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

## **Volume V: Technology Design and User's Guide**

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

## **Volume V: Technology Design and User's Guide**

prepared by

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This document is the fifth 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.

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# 1.0 Introduction

A modeling-based methodology entitled “A Framework for Finite-Source Multi-media, Multi-pathway, and Multi-receptor Risk Assessment (3MRA)” [1] has been developed with the goal of facilitating the establishment of national regulatory limits related to “safe” constituent concentration levels in wastestreams entering land-based solid waste management units. The 3MRA methodology is a conceptual approach to “site-based” regulatory risk assessment problems. Site-based regulatory problems and assessments, in this context, refer to national scale regulatory decisions that are based on the results of modeling risk at individual sites. The 3MRA methodology calls for the application of a site-based multimedia risk assessment at a statistically-sampled number of waste management sites across the nation. The national risks are expressed as a quantitative relationship between constituent concentrations in waste streams and the percentage of human and ecological receptors that are “protected”. This relationship can be established as a function of various regulatory decision scenarios. For example, decision analysts may wish to know what the relationship between waste concentrations and protectiveness is for a particular sensitive receptor group (e.g., children) or for specific categories of waste management units (e.g., landfills). The 3MRA methodology provides a means by which to “roll-up” site-based risk results to provide decision makers multiple views of the national risk picture.

Because the process of establishing such a relationship between cause and effect includes numerous uncertainties, the 3MRA methodology was also designed to generate estimates of uncertainty related to the estimates of national protection. Specifically, the methodology provides assessment procedures for the characterization and separation of natural variability (irreducible uncertainty) and uncertainty due to errors principally resulting from a lack of knowledge (reducible uncertainty – whether it be due to errors in measurement, sampling, model, site conceptualization, etc.).

In order to inform national regulatory decisions the 3MRA methodology has been expressed in the form of a facilitating technology. The 3MRA technology is an integrated environmental modeling system consisting of a “modeling domain”, an “assessment domain”, and a facilitating software infrastructure. The modeling domain includes a comprehensive set of science-based models and databases. The models are designed to simulate all aspects of a site-based human and ecological risk assessment (i.e., source release, multimedia fate and transport, aquatic and terrestrial foodweb dynamics, and human and ecological exposure and risk). The databases include data descriptive of waste disposal unit operations, environmental conditions, chemical properties, and exposure and risk factors. The assessment domain envelopes the modeling domain and provides a strategy for applying the models and data components to solve specific regulatory problems. The software infrastructure supports the development and application of the tools contained in the assessment and modeling domains and consists of 1) a user interface, 2) data representation and transfer standards and facilitating software, 3) execution management software, and 4) several software utilities. These elements of the 3MRA technology are integrated in such a manner as to facilitate the intended national environmental risk assessment.

The purpose of this document is to provide an overview of the 3MRA software-based modeling technology designed to automate the 3MRA national risk assessment methodology. The 3MRA modeling technology is described in terms of its required functionality, integrated systems design, and user operation. The “science” of the multi-media modeling and the

statistical theory driving the national assessment strategy are described only to the extent to make clear the connection between methodology and technology. The presentation is intended to provide regulatory analysts (who may apply the technology to risk-based regulatory problems) and model developers (who may either incorporate their models within the modeling system or apply the system in the conduct of research) sufficient information to make a determination of the modeling systems applicability to their work.

A summary description of the 3MRA methodology is presented in Section 2 to provide the basis for describing the technology. The 3MRA technology design is presented in Section 3 (first in terms of set of system requirements [Section 3.1], then a description of the overall system design for the technology [Section 3.2], and finally a more detailed description of each of the major components of the 3MRA technology system [Section 3.3]). Section 4 presents a User's Guide for installation and operation of the technology.

## A note about 3MRA software technologies

Currently there exist three technologies related to 3MRA.

- 3MRA Version 1.0 : This technology represents the modeling system designed to execute national site-based risk assessments.
- This technology is the sole subject of this document and is fully available to the public.
- 3MRA Version 1.x : This technology is an extension of 3MRA Version 1.0 that includes software specifically designed to facilitate 1) the execution of 3MRA Version 1.0 on a network of 160 Personal Computers linked together to form a Super computer capability, and 2) the execution of uncertainty analysis and sensitivity analysis studies using 3MRA Version 1.0.
- This technology is currently operational in a research context. It is being applied to assess the uncertainties and sensitivities in the application of 3MRA Version 1.0.
- 3MRA Version 2.0 : This technology represents an extension of 3MRA Version 1.0 to facilitate the execution of site-specific risk assessments and to advance the design of the underlying software infrastructure. The science-based goal of this technology is to contain the science models and databases needed to conduct both national and site-specific assessments within the same modeling system. Achieving this goal is intended to facilitate the assimilation of new science into modeling technologies that can be used to conduct regulatory-based risk assessments and to establish consistency across regulatory programs.
- This technology is coming online, in Beta release form, during the summer of 2003.

Finally, the infrastructure for each of the 3MRA technologies is based on the **Framework for Risk Analysis in Multimedia Environmental Systems (FRAMES)**. FRAMES represents a collaborative effort among four Federal Agencies (EPA, DoE, DoD, and NRC) to establish a common modeling infrastructure for conducting human and ecological risk assessments. The goal of the FRAMES effort is to facilitate scientific collaboration among the Agencies and to maximize community access to the collective set of models, databases, and data analysis tools developed and applied by the Agencies. Thus, the reader may see references to the following technologies that are synonymous with those listed above.

FRAMES 3MRA Version 1.0  
FRAMES 3MRA Version 1.x  
FRAMES 3MRA Version 2.0