BUREAU OF ENVIRONMENTAL REMEDIATION/REMEDIAL SECTION GUIDELINE

MINIMUM STANDARDS FOR MODEL USE

BER POLICY#BER-RS-007
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REVISIONS

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ORIGINATOR

Originator: Rachel Miller **Date:** 1993

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INTRODUCTION

Modeling, commonly groundwater flow, contaminant fate and transport, and vadose zone modeling, is accepted by several BER programs for applications including, but not limited to: support for contaminant fate and transport predictions associated with baseline risk assessments; develop, evaluate, screen, and select remedial alternatives; aid in design of remedial alternatives; and, provide a basis for developing site specific cleanup objectives as is allowed via the Risk-based Standards for Kansas (RSK) Tier 3 process. While BER does conduct some modeling in-house, most modeling is performed by environmental consultants for specific projects on behalf of voluntary parties and responsible parties working with BER's Remedial Section through oversight programs, primarily the Voluntary Cleanup and Property Redevelopment Program and the State Cooperative Program. Modeling may also be performed by environmental contractors working under the direction of BER.

BER's Remedial Section developed a policy in 1993, "Minimum Standards for Model Use" to establish and standardize minimum regulatory requirements for modeling. The policy has been revised and updated in response to significant progression in model availability, variety, ease of use, and resulting increased frequency of model use over the last several years. This policy has not been developed as a "how to" guidance for modeling as resources for such guidance exist and are readily available through published literature, federal and other state guidance documents, ASTM Standards, etc. This policy will generally describe the common components of the modeling process for which regulatory approval will be required with focus on required content and presentation in a resulting modeling report.

MODELING REVIEW CONSIDERATIONS

BER may review modeling in-house or may outsource the review to a time and materials contractor appropriately experienced and qualified to perform model reviews. In either case, modeling will be reviewed in detail and will involve inspection of model input and output files, in addition to duplication of model runs. BER does possess numerous proprietary modeling software packages to facilitate modeling review; however, if BER does not possess a specific proprietary software used for modeling, the proprietary software package used may need to be provided to BER for acceptance of the modeling and to allow its comprehensive review.

BER prefers use of well-documented and peer-reviewed models. Numerous modeling software packages meeting these requirements are available on the market. Typically, these proprietary modeling packages are based on established and accepted public-domain model code (e.g., USGS MODFLOW, MT3D, AT123D, SESOIL,VLEACH) with variations in pre- and post-processing and enhanced graphic user-interface.

THE MODELING PROCESS

In general, the modeling process consists of a few obviously desired and necessary steps:

- **Initial Discussions with Regulators**. BER encourages upfront communication with the appropriate BER program contact. This communication should involve, at a minimum, the

environmental consultant and their modeler, the client, and the BER project manager. The process would benefit greatly if modeling discussions are initiated during the modeling work plan development stage and include discussion of the site and definition of the contamination problem, the site and regional geohydrologic setting and conceptual model development, the scope of the proposed modeling effort, modeling objectives and overall intent with respect to project and program requirements. Considering that significant resources could be expended in a 3-D numerical flow modeling and or fate and transport modeling effort, it would make sense to verify regulatory acceptance of the intent for performing the modeling and obtain assurance that modeling results, assuming modeling is performed satisfactorily, will be acceptable by the BER program for the intended purpose.

- **Modeling Work Plan**. A work plan for the modeling should be developed for formal BER review and approval. The work plan should be prepared to document conclusions and concurrence from the initial discussions. The work plan should include presentation of the site conceptual model, a description of the proposed modeling process, objectives and intended use of the model, and evaluation and selection of the model to be used. The work plan should provide other detail as necessary to demonstrate intended modeling objectives will be achieved and a model report, consistent with the prescribed content and format, can be prepared to document the modeling effort. The work plan can either be a stand alone document or combined with other related deliverables as approved by the BER project manager.

- **Modeling Report.** A modeling report will be prepared to present results of modeling. The level of effort required for model report preparation will be dictated by the complexity of modeling performed, the intended use of the model, and will comprehensively document the modeling process. All modeling reports will be accompanied by the actual electronic modeling files. Attachment 1 presents the basic suggested (or required depending on the oversight program and final determination by the BER project manager) content and format for modeling reports. The level of detail should be commensurate with the intended use of the model. For example, the level of detail presented for a straightforward capture zone evaluation involving 2-D analytical modeling would be expected to less than a 3-D numerical model application for groundwater flow and contaminant transport used quantify risk to various receptors. Additionally, the suggested content and format apply to conventional modeling efforts; modifications would be considered accordingly for unique or unconventional modeling applications.

Attachment 1 provides the suggested (or required depending on the program) content and format for modeling reports.

Attachment 1
Suggested Content and Format for Modeling Reports

CONTENT

The model report must document the modeling effort and should provide detailed discussion on model selection, development, calibration, verification, and use. The report must include:

- a description of the purpose and scope of the model;
- the geohydrologic, hydrologic, lithologic, and analytical data used to characterize the site;
- documentation of the source of all data used in the model;
- a description of the conceptual model;
- identification of the model selected to perform the task (applicability, inherent assumptions, and limitations);
- a documentation of all calculations;
- a summary of all model calibration and history matching;
- a summary of the sensitivity analysis;
- presentation of all model simulation results; and
- a range of probable results based on model uncertainty.

FORMAT/CONTENT

Organization and format of the modeling report presented herein is based on conventional modeling applications. Any modifications from the suggested format and content should be identified during the modeling work plan phase and a modified report format and content proposed as part of the work plan. Standard modeling reports should include or address the following components or sections, as applicable:

- Title page, table of contents, list of appendices, figures and tables
- Introduction and Objectives
  -include site description, brief history, previous work conducted and identify modeling objectives
- Quality Assurance Considerations – Relating to Modeling Protocol
  -discuss criteria for model selection and protocols for model formulation, model calibration and limits on parameter adjustments, sensitivity analysis and error analysis
- Geologic/hydrologic characterization and conceptualization
  -site description supported by maps, cross sections, etc.
- Model Selection
  - discussion of benefits and detriments of selected code and why other applicable codes were not selected including discussion of necessary assumptions for application of the model selected
- Numerical Implementation
  -identification of rationale for extent of model domain (size and shape), grid setup (mesh) and spacing, layer assignment and elevation, input parameter values and ranges, boundary conditions, simulation type (transient or steady state), and modeling scenarios
- Model Calibration and Verification
  -discussion and identification of calibration targets/goals, initial input parameters and changes made during calibration, documentation of calibration process with supporting statistics, graphs, and tables, presentation of final input parameters, and verification of calibrated model comparing various modeled to observed field conditions
- Sensitivity Analysis
  -discussion of sensitivity analysis process, sensitivities of model parameters, etc. Graphical presentation and documentation of sensitivity analysis and conclusions and recommendations of sensitivity analysis with respect to model response and input data quality

- Predictive Simulations
  -discussion and analysis of predictive simulations
- Uncertainty Simulations
  -discussion and analysis of model uncertainty, identification of corrective actions to address uncertainty, and identification of limitations on model predictions/use based on uncertainty
- Conclusions and Recommendations
- References
- Tables
- Figures
- Appendices

Tables — Tables should be used to the extent practicable to summarize and present data pertinent to the modeling effort. Examples of data that should be summarized in tables within the modeling report include, but are not limited to, well/boring elevation (casing and screen) data, lithologic contact elevation data, hydraulic head data, aquifer pumping/slug test data. Tables should definitely be included for summarization of model calibration and verification results with comparison of measured versus simulated calibration targets and residuals, and sensitivity analysis results with ranges for adjusted parameters, etc.

Figures — Figures should be used as much as possible to present the site description, model setup and simulation results, including:

- Regional site location map with topography
- Site map with boring and well locations
- Geologic cross section.
- Potentiometric surface map (measured)
- Bedrock elevation map
- Model Grid map and boundary assignments
- Maps showing assignment of input parameters such as recharge, hydraulic conductivity, etc.
- Maps demonstrating results of predictive model simulations
- Other maps as appropriate to support presentation of the modeling effort

Reference Cited for Modeling Report Format and Content:

Michigan Department of Environmental Quality (2003) *"Documentation of Groundwater Flow and Fate and Transport Models"*. MDEQ Groundwater Modeling Program, Lansing, MI 48909 [http://www.Michigan.gov/deq].