

**Minutes of the  
Groundwater Modeling Technical Advisory Group  
Metropolitan Council – M94 Office Park  
January 17, 2008  
1:00 PM – 3:00 PM**

Chris Elvrum, Metropolitan Council, moderated the meeting. Introductions were made; an attendance list is attached.

An update of the synoptic groundwater level measurement was given. USGS contact information was provided on the agenda. Tim Cowdery reiterated that any water level measurement data that is collected during the synoptic measurement and submitted to the USGS, provided a project field sheet is also submitted, will be included in the final database.

**Presentation: Model Calibration** – Ray Wuolo & Evan Christianson, Barr Engineering

Evan Christianson summarized the modeling work that has been done since the last meeting.

Randal Barnes asked how many pumping tests were used to calibrate the model and where the test data came from. Evan responded that 55 pumping tests were included in the model. Data was provided by Steve Robertson at the MDH.

Evan concluded that calibration of the regional model is generally good, and provided calibration statistics to support this. However, a few model areas are still problematic. One problem area is the Mt. Simon-Hinckley aquifer in the vicinity of the core cities.

Amal Djerrari asked if the graph of all calibration results for head targets (slide 12 of the presentation) had been split into three or more separate graphs to represent calibration in different geographic regions (i.e. how does model fit vary across the metro region). Evan responded that this has not been done, but Ray Wuolo noted that this can be included in future work.

Mindy Erickson asked if the calibration data had been graphed by model layer. Evan replied that this had been done and indicates that model calibration is good, except for the lower layers (Eau Claire and Mt. Simon) which show a lot of scatter.

Ray noted that the calibration results in the Mt. Simon show that the model consistently predicts water levels approximately 50 meters above the observed levels. He asked the group for advice on how to handle this problem. He specifically wanted to know:

- Are the head targets too low, because they were impacted by past pumping and don't represent equilibrium conditions?
- Should we expect to see a downward gradient from shallow aquifers to deeper aquifers in the central cities?

Doug Hansen responded that the original Metro Model used Schoenberg's 1990 report (USGS Water-Resources Investigations Report 90-4001: Effects of Present and Projected Ground-Water Withdrawals on the Twin Cities Aquifer System, Minnesota) to

say that a cone of depression was present under the central cities, but there is no current data to resolve this question.

Bob Tipping asked if the model includes Mt. Simon pumping wells. Ray responded that there are, but they are not pumping at a rate high enough to cause a cone of depression as large as the one indicated by the 1990 report.

Chris asked if the head targets are existing observation wells. Evan replied that the head targets include Minnesota County Well Index (CWI) static water levels measured from the 1940's to the 1990's. Bob asked if the static water levels recorded in the CWI differ very much from observation well data.

Amal suggested changing the resistance until the model is calibrated to the head targets. The amount of change needed to bring the model into calibration might shed light on the validity of using the current head targets.

Bill Olsen asked where in the model is water entering the Mt. Simon – from the model boundaries, faults, multi-aquifer wells, leakage? Ray responded that water is primarily entering the Mt. Simon as leakage from the Eau Claire.

Amal asked if a model water budget was created for the Mt. Simon layer. Evan replied that this had not been done.

Ray restated the problem: if the model is calibrated to observation wells, leakage between the Eau Claire and Mt. Simon model layers will be significantly reduced. Is it realistic to use these very low leakage values?

Chris asked how important it is to perfect the calibration for the Mt. Simon aquifer, because we don't plan to drill wells into it (based on current legislation prohibiting it). Ray responded that, if leakage is very low, all recharge to the Mt. Simon aquifer will occur from the model edges where out-state cities are using this aquifer. If the model defines leakage as very low, the model will predict huge impacts to the Mt. Simon aquifer in the central cities due to pumping near St. Cloud.

Randal commented that there is no reason to assume that, under steady-state conditions, the Mt. Simon aquifer will equilibrate to stage in the Mississippi and Minnesota Rivers. Bill disagreed, referring to a historic photo illustrating the artesian conditions of the Mt. Simon in the central cities at the turn of the century. This photo indicates that, under non-pumping conditions, the head gradient is up from the Mt. Simon.

Bill asked what resistivity value was assigned to the Eau Claire. Evan specified that the value varied across the model, but it was in the range of  $1/1000$  of a meter per day.

Randal suggested that Ray and Evan do a rough calculation to predict current water levels in the Mt. Simon aquifer based on past pumping history. This back-of-the-envelope estimate might shed some light on the calibration problem.

The Mt. Simon calibration discussion was concluded with the decision to adjust leakage between the Eau Claire and Mt. Simon to see what impacts occur.

Evan then introduced the second area where model calibration was poor. Currently, the model prediction of baseflow discharge to the Mississippi River in Minneapolis is too high. The reason for this is still unclear.

Mindy suggested graphing percent baseflow residual versus total flow.

Tim suggested that Evan and Ray speak with James Fallon at the USGS Water Science Center of Minnesota. James is familiar with Mississippi River baseflow estimates in Minneapolis. Tim felt that the recharge estimate used in the model is better than the estimated baseflow used to calibrate the model.

Ray summarized the calibration process and progress, and he concluded that the range of hydraulic conductivity values used in this first step of model calibration is still too broad to realistically represent aquifer properties. He asked the group to review the hydraulic properties currently used in the model (presentation slides 21 and 22) and suggest reasonable ranges that further calibration should be restricted to.

Amal asked if there is a map showing hydraulic conductivity values for each zone in the model. Evan replied that this map can be found in the PowerPoint presentation (slides 44 and 45). Randal asked if the excess hydraulic conductivity values in the Jordan aquifer in southern Dakota County may indicate a boundary problem. Ray and Evan concurred that the hydraulic conductivity values need to be reviewed and adjusted here.

Amal asked how long it takes to run the model, expressing concern that updating the model will require resources beyond those currently available at the Met Council or other government agencies. Evan responded that the current calibrated model takes about thirty seconds to run, if the starting heads are good. With changes, the model may take five minutes. Calibrating this model with PEST took several days on multiple computers.

Ray changed the subject to discuss how the model will be used to solve local water supply problems. He presented a hypothetical example, based on the City of Ramsey. Step one would be to add the proposed stress to the regional model. Step two would be to include the stress in an existing subregional model, or create one using telescopic mesh refinement (TMR). Step three would be to use telescopic mesh refinement to create a local model.

Amal Djerri expressed concern that TMR in Groundwater Vistas is troublesome, because more cells are created to represent what was a single cell in the larger model. This changes the model values and budget. Ray acknowledged this problem, and offered a solution that relies on GIS to re-define boundary conditions in the new local model.

Randal Barnes asked how Barr is planning on representing/presenting uncertainty to potential users, which is particularly challenging as uncertainty varies across the model and from layer to layer. When Ray Wuolo replied that this had not yet been decided and asked for suggestions, Randal suggested uncertainty maps. Ray Wuolo clarified that the model can make predictions to quantify uncertainty, although this process is very sophisticated and difficult to present. Reporting parameter sensitivity might be a more straightforward way to describe uncertainty. Bob Tipping wanted to know how to address uncertainty introduced by changing the model calibration set as the model is updated. This introduced a discussion of the challenges of defining a steady-state calibration data

set. Randal Barnes suggested calling calibration data “long-term average” instead of “steady-state”. Tim Cowdery suggested calculating total pumping from each aquifer/layer and comparing this volume to the flux volume through the corresponding aquifer/layer. Amal Djerreri suggested creating a map of leakage variation across each layer.

The discussion then turned back to the hypothetical example of applying the model to solve local water supply problems. Ray pointed out that, when assessing local model certainty, the regional model can be used to do PEST predictive analysis. Local models created through TMR should not be used with PEST predictive analysis.

Randal asked if a sensitivity analysis was done using the pump test data targets. Ray responded that this had been done, but he did not have the results. A discussion ensued about municipal pump test data biasing estimates of hydraulic conductivity, because municipal wells are sited only in areas where aquifer production is known to be high. Ray commented that, in his experience, most cities site wells before calling a geologist so no bias toward high hydraulic conductivity zones actually occurs. Evan Christianson noted that bias due to pump test well location was most likely to occur in the Quaternary aquifers. Amal Djerreri concluded that he didn't think this potential bias is an important concern in this type of study.

Princesa VanBuren commented on the map of pump test locations, expressing concern that only two pump tests in Ramsey County were included. Marc Janovec noted that he may have some pump test data for Ramsey County that could be included in the model.

Bill Olsen returned to the subject of model calibration in the Mt. Simon in Ramsey County, double-checking that the plan to solve the head problem is to lower resistivity in the Mt. Simon. He noted that huge fractures are probable and asked how they would be addressed.

Randal Barnes commented that there is regional value in presenting a map of recharge distribution and values, leakage maps, and flux to and from the stream baseflow reaches. Raw data, even uncertain data, are great for generating discussion. It will also be worthwhile to determine how to incorporate geochemical data. Tim Cowdery added that vertical temperature modeling would also be a useful addition. Tim concluded that total volume moving through the model is our total water supply resource. The volume of metro area aquifers is not as important a number for water supply management.

## **Conclusion**

The next meeting will be scheduled when the calibrated model is ready to be distributed for review by the group. It is expected that this will occur this coming spring.

**Attendees  
Groundwater Modeling Technical Advisory Group  
Metropolitan Council – M94 Office Park  
January 17, 2008**

NAME	ORGANIZATION	Email
Chris Elvrum	Metropolitan Council	christopher.elvrum@metc.mn.state.us
Sara Bertelsen	Metropolitan Council	sara.bertelsen@metc.mn.state.us
Lanya Ross	Metropolitan Council	lanya.ross@metc.mn.state.us
Tim Cowdery	U.S. Geological Survey	cowdery@usgs.gov/763-783-3272
Andrew Streitz	MPCA	Andrew.streitz@pca.state.mn.us
Erik Anderson	SEH	eanderson@sehinc.com
Erik Tomlinson	SEH	etomlinson@sehinc.com
Bill Olsen	Dakota County	bill.olsen@co.dakota.mn.us
Steve Robertson	MDH	steve.robertson@state.mn.us
Mindy Erickson	MPCA	Mindy.erickson@state.mn.us
Mike Liljegren	DNR Waters	Michael.liljegren@dnr.state.mn.us
Ray Wuolo	Barr Engineering	rwuolo@barr.com/952-832-2692
Tim Brown	Barr Engineering	tbrown@barr.com
Evan Christianson	Barr Engineering	echristianson@barr.com
Sherri Kroening	MPCA	Sharon.Kroening@state.mn.us
Randal Barnes	U of M	Barne003@umn.edu
John Freitag	Washington County	John.Freitag@co.washington.mn.us
Amal Djerrari	MDH	Amal.djerrari@health.state.mn.us
Ole Olmanson	SMSC	oleolmanson@gmail.com
Beth Johnson	Geomatrix	bjohnson@geomatrix.com
Princesa VanBuren	EQB	Princesa.vanburen@state.mn.us
Mark Janovec	Bonestroo	mjanovec@bonestroo.com
Joel Settles	Hennepin County	Joel.settles@co.hennepin.mn.us
John Dustman	Summit	jdustman@summite.com
Brian Gulbranson	Summit	bgulbranson@summite.com
Doug Hansen	MPCA	douglas.hansen@pca.state.mn.us