoSynthetic Cover). If the site continues to be relicensed for the next 50 years, disposal of 100,000 cubic feet per year of diffuse NARM would *not* increase the hypothetical maximum onsite or offsite dose. It would increase the area of exposure to the 15 millirem from diffuse NARM to onsite intruders from 40 acres up to 80 acres.

An additional 100,000 cubic feet per year of diffuse NARM would not impact available disposal capacity for LLRW. There was a total of 55 million cubic feet of disposal capacity available at the commercial site, and 13.9 cubic feet of that capacity have been used. If the maximum allowable 100,000 cubic feet of diffuse NARM and the projected volumes of LLRW were disposed every year for the next 50 years, the total future volume would still be below the maximum capacity of the site.

Mitigation measures for this preferred alternative include establishing a radium limit, institutional controls, requiring an analysis of impacts for rollover volumes, improving the environmental monitoring program, using the Close-As-You-Go Schedule, and closing the site with the GeoSynthetic Cover.

1.6.3 Closure Preferred Alternatives

There are two closure preferred alternatives: cover design and cover schedule.

1.6.3.1 Cover Design – GeoSynthetic Cover

The GeoSynthetic Cover is the preferred cover design alternative. Several other cover designs, including the US Ecology Proposed Cover, the Asphalt Cover, and the Bentonite Cover were shown to be good designs as well. In fact, all of these covers had slightly lower predicted doses than the GeoSynthetic Cover. Although the US Ecology Proposed Cover and the Bentonite Cover provide an excellent barrier to radon, neither of these covers meets RCRA requirements for a cover on a hazardous waste site. Additionally, the long-term reliability of a bentonite clay layer, present in both these covers, in an arid environment was unknown. The Asphalt Cover meets RCRA requirements but was less accommodating to future ground water and/or vadose zone sampling once the cover was constructed. In addition, the surety analysis showed that funds were not adequate to construct the Asphalt Cover using the preferred Close-As-You-Go Schedule.

The state concluded that a GeoSynthetic Cover was the best alternative for a phased construction schedule and would allow the most flexibility for incorporating additional remedial actions or cover design changes that might result from the 2004 MTCA investigation. The reasons for identifying the GeoSynthetic Cover as the preferred cover are:

- This cover is RCRA-compliant and can adequately address risks associated with hazardous wastes.
- The hypothetical offsite maximum dose of 22 millirem per year is below the regulatory limit of 25 millirem per year.
- The hypothetical onsite maximum dose of 107 millirem per year is only slightly above the 100 millirem per year guidance value.
- The use of a GeoSynthetic Clay Liner for the impermeable barrier is well accepted in the industry.
- The GeoSynthetic Cover design works well with the three-phase construction schedule of the Close-As-You-Go Schedule.
- A 2003 surety analysis showed that there is adequate funding to construct the GeoSynthetic Cover using the Close-As-You-Go Schedule (Blacklaw 2003).

The preferred alternative cover design is conceptual and is not intended to be prescriptive. This means the precise design of the preferred alternative could change during the design and engineering phase of constructing the cover. The cover design may also be modified following the completion of the 2004 MTCA investigation. For these reasons, the preferred alternative is a reference for cover performance more so than a prescriptive design. This means the final cover can vary in design from the GeoSynthetic Cover, but it must have an equal or better performance (as defined by methodologies used in the EIS and appendices) and be in compliance with all applicable regulations.

Performance criteria for the GeoSynthetic Cover are:

- Water infiltration rate through the cover less than or equal to 0.5 mm/year.
- Radon 222 emanation rate through the cover less than or equal to 0.62 pCi/m^2s.
- Cover depth equal to or greater than five meters.
- Offsite Resident dose less than or equal to 22 millirem per year.

- Onsite Resident dose less than or equal to 107 millirem per year.

- Compliant with Minimum Technical Requirements for RCRA Landfills as defined in *RCRA guidance document--Landfill Design Liner Systems and Final Cover*, EPA PB 87-157 657/AS, 1987.

There are two potential post-closure unavoidable impacts predicted if the site is closed with the GeoSynthetic Cover. The first is an additional 36,100 truck round trips to bring the cover construction materials to the site. The impact of the increased truck traffic depends, in part, on whether or not it coincides with increased traffic generated from other construction projects elsewhere at Hanford. Managing overall traffic counts at Hanford will need to be coordinated between DOH and USDOE.

The second potential unavoidable impact is the hypothetical post-closure H-3 and I-129 groundwater concentrations that are predicted to exceed the state's groundwater quality standards and drinking water maximum contaminant levels (MCL). The I-129 groundwater concentration is predicted to exceed the standard at 5000 years after closure. The H-3 groundwater concentration is predicted to temporarily exceed the standard within 250 years after closure and then quickly drop to below the standard. Current groundwater concentrations of H-3 indicate that the future concentrations will likely be lower than those predicted through the mode. Environmental monitoring will be done to refine predicted concentrations of H-3. If future monitoring supports the predicted hypothetical groundwater concentrations of H-3 and I-129, further actions for addressing H-3 and I-129 will be considered.

The hypothetical groundwater concentrations of H-3 and I-129 are best presented in the context of the existing groundwater quality of the surrounding Hanford Site. The 100-acre commercial site is surrounded by contaminated groundwater due to waste management activities elsewhere on the Hanford Site. USDOE plans on remediating this groundwater using best available technology. It is anticipated that remediation of certain contaminants, including H-3 and I-129, will be delayed due to limits in technology. USDOE is planning to use institutional controls to restrict public access in the central plateau for *at least* 50 years after the Hanford Site is closed (USDOE 1999). In this context, hypothetical groundwater concentrations of H-3 or I-129 due to the commercial LLRW site would contribute little, if any, to the overall impact on public health.

Mitigation measures for this alternative include the following:

- Evaluate ways to reduce the offsite materials needed for cover construction.

- Institutional controls for the foreseeable future.

- License limits for radionuclides predicted to contribute to a post-closure dose; Ra-226, H-3, I-129, Tc-99, U-238, C-14, U-234, and Pu-239.

- Deeper burial of discrete NARM.
- Secondary containment for radionuclides predicted to contribute to groundwater concentrations; H-3, I-129, Tc-99, U-238, C-14, U-234, and Pu-239.
- Continued environmental monitoring to refine future hypothetical groundwater concentrations.
- Establish and maintain vegetation on the completed cover.
- A biological survey of the northwest 15 acres prior to excavation.
- Continued consultation with Native Americans.
- Coordination of construction schedules with USDOE to minimize traffic impacts.
- Use of the Close-As-You-Go Schedule.

1.6.3.2 Close-As-You-Go Schedule

The Close-As-You-Go Schedule was identified as the preferred schedule alternative because it provides a hypothetical reduction in the offsite dose of over 100 millirem per year during the first 1,000 years after closure. The Close-As-You-Go Schedule permanently closes the site in three phases.

The first construction phase would start no later than 2005. The first phase constructs a low permeability cover over all existing waste (40 acres). The state's intent is to construct only the bottom layers of the cover design, up to and including the impermeable barrier. The second phase, scheduled to begin in 2008, will follow the completion of the 2004 MTCA investigation. The second phase completes the final cover over the first 40 acres by constructing the upper layers over the first phase construction. The second phase is delayed until after the MTCA investigation so that results from the MTCA investigation can be used, if necessary, to modify the cover design. Necessary modifications during second phase construction will not require the first phase of the cover to be removed. The third phase is ongoing and constructs the final cover in planned phases as waste is disposed.

1.6.4 Further Actions

- Within 60 days of publication of the EIS, the state will make a final determination on the US Ecology license application.
- Within 60 days of publication of the EIS, DOH will begin rule amendments to Chapter 246-249 WAC.

- Within 60 days of publication of the EIS, the state will issue a contract to begin the design of the final cover.

- Within 12 months of publication of the EIS, US Ecology will begin amending the 1996 US Ecology Closure Plan to include the final cover design and closure schedule.

1.7 Summary of Impacts

This section summarizes the range of impacts for each proposed action. Impact areas include public health, affected environment, and other considerations such as cultural resources, land use, and environmental justice. Much of the analysis was based on hypothetical scenarios that occur several thousand years in the future*. Hypothetical modeling is useful for comparing alternatives, but should not be interpreted as actual predictions of future impacts.*

Hypothetical impacts from the commercial LLRW site are best presented in the context of the surrounding 586-square mile Hanford Site. The commercial LLRW site is a 100-acre site in the middle of the much larger contaminated central plateau area of Hanford. USDOE has designated the central plateau for Industrial-Exclusive use in the final Hanford Comprehensive Land Use Plan (CLUP) EIS (USDOE 1999). The central plateau will be unfit for residential use or other long-term uses for *at least* 50 years after the Hanford Site is closed. In this context, hypothetical impacts from the commercial site would contribute little, if any, to the overall impact on public health. USDOE is planning to use institutional controls to restrict public access to the central plateau for the foreseeable future. It will be every future generation's responsibility to ensure that these controls remain in place for as long as necessary.

1.7.1 License

The License Alternatives were evaluated for the five-year renewal period and operations through 2056. Impacts through 2056 were evaluated to provide a clearer picture of what the total impacts might be from continuing to operate the site.

1.7.1.1 Areas of Evaluation with Little or No Impacts

Operational Risks. Normal operational risks associated with waste disposal activities are expected if the license is renewed or stays in timely renewal. These include slips, falls, and sprains. No unacceptable radiation exposure to the public or site workers is expected from continued operations. New license provisions that require additional handling of waste may increase worker dose. To minimize the potential for increased dose to workers, all new license requirements will be evaluated for ways to minimize worker exposure.

Cover Construction Risks. There are no unacceptable cover construction risks associated with the License Alternatives.

Earth. The License Alternatives will have little impact on the earth resources (geology, soils, and climate) because waste disposal activities would occur in previously disturbed areas.

Water. The License Alternatives are predicted to have little or no impact on groundwater or surface water quality for both the five-year renewal period and for the maximum potential operating period through 2056. Two reasons for the negligible impact on water quality are: (1) the projected future source term is a small fraction of the existing source term; and (2) the analysis assumed all waste disposed before 2003 will be covered with a low permeability cover in 2005, and all new waste will be covered in planned phases.

Air. If the license is renewed or remains in timely renewal, airborne radionuclides are not expected to increase. Historical annual monitoring data indicate no increasing trends for airborne radionuclides from the commercial LLRW site. Fugitive dust emissions will continue to be controlled with standard practices. Dust control methods will be investigated, including the use of soil fixatives and increased vegetation.

Ecology. The License Alternatives will have little impact on the ecological resources. Waste disposal activities would occur in previously disturbed areas. However, continued operations will delay the return of the shrub-steppe habitat that is already disturbed.

Cultural Resources. The presence of the commercial LLRW site has and will continue to have an impact on the Native American Cultural value of a pristine environment. The License Alternatives are not expected to lessen or significantly increase this impact. A cultural resource survey noted no cultural finds on the commercial LLRW site (PNNL 1997). Native American cultural resources, including the use of natural resources such as habitat and wildlife, and a clean and whole environment, have been impacted from the past 40 years of waste disposal. Future operations will delay the regeneration of the Native American cultural resources until after closure. Continued consultation with Native American representatives and the USDOE cultural resource office is recommended.

Land Use. All of the License Alternatives would be consistent with the USDOE Hanford Comprehensive Land-Use Plan EIS (USDOE 1999). USDOE has designated the central plateau, including the 100-acre commercial LLRW site, as Industrial-Exclusive to accommodate current and future waste management activities.

Resource Commitments. Resources needed to ship the waste to another commercial LLRW site would offset the resources required to operate the site.

Catastrophic Events. Potential catastrophic events include flooding (including local ponding), volcanic eruption, airplane crash, earthquake, and fire. The License Alternatives will have minimal impact on these events.

Environmental Justice. Environmental justice impacts were evaluated by comparing post-closure dose risks of the Native American and Rural Resident Communities. Continued operation of the site has no impact on future site dose and therefore no impact on environmental justice.

Cumulative Effects. Cumulative effects include impacts from the commercial LLRW site, the USDOE Hanford Site, and other facilities in the area. Continued operations at the commercial LLRW site are predicted to contribute little to the cumulative dose at Hanford. Continued operations could potentially contribute up to 200 to 250 truckloads of waste per year, depending on future disposal needs. The cumulative impact of this amount of truck traffic in and around Hanford will be dependent on the amount of traffic being generated by other Hanford activities.

Surety. Surety is a measure of whether or not the Closure Fund can afford the approved closure plan. The License Alternatives affect surety because the longer the site is in operation, the more interest is earned in the Closure Fund. Relicensing and operating the site through 2056 would allow the Closure Fund to grow to an amount that would fund all Cover Design Alternatives. However, the loss of fund growth that would result from closing the site early is partially offset by the lower costs to close the site. The License Alternatives have little impact on surety for the perpetual care and maintenance fund.

1.7.1.2 License Impacts and Mitigation Measures

There are no potential unavoidable significant impacts from the License Alternatives.

Transportation Risks. Based on a volume of 200,000 cubic feet of LLRW and NARM waste per year, there is a potential for 240 round trips via truck to the site. The statistical accident rate associated with these round trips is 0.13 accidents per year. If the license is renewed or remains in timely renewal, the dose to an individual from an incident-free shipment along all four routes is predicted to be 3.8×10^{-9} millirem per year. The average risk for exposure to these same individuals from a transportation accident is less than 1.0×10^{-8} along all four routes. These results mean that an individual would have a 0.0000001% increased risk of dying from cancer due to an accident during the transport of waste to the commercial LLRW site (Weiner 1998).

Mitigation measures include DOH providing emergency management training in local communities and increasing point-of-origin inspections at generator facilities.

Public Health. The License Alternatives have little or no impact on the predicted *maximum* onsite and offsite dose. The hypothetical maximum dose is from waste disposed prior to 2003. However, continued operation of the site will increase the area of exposure for the onsite intruder and could increase the dose from discrete NARM if it were not buried at greater than 23 feet.

Mitigation measures include deep disposal of discrete NARM, establishing a license limit for radionuclides predicted to contribute to a post-closure dose (Ra-226, H-3, I-129, Tc-99, U-238, C-14, U-234, Pu-239), requiring secondary containment for LLRW containing radionuclides that are predicted to contribute to groundwater concentrations (H-3, I-129, Tc-99, U-238, C-14, U-234, Pu-239), a comprehensive review of the environmental monitoring program, using the Close-As-You-Go Schedule, and closing with the GeoSynthetic Cover.

Socioeconomic. Operation of the commercial LLRW site has a small impact on the Tri-City economy, compared to USDOE activities elsewhere at Hanford. Renewing the license or keeping it in timely renewal would continue to provide employment for 28 people, disposal access to 56 in-state generators and 283 out-of-state generators, revenues to local and state government, and contributions to the perpetual care and maintenance fund. If the license were denied, the Tri-Cities economy and state and regional generators would lose these benefits.

1.7.2 Diffuse NARM

1.7.2.1 Areas of Evaluation with Little or No Impacts

Impacts of the automatic rollover in the No Action Alternative were not evaluated due to the unknowns associated with the numerous volume scenarios that could result from use of the rollover. Impacts of the case-by-case rollover were also not evaluated in the EIS. Case-by-case rollover will be evaluated at the time of use. US Ecology would request DOH to allow a specific volume of diffuse NARM, not to exceed the cumulative rollover amount. The request would include an analysis of impacts from transporting and disposing of the diffuse NARM. DOH would approve, modify, or deny the rollover request based on public health impacts.

Operational Risk. The Diffuse NARM alternatives have little or no impact on operational risks. Historical incident rates do not correlate with waste volumes, suggesting that other variables have a stronger influence on workplace safety. Worker risks are being mitigated by the use of standard Washington State industrial safety practices for all waste disposal activities.

Transportation Risk. Risk from transporting diffuse NARM is low. Disposal of 100,000 cubic feet of diffuse NARM could result in up to 120 truck round trips per year. The statistical accident rate for this many roundtrips is 0.07 accidents per year. The cancer mortality risk from an accident involving radionuclides is estimated at 1.0×10^{-9}. The incident-free dose to individuals along the transportation routes is 1.0×10^{-10} millirem per year (Weiner 1998).

Cover Construction Risk. Disposal of diffuse NARM is expected to have little or no effect on construction of the cover. Diffuse NARM, if continuously disposed at high volumes, could increase the size of the final cover. However, an increase in size of the cover is not expected to significantly increase construction risks.

Earth. The diffuse NARM alternatives have little or no impact on such things as climate, geology, and soil. Soil disturbance and other impacts associated with waste disposal will occur in previously disturbed areas.

Water. The Diffuse NARM Alternatives are predicted to have little or no impact on groundwater or surface water quality for both the five-year renewal period and for the maximum potential operating period, through 2056. The primary impact from NARM is the generation of radon gas. This gas generally moves upward through the vadose zone and does not impact groundwater.

Air. Radon is the primary air impact from radon. Radon impacts are discussed under public health.

Ecology. The Diffuse NARM Alternatives will have little impact on the ecological resources because waste disposal activities would occur in previously disturbed areas. Additional trenches are not expected to be required for the higher-volume NARM alternatives.

Cultural Resources. The continued disposal of diffuse NARM is not expected to lessen or significantly increase impacts to Native American cultural resources.

Land Use. Disposal of diffuse NARM would be consistent with the 1999 USDOE Hanford Comprehensive Land-Use Plan EIS. USDOE has designated the central plateau, including the 100-acre commercial LLRW site, as Industrial-Exclusive to accommodate current and future waste management activities.

Resource Commitments. Resources needed to dispose of diffuse NARM at the commercial LLRW site would be offset by the resources required to ship diffuse NARM elsewhere.

Catastrophic Events. The Diffuse NARM Alternatives will have little or no impact on the likelihood or effect of a catastrophic event.

Cumulative Effects. Future disposal of diffuse NARM is not predicted to contribute to the maximum onsite or offsite dose.

Environmental Justice. Environmental justice impacts were evaluated by comparing post-closure dose risks of the Native American and Rural Resident communities. Disposal of diffuse NARM has little impact on future dose and therefore little or no impact on environmental justice.

Surety. Disposal of diffuse NARM has little or no impact on surety. Although diffuse NARM contributes to the PC&M fund, a recent analysis predicts there are adequate PC&M funds without the additional revenue from diffuse NARM.

1.7.2.2 Diffuse NARM Impacts and Mitigation Measures

There are no unavoidable significant impacts from the Diffuse NARM Alternatives.

Public Health. The primary health impact to the onsite intruder from diffuse NARM is radon. If the site is relicensed over the next 50 years, the Diffuse NARM Alternatives are predicted to contribute between one and 15 millirem per year to the hypothetical *onsite* dose on the second 40 acres of the commercial LLRW site, and less than one millirem per year to the hypothetical *offsite* dose.

Socioeconomic. There are one in-state and 37 out-of-state generators who dispose of diffuse NARM at the commercial LLRW site. Disposal of diffuse NARM provides revenues to local governments, the PC&M Fund, and the Hanford Area Economic Investment Fund (HAEIF). Annual revenues for the Diffuse NARM Alternatives range from $0 to $200,000 for local governments, $0 to $450,000 for the HAEIF, and $0 to $175,000 for the PC&M Fund. These revenues will be lost if diffuse NARM is banned from the commercial LLRW site.

1.7.3 Cover Design

Discussing impacts associated with cover designs can be misleading. Generally speaking, the cover designs do not cause the impacts but rather mitigate the predicted impacts from past waste disposal. The doses and impacts discussed in this section would generally be higher if a cover were not constructed over the site.

1.7.3.1 Areas of Little or No Impact

Operational Risk. There is little or no increase in operational risk from constructing the cover. If cover construction begins while the site is still operating, there may be a small increase in risk to site workers due to the increased presence of heavy equipment, dump trucks, etc. The state believes the two activities of waste disposal and cover construction can co-exist with little additional risk. Site safety plans will be required prior to cover construction.

Transportation Risk. Transportation risks associated with cover design are presented under cover construction.

Earth. There are few or no impacts to the earth resources from cover construction. Construction will result in temporary site disturbance onsite that will increase the potential for wind and rain erosion. Standard construction and erosion control practices will be used.

Ecology. Construction of the covers will have a minimal impact on the ecology of the site because construction of the covers would occur in previously disturbed areas. Placement of a cover will encourage re-establishment of the shrub-steppe habitat on the

100-acre site. Early construction of the final cover will allow a quicker regeneration of the shrub-steppe ecosystem. All covers will be vegetated with native plants.

There is a small, undisturbed tract of 15 acres located in the northwest corner of the site. Excavation of this area may be necessary to acquire more site soils for constructing the final cover. The 15 acres are adjacent to large areas of already disturbed areas. A biological survey of this area will be completed prior to excavation. If excavated, this area will be re-graded and planted with native vegetation similar to the final cover.

Land Use. Closing the commercial LLRW site by leaving the waste in place and covering the site with one of the cover design alternatives would be consistent with the 1999 USDOE Hanford Comprehensive Land-Use Plan EIS. USDOE has designated the central plateau, including the 100-acre commercial LLRW site, as Industrial-Exclusive to accommodate current and future waste management activities.

Catastrophic Events. Catastrophic events will have little or no impact on the performance of the cover designs. Earthquakes and fire may damage the impermeable barriers and the vegetative cover respectively; however, they are not expected to cause severe enough damage to affect groundwater or radon concentrations.

Socioeconomic. Construction of the cover will likely provide a small increase in temporary employment. Hauling cover materials to the site will increase wear and tear on local roads. These costs will be partially offset by gas taxes and other revenues that will be generated from the construction. Impacts on employment and local revenues are discussed in connection with the License Alternatives.

Environmental Justice. The state evaluated the environmental justice impacts of closing the site by comparing the hypothetical risk to the rural resident with that of the hypothetical risk to the Native American. Hypothetical post-closure risk, whether for the rural resident or the Native American, is best presented in the context of the surrounding Hanford Site.

EPA Guidance considers there to be a disparity in impacts if the increased risk for one community is more than twice that for another community (EPA 2000). The Native American risk is more than two times greater than the Rural Resident Adult risk; however, the EPA Guidance states that the disparity must be statistically significant to be considered an environmental justice impact. The risk estimates for both communities have high degrees of uncertainty. The minor difference in the central point risk estimates for the two communities is overwhelmed by the total uncertainty of either estimate (Thatcher 2003a). Based on this high uncertainty, no adverse disparate impacts have been identified.

Cumulative Effects. The contribution from the commercial LLRW site to the cumulative effects is likely to be small when compared to the contribution from all other Hanford activities. A more precise estimate cannot be made until an analysis of all impacts from Hanford and other surrounding activities is completed. This analysis is beyond the scope of the EIS. General mitigation measures include coordinating construction activities with USDOE and the use of ALARA in all decisions.

1.7.3.2 Cover Design Impacts and Mitigation Measures

Closing the site with any of the cover design alternatives decreases the public health and environmental risks when compared with not constructing a cover at all. The doses and impacts discussed in this section would generally be higher if the site were not closed with one of the cover alternatives in the EIS.

There are two potential unavoidable significant impacts projected from closing the site. They are: (1) an additional 20,000 to 40,000 truck round trips to bring cover materials to the site, potentially resulting in eight additional traffic accidents; and (2) hypothetical post-closure H-3 and I-129 groundwater concentrations that exceed the state's groundwater quality standards.

Construction Risk. The cover design alternatives have normal construction risks associated with a large-scale project, including vehicle accidents, lifting accidents, and accidents associated with the use of heavy equipment. None of the cover designs require unusual construction methods.

The most significant potential impact is associated with the transport of material needed for the Homogenous Cover and the Enhanced Covers. Transportation risks were calculated for transporting the silt loam and other materials that are procured offsite. The EIS estimated 100 truck miles per round trip. Most of the trips are required to transport the silt loam for the upper layers of engineered covers. For the engineered covers, round trips varied between 21,000 and 43,000 trips. Total miles ranged from 2.1 to 4.2 million miles. Accident rates are based on 1.8 accidents per million miles, and ranged from a total of 4 to 8 accidents (Fordham 2002).

Mitigation Measures include a safety transportation plan and evaluation of the cover designs for reducing the amount of offsite materials needed for construction.

Public Health. The Radiological Risk Assessment predicted that none of the cover design alternatives, except the Site Soil and Homogenous Cover, would result in a significant public health impact when constructed using the Close-As-You-Go Schedule. The Site Soils Cover is a simplistic alternative that lacks any special barriers for water infiltration and is missing the silt loam soils used in the other covers. As a result, the onsite exposure estimates are significantly greater than for any other cover. The Homogenous Cover lacks a low-permeability barrier for radon, which results in increased hypothetical onsite doses.

Maximum hypothetical *offsite* doses for the US Ecology Cover and the Enhanced Covers are less than the 25 millirem per year standard. Maximum hypothetical offsite resident doses ranged from 18 to 24 millirem per year, with the River Resident dose at a maximum of 11 millirem per year. Maximum hypothetical *onsite* doses for these covers range from 91 to 107 millirem per year. This means if an individual lived directly on the closed commercial LLRW site, they would hypothetically receive an additional dose of approximately 100 millirem per year

The projected results for the US Ecology Proposed Cover and all three enhanced covers are sufficiently close that no single cover, from a predictive dose standpoint, could be singled out as clearly outperforming the other. While the GeoSynthetic Cover's onsite resident dose is greater than 100 millirem per year, the uncertainty associated with these results makes these differences less significant.

Health impacts from non-radionuclides were not included in the EIS. These risks will be predicted following the 2004 MTCA investigation.

Mitigation measures for public health include institutional controls, deeper burial of discrete NARM, license limits for radionuclides predicted to contribute to a post-closure dose (Ra-226, H-3, I-129, Tc-99, U-238, C-14, U-234, Pu-239), secondary containment for all radionuclides predicted to contribute to groundwater concentrations (H-3, I-129, Tc-99, U-238, C-14, U-234, Pu-239), use of the Close-As-You-Go Cover, and enhanced environmental monitoring to validate the groundwater modeling.

Water. The groundwater model predicted that the Homogenous and Enhanced Cover designs would provide the best post-closure groundwater protection. For all cover designs, the hypothetical I-129 and H-3 concentrations are predicted to exceed a state groundwater quality standard. For closure with the GeoSynthetic Cover and the Close-As-You-Go Schedule, the hypothetical maximum concentration for H-3 is 80,000 picocuries per liter compared to the groundwater quality standard of 20,000 picocuries per liter. The hypothetical annual peak concentration of H-3 is predicted to occur at a point between 0 to 250 years after closure. After the H-3 concentration peaks, it is predicted to drop to 0.41 pCi/L. For I-129, the hypothetical maximum concentration is 3.0 picocuries per liter, compared to a standard of 1.0 picocuries per liter. The hypothetical I-129 concentration is predicted to exceed the standard between 5,000 and 10,000 years post-closure.

The hypothetical groundwater concentrations of H-3 and I-129 are best presented in the context of the existing groundwater quality of the surrounding Hanford Site. The 100-acre commercial site is surrounded by contaminated groundwater due to waste management activities elsewhere on the Hanford Site. USDOE plans on remediating this ground water using best available technology. It is anticipated that remediation of certain contaminants, including H-3 and I-129, will be delayed due to limits in technology. USDOE is planning to use institutional controls to restrict public access in the central plateau for *at least* 50 years after the Hanford Site is closed (USDOE 1999). In this context, hypothetical groundwater concentrations of H-3 or I-129 due to the commercial LLRW site, would contribute little, if any, to the overall impact on public health.

Post-closure concentrations of H-3 and I-129 are not a result of relicensing the site. Relicensing the site has little impact on groundwater concentration. The impacts are primarily a result of waste that has been disposed prior to 2003. These impacts are present with all cover design alternatives.

Mitigation measures for ground water include secondary containment and license limits for waste containing radionuclides that are predicted to contribute to groundwater dose (H-3, I-129, Tc-99, U-238, C-14, U-234, Pu-239). Further remedial actions for H-3 and I-129 will be implemented if future monitoring supports the predicted groundwater concentrations of H-3 and I-129.

Air. The primary air quality issue, other than post-closure doses via the air pathway, is fugitive dust generated during cover construction and transport of cover materials.

Mitigation measures include dust control abatement, selection of a soil vendor that is in close proximity, covering all shipments of silt loam soil during transport, restricting transport of cover materials during windy conditions, selecting a cover design less prone to wind erosion, and establishing and maintaining vegetation on the completed cover.

Cultural Resources. Closing the site by leaving the waste in place will impact the Native American cultural resource of a pristine environment.

Recommended mitigation includes revegetation of cover and borrow site area with native species, and consultation with Native Americans and the Hanford Site Preservation Officer.

Resource Commitments. Resources required for construction of the different cover alternatives vary by the amount of silt loam and the design of the low permeability barrier. Silt loam soil is likely to be procured from an offsite location within 100 miles of the commercial LLRW site. Required volumes of silt loam range from 0 to 616,000 cubic yards. Estimates of diesel fuel that will be required to bring the silt loam onsite range from 713,000 to 1,092,000 gallons.

Recommended mitigation includes evaluating the cover designs for opportunities to reduce silt loam needed for construction.

Surety. Both the cover design and the cover schedule impact surety. The Homogenous Cover is the most affordable cover design and meets the margin of safety factors for all cover schedule alternatives. The Asphalt Cover is the most expensive cover design and meets the margin of safety factor only if the final cover is constructed entirely in the year 2056 (“No Early Construction” Alternative). The Close-As-You-Go Schedule is the most expensive scheduling alternative and has marginal surety for all cover designs except the Homogenous Cover.

1.7.4 Cover Schedule

1.7.4.1 Areas of Little or No Impact

Operational Risk. There is little or no increased risk to workers from any of the cover schedule alternatives. Several of the schedule alternatives require construction during operations. However, this construction will generally occur away from the active trenches. Safety plans for both construction and operations will be coordinated to accommodate both activities.

Transportation. The cover schedule will have a small impact on transportation risks. Cover construction will require from 21,000 to 47,000 round trips via truck to bring cover materials onsite. The schedule alternatives that use a phased approach will spread those truck trips out over several construction periods and minimize the impact from any single period. The "Close-As-You-Go" Alternative would potentially spread truck traffic over 40 years, while the No Action Alternative would concentrate truck traffic within a several-year period.

Construction Risk. There is little or no increased risk to worker safety from the cover construction alternatives. The No Action Alternative would have less construction activity because it would occur all in one construction period. One construction period means less staging of construction equipment and less work because there would be only one cover constructed instead of several covers that require joining. However, the increase in activity required by phased construction is not expected to significantly increase construction risk.

Earth. There are few or no impacts to the earth resources from the cover schedule. Following construction, revegetation of the trench covers will occur. Standard erosion control practices will be used with any of the construction schedules.

Air. The cover schedule alternatives have no impact on offsite or onsite radon concentrations. The cover schedule will have little or no impact on fugitive dust emissions during closure. The schedules that include phased construction will spread the dust emissions over numerous years. The No Action Schedule will concentrate those emissions into a 3 to 4 year period. All construction, regardless of schedule, will be subject to dust abatement.

Ecology. The cover schedule will affect how quickly the vegetation and habitat on the commercial LLRW site is able to re-establish. The Close-As-You-Go Schedule will allow vegetation to establish sooner than the No Action Schedule.

Cultural Resources. The cover schedule will have little or no impact on the Native American cultural resource of a clean and natural environment.

Land Use. The cover schedule will have little or no impact on land use. All schedule alternatives are consistent with the 1999 USDOE Hanford Comprehensive Land-Use Plan EIS.

Catastrophic Events. The impact of a catastrophic event such as an earthquake, flood, or fire is expected to have little effect on the cover schedule.

Resource Commitments. The cover schedule has little or no impact on the amount of resources required for cover construction.

Socioeconomic. The cover schedule will influence the timing of the employment of additional workers. The schedule will either spread the additional employment out through several phases, or concentrate it in a 3-4-year period. None of the construction schedules are expected to significantly impact the local employment levels.

Environmental Justice. The cover schedule reduces, but does not eliminate, the difference in risk between the offsite Native American and the Rural Resident communities. Based on high uncertainty in the risk estimates, no disparate impacts have been identified for the closure schedule.

Cumulative Effects. The cover schedule favorably affects the offsite post-closure dose in the first 1,000 years after closure.

Surety. The cover schedule does not significantly affect the surety of the closure account because most cover designs are affordable with the majority of the schedule alternatives. Constructing the cover at the time of closure is the most affordable construction schedule because it has only one construction period. The Close-As-You-Go Schedule, with three construction phases, is marginally affordable for some of the cover designs.

1.7.4.2 Cover Schedule Impacts and Mitigation Measures

There are no unavoidable significant impacts from the Cover Schedule Alternatives.

Public Health. The cover construction schedule has little effect on post-closure *onsite* doses but is predicted to significantly reduce *offsite* doses. The Radiological Risk Assessment predicted that using the Close-As-You-Go Cover could reduce the hypothetical post-closure offsite dose by over 100 millirem in the first 1,000 years after closure. Assuming closure with the GeoSynthetic Cover, the Close-As-You-Go Schedule is predicted to result in a hypothetical dose of 22 millirem per year. This is compared to the No Action Schedule (construct entire cover at closure), which is projected to result in a hypothetical dose of 130 millirem per year. Impacts on dose by the US Ecology Schedule and the Prototype Schedule were not specifically calculated, but the state would expect these schedules to also provide some reduction in dose over the No Action Schedule.

Water. The Construction Schedule has a significant impact on the predicted groundwater concentrations in the first 1,000 years after closure. The groundwater model predicted the Close-As-You-Go Schedule to be more effective at reducing post-closure groundwater concentrations than the No Action Construction Schedule (no construction until 2056).

Table 1.A: License Alternatives: Summary of Impacts

No Action Alternative: Current License Remains in Timely Renewal	**Renew License with Additional License Requirements**	**Deny License**
TRANSPORTATION		
Impacts	**Impacts**	**Impacts**
Annual maximum of 240 trucks per year for transport of LLRW and NARM results in an average of 0.13 accidents per year	Same as No Action Alternative	No truck traffic from operations
Cancer mortality risk from accident involving nuclides: 1.0 x 10-08	Same as No Action Alternative	Zero cancer risk
Incident Free Dose: 3.8 x 10-09 mrem/year	Same as No Action Alternative	Zero incident free dose
Mitigation Measures	**Mitigation Measures**	**Mitigation Measures**
Increase emergency management training to local communities	Increase emergency management training to local communities	None
Increase point-of-origin inspections	Increase point-of-origin inspections	
PUBLIC HEALTH		
Impacts	**Impacts**	**Impacts**
Five-year relicense period: Little or no impact on maximum post-closure dose	Five-year relicense period: Same as No Action Alternative	No impact on post-closure dose
Operations through 2056: Increased onsite dose due to discrete NARM	Operations through 2056: Little or no impact on maximum post-closure dose due to deeper burial of discrete NARM	
Mitigation Measures	**Mitigation Measures**	**Mitigation Measures**
Construction of a low-permeability cover over all existing waste in 2005	Construction of a low-permeability cover over all existing waste in 2005	None
	Amend license to include all additional requirements	

No Action Alternative: **Current License Remains in Timely Renewal**	**Renew License with Additional License Requirements**	**Deny License**
SOCIEOCONOMIC **Impacts** US Ecology employment: 28 full-time jobs Five-Year Benton County revenue: $ 1,294,060 2003-2056 Benton County revenue: $13,717,000 Five-Year HAEIF revenue: $ 2,250,000 2003-1056 HAEIF revenue: $23,850,000 State revenue: $750,000 In-state generator access: 56 Out-of-state generator access: 283 Infrastructure: Truck traffic from operations and cover construction will impact roads and emergency services **Mitigation Measures** Employment services for displaced workers	**Impacts** All impacts same as No Action Alternative **Mitigation Measures** Same as No Action Alternative	**Impacts** US Ecology employment: Lost jobs Benton County: Loss of revenue HAEIF: Loss of revenue State revenue: Loss of revenue Generator access: No access for 339 generators - Envirocare (Utah) could accept 85% of regional waste Infrastructure: Truck traffic from closure would still occur; no truck traffic from operations **Mitigation Measures** None

Table 1.B: Diffuse NARM Alternatives: Summary of Impacts

No Action Alternative: 100,000 ft^3/year, with automatic rollover	**Adopt 100,000 ft^3/year, with case-by-case rollover**	**Adopt 8,600 ft^3/year, with no rollover**	**Adopt 36,700 ft^3/year, with case-by-case rollover**	**Zero ft^3/year.**
PUBLIC HEALTH **Impacts** Potentially increases the area from 40 acres to 80 acres that a resident onsite intruder could be exposed to a 15 millirem per year dose from diffuse NARM.	**Impacts** Same as No Action Alternative	**Impacts** Potentially contributes 1 millirem per year to a hypothetical resident onsite intruder on second 40 acres	**Impacts** Potentially contributes 6 millirem per year to a hypothetical resident onsite intruder on second 40 acres	**Impacts** No contribution to the resident onsite intruder on second 40 acres

No Action Alternative: 100,000 ft^3/year, with automatic rollover	Adopt 100,000 ft^3/year, with case-by-case rollover	Adopt 8,600 ft^3/year, with no rollover	Adopt 36,700 ft^3/year, with case-by-case rollover	Zero ft^3/year.
Specific impacts to transportation, worker safety, air quality, etc., from automatic rollover were not calculated due to the unknowns associated with potential volumes. **Mitigation Measures** Institutional controls	Impacts from case-by-case rollover will be determined at the time of a request for rollover volumes. **Mitigation Measures** Institutional controls DOH approval of site operator impact analysis for case-by-case rollover.	None **Mitigation Measures** Institutional controls	Impacts from case-by-case rollover will be determined at the time of a request for rollover volumes **Mitigation Measures** Institutional controls DOH approval of site operator impact analysis for case-by-case rollover.	None **Mitigation Measures** Institutional controls
SOCIOECONOMIC **Impacts** Benton County revenue: $200,000/yr HAEIF revenue: $450,000/yr PC&M Fund: $3,302/yr Diffuse NARM generators: In-state: 1 Out-of-state: 37 **Mitigation Measures** None	**Impacts** All impacts same as No Action Alternative **Mitigation Measures** None	**Impacts** Benton County revenue: $17,200/yr HAEIF revenue: $38,700/yr PC&M Fund: $284/yr Diffuse NARM generators: In-state: 1 Out-of-state: 37 **Mitigation Measures** None	**Impacts** Benton County revenue: $73,400/yr HAEIF revenue: $165,150/yr PC&M Fund: $1,212/yr Diffuse NARM generators: In-state: 1 Out-of-state: 37 **Mitigation Measures** None	**Impacts** Benton County revenue: $0/yr HAEIF revenue: $0/yr PC&M Fund: $0/yr Diffuse NARM generators: In-state: 0 Out-of-state: 0 **Mitigation Measures** None

Table 1.C: Cover Design Alternatives: Summary of Impacts

No Action Alternative: **Site Soils Cover**	**US Ecology Cover**	**Homogenous Cover**	**Enhanced Cover** ▪ **Asphalt** ▪ **GeoSynthetic** ▪ **Bentonite**
COVER CONSTRUCTION RISKS **Impacts** Most impact potential is from transporting offsite materials onsite Round trips: 0 Total truck miles: 0 Statistical accident rate: 0 **Mitigation Measures** None	**Impacts** Most impact potential is from transporting offsite materials onsite Round trips: 21,100 Total truck miles: 2.1 million Statistical accident rate: 4 **Mitigation Measures** Adopt approved traffic safety plan	**Impacts** Most impact potential is from transporting offsite materials onsite Round trips: 36,100 Total truck miles: 3.6 million Statistical accident rate: 7 **Mitigation Measures** Adopt approved traffic safety plan	**Impacts** Most impact potential is from transporting offsite materials onsite. Round trips: 36,000 – 47,000 Total truck miles: 3.6-4.3 million Statistical accident rate: 7 to 8 **Mitigation Measures** Adopt approved traffic safety plan
PUBLIC HEALTH **Impacts** *Assumed site is relicensed and operated through 2056, closed with the GeoSynthetic Cover and the Close-As-You-Go Schedule* Hypothetical 0 to 1000 year doses Native American Adult (mrem/yr): *N/C means not calculated Offsite Resident: 81 Onsite Resident: 336 Onsite Trespasser: N/C	**Impacts** *Assumed site is relicensed and operated through 2056, closed with the GeoSynthetic Cover and the Close-As-You-Go Schedule* Hypothetical 0 to 1000 year dose Native American Adult (mrem/yr): Offsite Resident: 18 Onsite Resident: 94 Onsite Trespasser: N/C	**Impacts** *Assumed site is relicensed and operated through 2056, closed with the GeoSynthetic Cover and the Close-As-You-Go Schedule* Hypothetical 0 to 1000 year dose Native American Adult (mrem/yr): Offsite Resident: 18 Onsite Resident: 164 Onsite Trespasser: N/C	**Impacts** *Assumed site is relicensed and operated through 2056, closed with the GeoSynthetic Cover and the Close-As-You-Go Schedule* Hypothetical 0 to 1000 year dose Native American Adult (mrem/yr): Offsite Resident: 18 Onsite Resident: 88 to 107 Onsite Trespasser: 1 River Resident: 9

No Action Alternative: **Site Soils Cover**	**US Ecology Cover**	**Homogenous Cover**	**Enhanced Cover** ▪ **Asphalt** ▪ **GeoSynthetic** ▪ **Bentonite**
Hypothetical H-3 and I-129 concentrations predicted to exceed drinking water MCL's **Mitigation Measures** Institutional controls; deeper burial of discrete NARM; license limits; increased secondary containment; enhanced environmental monitoring Further remedial actions for H-3 and I-129 will be implemented if future environmental monitoring supports the predicted groundwater concentrations of H-3 and I-129	Same as No Action Alternative **Mitigation Measures** Same as No Action Alternative	Same as No Action Alternative **Mitigation Measures** Same as No Action Alternative	Same as No Action Alternative **Mitigation Measures** Same as No Action Alternative
WATER **Impacts** H-3 predicted to peak at 90,000 pCi/L and exceed the 20,000 pCi/L Ground Water Quality Standard the first 500 years after closure I-129 predicted to peak at 5000 to 10,000 years at 3.20 pCi/L and exceed the 1.0 pCi/L Groundwater Quality Standard **Mitigation Measures** Secondary containment and license limits for nuclides that contribute to a hypothetical	**Impacts** H-3 predicted to peak at 80,000 pCi/L in first 250 years and exceed the 20,000 pCi/L Ground Water Quality Standard I-129 predicted to peak at 5000 to 10,000 years at 3.0 pCi/L and exceed the 1.0 pCi/L Groundwater Quality Standard **Mitigation Measures** Same as No Action Alternative	**Impacts** H-3 predicted to peak at 80,000 pCi/L in first 250 years and exceed the 20,000 pCi/L Ground Water Quality Standard I-129 predicted to peak at 5000 to 10,000 years at 2.93 pCi/L and exceed the 1.0 pCi/L Groundwater Quality Standard **Mitigation Measures** Same as No Action Alternative	**Impacts** H-3 predicted to peak at 80,000 pCi/L in first 250 years and exceed the 20,000 pCi/L Ground Water Quality Standard I-129 predicted to peak at 5000 to 10,000 years at 2.93 pCi/L and exceed the 1.0 pCi/L Groundwater Quality Standard **Mitigation Measures** Same as No Action Alternative

No Action Alternative: Site Soils Cover	US Ecology Cover	Homogenous Cover	Enhanced Cover ▪ Asphalt ▪ GeoSynthetic ▪ Bentonite
groundwater dose: H-3, I-129, Tc-99, U-238, C-14, U-234, Pu-239; institutional controls. Further remedial actions for H-3 and I-129 will be implemented if future environmental monitoring supports the predicted groundwater concentrations of H-3 and I-129			
AIR **Impacts** Fugitive dust potential during **c**over construction and from wind erosion of completed cover **Mitigation Measures** Halt construction during windy conditions; establish vegetation on completed cover	**Impacts** Fugitive dust potential during cover construction, from transport of silt loam, and from wind erosion of completed cover **Mitigation Measures** Halt construction during windy conditions; cover silt loam during transport; establish vegetation on completed cover	**Impacts** Fugitive dust potential during cover construction, from transport of silt loam, and from wind erosion of completed cover **Mitigation Measures** Halt construction during windy conditions; cover silt loam during transport; establish vegetation on completed cover	**Impacts** Fugitive dust potential during cover construction, from transport of silt loam, and from wind erosion of completed cover **Mitigation Measures** Halt construction during windy conditions; cover silt loam during transport; establish vegetation on completed cover
CULTURAL RESOURCES **Impacts** Closing the site by leaving the waste in place will impact the Native American cultural resource of a pristine environment **Mitigation Measures** Plant cover and borrow site area with native species; continued	**Impacts** Same as No Action Alternative but provides greater waste isolation **Mitigation Measures** Same as No Action Alternative	**Impacts** Same as No Action Alternative but provides greater waste isolation **Mitigation Measures** Same as No Action Alternative	**Impacts** Same as No Action Alternative but provides greater waste isolation **Mitigation Measures** Same as No Action Alternative

No Action Alternative: Site Soils Cover	US Ecology Cover	Homogenous Cover	Enhanced Cover ▪ Asphalt ▪ GeoSynthetic ▪ Bentonite
consultation with Native Americans: Consultation with the Hanford Site Preservation Officer			
RESOURCE COMMITMENTS **Impacts** Minimal amount of resources needed **Mitigation Measures** None	**RESOURCE COMMITMENTS** **Impacts** Silt loam soil: 280,000 cubic yds Diesel fuel: 211,000 gallons **Mitigation Measures** Evaluate options to reduce offsite materials in cover design	**RESOURCE COMMITMENTS** **Impacts** Silt loam soil: 616,000 cubic yds Diesel fuel: 361,000 gallons **Mitigation Measures** Evaluate options to reduce offsite materials in cover design	**RESOURCE COMMITMENTS** **Impacts** Silt loam soil: 616,000 cubic yds Diesel fuel: 361,000 to 429,000 gal **Mitigation Measures** Evaluate options to reduce offsite materials in cover design

Table 1.D: Cover Schedule Alternatives: Summary of Impacts

No Action Alternative: No Early Construction	US Ecology Schedule	Prototype Schedule	Close-As-You-Go Schedule
PUBLIC HEALTH **Impacts** GeoSynthetic Cover: 0 to 1000 year Onsite Native American Adult Resident dose: 130 mrem/year **Mitigation Measures** None	**Impacts** GeoSynthetic Cover: Not calculated **Mitigation Measures** None	**Impacts** GeoSynthetic Cover: Not calculated **Mitigation Measures** None	**Impacts** GeoSynthetic Cover: 0 to 1000 year Onsite Native American Adult Resident dose: 18 mrem/year **Mitigation Measures** None

No Action Alternative: No Early Construction	US Ecology Schedule	Prototype Schedule	Close-As-You-Go Schedule
WATER **Impacts** No reduction in groundwater concentrations from early construction **Mitigation Measures** None	**Impacts** Early construction over first seven trenches expected to reduce groundwater concentrations during 0 to 1000 year period **Mitigation Measures** None	**Impacts** Early construction over two trenches expected to have minimal reduction on ground water concentrations **Mitigation Measures** None	**Impacts** H-3 and I-129 showed significant reduction on 0 to 1,000 year groundwater concentrations **Mitigation Measures** None

2.0 BACKGROUND

2.1 Site History

Washington State is host to one of the nation's three commercial low-level radioactive waste disposal sites (commercial LLRW site). The commercial LLRW site is located in Benton County and is approximately 23 miles northwest of Richland in eastern Washington. The commercial LLRW site is located near the center of the 586-square mile United States Department of Energy (USDOE) Hanford Site, on approximately 100 acres of land leased to the state of Washington.

On September 10, 1964, Washington State and the Atomic Energy Commission (AEC) entered into a 100-year lease agreement for 1,000 acres of land on the Hanford Site.[5] In 1965, the state of Washington leased 100 acres of this land to US Ecology for the operation of the commercial LLRW site.[6] The commercial LLRW site has been in operation since 1965 and is still operated by US Ecology, Inc. The site is licensed to receive low-level radioactive waste (LLRW) and naturally occurring and accelerator-produced radioactive material (NARM). Disposal access for LLRW is limited to 11 states by the Northwest Compact. Approximately 80% of the LLRW disposed at the site is from generators in Washington and Oregon.

By 1979, the commercial LLRW site was receiving approximately half of the nation's low-level radioactive waste volume. As a result of the imbalance between the small volumes of waste Washington State was generating and the large volumes of waste it was receiving, the state, in conjunction with Nevada and South Carolina, sought passage of the Low-Level Radioactive Waste Policy Act of 1980 (Act), P. L. 96-573. The Act made each state responsible for disposal of its own low-level radioactive waste and encouraged the formation of compacts between states to manage low-level radioactive waste on a regional basis.

Before Washington State could comply with the Act, the citizens of Washington approved Initiative 383 on November 4, 1980. Initiative 383 banned the disposal of all non-medical waste generated outside Washington State. In 1981, a U.S. District Court held Initiative 383 to be unconstitutional. Following this decision, Washington State moved forward with forming a low-level radioactive waste compact with other states.

In 1981, the states of Washington, Alaska, Hawaii, Idaho, Montana, Oregon, and Utah formed the Northwest Interstate Compact. Congress ratified the Northwest Compact in 1985 and passed the Low-Level Radioactive Waste Policy Amendments Act

[5] This lease is now between the state and USDOE; the AEC was abolished, and the NRC and USDOE were created.

[6] In 1993, USDOE exercised its option under the lease and asked the state to return 900 of the 1,000 acres, leaving 100 acres of land for the commercial LLRW disposal site.

(Amendments Act) of 1985, P.L. 99-240. Wyoming exercised its option to join the Northwest Compact in 1992. The Amendments Act allowed state compacts with operating sites to exclude low-level radioactive wastes, beginning in 1993. In 1993, the Northwest Compact exercised its authority to exclude low-level radioactive wastes generated outside its member states. By formal agreement in 1993 between the Northwest Compact and the Rocky Mountain Compact, waste generated in the states of Nevada, Colorado, and New Mexico has been disposed at the commercial LLRW site.

In 1986, DOH adopted its first regulation with regard to NARM disposal. WAC 246-249-080 required NARM generators to obtain from DOH specific approval for shipments over 1,000 cubic feet per year without providing for any upper limit on the amount of NARM that could be disposed at the commercial LLRW site. In July 1995, DOH adopted amendments to WAC 246-249-080 that limited individual generators of diffuse NARM to 1,000 cubic feet per year and created a site limit of 8,600 cubic feet per year. In September 1995, US Ecology filed a civil suit against DOH contesting the 8,600 cubic foot limit. On May 15, 1996, DOH entered into a settlement agreement with US Ecology whereby DOH agreed to initiate rulemaking to consider a 100,000 cubic foot disposal limit for diffuse NARM with no individual generator limit. The court entered an order staying the 1995 amendments and requiring DOH to initiate rulemaking to adopt the 100,000 cubic foot limit. Rulemaking has been deferred pending the outcome of the EIS. The 100,000 cubic foot limit remains in effect today.

Figure 2.A: Commercial LLRW Site – Chronology of Significant Events

1965:
- Site licensed to California Nuclear, Inc. and begins accepting low-level radioactive waste

1968:
- Nuclear Engineering Company acquires California Nuclear, Inc. and takes over as site operator

1970:
- Chemical Trench holding approximately 17,000 cubic feet of waste is closed

1979:
- Site closed temporarily due to transportation and packaging-related noncompliance events

1980:
- LLRW Policy Act passed by Congress
- Initiative 383 approved, banning disposal of all non-medical waste generated out of state

1981:
- U.S. District Court finds Initiative 383 unconstitutional
- Nuclear Engineering Company changes its name to US Ecology, Inc.

1983:
- NRC adopts 10 CFR Part 61 for regulating commercial LLRW sites

1985:
- Hazardous scintillation fluids banned from disposal
- LLRW Amendments Act of 1985 passed

1986:
- SEPA checklist completed for License Renewal: Determination of Non-Significance

1991:
- SEPA checklist completed for License Renewal: Determination of Non-Significance

1993:
- Northwest Compact restricts disposal of LLRW to members and Rocky Mountain Compact states

1995:
- DOH adopts a NARM site limit of 8,600 cubic feet per year; US Ecology files a lawsuit

1996:
- A court order imposes 100,000 ft^3/year NARM site limit, pending rulemaking
- US Ecology submits *Site Stabilization and Closure Plan* for approval

1997:
- SEPA Determination of Significance for License Renewal, Diffuse NARM, and Site Closure

1999:
- Trojan reactor vessel disposed at commercial LLRW site

2000:
- 17.2 curies of radium (discrete NARM) received from Spain
- Draft EIS issued

2.1.1 Site Operator

US Ecology, Inc., a wholly owned subsidiary of American Ecology, Inc., has been the site operator since 1968. American Ecology is headquartered in Boise, Idaho. The company provides a variety of hazardous and low-level radioactive waste management services. Approximately 70% of the company's revenues are from its hazardous waste services, and 30% are from its low-level radioactive waste services.

US Ecology has a long history of providing low-level radioactive waste services. They have completed closure and transferred the licenses of commercial LLRW disposal sites to appropriate state agencies at Sheffield, Illinois, and Beatty, Nevada. US Ecology also formerly operated the disposal site at Maxey Flats, Kentucky, which is now the responsibility of the Commonwealth of Kentucky.[7]

The Washington Utilities and Transportation Commission (WUTC) regulates revenues from the site. In 2002, the WUTC approved an annual revenue requirement of more than $5.17 million for the period between 2002 through 2007. This operating margin assures viability of the site and a reasonable disposal fee, regardless of waste volumes. It allows US Ecology to remain capable of securing the necessary revenue to ensure safe operations of the commercial LLRW site. The sublease with US Ecology expires on July 29, 2005. The Department of Ecology intends to negotiate a new sublease with the company.

2.1.2 Historical Compliance

Regulatory compliance is the responsibility of both the waste generator and the site operator. US Ecology is responsible for ensuring the site is operated in accordance with regulatory and license requirements. Operator non-compliance is characterized as a deficiency, infraction, or violation. Deficiencies are items of non-compliance that have little or no impact to safety, public health, or the environment. Infractions usually involve incomplete documentation on such things as training records, occupational exposure history, and use of new equipment. Infractions are usually discovered through routine audits and are corrected prior to the next audit.

The unauthorized disposal of hazardous waste into the Chemical Trench from 1965 to 1970 by Nuclear Engineering Company (NECO), was apparently not documented as an item of non-compliance.[8] Information concerning the operation of the Chemical Trench is less than complete, so it is unclear what type of actions, other than directing NECO to close the trench, were taken by the state against NECO. US Ecology has had few violations in the last twenty years. When violations are found, US Ecology is required to

[7] US Ecology currently operates hazardous waste disposal sites in Beatty, Nevada; Robstown, Texas; and Grandview, Idaho.
[8] California Nuclear, Inc. (CNI) was the original site operator. In 1968, CNI sold its assets to Nuclear Engineering Company (NECO). In 1981, NECO changed its name to US Ecology, Inc.

address and correct the violations immediately. Past violations have included failure to perform a bioassay on an employee, inadequate surveys of waste trailers, and inadequate control of radioactive material.

A waste generator is responsible for ensuring the waste is packaged, shipped, and manifested according to regulations and license requirements. Generator violations can result in a warning call, warning letter, or suspension, based on the severity of the violation. If a generator is suspended from using the commercial LLRW site, DOH will reinstate their privileges only after submittal of an approved quality assurance program that is designed to correct the deficiencies. In addition, DOH must perform a point-of-origin inspection of the generator's facility prior to reinstatement.

The most notable generator violations occurred in the late 1970's and included material leaking from containers, improper packaging, and associated contamination in excess of USDOT limits. These types of violations contributed to the site temporarily being shut down on October 4, 1979 by Governor Dixie Lee Ray. Six weeks later, the commercial LLRW site was reopened with more stringent transportation and shipping requirements, in addition to a full-time onsite DOH inspector. Since that time, there have been considerably fewer generator violations. The most severe of these violations included isolated occurrences of improper manifests, loose closure devices, free-standing liquids, excessive void space in packages, and use of unapproved absorbents.

In 1992, DOH also initiated a point-of-origin inspection program to further minimize packaging and transportation problems. This inspection program requires DOH to conduct onsite inspections at generator facilities. The presence of the full-time inspector, as well as the point-of origin inspections, has reduced the likelihood of violations such as those described above.

2.1.3 Comparison to Other Commercial LLRW Disposal Sites

Nationwide there are three operating commercial LLRW disposal sites. Table 2.A provides a comparison of the three active sites in Richland, Washington; Barnwell, South Carolina; and Clive, Utah. Currently, there are no other approved commercial LLRW disposal sites scheduled to open.

Table 2.A: Comparison of Active Commercial LLRW Disposal Sites

Site Location	Richland, Washington	Barnwell, South Carolina	Clive, Utah
Date of Origin	1965	1971	1988
Operator	US Ecology, Inc.	Chem-Nuclear Systems, LLC	Envirocare of Utah, Inc.
Site Ownership	Federal	State	Private
Size of Site	100 Acres	235 Acres	540 Acres
Description of Site	Rainfall: 6 inches/year Average depth to groundwater: 315 ft	Rainfall: 36 inches/year Average depth to groundwater: 41 ft	Rainfall: 7 inches/year Average depth to groundwater: 25 ft

Site Location	Richland, Washington	Barnwell, South Carolina	Clive, Utah
Disposal Method	Shallow land burial	Shallow land burial	Below and above grade bulk disposal
Geographical Area of Waste Accepted	LLRW accepted only from Northwest and Rocky Mountain Compacts; NARM accepted from all states.	LLRW accepted from all states except North Carolina. South Carolina will begin exercising exclusionary authority in year 2008.	No LLRW accepted from the Northwest Compact; waste accepted from all other states.
Waste Accepted	Class A, B, and C LLRW and diffuse and discrete NARM	Class A, B, and C LLRW	Most types of Class A, diffuse NARM, uranium mill tailings, some mixed waste.

2.2 Legal, Regulatory, and Policy Considerations

Requirements that affect the commercial LLRW site include federal and state laws, regulations, guidelines, and various instruments and agreements written specifically for the commercial LLRW site. This section provides a brief description of the requirements that are most significant to the operation and closure of the site.

2.2.1 Federal and State Laws

Atomic Energy Act (AEA) 42 U.S.C. This Act establishes the regulatory and licensing basis for commercial and military use of atomic energy. The AEA gives the NRC responsibility for regulating the use of source, byproduct, and special nuclear materials. The AEA permits the NRC to enter into agreements with states to authorize regulation of radioactive materials covered by the agreement. These states are called "Agreement States".

Federal Low-Level Radioactive Waste Policy Act of 1980. This Act allows states to enter into compact agreements to establish and operate regional LLRW disposal sites.

Federal Low-Level Radioactive Waste Policy Amendments Act of 1985. Beginning in 1993, the Amended Act allowed the state compacts with operating sites to exclude out-of-compact waste.

Washington Nuclear Energy and Radiation Control Act, Chapter 70.98 RCW. Establishes a state program for regulation of ionizing radiation for the protection of the occupational and public health and safety.

Radioactive Waste Act, Chapter 43.200 RCW. Establishes a closure account and perpetual care and maintenance account to be used exclusively for final closure and decommissioning of the commercial LLRW site and gives authority to the Department of Ecology to implement the 1985 LLRW Policy Amendments Act.

Hazardous Waste Management Act, Chapter 70.105 RCW. Regulates closure and corrective actions for releases of non-radioactive hazardous waste and mixed waste through the State Dangerous Waste Rules, Chapter 173-303 WAC.

Model Toxics Control Act, Chapter 70.105D RCW. Establishes cleanup standards and requirements for the cleanup of hazardous waste sites.

Northwest Interstate Compact on Low-Level Radioactive Waste Management, Chapter 43.145 RCW. Enacts the Northwest Interstate Compact into state law and establishes the Compact's regulatory provisions, eligible parties, and other operating requirements.

2.2.2 Regulations

Table 2.B describes those regulations that are pertinent to operating and closing the site. DOH and the Department of Ecology are the two primary state agencies that regulate the commercial LLRW site. DOH is the lead agency at the commercial LLRW site under Chapter 246-250 WAC for radiological substances, including licensing, operational oversight, financial surety, and closure. The Department of Ecology is the lead agency for managing the lease agreements, permitting generators for use of the disposal site, and addressing past disposal of non-radiological substances. Other state and federal agencies having a role at the commercial LLRW site include the WUTC, the U.S. Environmental Protection Agency (EPA), the U.S. Department of Transportation (USDOT), and USDOE as the site landlord.

Model Toxics Control Act. At this time, the Department of Ecology does not intend to regulate the radiation hazards of AEA-regulated radionuclides under MTCA. Although MTCA includes radionuclides within its definition of "hazardous substances," a number of considerations affect the application of MTCA to the cleanup of radionuclides. There are legal questions concerning the application of MTCA to address those radionuclides regulated by the federal Atomic Energy Act of 1954 (AEA) (i.e., source, special nuclear, and byproduct materials as defined by the AEA). Federal courts have held that the AEA preempts state regulation of the radiation hazards of such materials, which may preclude the application of MTCA to remediate radiation risks. While the Department of Ecology does not concede any authority granted through MTCA, in light of these decisions, the Department of Ecology will focus its regulation under MTCA where its authority is clearest.

Ecology may apply MTCA in the event data indicate releases of AEA-regulated radionuclides that pose a non-radiological hazard, or releases of any non-AEA regulated radionuclides. Ecology's decision will include consideration of the potential application of other authorities pursuant to WAC 173-340-310(5)(d)(iii).

ALARA. Regulatory standards generally represent the maximum allowable limit for a radionuclide or non-radioactive chemical. The concept of achieving a lower limit is central to many regulatory standards and is critical for ensuring maximum protection of public health and the environment. In the field of radiation regulation, this concept is known as ALARA and means "as low as reasonably achievable." ALARA mandates that every reasonable effort must be made to limit exposure to radiation to the extent practicable, taking into account current technology, public health, worker safety, costs, and other socioeconomic considerations.

2.2.3 Instruments and Agreements

Agreement Authorizing State Authority. A December 6, 1966 agreement between the state of Washington and the Atomic Energy Commission authorized the state to regulate byproduct materials and source materials. The authorization for special nuclear materials was granted in September 1997.

Prime Lease. In 1964, the Federal Atomic Energy Commission entered into a long-term lease with the state of Washington for 1000 acres within the Hanford Reservation to promote nuclear-related activities. The leased area was later reduced to 100 acres. The lease expires on September 9, 2063. The state pays an annual lease payment of $600.00 to USDOE.

Sublease. The state of Washington subleases 100 acres leased from USDOE to US Ecology for operation of the commercial LLRW site. The current sublease has a term of 15 years – July 29, 1990 through July 28, 2005. Annual sublease payments started at $50,000 in 1993 and are increased every year by an amount equal to the consumer price index (CPI). Current payments are at $59,412. Unlike previous sublease agreements, there is no automatic renewal option.

Perpetual Care Agreement. In 1965, Washington State and the federal government entered into a perpetual care agreement. Under this agreement, the state is required to impose a surcharge on waste, and deposit those funds annually into the perpetual care and maintenance fund. The agreement states the funds shall be used exclusively for perpetual surveillance and maintenance of the commercial LLRW site.

NARM Settlement Agreement. On May 15, 1996, DOH entered into a settlement agreement with US Ecology, whereby DOH agreed to initiate rulemaking to consider a 100,000 cubic foot per year site limit for diffuse NARM. In return, US Ecology agreed to dismiss a lawsuit challenging the 1995 amendment to WAC 246-249-080 that limited disposal of diffuse NARM for individual generators to 1,000 cubic feet per year and established a site limit of 8,600 cubic feet per year. Rulemaking is deferred pending the outcome of the EIS. In the interim, the settlement agreement established a 100,000-foot site limit for diffuse NARM.

Washington State Radioactive Materials License, WN-I019-2. The license, issued by DOH to US Ecology, authorizes US Ecology to receive, transfer, repackage, and dispose of radioactive waste at the commercial LLRW site. The license sets concentration limits, waste form, packaging, manifest, and record keeping requirements. The license must be renewed every five years.

Facility Standards Manual. The manual provides specific standards and criteria for daily operations of the commercial LLRW site.

Hanford Site Permit. RCRA Permit WA7 89000 8967 is issued to USDOE, Fluor Daniel Hanford, Inc., CH2M Hill Hanford Group, Inc., Bechtel Hanford, Inc., and the Pacific Northwest National Laboratory. This permit is applicable to the entire Hanford Site, including the commercial LLRW site. US Ecology has objected to inclusion of the commercial LLRW site in the Hanford Site Permit, but did not appeal the inclusion when the permit decision was made. Solid waste management units located at the commercial LLRW site and subject to the permit include: (1) the Chemical Trench; (2) trenches 1 through 11A, and (3) an underground resin tank. The permit requires the Department of Ecology to make a decision on whether additional corrective action is necessary at these units. In June 2003, a permit modification was made to extend the schedule for the Department of Ecology to make a decision on whether or not additional corrective action will be required at the commercial LLRW site.

2.2.4 Native American Interests

The 1855 treaties between the federal government and the Yakama, Umatilla, and Nez Perce nations ceded hundreds of square miles to the United States, while retaining the core reservation lands for Native Americans. The Hanford Site, along with the commercial LLRW site, lies entirely within this ceded territory. These treaties are active, valid, and upheld by courts and the Constitution of the United States, and may not be amended. These treaties reserve rights that support the continuity and well being of the Native American people and their cultural traditions. Native American cultural traditions must be considered when making decisions about current and future activities at the commercial LLRW site. USDOE land use plans, described in Section 6.2, will affect how and when the Native Americans may use ceded lands within the Hanford Site.

Although Washington State is not party to the Treaties of 1855, it does have a “government-to-government” relationship with the tribes. The Centennial Accord of 1989 (State of Washington 1989) affirms this relationship. The state coordinated and consulted with several tribes in developing the EIS.

2.2.5 Washington State Policy on Importation of Radioactive Waste

The Washington State “policy” on the importing of radioactive waste is based on the equitable distribution and shared responsibility for the burden of low-level radioactive waste disposal. This fundamental policy is founded on the state’s commitment to the protection of public health, and compliance with all laws and regulations.

Washington State supports the Low-Level Radioactive Waste Policy Act of 1980 and the Policy Amendments Act of 1985, described in Section 2.1. As host state to the Northwest Compact and through agreement with the Rocky Mountain Compact, Washington State currently provides LLRW disposal capacity to 11 states. By doing so, Washington State is doing its fair share while at the same time limiting the importation of additional wastes as legally allowed. Some of the past actions that have formed the current informal policy on the importation of radioactive waste include:

- 1980 passage of Citizen Initiative 383, limiting the importation of low-level radioactive waste to only medical waste, and then subsequent repeal of that initiative by the United States Ninth Circuit Court of Appeals for violation of supremacy and commerce clauses
- Host state for the Northwest Interstate Compact
- Acceptance of waste from the Rocky Mountain Compact
- 1996 NARM Settlement Agreement between Washington State and US Ecology to limit NARM disposal based on public health concerns

Each of the above actions has been based on the equitable distribution of the burden of low-level radioactive waste disposal and the consideration of public health and compliance with laws and regulations. Equitable distribution, public health, and compliance with laws are expected to continue to influence future actions regarding the importation of radioactive wastes.

Table 2.B: Regulations and Guidance Values

CITATION OR NAME	DESCRIPTION
10 CFR, Part 61	Federal regulations that establish procedures and classification of waste for the operation and closure of a commercial LLRW site.
State of Washington, Chapter 70.98 RCW, Nuclear Energy and Radiation	Establishes a state program for the regulation of sources of ionizing radiation
Washington Department of Health, Chapter 246-250 WAC, Radioactive Waste – Licensing Land Disposal	Incorporates 10 CFR Part 61. Limits effluents that migrate offsite (groundwater, surface water, air, soil, plants, or animals) to no more than 25/75/25 mrem/year to any member of the public. Requires an approved closure plan that covers each disposal unit as it is filled with waste.
Washington Department of Ecology, Chapter 173-340 WAC, Model Toxics Control Act (MTCA)	Establishes cleanup levels and remedial actions for hazardous substances.
NCRP Report No. 116	Establishes a guideline of 500 mrem/year for members of the public who have infrequent annual exposures and 100 mrem/year for members of the public who have continuous or frequent exposure. Note: The onsite intruder limit of 100 mrem/year is based on this guideline.
Washington Department of Health, Chapter 246-249 WAC, Radioactive Waste – Use of the Commercial LLRW site	Establishes limits and waste disposal requirements including requirements for the disposal of transuranic waste. Establishes a site limit for acceptance of diffuse NARM.

CITATION OR NAME	DESCRIPTION
	The current limit in regulation is 8,600 cubic feet per year. This limit is stayed by a court order that allows 100,000 cubic feet per year with an automatic "rollover provision."
Washington Department of Health, Chapter 246-221 WAC, Radiation Protection Standard	Establishes the following limits: Occupational dose limit of 5,000 mrem/year for adults and 500 mrem/year for minors and pregnant women. 500 mrem/year to public from effluents and external radiation[9] 100 mrem/year to public from all licensed operations[10]
Washington Department of Health, Chapter 246-247 WAC, Radiation Protection – Air Emissions (references National Emissions Standard for Hazardous Air Pollutants 40 CFR Part 61)	Airborne concentrations to general public shall not exceed 10 mrem/year.
State of Washington, Chapter 49.17 RCW, Washington Industrial Safety and Health Act (WISHA)	Establishes safe and reasonable practices for the industrial workplace.
Washington Department of Health, Chapter 480-92 WAC, Low-Level Radioactive Waste	Empowers the Washington Utilities and Transportation Commission to establish the rate and fee structure for the commercial LLRW site.
State of Washington, Radioactive Waste Act, Chapter 43.200 RCW	Restricts low-level radioactive waste disposal at the commercial LLRW site to the Northwest and Rocky Mountain Compacts.
Washington Department of Ecology, Groundwater Quality Standards, Chapter 173-200 WAC	Establishes preventive standards for groundwater quality for the protection of both public health and the environment.
Washington Department of Health, Chapter 246-290 WAC, Public Water Supplies, (Incorporates 40 CFR Part 141 Safe Drinking Water Act)	Establishes point of use standards for the quality of public drinking water supplies including a 4-mrem/year dose.
Washington Department of Ecology, Chapter 173-303-WAC, Dangerous Waste Rules, (implements authorized program under Federal RCRA Requirements)	The state received partial authorization for the base RCRA Program in 1986; one year after the commercial LLRW site no longer received hazardous waste. Regulates closure and corrective actions for releases of non-radioactive hazardous waste and mixed waste, referencing substantive requirements of MTCA regulations.
U.S. Department of Energy, DOE Order 5400.5	Limits the dose to 100 mrem/year to general public for all USDOE operations.
U.S. Department of Transportation, Title 49 Code of Federal Regulations	Regulates the transport of radioactive material.
Washington Department of Ecology, Commercial Low-Level Radioactive Waste Disposal – Site Use Permits, Chapter 173-326 WAC	Institutes user permit system and describes requirements for generators and brokers using the commercial low-level radioactive waste disposal site.
Washington Department of Health, Hanford Guidance for Radiological	Establishes a cleanup guidance level of 15 mrem/year at Hanford for 1,000 years post-cleanup. Discretionary

[9] The US Ecology license requirement is 400 millirem per year.
[10] This requirement does not include the dose from USDOE facilities.

CITATION OR NAME	DESCRIPTION
Cleanup (DOH 1997a)	applicability for sites, including a commercial LLRW site, regulated by a state or federal regulation containing a closure standard specific for radionuclides.
National Historic Preservation Act of 1966 (36 CFR Part 800 Section 106)	The National Historic Preservation Act provides for the preservation of Heritage Resources and the consideration of impacts to these resources.

2.3 Waste

As of January 2003, the commercial LLRW site had received 13.9 million cubic feet of waste out of a total disposal capacity of approximately 35 million cubic feet (Elsen 2003). Table 2.C shows the annual volumes of waste disposed at the commercial LLRW site since 1965. Annual volumes have ranged from a low of 15,000 cubic feet in 1969 to a high of 1,440,000 cubic feet in 1981, when the site was receiving half of the national volume. Waste volumes have generally decreased since the high in the early 1980's. This decrease is attributed to the direct effect of the low-level radioactive waste compact system and voluntary waste reduction programs.

Table 2.C: Historical Volume of Waste Disposed (Cubic Feet)

Year	Total Volume	LLRW	NARM
1965	24,000.00		
1966	85,000.00		
1967	31,000.00		
1968	24,000.00		
1969	15,000.00		
1970	15,000.00		
1971	21,000.00		
1972	23,000.00		
1973	36,000.00		
1974	50,000.00		
1975	53,000.00		
1976	101,000.00		
1977	96,000.00		
1978	263,000.00		
1979	430,000.00		
1980	880,000.00		
1981	1,440,000.00		
1982	1,390,000.00		
1983	1,430,000.00		
1984	1,359,000.00		
1985	1,417,000.00		
1986	665,000.00		
1987	556,000.00		
1988	404,000.00		
1989	408,000.00		

Year	Total Volume	LLRW	NARM
1990	295,000.00		
1991	419,000.00		
*1992	447,699.45	398,089.50	49,609.95
1993	192,108.81	186,734.35	5,374.46
1994	175,729.55	124,713.26	51,016.29
1995	282,401.03	204,981.93	77,419.10
1996	118,004.21	105,166.96	12,837.25
1997	102,671.36	91,084.64	11,586.72
1998	162,434.06	144,824.40	17,609.66
1999	144,092.74	132,397.52	11,695.22
2000	167,909.99	159,037.04	8,872.95
2001	61,442.50	57,627.38	3,815.12
2002	92,579.06	87,886.31	4,692.75
TOTAL	13,877,072	1,692,543.29	254,529.47

*1992 was the first year NARM volumes were recorded separate from LLRW

The commercial LLRW site currently contains 4.2 million curies of radioactivity (Elsen 2003). If the commercial site continues to operate through 2056, it is estimated the site would contain 350,000 curies, adjusted for decay, in year 2066 (Thatcher 2000). There are several hundred different radionuclides and isotopes disposed at the commercial LLRW site (Blacklaw 1998). Records of the complete inventory are available from DOH. Table 2.D shows inventories for selected radionuclides that were disposed at the commercial LLRW site.

Table 2.D: Selected Radionuclide Inventories for the Commercial LLRW Site

Radionuclide	Inventory 1965-2002 (mCi)	Estimated Future Inventory (mCi yr^{-1})	Total 1965-2056 (mCi)	Total 1965-2215 (mCi)
Ac-227	6.01E+00		6.01E+00	6.01E+00
Am-241	4.64E+05	5.59E+01	4.67E+05	4.76E+05
Ba-133	6.68E+03		6.68E+03	6.68E+03
Bi-207	1.17E+03		1.17E+03	1.17E+03
C-14	3.97E+06	2.07E+04	5.09E+06	8.37E+06
Cd-113	2.94E+03		2.94E+03	2.94E+03
Cl-36	3.12E+03	2.05E+00	3.23E+03	3.55E+03
Cm-244	2.08E+05		2.08E+05	2.08E+05
Co-60	1.53E+09		1.53E+09	1.53E+09
Cs-134	1.59E+07		1.59E+07	1.59E+07
Cs-137	1.21E+08		1.21E+08	1.21E+08
Eu-152	2.52E+06		2.52E+06	2.52E+06
Eu-154	2.14E+06		2.14E+06	2.14E+06
Eu-155	4.48E+04		4.48E+04	4.48E+04
Fe-55	2.78E+08		2.78E+08	2.78E+08
H-3	7.99E+08	1.12E+06	8.60E+08	1.04E+09
Hf-182	1.56E+03		1.56E+03	1.56E+03
I-129	5.63E+03	6.35E+00	5.98E+03	6.99E+03

Radionuclide	Inventory 1965-2002 (mCi)	Estimated Future Inventory (mCi yr^{-1})	Total 1965-2056 (mCi)	Total 1965-2215 (mCi)
K-40	4.76E+03		4.76E+03	4.76E+03
Kr-85	5.89E+07		5.89E+07	5.89E+07
Na-22	3.47E+04		3.47E+04	3.47E+04
Nb-94	7.09E+03	5.95E+01	1.03E+04	1.98E+04
Ni-59	1.17E+06	1.94E+04	2.22E+06	5.30E+06
Ni-59 (activated metal)	3.04E+02		3.04E+02	3.04E+02
Ni-63	1.92E+08	3.22E+06	3.66E+08	8.78E+08
Ni-63 (activated metal)	5.40E+06		5.40E+06	5.40E+06
Pa-231	1.31E+00		1.31E+00	1.31E+00
Pb-210	1.92E+04		1.92E+04	1.92E+04
Pm-147	2.94E+08		2.94E+08	2.94E+08
Pu-238	1.06E+07	1.41E+02	1.06E+07	1.06E+07
Pu-239	4.50E+06	1.54E+02	4.51E+06	4.53E+06
Pu-240	1.95E+06	3.67E-03	1.95E+06	1.95E+06
Pu-241	2.48E+07	9.44E+03	2.53E+07	2.68E+07
Pu-242	2.39E+05	1.73E+00	2.39E+05	2.40E+05
Ra-226	2.33E+05	1.67E+03[11]	3.23E+05	5.89E+05
Sb-125	4.17E+06		4.17E+06	4.17E+06
Sm-151	3.19E+03		3.19E+03	3.19E+03
Sr-90	4.44E+07	9.98E+04	4.98E+07	6.57E+07
Tc-99	5.01E+04	9.27E+01	5.51E+04	6.98E+04
Th-230	1.95E+03		1.95E+03	1.95E+03
Th-232	1.16E+04	1.04E+01	1.22E+04	1.38E+04
Th-natural	1.98E+05		1.98E+05	1.98E+05
Tl-204	6.12E+03		6.12E+03	6.12E+03
U-232	1.34E+03		1.34E+03	1.34E+03
U-234	2.79E+05	1.62E+01	2.79E+05	2.82E+05
U-235	3.05E+04	1.77E+00	3.06E+04	3.09E+04
U-238	1.51E+06	8.74E+01	1.51E+06	1.52E+06

Table 2.E shows the status of disposal trenches at the site. Trench 1 began receiving waste in 1965. Trenches were left open until filled, then soil was placed over the trench, and a new trench was excavated to receive waste shipments. A separate trench was set aside to receive chemical waste.

One method of disposing of higher activity waste is to place the waste in a caisson. A caisson is a 24-inch diameter 30-foot vertical steel pipe that is placed on an eight-inch-thick concrete pad. There are two caissons located between trenches 3 and 4, and 28 caissons in Trench 11B. The caissons between trenches 3 and 4 were filled with concrete and capped. The caissons in Trench 11B are still active and are used exclusively to dispose of high activity casks (IF-300) from nuclear power plants.

[11] A value of 1.67 curies was used for the groundwater model. A value of 4.29 curies was used to determine radon emanation. Please see the Radiological Risk Assessment (Appendix II) for an explanation of Ra-226 activity.

Currently there are 19 closed trenches and three open, partially filled trenches. These are 11B, 14, and 18. Three more trenches (trenches 17, 19, and 20) are proposed to receive future waste. DOH estimates that an average of less than 200,000 cubic feet per year of low-level radioactive waste and NARM will be disposed at the commercial LLRW site for the remaining life of the site (Elsen 2003).[12] Based on this estimate, the commercial LLRW site is expected to receive less than 25 million cubic feet of waste by closure in year 2056 (Elsen 2003).

Table 2.E: Status of Disposal Trenches

Trench	Open Date	Close Date
1	09/16/65	09/12/66
2	08/18/66	11/30/71
3	12/01/71	03/31/75
4	04/01/75	08/10/78
4-A	04/30/82	06/18/82
4-B	07/09/84	08/23/85
5	04/29/78	09/05/79
6	08/22/79	06/10/80
7	10/29/82	10/12/83
7-A	06/03/85	07/16/85
8	05/05/80	05/22/81
9	09/09/83	11/30/84
10	05/05/81	12/20/82
11-A	10/29/84	01/21/86
11-B	10/29/84	Open
12-A	08/11/99	09/16/99
13	07/29/85	03/31/95
14	02/02/87	Open
15	Proposed	
16	01/08/92	06/22/99
17	Proposed	
18	11/21/95	Open
19	Proposed	
20	Proposed	
Chemical Trench	12/65	06/70
Reactor Head	04/22/76	04/22/76
Resin Tanks	06/12/72	05/04/87

In addition to the trenches, the site had five steel tanks ranging in size from 1000 to 23,000 gallons. Liquid mixed wastes (low-level plus hazardous) were placed in the tanks for treatment through solar evaporation. The tank farm accepted liquid wastes

[12] Predicted volumes are based on the average volumes from 1992 through 1999.

from 1965 through the 1970's. Beginning in 1985, the tank liquids were solidified and disposed in Trench 11A. The two smaller tanks were removed and the other three tanks were closed in place, using concrete. The tank farm was permanently closed in 1987.

2.3.1 Low-Level Radioactive Waste

On December 27, 1983, Chapter 246-249 WAC was adopted containing the NRC classification system for low-level radioactive waste.[13] There are three classes of low-level radioactive waste: Class A, Class B, and Class C. Class A waste contains the lowest radioactivity (activity) of the waste classes, and Class C contains the highest.

Class A waste primarily consists of discarded protective clothing and biomedical waste. Class A waste makes up over 98% by volume of the classified waste and 2.6 % of activity. Class B waste comprises 0.83% by volume of the classified waste disposed at the site, and 19% of the activity. Class B waste contains a higher proportion of materials with longer half-lives and includes industrial waste and wastes from nuclear power plants such as hardware, filters, and other equipment. Class C waste is only 0.75% by volume but accounts for 78.3% of activity at the site.[14] Class C waste is generated in nuclear power plants, medical research, and industrial activities. "Greater than Class C" waste is any waste that exceeds the concentration limits for Class C. Greater than Class C waste is not allowed to be disposed at the commercial LLRW site. Approximately 30% of all curies at the commercial LLRW site are from unclassified wastes disposed prior to the establishment of the NRC classification system. Figures 2.B and 2.C show the relative amounts of classified versus unclassified LLRW.

[13]Approximately 50% of all waste at the commercial LLRW site was disposed prior to 1984 and is unclassified.
[14]The 78.3% figure includes Class C waste from the Trojan Reactor Vessel.

Figure 2.B: Radioactive Waste Volumes (1965 – 2002)
Footnote Reference **15**&**16**

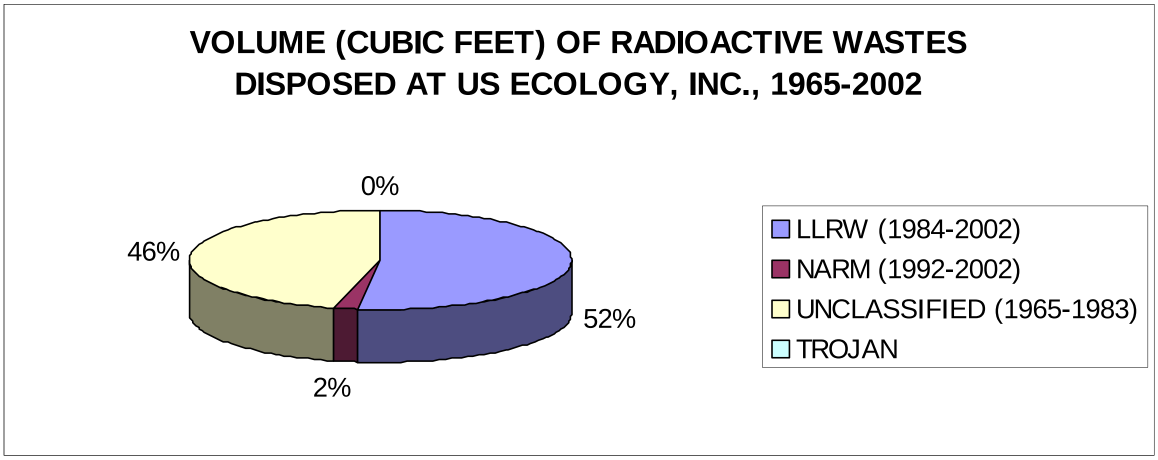
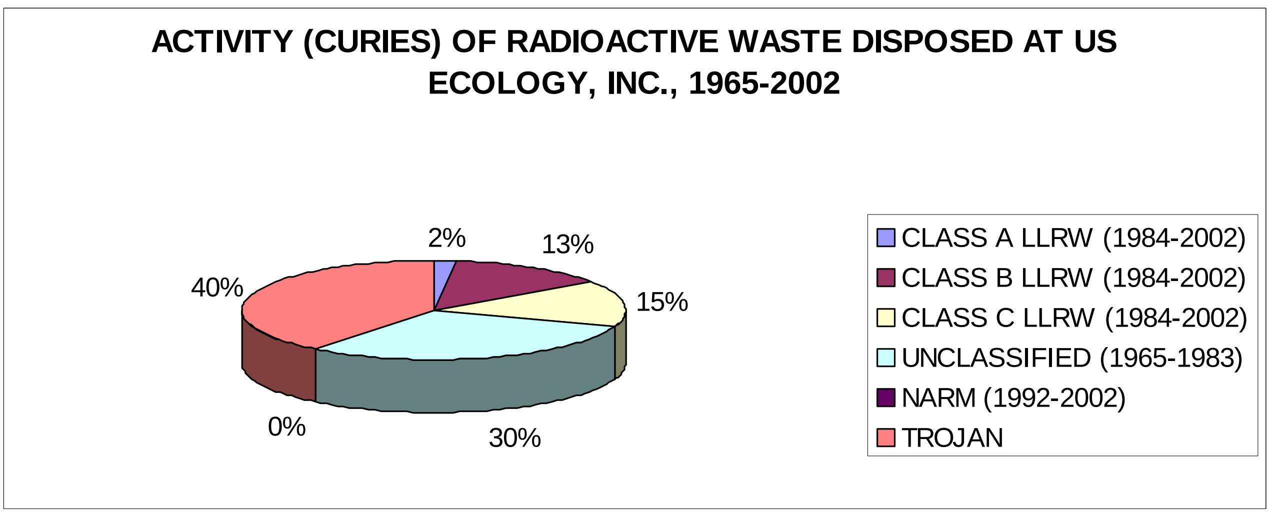


Figure 2.C: Radioactive Waste Activity (1965 – 2002)



2.3.1.1 Transuranic Waste

Radioactive waste containing elements with an atomic number greater than 92 is referred to as Transuranic (TRU) waste. Transuranic elements include plutonium, americium, neptunium, and curium. Material contaminated with transuranic elements is given special consideration due to its long half-lives.

Some TRU waste, as defined by the NRC, is allowed for disposal at the commercial LLRW site. Only TRU waste with less than 100 nanocuries per gram can be disposed

[15]NARM volumes recorded beginning 1992.
[16]Unclassified waste is all radioactive waste disposed before 1984.

at the commercial LLRW site. USDOE defines TRU waste as having greater than 100 nanocuries per gram; such waste is not allowed at the commercial LLRW site.[17]

Wastes containing Special Nuclear Material (SNM) are a unique subset of TRU waste. SNM is capable of releasing large quantities of atomic energy and includes plutonium, uranium 233, and uranium 235. Up until 1997, the disposal of wastes containing SNM in Washington State was licensed and regulated by NRC. In 1997, this license was transferred to the state. The US Ecology license contains strict requirements for the disposal and management of wastes containing SNM.

2.3.1.2 U.S. Department of Energy Waste

There have been several USDOE shipments of low-level waste received at the commercial LLRW site. State records show the commercial LLRW site has received the following USDOE waste:

1994	37.5 cubic feet	Idaho Operations Office
1997	7.5 cubic feet	Oak Ridge field Office
1999	4.7 cubic feet	Bonneville Power
2002	11.6 cubic feet	Bonneville Power

The amended LLRW Policy Act of 1985 states, in part, that the Federal Government is responsible for LLRW owned or generated by the Department of Energy. However, the Act also says there is nothing to prohibit states from accepting USDOE waste. At this time, the state policy for accepting USDOE waste is to accept or deny waste on a case-by-case basis using the following criteria:

- Regional capacity is not compromised
- USDOE meets all license requirements
- USDOE pays the same fees

2.3.1.3 Liquid Waste

Liquid wastes can be characterized as either free liquids or treated liquids (solidified, absorbed, or stabilized). Free liquids have never been allowed for trench disposal at the commercial disposal site. Up until 1999, free liquids were required to be solidified or absorbed before disposal. In February 1999, the license was amended to exclude the use of absorbents and to require all liquids to be solidified. The US Ecology license allows a de minimus amount of incidental liquids associated with otherwise solidified or stabilized waste. The current license restricts incidental free liquids up to a maximum of 0.1% volume of the waste package.

[17]USDOE defines TRU waste as containing alpha emitting radionuclides with a half-life greater than 20 years at concentrations *greater* than 100 nanocuries per gram. TRU waste disposed at the commercial LLRW site must be *less* than 100 nanocuries per gram.

Up until 1985, scintillation fluids containing radioactive and hazardous substances were disposed at the commercial LLRW site. In general, this waste was from radiological research and was disposed in sealed, 20 ml glass vials, surrounded by absorbent within plastic bag-lined containers. An absorbent sufficient to absorb at least twice the amount of any liquids was required for these wastes.

Liquid waste was disposed in the resin tanks at the commercial LLRW site. Five steel tanks ranging in size from 1,000 to 23,000 gallons received mixed low-level waste from laundering activities and ion exchange resins from Navy nuclear power plants for solar evaporation in the early 1970's (JLC 1985). In addition to LLRW, the resins contained organics and Co-60, Cs-137, H-3, and C-14. In the fall of 1985, the liquids and resins were extracted from the tanks into 2,000 55-gallon drums. The liquids were solidified and disposed in Trench 11A. The remaining tank bottoms were sampled and characterized as extremely hazardous wastes. Two of the tanks were removed and disposed. The remaining three tanks were left in place and filled with concrete.

2.3.1.4 Trojan Reactor

The Portland General Electric Trojan Reactor Vessel (TRV) was disposed at the commercial LLRW site on August 9, 1999. It has 5 to 8-inch carbon steel walls and is completely sealed. The TRV has a volume of 8,490 cubic feet and an associated activity of 1.54 million curies. The majority of the activity is expected to decay in a short period. Co-60, Fe-55, and Mn-54 make up 92% of all radionuclides in the reactor vessel. These radionuclides have half-lives from 1.5 to 5 years and will be fully decayed in 50 years or less. In 100 years, the total reactor vessel activity will be less than 4% of the original activity.

The TRV was disposed of intact with its internal components encased in cement grout. The components were classified as Class C waste, pursuant to the NRC's radionuclide concentration averaging guidelines (Fordham 1998).

2.3.2 NARM Waste

The commercial LLRW site accepts NARM waste from throughout the country, and in one case, has accepted NARM from a foreign country. NARM wastes are not regulated by any federal agency. NARM is not subject to the Low-Level Radioactive Waste Policy Amendments Act and therefore disposal is not restricted to states in the Northwest and Rocky Mountain Compacts.

NARM is defined as either diffuse or discrete. *Diffuse* NARM includes wastes such as pipe scale from routine maintenance on oil and gas pipelines, soils from the cleanup of mineral processing sites, and laboratory trash from the production of accelerator produced pharmaceuticals. Almost all *discrete* NARM comes from measuring devices, gauges, and radium needles used in medical procedures. Both types of NARM are disposed at the commercial LLRW site.

Until 1992, NARM volumes were recorded as low-level radioactive waste. Beginning in 1992, NARM volumes were recorded separately from low-level radioactive waste. Based on the past ten years of records, annual NARM volumes have ranged from a high of 77,000 cubic feet to a low of 3,815 cubic feet (see Table 2.C). Overall, NARM has averaged less than 30,000 cubic feet per year. NARM accounts for 2% of the total volume and less than 0.01% of the activity (approximately 253 curies) disposed at the site (Elsen 2003).

2.3.2.1 Foreign NARM Waste

The commercial disposal site has received one shipment of foreign waste. In August 2000, the commercial LLRW site received 120 55-gallon drums of discrete NARM waste from Spain. The waste contained 17.27 curies of radium and consisted of lightning rod heads, therapy needles and tubes, smoke detectors, and sealed sources. This waste was transported by air to Moses Lake and then by truck to the site.

This shipment is the only waste disposed at the commercial LLRW site that has been generated in a foreign country. However, the commercial LLRW site has received U.S. waste, such as military waste, generated on U.S. bases in foreign countries.

The state of Washington would prefer that foreign countries manage their own waste, but there are constitutional restrictions under the federal commerce clause that limit the federal and state government from banning the importation of NARM (Department of Ecology 2000a). However, future foreign NARM shipments are unlikely to occur because US Ecology has voluntarily agreed to not accept or solicit any other NARM shipments from foreign sources (US Ecology 2000).

2.3.3 High-Level Radioactive Waste

The commercial LLRW site has never been licensed to receive high-level radioactive waste. However, in the 1970’s, during the time the commercial site was under NRC authority, and before the federal government distinguished between high and low-level waste, approximately 13,800 curies of irradiated fuel segments and other spent fuel waste were disposed at the commercial LLRW site (DOH 2003a). Today, this waste would be classified as high-level waste. The 13,800 curies comprise less than 1% of the total 4.2 million curies disposed at the site.

In January 2003, the NRC issued a Draft Safety Evaluation Report for a Connecticut nuclear power plant named Millstone Unit 1 (NRC 2003). Millstone Unit 1 had reported that the location of two-high level fuel rods could not be determined. The safety analysis stated that the most likely disposal scenario was for the rods to have been inadvertently shipped to the commercial LLRW disposal site in Barnwell, South Carolina, in 1988. However, the safety analysis also concluded that there was a small chance that the rods may have unintentionally been buried at the commercial LLRW site in Washington.

The safety analysis concluded that if the two fuel rods were disposed at the Richland commercial LLRW site, it would not constitute a present or future risk to the public health and safety, nor to the environment. This conclusion was also supported by the USEPA (EPA 2003). Assuming the fuel rods were shipped to Richland, the waste type would have been misidentified on the manifest, but it is likely the activity would have been taken into account. This means the activity for that waste shipment has been included in the Radiological Risk Assessment (Appendix II) that was done for the Final EIS (Thatcher 2003a). The results of the Radiological Risk Assessment are discussed in Section 4.4, Post-Closure Radiological Dose.

2.3.4 Non-Radioactive Hazardous Waste

An estimated 17,000 cubic feet of unauthorized non-radioactive hazardous wastes were disposed at the commercial LLRW site between November 1965 and June 1970. These wastes were disposed in the Chemical Trench located in the north-central portion of the site. The Chemical Trench was approximately 80% full when it was closed.

Documented sources of waste in the Chemical Trench include nine drums of beryllium/copper solid metal shavings, 56 drums of unknown waste, and several thousand drums of phenolic waste.

Up until October 28, 1985, the license had authorized small amounts of hazardous waste in scintillation fluids to be disposed in trenches 1 through 10, 11A, and 13 (JLC 1985). This waste was a component of radioactive waste (mixed waste) and was from research labs, hospitals, and power plants. The chemicals in the scintillation fluids included toluene, benzene, and xylene. Disposal of these wastes ended in 1985.

2.4 Environmental Monitoring

Environmental monitoring at the commercial LLRW site addresses radioactive and non-radioactive substances in various media. Environmental monitoring data are not reported in this section. Environmental monitoring data are discussed in the various sections on public heath and the environment within chapters 4.0 and 5.0.

2.4.1 Radionuclides

Environmental monitoring for radionuclides has been ongoing at the commercial LLRW site for over 30 years. Beginning in 1965, soil, groundwater, and vegetation monitoring have been performed periodically. Air quality monitoring began in 1978. Ambient air and other experimental monitoring began in the mid-1980s. In 1987, an annual environmental monitoring program was initiated. The locations of groundwater monitoring wells are shown on Figure 2.D.

Figure 2.D Commercial LLRW Disposal Site

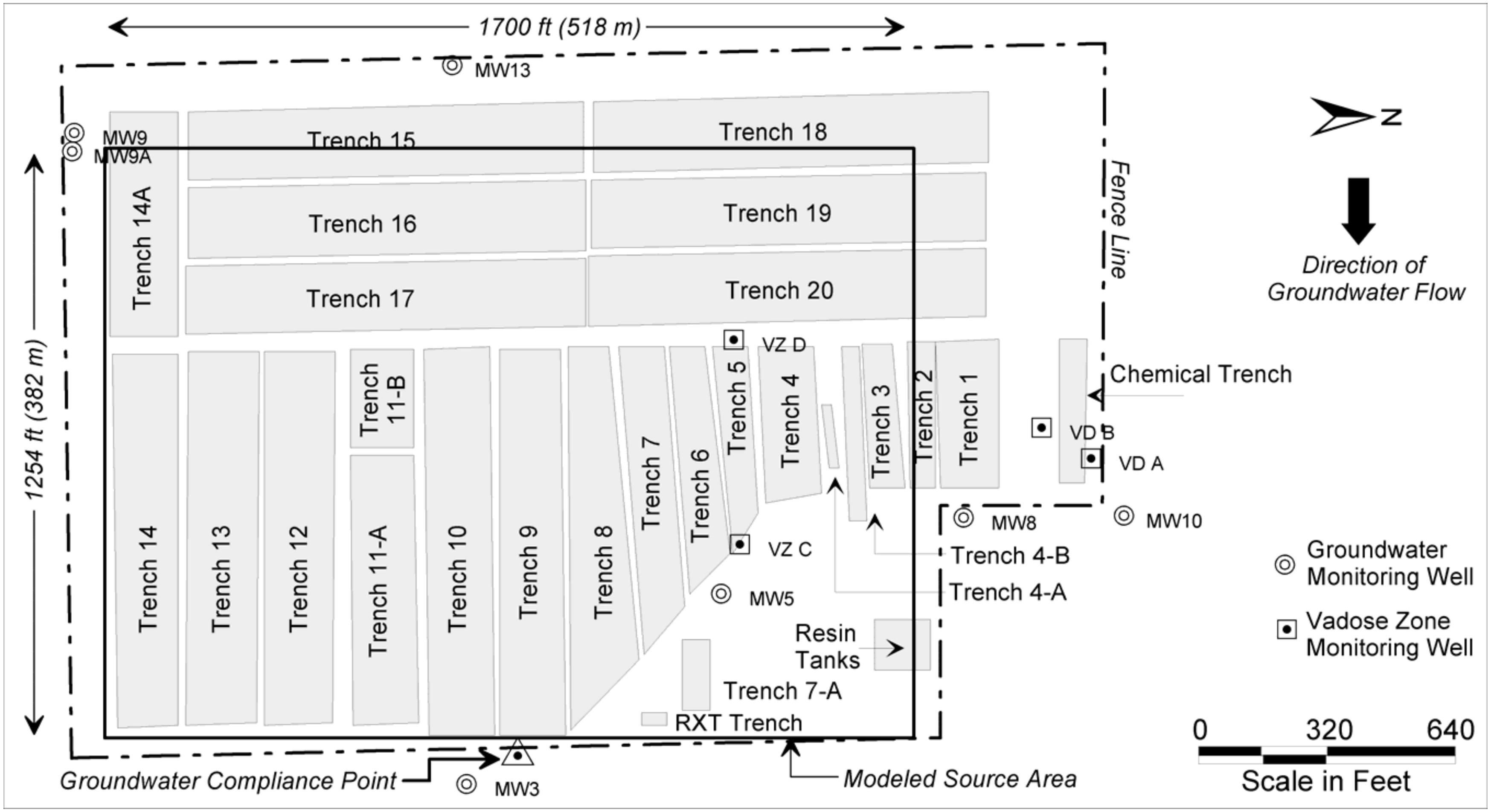


Table 2.F lists the components of the current annual environmental monitoring program. US Ecology runs the program and publishes an annual report. In conjunction with the annual environmental monitoring, DOH takes periodic confirmational groundwater and vegetation samples at the commercial LLRW site.

Table 2.F: Annual Environmental Monitoring Program

Media Sampled	Sample Sites	Sample Frequency	Constituents Sampled
Soil	9 stations, plus the NE and NW corners	Quarterly	Gross beta, total uranium, isotopic plutonium, Co-60, Cs-137, and gamma spectroscopy
Vadose Zone	3 vadose zone wells	Quarterly at depths of 35 ft.	Toluene, xylene, methane and combustible gases, Ra-222, and H-3
Groundwater	7 wells – 3 wells upgradient and 4 wells downgradient	Quarterly	Gross alpha, gross beta, H-3, C-14, Pu-238, Pu-239/240, Co-60, Cs-137, total uranium, gamma emitters, total dissolved solids, total organic carbon, nitrates, temperature, and specific conductance
Air Quality	9 stations	Continuous, weekly, and monthly	Gross beta, gross alpha, I-125, H-3, Co-60, and Cs-137
Ambient Air	Perimeter of site and fence-line near active trenches	Monthly, quarterly	Penetrating radiation
Vegetation	9 stations, NE and NW corner, and trench covers	Annually	Gross beta activity, total uranium, isotopic plutonium (Pu-238 and Pu-239/240), Co-60, Cs-137, H-3, and gamma spectroscopy

In addition to the regular scheduled environmental monitoring and DOH confirmational monitoring, several short-term investigations have been completed. These include the Phase I and Phase II US Ecology Site Investigation (US Ecology 1998b). This investigation was important for radionuclides because it was the first time the vadose zone soils were sampled under the trenches.

2.4.2 Non-Radioactive Hazardous Substances

Whereas the collection of radionuclide data at the site has been ongoing, monitoring for non-radioactive hazardous substances has been limited in scope. Non-radioactive data at the commercial LLRW site are primarily from Phase I and Phase II of the US Ecology Site Investigation.

The US Ecology Site Investigation included eight vadose zone borings with two locations under the Chemical Trench and two locations under Trench 5. Each location consisted of two borings, one for soil samples and the other for soil gas monitoring. Trench 5 was selected because its disposal history included high volumes of H-3 containing waste and volatile organic compounds such as toluene, xylene, and benzene. The Chemical Trench was included in the investigation because its disposal history indicates it may contain unique hazardous contaminants when compared with the other trenches.

In addition to the borings described above, two rounds of groundwater samples were collected from six existing onsite wells and one offsite well. The two sampling events occurred between September and December 1998. Table 2.G describes the scope of the 1998 US Ecology Investigation.

Table 2.G: US Ecology 1998 Site Investigation Summary

Media	Sample Sites and Locations	Sample Method	Constituents Sampled
Vadose Zone	Boring A1 – north boundary Chemical Trench Boring B1 – south boundary Chemical Trench Boring C1 – east boundary Trench 5 Boring D1 – west boundary Trench 5	30-degree drilling angle; 10 ft. from bottom corner of trench to 70 ft. below bottom of trench	Volatile organic compounds; semi-volatile organic compounds, metals, anions, cyanide, nitrate/nitrite, sulfide, organic content, gross gamma, isotopic plutonium, thorium, uranium, C-60, Ni-63, Sr-90, Tc-99, Ra-226 and 228, and Am-241
Vadose Zone Gas	8 well installations; 4 in soil boring wells, 4 ~ 10 ft. from geophysical wells	30-degree drilling angle; 10 ft. from bottom corner of trench to 25 and 45 ft. below bottom of trench	Volatile organic compounds, semi-volatile organic compounds, methane, and gross alpha/beta activity
Groundwater	6 onsite wells, 1 offsite well	1 W Trench 15, 2 S Trench 14A, 1 E Trench 6, 1 E Trench 1, 1 NE Chemical Trench, 1 E Trench 10; mean depth of wells 358 ft. below grade	Temperature, pH, conductivity, anions, total dissolved solids, nitrate, nitrite, sulfide, total organic content, volatile organic compounds, semi-volatile organic compounds, total metals, hexavalent chromium, total organic halides, cyanide, phenols, gross alpha/beta activity, isotopic plutonium, uranium, H-3, C-14, I-129, and Tc-99

2.4.2.1 MTCA Remedial Investigation and Feasibility Study

As a follow-up to the Phase 1 and Phase 2 US Ecology Site Investigation, the Department of Ecology is planning a MTCA remedial investigation and feasibility study investigation in 2004. In January 2001, Ecology conducted a site hazard assessment of the commercial LLRW site according to Chapter 173-340-320 WAC. The site's hazard ranking, an estimation of the potential threat to human health and the environment relative to all other Washington State sites, was determined to be a "5," where "1" represents the highest relative risk, and "5" the lowest (Department of Ecology 2001). The site was listed on the state Hazardous Sites List in February 2001.

The 2004 MTCA investigation will be conducted to further characterize non-radioactive hazardous contaminants at the site and to determine appropriate remedial actions. A Data Quality Objective Process involving stakeholders was used to help define the scope of the MTCA investigation (EQM 2003).

3.0 DESCRIPTION OF PROPOSED ACTIONS AND ALTERNATIVES

There are three proposed actions affecting the commercial LLRW site. The proposed actions are:

1. **License** – Approve or deny the US Ecology Washington State radioactive materials license application for continued operation of the commercial LLRW site.

2. **Diffuse NARM** – Select an annual limit for disposal of diffuse NARM at the commercial LLRW site.

3. **Site Closure** – Approve a cover design and a cover schedule for closing the commercial LLRW site.

SEPA requires that reasonable alternative actions be evaluated for each proposed action.

3.1 License Alternatives

There are three License Alternatives evaluated in the EIS:

License Alternatives
No Action Alternative: Current license remains in timely renewal
Alternative 1: Renew US Ecology license with additional operating requirements
Alternative 2: Deny license application

3.1.1 No Action Alternative – Timely Renewal

This action is referred to as the "Timely Renewal Alternative." This alternative would require DOH to take no final action on the license application. This means the current license remains in "timely renewal" and is in full effect until DOH takes action on the renewal application. The term "timely renewal" is defined in WAC 246-235-010(2). The rule states that an existing license, if filed in proper form, will not expire until a final determination has been made concerning the application. There is no time limit on how long a license may remain in timely renewal. DOH will make no significant revisions to the current license while it is in timely renewal.

3.1.2 Renew License

This alternative is referred to as the “Renew License Alternative.” This alternative would relicense the site for another five-year period and would impose additional requirements for site operation. This alternative was evaluated for both the five-year relicensing period, 2004 through 2009, and for operations through 2056.

Additional license requirements included in this alternative are listed in Table 3.A. The requirements are designed to enhance waste isolation, worker safety, and protection of public health (DOH 1998a).

3.1.3 Deny License

Under this alternative, DOH would deny the license, the site would cease accepting waste in 2004, and closure would begin in 2005. Denying the application for renewal means the state must either find a new operator, or close the site. At this time, the state believes that denying the license would most likely result in closing the site. It is reasonable to expect that the state of Washington and the Northwest Compact would attempt to identify alternate disposal options prior to the closure of the Richland site.

Closing the site means that generators in Washington, Oregon, Alaska, Hawaii, Idaho, Montana, Utah, Wyoming, Nevada, Colorado, and New Mexico would no longer be able to dispose of LLRW in Washington. Generators of Class B and Class C waste currently have no other disposal options. Generators of Class A waste could dispose all or some of their waste at the Envirocare facility in Clive, Utah.

Table 3.A: Requirements for Renew License Alternative

New Practice	Current Practice	Objective	Benefits
Dispose stable and unstable waste in separate trenches, beginning with Trench 12	Class A segregated from Class B and C; Class A Unstable must be 10 ft away from stable waste	Reduce future waste sub-sidence due to unstable waste	Greater waste isolation and stabilization
Include Class A Unstable in the <15% void requirement	Class A Stable, B, and C must have <15% by volume; Class A Unstable must be reduced to extent practicable	Reduce specific void space in Class A waste	Increased waste stability
Dispose both Class B and C waste at least five meters below cover surface grade	Class A and Class B waste must be a minimum of eight feet below grade; Class C waste must be disposed five meters below cover surface grade	Increase depth of Class B waste	Increased waste isolation and reduced surface radiation
Limit the use of NRC and USDOT provisions for “delisting”. Radionuclides greater than 0.1 millicuries will need to be listed	Current NRC and USDOT provisions allow some radionuclides to not be listed on the manifest	Require more radionuclides listed on manifest	Increased worker safety; increased source term accuracy

New Practice	Current Practice	Objective	Benefits
Improve procedures for data entry, and QA of data by licensee and DOH	Limited capability at commercial LLRW disposal site	Improve electronic record retention at site	Improved waste tracking
Randomly placed packages must be backfilled within one day of disposal	Unburied depth not to exceed six feet or within one business day of waste emplacement	Backfill trenches more often to increase trench stability	Greater waste isolation
Review and improve the environmental monitoring program as needed	Onsite monitoring of air, soil, vegetation, ground water, and vadose zone	Increase environmental monitoring	Increased environmental protection through early detection
Require chelated waste to be solidified and placed in Engineered Concrete Barriers (ECB)	HICs may be used to stabilize Class A, B, and C waste and ion exchange media; ECBs required for chelated waste	Enhance packaging for chelated wastes	Greater worker protection and waste isolation
Track location of Class B and C waste, ECBs, oils, and chelates with Geographical Positioning System (GPS) or improved surveying. Class A waste to be tracked within 50 feet horizontally and 10 feet vertically	Location of Class B and C waste, ECBs, oils, and chelates must be identified within 50 feet horizontally and 10 feet in vertical plane	Improve methods to track waste location	Improved waste tracking and monitoring
Investigate the feasibility of using gamma spectroscopy to identify radionuclides and verify waste activity	Visual periodic and for-cause inspections	Increase waste characterization	Increased worker safety, increased knowledge of sources term
Investigate methods to enhance stormwater system where appropriate	Berms around trenches to divert surface runoff	Improve stormwater management	Greater waste isolation and groundwater protection
Investigate the use of soil fixative, vegetative cover, and other mitigation methods for dust control	Dispersal of excavated materials by wind erosion limited to allowable dose limits listed in license	Improve dust control	Reduction of fugitive dust
Include specific limits in license for Ra-226, H-3, I-129, C-14, Tc-99, U-238, U-234, and Pu-239	No specific limits included	Minimize future dose	Less post-closure dose to public and inadvertent intruder
Secondary containment for all Class B and C waste and for LLRW containing H-3, I-129, C-14, Tc-99, U-238, U-234, and Pu-239	Primary containment for all waste; secondary containment for most for Class B and Class C	Increase waste isolation and structural integrity of burial trenches	Greater waste isolation during operations, and greater post-closure intruder protection
All discrete NARM must be placed in ECB’s and a minimum of 23 feet below grade	Discrete radium buried at various depths	Minimize radon emanation from trenches	Reduce dose to onsite intruder
Increased point-of-origin Inspections.	Inspection required only for suspended generators	Expand inspections to other generators	Increased generator compliance

3.2 Diffuse NARM Alternatives

There are five alternatives for diffuse NARM.

Diffuse NARM Alternatives
No Action Alternative: 100,000 cubic feet per year limit with automatic rollover
Alternative 1: Adopt 100,000 cubic feet per year limit – case-by-case rollover
Alternative 2: Adopt 36,700 cubic feet per year limit – case-by-case rollover
Alternative 3: Adopt 8,600 cubic feet per year limit – no rollover
Alternative 4: Adopt zero cubic feet per year limit

3.2.1 Diffuse NARM No Action Alternative

The No Action Alternative would require DOH to take no action on amending WAC 246-249-080, and instead retains the court-ordered diffuse NARM site limit of 100,000 cubic feet per year plus automatic rollover. This alternative is in conflict with the current settlement agreement that directs DOH to begin rulemaking for adopting a diffuse NARM site limit.

3.2.2 Diffuse NARM – 100,000 cubic feet per year; case-by-case rollover

DOH would amend Chapter 246-249 WAC and adopt the court-ordered site limit of 100,000 cubic feet per year for diffuse NARM. This alternative differs from the No Action Alternative by requiring rule adoption and allowing rollover only a case-by-case basis. Rollover refers to the volume of diffuse NARM that was not disposed in a given year. For example, if 10,000 cubic feet of diffuse NARM were disposed in a given year, the rollover amount for that year would be 90,000 for this alternative.

Under this alternative and all alternatives including rollover, US Ecology could request DOH to allow a specific volume of diffuse NARM, not to exceed the cumulative rollover for the previous years. The request would include an analysis of impacts from transporting and disposing of the diffuse NARM. DOH could approve, modify, or deny the request based on public health impacts.

The current limit of 100,000 cubic foot site limit is above present annual disposal rates. In 2002, the site received less than 4700 cubic feet of diffuse NARM – approximately five truckloads. If fully realized, the proposed limit of 100,000 cubic feet per year of diffuse NARM could potentially result in 120 truckloads of diffuse NARM per year.

3.2.3 Diffuse NARM – 8,600 cubic feet per year; no rollover

DOH would petition the court to remove the court-ordered stay on Chapter 246-249 WAC, thus reinstating the 8,600 cubic feet per year site limit and the 1,000 cubic feet per year individual generator limit. Reinstating the previous regulatory limit would significantly reduce the *allowable* volume of diffuse NARM for disposal. In practice, this alternative would not reduce *actual* disposed volumes if current levels of diffuse NARM continue. This alternative contains no rollover provision.

3.2.4 Diffuse NARM – 36,700 cubic feet per year; case-by-case rollover

DOH would amend WAC 246-249-080 to adopt a diffuse NARM limit of 36,700 cubic feet per year with case-by-case rollover. This limit is tied to past disposal rates based on the five-year period of 1992-1996.[18]

3.2.5 Diffuse NARM – Zero cubic feet per year

DOH would amend WAC 246-249-080 to adopt a diffuse NARM limit of zero cubic feet per year. This alternative would ban disposal of diffuse NARM from all sources, including Washington State.

3.3 Site Closure

There are two proposed actions for site closure: cover design and the cover schedule. The state is evaluating these two components of closure in the EIS because of the potential impact of the cover design and schedule on public health and the environment. Other components needed to close the site include institutional controls, environmental monitoring, potential further remedial actions resulting from the 2004 MTCA investigation, and perpetual care and maintenance. These were not evaluated as part of the EIS because they were assumed to be similar for all the alternatives.

The primary closure objective is long-term waste isolation. The *relative* comparisons of the cover design and schedule alternatives for the following five factors help predict how well each alternative performs in terms of waste isolation:

1. Cover depth
2. Control of water infiltration
3. Control of radon
4. Offsite and onsite dose
5. Long-term reliability

[18] Annual disposal rates for diffuse NARM have averaged less than 36,700 cubic feet per year in recent years.

3.3.1 Cover Design Alternatives

There are four cover design alternatives.

Cover Design Alternatives
Cover Design No Action: Site Soils Cover
Cover Design Alternative 1: US Ecology Cover
Cover Design Alternative 2: Homogenous Cover
Cover Design Alternative 3: Enhanced Cover ▪ Asphalt Cover ▪ GeoSynthetic Cover ▪ Bentonite Cover

The state did not intend the cover designs to be prescriptive in design, but rather to be representative of various performance levels.[19] Performance is defined by how well the closure objective of long-term waste isolation is met.

The key differences between the cover design alternatives are the type and amount of gravel in the surface layers, the percent and volume of silt loam soil in the top five feet, and the presence and/or characteristics of a low-permeability barrier. Gravel is included in the surface layer to minimize erosion. Silt loam soil is included to encourage plant growth and reduce infiltration. Low-permeability barriers are included in several of the cover designs to reduce radon gas emanation and provide a second level of protection against infiltration of water into the waste.

3.3.1.1 Source of Cover Materials

Most of the cover design alternatives will require large amounts of site soils, gravels, and silt loam soils for construction. The required site soils will be excavated onsite. Although a majority of the site soils will be excavated in disturbed areas adjacent to the trenches, a portion of the site soils will likely be excavated from the 15 undisturbed acres in the northwest corner of the site.

The silt loam and gravels needed for the cover designs are not available onsite. The preferred method for obtaining the silt loam and gravels will be to procure the material from an established offsite vendor and have those materials transported onsite. If a vendor is not available at the time of construction, a borrow site will most likely be developed at an offsite location for these materials. If it is necessary to develop a borrow site, a separate EIS will be completed at that time.

[19] The prescriptive nature of the conceptual covers was necessary for modeling their performance.

3.3.1.2 No Action Alternative – Site Soils Cover
Figure 3.A

The No Action Alternative means that DOH would take no action on approving a final cover design for the commercial LLRW site. The absence of an approved cover design means a final closure plan cannot be completed. Without an approved closure plan, the current practice of covering filled trenches with 8 to 11 feet of site soils would continue. Site soils are primarily sandy loams and have a high sand content, low organic matter, and low water holding capacity. This alternative does not meet the requirements needed for an approved closure plan under Chapter 246-250 WAC. Inevitably, the license application could not be renewed under this alternative.

3.3.1.3 US Ecology Cover
Figure 3.B

This alternative is the cover design proposed in the 1996 Closure Plan submitted by US Ecology. The US Ecology Proposed Cover is a multi-layer engineered cover that is 16 feet, 4 inches thick. The key characteristics of the cover are a 4-inch surface layer with 50% gravel, a 36-inch silt loam layer, and a 12-inch bentonite clay (12%) low-permeability barrier. The US Ecology Proposed Cover was designed in coordination with DOH and the Department of Ecology. This cover was evaluated previously by DOH (DOH 1999).[20]

3.3.1.4 Homogenous Cover
Figure 3.C

The Homogenous Cover is 16 feet, 6 inches thick and has a near-surface 60-inch thick silt loam layer over a second layer of site soils. Differences between the Homogenous Cover and the US Ecology Cover include a thicker silt loam layer (60 inches versus 36 inches), and a higher percentage of silt in the silt loam layer (85% versus 75%). This cover is the only cover other than the Site Soils Cover that does not include a low-permeability barrier. This cover design is similar to the design selected by US Ecology to close the Beatty, Nevada commercial LLRW site (US Ecology 1989).

3.3.1.5 Enhanced Covers
Figures 3.D, 3.E, 3.F

The Enhanced Cover Alternative is comprised of three different designs. All include a 60-inch silt loam layer and a low permeability barrier. The covers differ by the type of low permeability barrier. The three design variations are:

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[20] The previous evaluation of the US Ecology Proposed Cover was done to satisfy NRC requirements.

- **Asphalt Cover** – contains a 12-inch asphalt barrier
- **GeoSynthetic Cover** – contains a geotextile clay layer
- **Bentonite Cover** – contains a 12-inch bentonite barrier

3.3.2 Cover Schedule Alternatives

"Cover schedule" refers to the schedule for constructing the final cover. There are four schedule alternatives evaluated in the EIS.

Cover Schedule Alternatives
No Action Cover: No Early Construction
Cover Schedule Alternative 1: US Ecology Schedule
Cover Schedule Alternative 2: Prototype Schedule
Cover Schedule Alternative 3: Close-As-You-Go Schedule

The lease between the state and USDOE for the land the commercial LLRW site occupies expires on September 9, 2063. At that time or before, the site will be permanently closed. DOH has proposed the year 2056 as the latest possible year for disposal operations to cease and final closure to begin. The schedule alternatives range from constructing the cover entirely at time of final closure, to constructing the final cover in phases.

3.3.2.1 Cover Schedule No Action Alternative

The No Action Schedule means the state would take no action to construct a cover *before* final closure. With this schedule, final cover construction would begin when operations cease in 2056 or earlier. This alternative provides little waste isolation during the period of operations because the filled trenches are covered only with the permeable site soils. This alternative subjects the waste to higher infiltration rates for the entire operating period, resulting in higher groundwater concentrations and higher future hypothetical dose rates.

3.3.2.2 US Ecology Schedule

This alternative is included in the US Ecology Closure Plan and was developed in coordination with DOH and the Department of Ecology. The US Ecology Schedule will permanently close trenches 1-7 and the Chemical Trench upon completion of the EIS. The remainder of the trenches will be closed when the site is permanently closed in 2056 or earlier. Trenches 1-7 and the Chemical Trench were selected for immediate closure because they are the oldest trenches and have the most potential to release radionuclides and non-radioactive chemicals. The US Ecology Schedule is designed to provide early waste isolation for the oldest trenches, including those trenches that received non-radioactive hazardous waste.

3.3.2.3 Prototype Schedule

The Prototype Schedule will permanently close two trenches (to be selected) upon completion of the EIS. The remainder of the cover would be constructed upon final closure, in 2056 or earlier. Although this alternative provides only minimal early waste isolation, it allows the state to study the performance and reliability of a specific cover design before committing to that design for the entire site.

3.3.2.4 Close-As-You-Go Schedule

The Close-As-You-Go Schedule permanently closes the site in three phases. This schedule works best with the US Ecology Proposed Cover or one of the Enhanced Covers. The state is committed to starting the first construction phase no later than 2005. During the first phase, a low permeability cover will be constructed over all existing waste (40 acres). The state's intent is to construct the bottom layers of the selected cover design, up to and including the impermeable barrier.

The second phase, scheduled to begin in 2008, will follow the completion of the 2004 MTCA investigation. The second phase completes the final cover over the first 40 acres by constructing the upper layers of the selected cover design over the low-permeability cover constructed during the first phase. The second phase is delayed until after the MTCA investigation so that results from the MTCA investigation can be used to modify the cover design, if necessary. For example, the "presumptive remedy" at landfills, such as the commercial LLRW site, is to cover the waste in-place. However, the MTCA investigation may determine that the cover design requires modification; e.g., venting of volatile gases. In addition to cover modification, the MTCA investigation may conclude that additional remedial actions; e.g., pump and treat of groundwater, may also be required. Necessary modifications during second phase construction will not require the first phase of the cover to be removed. The third phase of cover construction is ongoing and constructs the final cover in planned phases as new waste is disposed.

3.4 Alternatives Not Considered

Other alternatives were considered but not included in the EIS. Reasons for not including other alternatives were based on an initial assessment of reasonableness, environmental impacts, and the defined scope of the EIS.

3.4.1 License

License alternatives using above ground disposal were considered, but not included in the EIS. An above ground vault has the benefit of waste retrieval at some future date, but it also has the requirement of long-term care and maintenance for the life of the radionuclides. Active long-term maintenance was in conflict with current state objectives to close the site such that active maintenance is not required after 100 years.

A license alternative that limited disposal of LLRW to only those wastes generated in Washington and Oregon was not included in the EIS due to constitutional restrictions under the federal commerce clause. The Federal compact system only allows exclusion of LLRW to those wastes generated outside the Northwest Compact States.

A change in the site operator was not included as a license alternative because it is an administrative decision that could apply to any of the license alternatives. Negotiation of the sublease and selection of an operator is a process separate from actions evaluated in the EIS. Decisions on the sublease between the state and US Ecology will be made by the Department of Ecology before the expiration date in July 2005. At that time, the department will consider all pertinent factors, including experience, compliance record, safety records, and the financial strength of the company.

A license alternative that fills the commercial LLRW site to capacity was not included in the Final EIS. The “Filled Site” Alternative was included in the Draft EIS; but based on the restrictions of the Northwest Compact, the lease with USDOE, and current waste volumes, it was determined that this alternative was not viable, so it was deleted from the Final EIS. Filling the site to capacity was evaluated in the Radiological Risk Assessment to provide an upper bound for the analysis.

3.4.2 Diffuse NARM

Diffuse NARM alternatives greater than 100,000 cubic feet per year were considered, but not included in the EIS. Past trends indicate that future NARM volumes received at the disposal site will be significantly less than 100,000 cubic feet per year. Based on past and predicted volumes, DOH determined that a diffuse NARM alternative exceeding 100,000 cubic feet per year was not reasonable.

A diffuse NARM alternative allowing only disposal of Washington NARM or Washington and Oregon NARM was not considered due to constitutional restrictions under the federal commerce clause that limit the ability of the state to accept disposal of waste from one state and not another.

3.4.3 Site Closure

Closure alternatives other than constructing a cover over the waste were not included in the EIS. The Department of Ecology may determine additional remedial actions are needed under MTCA or RCRA Corrective Action. If additional remedial actions are needed, those actions will be incorporated into the closure plan at that time.

Figure 3.A: No Action Alternative – Site Soils Cover

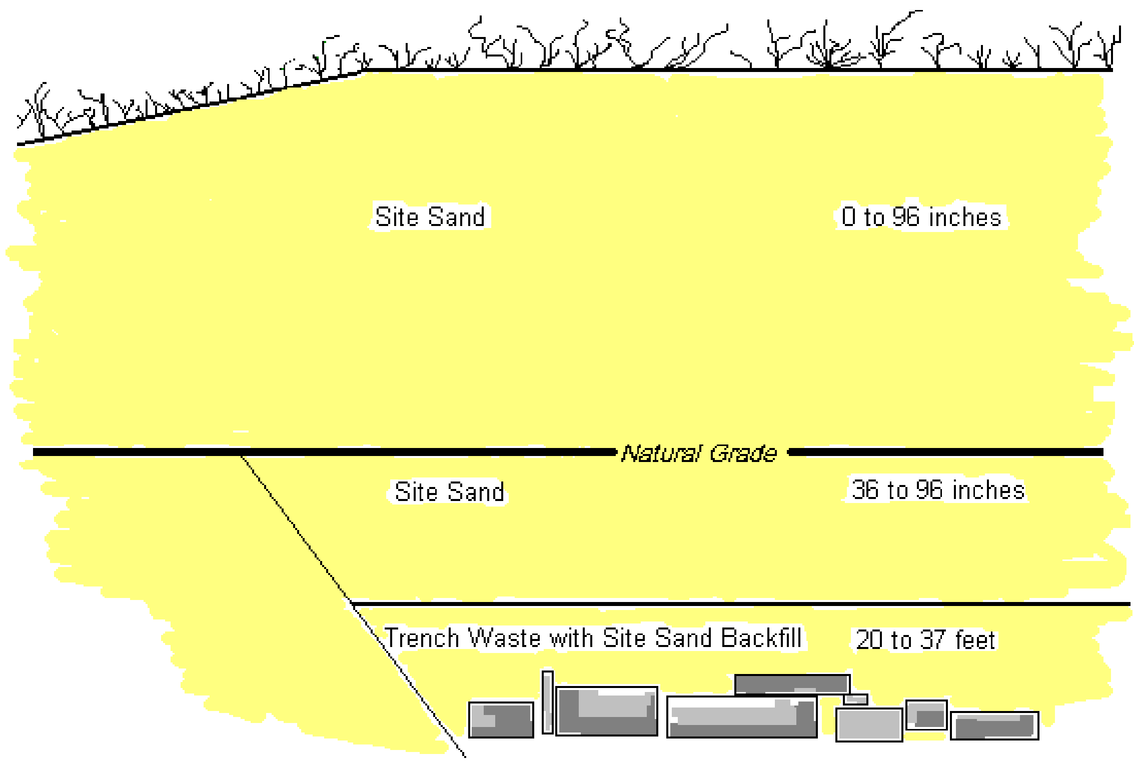


Figure 3.B: US Ecology Cover

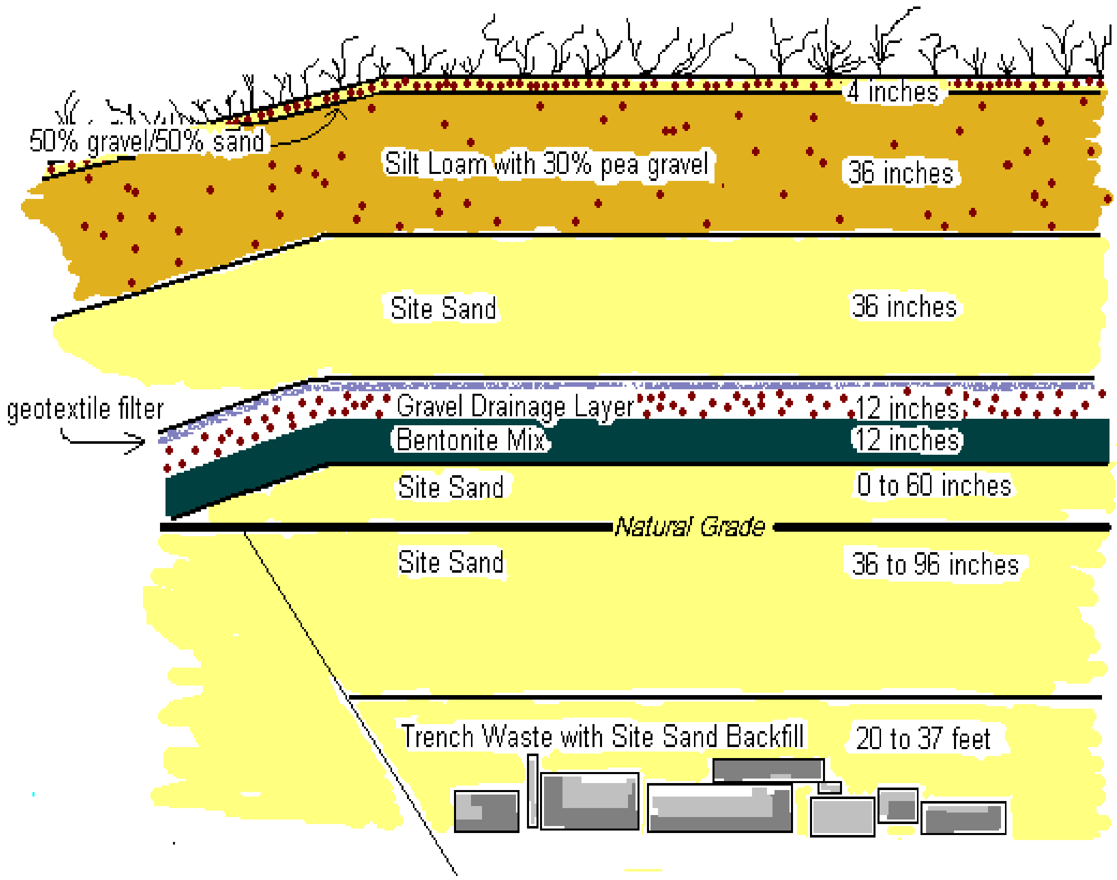


Figure 3.C: Homogenous Cover

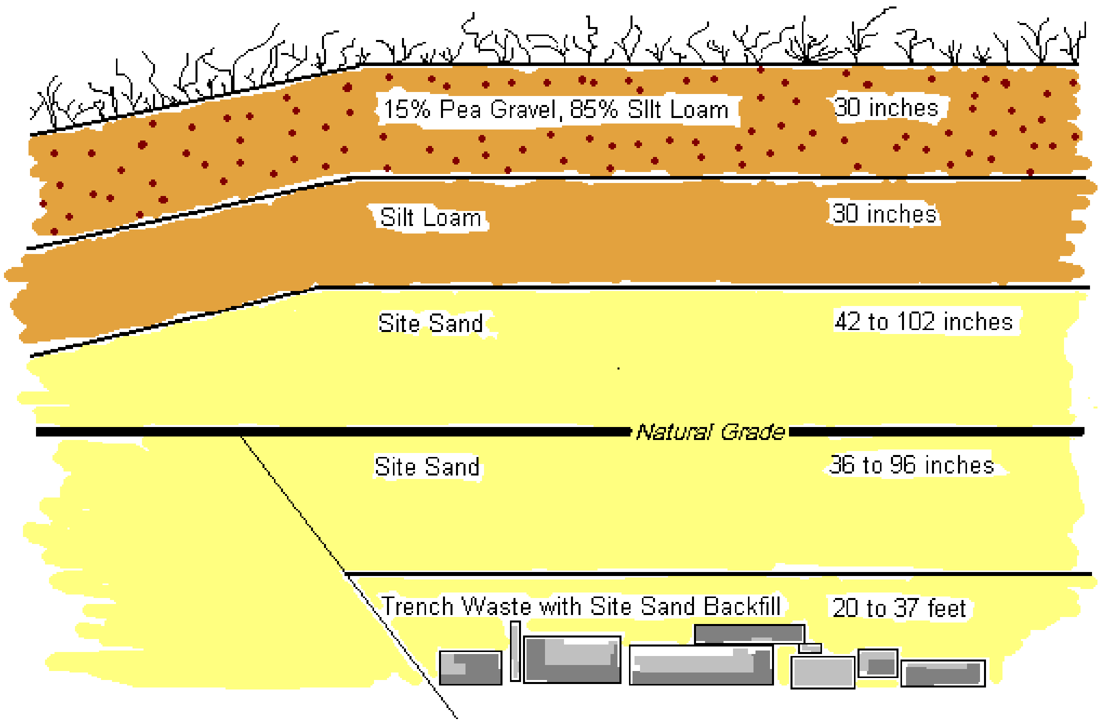


Figure 3.D: Enhanced – Asphalt Cover

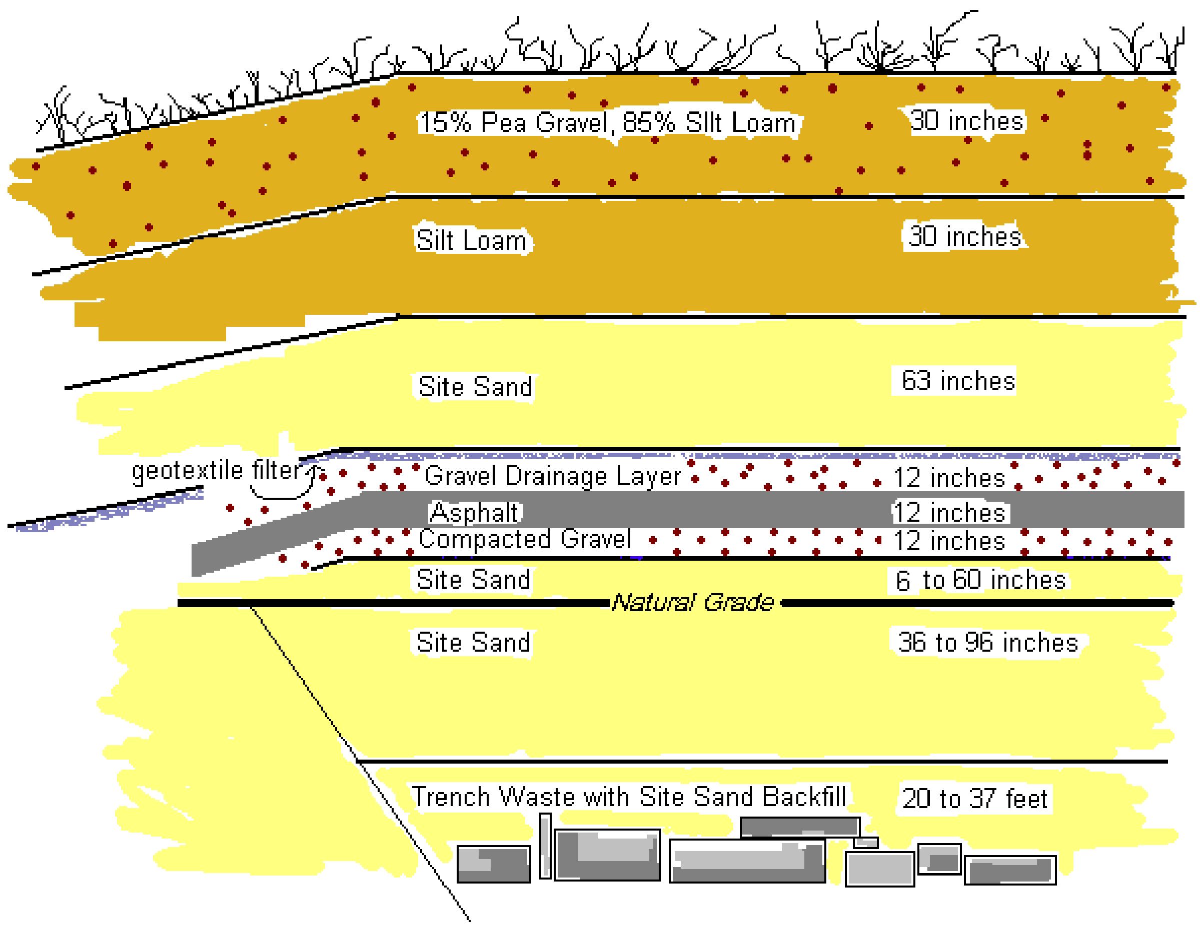


Figure 3.E: Enhanced – GeoSynthetic Cover

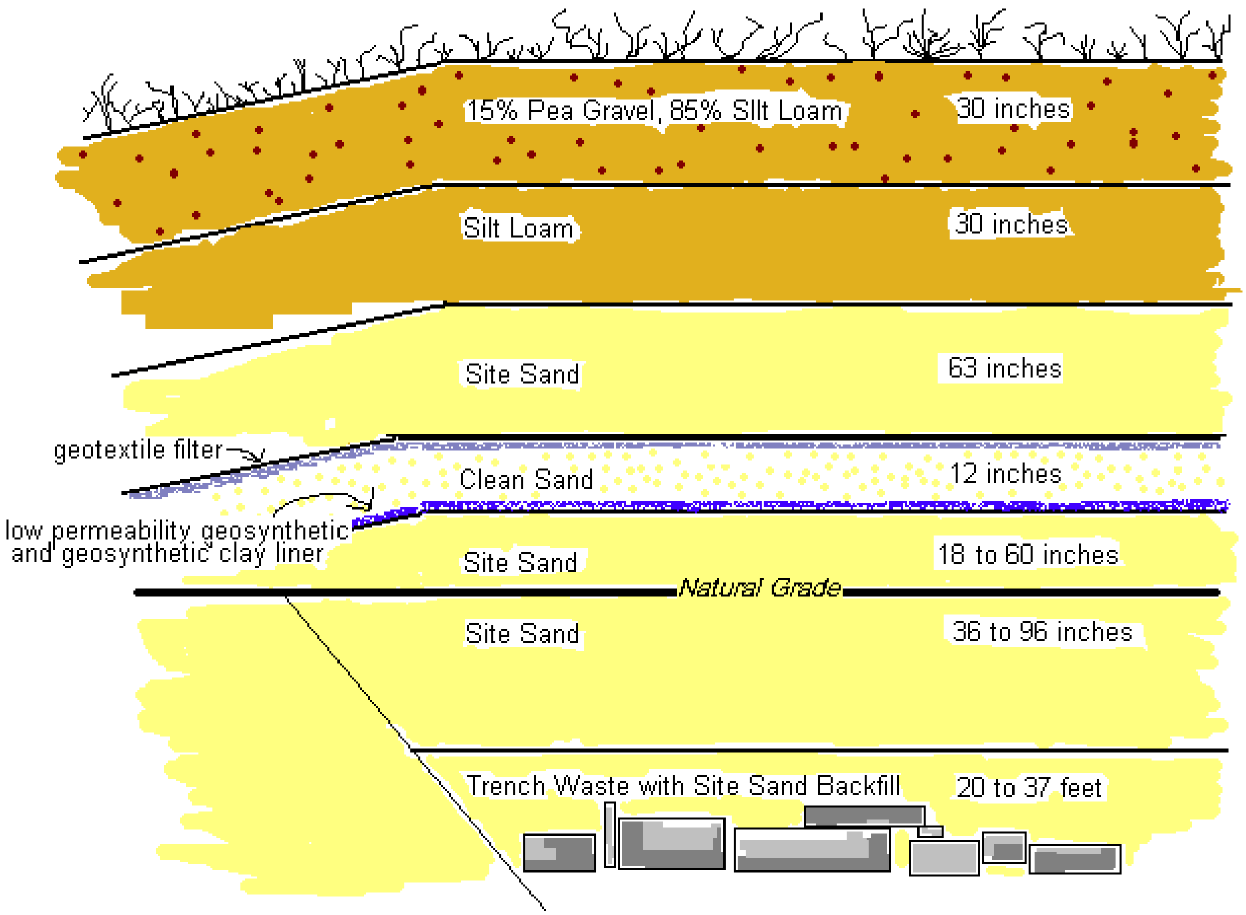
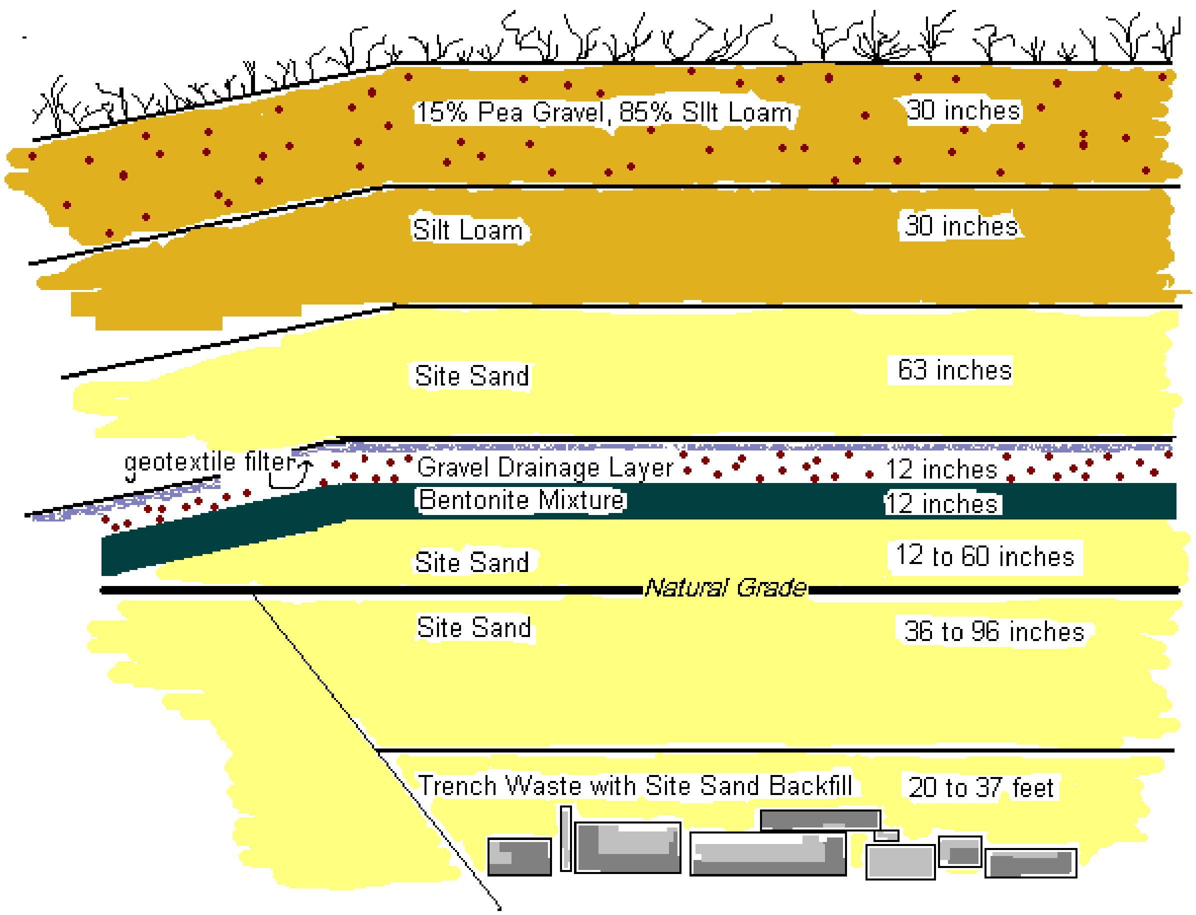


Figure 3.F: Enhanced – Bentonite Cover



4.0 PUBLIC HEALTH

This chapter discusses potential impacts to public health. At this time, there are no known existing health impacts to the public or site workers from the commercial LLRW site (Fordham 2000, Department of Ecology 2000). Potential health impacts are divided into short-term impacts and future post-closure impacts. Short-term health impacts are defined as those that may occur before the site is closed, and include risks associated with site operations, waste transportation, and construction of the cover. Post-closure health impacts are those impacts that may occur within 10,000 years after closure.[21]

Any discussion of post-closure public health impacts from the commercial LLRW site is best presented in the context of the surrounding 586-square mile Hanford Site. The commercial site is a 100-acre site in the middle of the contaminated central plateau area of Hanford. USDOE has designated the central plateau for Industrial-Exclusive use in the final Hanford Comprehensive Land Use Plan (CLUP) EIS (USDOE 1999). Waste management activities surrounding the commercial LLRW site will make the central plateau area unfit for residential use or other long-term uses for *at least* 50 years after the Hanford Site is closed. USDOE is planning to use institutional controls to restrict public access in the central plateau during this time (USDOE 1999). In this context, the hypothetical post-closure dose or risk from the commercial LLRW site would add little, if any, to the impact on public health. It will be every future generation's responsibility to ensure that adequate institutional controls are in place to address the public health impacts in the central plateau for as long as necessary.

4.1 Operational Risks

Operational risks are risks to public health and worker safety associated with normal operations at the commercial LLRW site.

Applicable standards include:

- 25 millirem per year public dose from effluents migrating offsite (Chapter 246-250 WAC)
- 500 millirem per year public dose from effluents and external radiation for licensed facilities (Chapter 246-221 WAC)
- Occupational dose limits of 5,000 millirem per year (Chapter 246-221 WAC)
- Washington Industrial Safety and Health Act (Chapter 49.17 RCW)

[21] The Uncertainty Analysis in the Risk Assessment estimated a high level of uncertainty for dose projections after 1,000 years.

4.1.1 Operational Risks to the Public

The public includes offsite residents and onsite visitors at the commercial LLRW site. Chapter 246-221 WAC establishes an upper limit of 500 millirem per year from all radiation sources for the onsite public. The US Ecology license establishes a more restrictive limit of 400 millirem per year for this requirement. Routine monitoring has shown that annual doses to the onsite public are consistently far below 400 millirem per year (Fordham 2000).

Chapter 246-250-170 requires that the combined dose from effluents migrating off the commercial LLRW site via groundwater, surface water, air, soil, plants, or animals shall not result in a combined annual dose exceeding 25 millirem to any member of the public. This requirement is also monitored and enforced through the current US Ecology license. At present, there is no significant dose to the public from effluents migrating off the commercial LLRW site (Fordham 2000).

4.1.2 Operational Risks to Workers

Operational risks include common occupational hazards as well as potential exposure to radionuclides. Common occupational hazards are regulated by WISHA standards. These hazards are non-radiological and can included slips, trips, falls, and lifting injuries. The number of reportable injuries and the number of waste shipments for a representative period are shown in Table 4.A (US Ecology 1998).

Table 4.A: Commercial LLRW Site OSHA Incident Rates

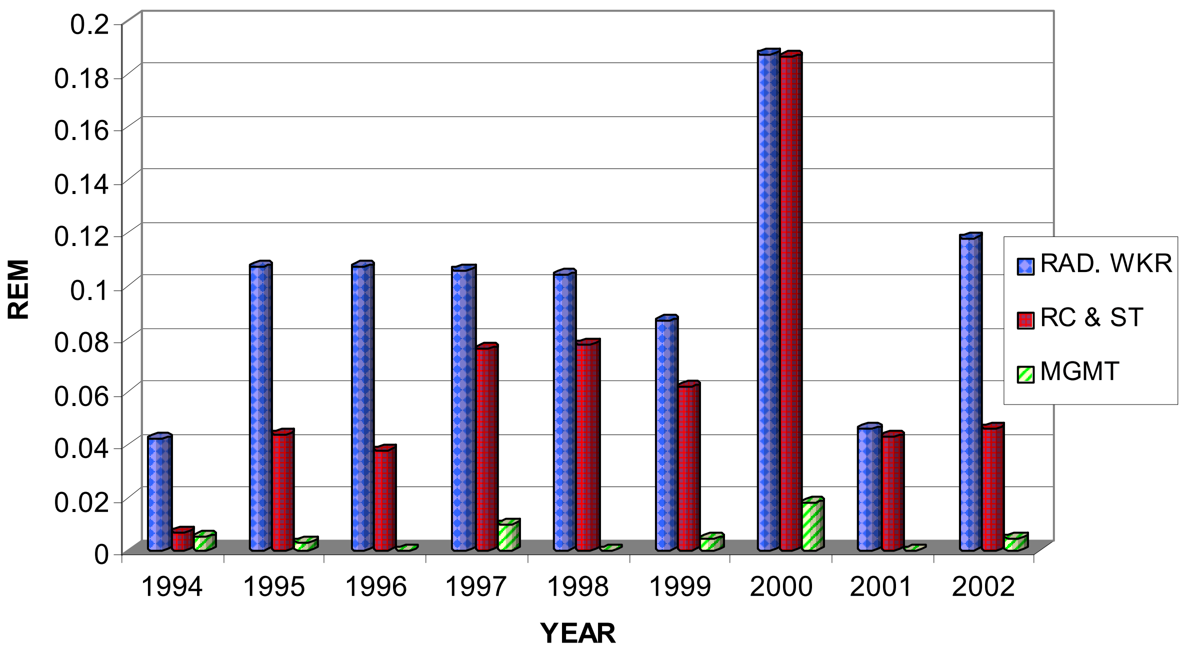
Year	Number of OSHA Reportable Injuries	Number of Shipments	Cubic Feet of Waste Received
1997	1	208	102,671
1996	3	235	118,048
1995	2	583	282,401
1994	1	489	175,729
1993	4	446	192,108
1992	4	936	447,699
1991	3	979	419,207
1990	10	661	295,299
1989	0	810	408,291
1988	1	756	403,630

A comparison of the injuries with the number and volume of shipments received shows little correlation between workload and accidents. This lack of correlation suggests that other variables may have more of an influence on the injury rate at the commercial LLRW site. Other variables may be weather, type of waste received, and safety awareness.

Radiological dose limits for the commercial LLRW site are 5,000 millirem per year for general workers and 500 millirem per year for minors and pregnant women. US

Ecology annually collects and analyzes data on dose limits. Employees wear thermoluminescent dosimeters (TLDs) to monitor external radiation to the whole body and extremities. Additionally, employees track daily exposures using self-reading dosimeters. Internal exposures are monitored by urinalysis for low and medium energy beta emitters and by direct counting of iodine in the thyroid gland. US Ecology compiles this information in its annual ALARA report (US Ecology 2003). Figure 4.A presents an eight-year record of the dose received by different categories of workers (Elsen 2003).

Figure 4.A: Average TEDE Received at the Commercial LLRW Site



NOTE: To convert from rem to millirem, multiply by 1000. RC&ST means Radiation Control and Safety Technician.

All radiological doses were significantly below the occupational dose limits of 5,000/500 millirem per year. In the past, workers were likely to receive most of their occupational dose when offloading waste packages from trucks. Little occupational dose came from actual disposal of the waste, as it was quickly and randomly placed into the trenches. In recent years, US Ecology workers have had an increase in occupational doses. These increases are likely due to the increased amount of time spent placing the waste in an orderly pattern in the trenches, as opposed to the past random pattern (US Ecology 1998a).

4.1.3 Potential Future Risk

The commercial LLRW site has historically operated with an acceptable accident and lost workday record. There would be no risks from operating the site if a license was denied. If the license is renewed or stays in timely renewal, the current low risk to workers and the public is not expected to change. The volume of LLRW or diffuse NARM disposed at the site is not correlated to operational risk. Therefore, the diffuse NARM alternatives are expected to have little or no impact on operational risks.

4.1.4 Preferred Alternative Impacts, Mitigation Measures, and Significant Unavoidable Impacts

Renew License Impacts. The current low risk to workers and the public is not expected to change if the license is renewed for five years, or if the license continues to be renewed and the site is operated through 2056.

Diffuse NARM Impacts – 100,000 cubic feet per year. Little or no impact to operational risk expected from 100,000 cubic feet per year.

GeoSynthetic Cover Impacts. The GeoSynthetic cover is not expected to impact operational risks.

Close-As-You-Go Schedule Impacts. Constructing the cover before the site is closed will increase vehicle traffic and onsite activities. This may impact the number of accidents associated with operations.

Mitigation Measures. Coordinate operations and cover construction activities to minimize potential increase in onsite accidents. Update the US Ecology Safety Plan to address both activities.

Significant Unavoidable Impacts. None.

4.2 Transportation Risk

This section evaluates risks associated with transporting waste to the commercial LLRW site. The transport of radioactive waste is governed by safety standards set forth in NRC's regulation 10 CFR Part 71 and USDOT regulations 49 CFR Parts 170-178. These safety standards are based on: (1) protection of the public from external radiation; and (2) assurance that the contents are unlikely to be released during either normal or accident conditions of transport. If the container is not designed to withstand accidents, the safety standards limit the contents in order to preclude a significant radiation safety problem if released. These safety standards are applicable to packages used in all modes of transport. In addition to the federal requirements, DOH includes specific transportation requirements in the US Ecology license for all waste shipped to the commercial LLRW site.

Table 4.B shows how waste has been transported to the commercial LLRW site from 1998 to 2001. Since 2001, all shipments have been transported by truck.

Table 4.B: Shipment Methods for 1998 - 2001

Year	Truck	Barge	Air	Train
1998	298	0	0	0
1999	226	1	0	0
2000	316	0	1	0
2001	131	0	0	0

Historically, the majority of waste has been shipped by truck to the site. In 1999, the Trojan Nuclear Reactor Vessel was the first and only shipment to be received by barge. A technical evaluation report was completed prior to the Trojan shipment. This report concluded that shipping the vessel by barge was the safest method (Fordham 1998).

In 2000, the first and only shipment by air was received at the commercial LLRW site. Shipments by air are rare because of the costs associated with air transport. The air shipment was unique because it was an international shipment of discrete NARM from Madrid, Spain. The shipment (900 cubic feet of waste) was flown to the Moses Lake Airport and then shipped 100 miles to the site via three truckloads. International shipments of radioactive waste must comply with the requirements of the International Atomic Energy Agency, International Air Transport Association, and the International Civil Aviation Association.

The Final Environmental Impact Statement on the Transportation of Radioactive Material by Air and Other Modes revealed no recorded air accidents involving nuclear material (NRC 1977). The low rate of air transported shipments (one shipment to the commercial LLRW site in 38 years), together with the historic record of no air accidents, makes the risk of an accident involving air transported radioactive waste to the commercial LLRW site very low.

Rail shipments are used for loads too heavy for truck travel. Rail shipments have been used primarily for waste from nuclear power plants. The last rail shipment received at the commercial LLRW site was received in the early 1990's. The only operating power plant still shipping waste to the site is the Columbia Generating Station (CGS), located about 10 miles away. Waste from CGS is trucked to the commercial LLRW site.

4.2.1 Emergency Management Services

Impacts associated with a transportation accident depend, in part, on the adequacy of emergency services in the local area. The ability of local emergency management services (EMS) to address radiological hazards differs among local communities.

EMS for radiological events in the Tri-City Area is well established. In the Tri-Cities, there are three area hospitals specifically trained to deal with a catastrophic radiological event. All three hospitals maintain supplies and receive annual training on receiving and caring for patients from a nuclear event.

Outside of the Tri-Cities, some statewide training is offered to first responders and hospitals. This training includes dealing with radiological hazards that might be associated with a transportation accident. A 2003 emergency management drill carried out by local, state, and federal EMS personnel showed that more training is necessary to properly manage an accident or incident involving radionuclides. A program to provide such training is currently in development by DOH.

4.2.2 Historic Transportation Risk

There have been no significant impacts to public health from any transportation incident associated with the commercial LLRW site. However, there have been incidents when waste was not transported in compliance with regulations. There have also been accidents involving the transport of waste to the commercial LLRW site.

On October 4, 1979, the commercial LLRW site was temporarily closed due to improper waste packaging, including containers that leaked during transport. As a result of this shutdown, State Executive Order E079 was issued, requiring additional efforts to reduce transport risk. These efforts include Washington State Patrol inspections at ports of entry of all vehicles carrying radioactive waste, and the establishment of a permanent onsite DOH state inspector at the commercial LLRW site.

Every truck transporting radioactive waste to the commercial LLRW site is required to have a vehicle safety inspection by the Washington State Patrol. Those vehicles that constitute a road hazard are placed out of service and are detained at the Port of Entry until the vehicle is repaired. In memos from the State Patrol to DOH dated February 12 and 14, 2001, the State Patrol noted the following:

> In 1997, 165 vehicles carrying radioactive waste were inspected. Of those 165, 18 (10.91%) were placed out of service. In 1998, out of 304 trucks inspected, 28 (9.21%) were placed out of service. In 1999, 423 trucks were inspected and 28 (6.62%) were placed out of service, while in year 2000, 22 (3.42%) trucks out of 643 were placed out of service. Among the most noted violations were items such as log book problems, brake adjustments, lights, and flat tires. It should be noted that these inspections included many vehicles destined to facilities other than the commercial LLRW site.

There have been no documented accidents or incidents involving shipments of waste via air, barge, or train. There have been two accidents involving transportation of radioactive waste to the commercial LLRW site via truck (Robertson 2000). The first accident occurred on January 16, 1987 on Highway 243. The truck jackknifed on black ice and skidded off the shoulder of the road. No radioactive material was released. A second accident occurred on December 31, 1987. A tractor-trailer overturned on Stevens Drive in the City of Richland. Workers were dispatched from Hanford and the contamination was immediately cleaned up. There were no radioactive exposures reported from these two accidents.

4.2.3 Future Transportation Risk

There would be no in-state transportation risk from any mode of transport if the license were denied and the site closed. If the license is renewed, the likelihood that future waste shipments will be transported to the site via air, barge, or rail is low. Although the probability of waste coming to the site via air, barge, or rail is low, the consequences of an accident via these transport methods could be significant.

The potential consequences of an accident would depend on the volume of waste shipped, the type of radionuclides, the amount of activity, the type of packaging, and the location of the incident. Consequences via barge could range from catastrophic contamination of the Columbia River to low or no impacts. A similar range of impacts is possible for air and rail transport. Because the likelihood of future shipments via air, barge, or rail is so low, it is not reasonable to try and generalize about potential future consequences. Instead, DOH will require a site-specific evaluation of accident potential and impacts to be done for any future proposed shipment via air, barge, or rail.

Truck shipments to the site are expected to continue for as long as the site remains open. The average truck may carry 800 to 1000 cubic feet of waste. Based on projected volumes of LLRW and the maximum diffuse NARM alternative of 100,000 cubic feet per year, the state can expect fewer than 250 truck shipments to the site each year. For the five-year relicensing period, this would mean fewer than 1,250 trucks. If the site were to remain open through year 2056, this could result in 12,750 additional truck shipments to the site.

4.2.4 Hypothetical Dose from Future Truck Shipments

RADTRAN 4 was used to predict dose rates from trucks transporting LLRW waste to the commercial LLRW site (Weiner 1998). The dose and risk figures reported in this section are hypothetical and apply to individuals along the transportation corridor. These figures do not consider the capabilities of local hospitals and emergency workers to adequately respond to a transportation accident.

There are four routes (transportation corridors) used to transport waste to the commercial LLRW site:

- **Albany route**, from Albany, Oregon, east along the Columbia Gorge to Umatilla, Oregon, and then north on I-82 to I-182, to State Route 240, to the commercial LLRW site.

- **Spokane route**, from Coeur d’Alene, Idaho, west on I-90 to Ritzville, Washington, then south on US 395 to Pasco, Washington, then north on I-182, to State Route 240, to the commercial LLRW site.

- **Seattle route**, east on I-90 to Ellensburg, Washington, then south on I-82 through Yakima, Washington, and east to I-182 to State Route 240, to the commercial LLRW site.

- **Umatilla route**, from Ontario, Oregon, east on I-84 to Hermiston, Oregon, and then north on I-82 to State Route 240, to the commercial LLRW site.

RADTRAN 4 was used to model both an incident-free dose and an accident risk. The incident-free dose is from external radiation to individuals during transport of the waste. In calculating the incident-free dose, RADTRAN 4 assumes that all USDOT standards are met at the maximum allowable dose for the entire transportation route.[22]

Accident risk is based on exposure to radioactive material released as a direct result of an accident during transport. The accident risk is based on accident rate, probability of container failure, fraction of material released, chemical and physical nature of the material, radioactivity of the material, and proximity of individuals to the accident site.

RADTRAN 4 assumes that the probability of an accident involving a truck carrying radioactive material is one accident for every 1,000,000 vehicle-miles. If an accident happens, the probability that the accident will involve a significant release of radioactive materials is less than 5%. If the license were denied, there would be a zero risk of exposure from truck transport of waste in-state to the commercial LLRW site. If the license is renewed or remains in timely renewal, the dose to an individual from an incident-free shipment along all four routes is predicted to be 3.8×10^{-9} millirem per year. The average hypothetical risk for exposure to these same individuals from a transportation accident is less than 1.0×10^{-8} along all four routes. These results mean that an individual would have a 0.0000001% increased risk of dying from cancer due to an accident during the transport of waste to the commercial LLRW site.

Transportation dose and risk were calculated separately for NARM volumes. If the Zero Limit Diffuse NARM Alternative were adopted, there would be no risk from transporting diffuse NARM to the commercial LLRW site. RADTRAN 4 predicted that the transport of 100,000 cubic feet per year of NARM would contribute less than 1.0×10^{-10} millirem per year to the incident-free dose, and the average hypothetical risk of exposure from a transportation accident is less than a 1.0×10^{-9} for individuals living along any of the four routes.

In evaluating the results of the RADTRAN 4 model, it is important to remember that the model does not consider the increased transportation risk when a shipment is not in compliance with USDOT requirements. This includes waste packaging violations. Such violations could increase overall transportation risks. RADTRAN 4 also does not factor in the ability of the local community to handle accidents involving radioactive releases.

[22] Experience indicates that the external dose rate is well below the regulatory limit in most shipments, and is undetectably low for many shipments (Weiner 1998).

When the commercial LLRW site is closed, transportation risks outside Washington may increase. The potential increase in transportation risk outside Washington was not included in the EIS.

4.2.5 Preferred Alternative Impacts, Mitigation Measures, and Significant Unavoidable Impacts

Renew License Impacts. If the license is renewed, the hypothetical additional dose to an individual from an incident-free shipment along all four routes is predicted to be 3.8×10^{-9} millirem per year. The hypothetical risk of exposure to these same individuals is 1.0×10^{-8} from a transportation accident. This projection does not consider the local communities' ability to provide emergency services, nor does it consider increased transportation risk when a shipment is not in compliance with USDOT requirements. The Renew License Alternative will increase point-of-origin inspections. These inspections are designed to minimize packaging violations during transport, and to maintain transportation risks at a low level.

Diffuse NARM Impacts – 100,000 cubic feet per year. The transport of 100,000 cubic feet per year of NARM would contribute less than 1.0×10^{-10} millirem per year to the incident-free dose, and the average hypothetical risk of exposure from a transportation accident is 1.0×10^{-9} for individuals living along any of the four routes.

GeoSynthetic Cover Impacts. Transportation risks in this section are associated with operations. Transportation risks associated with cover construction are included in Section 4.3.

Close-As-You-Go Schedule Impacts. None.

Mitigation Measures. Increase emergency management training to local communities along the four transportation routes outside of the Tri-Cities. Increase point-of-origin inspections to ensure proper waste packaging and labeling.

Significant Unavoidable Impacts. None.

4.3 Cover Construction Risk

The construction of the final cover, as with all large construction projects, has inherent risks. Risks include the potential for injuries associated with vehicles, heavy equipment, heavy lifting, and falls. None of the cover design alternatives are considered unusual or overly dangerous to construct (DOH 1998b). The Site Soils cover and the Homogenous Cover are less complex covers, need fewer worker hours to construct, and will therefore have a lower potential for accidents.

Cover size will also affect the relative potential for accidents. The larger the cover needed, the more potential for accidents. The cover schedule might also affect the accident rate. The three-phase Close-As-You-Go schedule may result in more accidents than the schedule alternatives that build the entire cover at one time. Worker exposure to radiation during cover construction is unlikely because there will be no handling of, nor exposure to, the waste packages by construction workers (DOH 1998b). The actual frequency and severity of accidents during cover construction will likely be more dependent on the safety culture than on the variables of size and design.

4.3.1 Transportation Risk for Cover Construction

Materials for cover construction will most likely be procured from an offsite location and transported to the site by truck. These materials include silt loam, gravel, asphalt, bentonite, and/or a synthetic liner. The Site Soils Cover is the only alternative that requires no offsite materials. When complete, the final cover will be from 40 acres to 80 acres, depending on how much additional waste is disposed at the site before final closure. A larger cover has more potential for construction risk because of the longer time to construct and the need for increased transport of materials. For this analysis, all covers are assumed to be 80 acres. A 100-mile roundtrip distance was arbitrarily selected for the analysis. Table 4.C shows truck miles needed to transport materials and equipment to the site for an 80-acre cover (Blacklaw and Ahmad 1998).

Table 4.C: Transportation Requirements for 80-Acre Final Cover

Cover Design	Offsite Materials (cubic yards)	Round Trips Required	Total Miles (100 miles/RT)
Site Soils	0	0	0
US Ecology	422,000	21,000	2,110,000
Homogenous	722,000	36,100	3,610,000
Asphalt	978,178	42,900	4,290,000
GeoSynthetic	722,000	36,100	3,610,000
Bentonite	758,000	37,900	3,790,000

Estimated accident rates for dump trucks are approximately 1.8 accidents per million miles (Fordham 2002). Using the above figures, estimated accident rates from transporting materials to the site are zero for the Site Soils Cover, four accidents for the US Ecology Proposed Cover, and seven to eight accidents each for the Homogenous and Enhanced Covers.

4.3.2 Preferred Alternative Impacts, Mitigation Measures, and Significant Unavoidable Impacts

Renew License Impacts. Renewing the license may increase the cover size, which will increase the potential for accidents. Renewing the license for only five years will have no impact on cover size. Operating the site through 2056 could potentially double the size of the cover.

Diffuse NARM Impacts – 100,000 cubic feet per year. 100,000 cubic feet of diffuse NARM could increase the cover size, which will increase the potential for accidents. At current disposal rates, if the site were operated through 2056, additional trench capacity for diffuse NARM is expected to increase the size of the cover less than 10%.

GeoSynthetic Cover Impacts. The GeoSynthetic Cover design requires 36,100 truck round trips to bring the required volume of silt loam to the site. The estimated vehicle accident rate for constructing this cover is eight additional accidents. Non-accident impacts to the local community from this additional truck traffic are discussed in Section 6.5, Socioeconomics.

Close-As-You-Go Schedule Impacts. The three-phase Close-As-You-Go schedule will require several different construction periods. Three construction periods will spread the truck traffic out over several different years. Spreading the truck traffic over three construction periods may or may not be a benefit in terms of traffic congestion and highway safety.

Mitigation Measures. Standard construction and safety practices, as required by WISHA, will be used for all cover designs. DOH will require an approved transportation plan that addresses truck safety and safety checks, transport routes, restricted schedule, weather hazards, and signage. US Ecology will evaluate alternate transport methods and ways to reduce the amount of offsite material needed for cover construction.

Significant Unavoidable Impacts. Increased truck traffic is projected to result in an additional eight vehicle accidents. The impacts of these accidents are unknown.

4.4 Post-Closure Radiological Dose

Hypothetical radiation doses are presented in Appendix II, *DOH Radiological Risk Assessment for the Commercial Low-Level Radiological Waste Site* (Thatcher 2003). Information in this section, unless specified otherwise, is based on results and discussion in the Radiological Risk Assessment.

The scope of the Radiological Risk Assessment is summarized in the following statements:

- All doses are hypothetical.
- Doses are projected for 10,000 years.
- All cover design alternatives were evaluated.

- A future disposal rate of 100,000 cubic feet per year of diffuse NARM is assumed for all alternatives.[23]

- Site closure dates of 2005, 2056, and 2215 were evaluated for the GeoSynthetic Cover.

- Two cover construction schedules were evaluated: the Close-As-You-Go Schedule, and the No Action Schedule.

- The "offsite resident" analysis includes both a fence line and a river resident scenario.

- The "onsite intruder" analysis includes both a lifetime resident and short-term trespass scenario.

The state used two dose standards for comparing the alternatives. These are:

- Annual offsite dose to public not to exceed 25 millirem (plus ALARA) (Chapter 246-250-170).

- 100 millirem (plus ALARA) per year onsite guidance dose (NCRP 1993).

Comparison of the dose standards with the hypothetical future doses was done only to evaluate the relative performance of the alternatives. The dose standards were not used to determine future compliance of an alternative. Future compliance cannot be determined because the predicted dose for the alternatives is only hypothetical. The state will determine compliance in the future by comparing monitoring data with applicable standards.

4.4.1 Cover Design Reliability

Cover design reliability is an important consideration for projecting future doses. Cover reliability is defined as how well a cover will perform over the long term. Cover materials such as the addition of pea gravel and the silt loam surface layer were included to increase long-term performance. However, engineered covers are a relatively new practice and there are little data on their long-term reliability. As a result, it was necessary to make assumptions on long-term cover reliability. The assumptions on cover reliability greatly impact the predicted future doses and represent one area of uncertainty in the Radiological Risk Assessment.

The three primary cover features that affect performance and long-term reliability are cover thickness, control of infiltration, and control of gas emanation. The state assumed that a cover's original thickness only changed minimally over the entire life of the cover

[23] The Risk Assessment completed for the Draft EIS assumed a future disposal rate of 36,700 cubic feet per year of diffuse NARM.

and therefore was not a factor in long-term reliability. For control of infiltration, the state assumed all covers would catastrophically fail at 500 years. After failure, the infiltration rate through the covers would return to natural rates for all alternatives. Control of gas emanation is important for the control of radon. After 1000 years, the ability of the bentonite barrier to control radon in the Enhanced Bentonite Cover and the US Ecology Covers is assumed to outpace the performance of all other covers.

The assumptions on cover reliability rely, in part, on the ability of the state or other caretaker to maintain the covers when damaged. Maintenance requirements could include repair of the impermeable barriers, wind erosion damage, water erosion damage, loss of vegetative cover due to drought or range fires, and damage caused by subsidence. Surface damage can be readily repaired, but repair of the impermeable barriers may prove unfeasible. Table 4.D shows potential maintenance requirements for the cover designs.

Table 4.D: Maintenance Requirements for Cover Designs

Potential Damage Affecting Reliability	US Ecology Proposed	Site Soils	Homogenous	Enhanced Covers; Asphalt, Bentonite, GeoSynthetic
	Resistance to Damage and Feasibility of Repair			
Bentonite dries and cracks	Difficult repair	N/A	N/A	N/A for asphalt; difficult repair for Bentonite and GeoSynthetic covers.
Wind erosion	Moderate potential; pea gravel added to minimize erosion. Repair to surface layers feasible.	High potential. Repair to surface layers feasible.	Moderate potential; pea gravel added to minimize erosion. Repair to surface layers feasible.	Moderate potential; pea gravel added to minimize erosion. Repair to surface layers feasible.
Water erosion	Moderate potential; pea gravel added to minimize erosion. Repair to surface layers feasible.	High potential.	Moderate potential; pea gravel added to minimize erosion. Repair to surface layers feasible.	Moderate potential; pea gravel added to minimize erosion. Repair to surface layers feasible.
Loss of vegetative cover	36 inches of silt loam will help re-establish vegetation.	Vegetation will be difficult to re-establish on site soils.	60 inches of silt loam will help re-establish vegetation.	60 inches of silt loam will help re-establish vegetation.
Damage due to subsidence	Surface soil damage is repairable; barrier difficult to repair.	Surface soil damage is repairable; no barrier.	Surface soil damage is repairable; no barrier.	Surface soil damage is repairable; no barrier.

4.4.2 Source Term

The source term used for the Radiological Risk Assessment includes all radioactive waste disposed at the site (Elsen and Thatcher 2002). The source term does not include chemical waste. Future source term projections were based on waste activity from 1993 through 1996, plus the Trojan and Washington Public Power Supply reactor vessels.

The total commercial LLRW site inventory contains about 622 separate isotopes. A majority of these radionuclides are short-lived or of minimal activity. Screening tools were used to identify the radionuclides with the highest likelihood of contributing to dose. The source term used to project public health impacts is listed in Table 2.E: Selected Radioactive Inventories for the Commercial LLRW Site (DOH 2003). Twenty-one radionuclides passed the initial screening criteria of a half-life greater than 5.5 years and a total activity of at least 1 curie. Table 2.E lists the estimated future source term for these radionuclides.

The existing source term for the 21 radionuclides is 1.1 million curies. Future source term (2002 through 2056) for these radionuclides was estimated to be 4,490 curies. This difference in source term between the first 50 years of operation and the potential next 50 years of operation has a significant effect on the results of the Radiological Risk Assessment. Also important are the characteristics of the individual radionuclides. Radionuclide characteristics important in projecting future doses are half-life, mobility in the vadose zone, and mobility for gaseous release.

4.4.3 Institutional Controls

Institutional controls are used to restrict access to contaminated sites. Institutional controls can include signage, fencing, monuments, and deed restrictions. The 100-acre commercial LLRW is located on the central plateau and is surrounded by the 586-acre Hanford Site. USDOE has designated the central plateau Industrial-Exclusive and intends to use institutional controls to control access to the central plateau for the foreseeable future (USDOE 1999). State regulations also require that institutional controls be used to restrict access to the commercial LLRW site for at least 100 years. Although neither USDOE’s land use plans nor the state’s regulations specifically address the use of institutional controls for perpetuity, it will be every generation’s responsibility to ensure that access is restricted to the central plateau for as long as necessary to protect public health.

4.4.4 Direct Contact Pathway

Direct intrusion into the waste is one of three pathways evaluated in the Radiological Risk Assessment. The probability of a person, animal, or plant coming into direct contact with the waste is affected both by the cover thickness and by the materials in the cover. Materials such as the asphalt in the Enhanced Asphalt Cover may deter direct contact by forming a physical barrier. Covers at least five meters thick are expected to be effective at preventing direct contact by an inadvertent intruder (NRC 1982). All cover designs except the 11’6” thick Site Soils Cover are at least 16 feet thick.

Biotic intrusion includes both plant roots and burrowing animals. USDOE summarized the published information on plant rooting and animal burrowing depths for Hanford (USDOE 1995). The deepest burrowing animal was the harvest ant at 8.9 feet, and the badger was the deepest burrowing mammal at 8.2 feet. The plant species with the greatest average maximum rooting depth is antelope bitterbrush at 9.7 feet. Based upon this information, the direct contact exposure pathway of plants or animals is considered negligible for all cover designs.

4.4.5 Air Pathway

Gas emanation through the cover designs was modeled for 10,000 years post-closure. This section describes the factors affecting the potential emanation of gaseous radionuclides at the commercial LLRW site. Radon (and progeny), C-14, and H-3 are the three potential contributors to dose. Radon is the most significant contributor to dose. NARM is the primary contributor of radon.

Radium 226, with a half-life of 1600 years, decays to radon 222 with a half-life of 3.8 days. Radon is a gas, and as such, a fraction of the radium 226 that decays escapes the confines of the soil column and migrates toward the surface. This diffuse radon can accumulate in houses through cracks in the floor, around floor penetrations (such as drainpipes), and through the concrete floor. A portion of the radon (and progeny) in the air is respirated and retained in the lung, where the radon daughters (Po-218, Bi-214, Pb-214, and Po-214) deliver a dose that is approximately 100 times greater than the dose of radon 222.

The Radiological Risk Assessment projects the highest radon concentrations to be indoors. One driving assumption for the indoor radon dose is that a resident intruder will build a home with a basement. Building requirements for access and egress from a basement dictate that a seven-foot excavation depth is reasonable for new construction.

Depth to waste, the presence of clay, the type of low-permeability barrier, and the soil moisture content are three main factors that affect the projected radon flux. The modeling has shown that radon is significantly reduced by burying the waste containing radium 226 at a depth of 23 feet below grade. A clay barrier is estimated to reduce the predicted emanation rate by a factor of 2.5. Table 4.E presents the predicted surface radon flux for the cover design alternatives.

Table 4.E: Onsite Radon 222 Emanation Rates

Cover Designs	Emanation Rate (pCi/m²s)
US Ecology Proposed Cover	0.478
Site Soils Cover	2.59
Homogenous Cover	1.11
Asphalt Cover	0.475
GeoSynthetic Cover	0.615
Bentonite Cover	0.444

4.4.6 Groundwater Pathway

The third pathway evaluated was groundwater. Groundwater contamination has the potential to impact the greatest number of individuals. The primary route for exposure to individuals is direct ingestion of groundwater used as drinking water. Other pathways for groundwater include exposure via inhalation while in steam rooms (as is the case for the Native American sweat lodge), consumption of plant and animal products that have been irrigated with contaminated water, and external exposure such as bathing.

4.4.6.1 Cover Infiltration

Infiltrating water is the primary mechanism of radionuclide transport to groundwater (Rood 2003). UNSAT-H, a numeric model, was used to predict infiltration through the cover designs (Fayer and Jones 1990). This work is reported in Appendix III, *Estimates of Infiltration Rates Through Conceptual Cover Design Alternatives for the Commercial LLRW Site, Richland, Washington* (Dunkelman 2003). In UNSAT-H, the cover characteristics most important for controlling infiltration are percent gravel, percent silt, and depth of the upper silt loam layer. Only the top layers of the covers, down to, but not including the low-permeability barriers (asphalt, bentonite, geosynthetic), were included in the UNSAT-H modeling. The barriers were not included in the model because they are considered secondary to the evaporative properties of the covers in controlling infiltration. The barriers act as a safeguard against infiltration in case the surface layers of the cover fail due to an event such as fire, erosion, or surface subsidence.[24]

Table 4.F shows that UNSAT-H predicted that the Site Soils Cover would have the highest infiltration rate, followed by the US Ecology Proposed Cover and then the Enhanced Covers and the Homogenous Cover. The Enhanced Covers and the Homogenous Cover all have the same predicted infiltration rate because these covers all have 60 inches of silt loam in their top layers. Table 4.F shows the predicted infiltration rates for each cover.

Table 4.F: Infiltration Rates through the Cover Alternatives

Closure Cover Designs	Infiltration Rate[25]
US Ecology Proposed Cover	2.0 mm/year
Site Soils Cover	20 mm/year
Homogenous Cover	0.5 mm/year
Asphalt Cover	0.5 mm/year
GeoSynthetic Cover	0.5 mm/year
Bentonite Cover	0.5 mm/year

[24] The asphalt, geosynthetic, and bentonite barriers were included in the modeling for air emanation because these barriers are considered primary in controlling radon.

[25] Water infiltration through the Homogenous and Enhanced covers was predicted to be less than 0.001 mm/year infiltration. However, a rate of 0.5 mm/year was used in the modeling. Please see Appendix III for discussion.

The evaporative properties of the covers were assumed to fail at 500 years. Following failure, infiltration rates of all cover designs were assumed to return to a background infiltration of 5 millimeters per year (Rood 2003). In the case of the site soils cover, "failure" of the cover results in a lower infiltration rate.

4.4.6.2 Groundwater Concentrations

The groundwater concentrations used in the Radiological Risk Assessment are reported in Appendix IV, *Groundwater Concentrations and Drinking Water Doses with Uncertainty for the US Ecology Low-Level Radioactive Waste Disposal Facility, Richland Washington* (Rood 2003). Information in this section, unless specified otherwise, is based on Appendix IV.

The original groundwater modeling done in the Draft EIS used the GWSCREEN Version 2.5 code (Rood 1999). For the Final EIS, the modeling was revised to reconcile measured concentrations of radionuclides in the unsaturated zone with model-predicted values. Evaluation of concentrations in the unsaturated zone required a new conceptual and mathematical model of waste disposal and radionuclide transport in the unsaturated zone.

The new models, the Disposal Unit Source Term Model (DUST) (Sullivan 1996) and the First Order Leach and Transport (FOLAT) (Rood 2003a) more accurately reflect the waste disposal history, time-variable infiltration, and radionuclide transport in the unsaturated zone. Radionuclides used to recalibrate transport through the vadose zone include Ni-63, Sr-90, Tc-99, Pu-239/240, and U-238. The recalibration determined there was a small but highly mobile fraction of waste, which has moved essentially at the rate of water through the vadose zone.

Of the more than 600 radionuclides disposed at the LLRW disposal site, very few have a long enough half-life, large enough source term, and are soluble enough to cause a potential impact to groundwater. The initial screening identified 15 radionuclides as potentially important in terms of their impact to groundwater: C-14, Cl-36, H-3, I-129, Pu-238, Pu-239, Pu-240, Pu-242, Ra-226, Tc-99, Th-230, Th-232, U-234, U-235, and U-238.

Of the 15 radionuclides, the modeling predicted that seven would be important for groundwater during the zero to 10,000-year time period. These seven radionuclides are I-129, Tc-99, U-238, H-3, C-14, and the mobile fractions (MF) of U-234 and Pu-239. The contributions from Ni-63 and Sr-90, although in measurable quantities in the vadose zone, were not significant in terms of future groundwater concentrations. The lack of influence of Ni-63 and Sr-90 was due to the short half-lives (100 and 30 years respectively) of these two nuclides.

Predicted groundwater concentrations are presented in Tables 16 through 20 in Appendix IV. *Groundwater concentrations were both higher and lower compared to the* *original modeling effort reported in the Draft EIS.* Higher concentrations were due to: (a) increased infiltration due to the absence of a low permeability cover during the first 40 years of site operation; (b) assumed cover failure after 500 years; and (c) increased uranium solubility. Lower concentrations were due to lower leaching rate constants for Tc-99 and Cl-36.

The cover designs with the lowest infiltration rates (Homogenous, Enhanced Bentonite, Asphalt, and GeoSynthetic) result in the lowest groundwater concentrations. Groundwater concentrations after about 1,000 years are essentially the same for each cover design. In the first 100 years, concentrations of H-3 are most significant. [26] For the 100 to 1000-year timeframe, U-238 and Tc-99 are most significant. For the 1,000 to 10,000-year period, the most significant radionuclides are I-129, C-14, Pu-239, and U-238.

The groundwater model evaluated closure of the site with the GeoSynthetic cover in years 2005, 2056, and 2215. The model predicted that additional source term from relicensing the site would have little or no impact on the maximum groundwater concentrations. Two reasons for the negligible impact on the hypothetical groundwater concentrations are: (1) the projected future source term is a small fraction of the existing source term; and (2) the analysis assumed all existing waste will be covered with a low permeability cover in 2005, and all new waste will be covered soon after disposal (i.e., Close-As-You-Go Schedule).

The groundwater model also evaluated the impact of the Close-As-You-Go Schedule compared to the No Action Schedule (no early construction). The modeling predicted an annual 112 millirem dose increase to the onsite resident Native American Adult for the No Action Schedule. Impacts on dose by the US Ecology Schedule and the Prototype Schedule were not specifically calculated, but the state would expect these schedules to also provide some reduction in dose over the No Action Schedule.

4.4.6.3 Hypothetical Impacts to Drinking Water

The state evaluated post-closure impacts to drinking water by comparing the hypothetical groundwater concentrations with the federal maximum contaminant levels (MCL) (EPA 2000a). The hypothetical impacts to drinking water from the commercial LLRW site are best presented in the context of the degraded groundwater quality surrounding the commercial LLRW site.

Of the seven radionuclides predicted to contribute to a post-closure dose at the commercial site, only I-129 and H-3 are predicted to exceed a drinking water MCL. For H-3, the hypothetical maximum concentration is 80,000 picocuries per liter, and the drinking water MCL is 20,000. For I-129, the hypothetical maximum concentration is 3.0 picocuries per liter, and the MCL is 1.0. The H-3 concentration is predicted to exceed

[26] The transport model assumes all H-3 travels in the dissolved-phase to the aquifer with no vapor transport to the surface.

the MCL in the first 250 years after closure, and I-129 is predicted to exceed the MCL between 5000 and 10,000 years after closure. Current groundwater data for H-3 indicate that the future hypothetical concentration may be less than 80,000 picocuries per liter.

Comparison of the hypothetical groundwater concentrations with the MCL's was used only to evaluate the relative performance of the alternatives. The MCLs were not used to determine future compliance of an alternative. Future compliance cannot be determined with hypothetical values. The state will determine compliance in the future by comparing actual monitoring data with applicable drinking water standards.

4.4.7 Total Effective Dose Equivalent

The hypothetical total effective dose equivalent (TEDE) is reported in the Radiological Risk Assessment (Appendix II) and represents the total dose from all exposure pathways to the whole body.

4.4.7.1 Hypothetical Lifestyle Scenarios

In order to predict the post-closure dose and risk that individuals would be expected to receive from all pathways, scenarios were developed to approximate the lifestyles of the hypothetical individuals. The scenarios used in the Radiological Risk Assessment are:

- Offsite Rural Resident Scenario
- Offsite Native American Scenario
- Onsite Intruder Rural Resident Scenario
- Onsite Intruder Native American Scenario
- Onsite Intruder Native American Upland Hunter Scenario
- Offsite Native American River Resident

Onsite intruders can be either inadvertent or deliberate. The inadvertent intruder is unaware that he or she is living or trespassing on the closed commercial LLRW site. The deliberate intruder is aware of the disposal site and chooses to intrude anyway. The NRC and DOH closure regulations are written to primarily protect the inadvertent intruder.

Table 4.G outlines the hypothetical lifestyle scenarios used in the Radiological Risk Assessment.

Table 4.G: Lifestyle Scenarios

Scenario	Location of Exposure	Time of Exposure*	Special Considerations
Offsite Rural Resident	Disposal site boundary	Adult: 30 years Child: 6 years as child; 24 as adult	Builds a home at the commercial LLRW site boundary in the predominant downwind and downgradient direction. Spends 100% of time at home. Drills water well for drinking water and domestic uses. Grows a portion of own food.
Offsite Native American	Disposal site boundary	Adult: 70 years Child: 6 years as child; 64 as adult	Similar to offsite rural resident, with increased production of food crops, daily sweat lodge use, and longer residency time.
Onsite Intruder Rural Resident	Throughout disposal site	Adult: 30 years Child: 6 years as child; 24 as adult	Takes up residence on commercial LLRW site. Lifestyle similar to offsite resident, except that a water well is drilled through the waste and the drill cuttings are spread on the surface.
Onsite Intruder Native American	Throughout disposal site	Adult: 70 years Child: 6 years as child; 64 as adult	Takes up residence on commercial LLRW site and lives entire life onsite. Lifestyle similar to the offsite Native American, except that a water well is drilled through the waste and the spoils are spread on the surface. Spends less time indoors than the Rural Resident.
Onsite Intruder Native American Upland Hunter	Throughout disposal site	1 week	Spends time on site hunting, camping, etc. Exposure routes include ingestion of game, plants/roots, and groundwater. Assume no direct contact of waste.
Native American Subsistence River Resident	Near Columbia River	Adult: 70 years Child: 6 years as child; 64 as adult	Lives a traditional lifestyle spending time near shoreline and upland areas. Assumed to drink water from seeps that are contaminated only from commercial LLRW site (not Hanford sources), swims and bathes in river, eats food irrigated with river water.

4.4.7.2 Hypothetical Dose

This section summarizes the hypothetical doses predicted in the Radiological Risk Assessment (Appendix II). The following assumptions and statements apply to the hypothetical doses presented in Table 4.H.

- For predicting doses, the 100-acre commercial LLRW site acts like two separate sites. The current 40 acres have significantly more activity than is projected for the second 40 acres. This means that doses to the onsite intruder are different, depending on where the hypothetical intruder builds a home. The discussion in this section focuses on the maximum dose predicted for the first 40 acres, with an understanding that the intruder is exposed to smaller doses on the second 40 acres of the site.

- All Cover Design Alternatives have a predicted post-closure dose. This dose is primarily from waste that has already been disposed at the commercial LLRW site.

- All Rural Resident doses are intended to represent the maximally exposed individual (MEI). The MEI is a "single-point" dose that 95% of the general population would be expected to be below.

- The Native American doses are intended to represent the exposure to the average member of this critical group.

- All covers are constructed using the Close-As-You-Go Schedule. This schedule constructs a low-permeability cover over all existing waste in 2005. The GeoSynthetic Cover was also evaluated for the No-Action Schedule. The No Action Schedule delays all construction until 2056 or final closure, whichever is sooner.

- 100,000 cubic feet of diffuse NARM are disposed each year from 2003 through 2056.

- All newly disposed discrete NARM will be buried at 23 feet below grade.

Table 4.H: Hypothetical Dose for All Covers and Scenarios (mrem/y)

Cover*	Proposed US Ecology		Site Soils		Homo-genous		Enhanced Asphalt		Enhanced Bentonite		Enhanced Geo - Synthetic		Enhanced Synthetic with Construction in 2056		Enhanced Geo - Synthetic		Enhanced Geo - Synthetic	
Closure Date	2056		2056		2056		2056		2056		2056		2056		2005		2215	
Timeframes (y)	0-1,000	1,000 - 10,000	0-1,000	1,000 - 10,000	0-1,000	1,000 - 10,000	0-1,000	1,000 - 10,000	0-1,000	1,000 - 10,000	0-1,000	1,000 - 10,000	0-1,000	1,000 - 10,000	0-1,000	1,000 - 10,000	0-1,000	1,000 - 10,000
Scenarios																		
Onsite Resident Intruder																		
Rural Resident Adult	87	78	384	214	173	147	87	78	82	74	105	93	105	92	106	93	97	88
Rural Resident Child	84	75	382	212	169	145	83	76	79	72	102	91	102	89	103	91	94	86
Native American Adult	94	87	336	195	164	151	91	92	88	89	107	105	104	95	107	104	101	101
Native American Child	81	77	333	190	152	136	79	77	75	74	95	90	95	87	95	89	88	86
Offsite Resident																		
Rural Resident Adult	8	6	17	7	8	7	8	6	8	6	8	6	36	5	9	6	8	7
Rural Resident Child	8	7	20	8	8	9	8	8	8	8	8	8	39	6	9	7	8	9
Native American Adult	18	16	81	11	18	23	18	22	18	22	18	22	130	13	19	21	18	24
Native American Child	9	11	29	11	9	13	9	12	9	12	9	12	48	9	10	11	9	14
Onsite Upland Hunter																		
Native American Adult											1	1						
Native American Child											1	2						
Resident River																		
Native American Adult											9	11						
Native American Child											4	5						

* Cover construction start date is 2005, unless otherwise noted.

The hypothetical offsite and onsite dose projections are summarized in the following statements.

4.4.7.2.1 Offsite Dose

- In general, over 95% of the offsite dose is from the groundwater pathway.

- Hypothetical offsite doses are generally higher for the Native American when compared to the Rural Resident. The Native American hypothetical daily use of a sweat lodge accounts for the majority of the difference. The remainder of the difference is due to an assumed higher subsistence food and water consumption for the Native American.

- Cover designs, except the Site Soils Cover, are predicted to meet the 25 millirem per year offsite dose limit.

- The Site Soils Cover is a simplistic alternative that lacks any special barriers for water infiltration and is missing the improved soils used in a vegetative cover. As a result, the onsite exposure estimates are significantly greater than any other cover.

- The US Ecology Proposed Cover provides the lowest hypothetical peak offsite doses. The Proposed US Ecology cover, although not as robust in design as the Enhanced Covers, allows for a greater amount of contaminants to leach out of the waste prior to cover failure. Therefore, when the cover does fail, the peak concentrations for contaminants are not as great when compared to the Enhanced Covers. So, while the US Ecology Proposed Cover provides a lower hypothetical peak dose than the Enhanced Covers, a greater amount of leachate contaminant is in the groundwater over a longer period of time.

- Hypothetical doses are predicted to be 9 to 11 millirem for the Native American River Resident Adult for closure with the GeoSynthetic Cover. The dose at the river is approximately 50% of the fenceline resident dose, due to dilution in the aquifer.

- The construction schedule has a significant impact on the predicted offsite doses. The GeoSynthetic Cover was evaluated using both the No Action Construction Schedule (no construction until 2056) and the Close-As-You-Go Schedule. Comparing the predicted dose for these two schedules for the first 1,000 years shows that the hypothetical offsite dose exceeds 25 millirem for all offsite residents when cover construction is delayed.

- The License Alternatives have little or no impact on the hypothetical maximum offsite doses. The two reasons why additional waste disposal does not affect offsite doses are: (1) the reduced source term for the second 50 years of site operation; and (2) the use of the Close-As-You-Go Schedule, which covers all existing waste with an impermeable cover in 2005, and all new waste in planned phases.

- Closing the site in 2005 actually results in a slightly higher hypothetical offsite dose, because it will result in an earlier exposure scenario that has less time for cesium 137 to decay. The short-lived cesium 137 (30-year half-life) has more time to decay during the extended operating periods associated with the closure dates of 2215 and 2056.

4.4.7.2.2 Onsite Dose

- Hypothetical offsite doses are generally higher for the Native American when compared to the Rural Resident. The Native American hypothetical daily use of a sweat lodge accounts for the majority of the difference. The remainder of the difference is due to an assumed higher subsistence food and water consumption for the Native American.

- The hypothetical doses in Table 4.H represent the maximum dose that the onsite intruder would be exposed to on the current 40 acres of waste at the commercial LLRW site. If the site continues to be relicensed over the next 50 years, disposal of 100,000 cubic feet per year of diffuse NARM would *not* increase the predicted maximum onsite or offsite dose, but it would increase the potential area of exposure to radon from diffuse NARM from 40 acres to as much as 80 acres.

- The hypothetical maximum onsite intruder dose is from pre-2003 waste. Sixty percent of the onsite intruder dose is from indoor radon (radium 226). The majority of the radon is from discrete NARM (75%).

- For the GeoSynthetic Cover, pre-2003 *discrete* NARM is predicted to contribute approximately 55 millirem per year to the hypothetical onsite intruder who lives on the first 40 acres. If the site is relicensed, future disposal of discrete NARM is predicted to contribute two millirem per year to the onsite intruder who lives on the second 40 acres. The difference in dose is due to the assumption that future discrete NARM will be buried 23 feet below depth.

- For the GeoSynthetic Cover, pre-2003 *diffuse* NARM contributes approximately 15 millirem per year to the hypothetical onsite intruder who lives on the first 40 acres. If 100,000 cubic feet per year are disposed through 2056, diffuse NARM will also contribute 15 millirem per year to the onsite intruder who lives on the second 40 acres. The 36,700, 8,600, and zero cubic feet per year Diffuse NARM Alternatives will contribute 6, 1, and 0 millirem per year, respectively, to the hypothetical offsite intruder living on the second 40 acres.

- The predicted results for the US Ecology Proposed Cover and all three enhanced covers are sufficiently close that no single cover, from a predictive dose standpoint, could be singled out as clearly outperforming the other. While the GeoSynthetic Cover's hypothetical dose is predicted to be greater than 100 millirem per year, the uncertainty associated with these results makes these differences less significant.

- Hypothetical onsite doses for the Homogeneous Cover are significantly greater than for the Enhanced Covers. The greater onsite doses are due to the poor performance of the Homogenous Cover in controlling radon. Unlike the Enhanced Covers, there is no impermeable barrier in the Homogenous Cover to control gaseous emanation.

- A one to two millirem per year dose is predicted for a seven-day exposure to the Native American Upland Hunter. *The difference between the onsite resident dose and the Upland Hunter dose confirms the importance of effective institutional controls in deterring long-term residents from the commercial LLRW site.*

4.4.7.2.3 Diffuse NARM Contribution to Dose

Disposal of 100,000 cubic feet per year of diffuse NARM was predicted to result in no significant public health or environmental impacts. If the site is closed with the GeoSynthetic Cover, diffuse NARM disposed before year 2003 is predicted to contribute 15 millirem per year to the hypothetical *onsite* dose, and less than one millirem per year to the hypothetical *offsite* dose. If the site continues to be relicensed over the next 50 years, disposal of 100,000 cubic feet per year of diffuse NARM would *not* increase the predicted maximum onsite or offsite dose, but it would increase the area of radon exposure from 40 acres to as much as 80 acres.

4.4.7.2.4 Uncertainty Analysis for Hypothetical Doses

The Radiological Risk Assessment includes an uncertainty analysis for the predicted hypothetical doses. The analysis only evaluates the GeoSynthetic Cover and the Rural Resident Adult Scenario. The purpose of the uncertainty analysis is: (1) to determine how accurate the single-point dose projections are in determining the MEI; and (2) to calculate the most probable dose estimate.

The uncertainty analysis considers the possible range of a given parameter such as drinking water ingestion rate, amount of food grown, and time of residence. Ranges were determined for selected parameters, and a Monte Carlo approach was used to determine uncertainty. This approach allows each parameter to vary within a predicted distribution in order to determine the most likely dose and the 95^{th} percentile dose. A list of parameters used in the Monte Carlo Analysis is included as Attachment 1 in the Radiological Risk Assessment (Appendix II).

The uncertainty analysis evaluated uncertainty for the offsite and onsite resident at 60 years, 1000 years, and 10,000 years after closure. Since institutional controls are assumed for 100 years, no analysis was done for the onsite resident at 60 years. Table 4.I presents the uncertainty analysis results. The most probable dose is represented by the mode value, and the 95 percentile represents the maximally exposed individual.

Table 4.I: Rural Resident Adult Uncertainty Results

Time Frame	Single-Point Dose	Mode	95% (MEI)
60 Year			
Offsite Dose (mrem/yr)	8 (0 to 500 years)	2.5	9.5
Onsite Dose (mrem/yr)	42 (0 to 500 years)	NA	NA
1,000 Year			
Offsite Dose (mrem/yr)	2 (500 to 1000 years)	3.5	17
Onsite Dose (mrem/yr)	105 (500 to 1000 years)	28	97
10,000 Year			
Offsite Dose (mrem/yr)	6 (1000 to 10,000 years)	4	65
Onsite Dose (mrem/yr)	93 (1000 to 10,000 years)	30	130

The results of the uncertainty analysis indicate that the maximum single-point dose projections presented in Table 4.I are likely to represent the MEI during the first 500 years after closure, but they under-represent the MEI during the 500 to 10,000 year period. The uncertainty analysis shows that the single-point dose estimates are less certain after 1000 years. The mode value represents the most probable dose an individual would receive.

As stated previously for the drinking water dose, the uncertainty analysis provides a measure of precision of the models used in the Radiological Risk Assessment and should not be interpreted as the probability of any real or actual exposure occurring. It is simply a measure of the precision by which the models can estimate concentrations and doses far into the future. This analysis shows that the models used in the Radiological Risk Assessment are more accurate for the 1,000-year timeframe than for the 10,000-year timeframe.

4.4.7.3 Radiological Cancer Risk

Hypothetical cancer risks are calculated by multiplying the hypothetical dose by the assumed years of exposure and a probability of fatal cancer coefficient (ICRP 1990). Although risk is included in the EIS, it is not used for evaluating the alternatives.[27] Radiological risk has a much higher uncertainty than even the dose values. The hypothetical radiological risk levels presented in Table 4.J do not represent actual risks to the public.

[27] Radionuclide risk is used to compare environmental justice impacts because environmental justice impacts have been historically compared in this manner.

Table 4.J: Lifetime Hypothetical Risk for Individuals

	Cover	Enhanced GeoSynthetic		Enhanced GeoSynthetic with no Cover Until 2056		Enhanced GeoSynthetic		Enhanced GeoSynthetic	
	Closure Date	2056		2056		2005		2215	
	Timeframes (y)	0-1000	1000-10,000	0-1000	1000-10,000	0-1000	1000-10,000	0-1000	1000-10,000
Scenarios	**Onsite Resident Intruder**								
	Rural Resident Adult	1.58E-03	1.40E-03	1.57E-03	1.37E-03	1.59E-03	1.40E-03	1.46E-03	1.32E-03
	Rural Resident Child	1.57E-03	1.39E-03	1.56E-03	1.37E-03	1.58E-03	1.39E-03	1.45E-03	1.31E-03
	Native American Adult	3.75E-03	3.67E-03	5.98E-03	3.34E-03	3.76E-03	3.65E-03	3.52E-03	3.55E-03
	Native American Child	3.71E-03	3.62E-03	5.71E-03	3.31E-03	3.72E-03	3.60E-03	3.48E-03	3.50E-03
	Offsite Resident								
	Rural Resident Adult	1.17E-04	9.53E-05	5.37E-04	7.41E-05	1.29E-04	9.11E-05	1.16E-04	1.11E-04
	Rural Resident Child	1.18E-04	9.94E-05	5.47E-04	7.75E-05	1.31E-04	9.39E-05	1.17E-04	1.16E-04
	Native American Adult	6.26E-04	7.74E-04	4.54E-03	4.43E-04	6.56E-04	7.49E-04	6.24E-04	8.42E-04
	Native American Child	6.00E-04	7.43E-04	4.29E-03	4.33E-04	6.29E-04	7.18E-04	5.98E-04	8.11E-04
	Onsite Upland Hunter								
	Native American Adult	4.12E-05	4.74E-05						
	Native American Child	4.12E-05	4.85E-05						
	Resident River								
	Native American Adult	3.12E-04	3.71E-04						
	Native American Child	2.97E-04	3.54E-04						

Table 4.J: Lifetime Hypothetical Risk for Individuals (Continued)

	Cover	Proposed US Ecology		Site Soils		Thick Homogeneous (same gw as EC covers)		Enhanced Asphalt		Enhanced Bentonite	
	Closure Date	2056		2056		2056		2056		2056	
	Timeframes (y)	0-1000	1000-10,000	0-1000	1000-10,000	0-1000	1000-10,000	0-1000	1000-10,000	0-1000	1000-10,000
Scenarios	**Onsite Resident Intruder**										
	Rural Resident Adult	8.40E-04	1.16E-03	5.76E-03	3.21E-03	2.59E-03	2.21E-03	6.10E-04	1.17E-03	8.23E-04	1.12E-03
	Rural Resident Child	8.27E-04	1.16E-03	5.76E-03	3.20E-03	2.58E-03	2.20E-03	5.96E-04	1.16E-03	8.09E-04	1.11E-03
	Native American Adult	1.41E-03	1.31E-03	5.04E-03	2.92E-03	2.46E-03	2.26E-03	8.72E-04	1.38E-03	1.32E-03	1.34E-03
	Native American Child	1.37E-03	1.28E-03	5.03E-03	2.91E-03	2.43E-03	2.22E-03	8.26E-04	1.34E-03	1.28E-03	1.29E-03
	Offsite Resident										
	Rural Resident Adult	1.18E-04	3.78E-05	2.57E-04	7.73E-05	1.21E-04	5.10E-05	1.14E-04	3.27E-05	1.16E-04	3.18E-05
	Rural Resident Child	1.19E-04	3.93E-05	2.66E-04	8.18E-05	1.22E-04	5.17E-05	1.16E-04	3.34E-05	1.18E-04	3.25E-05
	Native American Adult	6.41E-04	4.24E-04	2.83E-03	2.42E-04	6.36E-04	4.20E-04	6.20E-04	3.77E-04	6.25E-04	3.75E-04
	Native American Child	6.13E-04	4.01E-04	2.67E-03	2.50E-04	6.09E-04	3.97E-04	5.93E-04	3.54E-04	5.99E-04	3.53E-04
	Onsite Upland Hunter										
	Native American Adult										
	Native American Child										
	Resident River										
	Native American Adult										
	Native American Child										

4.4.7.4 Preferred Alternative Impacts, Mitigation Measures, and Significant Unavoidable Impacts

Renew License Impacts. Renewing the license for five years has no impact on hypothetical post-closure doses. Renewing the license and operating the site through 2056 contributes less than one millirem per year to the hypothetical post-closure offsite dose. Operating the site through 2056 also has little impact on the maximum onsite hypothetical dose, but it does increase the size of the onsite intruder area from 40 to as much as 80 acres.

Diffuse NARM Impacts – 100,000 cubic feet per year. An annual site limit of 100,000 cubic feet of diffuse NARM does not increase the maximum hypothetical post-closure dose to the onsite or offsite resident. Diffuse NARM disposed before 2003 contributes approximately 15 millirem per year to the hypothetical onsite intruder. Continued disposal of diffuse NARM through 2056 would not increase this dose, but it would increase the onsite exposure area from 40 to as much as 80 acres.

GeoSynthetic Cover Impacts. Hypothetical doses are less than the offsite 25-millirem regulatory requirement and slightly above the 100 millirem onsite guidance value. Hypothetical post-closure groundwater concentrations are predicted to exceed the drinking water MCL's for H-3 (0 to 250 years) and I-129 (5,000 to 10,000 years). *The hypothetical post-closure concentrations of H-3 and I-129 are not a result of relicensing the site. Potential groundwater impacts are predicted to be a result of waste disposed before 2003.*

Close-As-You-Go Schedule Impacts. Predicted to significantly reduce offsite post-closure doses for the first 1,000 years after closure.

Mitigation Measures. Use post-closure institutional controls and conduct performance and reliability monitoring of early constructed covers. If the license is renewed, implement additional license requirements, including license limits for all nuclides that are predicted to contribute to the hypothetical post-closure dose (Ra-226, H-3, I-129, Tc-99, U-238, C-14, U-234, Pu-239), secondary containment for LLRW containing radionuclides that are predicted to contribute to hypothetical groundwater concentrations (H-3, I-129, Tc-99, U-238, C-14, U-234, Pu-239), and deeper burial of discrete NARM. Groundwater and vadose zone monitoring will be done to refine modeling predictions for H-3 and I-129. If future monitoring supports the predicted groundwater concentrations of H-3 and I-129, further remedial actions for H-3 and I-129 will be implemented.

Significant Unavoidable Impacts. Hypothetical post-closure H-3 and I-129 concentrations are predicted to exceed drinking water MCL's. The elevated concentrations of H-3 and I-129 are best presented in the context of the groundwater quality surrounding the commercial site and USDOE's plans to use institutional controls to restrict public access to the central plateau.

4.5 Risk from Non-Radioactive Hazardous Waste

This section addresses risk from non-radioactive hazardous wastes that were disposed at the commercial LLRW site. Two of the key requirements the Department of Ecology will use to determine the adequacy of site closure are:

- RCRA guidance document--*Landfill Design Liner Systems and Final Cover*, EPA PB 87-157 657/AS, 1987.
- MTCA Cleanup risk levels for non-radioactive hazardous substances (Chapter 173-303 WAC).

4.5.1 RCRA Compliance

The RCRA minimum technology requirements for landfill covers are designed to specifically address the hazards of hazardous wastes. The commercial LLRW site is subject to these requirements because the site received hazardous and mixed waste before these wastes were banned for disposal. Table 4.K identifies those cover design alternatives that comply with the RCRA minimum technical requirements (Heppner 1998).

Table 4.K: RCRA Cover Design Compliance

Closure Cover Design	Meets RCRA Requirements?	Comments
US Ecology Proposed Cover	No	Includes 1 foot thick bentonite/soil low-permeability barrier – RCRA compliance requires 2-foot thick bentonite/soil low-permeability barrier
Site Soils Cover	No	High infiltration
Homogenous Cover	No	Lacks a secondary low-permeability barrier
Asphalt Cover	Yes	Meets requirements
GeoSynthetic Cover	Yes	Meet requirements
Bentonite Cover	No	Includes 1 foot thick bentonite/soil low-permeability barrier – RCRA compliance requires 2-foot bentonite/soil low-permeability barrier

The Asphalt Cover and the GeoSynthetic Cover meet RCRA requirements. Both the US Ecology Proposed Cover and the Bentonite Cover could be modified to be RCRA-compliant by doubling the thickness of the low-permeability bentonite barrier (Heppner 1998).

4.5.2 MTCA Compliance

MTCA requires cleanup of hazardous substances to a cancer health risk level. The health risk from the past disposal of non-radioactive hazardous waste was predicted in the *Final Chemical Risk Assessment for the Commercial Low-Level Radioactive Waste*

Disposal Facility (Kirner 1999). This report was only preliminary and was completed prior to the completion of the US Ecology Site Investigation.

The Department of Ecology will conduct a MTCA investigation at the commercial LLRW site in 2004. A risk assessment on non-radioactive hazardous substances will be completed by the Department of Ecology following the 2004 MTCA investigation. Results of the MTCA risk assessment will be used to determine if remedial actions, in addition to the presumptive remedy of a cover, will be necessary to address non-radioactive hazardous substances. An example of further remedial actions might be a groundwater pump-and-treat system. This information will also be used, if necessary, to determine if modifications to the design of the final cover are necessary. An example of a cover modification might be the installation of vents to address volatile non-radioactive substances.

4.5.3 Preferred Alternative Impacts, Mitigation Measures, and Significant Unavoidable Impacts

Renew License Impacts. Renewing the license will have no impact on risk from non-radiological hazardous waste. Non-radioactive hazardous waste is not licensed for disposal at the commercial LLRW site.

Diffuse NARM Impacts – 100,000 cubic feet per year. A NARM limit of 100,000 cubic feet will have no impact on risk from non-radiological hazardous waste. Diffuse NARM is not a hazardous waste.

GeoSynthetic Cover Impacts. The GeoSynthetic Cover complies with RCRA requirements for a hazardous waste site. Post-closure risk from hazardous waste will be determined following the 2004 MTCA investigation.

Close-As-You-Go Schedule Impacts. The three construction phases of the Close-As-You-Go Schedule allow for the 2004 MTCA investigation results to be incorporated into the final cover design.

Mitigation Measures. Incorporate results of the 2004 MTCA investigation into the final cover design.

Significant Unavoidable Impacts. None.

5.0 AFFECTED ENVIRONMENT

This section discusses the existing environment and potential future impacts of the proposed actions. The environment includes earth, water, air, and ecological and biological resources at and adjacent to the commercial LLRW site. Descriptions of the existing environment are based on monitoring data and field observations. Future potential impacts described in this section are hypothetical. The predicted hypothetical impacts are best used to make relative comparisons of the various alternatives and do not represent actual future conditions.

5.1 Earth Resources

This section discusses the climate, geology, and surface soils.

5.1.1 Climate

Climate at the Hanford Site is strongly influenced by the rain shadow effect of the Cascade Mountain Range. Climatic data have been collected at the Hanford Meteorological Monitoring Network stations. The Hanford Meteorological Station (HMS), located near the commercial LLRW site, is the most completely instrumented station. From 1961 through 1990, the average monthly temperatures varied from 31° Fahrenheit (F) in January to 76° F in July (Neitzel 2000). The average annual precipitation measured at the HMS is 6.8 inches. The bulk of the precipitation (54%) occurs November through February. Annual average snowfall is 15 inches *(*Neitzel 2000).

The area is known for its windy conditions and its “dust storms.” Prevailing winds are generally from the west-northwest, but peak gusts are often from the southwest. Wind speeds average four to seven miles per hour, with the strongest winds occurring in June. Winds over 18 miles per hour occur less than five percent of the time. Atmospheric dispersion, or the ability for particles such as soil and contaminants to be carried by the wind, is highest in the summer and lowest in the winter (Neitzel 2000).

5.1.2 Geology

The Hanford Site lies within the Pasco Basin, a structural depression that has accumulated a thick sequence of fluvial lacustrine and glacio-fluvial sediments (Neitzel 2000). The unconsolidated sediments, known as the Hanford and Ringold Formation, vary in thickness and texture, and overlie thick basaltic lava flows of the Columbia River Basalt Group. Together the Hanford and Ringold Formation host an unconfined aquifer system.

The Hanford Formation was deposited by the cataclysmic Columbia River floods during the Ice Age (Pleistocene) and consists of alternating layers of silt, fine sand, and medium to coarse sand over poorly sorted sands, silts, and gravels. Sediments in the lower Ringold Formation are more consolidated and partially cemented, making them 10 to 100 times less permeable than the sediments of the overlying Hanford formation.

On the Columbia Plateau, clastic dikes are commonly associated with the cataclysmic flood deposits, and some examples can be seen in the trench walls at the commercial LLRW site. Clastic dikes may provide preferential pathways for rapid lateral and vertical migration of contaminants through the vadose zone. On the plateau, dikes vary in width from less than 1 mm to greater than 2 meters. Vertical extents range from less than one meter to greater than 50 meters, with a large number of dikes greater than 20 meters in size (Neitzel 2000).

Clastic dikes appear to exhibit greater flux than the surrounding soils at low infiltration rates (1 mm/year). However, at higher infiltration rates (100 mm/year), flux rates are nearly the same in the dikes as in the surrounding soils. The vertical hydraulic continuity of the dikes at depth is not understood. The relative degree of hydraulic continuity will greatly influence the importance of dikes as a preferential pathway through the vadose zone (Murray 2003). At this time, there is insufficient evidence to determine if clastic dikes have or will influence the migration of contaminants at the commercial disposal site. The 2004 MTCA investigation may provide more information on the role of clastic dikes at the commercial LLRW site.

5.1.3 Surface Soils

The *Soil Survey: Hanford Project in Benton County, Washington* (Hajek 1966) describes the predominant surface soil types on the central plateau as Quincy sand (40%), Burbank loamy sand (39%), and Ephrata sandy loam (14%). These site soils have characteristically low water-holding capacity, due to low organic matter and a low percentage of clay. The surface soils at the commercial LLRW site are about 10 to 20 feet deep and are primarily sandy loam and silty sands (US Ecology 1996).

For the past 45 years, soils at the commercial LLRW site have been subject to disturbance from normal waste operations. Soil disturbance commonly alters soil productivity, structure, and water-holding capacity.

Radionuclide levels in surface soils at the commercial LLRW site are listed in Table 5.A. The data show that there have been some small increases in gross beta, uranium, cesium 137, cobalt 60, and europium 155. All of the levels are below the reporting levels in the US Ecology license. The reporting levels in the US Ecology license are early warning values and are established below levels considered a threat to public health.

Table 5.A: Radionuclide Concentrations in Soil (pCi/g)

Radionuclide	1998 Data		2001 Data		Reporting Level	*Ambient Background
	High	Avg.	High	Avg.		
Gross Beta	21.6	18.10	33.3	19.7	35.0	17.0
Total Uranium	0.8	0.36	0.64	0.35	1.0	0.31
Plutonium 238	<0.01	<0.01	<0.01	<0.01	0.03	<0.01
Plutonium 239/240	<0.01	<0.01	<0.01	<0.01	0.03	<0.01
Cesium 137	0.12	0.03	0.09	0.03	0.25	0.04
Cobalt 60	0.03	<0.01	<0.02	<0.02	0.30	<0.02
Europium 155	0.06	0.03	0.06	0.04	0.25	<0.02

*Ambient background is based on data collected at Station #1, located at the northeast corner of the site (near the US Ecology office). These data are subject to influence by activities at Hanford.

5.1.4 Non-Radionuclide Hazardous Substances in Surface Soils

There are no data for non-radiological substances in surface soils. The 2004 MTCA investigation will sample contaminants of potential concern as defined by the Data Quality Objective process (EQM 2003).

5.1.5 Potential Future Impacts

There are no anticipated potential impacts to the climate of the commercial LLRW site from the three proposed actions. Impacts to the subsurface of the site are primarily impacts to the vadose zone and are discussed in Section 4.2.2, Water. There will be some impact to site soils from the three proposed actions.

Based on historical data, including data shown in Table 5.A, radionuclide contamination of surface soils is not expected to increase significantly with continued site operations. There will be no additional site disturbance from operations if the license is denied. If the license is renewed or stays in timely renewal, new trenches are likely to be constructed. However, all new trench construction will occur in previously disturbed areas, so additional soil disturbance is not expected to result in significant environmental harm. Continuing to operate the site under the Renew License or Timely Renewal alternatives will delay remediation of the site anywhere from five to 50 years.

Construction of the cover will cause a temporary disturbance through excavation and soil moving activities. Fifteen acres of undisturbed habitat located in the northwest corner of the site may be used as a borrow site for construction of the cover. If so, this area will experience long-term disturbance. Once the cover is complete, it will increase the water-holding capacities and soil productivity on the site. Cover design alternatives with the most silt loam, such as the Enhanced Covers and Homogenous Covers, will most benefit water-holding capacities and soil productivity. Cover schedule alternatives that include early construction of a cover, such as the Close-As-You-Go Schedule, will mitigate surface soils sooner. Construction of a cover will also isolate any existing surface contamination.

5.1.6 Preferred Alternative Impacts, Mitigation Measures, and Significant Unavoidable Impacts

Renew License Impacts. No increase in contamination of surface soils is anticipated from renewing the license. Soil disturbance will be minimal over the next five-year licensing period because it is unlikely there will be any new trench construction. Through 2056, soil disturbance will occur from the construction of an estimated two additional trenches. Continued operations under a renewed license will delay surface soil remediation in those areas of the site receiving new waste.

Diffuse NARM Impacts – 100,000 cubic feet per year. No additional impacts are anticipated from a 100,000 cubic foot per year limit.

GeoSynthetic Cover Impacts. Cover construction will cause a temporary increase in soil disturbance. The undisturbed 15 acres in the northwest corner may be used as a borrow site. If so, the soils in this area will experience long-term impacts.

Close-As-You-Go Schedule Impacts. The Close-As-You-Go Schedule will mitigate soil disturbance as phases of the cover are completed.

Mitigation Measures. The cover will be planted with native plants. Standard erosion control practices will be used in all disturbed areas. Any disturbance to the 15 acres in the northwest corner will be mitigated through grading and re-vegetating the area.

Significant Unavoidable Impacts. None.

5.2 Water

This section discusses the vadose zone, groundwater, and the surface water at or near the commercial LLRW site. Applicable water quality standards include the Washington State Groundwater Quality Standards (Chapter 173-200 WAC) and the Washington Surface Water Quality Standards (Chapter 173-201 WAC). The standards are used to determine if *existing* water quality is in compliance. The standards are also used to compare the relative hypothetical future impacts of the proposed actions on water quality by comparing the standards with the predicted water quality.

5.2.1 Vadose Zone

The vadose zone is the unsaturated zone located between the surface soils and the water table or saturated zone. Concentrations measured in the vadose zone provide early warning for potential impacts to groundwater. Under the commercial LLRW site, the vadose zone is unconsolidated glacio-fluvial sands and gravels of the Hanford Formation and is 300 feet thick (US Ecology 1996). Water movement through the vadose zone is the primary driver for contaminants reaching the groundwater.

Natural recharge in the central plateau area is estimated to be 5 mm/year (PNNL 1998). Recharge in unvegetated areas and disturbed areas has been estimated as high as 20 mm/year (Gee 1993). Preferential and higher rates of flow may occur through the vadose zone along discontinuities such as clastic dikes. The influence of clastic dikes on water movement through the vadose zone at the commercial LLRW site has not been quantified (Neitzel 2000).

5.2.1.1 Radionuclides in the Vadose Zone

The 1998 US Ecology Site Investigation is the primary source of vadose zone data at the commercial LLRW site. Table 5.B shows data for nine radionuclides that were reported in the 1998 Investigation (US Ecology 1998b). Of these nine radionuclides, Ni-63, Pu-239/240, and Sr-90 were found in a significant number of samples; Am-241, Pu-238, and Tc-99 were found in a small number of samples at values slightly higher than the maximum detectable concentration (MDC); Ra-226 and U-238 were found at natural background levels; and Co-60 was detected at levels below the MDC (DOH 2002a). The radionuclides in the vadose zone are not an immediate threat to public health or the environment. However, the presence of these radionuclides serves as an early warning that groundwater could be impacted in the future.

Table 5.B: Vadose Zone Soil Radionuclide Levels

Radionuclide	Chemical Trench (Boreholes A and B) pCi/g	Trench 5 (Boreholes C and D) pCi/g	Comments
Am-241	< MDC – 0.2	< MDC	All results below MDC, except for one sample that was slightly above the MDC in borehole B.
Co-60	< MDC	< MDC	All results below MDC.
Ni-63	1 - 6	3 - 10	All results above MDC. Detected in a significant number of samples in all boreholes.
Pl-238	< MDC - .04	< MDC	Majority of results below MDC. Three samples under Chemical Trench above MDC.
Pl-239/240	< MDC - .04	< MDC	Significant number of samples in boreholes A & B have concentrations equal to or above MDC.
K-40	16.5 – 26.5	16.5-26.5	Results consistent with natural background values.
Ra-226	0.3 - 0.7	0.3 – 1.0	Results consistent with natural background values.
Sr-90	0.1 – 1.2	0.1 – 0.3	Most samples above MDC. Higher concentrations under Chemical Trench.
Tc-99	< MDC – 1.0	< MDC – 1.0	Most results below MDC.
U-238	0.1 – 0.4	0.1-0.3	Results consistent with natural background values.

Note: All data from the US Ecology Site Investigation

5.2.1.2 Non-Radionuclide Hazardous Substances in the Vadose Zone

Results from the US Ecology Site Investigation indicate the presence of non-radioactive hazardous substances in the vadose zone and vadose zone gases (Department of Ecology 2000). Concentrations of metals that exceed screening levels in the vadose zone include arsenic, beryllium, cadmium, and chromium. Table 5.C lists the hazardous substances that were detected in the vadose zone, vadose zone gas, and the groundwater.

Table 5.C: Hazardous Substances Detected at the Commercial LLRW Site[28]

Chemical Constituent	Chemical Trench		Trench 5		Groundwater
	Vadose Zone	Vadose Zone Gas	Vadose Zone	Vadose Zone Gas	
Acetone			X		
1, 2, 4-trimethylbenzene			X		
Trichloroethene (TCE)		X		X	X
tetrachloroethene (PCE)	X	X			
Chloroform		X		X	X
Freon 11		X		X	
Freon 12		X		X	
Freon 113		X		X	
Freon 114				X	
1, 1, 1-trichloroethane		X		X	
1, 1-dichloroethane		X		X	
1, 1,-dichloroethene		X		X	
Methylene chloride		X		X	
1, 2-dichloroethane		X		X	
Benzene		X		X	
Cis-1, 2-dichloroethene		X		X	
1, 2- dichloropropane		X		X	
Toluene		X	X	X	
Chloroethane		X		X	
Vinylchloride				X	
1, 1, 2-trichloroethane				X	
Bromomethane		X			
Carbon tetrachloride		X		X	
Chlorobenzene		X			
Ethylbenzene		X		X	
Styrene		X			
Vinyl chloride				X	
Cis-1, 2-dichloroethene		X		X	
Xylene, total		X	X	X	
Chloromethane		X		X	
Hexavalent chromium	X		X		X
Arsenic	X		X		X

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[28] Project screening levels for non-radioactive substances in the vadose zone soils and the groundwater were established at MTCA Method B Levels as appropriate. There were no screening levels for vadose zone gas.

Chemical Constituent	Chemical Trench		Trench 5		Groundwater
	Vadose Zone	Vadose Zone Gas	Vadose Zone	Vadose Zone Gas	
Barium					X
Beryllium	X				
Cadmium	X		X		
Calcium					X
Trivalent chromium	X		X		X
Total chromium	X		X		X
Copper	X		X		
Mercury			X		
Silver			X		
Thallium			X		
Cyanide	X		X		
Sulfide	X		X		
Iron					X
Manganese					X
Nickel	X		X		X
Selenium	X		X		X
Sodium					X
Chloride	X		X		X
Fluoride	X		X		X
Nitrate	X		X		X
Phosphate					X
Sulfate	X		X		X
Total phenols					X
Lead	X		X		X
Zinc	X		X		X
Bis(2-ethylhexyl)phthalate					X

The presence of these chemicals indicates a release and the threat of additional releases of non-radioactive hazardous substances from the commercial LLRW site (Ecology 2000). High concentrations of volatile organic compounds were detected in soil gas samples beneath the trenches in the vadose zone. However, the public health risk from the concentrations detected in the vadose zone is limited, due to the remote location of the US Ecology Site (Ecology 2000).

5.2.2 Groundwater

The groundwater most vulnerable to activities at the commercial LLRW site is the unconfined aquifer located in the Ringold and Hanford formations at approximately 300 feet below the commercial LLRW site. Natural groundwater quality is good, but the existing groundwater quality has been impacted by many of the activities at Hanford. Large areas underlying the Hanford Site have elevated levels of both radiological and non-radiological constituents. Principal groundwater contaminants of concern at Hanford include trichloroethene, carbon tetrachloride, uranium, plutonium, Co-60, Sr-90, H-3, C-14, Cs-137, and Tc-99 (USDOE 1999).

The direction of groundwater flow is generally from southwest to northeast at a gradient of 0.0004 ft/ft (Riley 2002). The rate of groundwater flow in the unconfined aquifer is extremely variable. Groundwater flow under the commercial LLRW site has been estimated at 1,095 ft/year (Grant 1996). This rate of flow was estimated using standard hydrogeologic techniques, but it has not been measured directly.

Prior to wastewater discharges at the Hanford Site, the unconfined or upper aquifer was mainly within the Ringold Formation, and the water table extended into the Hanford formation at only a few locations (Newcomb 1972). Wastewater discharges at Hanford have since raised the water table elevation and created groundwater mounds in the 200 Area, causing the unconfined aquifer to extend up into the Hanford Formation. This increase in water level has resulted in increased transmissivity because of the highly permeable Hanford Formation and the greater volumes of groundwater.

With the cessation of those discharges, the groundwater levels at the commercial LLRW site have been dropping at a rate of approximately 0.5 foot per year, and are expected to continue to drop for several more years (Riley 2002). However, the gradient and direction of groundwater has not changed in response to the dissipation of groundwater mounds beneath the 200 West and 200 East areas (Riley 2002).

5.2.2.1 Radionuclides in Groundwater

Table 5.D shows radionuclide levels detected in groundwater under the commercial LLRW site. The data in Table 5.D are a compilation of three data sets, including the Annual Environmental Monitoring, the DOH Confirmational Monitoring, and the US Ecology Site Investigation (DOH 2002a).

Table 5.D: 1995-2001 Radionuclide Groundwater Data**

Radionuclide	Downgradient (pCi/L)	Upgradient* (pCi/L) Wells 9, 9A and 13	License Reporting Level (pCi/L)	Comment
Gross Alpha	< MDC – 8	<MDC – 7	15.0	b, c, f, i, k
Gross Beta	4.6 - 8.8	5.6 – 11.0	50.00	g, k, h, j
Co- 60	< MDC - 2	< MDC 3	100.0	b, c, f, i, k
Cs-137	< MDC	< MDC	200.0	a, k
Tc-99	5 - 28	5 - 38	None	e, f, k
Pu-238	< MDC	< MDC	40.0	a, k
Pu-239/240	< MDC - .25	< MDC - .1	40.0	b, d, f, i, k
U-238	0.2 - 1.8	.5 - 1.2	30.0	e, f, i, k
C-14	< MDC - 100	< MDC-125	2,000	b, c, f, k
H-3	2000 - 3500	1000 - 5000	20,000	e, h, j, k

**Data are rounded.
*pCi/L means picocuries per liter.
*MDC means minimum detectable concentration. MDC's varied among different data sets.
< MDC means the sample concentration is less than the minimum detectable concentration.

Table Key:
a. All results are below the MDC.
b. Most results are below the MDC.
c. The few results greater than the MDC are less than twice the MDC.
d. The few results greater than the MDC were not confirmed with follow-up sampling.
e. All or most results are above the MDC.

f. For the results above the MDC, the downgradient and upgradient concentrations are similar.
g. Concentrations in the downgradient well are greater than those in the upgradient well.
h. Concentrations in the upgradient well are greater than those in the downgradient well.
i. Most results are consistent with natural background concentrations.
j. Most results are greater than background concentrations.
k. All results are less than State Groundwater Quality Standards (Chapter 173-200 WAC).

Table 5.D shows values above MDC's for gross alpha, gross beta, C-60, Tc-99, Pu-239/240, U-238, C-14, and H-3. Although Table 5.D shows positive values for gross alpha, C-60, andPu-239/240, the preponderance of data for these radionuclides are below the MDC, meaning there is low confidence that these radionuclides are actually present in the groundwater below the commercial LLRW site. The preponderance of data for gross beta, Tc-99, U-238, and H-3, are above the MDC's, giving higher confidence that these radionuclides exist in groundwater below the site (DOH 2002). All of the radionuclide levels in Table 5.D are below the Washington State Groundwater Quality Standards. The source of the radionuclides detected in the groundwater is inconclusive.

5.2.2.2 Non-Radioactive Substances in Groundwater

Results of the US Ecology Site Investigation indicate the presence of non-radioactive hazardous substances in the groundwater below the commercial LLRW site. Table 5.D shows the hazardous substances that were detected in groundwater. Organic chemicals detected in groundwater include trichloroethene (TCE) and chloroform (US Ecology 1998b). TCE was detected at 5.7 parts per billion (ppb) and 10 ppb in third and fourth quarter sampling, respectively. The MTCA cleanup standard for TCE is 3.98 ppb. Chloroform was detected at 7.9 and 20 ppb in third and fourth quarters, respectively. The MTCA cleanup standard for chloroform in groundwater is 7.17 ppb. Hexavalent chromium and nitrate exceeded the screening levels for third and fourth quarter groundwater sampling.

The source of the hazardous substances in the groundwater under the commercial LLRW site has not yet been determined. Some of the substances had similar upgradient and downgradient values. Most of the hazardous substances detected in groundwater were also detected in the vadose zone. Public health impacts from non-radioactive substances in groundwater under the commercial site will be determined following the 2004 MTCA investigation.

5.2.3 Surface Water

There is no surface water located on the commercial LLRW site. Surface water in the general area includes Cold Creek, the Yakima River, the Columbia River, and several springs. In terms of total flow, the Columbia River is the second largest river in the contiguous United States. The Columbia River is located approximately 15 miles east of the commercial LLRW site. Groundwater in the vicinity of the commercial LLRW site is not used for drinking water; however, the Columbia River is a regional drinking water source.

USDOE has documented impacts on the Columbia River from their past activities elsewhere at the Hanford Site (PNNL 1999). However, there has been no documentation of contaminants reaching the Columbia River from the commercial LLRW site.

5.2.4 Predicted Future Impacts

5.2.4.1 Radionuclides

Hypothetical future groundwater concentrations are discussed in Section 4.4.6.2, Groundwater Concentrations. The groundwater model predicted little impact on maximum groundwater concentrations from license renewal. Future waste disposal is not predicted to impact maximum groundwater concentrations because: (1) the source term for the next 50 years is a small fraction of the source term already received; and (2) the assumed use of the Close-As-You-Go Schedule significantly limits additional releases of radionuclides into the vadose zone.

The groundwater model predicted that seven radionuclides might impact groundwater during the 0 to 10,000-year period after closure. These seven radionuclides are I-129, Tc-99, U-238, H-3, C-14, and the mobile fractions of U-234 and Pu-239. The groundwater model predicts that the Homogenous and Enhanced Cover designs and the Close-As-You-Go Schedule would provide the greatest protection against post-closure groundwater contamination.

For all cover designs and cover schedules, hypothetical I-129 and H-3 concentrations are predicted to exceed a state groundwater standard. For closure with the GeoSynthetic Cover and the Close-As-You-Go Schedule, the hypothetical maximum concentration for H-3 is 80,000 picocuries per liter; the standard is 20,000 picocuries per liter. The H-3 peak is predicted to occur within 250 years after closure. After the H-3 concentration peaks, it drops to 0.41 picocuries per liter. For I-129, the hypothetical maximum concentration is 2.93 picocuries per liter; the groundwater standard is 1.0 picocuries per liter. The I-129 concentration is predicted to exceed the standard between 5,000 and 10,000 years.

The impacts of H-3 and I-129 in groundwater are best presented in the context of the groundwater quality of the surrounding Hanford Site. The groundwater under the central plateau is currently contaminated and is likely to remain so for the foreseeable future. USDOE plans on remediating this ground water using best available technology. It is anticipated that remediation of certain contaminants, including H-3 and I-129, will be delayed due to limits in technology. USDOE is planning to use institutional controls to restrict public access in the central plateau for *at least* the next 50 years after the Hanford Site is closed (USDOE 1999). In this context, hypothetical groundwater concentrations of H-3 or I-129 due to the commercial LLRW site, would contribute little if any to the overall impact on public health.

Washington's Surface Water Quality Standards have the same radiological standards as groundwater. Groundwater travel time to the Columbia River from the commercial LLRW site is calculated to be approximately 80 years. Dilution in the aquifer was not considered in the groundwater modeling. However, dilution due to bank storage was assumed to reduce radionuclide concentrations by about 50% before the contaminants enter the Columbia River (Thatcher 2003). Even with the bank storage dilution, the hypothetical groundwater concentrations for H-3 and I-129 are predicted to exceed the surface water standards at the point of discharge into the Columbia River.

5.2.4.2 Non-Radioactive Hazardous Substances

The US Ecology Site Investigation indicated the presence of non-radioactive hazardous substances in the vadose zone and groundwater. The presence of these substances indicates the threat of additional releases of non-radioactive hazardous substances from the commercial LLRW site (Department of Ecology 2000). The future risk from contaminant concentrations in the vadose zone gas can be estimated using Henry Law's Constant to calculate those concentrations in the future. This analysis indicated that existing concentrations of acetone in the vadose zone gas could result in groundwater concentrations that exceed MTCA cleanup levels (Department of Ecology 2000).

Any release of a hazardous substance to the environment may pose a threat to human health and the environment when MTCA levels are exceeded. However, similar to radionuclides, exposure to non-radionuclides via groundwater will be limited by USDOE controlled access.

There has been no modeling done to predict public health or environmental impacts from non-radionuclide hazardous substances at the commercial LLRW site. A risk assessment for hazardous substances will be conducted following the 2004 MTCA investigation.

5.2.5 Preferred Alternative Impacts, Mitigation Measures, and Significant Unavoidable Impacts

Renew License Impacts. The Renew License Alternative will have little or no impact on the maximum hypothetical groundwater concentrations if the site is relicensed for five years or operated through 2056.

Diffuse NARM Impacts – 100,000 cubic feet per year. Disposal of 100,000 cubic per year of diffuse NARM will have little or no impact on groundwater concentrations.

GeoSynthetic Cover Impacts. Hypothetical H-3 and I-129 concentrations are predicted to exceed a state groundwater quality standard at 250 and 5000 years, respectively.

Close-As-You-Go Schedule Impacts. The Close-As-You-Go Schedule significantly reduces offsite post-closure concentrations for the first 1,000 years after closure.

Mitigation Measures. Require secondary containment and license limits for LLRW containing radionuclides that are predicted to contribute to hypothetical groundwater concentrations (H-3, I-129, Tc-99, U-238, C-14, U-234, Pu-239). Increase environmental monitoring for H-3 and I-129. Consider further remedial actions for H-3 and I-129 if future monitoring supports the predicted groundwater concentrations of H-3 and I-129. Require institutional controls for the foreseeable future.

Significant Unavoidable Impacts. Hypothetical post-closure concentrations of H-3 and I-129 may potentially exceed the State Groundwater Quality Standards. Elevated groundwater concentrations are best presented in the context of the degraded groundwater quality surrounding the commercial site.

5.3 Air Quality

This section discusses existing environmental air quality and predicted future air quality at the commercial LLRW site. This section does not address public health impacts resulting from radon or other airborne radionuclides. These impacts are discussed in Section 4.4.

The current air quality at the commercial LLRW site is generally good, but it has been influenced by fugitive dust and routine emissions of radionuclides from the commercial LLRW site and adjacent Hanford operations. Local air quality at the Hanford Site is monitored regularly and is in compliance with national ambient air quality standards (USDOE 2002).

Non-radioactive emissions including vehicle emissions and fugitive dust are present at the commercial LLRW site. Carbon monoxide, nitrogen dioxide, sulfur dioxide, and particulate matter are produced from the combustion of fossil fuels. Fugitive dust can be generated through trench excavation, waste disposal, and vehicle traffic. The arid climate and windy conditions add to the generation of fugitive dust. Routine dust abatement measures, including watering of roads, covering of loose soils, and revegetation efforts, have helped minimize impacts on windy days.

Airborne radioactivity at the commercial LLRW site is also monitored on a regular basis. The 2001 environmental monitoring data shown in Table 5.E indicate a small increase in radon. This increase has historically been intermittent and is concurrent with periods of surface soils excavation (Fordham 2000). Data show that the maximally exposed person (MEI) receives less than 0.1 millirem per year for the commercial LLRW site, which is significantly lower than the 10-millirem per year ambient air standard (Fordham 2000).

Table 5.E: Airborne Radionuclide Concentrations (uCi/cc)

Radionuclide	1998 Data		2001 Data		US Ecology License Reporting Level	Area Background Levels
	High	Avg.	High	Avg.		
Gross Beta	5.1 E-14	2.1 E-14	5.6 E-14	1.6 E -14	2.6 E -11	1.7 E-14
Gross Alpha	6.7 E-15	2.0 E-15	5.2 E-15	1.3 E-15	1.7 E - 14	1.6 E-15
H-3	1.1 E-11	2.4 E-14	1.4 E-11	2.7 E-12	6.1 E-8	1.3 E-12
Radon-222 (pCi/L)	2.8	1.4	4.3	1.7	None	1.4
Gamma Emitters	< MDC	< MDC	<MDC	< MDC	5 x MDC	< MDC

- UCi/cc means microcuries per cubic centimeter
- MDC means minimum detectable concentration

Concentrations in Table 5.E are below the reporting levels in the US Ecology License and below the Radiation Protection Air Emissions Standards (Chapter 246-247 WAC).

5.3.1 Potential Future Impacts

5.3.1.1 Radionuclides

If the license were denied, there would be no risk of increased airborne radionuclides from operating the site. If the site were relicensed or remained in timely renewal, current trends of airborne radionuclides at the commercial LLRW site indicate that radionuclide concentrations would remain below the license reporting levels over the next five-year license period. Current trends also indicate that airborne radionuclides would remain below reporting levels if the site were to operate through 2056. Longer-term public health impacts from radon are discussed in Section 4.4, Post-Closure Radiological Dose.

5.3.1.2 Non-Radionuclide Hazardous Substances

If the license were denied, there would be no further emissions from vehicles during operations. If the license were renewed or remained in timely renewal, vehicle emissions would continue at current levels. During cover construction, 200,000 to 400,000 gallons of diesel fuel may be needed to transport cover materials and construct the cover (Pachernegg 2002). The impacts on air quality from the vehicle emissions have not been quantified.

If the license were denied, there would be no future emissions of fugitive dust from operating the site. If the license were renewed or remained in timely renewal, fugitive dust would continue to be generated by waste disposal activities. Construction and maintenance of the cover will also result in fugitive dust. Due to dust abatement measures, fugitive dust emissions from the site have not been a problem in the past. These measures are expected to continue at the commercial LLRW site.

5.3.2 Preferred Alternative Impacts, Mitigation Measures, and Significant Unavoidable Impacts

Renew License Impacts. Past radionuclide emissions indicate that no air quality license reporting levels will be exceeded if the site is relicensed for five years or continues to be relicensed and operated through 2056.

Diffuse NARM Impacts – 100,000 cubic feet per year. The primary impact from diffuse NARM is radon. These impacts are discussed in Section 4.4, Post-Closure Radiological Dose.

GeoSynthetic Cover Impacts. There will be a temporary increase in fossil fuel emissions and fugitive dust during construction.

Close-As-You-Go Schedule Impacts. The Close-As-You-Go Schedule will extend air quality impacts over three construction periods.

Mitigation Measures. DOH will require continued use of dust control abatement measures during operations. All shipments of materials will be covered during transport, and shipments will be restricted during windy conditions. Vegetation will be established and maintained as the cover is completed.

Significant Unavoidable Impacts. None

5.4 Biological and Ecological Resources

The commercial LLRW site and the surrounding Hanford Site are a shrub-steppe ecosystem. The undeveloped section of the site (15 acres in the northwest corner) is mature shrub-steppe habitat, but only minimal vegetation is left within the developed portion of the site.

Shrub-steppe is defined as a vegetative community consisting of one or more layers of perennial grass with a discontinuous over-story layer of shrubs. These communities usually contain bigleaf sagebrush (*Artemisia tridentata*) in association with bunchgrasses. Washington State considers pristine shrub-steppe habitat as a priority habitat because of its relative scarcity in the state and because it is where several local and national species of concern nest and breed.

As a result of the past 50 years of land use restrictions, the Hanford Site is now the largest tract of contiguous shrub-steppe habitat remaining in Washington State (Neitzel 2000)**.** An ongoing biological inventory by The Nature Conservancy (TNC) states, “From a conservation standpoint, the Hanford Site is a vital and perhaps the single most important link in preserving and sustaining the diverse plants and animals of the Columbia Basin Ecoregion” (TNC 1999).

There is no aquatic habitat located within the 100 acres of the commercial LLRW site.

5.4.1 Threatened and Endangered Species

A 1999 inventory by The Nature Conservancy indicated 28 rare plant taxa (TNC 1999). The Hanford Site is also habitat to numerous federal or Washington State listed threatened and endangered species. Threatened and endangered plants and animals identified on the Hanford Site are shown in Table 5.F (50 CFR 17) (Washington Natural Heritage Program 2000) (Hueckel 2002).

Table 5.F: Federal and Washington State Listed Species Occurring on the Hanford Site

Common Name	Scientific Name	Designation
Plants		
Columbia milkvetch	Astragalus columbianus	FSC/ST
Dwarf evening primrose	Camissonia pygmaea	ST
Hoover's desert parsley	Lomatium tuberosum	FSC/ST
Loeflingia	Loeflingia squarrosa var. squarrosa	ST
Persistent sepal yellow cress	Rorippa columbiae	FSC/ST
Umptanum desert buckwheat	Eriogonum codium	FC/SE
White Bluffs bladderpod	Lesqueerella tuplashensis	FC/SE
White eatonella	Eatonella nivea	ST
Vertebrates		
Spring-run Chinook	Oncorhynchus tshawytscha	FE/SC
Steelhead	Oncorhynchus mykiss	FE/SC
American White Pelican	Pelecanus erythrorhychos	SE
Bald Eagle	Haliaeetus leucocephalus	FT/ST
Burrowing Owl	Athene cunicularia	FSC/SS
Common Loon	Gavier immer	SS
Ferruginous Hawk	Buteo regalis	FSC/ST
Loggerhead Shrike	Lanius ludovicianus	FSC/SS
Olivesided Flycatcher	Contopus cooperi	FSC
Sandhill Crane	Grus canadenis	SE
Sagebrush Lizard	Sceloporus graciosus	FSC

Common Name	Scientific Name	Designation
Northern Goshawk	Accipter gentilis	FSC/SC
Greater Sage Grouse	Centrocercus urophasianus phaios	FSC/ST
Pygmy Rabbit	Brachylagus idahoensis	FE/SE
Washington Ground Squirrel	Spermophilus washingtoni	FC/SS
Willow Flycatcher	Empidonax traillii	FSC
Lewis Woodpecker	Melanerpes lewis	SC
Vaux's Swift	Chaetura vauxi	SC
State Sensitive (SS), State Threatened (ST), State Endangered (SE), State Candidate (SC), Federal Species of Concern (FSC), Federal Candidate (FC), Federal Endangered (FE)		

No plant or animal species protected under the Endangered Species Act, candidates for such protection, or species listed by the state of Washington, were observed in the vicinity of the commercial LLRW site during the October 9, 1997 biological review (PNNL 1997). However, because the review was completed outside of the nesting season and the period of activity for reptiles, there may be animal species using the site that were not observed.

5.4.2 Radionuclides

Radionuclide levels in vegetation at the commercial LLRW site are monitored regularly. Table 5.G shows the 1998 and 2001 annual monitoring data for vegetation:

Table 5.G: Radionuclide Concentrations in Vegetation (pCi/g)

Radionuclide	1998 Data		2001 Data		Reporting Level
	Max.	Min.	Max	Min.	
Gross Beta	53.0	7.8	67.2	14.9	100 (dry)
Gross Beta (trench cap)	40.9	20.3	48.3	24.7	100 (dry)
Total Uranium	0.04	0.005	0.05	.006	0.25
Total Uranium (trench cap)	0.11	0.06	0.08	0.02	0.25
Pu-238	< MDC	< MDC	< MDC	< MDC	0.02
Pu-239/240	< MDC	< MDC	< MDC	< MDC	0.02
Co-60	< MDC	< MDC	< MDC	< MDC	0.1
Cs-137	< MDC	< MDC	0.06	< MDC	0.2
H-3 (trench cap)	74.0	0.6	25	0.31	None
Gamma Spec	< MDC	< MDC	< MDC	< MDC	5 x MDC

*pCi/g means picocuries per gram.
*MDC means minimum detectable concentration.

None of the vegetation data exceeded the US Ecology license reporting levels. The increases noted between 1998 and 2001 are not significant enough to rule out seasonal fluctuations (Fordham 2000). Due to the offsite influences from activities elsewhere on the Hanford Site, DOH has not been able to identify a background station for vegetation (Fordham 2000).

5.4.3 Non-Radioactive Hazardous Substances

There are no data for non-radiological substances in vegetation. The 2004 MTCA investigation will sample contaminants of potential concern as defined by the Data Quality Objective process (EQM 2003).

5.4.4 Potential Future Impacts

The shrub-steppe habitat on most of the 100-acre commercial LLRW site has already been disturbed through waste disposal activities. Denying the license will stop disturbance from operations and allow closure to begin immediately. If the site is relicensed or stays in timely renewal, the onsite disturbance from waste disposal will continue. However, waste disposal activities will occur in previously disturbed areas. The 15 acres of undisturbed habitat in the northwest corner of the commercial LLRW will be destroyed if it is excavated for a borrow site. The state will investigate possible alternative sites for site soils to avoid destroying the habitat within the15 acres.

5.4.4.1 Ecological Risk

DOH chose a guidance value of 0.1 rad/day to assess the radiological impacts of operations and closure at the commercial LLRW site on the ecosystem. Although there is no regulatory limit, the International Atomic Energy Agency has established a consensus standard of 0.1 rad/day for terrestrial organisms as a level below which observable changes are not expected.[29] DOH evaluated a terrestrial ecosystem with a food web that includes grass, the Great Basin pocket mouse, the mule deer, a coyote, and a hawk (Thatcher 2000a). Table 5.H lists the post-closure ecological dose for these species at the commercial LLRW site.[30] The highest dose predicted was 0.05 rad/day for the mouse. Predicted doses for the other organisms are less. This dose is the result of previous activities at the site and is not a result of projected future waste volumes associated with relicensing the site.

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[29] A rad is defined as the radiation absorbed dose and is a measure of absorbed radiation.
[30] Ecological dose was calculated based on the US Ecology Proposed Cover and the US Ecology Cover schedule. Risk for all other cover designs, except the Site Soils Cover, is expected to be equal to or lower than the risk calculated.

Table 5.H: Estimated Doses to Organisms in Terrestrial Food Web for the US Ecology Proposed Cover

Organism	Dose (rad/day)
Plant	2.3 E-05
Mouse	4.8 E-02
Mule deer	7.6 E-07
Coyote	1.4 E-03
Hawk	3.2 E-03

Due to the predicted low ecological onsite doses, an ecological dose was not quantified at the Columbia River, which is located approximately 15 miles to the east. Ecological risk from non-radioactive hazardous substances will be assessed upon completion of the 2004 MTCA investigation.

5.4.5 Preferred Alternative Impacts, Mitigation Measures, and Significant Unavoidable Impacts

Renew License Impacts. Relicensing the site for five years or operating the site through 2056 is not predicted to significantly increase the future ecological risk onsite. Continued operation of the site will delay re-establishment of shrub-steppe habitat onsite.

Diffuse NARM Impacts – 100,000 cubic feet per year. A 100,000 cubic foot diffuse NARM limit is not predicted to significantly increase the onsite ecological risk.

GeoSynthetic Cover Impacts. Excavation of the undisturbed northwest corner for cover materials will temporarily destroy up to 15 acres of habitat.

Close-As-You-Go Schedule Impacts. The Close-As-You-Go Schedule allows quicker re-establishment of shrub steppe habitat over filled trenches.

Mitigation Measures. Prior to excavation, conduct a biological survey on the northwest 15 acres to minimize potential biological impacts and to determine the correct mitigation ratio. Plant the cover and disturbed areas with native plants. Hanford Site guidance requires that habitat replacement ratios be determined on a case-by-case basis.

Significant Unavoidable Impacts. None.

6.0 OTHER CONSIDERATIONS

This section addresses other subject areas that the state considered for evaluating the impacts of the three proposed actions. Other considerations include cultural resources, land use, catastrophic events, environmental justice, the US Ecology Site Investigation, and financial surety for closure.

6.1 Cultural Resources

Cultural resources on federal land are protected under the National Historic Preservation Act of 1966 (16 USC 470). The National Historic Preservation Act provides for the preservation of heritage resources and the consideration of impacts to these resources. Heritage resources include historic or prehistoric objects, buildings, structures, or places used by humans that are recognized as important for an understanding of our state and national heritage.

The Natural Historic Preservation Act also protects Native American cultural resources. The Native American people that occupied the site identify all of Hanford as a cultural property due to its spiritual, ancestral, and social importance (Harper 1998). Native American people have occupied parts of the Hanford Site for at least 11,000 years. The Hanford Site contains many sites of significant historical and spiritual importance to the Yakama, Umatilla, and Nez Perce peoples. Native American cultural resources on the Hanford Site include natural resources such as habitat, wildlife, soil, vegetation, and groundwater. Native American cultural resources also include individual sacred sites and burial grounds. The identification of such properties is not dependent on physical evidence but on identification by the affected community. Essential to the Native American cultural identity is the ability for a member to conduct activities in a clean and whole environment.

The Hanford Cultural Resources Laboratory has recorded over 960 cultural resource sites and isolated finds on the Hanford Site (Neitzel 2000). Of these 960 sites, forty-eight are archaeological sites and one is a building, all listed on the National Register.

In 1983, a mastodon bone was found in one of the trenches at the commercial disposal site. Subsequent surveys of the trench detected no other findings (Carpenter 1983). In 1997, PNNL investigated the site for cultural resources, but had no significant finds (PNNL 1997).

No specific Native American sacred sites or burial grounds have been identified on the commercial LLRW site. However, the entire natural environment is considered sacred to the Native Americans (Harper 1998). The sacred natural environment includes the land, flora, and fauna, as well as other aspects of the natural environment.

6.1.1 Potential Future Impacts

If the license were denied, the impacts to the Native American cultural resources; i.e., the natural environment, would still be present. Denying the license would allow immediate closure of the entire site. Closing the site immediately would allow remediation of the environment to occur sooner. If the site is relicensed or remains in timely renewal, future waste disposal would occur in previously disturbed areas. Based on the1997 cultural resource review, there is a high probability that the proposed actions will not impact any historic buildings, archaeological sites, or specific Native American sites.

6.1.2 Preferred Alternative Impacts, Mitigation Measures, and Significant Unavoidable Impacts

Renew License Impacts. No impacts to historic buildings, archeological sites, or specific Native American sites are anticipated from renewing the license for five years or operating the site through 2056.

Diffuse NARM Impacts – 100,000 cubic feet per year. The current level of impact to the Native American cultural resource will continue under the 100,000 cubic feet per year alternative.

GeoSynthetic Cover Impacts. Leaving the waste in place will impact Native American cultural values. The GeoSynthetic Cover will isolate the waste and help mitigate impacts to the Native American cultural values.

Close-As-You-Go Schedule Impacts. The Close-As-You-Go Schedule will allow remediation of the natural environment to occur sooner.

Mitigation Measures. Plant the cover and borrow site area with native species. Continue consultation with Native Americans and the Hanford Site Preservation Officer.

Significant Unavoidable Impacts. None

6.2 Land Use

As the landowner, USDOE is responsible for determining future land use for the central plateau and elsewhere at the Hanford Site. The current land use on the Hanford central plateau is waste management and disposal. USDOE has published two documents on their intentions for future use of the Hanford Site, entitled *The Future for Hanford: Uses and Cleanup, the Final Report of the Hanford Future Site Uses Working Group* (USDOE 1992), and *Final Hanford Comprehensive Land-Use Plan Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement,* DOE/DEIS-0222-F (USDOE 1999).

The 1992 report proposed, “In general, …the overall cleanup criteria for the central plateau should enable general usage of the land and groundwater for other than waste management activities in the horizon of 100 years from the decommissioning of waste management facilities and closure of waste disposal areas” (USDOE 1992).

At a subsequent date on November 2, 1999, USDOE adopted a record of decision for the Hanford Comprehensive Land Use Plan (CLUP), designating the central plateau, including the commercial LLRW site, as a waste management zone. The CLUP states, “Lands within the central plateau geographic area would continue to be used for the management of radioactive and hazardous waste materials. These management activities would include the collection and disposal of radioactive and/or hazardous waste materials that remain onsite, contaminated groundwater management, current offsite commitments, and other related and compatible uses." The CLUP considers land use at Hanford for at least the next 50 years (USDOE 1999).

On June 9, 2000, the Hanford Reach National Monument was established for its natural beauty and to protect the wildlife, rare plants, and shrub steppe habitat. The 200,000-acre Monument surrounds the Hanford Site and includes the last free-flowing stretch of the Columbia River in the United States. The commercial LLRW site is located a minimum of five miles from the monument. A Federal Planning Advisory Committee was established to make recommendations to the U.S. Fish and Wildlife Service on a plan for the monument. It is not known at this time how the monument may impact future land use at the commercial LLRW site.

6.2.1 Potential Future Impacts

USDOE’s decision to manage the central plateau as a waste management zone for at least the next 50 years is consistent with the potential operating period for the commercial LLRW site. Institutional controls maintained by USDOE will help deter resident intruders and trespassers from the commercial LLRW site. USDOE has not yet finalized plans for land use after 50 years. It will be every future generation’s responsibility to ensure that adequate institutional controls are in place to address the public health impacts in the central plateau for as long as necessary.

6.2.2 Preferred Alternative Impacts, Mitigation Measures, and Significant Unavoidable Impacts

Renew License Impacts. Renewing the license for only five years or operating the site through 2056 is consistent with USDOE’s 50-year waste management zone designation.

Diffuse NARM Impacts – 100,000 cubic feet per year. The 100,000 cubic foot diffuse NARM limit is consistent with USDOE’s 50-year waste management zone designation.

GeoSynthetic Cover Impacts. Leaving the waste in place and constructing the GeoSynthetic Cover is consistent with USDOE’s 50-year waste management zone designation. USDOE's institutional controls will deter onsite intruders for the next 50 years.

Close-As-You-Go Schedule Impacts. This schedule is consistent with USDOE's 50-year waste management zone designation.

Mitigation Measures. Use post-closure institutional controls such as signage, monuments, and fencing to deter intruders.

Significant Unavoidable Impacts: None.

6.3 Catastrophic Events

This section discusses the likelihood of a catastrophic event and the impacts the three proposed actions would have on the severity of the event. Catastrophic events are natural or human-caused occurrences that are infrequent but have the potential to result in significant adverse impacts. These events include extreme weather, volcanic activity, earthquakes, fire, and human-caused accidents. This section does not address every potential catastrophic event. Events such as war, meteorites, and other extremely unlikely natural phenomena are not considered.

6.3.1 Flooding

Cold Creek. Cold Creek is a small seasonal stream that flows through the Hanford Site. It is the only potential offsite source of local flooding in the vicinity of the commercial LLRW site (Skaggs and Walters 1981). A hydraulic analysis conducted by Skaggs and Walters concluded that the commercial LLRW site would not be impacted by a maximum peak discharge on Cold Creek.

Yakima River. The Yakima River follows a small part of the southern boundary of the Hanford Site. The closest portion of the Yakima River is approximately 13 miles southeast of the site. Based on historic flood flows, a flood on the Yakima River is not expected to impact the commercial LLRW site.

Columbia River. There are three potential scenarios for a catastrophic flood on the Columbia River (US Ecology 1996). They are a maximum precipitation event, a breach of a nearby dam, or a landslide blockage of the Columbia River.

1. Maximum Precipitation and Runoff

The probable maximum flood for the Columbia River below Priest Rapids Dam was calculated to be 1,400,000 cubic feet per second (Neitzel 2000). A flood of this magnitude would inundate much of the Hanford Site adjacent to the river, and large areas of the City of Richland. The central plateau, including the commercial LLRW site, would remain unaffected by such a catastrophic flood.

2. Dam Failure

The U.S. Army Corps of Engineers studied the potential impact of a catastrophic flood from dam failure (U.S. Army Corps of Engineers 1951). A hypothetical 50% breach of Grand Coulee Dam resulted in a calculated flow of 8,000,000 cubic feet per second. The areas inundated by such a flood would be more extensive than the probable maximum flood event described above. The commercial LLRW site would not be affected by this catastrophic flood event.

3. Landslide River Blockage

Several scenarios were evaluated for flooding due to landslides (Skaggs and Walters 1981). A 1,000,000 cubic yard landslide, together with a flood flow of 600,000 cubic feet per second (the 200-year flood), would result in a calculated flood wave crest elevation of 400 feet above mean sea level. A probable maximum flood flow of 1,400,000 cubic feet per second would result in a flood wave crest of 410 feet above mean seal level. In both cases, the commercial LLRW site would not be impacted.

6.3.2 Local Ponding Due to Severe Weather

Open operating trenches or filled trenches not yet permanently closed are the most susceptible to impacts if flooding from a sudden freeze/thaw were to occur. In 1985, a sudden warm weather system thawed the frozen ground and snow at the commercial LLRW site, causing localized ponding. This phenomenon was short-term, lasting less than a week. There was no evidence of damage to the trenches, or any resulting contamination from this event (DOH 1985). After this event, US Ecology constructed a storm drainage system to rapidly divert and move any standing water away from the trenches. This drainage system is designed to handle a 100-year, 24-hour storm event. The storm drainage system has worked well in subsequent events, and the likelihood of future flooding from a sudden thaw at the commercial LLRW site is moderate to low.

6.3.3 Volcanoes

There are two volcanoes in proximity to the commercial LLRW site. Mount Rainier is located about 125 miles from the Richland site. At 14,410 feet, it is the highest peak in the Cascade Range. This dormant volcano's size and mass of glaciers pose a variety of geologic hazards, both during dormant periods and inevitable future eruptions. Mount St. Helens is 130 miles from the commercial LLRW site. Although this volcano is much smaller than Mount Rainer, it is active and as recently as 1980 had a major eruption. Other than the devastation in the blast zone, the primary impact from the 1980 eruption was from ashfall. Lesser impacts were felt within 50 miles of the commercial LLRW site.

If Mount Rainier were to erupt, the only hazard predicted to affect the commercial LLRW site was volcanic ash (Hoblitt 1995). However, the 1980 eruption of Mt. St. Helens shows that even thin accumulations of ash can profoundly disrupt activities. It was found that ashfall of less than 1/4 inch was a major inconvenience, and that ashfall of more than 2/3 inch brought most activities to a halt for several days. Ashfall on the commercial LLRW site would have a temporary impact on site operations. Trucks in route to the site may experience temporary delays.

6.3.4 Airplane Crash

Data maintained by the National Transportation Safety Board (NTSB) on airplane crashes in the Richland, Pasco, and Kennewick (Tri-Cities) area were reviewed for January 1983 through July 1998. During that 15-year period in the Tri-Cities, a total of 31 airplane crashes of all types resulted in a total of 12 fatalities (USDOT 1998). There were no airplane crashes specifically identified for the Hanford Site in the NTSB database.

Of the 31 airplane crashes in the Tri-Cities area, 25 involved problems in take-off and landings and were confined to the near vicinity of an airport (within seven miles). Four crashes involved unsuccessful “crop dusting” encounters with “terrain conditions” and/or man-made objects, and three involved engine problems during flight. None of the three Tri-Cities accidents with engine problems were associated with the commercial LLRW site.

There are no airports within ten miles of the commercial LLRW site, nor are there agricultural fields or “terrain conditions” in the vicinity. Based on this information, an airplane crash in the vicinity of the commercial LLRW site would most likely be initiated by engine problems. Under such circumstances, the pilot would be seeking a flat, smooth area for a landing strip. Open disposal trenches would be avoided in favor of the smooth surface of one of the completed trenches. Landing gear would likely sink into the soft sand or other cover material, and the aircraft would likely “nose over” or flip as has been documented on other engine failure crashes. Damage to the commercial LLRW site from a crash onto the site cover would likely be limited to surface damage of the cover. A resulting fire might impact cover vegetation on closed trenches.

6.3.5 Earthquake

Seismicity in the Columbia Plateau is attributed to a north-south compression force regime that has resulted in thrust or reverse dip-slip faulting. Seismic data and observations since 1872 show most large earthquakes occur further than 124 miles from the Pasco Basin. The 1996 National Earthquake Hazard Reduction Maps concluded that any area west of the crest of the Rocky Mountains is capable of experiencing a 7.0 magnitude earthquake. However, seismic events in the central Columbia Plateau, including the Pasco Basin, have generally been short in duration and less than 3.5 on the Richter Scale (Neitzel 2000).

The Hanford Site is located in an area of moderate seismic activity (Department of Ecology 1987). The poor cohesive quality of the sand deposits in and around the site would make it unlikely that a fissure formed by seismic activity, however extreme, would remain open. The most serious potential seismic impact associated with the site would be the possibility that an earthquake could accelerate waste subsidence through mechanical agitation. This subsidence could lead to a rupture of containers or damage to the cover. Earthquakes intense enough to cause subsidence have not been recorded at the commercial LLRW site.

6.3.6 Fire

Range fires are not uncommon in the arid shrub-steppe environment. A range fire burned approximately 200,000 acres on Hanford in August of 1984 (Price 1986). In June 2000, the 24-Command Fire burned 163,884 acres. One hundred percent of the fire area was classified as low burn severity or unburned (USFWS 2000). This result is typical of a range fire that spreads rapidly through light fuels. Range fires typically burn hot on the surface but move fast enough so that the subsoil is unaffected. A range fire of this magnitude could easily destroy a trench cover's vegetation, but it is unlikely to damage the buried waste.

Table 6.A summarizes the likelihood of a catastrophic event and possible outcomes.

Table 6.A: Summary of Potential Catastrophic Events

Catastrophic Event	Impacts	Probability
Flooding – Cold Creek	No impact to disposal site.	Low
Columbia River Flood	No impact to disposal site.	Low
Local Ponding	Standing water onsite may increase infiltration in open trenches and filled trenches not permanently closed.	Low-Moderate
Volcanic Eruption	Temporary impacts to operations from ashfall.	Low-Moderate
Airplane crash	Damage to cover on closed trenches.	Low
Earthquake	Increased subsidence may impact covers on closed trenches.	Low-Moderate
Fire	Impact to cover vegetation on closed trenches.	Moderate

6.3.7 Preferred Alternative Impacts, Mitigation Measures, and Significant Unavoidable Impacts

Renew License Impacts. The Renew License Alternative includes additional stormwater requirements and void reduction requirements. These requirements will benefit the site by reducing impacts from local ponding and earthquakes for the next five-year licensing period or if the site is operated through 2056.

Diffuse NARM Impacts – 100,000 cubic feet per year. None.

GeoSynthetic Cover Impacts. The high water holding capacity and impermeable barrier in the GeoSynthetic Cover will protect against a ponded water event. The high silt loam content of the cover will help to re-establish vegetation in case of loss due to a range fire.

Close-As-You-Go Schedule Impacts. This schedule will isolate waste earlier than the other alternatives. Early isolation is a benefit in case of a range fire, airplane crash, or ponded water event.

Mitigation Measures: None.

Significant Unavoidable Impacts: None.

6.4 Resource Commitments: Fuel, Water, and Electricity

Materials and energy are required to operate the site, dispose of diffuse NARM, and close the site. This section evaluates those resources required to construct the cover design alternatives. Materials and energy required to operate the site and dispose of diffuse NARM are not evaluated. The state has assumed that the resources required for the License and Diffuse NARM Alternatives would be offset by similar materials that would be required if the waste were shipped to another site.

Resources required for construction of the cover alternatives vary primarily by the volume of silt loam and the type of barrier in the cover. Large amounts of silt loam will be necessary to construct most of the cover designs. Diesel fuel will be required to truck this material to the site. Resource commitments for constructing the cover design alternatives are summarized in Table 6.B (Fordham 2002a).

Table 6.B: Resource Commitments for Cover Construction

Resource	USE Proposed Cover	Site Soils Cover	Homogenous Cover	Asphalt Cover	GeoSynthetic Cover	Bentonite Cover
Electricity (Mw -hrs)	450	100	450	450	450	450
Diesel Fuel (gal)*	211,000	0	361,000	429,000	361,000	379,000
Gasoline (gal)	3,700	3,700	3,700	3,700	3,700	3,700
Asphalt (cubic yds)	0	0	0	120,178	0	0
Gravel Layer (cubic yd)	20,000	0	0	136,000	0	20,000
Pea Gravel (cubic yd)	106,000	0	106,000	106,000	106,000	106,000
Silt Loam (cubic yd)	280,000	0	616,000	616,000	616,000	616,000
Bentonite (cubic yd)	16,000	0	0	0	0	16,000
Synthetic Liner (sq.yd)	0	0	0	0	290,000	0
Water Usage (gal)	20,160	20,160	20,160	20,160	20,160	20,160

* Based on mileage estimates in Table 4.C.

6.4.1 Preferred Alternative Impacts, Mitigation Measures, and Significant Unavoidable Impacts

Renew License Impacts. Not evaluated.

Diffuse NARM Impacts – 100,000 cubic feet per year. Not evaluated.

GeoSynthetic Cover Impacts. All cover designs require resource commitments. The GeoSynthetic Cover will require significant amounts of silt loam and diesel fuel.

Close-As-You-Go Schedule Impacts. The three construction phases of this schedule will require slightly more resources than a schedule using a single construction phase, due to the multiple staging periods that will be required.

Mitigation Measures. Evaluate options to reduce silt loam requirements in the cover design.

Significant Unavoidable Impacts. None.

6.5 Socioeconomics

The commercial LLRW site affects the socioeconomics of the local community, the state of Washington, and the states within the Northwest and Rocky Mountain Compacts.

6.5.1 Local Community

The commercial LLRW site employs 28 people directly and indirectly in the local community. If the license were denied, a percentage of these employees would lose their employment. Although this number is small relative to employment levels at Hanford, the commercial LLRW site contributes to employment diversification in the local area.

Benton County benefits financially from the commercial LLRW site through lease payments and disposal fees. If the license were denied, many financial benefits to the local community would be lost. Table 6.C shows the fiscal benefits to the host community for the five-year relicensing period if the commercial LLRW site received an average of 100,000 cubic feet per year of waste of LLRW. Table 6.C also shows the benefit to Benton County if the site were relicensed and operated to 2056. Table 6.D shows the additional contribution associated with different NARM volumes.

Table 6.C: Annual Revenue to Local Community

LLRW ft^3/year	Lease Payment to Benton County	Benton County Portion of Surcharge	HAEIF Portion of Surcharge
100,000	$58,812	$200,000	$450,000

Table 6.D: Annual Revenue for Diffuse NARM Alternatives

NARM ft^3/year	Benton County Annual Revenues	HAEIF Annual Revenues	Perpetual Care and Maintenance Fund Annual Contributions
0	0	0	0
8,600	$17,200	$38,700	$ 284.00
36,700	$73,400	$165,150	$1,212.00
100,000	$200,000	$450,000	$3,302.00

The Department of Ecology currently collects a sublease payment of $59,412 per year from US Ecology.[31] By a 1991 agreement, the Department of Ecology gives $58,812 of this payment to Benton County. In addition to the lease payment, Benton County receives fee money. In accordance with RCW 43.200.230, effective January 1, 1993, the Department of Ecology imposed a fee of $6.50 for each cubic foot of waste accepted for disposal at the site. These monies are split between Benton County ($2.00 per cubic foot) and the Hanford Area Economic Investment Fund (HAEIF) ($4.50 per cubic foot). In 2001, the fee generated $122,885 for Benton County and $276,000 for HAEIF.

Benton County also imposes a property tax on US Ecology of $5,800 per year. The costs for all fees and payments are passed on to the generator in the form of disposal costs.

One impact to the local community is from truck traffic. Truck traffic from operations has averaged approximately 240 trucks per year over the last seven years. During cover construction, there will be increased truck traffic. Assuming an offsite source for cover materials, the cover alternatives could result in 20,000 to 40,000 round trips from a borrow site to the commercial LLRW site. Assuming 100 miles per round trip, construction of the cover could result in 3,000,000 to 4,000,000 additional truck miles on regional roads, spread out over three construction phases. These additional truck miles will contribute to road wear and vehicle accidents, and may impede traffic flow.

[31] Current terms require the sublease payment to be adjusted every three years based on the Consumer Price Index.

6.5.2 State of Washington

The primary benefit to the state of Washington from the operation of the commercial LLRW site is having a regulated disposal site for Washington generators of low-level waste. Providing access to a regulated disposal site reduces costs and environmental impacts associated with improper and illegal storage or disposal of low-level waste within Washington.

There are 51 LLRW and five NARM generators (one diffuse and five discrete) in Washington that use the commercial LLRW site. If the license were denied, these generators would have the option of using Envirocare in Clive, Utah for their Class A waste, but would have to ship their Class B and Class C waste to South Carolina. When South Carolina closes its site to out-of-state waste in 2008, these generators would be required to store their Class B and Class C waste onsite. The majority of in-state waste could currently be disposed at Envirocare (Garner 1999). However, dependence on a commercial LLRW disposal site outside of Washington means less certainty in disposal capacity and greater costs for most in-state generators. It might also mean unsafe storage of Class B and Class C waste after 2008.

Fees collected for use of the commercial LLRW site benefit the state of Washington through funding programs and employment in several state agencies. Site use permits issued by the Department of Ecology for waste disposal at the commercial LLRW site generate approximately $250,000 in annual revenue. This revenue funds the Department of Ecology’s maintenance of the permit system, staffing for the Northwest Compact, and general oversight activities.

DOH collects a cubic foot surcharge known as the "surveillance fee" to fund its FTEs responsible for site operations and closure. Currently the surveillance fee is $9.00 per cubic foot, generating approximately $500,000 annually. The revenue collected by DOH also funds the USDOT inspection requirements that are carried out by the Washington State Patrol.

The Washington Utilities and Transportation Commission regulates the disposal fees charged by US Ecology. WUTC audits the company’s expenses, including overhead, linking costs with specific waste disposal activities, and developing disposal rates that equitably distribute costs among site users. The activities of WUTC are funded by a fee equivalent to one percent (1.0%) of the rates charged by US Ecology. These monies are included in US Ecology’s annual revenue requirement.

6.5.3 Northwest Compact, Rocky Mountain Compact, and Out-of-Region Generators

The commercial LLRW site provides disposal access for states within the Northwest and Rocky Mountain Compacts. If the commercial LLRW site were closed, in-region generators in Oregon, Alaska, Hawaii, Idaho, Montana, Utah, Wyoming, Nevada, Colorado, and New Mexico would no longer be able to dispose of LLRW or discrete

NARM in Washington. There are currently 84 non-military and 24 military *in-region* generators using the commercial LLRW site. Recent amendments to the Envirocare license means the Envirocare facility could accept approximately 85-90% of the regional waste by volume (Garner 1999).

Nation-wide there are 76 non-military generators and 99 military generators that dispose of NARM at the commercial LLRW site. The revenue received for the disposal of NARM helps offset costs for LLRW generators. Accepting NARM at the commercial LLRW site does not affect the capacity of the site for disposal of LLRW. There is approximately 21 million cubic feet of disposal capacity remaining at the commercial site. If 100,000 cubic feet per year of diffuse NARM plus 100,000 cubic feet per year of LLRW is disposed for the next 50 years, there will still be approximately 4 million cubic feet of capacity remaining at the commercial site.

6.5.4 Preferred Alternative Impacts, Mitigation Measures, and Significant Unavoidable Impacts

Renew License Impacts. The Renew License Alternative will provide continued LLRW disposal access to in-state, Northwest Compact, and Rocky Mountain Compact generators. Renewing the license will also provide continued access to NARM generators nation-wide. Local employment and local revenues will benefit from relicensing the site.

Diffuse NARM Impacts – 100,000 cubic feet per year. Allows continued access for one in-state and 37 out-of-state generators of diffuse NARM. Disposal of 100,000 cubic feet per year of diffuse NARM also helps offset disposal costs for LLRW generators and provides revenues to local government.

GeoSynthetic Cover Impacts. Construction of the GeoSynthetic Cover will increase wear on roads, increase the potential for vehicle accidents, and may impede the flow of traffic for the local community. Cover construction will provide a temporary increase in local employment.

Close-As-You-Go Schedule Impacts. The Close-As-You-Go Schedule will help to mitigate road impacts by spreading construction over three phases.

Mitigation Measures. Employment services for displaced workers.

Significant Unavoidable Impacts. None.

6.6 Environmental Justice

The commercial LLRW site and the surrounding area are located on land ceded by Native Americans to the United States under treaties of 1855. There are no persons living on or adjacent to the commercial LLRW site. There is a total population of approximately 323,600 people within a 50-mile radius of the commercial LLRW site (USCB 2000). The minority population within this area consists of approximately 117,700 persons, or less than 50% of the total population. The minority population includes Hispanic or Latino (48%), American Indians/Alaska Natives (0.09%), Asian (0.04%), African Americans (0.03%), and Native Hawaiian/Pacific Islanders (0.004%).

Within and adjacent to the 50-mile radius, the minority population is distributed throughout Benton County (142,475), Franklin County (49,347), and the Yakama Reservation and off-reservation trust land (31,799). Forty-eight percent of the minority population is considered low-income.

In the EIS, the Native American is the minority population used in the analysis of environmental justice impacts. The Native American population was selected because of the potential that the land occupied by the commercial LLRW site could someday be ceded back to the Native Americans. However, USDOE has stated their intent to keep residential use away from the central plateau for the foreseeable future (USDOE 1999).

The state evaluated the environmental justice impacts of the three proposed actions by comparing the hypothetical risk to the rural resident with that of the hypothetical risk to the Native American. These risks are listed in Table 4.J. The difference in the risk between the two communities is due to the assumptions that were made concerning the two future lifestyles. There are two primary reasons why the Native American community has a higher hypothetical risk than the Rural Resident Community. First, the Native American is assumed to use a sweat lodge once a day, which increases their inhalation of radionuclides and consumption of water. Secondly, the Native American is assumed to live 70 years on or adjacent to the site, whereas the Rural Resident is only assumed to live there for 30 years. The additional exposure due to the sweat lodge use and the longer time in residence creates the higher hypothetical risk for the Native American.

EPA Guidance considers there to be a disparity in impacts if the increased risk for one community is statistically more than twice that for another community (EPA 2000). Comparing risks for the Rural Resident and the Native American shows the Native American risk is more than two times greater than the Rural Resident.[32] However, the risk estimates for both communities have high degrees of uncertainty. The minor difference in the central point risk estimates for the two communities is overwhelmed by the total uncertainty of either estimate (Thatcher 2003a). Based on this high uncertainty, the differences are not statistically significant and no adverse disparate impacts have been identified for the preferred alternatives.

Environmental justice for the Native American is best presented in the context of the surrounding Hanford Site. When all pathways are considered, predicted post-closure risk from USDOE activities in the Central Plateau is generally higher than the

[32] The first 1000 years of hypothetical post-closure risk predicted for the preferred cover design and cover schedule alternatives was used to evaluate environmental justice impacts.

hypothetical risk calculated for the commercial LLRW site (USDOE 2002). USDOE has designated the central plateau for Industrial-Exclusive use in the final Hanford Comprehensive Land Use Plan (CLUP) EIS (USDOE 1999). This area will be unfit for residential use or other long-term uses for *at least* 50 years after the Hanford Site is closed (USDOE 1999). USDOE is planning to use institutional controls to restrict public access in the central plateau during this time period. In this context, the commercial site's contribution to environmental justice issues is little, if any. Whether or not a statistically significant disparate impact is predicted, it will be every future generation's responsibility to ensure that adequate institutional controls are in place to address public health impacts for as long as necessary.

6.6.1 Preferred Alternative Impacts, Mitigation Measures, and Significant Unavoidable Impacts

Renew License Impacts. No impact.

Diffuse NARM Impacts – 100,000 cubic feet per year. No impact.

GeoSynthetic Cover Impacts. The Native American community has a greater hypothetical risk than that of the Rural Resident. However, based on the uncertainty of the predicted risk, no disparate impacts have been identified.

Close-As-You-Go Schedule Impacts. Based on the uncertainty of the predicted risk, no disparate impacts have been identified.

Mitigation Measures. Mitigation measures include DOE institutional controls to minimize long-term residence on or adjacent to the commercial LLRW site.

Significant Unavoidable Impacts. None.

6.7 Cumulative Effects

SEPA requires an EIS to include reasonable references to past projects and future expectations. Cumulative effects are defined as the impact to the environment and public health, when current impacts are added to past, present, and reasonably foreseeable future actions. Cumulative effects can be the result of individually minor but collectively significant actions taking place over a period of time. There are no regulatory standards that directly address cumulative effects during the post-closure period. USDOE Oder 5400.5 establishes a 100 millirem per year dose from all USDOE operations.

Cumulative effects at the Hanford Site are a concern because of the extent of past, present, and future waste management activities. These activities include the USDOE operation and closure of the Environmental Restoration and Disposal Facility, management of K Basin fuel, remediation and closure of tank farms, and operation and closure of the USDOE LLRW burial grounds.

Cumulative effects from activities on the central plateau have been discussed in several documents, including the USDOE *Final Environmental Impact Statement on Tank Waste Remediation Systems* (USDOE 1996). In addition, USDOE has quantified a cumulative radiological dose in the *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site* (PNNL 1998).

The 1998 Composite Analysis predicted a total cumulative dose from Hanford's central plateau of six millirem per year. The commercial LLRW site was predicted to contribute a minor amount to the six-millirem dose. The six-millirem dose is not directly comparable to the doses predicted in the EIS because the two analyses used different theoretical models, different lifestyle parameters, and different points of compliance. However, USDOE's conclusion that the commercial LLRW site will contribute a minor amount to the future cumulative dose remains relevant.

The contribution from the commercial LLRW site to cumulative effects is small when compared to the contribution from all other Hanford activities. A precise estimate of the commercial site's relative contribution cannot be made until an analysis of all impacts from Hanford and other surrounding activities is completed. This analysis is beyond the scope of the EIS. General mitigation measures include coordinating construction activities with USDOE and the use of ALARA in all decisions.

6.7.1 Preferred Alternative Impacts, Mitigation Measures, and Significant Unavoidable Impacts

Renew License Impacts. Little or no contribution to cumulative effects.

Diffuse NARM Impacts – 100,000 cubic feet per year. Little or no contribution to cumulative effects.

GeoSynthetic Cover Impacts. For the first 1,000 years after closure, if the site is closed with the Close-As-You-Go Schedule, the predicted contribution to the hypothetical Native American Adult cumulative dose is 18 millirem per year for the offsite resident, 107 millirem per year for the onsite resident, nine millirem per year for the river resident, and one millirem per year for the onsite hunter. The higher hypothetical dose to the onsite resident highlights the importance of effective institutional controls.

Constructing the cover will cause a significant increase in truck traffic. Roundtrips for transporting offsite materials are estimated at 36,100. Accident rates are based on 1.8 accidents per million miles, and ranged from a total of 4 to 8 accidents (Fordham 2002).

Close-As-You-Go Schedule Impacts. The Close-As-You-Go Schedule reduces the offsite dose by 100 millirem per year as compared to other schedules evaluated in the EIS.

Mitigation Measures. Institutional controls, coordination of construction schedules with USDOE to minimize traffic impacts, and use of ALARA in all decisions.

Significant Unavoidable Impacts. None.

6.8 Surety and Closure Costs

This section evaluates surety for closure and perpetual care and maintenance of the commercial LLRW site.[33] The state has created a site closure account and a perpetual surveillance and maintenance account (Title 43 RCW 43.200.080) that will fund all activities associated with closure and maintenance of the commercial site.

Costs and surety calculations are shown in 1998 dollars. To validate the current accuracy of the 1998 projections, a new cost and surety analysis was performed for the GeoSynthetic Cover and the Close-As-You-Go Schedule in 2003 dollars (Blacklaw 2003). This analysis considered actual interest earned between 1998 and 2003, and the current consumer price index. The 2003 analysis showed that the 1998 cost and surety figures remain valid for 2003 because the escalation of the 1998 cost estimates was offset by the previous four years' growth of the Closure Fund.

6.8.1 Closure Costs

Closure costs vary by cover design and construction schedule. Costs were not calculated for the Site Soils Cover because placing site soils over filled trenches is currently part of the operating costs. Table 6.E shows estimated costs for the cover designs and schedule alternatives (Blacklaw and Ahmad 1998).

Schedule alternatives that propose to build the cover in multiple phases are more costly than the alternatives that propose to build the entire cover in a single construction period. The "closure scheduling cost factor" shows the cost of the schedule alternatives relative to closing the entire site, all at one time, in 2056. The higher this factor, the more expensive the cover schedule alternative.

[33] Site operations are not included in this surety evaluation; they are paid for by generator disposal charges.

Table 6.E: 1998 Cover Design Costs Versus Scheduling Alternatives

Closure Scheduling Alternatives	Cover Design					
	Closure Scheduling Cost Factor[34]	US Ecology Proposed Cover	Homo-genous Cover	Asphalt Cover	Geo-Synthetic Cover	Bentonite Cover
Close Entire Site in Year 2000	0.68	$22,937,000	$20,207,000	$38,009,000	$24,522,000	$26,052,000
No Action Schedule	1.000	$33,582,000	$29,585,000	$55,650,000	$35,903,000	$38,143,000
US Ecology Proposed Schedule	1.120	$37,612,000	$33,135,000	$62,328,000	$40,211,000	$42,720,000
Prototype Schedule	1.098	$36,873,000	$32,484,000	$61,104,000	$39,421,000	$41,881,000
Close-As-You-Go Schedule	1.150	$38,619,000	34,023,000	$63,998,000	$41,288,000	$43,864,000

6.8.2 Closure Surety

Surety is a measure of whether or not the Closure Fund can afford the approved closure plan**.** Chapter 246-250 WAC requires the state to ensure that sufficient funds are available in the Site Closure Account to fund an approved closure plan. In 2002, the Closure Account had approximately $31.7 million. In 2003, legislation was passed allowing Washington State to transfer $13.8 million from the Site Closure Account to the state General Fund to help offset the current budget deficit. On March 1, 2004, following the transfer of funds, there was $19.2 million remaining in the Site Closure Account. The legislation provides for repayment of the funds plus interest. There are two options for repayment. The preferred method is to use interest earnings from the Perpetual Care and Maintenance Account.[35] The second method is to repay the Closure Account from the General Fund.

Repayment is scheduled to begin in 2008 and be completed by 2033. Should the site be closed prior to 2033, the amount of money remaining to be repaid will be transferred from the General Fund to the Closure Account. The legislation indicates that the surety requirement is fulfilled if the sum of the balance remaining in the Site Closure Account, together with the amount owed to the account by the state, is equal to or in excess of the amount needed to close the site.

Surety is evaluated by comparing the projected closure costs to the value of the Closure Fund at the time of closure.[36] Table 6.F shows the ratio between the 1998 projected

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[34] The closure scheduling cost factor represents the relative costs between the No Action Alternative (factor = 1) and other cover schedule alternatives.

[35] This method of repayment requires USDOE concurrence.

[36] The 1998 costs from the Draft EIS were retained in the surety analysis because a subsequent analysis showed the 1998 costs to still be valid for evaluating surety (Blacklaw 2003).

value of the Closure Account and the 1998 cost of the cover design/schedule combination at the time of fund obligation. A ratio of less than one means the cover design and cover schedule combination are projected to exceed available Closure Funds. Surety is considered marginal if the ratio is 1.0 to 1.25. Surety is considered adequate if the ratio is greater than 1.25.

Table 6.F: 1998 Comparison of Surety Adequacy

Cover schedule Alternatives and Closure Dates	Cover Designs				
	US Ecology Proposed Cover	Homogenous Cover	Asphalt Cover	GeoSynthetic Cover	Bentonite Cover
Close Entire Site in 2056	2.5	2.8	1.5	2.3	2.2
No Action Schedule	1.2	1.4	0.7	1.1	1.1
US Ecology Proposed Schedule	1.5	1.7	0.9	1.4	1.3
Prototype Schedule	1.9	2.2	1.2	1.8	1.7
Close-As-You-Go Schedule	1.2	1.3	0.7	1.1	1.0

NOTE: No shading means adequate surety; light shading means marginal surety; dark shading means inadequate surety.

6.8.3 Perpetual Care and Maintenance

The Perpetual Care and Maintenance (PC&M) fund was established to monitor and maintain the site for a minimum of 100 years after closure. The fund is intended to cover activities such as maintenance of the cover, environmental monitoring, access control, and other requirements needed to maintain the site. US Ecology is responsible for PC&M at the commercial LLRW site for the first five years after closure. After the initial five-year stabilization period, the state will return the commercial LLRW site to USDOE under the terms of the 1965 Perpetual Care Agreement (USDOE 1965). At the same time, the state will transfer the PC&M Fund to USDOE. In lieu of the state returning the site to USDOE, USDOE may elect to sell the commercial LLRW site to the state for fair market value. The state is obligated to use its best efforts to obtain the necessary appropriation to complete the sale. If the site is purchased by the state, the PC&M Fund will remain under the state's authority.

A separate surety analysis was completed for the PC&M Fund (Ahmad 2003). This analysis showed that the current PC&M fund is more than sufficient to cover the cost of PC&M for at least 100 years, irrespective of the site closure date. As of March 4, 2004, the PC&M Fund totaled $35.6 million. This fund continues to grow through interest and a $1.75 per cubic foot surcharge on waste. The surety analysis for the PC&M Fund showed that if the site were closed in 2056, the 100-year cost in real dollars would be $28.0 million. Assuming a 2% growth rate, the PC&M Fund will have $35.8 million in year 2005, and $115.11 million in year 2064. Based on the outcome of negotiations with USDOE, some of the PC&M funds may be used to repay the 2003 transfer from the Closure Fund to the state General Fund.

6.8.4 Preferred Alternative Impacts, Mitigation Measures, and Significant Unavoidable Impacts

Renew License Impacts. Relicensing the site for five years has little benefit to closure surety, but relicensing and operating the site through 2056 will benefit surety through growth of the closure fund. Relicensing and operating the site through 2056 will also allow the PC&M Fund to grow. Benefits to the PC&M Fund are less significant because there are sufficient funds to carry out post-closure care even if the license is denied.

Diffuse NARM Impacts – 100,000 cubic feet per year. Disposal of diffuse NARM has little impact on surety for closure. Disposal of diffuse NARM could have a greater impact if a new closure fee were imposed on all waste disposed at the facility. Diffuse NARM does benefit the PC&M Fund. A site limit of 100,000 cubic feet per year of diffuse NARM would result in a maximum of $175,000 per year for the PC&M Fund. The PC&M Fund is projected to be sufficient with or without contributions from diffuse NARM.

Geosynthetic Cover Impacts. Surety is marginal.

Close-As-You-Go Schedule Impacts. Surety is adequate.

Mitigation Measures. None.

Significant Unavoidable Impacts. None.

GLOSSARY

100-year flood. A flood event of a magnitude that occurs, on average, once every 100 years, and equates to a 1-percent probability of occurring in any given year.

Affected environment. The affected environment is that portion of the existing environment that may be impacted by implementing the proposed actions.

Background (area) radiation. Radiation levels in the general area not affected by the commercial disposal site. These levels may be elevated due to facilities and activities other than the commercial disposal site. Area background levels are generally higher than natural background levels.

Background (natural) radiation. Radiation from cosmic sources; naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material); consumer products containing nominal amounts of radioactive material or producing nominal amounts of radiation; and global fallout that exists in the environment (e.g., from the testing of nuclear explosive devices).

Confined aquifer. An aquifer bounded above and below by less permeable layers. Groundwater in the confined aquifer is under a pressure greater than atmospheric pressure.

Contamination. The presence of radioactive and/or hazardous materials above natural background concentrations.

Cumulative effect. 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. Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time.

Curie. A unit of activity defined as the quantity of any radioactive nuclide in which the number of disintegrations per second is 3.700×10^{10}.

Decommissioning. The process of removing a facility from operation, followed by decontamination, entombment, dismantlement, or conversion to another use.

Dose (or radiation dose). Generally denotes the quality of radiation or energy that is absorbed by the organism. Means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent.

Endangered species. Animals, birds, fish, plants, or other living organisms threatened with extinction by man-made or natural changes in their environment. Requirements for declaring a species endangered are contained in the Endangered Species Act of 1973.

Environmental justice. The fair treatment of people of all races, cultures, and incomes, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

Fugitive dust. The particulate matter that is stirred up and released into the atmosphere during excavation or construction activities.

Groundwater. The supply of water in the saturated zone below the land surface.

Half-life. The time in which half the atoms of a particular radioactive substance disintegrate to a different nuclear form. Measured half-lives vary from millionths of a second, to billions of years.

Hanford Federal Facility Agreement and Consent Order. The Hanford Federal Facility Agreement and Consent Order (also referred to as the Tri-Party Agreement, or TPA), is a binding agreement, negotiated pursuant to Section 120 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, and the Resource Conservation and Recovery Act signed by the U.S. Department of Energy, the U.S. Environmental Protection Agency (Region 10), and the Washington State Department of Ecology. It describes the responsibilities for remediation and compliance actions at the Hanford Site and establishes enforceable milestones by which the remediation and compliance actions will be accomplished. This agreement commits the three agencies to a long-term cooperative program.

Hazardous substance. Any non-radioactive substance subject to the state's Dangerous Waste Regulations (Chapter 173-303) that, when released to the environment in an uncontrolled or unpermitted fashion, becomes subject to the reporting and possible response provisions of the Clean Water Act of 1977, the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 or the state Model Toxics Control Act Regulations.

Hazardous waste. Those wastes that are identified as hazardous pursuant to RCRA (40 CFR 261).

High-level waste. The highly radioactive waste material that results from processing or reprocessing spent nuclear fuel, including liquid waste produced directly from reprocessing, and any solid waste derived from the liquid, that contains a combination of transuranic and fission product radionuclides in quantities that require permanent isolation. High-level waste may include other highly radioactive material that the U.S. Nuclear Regulatory Commission, consistent with existing law, determines by rule to require permanent isolation.

Impact. The effect, influence, alteration, or imprint of an action. Impacts may be beneficial or detrimental.

Inadvertent intruder. An individual who unintentionally intrudes onto the disposal site.

Institutional control. Control of waste management facilities through human institutions. Institutional controls include such measures as access restrictions, deed restrictions, or restrictions on activities or site use.

Land use. A term used to indicate the utilization of any piece of land. The way in which land is being used is the land use.

Low-level radioactive waste. Radioactive waste that is not classified as high-level waste, transuranic waste, or spent nuclear fuel. Test specimens of fissionable material irradiated for research and development, and not for the production of power or plutonium, may be classified as low-level radioactive waste if the concentration of transuranic elements is less than 100 nanocuries per gram of waste.

Maximally exposed individual (MEI). A hypothetical person who, by virtue of location and living habits, could receive the highest possible radiation dose.

Maximum contaminant level (MCL). Under the Safe Drinking Water Act of 1974, the maximum permissible concentrations of specific constituents in drinking water delivered to any user of a public water system that serves 15 or more connections and 25 or more people. The standards take into account the feasibility and cost of attaining the standard. In this environmental impact statement, MCLs are referred to as Drinking Water Standards.

Millirem (mrem). One thousandth (10^{-3}) of a rem (see also, rem).

Mitigation. Those actions that avoid impacts altogether, minimize impacts, rectify impacts, reduce or eliminate impacts, or compensate for impacts.

Mixed waste. Waste containing both radioactive and hazardous substances as defined by the Atomic Energy Act of 1954 and the Resource Conservation and Recovery Act of 1976, respectively.

Model Toxics Control Act (MTCA). Washington state's hazardous waste cleanup law (RCW 70.105D) was adopted in 1989. Implementing regulations are Chapter 173-340 WAC.

Naturally Occurring and Accelerator Produced Material. Any radioactive material of natural or accelerator origin; does not include byproduct, source, or special nuclear material.

Offsite. Any place located outside the boundaries of the commercial LLRW site.

Onsite. Any place located within the boundaries of the commercial LLRW site.

Permeability. The degree of ease with which water can pass through rock or soil.

Plume. The cloud of a pollutant in air, surface water, or groundwater formed after the pollutant is released from a source.

Probable maximum flood. The largest flood for which there is any reasonable expectancy in a specific area. The probable maximum flood is normally several times larger than the largest flood of record.

Rad. The unit of absorbed dose of ionizing radiation. One rad is equal to an absorbed dose of 100 ergs/gram.

Radiation (ionizing radiation). Alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions.

Radioactivity. The property of some radionuclides whose nuclei spontaneously disintegrate emitting alpha particles, beta particles, and sometimes also gamma rays.

Radionuclide. A generic term referring to all known isotopes, both stable and unstable, of the chemical elements.

Recharge. Replenishment of water to an aquifer.

Rem. The unit of dose of any ionizing radiation that produces the same biological effect as a unit of absorbed dose of ordinary X-rays. Acronym for roentgen-equivalent man.

Remediation. The process of cleaning up a site where a release of a radioactive or hazardous substance has occurred.

Riparian habitat. A specialized form of wetland restricted to areas along, adjacent to, or contiguous with perennially flooded and intermittently flowing rivers and streams. Also, periodically flooded lake and reservoir shore areas.

Risk. Quantitative expression of possible loss that considers both the probability that a hazard causes harm, and the consequences of that event.

Saturated zone. A subsurface area in which all pores are filled with water under pressure equal to or greater than atmospheric pressure.

Scoping process. An early and open public participation process for determining the scope of issues to be addressed, and for identifying the significant issues related to a proposed action.

Shrub-steppe. Typically a treeless area covered by grasses and shrubs occurring in a semiarid climate. Precipitation is typically very slight, but sufficient to support the growth of sparse grass and other plants adapted to living in conditions where water is scarce. The Washington State Department of Fish and Wildlife considers shrub-steppe a priority habitat.

Socioeconomic. An adjective that relates a subject to social or economic factors or to a combination of social and economic factors.

Source term. The total activity, by radionuclide, of wastes disposed in the commercial LLRW site.

Stable waste. A stable waste will maintain its physical dimensions and its form for a minimum of 300 years when subjected to the weight of overburden and compaction equipment, the presence of moisture, microbial activity, and internal factors such as radiation effects and chemical changes. Structural stability can be achieved by the waste form itself, processing the waste to a stable form, or placing the waste in a disposal container or structure that provides stability after disposal. Unstable waste is waste that does not meet the requirements of a stable waste.

State Environmental Policy Act (SEPA). The general policies and regulations intended to help everyone make a better environmental decision; found in Chapter 43.21C of the Revised Code of Washington (RCW).

Surface soil. The upper 15 feet of soil comprising the A, B, and C horizons.

Total Effective Dose Equivalent (TEDE). The sum of the deep dose equivalent and the committed dose equivalent to the organ or tissue receiving the highest dose.

Transmissivity. The rate at which water is transmitted through a vertical section of an aquifer one foot wide, extending the full saturated height of an aquifer under a hydraulic gradient of 1, and measured in gallons per minute (English System).

Transuranic waste. The NRC defines transuranic waste as material contaminated with elements that have an atomic number greater than 92, including neptunium, plutonium, americium, and curium, and that are in concentrations greater than 10 nanocuries per gram.

Unconfined aquifer. An aquifer that has a water table or surface at atmospheric pressure. At the Hanford Site, the unconfined aquifer is the uppermost aquifer and is the most susceptible to contamination from Hanford Site operations.

Unsaturated zone. The portion of a porous medium where the interconnecting interstices are only partially filled with fluid.

Unstable waste. Unstable waste is waste that does not meet the requirements of a stable waste (see definition of stable waste).

Vadose zone. The area between the land surface and the top of the water table. Saturated bodies, such as perched groundwater, may exist in the vadose zone. The vadose zone is also known as the zone of aeration and the unsaturated zone.

Waste management. The planning, coordination, and direction of functions related to the generation, handling, treatment, storage, transport, and disposal of waste, as well as associated surveillance and maintenance activities.

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