

*Final Environmental Impact Statement for*

**Decommissioning and/or Long-Term Stewardship at the  
West Valley Demonstration Project and  
Western New York Nuclear Service Center**



*The West Valley Site*

Volume 2

*(Appendices A through R)*



AVAILABILITY OF THE  
FINAL EIS FOR DECOMMISSIONING AND/OR LONG-  
TERM STEWARDSHIP AT THE WEST VALLEY  
DEMONSTRATION PROJECT AND WESTERN NEW YORK  
NUCLEAR SERVICE CENTER

For further information on this Final EIS, or to request a copy  
of the EIS or references, please contact:

Catherine Bohan, EIS Document Manager  
West Valley Demonstration Project  
U.S. Department of Energy  
Ashford Office Complex  
9030 Route 219  
West Valley, NY 14171  
Telephone: 716-942-4159  
Fax: 716-942-4703  
E-mail: [catherine.m.bohan@wv.doe.gov](mailto:catherine.m.bohan@wv.doe.gov)



*Printed with soy ink on recycled paper*

---

## COVER SHEET

**Co-Lead Agencies:** U.S. Department of Energy (DOE)  
New York State Energy Research and Development Authority (NYSERDA)

**Cooperating Agencies:** U.S. Nuclear Regulatory Commission (NRC)  
U.S. Environmental Protection Agency (EPA)  
New York State Department of Environmental Conservation (NYSDEC)

**Involved Agencies:** New York State Department of Health (NYSDOH)  
New York State Department of Environmental Conservation (NYSDEC)

**Title:** *Final Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center*  
(DOE/EIS-0226)

**Location:** Western New York Nuclear Service Center, 10282 Rock Springs Road, West Valley,  
New York 14171-0191 (Erie and Cattaraugus Counties)

*For additional information on this Final Environmental Impact Statement (EIS) or for references, contact:*

Catherine Bohan, EIS Document Manager  
West Valley Demonstration Project  
U.S. Department of Energy  
Ashford Office Complex  
9030 Route 219  
West Valley, NY 14171  
*Telephone:* 716-942-4159  
*Fax:* 716-942-4703  
*E-mail:* catherine.m.bohan@wv.doe.gov

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

Carol M. Borgstrom, Director  
Office of NEPA Policy and Compliance  
U.S. Department of Energy  
1000 Independence Avenue, SW  
Washington, DC 20585-0103  
*Telephone:* 202-586-4600, or leave a message  
at 1-800-472-2756

*For general questions and information about NYSERDA, contact:*

Paul J. Bembia, Program Director  
West Valley Site Management Program  
New York State Energy Research and Development Authority  
Ashford Office Complex  
9030 Route 219  
West Valley, NY 14171  
*Telephone:* 716-942-9960 x4900  
*Fax:* 716-942-9961  
*E-mail:* pjb@nyserda.org

*For general information on the State Environmental Quality Review Act (SEQR) process, contact:*

David A. Munro, Deputy Counsel  
New York State Energy Research and Development Authority  
17 Columbia Circle  
Albany, NY 12203  
*Telephone:* 1-866-697-3732  
*Fax:* 518-862-1091  
*E-mail:* dam@nyserda.org

**Abstract:** The Western New York Nuclear Service Center (WNYNSC) is a 1,351-hectare (3,338-acre) site located 48 kilometers (30 miles) south of Buffalo, New York and owned by NYSERDA. In 1982, DOE assumed control but not ownership of the 68-hectare (167-acre) Project Premises portion of the site in order to conduct the West Valley Demonstration Project (WVDP), as required under the 1980 West Valley Demonstration Project Act. In 1990, DOE and NYSERDA entered into a supplemental agreement to prepare a joint EIS to address both the completion of WVDP and closure or long-term management of WNYNSC. A Draft EIS was issued for public comment in 1996: the *Draft Environmental Impact Statement for*

*Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Service Center*, also referred to as the 1996 *Cleanup and Closure Draft EIS*, DOE/EIS-0226D, January 1996. The 1996 Draft EIS did not identify a preferred alternative.

Based on decommissioning criteria for WVDP issued by NRC since the publication of the 1996 *Cleanup and Closure Draft EIS* and public comments on that EIS, DOE and NYSERDA issued the *Revised Draft Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center* (also referred to as the *Decommissioning and/or Long-Term Stewardship EIS*) in December 2008, revising the 1996 Draft EIS. This *Decommissioning and/or Long-Term Stewardship EIS* has been prepared in accordance with NEPA and the State Environmental Quality Review Act (SEQR) to examine the potential environmental impacts of the range of reasonable alternatives to decommission and/or maintain long-term stewardship at WNYNSC. The alternatives analyzed in this EIS include the Sitewide Removal Alternative, the Sitewide Close-In-Place Alternative, the Phased Decisionmaking Alternative (Preferred Alternative), and the No Action Alternative. The analysis and information contained in this EIS are intended to assist DOE and NYSERDA with the consideration of environmental impacts prior to making decommissioning or long-term management decisions.

***Phased Decisionmaking Alternative (Preferred Alternative):*** Under the Preferred Alternative, decommissioning would be accomplished in two phases: Phase 1 would include removal of all Waste Management Area (WMA) 1 facilities, the source area of the North Plateau Groundwater Plume, and the lagoons in WMA 2. Phase 1 activities would also include additional characterization of site contamination and scientific studies to facilitate consensus decisionmaking for the remaining facilities or areas. Phase 2 actions would complete decommissioning or long-term management decisionmaking according to the approach determined most appropriate during the additional Phase 1 evaluations. In general, the Phased Decisionmaking Alternative involves near-term decommissioning and removal actions where there is agency consensus and undertakes characterization work and studies that could facilitate future decisionmaking for the remaining facilities or areas. Phase 1 activities are expected to take 8 to 10 years to complete. The Phase 2 decision would be made no later than 10 years after issuance of the initial DOE Record of Decision and NYSERDA Findings Statement, if the Phased Decisionmaking Alternative is selected. In response to public comments, the Preferred Alternative has been modified since the Revised Draft EIS was issued.

***Public Comments:*** In preparing this Final EIS, DOE considered comments received during the scoping period (March 13 through April 28, 2003) and public comment period on the Revised Draft EIS (December 5, 2008 through September 8, 2009). Public hearings on the Revised Draft EIS were held in Albany, Irving, West Valley, and Buffalo, New York during the public comment period. In addition, a videoconference with the DOE Assistant Secretary for Environmental Management, the President of NYSERDA, and various stakeholders was held on September 4, 2009. Comments on the Revised Draft EIS were requested during the 9-month period following publication of the U.S. Environmental Protection Agency's (EPA's) Notice of Availability in the *Federal Register*. All comments, including late comments and those presented during the September 4, 2009 videoconference, were considered during preparation of this Final EIS.

This Final EIS contains revisions and new information based in part on comments received on the 2008 Revised Draft EIS. Vertical change bars in the margins indicate the locations of these revisions and new information. Volume 3 contains the comments received during the public comment period on the Revised Draft EIS including late comments, and DOE's and NYSERDA's responses to the comments. DOE will use the analysis presented in this Final EIS, as well as other information, in preparing its Record(s) of Decision (RODs) regarding actions to complete WVDP. DOE will issue ROD(s) no sooner than 30 days after EPA publishes a Notice of Availability of this Final EIS in the *Federal Register*. NYSERDA will use the analysis presented in this Final EIS, as well as other information, in preparing its Findings Statement, which will be published in the *New York State Environmental Notice Bulletin* no sooner than 10 days after the Final EIS is issued.

## **TABLE OF CONTENTS**

---

---

# TABLE OF CONTENTS

## Volume 2

### Appendices A through R

Table of Contents .....	vii
List of Figures .....	xviii
List of Tables.....	xxiii
Acronyms, Abbreviations, and Conversion Charts .....	xxxiii

#### Appendix A

##### **Summary of Comments Received on the 1996 Draft Environmental Impact Statement for Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Service Center**

<b>A.1</b>	<b>Background .....</b>	<b>A-1</b>
<b>A.2</b>	<b>The Public Comment Process .....</b>	<b>A-1</b>
<b>A.3</b>	<b>Categorization of Issues Raised During the 1996 Public Comment Period .....</b>	<b>A-3</b>
<b>A.4</b>	<b>Summary of and Response to Comments by Category.....</b>	<b>A-3</b>
A.4.1	Inadequate or Inaccurate Characterization of the Site, Waste, Contamination, or Presentation of Data in the Environmental Impact Statement .....	A-3
A.4.2	Reasonableness of Alternatives.....	A-4
A.4.3	Design or Operational Details .....	A-6
A.4.4	Near-term Impact Analysis Issues.....	A-6
A.4.5	Long-term Erosion Analysis Issues.....	A-7
A.4.6	Long-term Hydrologic Transport Analysis Issues .....	A-7
A.4.7	Erosion Control Strategies .....	A-8
A.4.8	Long-term Performance Assessment Issues.....	A-8
A.4.9	Preference For or Against a Particular Alternative .....	A-9
A.4.10	Preferred Alternative.....	A-10
A.4.11	Regulatory Compliance.....	A-10
A.4.12	Understanding the Purpose and Content of the Environmental Impact Statement and Its Relationship to Decisionmaking.....	A-11
A.4.13	Out-of-Scope Comments.....	A-12
<b>A.5</b>	<b>References.....</b>	<b>A-20</b>

#### Appendix B

<b>New York State Environmental Notice Bulletins and Federal Register Notices .....</b>	<b>B-1</b>
---	------------

## Appendix C

### Descriptions of Facilities/Areas, Decommissioning Activities, and New Construction

<b>C.1</b>	<b>Introduction.....</b>	<b>C-1</b>
<b>C.2</b>	<b>Buildings, Facilities, and Waste Disposal Areas Analyzed in this Environmental Impact Statement..</b>	<b>C-1</b>
C.2.1	Waste Management Area 1: Main Plant Process Building and Vitrification Facility Area .....	C-1
C.2.1.1	Main Plant Process Building .....	C-3
C.2.1.2	Vitrification Facility .....	C-5
C.2.1.3	01-14 Building .....	C-6
C.2.1.4	Load-In/Load-Out Facility .....	C-7
C.2.1.5	Utility Room and Utility Room Expansion .....	C-7
C.2.1.6	Fire Pumphouse and Water Storage Tank .....	C-8
C.2.1.7	Plant Office Building .....	C-8
C.2.1.8	Electrical Substation.....	C-8
C.2.1.9	Underground Tanks.....	C-8
C.2.1.10	Off-Gas Trench .....	C-9
C.2.1.11	Underground Lines.....	C-9
C.2.2	Waste Management Area 2: Low-Level Waste Treatment Facility Area .....	C-9
C.2.2.1	Low-Level Waste Treatment Facility.....	C-11
C.2.2.2	Lagoon 1 .....	C-11
C.2.2.3	Lagoons 2, 3, 4, and 5 .....	C-11
C.2.2.4	Neutralization Pit and Interceptors.....	C-13
C.2.2.5	Solvent Dike.....	C-14
C.2.2.6	Maintenance Shop Leach Field .....	C-14
C.2.2.7	Fire Brigade Training Area .....	C-14
C.2.2.8	Underground Pipelines .....	C-14
C.2.3	Waste Management Area 3: Waste Tank Farm Area .....	C-14
C.2.3.1	Waste Storage Tanks and Vaults.....	C-16
C.2.3.2	High-Level Waste Transfer Trench.....	C-19
C.2.3.3	Permanent Ventilation System Building .....	C-19
C.2.3.4	Supernatant Treatment System and Supernatant Treatment System Support Building..	C-20
C.2.3.5	Equipment Shelter and Condensers.....	C-20
C.2.3.6	Con-Ed Building .....	C-21
C.2.3.7	Underground Pipelines .....	C-21
C.2.4	Waste Management Area 4: Construction and Demolition Debris Landfill .....	C-21
C.2.5	Waste Management Area 5: Waste Storage Area .....	C-23
C.2.5.1	Remote-Handled Waste Facility .....	C-23
C.2.5.2	Lag Storage Area 4.....	C-25
C.2.5.3	Construction and Demolition Area.....	C-25
C.2.6	Waste Management Area 6: Central Project Premises .....	C-26
C.2.6.1	Rail Spur .....	C-26
C.2.6.2	Demineralizer Sludge Ponds .....	C-26
C.2.6.3	Equalization Basin .....	C-28
C.2.6.4	Equalization Tank .....	C-28
C.2.6.5	Low-Level Radioactive Waste Rail Packaging and Staging Area .....	C-28
C.2.6.6	Sewage Treatment Plant.....	C-28
C.2.6.7	Waste Tank Farm Test Towers .....	C-29
C.2.7	Waste Management Area 7: NRC-Licensed Disposal Area and Associated Facilities .....	C-29
C.2.7.1	Disposal Areas Within the NRC-Licensed Disposal Area .....	C-31
C.2.7.2	Interceptor Trench and Liquid Pretreatment System.....	C-32
C.2.7.3	Leachate Transfer Line.....	C-33
C.2.7.4	Former NRC-Licensed Disposal Area Lagoon .....	C-33
C.2.8	Waste Management Area 8: State-Licensed Disposal Area and Associated Facilities .....	C-34
C.2.8.1	Disposal Areas .....	C-36
C.2.8.2	Mixed Waste Storage Facility .....	C-38
C.2.8.3	Filled Lagoons.....	C-38

C.2.9	Waste Management Area 9: Radwaste Treatment System Drum Cell .....	C-39
C.2.10	Waste Management Area 10: Support and Services Area.....	C-39
	C.2.10.1 New Warehouse .....	C-42
	C.2.10.2 Meteorological Tower .....	C-42
	C.2.10.3 Security Gatehouse and Fences .....	C-42
C.2.11	Waste Management Area 11: Bulk Storage Warehouse and Hydrofracture Test Well Area .....	C-42
C.2.12	Waste Management Area 12: Balance of Site.....	C-44
	C.2.12.1 Dams and Reservoirs.....	C-44
	C.2.12.2 Parking Lots and Roadways .....	C-44
	C.2.12.3 Railroad Spur .....	C-45
	C.2.12.4 Soils and Stream Sediments .....	C-45
	C.2.12.5 Other Potentially Contaminated Areas .....	C-45
C.2.13	North Plateau Groundwater Plume .....	C-45
	C.2.13.1 Groundwater Recovery System.....	C-47
	C.2.13.2 Permeable Treatment Walls .....	C-48
C.2.14	Cesium Prong.....	C-48
<b>C.3</b>	<b>Decommissioning Activities.....</b>	<b>C-48</b>
C.3.1	Sitewide Removal Alternative .....	C-50
	C.3.1.1 Waste Management Area 1: Main Plant Process Building and Vitrification Facility Area .....	C-50
	C.3.1.2 Waste Management Area 2: Low-Level Waste Treatment Facility Area.....	C-59
	C.3.1.3 Waste Management Area 3: Waste Tank Farm Area .....	C-63
	C.3.1.4 Waste Management Area 4: Construction and Demolition Debris Landfill.....	C-69
	C.3.1.5 Waste Management Area 5: Waste Storage Area .....	C-70
	C.3.1.6 Waste Management Area 6: Central Project Premises .....	C-72
	C.3.1.7 Waste Management Area 7: NRC-Licensed Disposal Area and Associated Facilities .....	C-75
	C.3.1.8 Waste Management Area 8: State-Licensed Disposal Area and Associated Facilities .....	C-80
	C.3.1.9 Waste Management Area 9: Radwaste Treatment System Drum Cell.....	C-85
	C.3.1.10 Waste Management Area 10: Support and Services Area.....	C-85
	C.3.1.11 Waste Management Area 11: Bulk Storage Warehouse and Hydrofracture Test Well Area .....	C-86
	C.3.1.12 Waste Management Area 12: Balance of Site .....	C-87
	C.3.1.13 North Plateau Groundwater Plume.....	C-89
	C.3.1.14 Cesium Prong .....	C-90
	C.3.1.15 Removal of Environmental Monitoring Equipment.....	C-91
C.3.2	Sitewide Close-In-Place Alternative .....	C-92
	C.3.2.1 Waste Management Area 1: Main Plant Process Building and Vitrification Facility Area .....	C-92
	C.3.2.2 Waste Management Area 2: Low-Level Waste Treatment Facility Area.....	C-98
	C.3.2.3 Waste Management Area 3: Waste Tank Farm Area .....	C-100
	C.3.2.4 Waste Management Area 4: Construction and Demolition Debris Landfill.....	C-105
	C.3.2.5 Waste Management Area 5: Waste Storage Area .....	C-105
	C.3.2.6 Waste Management Area 6: Central Project Premises .....	C-106
	C.3.2.7 Waste Management Area 7: NRC-Licensed Disposal Area and Associated Facilities .....	C-108
	C.3.2.8 Waste Management Area 8: State-Licensed Disposal Area and Associated Facilities .....	C-110
	C.3.2.9 Waste Management Area 9: Radwaste Treatment System Drum Cell.....	C-112
	C.3.2.10 Waste Management Area 10: Support and Services Area.....	C-113
	C.3.2.11 Waste Management Area 11: Bulk Storage Warehouse and Hydrofracture Test Well Area .....	C-114
	C.3.2.12 Waste Management Area 12: Balance of Site .....	C-114
	C.3.2.13 North Plateau Groundwater Plume.....	C-115
	C.3.2.14 Cesium Prong .....	C-115



C.3.3	Phased Decisionmaking Alternative .....	C-116
C.3.3.1	Waste Management Area 1: Main Plant Process Building and Vitrification Facility Area .....	C-117
C.3.3.2	Waste Management Area 2: Low-Level Waste Treatment Facility Area.....	C-119
C.3.3.3	Waste Management Area 3: Waste Tank Farm Area.....	C-119
C.3.3.4	Waste Management Area 4: Construction and Demolition Debris Landfill.....	C-121
C.3.3.5	Waste Management Area 5: Waste Storage Area .....	C-121
C.3.3.6	Waste Management Area 6: Central Project Premises .....	C-122
C.3.3.7	Waste Management Area 7: NRC-Licensed Disposal Area and Associated Facilities .....	C-123
C.3.3.8	Waste Management Area 8: State-Licensed Disposal Area and Associated Facilities .....	C-124
C.3.3.9	Waste Management Area 9: Radwaste Treatment System Drum Cell.....	C-125
C.3.3.10	Waste Management Area 10: Support and Services Area.....	C-125
C.3.3.11	Waste Management Area 11: Bulk Storage Warehouse and Hydrofracture Test Well Area .....	C-126
C.3.3.12	Waste Management Area 12: Balance of Site.....	C-126
C.3.3.13	North Plateau Groundwater Plume.....	C-127
C.3.3.14	Cesium Prong .....	C-128
<b>C.4</b>	<b>Construction of New Facilities/Structures .....</b>	<b>C-128</b>
C.4.1	Interim Storage Facility (Dry Cask Storage Area) in Waste Management Area 6.....	C-131
C.4.2	Waste Tank Farm Waste Processing Facility in WMA 3.....	C-131
C.4.3	Soil Drying Facility in Waste Management Area 6 .....	C-134
C.4.4	Container Management Facility in Waste Management Area 9.....	C-134
C.4.5	Leachate Treatment Facility in Waste Management Area 9 .....	C-138
C.4.6	Environmental Enclosures and Confinement Structures.....	C-140
C.4.6.1	NRC-Licensed Disposal Area Environmental Enclosure.....	C-140
C.4.6.2	West Valley Demonstration Project Disposal Area Environmental Enclosure .....	C-143
C.4.6.3	South State-Licensed Disposal Area Environmental Enclosure.....	C-143
C.4.6.4	North State-Licensed Disposal Area Environmental Enclosure.....	C-144
C.4.6.5	State-Licensed Disposal Area Lagoon Confinement Structures.....	C-145
C.4.6.6	Lagoon 1 (Waste Management Area 2) Confinement Structure .....	C-146
C.4.6.7	North Plateau Groundwater Plume Source Confinement Structure .....	C-146
C.4.6.8	Modular Shielded Environmental Enclosure.....	C-146
C.4.7	Waste Management Area 1 Main Plant Process Building Excavation Downgradient Barrier Wall .....	C-148
C.4.8	Installation of the Waste Management Area 1 and Waste Management Area 3 Circumferential Hydraulic Barrier Walls and Multi-layer Cap.....	C-149
C.4.8.1	Conceptual Design of the Closure System .....	C-149
C.4.8.2	Construction of the Hydraulic Barrier Walls.....	C-150
C.4.8.3	Multi-layer Closure Cap Design.....	C-152
C.4.8.4	Performance of Permeable Treatment Walls, Hydraulic Barrier Walls, and Covers ...	C-153
C.4.9	Waste Management Area 2 Lagoons Engineered Multi-layer Cover.....	C-154
C.4.10	Barrier Wall in Waste Management Area 2 .....	C-154
C.4.11	NRC-Licensed Disposal Area and State-Licensed Disposal Area Engineered Multi-layer Covers .....	C-156
C.4.12	Circumferential Barrier Wall in Waste Management Area 2 .....	C-156
C.4.13	Erosion Control Structures .....	C-156
<b>C.5</b>	<b>References.....</b>	<b>C-161</b>

## Appendix D

### Overview of Performance Assessment Approach

<b>D.1</b>	<b>Summary of Performance Assessment Approach.....</b>	<b>D-1</b>
<b>D.2</b>	<b>Short-term Performance Assessment .....</b>	<b>D-3</b>
D.2.1	Short-term Performance Assessment Exposure Scenarios .....	D-3
D.2.1.1	Site Conceptual Model .....	D-4
D.2.1.2	Short-term Performance Assessment Release Rates .....	D-4
D.2.1.3	Short-term Performance Assessment Human Receptors .....	D-5
D.2.1.4	Summary of Short-term Performance Assessment Exposure Scenarios .....	D-5
D.2.2	Selection of Short-term Performance Assessment Calculation Model.....	D-5
<b>D.3</b>	<b>Long-term Performance Assessment.....</b>	<b>D-6</b>
D.3.1	Long-term Performance Assessment Exposure Scenarios .....	D-6
D.3.1.1	Site Conceptual Model .....	D-6
D.3.1.2	Long-term Performance Assessment Release Rates and Environmental Transport Pathways.....	D-8
D.3.1.3	Long-term Performance Assessment Human Receptors and Exposure Modes.....	D-9
D.3.1.4	Summary of Long-term Performance Assessment Exposure Scenarios .....	D-15
D.3.2	Selection of Long-term Performance Assessment Calculation Models .....	D-17
D.3.2.1	Review of Existing Models and Conceptual Alternatives .....	D-17
D.3.2.2	Site-specific Models .....	D-18
D.3.2.3	Approach to Addressing Long-term Performance Assessment Uncertainty .....	D-21
<b>D.4</b>	<b>References.....</b>	<b>D-22</b>

## Appendix E

### Geohydrological Analysis

<b>E.1</b>	<b>Introduction.....</b>	<b>E-1</b>
<b>E.2</b>	<b>Site Characteristics .....</b>	<b>E-2</b>
E.2.1	Overview of Geologic and Hydrogeologic Setting .....	E-2
E.2.1.1	Location and Main Features .....	E-2
E.2.1.2	Geology .....	E-5
E.2.1.3	Site Stratigraphy.....	E-5
E.2.2	Definition of Hydrostratigraphic Units .....	E-7
E.2.2.1	Thick-bedded Unit Sand and Gravel and Slack-water Sequence .....	E-11
E.2.2.2	Lavery Till.....	E-13
E.2.2.3	Lavery Till-Sand .....	E-14
E.2.2.4	Kent Recessional Sequence.....	E-15
E.2.2.5	Kent Till, Olean Recessional Sequence, and Olean Till.....	E-16
E.2.2.6	Bedrock .....	E-16
E.2.3	Flow Systems .....	E-17
E.2.3.1	Surface Water and Seepage Faces.....	E-17
E.2.3.2	Groundwater.....	E-21
E.2.3.3	Water Balances.....	E-25
<b>E.3</b>	<b>Groundwater Flow Model.....</b>	<b>E-26</b>
E.3.1	Model Boundaries .....	E-27
E.3.2	Description of Model Grid .....	E-27
E.3.3	Boundary Conditions .....	E-30
E.3.4	Input Parameters .....	E-33
E.3.4.1	Hydraulic Conductivity .....	E-34
E.3.4.2	Infiltration .....	E-41
E.3.4.3	Soil Moisture Characteristics .....	E-42

E.3.5	Model Calibration .....	E-42
E.3.6	Sensitivity and Uncertainty .....	E-49
E.3.7	Results .....	E-53
E.3.7.1	Predicted Water Tables .....	E-53
E.3.7.2	Groundwater Flow Directions .....	E-57
E.3.7.3	Flows .....	E-64
E.3.7.4	Alternative Conceptual Model – Weathered Bedrock Outlet .....	E-65
<b>E.4</b>	<b>Near-field Groundwater Flow Models .....</b>	<b>E-65</b>
E.4.1	North Plateau .....	E-65
E.4.1.1	Historical Conditions (No Action Alternative) .....	E-70
E.4.1.2	Engineered Features (Sitewide Close-In-Place Alternative) .....	E-79
E.4.1.3	Phased Decisionmaking Alternative .....	E-85
E.4.2	South Plateau .....	E-86
E.4.2.1	Historical Conditions.....	E-87
E.4.2.2	Short-term Conditions for the No Action and Phased Decisionmaking Alternatives.....	E-88
E.4.2.3	Long-term Conditions for the No Action and Sitewide Close-In-Place Alternatives ....	E-90
<b>E.5</b>	<b>References.....</b>	<b>E-92</b>

## **Appendix F Erosion Studies**

<b>F.1</b>	<b>Overview of Western New York Nuclear Service Center Erosional Processes and History .....</b>	<b>F-2</b>
F.1.1	Overview of Erosional Processes .....	F-2
F.1.2	Overview of Geomorphic History .....	F-5
<b>F.2</b>	<b>Summary of Site Erosion Measurements.....</b>	<b>F-6</b>
F.2.1	Sheet and Rill Erosion Measurement .....	F-7
F.2.2	Stream Downcutting .....	F-7
F.2.2.1	Radiocarbon and Luminescence Dating of Fluvial Deposits .....	F-7
F.2.2.2	Analysis and Interpretation of Dating Samples.....	F-13
F.2.2.3	Estimating Downcutting from Repeated Cross-Section Surveys .....	F-15
F.2.3	Historical Stream Valley Rim Widening .....	F-15
F.2.3.1	Rim-Widening Estimates Based on Stream Downcutting Measurements.....	F-16
F.2.3.2	Rim-Widening Estimates Based on Slope Movement Measurements .....	F-17
F.2.3.3	Measurement of Gully Advance Rates.....	F-17
<b>F.3</b>	<b>Erosion Rate Prediction Methods.....</b>	<b>F-18</b>
F.3.1	Long-term Models.....	F-18
F.3.1.1	Review of Erosion Models .....	F-19
F.3.1.2	Overview of Approach to Erosion Modeling .....	F-20
F.3.1.3	Overview of CHILD Model Calibration Strategy .....	F-21
F.3.1.4	Parameter Selection for CHILD Model.....	F-23
F.3.1.5	Testing and Calibration Results .....	F-40
F.3.1.6	Forward Modeling of Erosion Patterns .....	F-44
F.3.2	Verification of Landscape Evolution Modeling Results – Short-term Modeling Studies .....	F-79
F.3.2.1	Short-term Sheet and Rill Erosion Prediction .....	F-80
F.3.2.2	Short-term Channel Downcutting and Valley Rim–Widening Prediction .....	F-90
F.3.2.3	Short-term Infiltration Capacity Prediction.....	F-92
<b>F.4</b>	<b>Summary.....</b>	<b>F-95</b>
<b>F.5</b>	<b>References.....</b>	<b>F-98</b>

**Appendix G**

**Models for Long-term Performance Assessment**

**G.1 Approach for Development of Mathematical Models.....G-1**

**G.2 Residual Contamination of Surface Soil .....G-4**

G.2.1 Residual Radioactive Material ..... G-4

G.2.2 Residual Chemical Constituents ..... G-5

G.2.2.1 Inadvertent Ingestion of Soil..... G-5

G.2.2.2 Inhalation of Fugitive Dust ..... G-6

G.2.2.3 Ingestion of Drinking Water ..... G-7

G.2.2.4 Ingestion of Crops ..... G-8

G.2.2.5 Ingestion of Meat ..... G-8

G.2.2.6 Ingestion of Milk..... G-9

**G.3 Groundwater Release Scenarios .....G-10**

G.3.1 Structure of Integrated Codes..... G-12

G.3.2 Release Modules ..... G-14

G.3.2.1 Rectangular Geometry, Analytic Release Model ..... G-14

G.3.2.2 Rectangular Geometry, Finite Difference Release Model..... G-20

G.3.2.3 Cylindrical Geometry, Finite Difference Release Model..... G-23

G.3.3 Groundwater Transport Module..... G-26

G.3.3.1 Localized Sources ..... G-26

G.3.3.2 Distributed Sources ..... G-27

G.3.4 Human Health Effects Impact Module..... G-28

G.3.4.1 Calculation of Ingrowth and Decay..... G-28

G.3.4.2 Calculation of Concentrations of Hazardous Constituents in Soil ..... G-31

G.3.4.3 Calculation of Measures of Human Health Impact ..... G-32

**G.4 Intruder Scenario Models .....G-39**

G.4.1 Organization of the Model ..... G-39

G.4.2 Intruder Dose Models..... G-40

G.4.2.1 The Home Construction Intruders..... G-40

G.4.2.2 Drilling Intruder ..... G-41

G.4.2.3 Residential Farmer Intruder ..... G-42

G.4.2.4 Recreational Hiking..... G-43

**G.5 Erosion Collapse Scenario Models .....G-43**

**G.6 References.....G-47**

**Appendix H**

**Long-Term Performance Assessment Results**

**H.1 Introduction.....H-2**

H.1.1 The Waste Management Areas ..... H-2

H.1.2 The Four Alternatives ..... H-4

H.1.3 The Receptors ..... H-5

H.1.3.1 Summary List – Receptor Locations ..... H-5

H.1.3.2 Types of Receptors..... H-8

**H.2 Long-Term Impacts .....H-18**

H.2.1 Sitewide Removal ..... H-18

H.2.2 Sitewide Close-In-Place and No Action Alternatives ..... H-20

H.2.2.1 Parameters in the Impact Analysis ..... H-20

H.2.2.2 Indefinite Continuation of Institutional Controls ..... H-29

H.2.2.3 Conditions Assuming Loss of Institutional Control ..... H-51

H.2.2.4 Loss of Institutional Controls Leading to Unmitigated Erosion..... H-72

H.2.3 Some Observations on the Phased Decisionmaking Alternative..... H-76

<b>H.3</b>	<b>Sensitivity Analysis .....</b>	<b>H-78</b>
H.3.1	Amount of Precipitation.....	H-78
H.3.2	Degree of Degradation of Engineered Caps.....	H-79
H.3.3	Retention of Technetium.....	H-79
H.3.4	Erosion Damage of Groundwater Flow Barriers.....	H-80
H.3.5	Degree of Degradation of Slurry Walls.....	H-81
<b>H.4</b>	<b>References.....</b>	<b>H-83</b>

## **Appendix I**

### **Decommissioning Radiological and Hazardous Chemical Human Health Impacts Evaluation**

<b>I.1</b>	<b>Introduction.....</b>	<b>I-1</b>
<b>I.2</b>	<b>Human Health Radiological Impacts .....</b>	<b>I-1</b>
I.2.1	Nature of Radiation and Its Effects on Humans.....	I-1
I.2.2	Radiation Measuring Units .....	I-3
I.2.3	Radiation Sources .....	I-4
I.2.4	Exposure Pathways .....	I-4
I.2.5	Radiation Protection Guides .....	I-5
I.2.6	Radiation Exposure Limits.....	I-6
<b>I.3</b>	<b>Health Effects .....</b>	<b>I-6</b>
<b>I.4</b>	<b>Normal Operations Radiological Impacts During Implementation of Alternatives .....</b>	<b>I-10</b>
I.4.1	GENII Computer Code Generic Description .....	I-10
I.4.2	GENII Input Data.....	I-11
I.4.3	Meteorological Data.....	I-13
I.4.3.1	Population Data.....	I-13
I.4.3.2	Source Term Data .....	I-13
I.4.3.3	Food Production and Consumption Data .....	I-15
I.4.3.4	GENII Basic Assumptions .....	I-16
I.4.3.5	Radiological Consequences from Normal Operations .....	I-17
I.4.3.6	Analysis Uncertainties.....	I-19
<b>I.5</b>	<b>Impacts of Accidents During Alternative Implementation .....</b>	<b>I-20</b>
I.5.1	Accident Relationship to Environmental Impact Statement Alternative.....	I-20
I.5.2	Radiological Source Term Methodology .....	I-21
I.5.3	Accident Scenario Development Methodology .....	I-22
I.5.4	Accident Source Term.....	I-25
I.5.5	Accident Frequency .....	I-31
I.5.6	MACCS2 Code Description.....	I-33
I.5.7	Radiological Accident Results .....	I-35
I.5.8	Toxic Chemical Accidents .....	I-39
I.5.9	Accident Radiological and Chemical Impacts Conclusion .....	I-41
<b>I.6</b>	<b>References.....</b>	<b>I-43</b>

## **Appendix J**

### **Evaluation of Human Health Effects from Transportation**

<b>J.1</b>	<b>Introduction.....</b>	<b>J-1</b>
<b>J.2</b>	<b>Scope of Assessment.....</b>	<b>J-1</b>
J.2.1	Transportation-related Activities.....	J-1
J.2.2	Radiological Impacts.....	J-1
J.2.3	Nonradiological Impacts .....	J-2

J.2.4	Transportation Modes .....	J-2
J.2.5	Receptors.....	J-2
<b>J.3</b>	<b>Packaging and Transportation Regulations .....</b>	<b>J-2</b>
J.3.1	Packaging Regulations.....	J-3
J.3.2	Transportation Regulations .....	J-4
<b>J.4</b>	<b>Transportation Analysis Impact Methodology.....</b>	<b>J-5</b>
J.4.1	Transportation Routes .....	J-7
J.4.2	Radioactive Material Shipments .....	J-9
J.4.3	Radionuclide Inventories .....	J-12
<b>J.5</b>	<b>Incident-free Transportation Risks.....</b>	<b>J-13</b>
J.5.1	Radiological Risk.....	J-13
J.5.2	Nonradiological Risk .....	J-16
J.5.3	Maximally Exposed Individual Exposure Scenarios.....	J-16
<b>J.6</b>	<b>Transportation Accident Risks.....</b>	<b>J-17</b>
J.6.1	Methodology .....	J-17
J.6.2	Accident Rates .....	J-17
J.6.3	Accident Severity Categories and Conditional Probabilities .....	J-18
J.6.4	Atmospheric Conditions.....	J-19
J.6.5	Radioactive Release Characteristics.....	J-20
J.6.6	Acts of Sabotage or Terrorism .....	J-20
<b>J.7</b>	<b>Risk Analysis Results.....</b>	<b>J-21</b>
<b>J.8</b>	<b>Impact of Construction and Operational Material Transport.....</b>	<b>J-29</b>
<b>J.9</b>	<b>Conclusions.....</b>	<b>J-30</b>
<b>J.10</b>	<b>Long-term Impacts of Transportation.....</b>	<b>J-30</b>
<b>J.11</b>	<b>Uncertainty and Conservatism in Estimated Impacts .....</b>	<b>J-31</b>
J.11.1	Uncertainties in Material Inventory and Characterization .....	J-32
J.11.2	Uncertainties in Containers, Shipment Capacities, and Number of Shipments.....	J-32
J.11.3	Uncertainties in Route Determination.....	J-32
J.11.4	Uncertainties in the Calculation of Radiation Doses.....	J-32
J.11.5	Uncertainties in Traffic Fatality Rates .....	J-33
<b>J.12</b>	<b>References.....</b>	<b>J-34</b>

**Appendix K**  
**Method for Estimating Nonradiological Air Quality Impacts**

<b>K.1</b>	<b>Introduction.....</b>	<b>K-1</b>
<b>K.2</b>	<b>Model Description.....</b>	<b>K-3</b>
<b>K.3</b>	<b>Summary of Modeling Results.....</b>	<b>K-10</b>
K.3.1	Sitewide Removal Alternative .....	K-10
K.3.2	Sitewide Close-In-Place Alternative .....	K-10
K.3.3	Phased Decisionmaking Alternative .....	K-11
K.3.4	No Action Alternative .....	K-11
<b>K.4</b>	<b>Comparison of Modeling Results.....</b>	<b>K-12</b>
<b>K.5</b>	<b>References.....</b>	<b>K-14</b>

## Appendix L Regulatory Compliance Discussion

<b>L.1</b>	<b>Resource Conservation and Recovery Act.....</b>	<b>L-2</b>
<b>L.2</b>	<b>U.S. Nuclear Regulatory Commission Decommissioning Criteria .....</b>	<b>L-3</b>
L.2.1	Sitewide Close-In-Place Alternative with Continuation of Institutional Controls .....	L-4
L.2.1.1	Cattaraugus Creek Receptor .....	L-5
L.2.1.2	Seneca Nation of Indians Receptor .....	L-6
L.2.1.3	Lake Erie/Niagara River Water User .....	L-6
L.2.1.4	Site Worker .....	L-6
L.2.1.5	Conclusion .....	L-7
L.2.2	Sitewide Close-In-Place Alternative with Loss of Institutional Controls .....	L-7
L.2.2.1	Well Driller .....	L-7
L.2.2.2	Resident Farmer (with or without a well).....	L-8
L.2.2.3	Scenarios Leading to Unmitigated Erosion.....	L-10
L.2.2.4	Conclusions.....	L-14
<b>L.3</b>	<b>Radiological Decommissioning of the State-Licensed Disposal Area .....</b>	<b>L-14</b>
<b>L.4</b>	<b>References.....</b>	<b>L-15</b>

## Appendix M Floodplain and Wetland Assessment

<b>M.1</b>	<b>Introduction.....</b>	<b>M-1</b>
<b>M.2</b>	<b>Alternatives and Affected Environment .....</b>	<b>M-1</b>
M.2.1	Floodplains.....	M-2
M.2.2	Wetlands .....	M-7
<b>M.3</b>	<b>Floodplain and Wetland Impacts .....</b>	<b>M-11</b>
M.3.1	Sitewide Removal Alternative .....	M-11
M.3.1.1	Floodplains.....	M-11
M.3.1.2	Wetlands.....	M-12
M.3.2	Sitewide Close-In-Place Alternative .....	M-12
M.3.2.1	Floodplains.....	M-12
M.3.2.2	Wetlands.....	M-13
M.3.3	Phased Decisionmaking Alternative .....	M-15
M.3.3.1	Floodplains.....	M-15
M.3.3.2	Wetlands.....	M-15
M.3.4	No Action Alternative .....	M-16
M.3.4.1	Floodplains.....	M-16
M.3.4.2	Wetlands.....	M-16
<b>M.4</b>	<b>Mitigation Measures .....</b>	<b>M-16</b>
M.4.1	Floodplains.....	M-16
M.4.2	Wetlands .....	M-17
<b>M.5</b>	<b>References.....</b>	<b>M-19</b>

**Appendix N**

**Intentional Destructive Acts**

<b>N.1</b>	<b>Introduction</b> .....	<b>N-1</b>
<b>N.2</b>	<b>Scenario Development</b> .....	<b>N-2</b>
<b>N.3</b>	<b>Scenarios Considered but Not Analyzed</b> .....	<b>N-3</b>
<b>N.4</b>	<b>Source Terms</b> .....	<b>N-4</b>
<b>N.5</b>	<b>Human Health Effects</b> .....	<b>N-7</b>
	N.5.1 High-Level Radioactive Waste Tank Radiological Dispersal Device.....	N-7
	N.5.2 NRC-Licensed Disposal Area Radiological Dispersal Device.....	N-8
	N.5.3 Radioactive Waste Transportation Intentional Destructive Act.....	N-9
	N.5.4 Chemical Dispersal Device .....	N-10
<b>N.6</b>	<b>Summary of Intentional Destructive Acts Consequences</b> .....	<b>N-10</b>
<b>N.7</b>	<b>Intentional Destructive Acts Emergency Planning, Response, and Security</b> .....	<b>N-12</b>
<b>N.8</b>	<b>References</b> .....	<b>N-13</b>

**Appendix O**

	<b>Consultation Letters</b> .....	<b>O-1</b>
--	-----------------------------------	------------

**Appendix P**

**The SDA Quantitative Risk Assessment**

<b>P.1</b>	<b>Introduction</b> .....	<b>P-1</b>
<b>P.2</b>	<b>The QRA Framework</b> .....	<b>P-2</b>
<b>P.3</b>	<b>The QRA Scope</b> .....	<b>P-2</b>
<b>P.4</b>	<b>Evaluated Threats</b> .....	<b>P-3</b>
<b>P.5</b>	<b>Release Mechanisms and Scenarios</b> .....	<b>P-3</b>
<b>P.6</b>	<b>Supporting Analyses</b> .....	<b>P-4</b>
<b>P.7</b>	<b>The SDA Risk</b> .....	<b>P-5</b>
<b>P.8</b>	<b>Conclusions</b> .....	<b>P-7</b>
<b>P.9</b>	<b>Recommendations</b> .....	<b>P-9</b>

**Appendix Q**

	<b>Concurrence Letters</b> .....	<b>Q-1</b>
--	----------------------------------	------------

**Appendix R**

	<b>Contractor Disclosure Statements</b> .....	<b>R-1</b>
--	---	------------



## LIST OF FIGURES

### Appendix C

Figure C-1	Waste Management Area 1 – Main Plant Process Building and Vitrification Facility Area .....	C-2
Figure C-2	General Arrangement of the Main Plant Process Building .....	C-3
Figure C-3	Waste Management Area 2 – Low-Level Waste Treatment Facility Area .....	C-10
Figure C-4	Waste Management Area 3 – Waste Tank Farm Area .....	C-15
Figure C-5	Waste Management Area 4 – Construction and Demolition Debris Landfill .....	C-22
Figure C-6	Waste Management Area 5 – Waste Storage Area .....	C-24
Figure C-7	Waste Management Area 6 – Central Project Premises .....	C-27
Figure C-8	Waste Management Area 7 – NRC-Licensed Disposal Area and Associated Facilities.....	C-30
Figure C-9	Waste Management Area 8 – State-Licensed Disposal Area and Associated Facilities.....	C-35
Figure C-10	Waste Management Area 9 – Radwaste Treatment System Drum Cell .....	C-40
Figure C-11	Waste Management Area 10 – Support and Services Area .....	C-41
Figure C-12	Waste Management Areas 11 and 12 – Bulk Storage Warehouse and Hydrofracture Test Well Area (Waste Management Area 11) and also Balance of Site (Waste Management Area 12).....	C-43
Figure C-13	North Plateau Groundwater Plume .....	C-46
Figure C-14	1979 Aerial Radiation Survey .....	C-49
Figure C-15	Conceptual Layout of Waste Management Area 1 Excavation .....	C-55
Figure C-16	Location of the Interim Storage Facility (Dry Cask Storage Area) in Waste Management Area 6 .....	C-132
Figure C-17	Conceptual Container Management Facility in Waste Management Area 9 – Elevation and Plan View .....	C-135
Figure C-18	Locations of Container Management and Leachate Treatment Facilities in Waste Management Area 9 .....	C-136
Figure C-19	Conceptual Leachate Treatment Facility in Waste Management Area 9 – Plan View .....	C-139
Figure C-20	Conceptual NRC-Licensed Disposal Area Environmental Enclosure – Plan and Elevation .....	C-141
Figure C-21	Conceptual NRC-Licensed Disposal Area Barrier Wall and French Drain Layout .....	C-142
Figure C-22	Conceptual South State-Licensed Disposal Area Environmental Enclosure Footprint .....	C-144
Figure C-23	Conceptual North State-Licensed Disposal Area Environmental Enclosure Footprint .....	C-145
Figure C-24	North Plateau Closure Cap Conceptual Plan View .....	C-151
Figure C-25	Plan View of Cap and Barrier Wall in Waste Management Area 2 .....	C-155
Figure C-26	Location and Conceptual Design for Long-term Erosion Control.....	C-157
Figure C-27	Typical Diversion Berm .....	C-158
Figure C-28	Typical Water Control Structure .....	C-159

### Appendix D

Figure D-1	Performance Assessment Flow Diagram.....	D-3
------------	--	-----

### Appendix E

Figure E-1	General Location Map of the Western New York Nuclear Service Center and the West Valley Demonstration Project.....	E-3
Figure E-2	West Valley Demonstration Project Site and Waste Management Areas.....	E-4
Figure E-3	Surface Geology in the Vicinity of the Western New York Nuclear Service Center .....	E-6
Figure E-4	Geologic Cross-section through the Buttermilk Creek Valley .....	E-7
Figure E-5	Geologic Cross-section through the North Plateau.....	E-9
Figure E-6	Geologic Cross-section through the South Plateau.....	E-9
Figure E-7	Conceptual Block Models of the North and South Plateau Groundwater Flow System at the West Valley Demonstration Project Site .....	E-10
Figure E-8	Surficial Sand and Gravel Showing the Extent of Both the Thick-bedded Unit and the Slack-water Sequence .....	E-12

Figure E-9	Site Surface Hydrology .....	E-18
Figure E-10	Locations of Perimeter Seeps and Stream Gauging Stations for the North Plateau .....	E-20
Figure E-11	Fourth Quarter 2007 the Surficial Sand and Gravel Aquifer Groundwater Levels .....	E-23
Figure E-12	Fourth Quarter 2007 South Plateau Groundwater Levels.....	E-24
Figure E-13	Plane View of Model Domain and Grid.....	E-28
Figure E-14	Schematic Representation of the Geologic Model in the Vicinity of the North Plateau.....	E-29
Figure E-15	Surface Boundary Conditions for Model.....	E-31
Figure E-16	Boundary Condition Set Relative to Top of the Kent Recessional Sequence.....	E-33
Figure E-17	Changes in the Thick-bedded Unit Hydraulic Conductivity during the Period of 1987 to 2004.....	E-35
Figure E-18	Kriged Thick-bedded Unit Hydraulic Conductivity (log-transformed) .....	E-36
Figure E-19	Horizontal Hydraulic Conductivity of the Thick-bedded Unit in Layers 1, 2, and 3.....	E-37
Figure E-20	Unweathered Lavery Till Hydraulic Conductivity as a Function of Depth .....	E-38
Figure E-21	Locations of Target Wells Used in Calibration of the Site Model.....	E-45
Figure E-22	Observed Versus Predicted Heads in the Base Case Model (all well locations) .....	E-47
Figure E-23	The Observed Versus Predicted Heads in the Base Case Model (upper aquifer only) .....	E-47
Figure E-24	Results of Sensitivity Analysis of Base Case Model.....	E-50
Figure E-25	Simulated Upper Aquifer Water Table in the Thick-bedded Unit and Weathered Lavery Till (Model Layer 3 Head) .....	E-54
Figure E-26	Simulated Lower Aquifer Water Table in the Kent Recessional Sequence (Model Layer 12) .....	E-56
Figure E-27	Upper and Lower Aquifers Tables at the North Plateau .....	E-57
Figure E-28	Saturation in the Unweathered Lavery Till.....	E-58
Figure E-29	North Plateau Velocity Field in Profile .....	E-59
Figure E-30	South Plateau Velocity Field in Profile .....	E-59
Figure E-31	Streamlines in the North Plateau Flow Field.....	E-61
Figure E-32	Streamlines in the South Plateau Flow Field.....	E-61
Figure E-33	Modeled Streamlines from the Vicinity of the Main Plant Process Building and the Waste Tank Farm.....	E-62
Figure E-34	Modeled Streamlines from the NRC-Licensed Disposal Area and the State-Licensed Disposal Area.....	E-63
Figure E-35	Boundaries of Model Areas for the North and South Plateau Near-field Groundwater Flow Models .....	E-66
Figure E-36	Cross Section of the Near-field Groundwater Flow Model of the North Plateau: Southwest to Northeast Distance of 0 to 80 Meters.....	E-67
Figure E-37	Cross Section of the Near-field Groundwater Flow Model of the North Plateau: Southwest to Northeast Distance of 80 to 120 Meters.....	E-68
Figure E-38	Cross Section of the Near-field Groundwater Flow Model of the North Plateau: Southwest to Northeast Distance of 120 to 250 Meters.....	E-68
Figure E-39	Cross Section of the Near-field Groundwater Flow Model of the North Plateau: Southwest to Northeast Distance of 250 to 310 Meters.....	E-69
Figure E-40	Cross Section of the Near-field Groundwater Flow Model of the North Plateau: Southwest to Northeast Distance of 310 to 820 Meters.....	E-69
Figure E-41	Water Table Plot for the North Plateau Near-field Flow Model, Historical Conditions .....	E-72
Figure E-42	Near-field Groundwater Flow Model Prediction of Concentration of Strontium-90 in the North Plateau Plume 27 Years After Release .....	E-74
Figure E-43	Near-field Groundwater Flow Model Prediction of Concentration of Technetium-99 for a Release at the Waste Tank Farm 5 Years After Release .....	E-76
Figure E-44	Rate of Arrival of Technetium-99 at the Model Boundary for a Source at the Waste Tank Farm Tanks .....	E-77
Figure E-45	One-dimensional Groundwater Transport Model Prediction of Concentration of Strontium-90 in the North Plateau Plume 27 Years After Release.....	E-79
Figure E-46	Schematic of an Engineered Cap.....	E-80
Figure E-47	Water Table Elevation for Sitewide Close-In-Place Alternative Conditions.....	E-82
Figure E-48	Elevation of the Water Table on the North Plateau Phased Decisionmaking Alternative, Near-field Flow Model .....	E-86
Figure E-49	Elevation of the Water Table on the South Plateau Historical Conditions, Near-field Flow Model .....	E-88

Figure E-50	Elevation of the Water Table for Short-term No Action and Phased Decisionmaking Alternative Conditions, Near-field Flow Model.....	E-89
Figure E-51	Elevation of the Water Table for Long-term No Action and Sitewide Close-In-Place Alternative Conditions, Near-field Flow Model.....	E-90

**Appendix F**

Figure F-1	Western New York Nuclear Service Center Topography.....	F-3
Figure F-2	Buttermilk Creek Drainage Basin.....	F-4
Figure F-3	Shaded Relief Image of Buttermilk Creek and Vicinity, Showing Rounded Bedrock Hills, Glacial Terraces, and Stream Valley Bottoms.....	F-6
Figure F-4	Sheet and Rill Erosion Frame Measurement Locations.....	F-8
Figure F-5	North and South Plateau Gully Locations .....	F-9
Figure F-6	Contour Map of Buttermilk Creek Showing Optically Stimulated Luminescence Sample Locations .....	F-12
Figure F-7	Topography of the Pre-Incision Buttermilk Creek Valley that was used to Calibrate the Landscape Evolution Models .....	F-26
Figure F-8	Plan-view Images of Buttermilk Creek and Best-fit CHILD Calibration Run and Two Examples of Poor Fit CHILD Calibration Runs (lower left and lower right) .....	F-41
Figure F-9	Comparison of Observed and Best-fit Longitudinal Profile, Projected to North-South Axis .....	F-42
Figure F-10	Comparison Between Observed and Predicted Hypsometric Curve .....	F-42
Figure F-11	Observed and Predicted Slope-Area Distribution .....	F-43
Figure F-12	Observed Versus Best-fit Modeled Width Function.....	F-43
Figure F-13	Observed Versus Best-fit Modeled Cumulative-area Index .....	F-44
Figure F-14	Modern Topography of Buttermilk Creek Watershed .....	F-45
Figure F-15	Initial In-Place-Closure Topography North and South Plateaus.....	F-46
Figure F-16	CHILD Meshes with North Plateau at a 2.8-meter Resolution (left) and South Plateau at a 2.8-meter Resolution (right).....	F-47
Figure F-17	Results of CHILD North Plateau Standard (NPstd) No Action Case .....	F-50
Figure F-18	Results of CHILD NPa1 No Action Case.....	F-51
Figure F-19	Results of CHILD NPa2 No Action Case.....	F-52
Figure F-20	Results of CHILD NPa3 No Action Case.....	F-53
Figure F-21	Results of CHILD NPa4 No Action Case.....	F-54
Figure F-22	Results of CHILD South Plateau Standard (SPstd) No Action Case.....	F-56
Figure F-23	Results of CHILD SPa1 No Action Case .....	F-57
Figure F-24	Results of CHILD SPa2 No Action Case .....	F-58
Figure F-25	Results of CHILD SPa3 No Action Case .....	F-59
Figure F-26	Results of CHILD SPwet No Action Case .....	F-60
Figure F-27	Results of CHILD SP Wet + Fast Creep No Action Case .....	F-61
Figure F-28	Results of CHILD North Plateau Tumulus Standard (NPTstd) Sitewide Close-In-Place Case.....	F-63
Figure F-29	Results of CHILD NPTa1 Sitewide Close-In-Place Case .....	F-64
Figure F-30	Results of CHILD NPTa2 Sitewide Close-In-Place Case .....	F-65
Figure F-31	Results of CHILD NPTa3 Sitewide Close-In-Place Case .....	F-66
Figure F-32	Results of CHILD NPTa4 Sitewide Close-In-Place Case .....	F-67
Figure F-33	Results of CHILD NPTwet Sitewide Close-In-Place Case .....	F-68
Figure F-34	Results of CHILD South Plateau Tumulus Standard (SPTstd) Sitewide Close-In-Place Case .....	F-70
Figure F-35	Results of CHILD SPTa1 Sitewide Close-In-Place Case .....	F-71
Figure F-36	Results of CHILD SPTa2 Sitewide Close-In-Place Case .....	F-72
Figure F-37	Results of CHILD SPTa3 Sitewide Close-In-Place Case .....	F-73
Figure F-38	Results of CHILD SPTa4 Sitewide Close-In-Place Case .....	F-74
Figure F-39	Results of CHILD SPTwet Sitewide Close-In-Place Case .....	F-75
Figure F-40	Results of CHILD SPTwet + Fast Creep Sitewide Close-In-Place Case.....	F-76
Figure F-41	USLE and SEDIMOT II Modeling Studies Subwatershed Areas .....	F-81
Figure F-42	Location of CREAMS Study Area .....	F-85
Figure F-43	Water Erosion Prediction Project Modeling Study Channel Network and Hillslope Areas .....	F-87
Figure F-44	SWAT Delineation of Subdrainage Basin Areas within Cattaraugus Creek Watershed .....	F-93
Figure F-45	Comparison of SWAT-simulated Streamflow to USGS Gowanda Gauge Observed Streamflow during Calibration Period 1961-1965.....	F-94

**Appendix G**

Figure G-1 Schematic of the Design, Analysis, and Evaluation Process .....G-2

Figure G-2 Concept for Groundwater Scenario Analysis ..... G-10

Figure G-3 Organization of Integrated Codes ..... G-13

Figure G-4 Disposal System Schematic with Tumulus, French Drain, and Slurry Wall ..... G-15

Figure G-5 Schematic for a Layered, Rectangular Geometry Wasteform ..... G-15

Figure G-6 Schematic of Spatial Distribution of Constituent Concentration for the Plug Flow  
Analytic Solution Model ..... G-17

Figure G-7 Algorithm for Grouping Impact Period Releases into Release Period Releases..... G-20

Figure G-8 Solution Algorithm for the Rectangular Geometry, Finite Difference Solution  
Release Model ..... G-22

Figure G-9 Schematic of the Tank Closure System ..... G-23

Figure G-10 Schematic of the Cylindrical Model Coordinate System..... G-25

Figure G-11 Algorithm for Accumulation of Concentration Pulses ..... G-27

Figure G-12 Order of Calculations for the Human Health Effects Impact Module ..... G-29

Figure G-13 Algorithm for Radionuclide Ingrowth Calculations ..... G-30

Figure G-14 Organization of Intruder Scenario Analysis Computer Code ..... G-40

Figure G-15 Concept for Erosion Scenario Impact Analysis ..... G-44

Figure G-16 Algorithm for Erosion Collapse Scenario Impact Estimation ..... G-45

Figure G-17 Schematic of a Simplified Single Gully ..... G-46

**Appendix H**

Figure H-1 Location of Waste Management Areas..... H-3

Figure H-2 Location of Offsite Receptors and Buttermilk Creek Receptor ..... H-7

Figure H-3 Location of Wells and Resident/Recreational Hikers ..... H-9

Figure H-4 CHILD Landscape Evolution Model Single Large Gully at 100 Years ..... H-27

Figure H-5 CHILD Landscape Evolution Model Single Large Gully at 4,000 Years ..... H-28

Figure H-6 Annual Total Effective Dose Equivalent for the Cattaraugus Creek Receptor with the  
Sitewide Close-In-Place Alternative and Indefinite Continuation of Institutional Controls..... H-32

Figure H-7 Annual Total Effective Dose Equivalent for the Cattaraugus Creek Receptor with the  
No Action Alternative Indefinite Continuation of Institutional Controls ..... H-32

Figure H-8 Lifetime Cancer Risk from Radionuclides and Hazardous Chemicals for the Cattaraugus  
Creek Receptor with the Sitewide Close-In-Place Alternative and Indefinite Continuation  
of Institutional Controls..... H-37

Figure H-9 Lifetime Cancer Risk from Radionuclides and Hazardous Chemicals for the Cattaraugus  
Creek Receptor with the No Action Alternative and Indefinite Continuation  
of Institutional Controls..... H-38

Figure H-10 Annual Total Effective Dose Equivalent for the Seneca Nation of Indians Receptor with the  
Sitewide Close-In-Place Alternative and Indefinite Continuation of Institutional Controls..... H-40

Figure H-11 Annual Total Effective Dose Equivalent for the Seneca Nation of Indians Receptor with the  
No Action Alternative and Indefinite Continuation of Institutional Controls ..... H-41

Figure H-12 Lifetime Cancer Risk from Radionuclides and Hazardous Chemicals for the Seneca Nation  
of Indians Receptor with the Sitewide Close-In-Place Alternative and Indefinite  
Continuation of Institutional Controls ..... H-46

Figure H-13 Lifetime Cancer Risk from Radionuclides and Hazardous Chemicals for the Seneca Nation  
of Indians Receptor with the No Action Alternative and Indefinite Continuation  
of Institutional Controls..... H-46

Figure H-14 Time Series of Dose for Onsite Receptors for North Plateau Groundwater Plume  
Under Sitewide Close-In-Place – Time Measured from Completion of Decommissioning ..... H-56

Figure H-15 Annual Total Effective Dose Equivalent for the Cattaraugus Creek Receptor with the  
No Action Alternative and Loss of Institutional Controls after 100 Years..... H-57

Figure H-16 Lifetime Cancer Risk from Radionuclides and Hazardous Chemicals for the Cattaraugus  
Creek Receptor with the No Action Alternative and Loss of Institutional Controls  
After 100 Years ..... H-62

Figure H-17	Annual Total Effective Dose Equivalent for the Seneca Nation of Indians Receptor with the No Action Alternative and Loss Institutional Controls After 100 Years.....	H-65
Figure H-18	Annual Total Effective Dose Equivalent (millirem per year) for the Cattaraugus Creek Receptor as a Function of Time with the Sitewide Close-In-Place Alternative and Unmitigated Erosion.....	H-74

### **Appendix I**

Figure I-1	Location of Maximally Exposed Individual for Normal Operations .....	I-12
------------	--	------

### **Appendix J**

Figure J-1	Transportation Risk Assessment .....	J-6
Figure J-2	Analyzed Truck and Rail Routes.....	J-10

### **Appendix K**

Figure K-1	Directions for Polar Grid.....	K-5
------------	--------------------------------	-----

### **Appendix L**

Figure L-1	Sitewide Close-In-Place Alternative with Continuation of Institutional Controls Peak Annual Dose to Cattaraugus Creek Receptor .....	L-5
Figure L-2	Sitewide Close-In-Place Alternative with Loss of Institutional Controls Time Series of Peak Dose to Onsite Receptors of North Plateau Groundwater Plume .....	L-10
Figure L-3	Sitewide Close-In-Place Alternative with Loss of Institutional Controls, Unmitigated Erosion Scenario, Time Series of Peak Annual Dose to Cattaraugus Creek Resident Farmer .....	L-12

### **Appendix M**

Figure M-1	The Western New York Nuclear Service Center.....	M-3
Figure M-2	Location of Waste Management Areas 1 Through 10.....	M-4
Figure M-3	Waste Management Areas 11 and 12 – Bulk Storage Warehouse Area and Balance of the Western New York Nuclear Service Center .....	M-5
Figure M-4	100-Year Floodplain Near the West Valley Demonstration Project.....	M-6
Figure M-5	Probable Maximum Flood.....	M-8
Figure M-6	Wetlands in the Vicinity of the Project Premises .....	M-9
Figure M-7	Wetlands in the Southern Vicinity of the Project Premises .....	M-10
Figure M-8	Floodplain Encroachment by Multi-layer Covers for Waste Management Areas 7 and 8 .....	M-14

### **Appendix P**

Figure P-1	SDA Risk Curves, Exceedance Frequency Format .....	P-17
Figure P-2	Release Frequency for Exceeding a Dose of 0.1 mrem in 1 Year, Probability Density Format.....	P-18
Figure P-3	Release Frequency for Exceeding a Dose of 100 mrem in 1 Year, Probability Density Format.....	P-19
Figure P-4	SDA Risk Curves, 30-Year Operation Period Exceedance Format (Expanded Scale).....	P-20
Figure P-5	Releases in SDA 30-Year Operation Period with Doses that Exceed 100 mrem in 1 Year .....	P-21

## LIST OF TABLES

### Appendix A

Table A-1	Index of Commentors .....	A-16
-----------	---------------------------	------

### Appendix C

Table C-1	Estimated Radionuclide Inventory Within the Above- and Below-Grade Portions of the Main Plant Process Building .....	C-4
Table C-2	Estimated Chemical Contamination Within the Above- and Below-Grade Portions of the Main Plant Process Building .....	C-5
Table C-3	Estimated Radionuclide Inventory in the Vitrification Facility .....	C-6
Table C-4	Estimated Hazardous Chemical Inventory in the Vitrification Facility .....	C-6
Table C-5	Estimated Radionuclide Inventory in the 01-14 Building .....	C-7
Table C-6	Estimated Radionuclide Inventory in Lagoon 1 .....	C-11
Table C-7	Estimated Radionuclide Inventory in Lagoon 2 .....	C-13
Table C-8	Radionuclide Inventory in the Waste Tank Farm – Conservative Case .....	C-16
Table C-9	Estimated Hazardous Chemical Inventory in the Waste Tank Farm .....	C-17
Table C-10	Estimated Radionuclide Inventory of the Buried Waste at the NRC-Licensed Disposal Area .....	C-32
Table C-11	Estimated Hazardous Chemical Inventory of the Buried Waste at the NRC-Licensed Disposal Area .....	C-33
Table C-12	Estimated Radionuclide Inventory of the Buried Waste at the State-Licensed Disposal Area .....	C-37
Table C-13	Estimated Hazardous Chemical Inventory of the Buried Waste at the State-Licensed Disposal Area .....	C-37
Table C-14	Estimated Radionuclide Inventory in the North Plateau Groundwater Plume .....	C-47
Table C-15	Estimated Waste to be Generated: Waste Management Area 1 .....	C-58
Table C-16	Estimated Waste to be Generated: Waste Management Area 2 .....	C-63
Table C-17	Estimated Waste to be Generated: Waste Management Area 3 .....	C-69
Table C-18	Estimated Waste to be Generated: Waste Management Area 4 .....	C-70
Table C-19	Estimated Waste to be Generated: Waste Management Area 5 .....	C-72
Table C-20	Estimated Waste to be Generated: Waste Management Area 6 .....	C-74
Table C-21	Estimated Waste to be Generated: Waste Management Area 7 .....	C-80
Table C-22	Estimated Waste to be Generated: Leachate Treatment Facility and Container Management Facility .....	C-80
Table C-23	Estimated Waste to be Generated: Waste Management Area 8 .....	C-84
Table C-24	Estimated Waste to be Generated: Waste Management Area 9 .....	C-85
Table C-25	Estimated Waste to be Generated: Waste Management Area 10 .....	C-86
Table C-26	Estimated Waste to be Generated: Waste Management Area 11 .....	C-87
Table C-27	Estimated Waste to be Generated: Waste Management Area 12 .....	C-89
Table C-28	Estimated Waste to be Generated: North Plateau Groundwater Plume (nonsource area) .....	C-90
Table C-29	Estimated Waste to be Generated: Cesium Prong .....	C-91
Table C-30	Estimated Waste to be Generated: Waste Management Area 1 .....	C-97
Table C-31	Estimated Waste to be Generated: Waste Management Area 2 .....	C-100
Table C-32	Estimated Waste to be Generated: Waste Management Area 3 .....	C-104
Table C-33	Estimated Waste to be Generated: Waste Management Area 5 .....	C-106
Table C-34	Estimated Waste to be Generated: Waste Management Area 6 .....	C-107
Table C-35	Estimated Waste to be Generated: Waste Management Area 7 .....	C-110
Table C-36	Estimated Waste to be Generated: Leachate Treatment Facility .....	C-110
Table C-37	Estimated Waste to be Generated: Waste Management Area 8 .....	C-112
Table C-38	Estimated Waste to be Generated: Waste Management Area 9 .....	C-113
Table C-39	Estimated Waste to be Generated: Waste Management Area 10 .....	C-114
Table C-40	Estimated Waste to be Generated: Waste Management Area 12 .....	C-115
Table C-41	Estimated Waste to be Generated: North Plateau Groundwater Plume (nonsource area) .....	C-116
Table C-42	Estimated Waste to be Generated: Waste Management Area 1 .....	C-118

Table C-43	Estimated Waste to be Generated: Waste Management Area 2.....	C-119
Table C-44	Estimated Waste to be Generated: Waste Management Area 3.....	C-121
Table C-45	Estimated Waste to be Generated: Waste Management Area 5.....	C-122
Table C-46	Estimated Waste to be Generated: Waste Management Area 6.....	C-123
Table C-47	Estimated Waste to be Generated: Waste Management Area 7.....	C-124
Table C-48	Estimated Waste to be Generated: Waste Management Area 8.....	C-124
Table C-49	Estimated Waste to be Generated: Waste Management Area 9.....	C-125
Table C-50	Estimated Waste to be Generated: Waste Management Area 10.....	C-126
Table C-51	Estimated Waste to be Generated: Waste Management Area 12.....	C-127
Table C-52	Estimated Waste to be Generated: North Plateau Groundwater Plume (nonsource area) .....	C-128
Table C-53	Proposed New Construction Under Each Action Alternative.....	C-129

**Appendix D**

Table D-1	Intake Parameter Values for Drinking Water and Fish Consumption by Receptors Outside Current Western New York Nuclear Service Center Boundary .....	D-12
Table D-2	Intake Parameter Values for Drinking Water and Fish Consumption by Receptors Inside the Western New York Nuclear Service Center Boundary.....	D-14
Table D-3	Summary of Exposure Scenarios.....	D-16
Table D-4	Summary of Receptor Exposure Modes .....	D-16
Table D-5	Summary of Integrated Release/Transport/Exposure Models .....	D-20

**Appendix E**

Table E-1	Stratigraphy of the West Valley Demonstration Project Premises and the State-Licensed Disposal Area.....	E-8
Table E-2	Observed Seep and Stream Flows .....	E-19
Table E-3	Final Hydraulic Conductivities for the West Valley Groundwater Models.....	E-41
Table E-4	Porosities .....	E-42
Table E-5	Lookup Table for Soil Moisture Characteristics.....	E-42
Table E-6	Groundwater Elevation Targets for Model Calibration .....	E-43
Table E-7	Comparison of Observed and Modeled Seep and Stream Discharges .....	E-48
Table E-8	Soil Moisture Characteristics for the Near-field Flow Models.....	E-70
Table E-9	North Plateau Near-field Flow Model Calibration for Head .....	E-71
Table E-10	Summary of Volumetric Flows for the North Plateau Near-field Model, Historical Conditions .....	E-71
Table E-11	Comparison of North Plateau Near-field Flow Model Predictions With Observed North Plateau Plume Concentrations of Strontium-90 .....	E-73
Table E-12	Near-field Groundwater Flow Model Predictions of Concentration of Strontium-90 in the North Plateau Plume for Calendar Year 1995 .....	E-73
Table E-13	Average Linear Velocity for Flow Path Originating at the Main Plant Process Building .....	E-75
Table E-14	Aqueous Flow Balances for Below-grade Cells of the Main Plant Process Building, Historical Conditions .....	E-75
Table E-15	Aqueous Flow Balance for the High-Level Radioactive Waste Tank Excavation, Historical Conditions .....	E-77
Table E-16	Aqueous Flow Balances for the Sections of the Waste Tank Farm Tanks, Historical Conditions .....	E-78
Table E-17	Values of Hydraulic Parameters for an Engineered Cap .....	E-81
Table E-18	Distribution of Flows for an Engineered Cap for Design and Degraded Conditions .....	E-81
Table E-19	Summary of Volumetric Flows for the North Plateau Near-field Flow Model, Sitewide Close-In-Place Alternative.....	E-83
Table E-20	Aqueous Flow Balances for Below-grade Cells of the Main Plant Process Building, Sitewide Close-In-Place Alternative Conditions .....	E-83
Table E-21	Aqueous Flow Balance for the High Level Waste Tank Excavation, Sitewide Close-In-Place Alternative Conditions .....	E-84
Table E-22	Aqueous Flow Balances for the Sections of the Waste Tank Farm Tanks, Sitewide Close-In-Place Alternative Conditions .....	E-84

Table E-23	Magnitude and Direction of Groundwater Flow through Sub-surface Sediments of the Low-Level Waste Treatment Facility.....	E-85
Table E-24	Summary of Volumetric Flows for the North Plateau Near-field Flow Model, Phased Decisionmaking Alternative.....	E-85
Table E-25	Comparison of Measured and Predicted Heads for the South Plateau Near-field Flow Model.....	E-87
Table E-26	Summary of Volumetric Flows for the South Plateau Near-field Flow Model, Historical Conditions.....	E-87
Table E-27	Summary of Volumetric Flows for the South Plateau Near-field Flow Model, Short-term for No Action and Phased Decisionmaking Alternatives.....	E-89
Table E-28	Summary of Volumetric Flows for the South Plateau Near-field Flow Model, Long-term for No Action and Sitewide Close-In-Place Alternatives.....	E-91
Table E-29	Estimates of Darcy Velocity for Waste Disposal Areas on the South Plateau for Long-term No Action and Sitewide Close-In-Place Alternative Conditions.....	E-91

**Appendix F**

Table F-1	Sheet and Rill Erosion Measurements.....	F-10
Table F-2	Optically Stimulated Luminescence Sample Locations.....	F-13
Table F-3	Optically Stimulated Luminescence Sample Ages and Average Incision Rates using a Central-Age Model.....	F-13
Table F-4	Optically Stimulated Luminescence Sample Ages and Average Incision Rates using a Minimum-Age Model.....	F-14
Table F-5	Estimates of Stream Valley Rim Widening Based on Stream Downcutting.....	F-16
Table F-6	Estimates of Stream Valley Rim Widening Based on Slope Movement.....	F-17
Table F-7	Gully Advance Rate Measurements.....	F-18
Table F-8	Values of CHILD Input Parameters Selected for Calibration Runs.....	F-24
Table F-9	Drainage Area, Storm Discharge, and Runoff at Gauging Stations.....	F-31
Table F-10	Published Values of the Coefficient $K_d$ .....	F-37
Table F-11	Parameters Associated with the Top Scoring Calibration Runs.....	F-40
Table F-12	Summary of Forward Runs.....	F-48
Table F-13	USLE Input Parameters and Results.....	F-82
Table F-14	SEDIMOT II Hydrologic and Soil Input Parameters.....	F-83
Table F-15	CREAMS Model Input Parameters and Results.....	F-86
Table F-16	Water Erosion Prediction Project Model Soil Units and Properties.....	F-88
Table F-17	Water Erosion Prediction Project Modeling Hillslope Sediment Yield Results.....	F-89
Table F-18	Short-Term Modeling Soil Loss/Sediment Yield Results Comparison.....	F-90
Table F-19	Estimates of Channel Downcutting on Erdman Brook and Franks Creek from Single-Storm Events.....	F-91
Table F-20	Estimate of Long-Term Rim-Widening for Erdman Brook and Franks Creek.....	F-91
Table F-21	Data Entered into the SWAT Model.....	F-92
Table F-22	Average Annual SWAT Modeling Results.....	F-94

**Appendix G**

Table G-1	Steps in Development of Mathematical Models.....	G-2
Table G-2	Verification Procedure for Computer Models.....	G-3

**Appendix H**

Table H-1	Description of Waste Management Areas.....	H-2
Table H-2	Summary of Alternatives.....	H-6
Table H-3	Values of Parameters for the Home Construction Scenario.....	H-10
Table H-4	Values of Parameters for the Well Drilling Scenario.....	H-10
Table H-5	Values of Parameters for Exposure Time in Recreational Hiking.....	H-11
Table H-6	Data Values for Residential and Garden Exposure Pathways for Radionuclides on the North and South Plateaus: Contaminated Zone Data.....	H-12
Table H-7	Data Values for Residential and Garden Exposure Pathways for Radionuclides on the North and South Plateaus: Saturated Zone Hydrologic Data.....	H-13



Table H-8	Data Values for Residential and Garden Exposure Pathways for Radionuclides on the North and South Plateaus: Uncontaminated and Unsaturated Zone Hydrologic Data.....	H-13
Table H-9	Data Values for Residential and Garden Exposure Pathways for Radionuclides: Dust Inhalation and External Gamma Data .....	H-13
Table H-10	Data Values for Residential and Garden Exposure Pathways for Radionuclides: Dietary Data .....	H-14
Table H-11	Data Values for Residential and Garden Exposure Pathways for Radionuclides: Nondietary Data, North Plateau.....	H-14
Table H-12	Summary of Exposure Modes for Residential and Garden Exposure to Radionuclides .....	H-15
Table H-13	RESRAD Unit Dose Factors for Water-Dependent Pathways .....	H-15
Table H-14	RESRAD Unit Dose Factors for Water-Independent Pathways .....	H-16
Table H-15	Values of Parameters for Exposure to Hazardous Chemicals.....	H-17
Table H-16	Values for the Deer Ingestion Pathway .....	H-17
Table H-17	Exposure Pathway Data for Offsite Receptors .....	H-18
Table H-18	Examples of Derived Concentration Guideline Levels of Some Common Radionuclides for Soil Screening Surface Contamination Levels .....	H-19
Table H-19	Groundwater Flow Velocities for Human Health Impact Analysis .....	H-22
Table H-20	Estimated Concentrations in the North Plateau Groundwater Plume for Calendar Year 2020 .....	H-22
Table H-21	Surface Water Flow Rates for Estimation of Human Health Impacts .....	H-23
Table H-22	Flow Rates Through Waste Disposal Volumes for North Plateau Facilities for the No Action Alternative .....	H-24
Table H-23	Flow Rates Through Waste Disposal Volumes for North Plateau Facilities for the Sitewide Close-In-Place Alternative .....	H-25
Table H-24	Flow Areas and Disposal Area Volumes for Facilities on the South Plateau .....	H-25
Table H-25	Values of Distribution Coefficient for Long-term Impact Analysis .....	H-26
Table H-26	Dimensions of CHILD Simulation Gully for Elevated Precipitation, Low Infiltration Conditions .....	H-28
Table H-27	Bioaccumulation and Transfer Factors for Fish and Deer Consumption Pathways .....	H-30
Table H-28	Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Cattaraugus Creek Receptor (year of peak exposure in parentheses) – Indefinite Continuation of Institutional Controls.....	H-31
Table H-29	Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Cattaraugus Creek Receptor Broken Down by Waste Management Area Components (year of peak exposure in parentheses) – Indefinite Continuation of Institutional Controls .....	H-34
Table H-30	Controlling Nuclides and Pathways for the Cattaraugus Creek Receptor Broken Down by Waste Management Area Components at Year of Peak Annual Total Effective Dose Equivalent – Indefinite Continuation of Institutional Controls .....	H-35
Table H-31	Peak Lifetime Radiological Risk (risk of latent cancer morbidity) for the Cattaraugus Creek Receptor (year of peak risk in parentheses) – Indefinite Continuation of Institutional Controls .....	H-36
Table H-32	Peak Lifetime Risk from Hazardous Chemicals (risk of latent cancer morbidity) for the Cattaraugus Creek Receptor (year of peak risk in parentheses) – Indefinite Continuation of Institutional Controls.....	H-36
Table H-33	Peak Chemical Hazard Index for the Cattaraugus Creek Receptor (year of peak Hazard Index in parentheses) – Indefinite Continuation of Institutional Controls.....	H-38
Table H-34	Chemicals with Largest Fraction of Maximum Contaminant Levels in Cattaraugus Creek at Year of Peak Risk and Year of Peak Hazard Index – Indefinite Continuation of Institutional Controls .....	H-39
Table H-35	Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Seneca Nation of Indians Receptor (year of peak exposure in parentheses) – Indefinite Continuation of Institutional Controls .....	H-41
Table H-36	Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Seneca Nation of Indians Receptor Broken Down by Waste Management Area Components (year of peak exposure in parentheses) – Indefinite Continuation of Institutional Controls .....	H-43
Table H-37	Controlling Nuclides and Pathways for the Seneca Nation of Indians Receptor Broken Down by Waste Management Area Components at Year of Peak Total Effective Dose Equivalent – Indefinite Continuation of Institutional Controls.....	H-44

Table H-38	Peak Lifetime Radiological Risk (risk of latent cancer morbidity) for the Seneca Nation of Indians Receptor (year of peak risk in parentheses) – Indefinite Continuation of Institutional Controls .....	H-45
Table H-39	Peak Lifetime Risk from Hazardous Chemicals (risk of latent cancer morbidity) for the Seneca Nation of Indians Receptor (year of peak risk in parentheses) – Indefinite Continuation of Institutional Controls.....	H-45
Table H-40	Peak Chemical Hazard Index for the Seneca Nation of Indians Receptor (year of peak Hazard Index in parentheses) – Indefinite Continuation of Institutional Controls .....	H-47
Table H-41	Peak Annual Total Effective Population Dose Equivalent in person-rem per year for the Lake Erie/Niagara River Water Users (year of peak dose in parentheses) – Indefinite Continuation of Institutional Controls .....	H-48
Table H-42	Time-Integrated Total Effective Population Dose Equivalent for Lake Erie/Niagara Water Users (person-rem over 1,000 and 10,000 years) – Indefinite Continuation of Institutional Controls .....	H-49
Table H-43	Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Sturgeon Point Receptor (year of peak dose in parentheses) – Indefinite Continuation of Institutional Controls .....	H-50
Table H-44	Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Niagara River Receptor (year of peak dose in parentheses) – Indefinite Continuation of Institutional Controls .....	H-50
Table H-45	Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Buttermilk Creek Resident Farmer (year of peak dose in parentheses) – Loss of Institutional Controls After 100 Years.....	H-52
Table H-46	Estimated Peak Annual Total Effective Dose Equivalent in Millirem Per Year to Intruder Worker (well driller or home construction worker) – Intrusion After 100 Years.....	H-53
Table H-47	Estimated Peak Annual Total Effective Dose Equivalent in Millirem Per Year to Resident Farmer with a Garden Containing Contaminated Soil from Well Drilling or House Construction – Intrusion After 100 Years .....	H-54
Table H-48	Estimated Peak Total Effective Dose Equivalent in Millirem Per Year to a Resident Farmer using Contaminated Groundwater – Intrusion After 100 Years .....	H-55
Table H-49	Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Cattaraugus Creek Receptor (year of peak exposure in parentheses) – Loss of Institutional Controls After 100 Years .....	H-58
Table H-50	Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Cattaraugus Creek Receptor Broken Down by Waste Management Area Components (year of peak exposure in parentheses) – Loss of Institutional Controls After 100 Years .....	H-59
Table H-51	Controlling Nuclides and Pathways for the Cattaraugus Creek Receptor, Broken Down by Waste Management Area Components at Year of Peak Annual Total Effective Dose Equivalent – Loss of Institutional Controls After 100 Years.....	H-60
Table H-52	Peak Lifetime Radiological Risk (risk of latent cancer morbidity) for the Cattaraugus Creek Receptor (year of peak risk in parentheses) – Loss of Institutional Controls After 100 Years.....	H-61
Table H-53	Peak Lifetime Risk from Hazardous Chemicals (risk of latent cancer morbidity) for the Cattaraugus Creek Receptor (year of peak risk in parentheses) – Loss of Institutional Controls After 100 Years.....	H-62
Table H-54	Peak Chemical Hazard Index for the Cattaraugus Creek Receptor (year of peak Hazard Index in parentheses) – Loss of Institutional Controls After 100 Years.....	H-63
Table H-55	Chemicals with Largest Fraction of Maximum Concentration Levels in Cattaraugus Creek – Loss of Institutional Controls After 100 Years .....	H-64
Table H-56	Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Seneca Nation of Indians Receptor (year of peak dose in parentheses) – Loss of Institutional Controls After 100 Years .....	H-65
Table H-57	Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Seneca Nation of Indians Receptor Broken down by Waste Management Area Components (year of peak dose in parentheses) – Loss of Institutional Controls After 100 Years.....	H-66

Table H-58	Controlling Nuclides and Pathways for the Seneca Nation of Indians Receptor Broken Down by Waste Management Area Components at Year of Peak Total Effective Dose Equivalent – Loss of Institutional Controls After 100 Years.....	H-67
Table H-59	Peak Lifetime Radiological Risk (risk of cancer morbidity) for the Seneca Nation of Indians Receptor (year of peak risk in parentheses) – Loss of Institutional Controls After 100 Years.....	H-68
Table H-60	Peak Annual Total Effective Population Dose Equivalent in person-rem per year for Lake Erie/Niagara River Water Users (year of peak dose in parentheses) – Loss of Institutional Controls After 100 Years .....	H-69
Table H-61	Time-Integrated Total Effective Population Dose Equivalent for Lake Erie/Niagara River Water Users (person-rem over 1,000 and 10,000 years) – Loss of Institutional Controls After 100 Years .....	H-70
Table H-62	Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Sturgeon Point Receptor (year of peak dose in parentheses) – Loss of Institutional Controls After 100 Years .....	H-71
Table H-63	Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Niagara River Receptor (year of peak dose in parentheses) – Loss of Institutional Controls After 100 Years .....	H-71
Table H-64	Peak Annual Total Effective Dose Equivalent in Millirem Per Year to a Resident/Recreational Hiker on the Low-Level Waste Treatment Facility, NDA and SDA (year of peak exposure in parentheses) – Unmitigated Erosion.....	H-73
Table H-65	Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Buttermilk Creek Resident Farmer (year of peak exposure in parentheses) – Unmitigated Erosion .....	H-73
Table H-66	Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Cattaraugus Creek Receptor (year of peak exposure in parentheses) – Unmitigated Erosion.....	H-74
Table H-67	Peak Annual Total Effective Dose Equivalent in Millirem Per Year to the Seneca Nation of Indians Receptor (year of peak exposure in parentheses) – Unmitigated Erosion .....	H-75
Table H-68	Peak Annual Total Effective Dose Equivalent Population Dose in Person-Rem per year to the Lake Erie/Niagara Water Users (year of peak exposure in parentheses) – Unmitigated Erosion.....	H-75
Table H-69	Time-integrated Total Effective Population Dose Equivalent in Person-Rem to the Lake Erie Water Users – Unmitigated Erosion.....	H-75
Table H-70	Dependence of Infiltration through an Engineered Cap on Values of Hydraulic Parameters .....	H-79
Table H-71	Dependence of Onsite Resident Farmer Peak Annual Dose on the Value of Technetium Distribution Coefficient for Groundwater Release from Tank 8D-1 .....	H-80
Table H-72	Summary of Flow Conditions for Waste Tank Farm Slurry Wall Sensitivity Analysis .....	H-81
Table H-73	Summary of Peak Annual Dose Estimates for Waste Tank Farm Slurry Wall Sensitivity Analysis .....	H-81
Table H-74	Predicted Conditions for the North Plateau Three-dimensional Near-field Groundwater Flow Model, Slurry Wall Sensitivity Analysis.....	H-82
Table H-75	Flow Balance for the General Purpose Cell, Slurry Wall Sensitivity Analysis .....	H-82

## **Appendix I**

Table I-1	Exposure Limits for Members of the Public and Radiation Workers.....	I-6
Table I-2	Nominal Health Risk Estimators Associated with Exposure to 1 Rem of Ionizing Radiation .....	I-8
Table I-3	Total Airborne Radiological Releases by Alternative .....	I-14
Table I-4	Total Liquid Radiological Releases by Alternative .....	I-14
Table I-5	GENII Usage Parameters for Consumption of Plant Food (Normal Operations).....	I-15
Table I-6	GENII Usage Parameters for Consumption of Animal Products (Normal Operations) .....	I-15
Table I-7	GENII Usage Parameters for Exposure to Plumes (Normal Operations) .....	I-16
Table I-8	Population Impacts of Airborne Radiological Releases (Normal Operations) .....	I-17
Table I-9	Population Impacts of Liquid Radiological Releases (Normal Operations).....	I-17
Table I-10	Individual Impacts of Airborne Radiological Releases (Normal Operations) .....	I-18
Table I-11	Individual Impacts of Liquid Radiological Releases (Normal Operations).....	I-19
Table I-12	Alternative Parameters Affecting Accident Analysis Scenarios.....	I-21
Table I-13	Accident Scenarios Applicable to Each Alternative.....	I-21
Table I-14	Waste Management Area 3 High-Level Radioactive Waste Tank Material at Risk.....	I-25
Table I-15	Main Plant Process Building Total Residual Radioactivity Material at Risk .....	I-26

Table I-16	Waste Package Material at Risk .....	I-26
Table I-17	NRC-Licensed Disposal Area and State-Licensed Disposal Area Material at Risk .....	I-27
Table I-18	Accident Scenario Damage Ratio, Respirable Fraction, Airborne Release Fraction, and Leak Path Factor .....	I-28
Table I-19	Basis for Specific Accident Radionuclide Release Fraction.....	I-28
Table I-20	Waste Package Puncture and High-Integrity Container Drop Accident Source Terms.....	I-29
Table I-21	Waste Pallet Drop Accident Source Terms .....	I-30
Table I-22	High-level Radioactive Waste Tank and Main Plant Process Building Accident Source Terms.....	I-30
Table I-23	NRC-Licensed Disposal Area and State-Licensed Disposal Area Accident Source Terms .....	I-30
Table I-24	Accident Scenario Annual Frequency .....	I-32
Table I-25	MACCS2 Calculated Accident Risk and Consequences for Each Alternative.....	I-36
Table I-26	Risk Duration for Major Accident Scenarios .....	I-38
Table I-27	Relative Accident Risk Comparison Rating Between Alternatives for Entire Time Period.....	I-39
Table I-28	Inventory, Properties, and Serious Health Effect Limits of the West Valley Demonstration Project Toxic Chemicals .....	I-40
Table I-29	Largest Accident Radiological Consequence and Risk .....	I-42

**Appendix J**

Table J-1	Offsite Transport Truck and Rail Route Characteristics.....	J-8
Table J-2	Waste Type and Container Characteristics .....	J-11
Table J-3	Low-Specific-Activity, Class A, B, C and Greater-Than-Class C Waste Container Inventories (curies).....	J-13
Table J-4	Fuel and Hardware, Remote-Handled Class C and Transuranic Container Inventories (curies).....	J-13
Table J-5	Incident-free Unit Risk Factors for a Dose Rate of 1 Millirem per Hour at 1 Meter from the Shipping Container for Truck and Rail Shipments .....	J-15
Table J-6	Risk Factors per Shipment of Radioactive Waste .....	J-22
Table J-7	Estimated Number of Truck Shipments Under Each Alternative.....	J-24
Table J-8	Risks of Transporting Radioactive Waste Under Each Alternative (using Barnwell as the eastern U.S. proxy site for commercial Class B and C waste disposal) .....	J-25
Table J-9	Risks of Transporting Radioactive Waste Under Each Alternative (using the Hanford Site as the western U.S. proxy site for commercial Class B and C waste disposal) .....	J-26
Table J-10	Estimated Dose to Maximally Exposed Individuals Under Incident-Free Transportation Conditions .....	J-27
Table J-11	Estimated Dose to the Population and to Maximally Exposed Individuals Under Most Severe Accident Conditions .....	J-29
Table J-12	Estimated Impacts of Construction and Operational Material Transport .....	J-30
Table J-13	Cumulative Transportation-related Radiological Collective Doses and Latent Cancer Fatalities (1943 to 2047) .....	J-31

**Appendix K**

Table K-1	Applicable Ambient Air Quality Standards.....	K-2
Table K-2	Elevations at Polar Grid Receptors for ISCST3 Modeling (meters).....	K-3
Table K-3	Elevations at Special Receptor Locations for ISCST3 Modeling (meters).....	K-4
Table K-4	Emissions in Tons Per Year by Alternative.....	K-6
Table K-5	Comparison of Ozone Precursor Emissions to Cattaraugus County Emissions by Alternative (percent).....	K-10
Table K-6	Nonradiological Air Pollutant Concentrations by Alternative.....	K-11
Table K-7	Nonradiological Emissions from Trucking Shipments of Waste and Other Materials (metric tons) .....	K-13

**Appendix L**

Table L-1	Sitewide Close-In-Place Alternative Summary of U.S. Nuclear Regulatory Commission Dose Standards for Regulatory Options .....	L-4
Table L-2	Sitewide Close-In-Place Alternative with Continuation of Institutional Controls Peak Annual Dose to Cattaraugus Creek Receptor.....	L-5
Table L-3	Sitewide Close-In-Place Alternative with Continuation of Institutional Controls Peak Annual Dose to Seneca Nation of Indians Receptor.....	L-6
Table L-4	Sitewide Close-In-Place Alternative with Continuation of Institutional Controls Peak Annual Dose to Sturgeon Point Receptor .....	L-6
Table L-5	Exposure Scenarios and Estimated Scenario Development Time .....	L-7
Table L-6	Sitewide Close-In-Place Alternative with Loss of Institutional Controls Peak Annual Dose to Well Driller .....	L-8
Table L-7	Sitewide Close-In-Place Alternative with Loss of Institutional Controls Peak Annual Dose to Buttermilk Creek Receptor.....	L-8
Table L-8	Sitewide Close-In-Place Alternative with Loss of Institutional Controls Peak Annual Dose to Resident Farmer Using Contaminated Soil .....	L-9
Table L-9	Sitewide Close-In-Place Alternative with Loss of Institutional Controls Annual Peak Dose to Resident Farmer Using Contaminated Groundwater.....	L-9
Table L-10	Sitewide Close-In-Place Alternative with Loss of Institutional Controls, Unmitigated Erosion Scenario, Peak Annual Dose to Resident/Recreational Hiker Near the Low-Level Waste Treatment Facility and NRC-Licensed Disposal Area .....	L-11
Table L-11	Sitewide Close-In-Place Alternative with Loss of Institutional Controls, Unmitigated Erosion Scenario, Peak Annual Dose to a Buttermilk Creek Receptor .....	L-11
Table L-12	Sitewide Close-In-Place Alternative with Loss of Institutional Controls, Unmitigated Erosion Scenario, Peak Annual Dose to Cattaraugus Creek Receptor .....	L-12
Table L-13	Sitewide Close-In-Place Alternative with Loss of Institutional Controls, Unmitigated Erosion Scenario, Peak Annual Dose to Seneca Nation of Indians Receptor.....	L-13
Table L-14	Sitewide Close-In-Place Alternative with Loss of Institutional Controls, Unmitigated Erosion Scenario, Peak Annual Dose to Sturgeon Point Receptor .....	L-13

**Appendix N**

Table N-1	High-Level Radioactive Waste Tank Radiological Dispersal Device Source Term.....	N-5
Table N-2	NRC-Licensed Disposal Area Radiological Dispersal Device Liquid Release Source Term .....	N-5
Table N-3	Fuel and Hardware Drum Intentional Destructive Act Source Term .....	N-6
Table N-4	Greater-Than-Class C Drum Intentional Destructive Act Source Term .....	N-6
Table N-5	Class A Box Intentional Destructive Act Source Term .....	N-7
Table N-6	Radiological Consequences of High-Level Radioactive Waste Tank Radiological Dispersal Device .....	N-8
Table N-7	Radiological Consequences of NRC-Licensed Disposal Area Radiological Dispersal Device.....	N-9
Table N-8	Transportation Intentional Destructive Act Radiological Consequences .....	N-9
Table N-9	Range of Intentional Destructive Acts Human Health Consequences for the Alternatives .....	N-11
Table N-10	Intentional Destructive Act Scenario Vulnerable Time Period for Each Alternative .....	N-11
Table N-11	Qualitative Comparison of Intentional Destructive Act Risks for Each Alternative .....	N-12

**Appendix P**

Table P-1	Threats Included in the SDA Risk Assessment .....	P-10
Table P-2	Potential SDA Threats that were Evaluated and Eliminated from further Detailed Analysis .....	P-11
Table P-3	Release Mechanisms and Scenarios .....	P-13
Table P-4	SDA Risk Scenarios .....	P-15

**ACRONYMS, ABBREVIATIONS, AND CONVERSION  
CHARTS**

---

---

## ACRONYMS, ABBREVIATIONS, AND CONVERSION CHARTS

---

ALARA	as low as is reasonably achievable
AMCG	average member of the critical group
BEIR	Biological Effects of Ionizing Radiation
CDD	Chemical Dispersal Device
CDDL	Construction and Demolition Debris Landfill
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	<i>Code of Federal Regulations</i>
CMS	Corrective Measures Study
C-R-D	remote-handled Class C
DCGL	Derived Concentration Guideline Levels
DDE	deep-dose equivalent
DHS	U.S. Department of Homeland Security
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EDE	effective dose equivalent
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ERPG	Emergency Response Planning Guideline
FEHM	Finite Element Heat and Mass Transfer Code
FEMA	Federal Emergency Management Agency
FR	<i>Federal Register</i>
GTCC	Greater-Than-Class C waste
HEPA	high-efficiency particulate air
HEC	Hydrologic Engineering Center
HIC	high-integrity container
HRU	hydrologic response unit
ICRP	International Commission on Radiological Protection
IDA	intentional destructive acts
IRIS	Integrated Risk Information System
ISCORS	Interagency Steering Committee on Radiation Standards
LCF	latent cancer fatality
LLW	low-level radioactive waste
MAR	material at risk
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCL	maximum contaminant level
MEI	maximally exposed individual
NAAQS	National Ambient Air Quality Standards
NDA	NRC-licensed Disposal Area
NEPA	National Environmental Policy Act
NFS	Nuclear Fuel Services, Inc.
NRC	U.S. Nuclear Regulatory Commission
NRF	National Response Framework

NRIA	Nuclear/Radiological Incident Annex
NTS	Nevada Test Site
NYCRR	New York Code of Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSERDA	New York State Energy Research and Development Authority
OSL	optically stimulated luminescence
PCB	polychlorinated biphenyl
PM	particulate matter
PMF	probable maximum flood
PVC	polyvinyl chloride
QRA	quantitative risk assessment
rad	radiation absorbed dose
RCRA	Resource Conservation and Recovery Act
RDD	Radiological Dispersal Device
rem	roentgen equivalent man
RH	remote-handled
RMSE	root-mean-square-error
ROD	Record of Decision
SDA	State-Licensed Disposal Area
SEQR	State Environmental Quality Review Act
SPDES	State Pollutant Discharge Elimination System
SSR	sum of the square of the residuals
STOMP	Subsurface Transport Over Multiple Phases
STS	Supernatant Treatment System
SWMU	Solid Waste Management Unit
TEDE	total effective dose equivalent
TRAGIS	Transportation Routing Analysis Geographic Information System
TRU	transuranic
U.S.C.	United States Code
USGS	U.S. Geological Survey
USLE	Universal Soil Loss Equation
WEPP	Waste Erosion Prediction Project
WIPP	Waste Isolation Pilot Plant
WMA	Waste Management Area
WNYNSC	Western New York Nuclear Service Center
WVDP	West Valley Demonstration Project
WVNS	West Valley Nuclear Services Company, Inc.
° C	degrees Celsius
° F	degrees Fahrenheit



**CONVERSIONS**

METRIC TO ENGLISH			ENGLISH TO METRIC		
Multiply	by	To get	Multiply	by	To get
<b>Area</b>					
Square meters	10.764	Square feet	Square feet	0.092903	Square meters
Square kilometers	247.1	Acres	Acres	0.0040469	Square kilometers
Square kilometers	0.3861	Square miles	Square miles	2.59	Square kilometers
Hectares	2.471	Acres	Acres	0.40469	Hectares
<b>Concentration</b>					
Kilograms/square meter	0.16667	Tons/acre	Tons/acre	0.5999	Kilograms/square meter
Milligrams/liter	1 <sup>a</sup>	Parts/million	Parts/million	1 <sup>a</sup>	Milligrams/liter
Micrograms/liter	1 <sup>a</sup>	Parts/billion	Parts/billion	1 <sup>a</sup>	Micrograms/liter
Micrograms/cubic meter	1 <sup>a</sup>	Parts/trillion	Parts/trillion	1 <sup>a</sup>	Micrograms/cubic meter
<b>Density</b>					
Grams/cubic centimeter	62.428	Pounds/cubic feet	Pounds/cubic feet	0.016018	Grams/cubic centimeter
Grams/cubic meter	0.0000624	Pounds/cubic feet	Pounds/cubic feet	16,025.6	Grams/cubic meter
<b>Length</b>					
Centimeters	0.3937	Inches	Inches	2.54	Centimeters
Meters	3.2808	Feet	Feet	0.3048	Meters
Kilometers	0.62137	Miles	Miles	1.6093	Kilometers
<b>Temperature</b>					
<i>Absolute</i>					
Degrees C + 17.78	1.8	Degrees F	Degrees F - 32	0.55556	Degrees C
<i>Relative</i>					
Degrees C	1.8	Degrees F	Degrees F	0.55556	Degrees C
<b>Velocity/Rate</b>					
Cubic meters/second	2118.9	Cubic feet/minute	Cubic feet/minute	0.00047195	Cubic meters/second
Grams/second	7.9366	Pounds/hour	Pounds/hour	0.126	Grams/second
Meters/second	2.237	Miles/hour	Miles/hour	0.44704	Meters/second
<b>Volume</b>					
Liters	0.26418	Gallons	Gallons	3.78533	Liters
Liters	0.035316	Cubic feet	Cubic feet	28.316	Liters
Liters	0.001308	Cubic yards	Cubic yards	764.54	Liters
Cubic meters	264.17	Gallons	Gallons	0.0037854	Cubic meters
Cubic meters	35.314	Cubic feet	Cubic feet	0.028317	Cubic meters
Cubic meters	1.3079	Cubic yards	Cubic yards	0.76456	Cubic meters
Cubic meters	0.0008107	Acre-feet	Acre-feet	1233.49	Cubic meters
<b>Weight/Mass</b>					
Grams	0.035274	Ounces	Ounces	28.35	Grams
Kilograms	2.2046	Pounds	Pounds	0.45359	Kilograms
Kilograms	0.0011023	Tons (short)	Tons (short)	907.18	Kilograms
Metric tons	1.1023	Tons (short)	Tons (short)	0.90718	Metric tons
<b>ENGLISH TO ENGLISH</b>					
Acre-feet	325,850.7	Gallons	Gallons	0.00003046	Acre-feet
Acres	43,560	Square feet	Square feet	0.000022957	Acres
Square miles	640	Acres	Acres	0.0015625	Square miles

a. This conversion is only valid for concentrations of contaminants (or other materials) in water.

**METRIC PREFIXES**

Prefix	Symbol	Multiplication factor
exa-	E	1,000,000,000,000,000,000 = 10 <sup>18</sup>
peta-	P	1,000,000,000,000,000 = 10 <sup>15</sup>
tera-	T	1,000,000,000,000 = 10 <sup>12</sup>
giga-	G	1,000,000,000 = 10 <sup>9</sup>
mega-	M	1,000,000 = 10 <sup>6</sup>
kilo-	k	1,000 = 10 <sup>3</sup>
deca-	D	10 = 10 <sup>1</sup>
deci-	d	0.1 = 10 <sup>-1</sup>
centi-	c	0.01 = 10 <sup>-2</sup>
milli-	m	0.001 = 10 <sup>-3</sup>
micro-	μ	0.000 001 = 10 <sup>-6</sup>
nano-	n	0.000 000 001 = 10 <sup>-9</sup>
pico-	p	0.000 000 000 001 = 10 <sup>-12</sup>