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Guidelines for Submittal of Information Developed from Models to the Central Valley Regional Board

Models can be necessary in water quality studies and investigations to predict future conditions of the ground or surface waters, or to examine critical or "worst case" conditions which cannot be directly measured without waiting indefinitely for those conditions to naturally occur.

Although often necessary, models can easily be miss-applied or misused. It is the responsibility of the Discharger or project proponent to demonstrate the appropriateness and usage of the model so that the Board and the public can fully understand the modeling process and understand the strengths and weakness of the model output. It is highly desirable for the model to be "transparent", that is, fully open to scrutiny. Proprietary models, because all or part of the model is "hidden" from review, have a higher burden of proof because it is more difficult to have a complete understanding of the modeling process for proprietary models.

The following is a list of general concepts applicable to all modeling that generally need to be demonstrated by the modeler before the Regional Board can accept a model for use. This list is provided for general guidance only. Specific applications of models may require different justification. It is strongly recommended that all modeling be discussed with appropriate Regional Board staff **before** the modeling is conducted so that all parties understand the modeling process. At a minimum, items 1 through 9 should be discussed and agreed to prior to commencement of the modeling effort.

1. What is the modeling objective? What is being modeled, why that information is needed, and how will the results be used?

2. What model has been chosen? (Name, author, version, etc.)

3. Why is the chosen model applicable to this situation?

4. Is the model open or proprietary? What level of peer review has been done on the model? Provide examples of previous use of the model.

5. If the model is proprietary, explain why open models or EPA-approved models are not appropriate for the application. It may be appropriate to ask for an independent peer review of the computer code of a proprietary model.

6. Describe the underlying fundamentals and assumptions of the model and why they are appropriate.

7. What are the critical conditions that you are trying to model? Flow? Temperature? pH? Critical conditions may be combinations of conditions for several parameters that occur at the same time, e.g. simultaneous low flow and low hardness. Explain why these are critical conditions. Where parameters are not independent, explain and justify the assumed relations.

8. What is the model's performance objective or target? An example is: "Reproduce total nitrogen and total phosph orus concentrations within ± 25% for 90% of observed data within the calibration and validation periods." [**Surface Water Quality Modeling: An Introduction**, May 2002, pg 15.]

9. How will model performance be demonstrated, and what efforts will be taken to improve the model's accuracy? Model performance may be improved through calibration and validation to reduce model uncertainty, and a sensitivity analysis can provide insight into the model uncertainty.

    a. How will the model be calibrated and validated? Calibration is the process of selecting model parameters to "fit" the model to the physical world that it simulates. Validation is the process of testing the model with the selected parameters to show that it simulates an independent data set. Calibration and validation information that should be provided include: (1) identification of the empirical data used, (2) discussion of the physical constants or other model variables that were modified or adjusted and why, (3) the procedures that were used to improve model accuracy, and (4) the results of calibration and validation.

    b. A sensitivity analysis evaluates whether a change in a model parameter results in either a relatively small change in a water quality response or a relatively large change in water quality response. It is typically performed by varying one calibration parameter or one model input at a time, usually by a fixed percentage, through an accepted range of values. A sensitivity analysis can identify the parameters that may be significant contributors to uncertainty in the model predictions. These parameters may then be further developed to reduce the uncertainty. The extent of sensitivity analysis that will be completed, including the parameters that will be analyzed, and the basis for selecting those parameters should be agreed upon prior to conducting the analysis.

    c. How will the model uncertainty be quantified? Model uncertainty describes how close the model results are to reality, and can be expressed as bias, precision, error, or as the margin of safety in the results. There should be agreement with Regional Board staff regarding the acceptable level of uncertainty in the model results. The quantification of uncertainty typically comes from the calibration, validation, and sensitivity analyses. There should be a goal to minimize the model uncertainty to a certain value if the model is being used to predict exact water quality constituent concentrations. However, if the model is being used to rank best and worst alternatives, the accuracy of the model may not be as important if the error in the model results is the same for each alternative.

10. Modeling reports should provide:

    a. All of the empirical data, including flow, chemical, and geometric data, used in the modeling effort, including an explanation of the quality of the data, the sources of the data, and how the data is appropriate for use in the modeling. If the data are too voluminous to provide in hard copy, provide hard copy summaries of the data and a detailed data electronically in an acceptable format.

    b. Model Performance Information

        1. Calibration and validation analyses and results

        2. Sensitivity analysis and results

        3. Model uncertainty and how it was determined

    c. The range of model applicability, and how it was determined. Model predictions for regulatory use should be confined to within the calibrated and validated ranges of the model.

    d. Raw input and output results. If the data and results are too voluminous, provide hard copy summaries of input/output data and detailed examples of selected scenarios, with all data and results being.

    e. Interpretation of output results. Run the model for normal and critical conditions. Evaluate the output data under normal and critical conditions. Explain what you believe the model shows and how the results should impact the Regional Board's decision-making process.

REFERENCES:
Additional guidance on modeling studies may be found at the following web sites.

Protocols for Water and Environmental Modeling, Bay-Delta Modeling Forum, January 2000, http://www.cwemf.org/Pubs/Protocols2000-01.pdf

Ground Water Modeling for Hydrogeologic Characterization: Guidance Manual for Ground Water Investigations. State of California Environmental Protection Agency, http://www.dtsc.ca.gov/sitecleanup/SMP_Groundwater_Modeling.pdf

Department of Pesticide Regulation studies on fate and transport of pesticides in soil and surface and ground waters. http://www.cdpr.ca.gov/docs/sw/protocol.htm

Center for Exposure Assessment Modeling (CEAM): http://www.epa.gov/ceampubl/

Council for Regulatory Modeling (CREM): http://cfpub.epa.gov/crem/index.cfm

Draft Guidance on the Development, Evaluation, and Application of Regulatory Environmental Models (US EPA), http://www.epa.gov/osp/crem/library/CREM%20Guidance%20Draft%2012_03.pdf

Guiding Principles for Monte Carlo Analysis, EPA/630/R-97/001, March 1997.

Policy for Use of Probabilistic Analysis in Risk Assessment at the U.S. Environmental Protection Agency, http://www.epa.gov/osa/spc/htm/probpol.htm

Science Policy Council Handbook - Peer Review, US EPA Office of Science Policy, EPA 100-B-00-001, December 2000

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