SOFTWARE VALIDATION TEST PLAN AND REPORT FOR SCIENTIFIC AND ENGINEERING SOFTWARE—GROUNDWATER MODELING SYSTEM (GMS) VERSION 6.0

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1 SCOPE OF VALIDATION

This document establishes the Software Validation Test Plan and Test Report for validating the installation and functionality of the groundwater modeling software, Groundwater Modeling System (GMS) Version 6.0 (Environmental Modeling Research Laboratory, 2006). GMS 5.1 and MODFLOW2000 were validated previously by Winterle (2003). The Software Validation Test Plan and Test Report applies only to GMS Version 6.0. Because GMS is only used as a graphical interface for the codes contained in the system and does not perform any calculations, it is only necessary to test the use of GMS to execute MODFLOW (Harbaugh, et al., 2000).

GMS is a comprehensive software system for groundwater and transport modeling. It simplifies the modeling process by providing tools necessary for every aspect of groundwater simulation. GMS includes a graphical environment for modeling, tools for site characterization and model development, calibration, postprocessing, and graphical visualization. The system supports Triangular Irregular Networks (TINs), solids, borehole data, two-dimensional and three-dimensional geostatistics, and both finite element and finite difference models in two and three dimensions.

GMS Version 6.0 is the latest release of the GMS interface. It provides a complete interface for the codes FEMWATER, WASH123D, ADH, MODFLOW2000, MODPATH, MT3DMS, RT3D, ART3D, SEAM3D, UTCHEM, MODAEM, and SEEP2D, as well as the parameter estimation codes PEST and UCODE. Version 6.0 has several new features and enhancements, such as user interface enhancements, display themes, mass calculations for transport solutions, and statistical analysis of MODFLOW/MT3D solutions. A complete list of new features can be found at www.ems-i.com.

One relevant feature for the intended use of GMS is the support for larger models in MODFLOW. MODFLOW model data are handled in GMS Version 6.0 in such a way that it is possible to build models many times larger than in previous versions of GMS. The memory-intensive components of a simulation have been moved from RAM to disk and, when needed in GMS, are temporarily loaded to RAM. This new method reduces the disk space and time necessary to run the model.

2 ENVIRONMENT

2.1 Software

The GMS interface was originally developed by the Environmental Modeling Research Laboratory at Brigham Young University in partnership with the U.S. Army Engineer Waterways Experiment Station and Version 6.0 was created on March 30, 2006. Technical support for the program is provided by Environmental Modeling Systems, Inc.

2.2 Hardware

GMS Version 6.0 is designed to run on MS Windows®-based operating systems. The program can be run on Windows 2000 or XP. The minimum requirements are a Pentium III computer, 256 MB of RAM (more recommended for larger models), 500 MB of disk space, CD-ROM, and

a minimum of 1,024 × 768 screen resolution with high color. The installation test was performed on the computer named Rattan.

3 PREREQUISITES

Users should be trained to use the codes executed in GMS. It is also necessary to have some knowledge of hydrogeology, in particular groundwater flow and mass transport in aquifers.

4 ASSUMPTIONS AND CONSTRAINTS

None.

5 TEST CASE

5.1 Execution of MODFLOW

This test case uses a MODFLOW 2000 model from a Center for Nuclear Waste Regulatory Analyses (CNWRA) letter report by Winterle (2003) entitled Grid S6b—Run 1. It is a calibrated, site-scale, saturated zone flow model that includes 5 mm/yr [0.197 in/yr] of recharge in the potential repository area.

5.1.1 Test Procedure

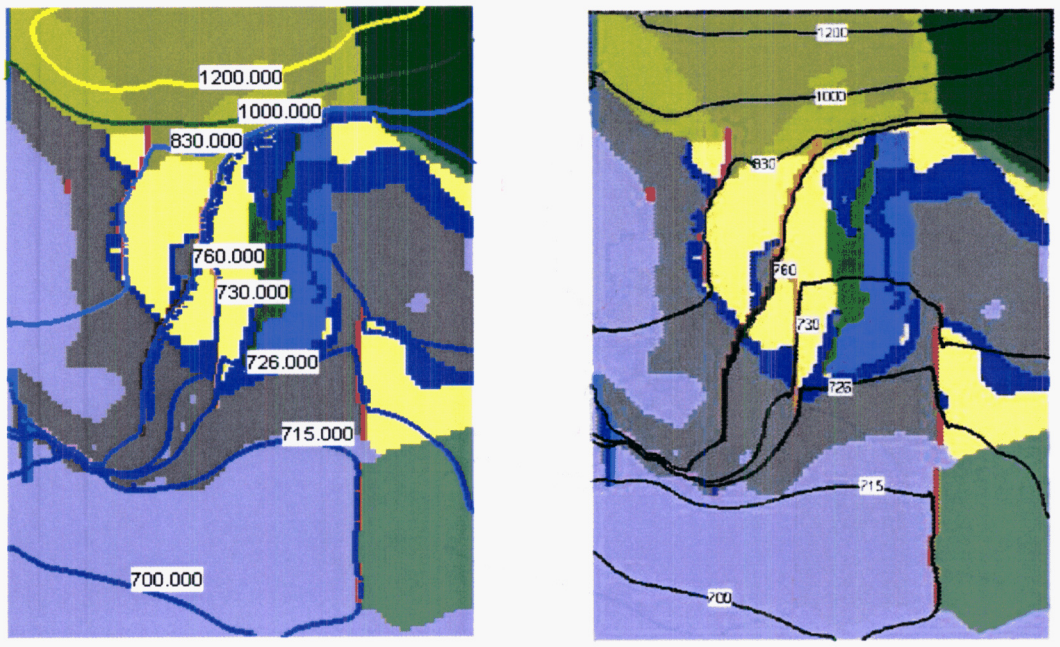
The model grid S6b was opened in GMS Version 6.0. Then the MODFLOW simulation was run, and the solution was read into GMS. Because GMS Version 6.0 includes essentially the same set of features as GMS Version 5.1 in terms of saturated zone groundwater flow modeling (except for its capability to handle large MODFLOW models), a visual comparison of calculated hydraulic head contour with that obtained by Winterle (2003) is sufficient for validation purposes.

5.1.2 Expected Test Results

The criteria for successful validation of this test case are that the software will display the model grid, read MODFLOW input files, allow changes to MODFLOW input, execute the MODFLOW code, display observation points, plot hydraulic head contour lines calculated by MODFLOW, and display calculated hydraulic heads for model cells. The calculated hydraulic head contour should agree with the GMS Version 5.1 results (see Winterle, 2003).

5.1.3 Actual Test Results

The MODFLOW code for the S6b grid converged, and the output was displayed in GMS. The resulting graphic is shown in Figure 1a. GMS displayed the observation points, hydraulic head contour lines, calculated hydraulic heads, and the model grid. The produced head contour matched with the one generated by GMS Version 5.1 (see Figure 1b).



(a) **(b)**

Figure 1. Comparison of Calculated Hydraulic Head Contours for Grid S6b-Run 1 at Layer 7 in (a) GMS Version 6.0 and (b) GMS Version 5.1

6 INDUSTRY EXPERIENCE

GMS is a widely accepted modeling system and is used in the public and private sector internationally. Because it supports such a large array of codes, GMS can be considered the most sophisticated groundwater modeling software available. Since its inception, new developments have made GMS more productive for users.

7 NOTES

None.

8 REFERENCES

Environmental Modeling Research Laboratory. "GMS 6.0 Tutorials." Provo, Utah: Brigham Young University, Environmental Modeling Research Laboratory. 2006.

Harbaugh, A.W., E.R. Banta, M.C. Hill, and M.G. McDonald. "MODFLOW-2000, The U.S. Geological Survey Modular Ground-Water Model-User Guide to Modularization Concepts and the Ground-Water Flow Process." U.S. Geological Survey Open File Report 00-92. 2000.

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