



Multimedia, Multipathway, and Multireceptor Risk Assessment (3MRA) Modeling System

Volume II: Site-based, Regional, and National Data

Multimedia, Multipathway, and Multireceptor Risk Assessment (3MRA) Modeling System

Volume II: Site-based, Regional, and National Data

prepared by

U.S. Environmental Protection Agency

Office of Research and Development
National Exposure Research Laboratory
Athens, GA
and
Research Triangle Park, NC

Office of Solid Waste
Washington, D.C.

This document is the second volume of a five-volume set. Volume I describes the conceptual design, scientific rationale, and supporting data that are the foundation for the 3MRA modeling system. This volume describes the data developed and used to run the 3MRA modeling system. Volume III describes the approach to quality assurance, including verification and validation activities ranging from extensive peer reviews to multimedia model comparisons. Volume IV describes the methodology used to evaluate sensitivity of model parameters and characterize different types of uncertainty in the 3MRA modeling system. Volume V describes the technology design and includes a user's guide.

Table of Contents

Section	Page
List of Figures	xvi
List of Tables	xviii
1.0 Introduction	1-1
1.1 3MRA Modeling System Development	1-2
1.2 Overview of the 3MRA Modeling System	1-2
1.3 Approach to Data Collection	1-6
1.4 Sites, Settings, and Area of Interest	1-8
1.5 Data Quality Objectives	1-11
1.6 Data Collection Methodology	1-16
1.6.2 Conventional Database Processing and Export to 3MRA Modeling System	1-18
1.6.3 Quality Assurance/Quality Control and Record Keeping	1-19
1.7 Organization of This Document	1-20
1.8 References	1-20
2.0 Spatial Framework	2-1
2.1 Modeled Sites	2-1
2.2 Site Locations	2-1
2.3 Settings and Area of Interest (AOI)	2-2
2.4 Regional Assignments	2-3
2.5 Site Layout, Spatial Data Layers, and Grid Database	2-3
2.6 Quality Assurance/Quality Control	2-7
2.7 Issues and Uncertainties	2-7
2.8 References	2-8
3.0 Waste Management Unit Data	3-1
3.1 Parameters Collected	3-1
3.2 Data Sources	3-1
3.2.1 Industrial D Screening Survey	3-7
3.2.2 National Survey of Hazardous Waste Treatment, Storage, Disposal, and Recycling Facilities	3-10
3.2.2.1 Tank Data Set	3-10
3.2.2.2 Tank Classification	3-11
3.2.2.3 Additional Tank Data Used for Imputation	3-12
3.2.3 National Data	3-13
3.3 Methodology	3-13
3.3.1 Site-Specific Data	3-13

Table of Contents (continued)

Section	Page
3.3.2 Site-Based Data	3-14
3.3.3 National Tank Data (Correlated)	3-15
3.3.4 Other National Data	3-15
3.4 Landfill Module Inputs	3-15
3.4.1 Landfill Module Design	3-15
3.4.2 Landfill Site-Specific Data	3-19
3.4.2.1 Screening and Replacement of Industrial D Data	3-19
3.4.2.2 Cover Soil Properties	3-20
3.4.3 Landfill Site-Based Data	3-21
3.4.3.1 Depth (SrcDepth)	3-21
3.4.3.2 Waste Loading Rate (load)	3-21
3.4.3.3 Distance Vehicle Travels on Active Landfill Cell Surface (mt)	3-21
3.4.3.4 Average Number of Vehicles per Day (nv)	3-21
3.4.3.5 Number of Spreading and Compacting Operations per Day (Nop)	3-22
3.4.3.6 Frequency of Disturbances per Month (fd)	3-22
3.4.3.7 Vehicle Weight (vw), Payload, and Number of Wheels (nw)	3-22
3.4.3.8 Number of Waste Layers in a Cell (Nly)	3-23
3.4.4 Landfill National Data	3-23
3.4.4.1 Optional Soil Cover Thickness (zC)	3-23
3.4.4.2 Thickness of Liner (or Subsoil Zone) (zS)	3-24
3.4.4.3 Dust Suppression Control Efficiency (effdust)	3-24
3.4.4.4 Fraction Vegetative Cover (veg)	3-24
3.4.4.5 Roughness Height (zruf)	3-24
3.4.4.6 Roughness Ratio (Lc)	3-24
3.4.4.7 Vehicle Speed (vs)	3-24
3.5 Waste Pile Module Inputs	3-24
3.5.1 Waste Pile Module Design	3-25
3.5.2 Waste Pile Site-Specific Data	3-25
3.5.3 Waste Pile Site-Based Data	3-28
3.5.3.1 Distance Vehicle Travels on Waste Pile Surface (mt)	3-28
3.5.3.2 Height of the Waste Pile Above Grade (zZ1WMU, SHight)	3-28
3.5.3.3 Refresh Frequency	3-30
3.5.3.4 Vehicle Weight (vw), Payload, and Number of Wheels (nw)	3-30
3.5.3.5 Vehicles per Day (nv)	3-31
3.5.3.6 Spreading/Compacting Operations per Day (Nop)	3-31
3.5.3.7 SCS Curve Number (CNwmu)	3-31
3.5.4 Waste Pile National Data	3-32

Table of Contents (continued)

Section		Page
	3.5.4.1 Dust Suppression Control Efficiency (effdust)	3-32
	3.5.4.2 Operating Life (CutOffYr)	3-32
	3.5.4.3 Vehicle Speed (vs)	3-32
	3.5.4.4 USLE Cover Factor (Cwmu)	3-33
	3.5.4.5 USLE Erosion Control Factor (Pwmu)	3-33
3.6	3.6 LAU Module Inputs	3-33
	3.6.1 LAU Module Design	3-33
	3.6.1.1 Unit Configuration	3-33
	3.6.1.2 Waste Application	3-37
	3.6.2 LAU Site-Specific Data	3-38
	3.6.3 LAU Site-Based Data	3-39
	3.6.3.1 Distance Vehicle Travels on LAU Surface (mt)	3-39
	3.6.3.2 Wet Waste Application Rate (Rappl)	3-40
	3.6.3.3 Vehicle Weight (vw), Payload, and Number of Wheels (nw)	3-40
	3.6.3.4 Vehicles per Day (nv)	3-41
	3.6.3.5 Waste Applications per Year (Nappl)	3-41
	3.6.3.6 Frequency of Cultivation (fcult)	3-41
	3.6.3.7 Frequency of Surface Disturbances per Month (fd)	3-42
	3.6.3.8 SCS Curve Number (CNwmu)	3-42
	3.6.4 LAU National Data	3-42
	3.6.4.1 Depth of Tilling (SrcDepth, zZ1WMU)	3-42
	3.6.4.2 Dust Suppression Control Efficiency (effdust)	3-43
	3.6.4.3 Fraction Vegetative Cover (veg)	3-43
	3.6.4.4 Operating Life (CutOffYr)	3-43
	3.6.4.5 Roughness Height (zruf)	3-43
	3.6.4.6 Roughness Ratio (Lc)	3-43
	3.6.4.7 Vehicle Speed (vs)	3-44
	3.6.4.8 Mode of Aggregate Size Distribution (asdm)	3-44
	3.6.4.9 USLE Cover Factor (Cwmu)	3-44
3.7	3.7 Surface Impoundment Module Inputs	3-44
	3.7.1 Surface Impoundment Module Design	3-44
	3.7.2 Surface Impoundment Site-Specific Data	3-48
	3.7.3 Surface Impoundment Site-Based Data	3-50
	3.7.3.1 Depth of Surface Impoundment (d_wmu, SrcDepth)	3-50
	3.7.3.2 Volumetric Influent Flow Rate (Q_wmu)	3-51
	3.7.3.3 Fraction of Unit Occupied by Sediments (d_setpt)	3-51
	3.7.3.4 Impellers/Aerator Number (n_imp), Total Horsepower (Powr), and Fraction Surface Area Turbulent (F_aer)	3-51
	3.7.4 Surface Impoundment National Data	3-52
	3.7.4.1 Ratio of Biologically Active Solids to Total Solids (kba1)	3-52
	3.7.4.2 Biomass Yield (bio_yield)	3-52

Table of Contents (continued)

Section	Page
3.7.4.3	Digestion Rate (Sediments) (k_{dec}) 3-52
3.7.4.4	Economic Life of Surface Impoundment (EconLife) 3-52
3.7.4.5	Impeller Diameter (d_{imp}) 3-52
3.7.4.6	Impeller Speed (w_{imp}) 3-52
3.7.4.7	Number of Economic Lifetimes (NumEcon) 3-52
3.7.4.8	Oxygen Transfer Correction Factor (O_2eff) 3-52
3.7.4.9	Oxygen Transfer Factor (J) 3-52
3.7.4.10	Saturated Hydraulic Conductivity of Sediment Layer ($hydc_sed$) 3-52
3.8	Aerated Tank Module Inputs 3-53
3.8.1	Aerated Tank Module Design 3-53
3.8.2	Aerated Tank Correlated Data 3-57
3.8.2.1	Aerated Tank Index (ATIndex) and Maximum Source Area (MaxSrcArea) 3-57
3.8.2.2	Tank Throughput (Q_{wmu}) 3-57
3.8.2.3	Preliminary Tank Depth 3-57
3.8.2.4	Estimating Tank Depth (d_{wmu}) from Tank Capacity 3-58
3.8.2.5	Surface Area (SrcArea) 3-58
3.8.2.6	Source Height (SHight) 3-58
3.8.2.7	Fraction Surface Area Turbulent (F_{aer}) 3-58
3.8.2.8	Total Aerator Horsepower (Powr) 3-59
3.8.2.9	Number of Impellers/Aerators (n_{imp}) 3-59
3.8.3	Aerated Tank National Data 3-59
3.8.3.1	Biologically Active Solids/Total Solids Ratio ($kba1$) 3-60
3.8.3.2	Biomass Yield (bio_yield) 3-60
3.8.3.3	Digestion (k_{dec}) 3-60
3.8.3.4	Economic Life of AT (EconLife) 3-60
3.8.3.5	Fraction of Tank Occupied by Sediments (d_{setpt}) 3-60
3.8.3.6	Impeller Diameter (d_{imp}) 3-60
3.8.3.7	Impeller Speed (w_{imp}) 3-60
3.8.3.8	Number of Economic Lifetimes (NumEcon) 3-60
3.8.3.9	Oxygen Transfer Correction Factor (O_2eff) 3-60
3.8.3.10	Oxygen Transfer Factor (J) 3-60
3.9	Quality Assurance/Quality Control 3-60
3.10	Issues and Uncertainties 3-61
3.10.1	Age/Accuracy of Industrial D Data 3-61
3.10.2	Underrepresentation of Highly Aerated Tanks 3-62
3.11	References 3-62
4.0	Meteorological Data 4-1
4.1	Parameters Collected 4-2
4.2	Data Sources 4-2

Table of Contents (continued)

Section	Page
4.2.1 Surface Meteorological Data: SAMSON	4-2
4.2.2 Surface Meteorological Data: Cooperative Summaries	4-5
4.2.3 Upper Air Mixing Height Data	4-5
4.2.4 Land Use Data	4-5
4.3 Methodology	4-6
4.3.1 Meteorological Station Assignment	4-7
4.3.2 Hourly Surface Data Collection	4-8
4.3.3 Hourly Upper Air Data Collection	4-9
4.3.4 Precipitation Data	4-9
4.3.5 Land Use-Related Parameters	4-10
4.3.5.1 Anthropogenic Heat Flux	4-10
4.3.5.2 Bowen Ratio	4-10
4.3.5.3 Monin-Obukhov Length	4-12
4.3.5.4 Albedo	4-12
4.3.5.5 Surface Roughness Length	4-13
4.3.5.6 Fraction of Net Radiation Absorbed by the Ground	4-13
4.3.6 PCRAMMET Input File Setup and Execution	4-14
4.3.7 Climatological Data Files	4-15
4.3.7.1 Equations	4-15
4.3.7.2 Programs	4-18
4.3.7.3 Quality Control	4-18
4.4 Results	4-18
4.4.1 Meteorological Station Assignments	4-18
4.4.2 Meteorological Data	4-18
4.5 Issues and Uncertainties	4-22
4.5.1 Precipitation Data	4-23
4.5.2 Meteorological Data Completeness	4-23
4.5.3 Meteorological Station Representativeness	4-23
4.5.4 Replacing Missing Data	4-23
4.6 References	4-24
5.0 Watershed and Waterbody Layout	5-1
5.1 Parameters Collected and Conceptual Framework	5-3
5.1.1 Area of Interest for Data Collection	5-5
5.1.2 Definitions	5-6
5.1.3 Assumptions—Waterbodies and Regional Watersheds	5-7
5.1.4 Headwater Criterion	5-8
5.1.5 Assumptions—Local Watershed	5-8
5.2 Data Sources	5-9
5.2.1 Surface Water Hydrography	5-9
5.2.2 One-Degree Digital Elevation Models	5-10
5.2.3 National Wetlands Inventory	5-10

Table of Contents (continued)

Section	Page
5.3	5.2.4 Geographic Information Retrieval and Analysis System 5-10
	Overview of Methodology 5-10
5.4	GIS Processing 5-12
	5.4.2 Step 2: Process Site-Specific Input Data 5-17
	5.4.3 Step 3: Method Determination Step 5-23
	5.4.4 Step 4: Delineate Watershed Subbasins 5-24
	5.4.5 Step 5: Delineation of Waterbodies 5-30
	5.4.6 Step 6: Delineation of Local Watershed 5-32
	5.4.7 Step 7: Create the UTM Reference Grid 5-34
5.5	Database Compilation and Processing 5-35
	5.5.1 Number of Waterbody Networks and Number of Reaches in Waterbody Network 5-35
	5.5.2 Number and Index of Reach that Impacts a Reach and Fraction of Reach Impacted by Another Reach 5-37
	5.5.3 Reach Length 5-38
	5.5.4 Reach Surface Area 5-38
	5.5.5 Stream Order 5-38
	5.5.6 Number and Index of Fishable Reaches 5-40
	5.5.6.1 Database Compilation for WBNNUMFishableRch and WBNFishableRchIndex 5-40
	5.5.7 Reach Type 5-40
	5.5.8 Waterbody Type 5-40
5.5.9	Number, Indices, and Fraction of Watershed Subbasins that Impact a Reach 5-42
	5.5.10 Index of Local Watershed that Impacts a Reach and Fraction of Local Watershed Impacting a Reach 5-45
	5.5.11 Number, Indices, and Fraction of Aquifers that Impact a Reach 5-46
	5.5.12 X,Y Coordinates for Waterbodies 5-47
	5.5.13 Number and Area of Watershed Subbasins 5-48
	5.5.14 Watershed Subbasin Slope 5-48
	5.5.15 Number of Local Watersheds and Local Watershed Slope 5-49
	5.5.16 Number and Area of Local Watershed Subareas and Index of Subarea Containing WMU 5-50
	5.5.17 Flow Length 5-51
	5.5.18 Ground Water Flow Direction 5-52
	5.5.19 X,Y Coordinates for Watersheds 5-53
5.6	Quality Assurance and Quality Control 5-53
	5.6.1 GIS Procedures 5-53
	5.6.2 Database Procedures 5-54
	5.6.3 Quality Assurance 5-55
5.7	Assumptions and Uncertainties 5-55
	5.7.1 Scale of Waterbody Data Layers 5-55

Table of Contents (continued)

Section	Page
5.7.2 Scale of the DEM	5-56
5.7.3 Different Watershed Delineation Methods	5-56
5.7.4 Manual Processing of Data	5-56
5.7.5 Incomplete National Wetlands Inventory	5-57
5.7.6 Anthropogenically Altered Drainage	5-58
5.7.7 Missing Reach Type in Pacific Northwest Reach Files	5-58
5.8 References	5-58
6.0 Surface Water Data	6-1
6.1 Parameters Collected	6-1
6.2 Data Sources	6-1
6.2.1 Water Quality Data	6-1
6.2.2 Stream Gage Data	6-6
6.3 Methodology and Results	6-7
6.3.1 Water Quality Data	6-7
6.3.2 Stream Baseflow Statistics (a _{bf} , b _{bf})	6-9
6.3.3 National Waterbody Data	6-10
6.4 Issues and Uncertainties	6-11
6.5 References	6-12
7.0 Soil Data	7-1
7.1 Parameters Collected	7-1
7.2 Data Sources	7-3
7.2.1 STATSGO Data	7-3
7.2.2 GIRAS Data	7-5
7.2.3 National Data Sources	7-6
7.3 Methodology	7-6
7.3.1 STATSGO GIS Processing	7-9
7.3.2 GIRAS GIS Processing	7-9
7.3.3 Database Processing	7-9
7.4 Results by Parameter	7-11
7.4.1 Soil Texture	7-11
7.4.2 Hydrologic Soil Group	7-14
7.4.3 Field Capacity	7-16
7.4.4 Wilting Point	7-17
7.4.5 SCS Curve Number	7-19
7.4.6 Root Zone Depth	7-19
7.4.7 Alpha, Beta, Residual Water Content, and Saturated Hydraulic Conductivity	7-21

Table of Contents (continued)

Section	Page
7.4.8 Saturated Water Content and Dry Bulk Density	7-22
7.4.9 Soil Moisture Coefficient b	7-26
7.4.10 Fraction Organic Carbon and Percent Organic Matter	7-26
7.4.11 Soil pH	7-28
7.4.12 Silt Content	7-29
7.4.13 USLE Erodibility Factor (K)	7-29
7.4.14 USLE Cover Factor (C)	7-29
7.4.15 USLE Erosion Control Factor (P)	7-30
7.4.16 Soil Column Temperature	7-31
7.5 Quality Assurance and Quality Control	7-31
7.5.1 Quality Control of Data Compilation	7-31
7.5.2 Quality Control of Data Transfer	7-31
7.5.3 Quality Assurance	7-31
7.6 Assumptions and Uncertainties	7-32
7.7 References	7-32
8.0 Human Exposure Factors	8-1
8.1 Parameters Collected	8-3
8.2 Data Sources	8-3
8.3 Methodology	8-5
8.3.1 National Distributions	8-6
8.3.2 Fixed Parameters	8-11
8.3.3 Quality Assurance/Quality Control	8-11
8.4 Results by Exposure Factor	8-12
8.4.1 Body Weight	8-12
8.4.2 Drinking Water Intake	8-17
8.4.3 Exposed Fruit Consumption	8-17
8.4.4 Protected Fruit Consumption	8-18
8.4.5 Exposed Vegetable Consumption	8-19
8.4.6 Root Vegetable Consumption	8-19
8.4.7 Protected Vegetable Consumption	8-20
8.4.8 Dairy Products (Milk) Consumption	8-20
8.4.9 Breast Milk Consumption	8-21
8.4.10 Beef Consumption	8-21
8.4.11 Fish Consumption	8-22
8.4.12 Soil Ingestion	8-22
8.4.13 Inhalation Rate	8-23
8.4.14 Shower Parameters	8-23
8.4.15 Fixed Parameters	8-23
8.5 Issues and Uncertainties	8-26
8.5.1 Source Data Uncertainties	8-26
8.5.2 Model (Distribution) Uncertainty	8-26

Table of Contents (continued)

Section	Page
8.5.3 Methods of Estimation	8-27
8.5.4 Testing Goodness of Fit	8-27
8.5.5 Treatment of Uncertainty	8-28
8.5.6 Breast Milk Pathway Issues and Uncertainties	8-28
8.6 References	8-29
9.0 Human Receptor Data	9-1
9.1 Parameters Collected	9-1
9.2 Data Sources	9-4
9.2.1 1990 U.S. Census STF 1B Attribute Data	9-5
9.2.2 1990 U.S. Census STF 3A Attribute Data	9-5
9.2.3 1990 U.S. Census TIGER/Line Block and Block Group Coverages ..	9-5
9.2.4 Census of Agriculture	9-8
9.2.5 National Survey of Fishing, Hunting, Wildlife, and Recreation (NSFWAR)	9-9
9.2.6 Exposure Factors Handbook	9-9
9.3 Methodology	9-9
9.3.1 GIS Data Preparation/Preprocessing	9-12
9.3.2 Human Receptor and Farm Placement and Processing	9-13
9.3.2.1 Place and Attribute Farms	9-14
9.3.2.2 Processing Block Group Census Data	9-15
9.3.2.3 Processing Block Census Data	9-15
9.3.3 Database Processing	9-16
9.3.4 Quality Assurance/Quality Control	9-17
9.4 Results	9-18
9.5 Issues and Uncertainties	9-18
9.6 References	9-22
10.0 Farm Food Chain and Terrestrial Food Web Data	10-1
10.1 Parameters Collected	10-1
10.1.1 Chemical-Specific Database	10-4
10.1.2 Exposure-Related Database	10-4
10.2 Data Sources	10-4
10.2.1 Farm Food Chain	10-4
10.2.2 Terrestrial Food Web	10-7
10.3 Methodology	10-8
10.3.1 Chemical-Specific Database	10-8
10.3.1.1 Database Compilation and Processing for Farm Food Chain	10-9
10.3.1.2 Database Compilation and Processing for Terrestrial Food Web	10-15

Table of Contents (continued)

Section	Page
10.3.1.3 Assumptions and Uncertainties for Chemical-Specific Database	10-19
10.3.2 Exposure-Related Parameters	10-22
10.3.2.1 Database Compilation and Processing for Farm Food Chain and Terrestrial Food Web	10-22
10.3.2.2 Assumptions and Uncertainties for Exposure-Related Parameters	10-26
10.4 Quality Assurance and Quality Control	10-28
10.4.1 Technical QA/QC	10-28
10.4.2 Data Entry QA/QC	10-28
10.5 References	10-28
11.0 Aquatic Food Web Data	11-1
11.1 Parameters	11-1
11.2 Data Sources	11-1
11.2.1 Chemical Properties Database	11-3
11.2.2 Fish Attribute Database	11-3
11.3 Methodology	11-3
11.3.1 Chemical Properties Database	11-5
11.3.1.1 Database Compilation	11-5
11.3.1.2 Data Processing	11-8
11.3.1.3 Assumptions and Uncertainties	11-8
11.3.2 Fish Attribute Database	11-9
11.3.2.1 Database Compilation	11-9
11.3.2.2 Database Processing	11-17
11.3.2.3 Assumptions and Uncertainties	11-18
11.4 Quality Assurance/Quality Control	11-19
11.4.1 Technical QA/QC	11-19
11.4.2 Data Entry QA/QC	11-19
11.4.3 Data Formatting	11-20
11.5 References	11-20
12.0 Ecological Exposure Factors	12-1
12.1 Parameters Collected	12-5
12.2 Data Sources	12-5
12.3 Methodology	12-8
12.3.1 Receptor Body Weights	12-8
12.3.2 Food Ingestion Rates	12-9
12.3.3 Water Ingestion Rates	12-10
12.3.4 Consumption Rate of Surficial Soil/Sediment	12-11

Table of Contents (continued)

Section	Page
12.3.5 Maximum/Minimum Dietary Preferences	12-12
12.3.6 Home Range Size	12-14
12.3.7 Data Entry and Data Processing Quality Assurance/Quality Control	12-16
12.3.7.1 Technical Quality Assurance/Quality Control.	12-16
12.3.7.2 Data Entry Quality Assurance/Quality Control.	12-16
12.4 Results	12-16
12.5 References	12-17
13.0 Ecological Receptors and Habitats	13-1
13.1 Development of Representative Terrestrial Habitats	13-1
13.1.1 Goals for Development of Representative Habitats	13-3
13.1.2 Criteria for Defining Representative Habitats	13-4
13.1.2.1 Criteria for Terrestrial and Wetland Habitats	13-4
13.1.2.2 Criteria for Waterbody Margin Habitats	13-5
13.1.3 Regionalization	13-6
13.1.4 Descriptions of the Representative Habitats	13-6
13.2 Food Webs and Receptor Groups	13-11
13.2.1 Food Webs	13-12
13.2.1.1 Terrestrial Habitat Food Web	13-12
13.2.1.2 Food Web for Aquatic Habitats	13-15
13.2.2 Receptor Groups	13-16
13.2.2.1 Assumptions for Habitat Assignment and Feeding Behavior Characterization	13-16
13.2.2.2 Regionalization of Receptor Groups	13-32
13.3 Habitat Delineation	13-33
13.3.1 Hand-Delineation Protocols	13-33
13.3.1.1 Technical Description of GIS Habitat Delineation Tool.	13-34
13.3.2 Terrestrial Habitat Delineation	13-36
13.3.2.1 Crosswalk Inconsistencies.	13-37
13.3.3 Delineation of Waterbody Margin Habitats	13-44
13.3.4 Delineation of Wetland Margin Habitats	13-45
13.3.4.1 Wetland Flood Regime	13-45
13.3.4.2 Treatment of Intermittently Flooded Wetlands	13-49
13.3.4.3 Delineation of Permanently Flooded Wetlands	13-49
13.4 Placement of Receptor Home Ranges	13-52
13.5 Automated Habitat Processing and Home Range Placement	13-55
13.5.1 GIS Data Preparation/Preprocessing	13-55
13.5.2 Habitat Processing	13-55
13.5.3 Database Processing	13-58
13.6 Quality Assurance/Quality Control	13-60
13.7 References	13-61

Table of Contents (continued)

Section	Page
14.0 Ecological Benchmarks	14-1
14.1 Parameters	14-1
14.2 Data Sources	14-1
14.2.1 Review Existing Synopses	14-2
14.2.2 Search Toxicological Databases	14-3
14.2.3 Conduct Online Literature Search	14-4
14.3 Methodology	14-5
14.3.1 Benchmark/CSCL Database	14-5
14.3.1.1 Database Compilation	14-5
14.4 Quality Assurance/Quality Control	14-29
14.4.1 Technical QA/QC	14-29
14.4.2 Data Entry QA/QC	14-30
14.4.3 Data Formatting QA/QC	14-30
14.5 References	14-30
15.0 Human Health Benchmarks	15-1
15.1 Parameters Collected	15-1
15.2 Data Sources	15-1
15.3 Methodology	15-3
15.3.1 Quality Assurance/Quality Control	15-4
15.4 Results	15-4
15.5 Issues and Uncertainties	15-5
15.6 References	15-6
16.0 Miscellaneous Data: Air, Aquifer, Waste, Risk, and Control Variables	16-1
16.1 Miscellaneous Air Module Inputs	16-1
16.1.1 Meteorological Station Variables	16-2
16.1.2 Urban/Rural Designation	16-2
16.1.3 Particulate Data	16-3
16.1.4 Sampled Chronological Input Model (SCIM) Inputs	16-3
16.1.5 Other National Variables	16-4
16.1.6 Quality Assurance/Quality Control	16-4
16.2 Aquifer Data	16-4
16.2.1 Site-Based Aquifer Data	16-5
16.2.2 Regional Aquifer Data	16-8
16.2.3 National Aquifer Data	16-10
16.2.4 Quality Assurance/Quality Control	16-11
16.2.5 Issues and Uncertainties	16-12
16.3 Waste Properties	16-12

Table of Contents (continued)

Section	Page
16.4 Risk and Control Variables	16-14
16.4.1 Termination Criteria	16-14
16.4.2 Risk Variables	16-15
16.5 References	16-15
17.0 Chemical Properties	17-1
17.1 Parameters Collected	17-1
17.2 Data Sources and Methodology	17-1
17.3 Quality Assurance/Quality Control	17-4
17.4 Results	17-4
17.5 Issues and Uncertainties	17-5
17.6 References	17-5

List of Figures

Figure	Page
1-1 3MRA modeling system design	1-4
1-2 Linkages among the source, fate, transport, exposure, and risk modules of the 3MRA modeling system	1-5
1-3 Overview of 3MRA data collection and processing	1-17
2-1 Site-based spatial overlays for the 3MRA modeling system spatial framework	2-4
2-2 Table format and content for the 3MRA modeling system grid database	2-6
2-3 Transfer of watershed polygons to 100 × 100 m template grid	2-6
3-1 Correlation of total capacity to area for landfills	3-20
3-2 Correlation of waste quantity to area for waste piles.	3-28
3-3 Correlation of waste quantity to area for LAUs	3-39
3-4 Correlation of waste quantity to area for surface impoundments	3-49
3-5 Correlation of total capacity to area for surface impoundments	3-50
4-1 Meteorological data collection process	4-6
4-2 Meteorological station assignments for the 201 Industrial D facilities	4-7
5-1 Site-specific spatial overlays for the 3MRA modeling system	5-2
5-2 Regional watershed subbasin delineation	5-3
5-3 Local watershed delineation	5-8
5-4 Overview of the 3MRA modeling system data collection methodology for watersheds and waterbodies	5-11
5-5 GIS data coverages for waterbody and watershed delineation	5-11
5-6 Reconditioning of the elevation grid (agree.aml)	5-19
5-7 DEM stream generation	5-20
5-8 NWI decision tree	5-21
5-9 Map of 201 representative national data set sites by watershed delineation method	5-24
5-10 Map of DEM-generated watershed subbasins showing pour points	5-26
5-11 Map of regional watershed with a large waterbody	5-27
5-12 Map of manually delineated regional subbasins	5-28
5-13 Map of watershed and waterbody delineation showing local watershed	5-32
5-14 Map of a local watershed	5-34
5-15 GIS database tables exported for further data processing	5-36
5-16 Example lake types used to fractionate watershed flows	5-43
7-1 3MRA modeling system soil data collection overview	7-8
7-2 Sample soil and land use coverages	7-10
7-3 GIS soil and land use data tables	7-11
7-4 3MRA modeling system soil data processing	7-12
9-1 Primary spatial data layers for the 3MRA modeling system human receptor data	9-2

List of Figures (continued)

Figure	Page
9-2 Human and farm receptor GIS process flow chart	9-11
9-3 QC spreadsheet for human receptor data collection	9-19
9-4 Web page for visual farm QC checks	9-21
13-1 Terrestrial food web, including example receptors	13-13
13-2 Interface between terrestrial receptors and aquatic food web, including example receptors.	13-14
13-3 Initial dialog box for delineation tool	13-34
13-4 Preprocessed habitat codes	13-35
13-5 Delineation tool habitat code drop-down list	13-36
13-6 Example delineation of terrestrial habitats–land use data.	13-38
13-7 Example delineation of terrestrial habitats.	13-39
13-8 Example delineation of waterbody margin habitats–land use data	13-46
13-9 Example delineation of waterbody margin habitats–elevation data	13-47
13-10 Example delineation of waterbody margin habitats	13-48
13-11 Example delineation of wetland habitats–NWI data	13-53
13-12 Example delineation of wetland habitats	13-54
13-13 Flow chart of delineation process	13-56
14-1 Simplified trophic structure of a generalized soil community	14-20
16-1 Miscellaneous Data Processed for the 3MRA Representative National Data Set	16-1
16-2 Miscellaneous Air Module Input Data	16-2
16-3 Urban Anderson Land Use Codes	16-3
16-4 Site-Based and Regional Hydrogeologic Data Sources, Collection Approach, and Data Locations	16-6
16-5 National Aquifer Data Sources and Values	16-7
16-6 3MRA Modeling System Hydrogeologic Environments	16-9
16-7 Empirical (User-Defined) Distribution for Aquifer Particle Diameter (DIAM)	16-10
16-8 Empirical Distribution for Aquifer Longitudinal Dispersivity (AL)	16-10
16-9 Empirical Probability Distribution for Aquifer pH	16-10
16-10 3MRA Modeling System Waste Property Data	16-12
16-11 3MRA Modeling System Risk and Control Variables	16-14

List of Tables

Table	Page
1-1. Chemicals Included in the Representative National Data Set	1-6
1-2. Data Collection Approach, by Data Type	1-8
1-3. Settings/WMU Type Distribution for the 201-Facility Sample	1-10
1-4. Data Types Used by the 3MRA Modeling System	1-12
1-5. 3MRA Data Quality Objectives: Specific Examples by Data Type	1-13
3-1 WMU Inputs by Module	3-2
3-2 WMU Data Sources	3-4
3-3 WMU Type Distribution of 201 Sample Facilities	3-8
3-4 Number of Industrial D WMUs Used for the Representative National Data Set	3-9
3-5 Screening Constraints and Replacement Values for Industrial D Data	3-9
3-6 Numbers of Tanks, by Classification	3-12
3-7 WMU Data Collected for the Landfill Module	3-16
3-8 WMU Data Collected for the Waste Pile Module	3-26
3-9 Waste Pile Curve Numbers (CNwmu), by Hydrologic Soil Group	3-32
3-10 WMU Data Collected for the LAU Module	3-34
3-11 LAU Curve Numbers (CNwmu), by Hydrologic Soil Group	3-43
3-12 WMU Data Collected for the Surface Impoundment Module	3-45
3-13 Distribution of Surface Impoundment Applications	3-48
3-14 WMU Data Collected for the Aerated Tank Module	3-54
4-1 Meteorological Data Timescale by Module	4-1
4-2 Meteorological Inputs by Module	4-3
4-3 Meteorological Parameters Collected by Data File	4-4
4-4 Relation Between Anderson Land Use Codes and PCRAMMET Land Use Codes	4-11
4-5 Daytime Bowen Ratio by Land Use and Season (Meteorological Stations Only) ..	4-12
4-6 Minimum Monin-Obukhov Length (Stable Conditions)	4-13
4-7 Albedo of Natural Ground Covers for Land Use Types and Seasons	4-13
4-8 Surface Roughness Length (m) for Land Use Types and Seasons	4-14
4-9 Climatological Parameters and Sources of Input Data	4-16
4-10 Meteorological Stations Used	4-19
5-1 3MRA Waterbody and Watershed Inputs by Module	5-4
5-2 Source Data for Watershed and Waterbody Delineations	5-9
5-3 3MRA Modeling System Watershed and Waterbody Processing by Parameter	5-12
5-4 AMLs used in the 3MRA Modeling System Watershed and Waterbody Delineations	5-14
5-5 GIRAS Water and Wetland Land Use Codes	5-22
5-6 RF3-Alpha REACHTYPE Descriptions	5-23

List of Tables (continued)

Figure		Page
5-7	Watershed Code Descriptions	5-25
6-1	Surface Water Inputs by Module	6-2
6-2	Surface Water Data Sources, Methodology, and National Values	6-3
6-3	Statistical Basis for Water Quality Parameters	6-8
6-4	Baseflow Regression Analysis Results: STORET 30Q2 Data	6-11
7-1	Soil Inputs by Module	7-2
7-2	Soil Property Data Sources	7-4
7-3	Anderson Land Use Codes	7-7
7-4	Soil Textures in CONUS	7-13
7-5	Crosswalk between STATSGO and CONUS Soil Textures	7-15
7-6	Hydrologic Soil Groups	7-17
7-7	Field Capacity Values	7-18
7-8	Wilting Point Values	7-18
7-9	SCS Curve Number Values	7-20
7-10	Depth to Root Zone Values	7-21
7-11	Unsaturated Zone Hydrologic Parameters: Moisture Retention Parameters (Alpha, Beta), Saturated Hydraulic Conductivity (SatK), and Residual Water Content (WCR)	7-23
7-12	Saturated Water Content and Dry Bulk Density	7-25
7-13	Soil Moisture Coefficient <i>b</i> Values	7-27
7-14	USLE Cover Factor C	7-30
7-15	USLE Erosion Control Factor	7-30
9-1	Human Receptor and Farm Input Variables	9-3
9-2	Primary Human Receptor Data Sets, Date, and Scale	9-5
9-3	Sources of Human Receptor Data by Input Parameter	9-6
9-4	Specific STF 1B Block-Level Census Items Used to Estimate Human Receptor Populations	9-7
9-5	Specific STF 3A Block Group-Level Census Items Used to Estimate Human Receptor Populations	9-7
9-6	Specific County-Level Census of Agriculture Items Used in Human/Farm Receptor Estimations	9-10
10-1	Farm Food Chain and Terrestrial Food Web Chemical-Specific Parameters	10-2
10-2	Farm Food Chain and Terrestrial Food Web Exposure-Related Parameters	10-3
10-3	Data Sources for Farm Food Chain Chemical-Specific Parameters	10-5
10-4	Data Sources for Farm Food Chain Exposure-Related Parameters	10-6
10-5	Data Sources for Terrestrial Food Web Chemical-Specific Parameters	10-8
10-6	Uptake Factors Identified for Small Amphibians	10-16
10-7	Uptake Factors Identified for Earthworms	10-17

List of Tables (continued)

Figure	Page
10-8 Uptake Factors Identified for Invertebrates	10-19
10-9 Daily Water Intake of Beef Cattle (gal/d)	10-23
10-10 Daily Water Intake of Milk-Producing Dairy Cows (gal/d)	10-24
11-1 Summary of Parameters Applied in Modeling the Aquatic Food Web	11-2
11-2 Key Data Sources Identified to Evaluate for Fish Attribute Database	11-4
11-3 Constants for Different Tissue Types Applied to Equation 11-1	11-7
11-4 Fish Body Weight and Length Ranges Used in Relative Size Determinations	11-10
11-5 Assignment of Prey Items in Fish Attribute Database to Prey Items in the Aquatic Food Web	11-14
11-6 Example of Dietary Fraction Raw Data Conversions to Meet Model and Food Web Requirements: Small Omnivores in Warmwater Ponds	11-16
12-1 Exposure Data Sources for Terrestrial Wildlife Receptors	12-2
12-2 Parameters Collected	12-6
12-3 Empirical Coefficients Used to Calculate Food Ingestion Rates	12-10
12-4 Prey Categories	12-12
12-5 Farm Food Chain Codes for Wildlife Diet Items	12-14
13-1 Parameters Collected for Terrestrial Habitats	13-2
13-2 Ecological Risk Assessment Representative Habitats for Terrestrial Receptors	13-7
13-3 Terrestrial Wildlife Receptors	13-17
13-4 Terrestrial Wildlife Receptors for Grasslands	13-25
13-5 Terrestrial Wildlife Receptors for Shrub/Scrub	13-25
13-6 Terrestrial Wildlife Receptors for Forests	13-26
13-7 Terrestrial Wildlife Receptors for Crop Fields and Pastures	13-26
13-8 Terrestrial Wildlife Receptors for Residential Habitats	13-27
13-9 Terrestrial Wildlife Receptors for River/Stream Habitats	13-27
13-10 Terrestrial Wildlife Receptors for Pond Habitats	13-28
13-11 Terrestrial Wildlife Receptors for Lake Habitats	13-28
13-12 Terrestrial Wildlife Receptors for Intermittently Flooded Grasslands	13-29
13-13 Terrestrial Wildlife Receptors for Intermittently Flooded Shrub/Scrub	13-29
13-14 Terrestrial Wildlife Receptors for Intermittently Flooded Forests	13-30
13-15 Terrestrial Wildlife Receptors for Permanently Flooded Grasslands	13-30
13-16 Terrestrial Wildlife Receptors for Permanently Flooded Shrub/Scrub	13-31
13-17 Terrestrial Wildlife Receptors for Permanently Flooded Forests	13-31
13-18 Crosswalk: Anderson Land Use Codes and Ecological Receptor Habitats	13-40
13-19 NWI Water Regime Modifiers Relevant to the 3MRA Modeling System	13-49
13-20 Crosswalk: National Wetland Inventory Codes and Wetland Habitats	13-51
14-1 Parameters Included in the Benchmark/CSCL Database	14-2
14-2 Status of Literature Review Process for Chemicals of Concern	14-3
14-3 Key Sources of Information Consulted in the Development of Benchmarks and CSCL	14-6

List of Tables (continued)

Figure		Page
14-4 Primary Literature Used in Mammalian and Avian Benchmark Derivation ^a	14-9
17-1 Chemical Properties by Module	17-2
17-2 Methodology and Data Sources for 3MRA Chemical Properties	17-3
17-3 Chemical Property Files Contained within 3MRA Modeling System	17-4

List of Appendices

Appendix

1A	Structure of the 3MRA Modeling System Input Database	1-24
1B	Model Inputs by Database Table	1-26
2A	201 Industrial D Waste Management Sites Used in the Representative National Data Set	2-9
2B	Facility Location	2-19
3A	WMU Data	3-67
3B	Aerated Tank Data	3-85
4A	Meteorological Data QA/QC Programs	4-29
	4A-1. Source Code for QAQC	4-32
	4A-2. Source Code for SQAQC	4-34
4B	METFIX Program	4-39
	4B-1. METFIX Source Code	4-41
4C	PRECIP Program	4-59
4D	Formats and Examples of 3MRA Modeling System Meteorological Data Files	4-63
4E	3MRA Modeling System Climatological Data Collection Programs	4-71
6A	STORET Water Quality Data	6-13
6B	STORET Temperature Data	6-53
9A	GIS Arc Macro Language (AML) Program for Calculating Human Receptor Locations and Attributes	9-23
9B	GIS Arc Macro Language (AML) Program for Placing Farms	9-63
9C	GIS Arc Macro Language (AML) Program for Calculating Median Farm Size	9-75
9D	Human Receptor Data for the Representative National Data Set: 201 Sites and 419 Settings	9-81
10A	Chemical-Specific Database Developed for the FFC and TFW Modules	10-33
10B	Exposure-Related Database Developed for the FFC and TFW Modules	10-51
11A	Parameter Values Applied for the Aquatic Food Web Chemical Properties Database	11-27
11B	Parameter Values Applied for the Aquatic Food Web Fish Attribute Database	11-37
13A	Arc Macro Language Program for Processing Habitat and Receptor Data	13-67
13B	Arc Macro Language Program for Processing Home Range Data	13-91
13C	Home Range Parameters for Ecological Receptors	13-103
14A-2.	Avian Benchmark Studies	14-45
15A	Human Health Benchmarks	15-9
16A	Site-Based Meteorological Station and Aquifer Data	16-19
16B	Regional Aquifer Data	16-31

This page intentionally left blank