

**Draft Minutes of the
Groundwater Modeling Technical Advisory Group
Metropolitan Council – M94 Office Park
June 25, 2007
1:30 – 3:00 PM**

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

Ray Wuolo, Barr Engineering Company, presented details of the Council's proposed regional groundwater flow model. Barr is charged by the Council to complete model construction and calibration by the 1st of the year. The presentation is attached. An informal discussion took place during and following the presentation and is summarized below.

Bob Tipping asked Ray about his intention to exclude the Platteville Formation from the model, pointing out the importance of flow through the Platteville in the area of Minnehaha Creek. Stu Grubb reiterated the significance of baseflow to Minnehaha Creek from the Platteville Formation. Ray responded that, on a regional scale, flow through the Platteville is not significant. However, the Platteville could be included in the model in areas where it has an influence on flow.

Tim Cowdery brought up the issue of how the model will address major faults, particularly where fault offset is great enough to set two units with significantly different hydraulic properties next to one another horizontally. Ray responded that faults would be addressed using differing hydraulic conductivity zones across faults. The same would be done with buried bedrock valleys. Chris Elvrum noted that some fault areas may warrant higher detail.

When asked about the status of MGS-generated grids of geologic surface elevations, Bob Tipping responded that geologic surfaces in Scott County has been updated and that the surfaces of deeper aquifer units have been updated in portions of the northwest metro. Ray suggested CWI data could be used to interpolate geologic unit surfaces in areas where geologic maps have not yet been updated. Bob agreed and added that the MGS would assist to define aquifer thicknesses in these areas.

Ray proposed to extend the model domain only slightly beyond the seven county metropolitan area. In the southern metro, he proposed to use model boundary conditions established by the MPCA's Metro Model. Bill Olsen requested that the model be extended as far south as possible. Al Frechette noted that Dan Barrett, when constructing the Scott County groundwater model, set the southern boundary at the groundwater divide north of the Cannon River. Tim Cowdery noted that, on the northwest and west sides of the model, it would make sense to extend the model domain to the edge of the major aquifers.

Bill Olson was concerned about using a constant flux boundary, as defined by the MPCA's Metro Model, on the southern edge of the model because this accepts all the uncertainty in the MPCA boundary. This is problematic for multiple reasons, including how it reduces our ability to answer questions of climate change impact. Ray responded that putting a flux boundary here, instead of a constant head boundary, will allow for more "natural" model results if new wells are added near the southern edge of the model domain. He said that a constant head boundary could be used initially and changed to a flux boundary for model predictive runs. Tim Cowdery noted that the southern metro will continue to be a problem area, due to the lack of data here.

Ray Wuolo solicited opinions from the group about adopting the MPCA's use of three sub-regional model provinces. He clarified that there would be a single metro-wide model and three sub-regional models. Some local models would also be constructed, using telescopic mesh refinement, in certain hydrologically unique areas. Stu Grubb commented that using linked sub-regional province models could cause problems when examining discharge to major rivers. Ray responded that the single metro-wide model would be used to set the discharge to the major rivers which would be then used in the sub-regional models.

Tim Cowdery asked what grid mesh size would be used. Ray responded that this will depend on Bob Tipping's work. Bob noted that existing geologic unit surface grids vary from 30 m² for the newest grids to 90 m² for older grids. Ray commented that the regional model would have grid cells as small as 500 m². The model would rely on ESRI grids to define layer tops and bottoms.

Bob Tipping asked how buried bedrock valleys would be represented in the model using such large grid cells. Course resolution was a problem in the Metro Model, which only represented the largest valleys. Ray responded that valley size should not be a problem in the sub-regional models. These features were easily included in Barr's Washington County model where the grid cell spacing varied from 100-500 m.

Ray asked the group if they felt the model should include layers deeper than the Mt. Simon-Hinckley Aquifer. The general response was no, although there are outcrops of Proterozoic rocks in the southwest metro area. Bob Tipping noted that modeling head in these deeper units is impossible due to lack of data, although limited chemical data provides some evidence of the hydrologic influence of saline water from these units on overlying aquifers. Tim Cowdery suggested specifying a flux boundary on the bottom of the Mt. Simon-Hinckley layer to represent the influence of the Proterozoic units where necessary.

Ray turned the discussion to the subject of recharge and summarized the Soil Water Balance (SWB) Code, which is in final beta testing. This method will be used to deterministically identify recharge values as a grid that exactly matches the model grid. Recharge will, therefore, be an uncalibrated estimate. The model will still be calibrated to baseflow. This SWB method will allow for the possibility of looking at land use changes on recharge.

Bob Tipping asked if the SWB method has been tested on large watersheds. Ray discussed three sites where this method has been used - a large forested watershed in Wisconsin, a watershed near Madison, Wisconsin, and at a site in the Great Lakes basin. Ray reiterated that recharge will be treated as a model input, like pumping rates, and not as a calibrated parameter.

Bill Olsen asked how recharge estimates will be checked to make sure they are reasonable. Tim Cowdery noted that the model calibration relies a lot on discharge data and asked what discharge data would be used. Ray responded that most of the data would come from the USGS and other agencies represented at this meeting. Tim expressed concerns about existing baseflow data quality, citing the trouble the USGS had trying to collect seepage data on major rivers. Ray acknowledged that this is a problem; on the major rivers, baseflow is less than the error brackets on flow measurements. He noted, however, that this model will be calibrated to data from many smaller streams, where the baseflow measurements are much more accurate. Tim commented that, as a group, we need to agree to collect more and better baseflow data for major rivers. Brian LeMon noted that part of Barr's project output will be recommendations for future needs.

Ray specified that the model would be calibrated simultaneously to hydraulic conductivity, steady state heads, transient calibration to DNR observation wells, selected drawdown on pumping tests,

and baseflow. Hydraulic conductivity would be calibrated across zones using pilot points using Single Value Decomposition Assist (SVDA). John Doherty will be here in September to help with the calibration process.

Al Frechette commented on the possibility of quantifying recharge by comparing withdrawal rates to pumping rates and transient water levels. Ray responded that this would not result in a unique solution, due to other controls on recharge.

Al Frechette noted that not including all stream flow (baseflow and stormflow) misses the influence of recharge events. Ray responded that including all stream flow in model calibration would require coupling the groundwater model to a surface water model which would be very difficult at the regional scale.

Bill Olsen asked Ray how the model would be calibrated to thousands of parameters, and Mindy Erickson asked what, specifically, thousands of parameters would be used. Ray responded that SVDA allows for very high levels of complexity, and that the model would be calibrated at hundreds of points to hydraulic conductivity, storage, riverbed conductance, leakance, etc. Tim clarified that the model would not be calibrated to recharge and discharge; those are fixed values and they control model results. Ray mentioned that the finished model will need to be capable of incorporating new datasets for improved calibration.

Bob Tipping asked if residence time could be used to calibrate the model. Ray said that this would be tricky because this introduces the need for effective porosity data. A head gradient could be used as a calibration target, however.

Ray noted that Groundwater Vistas will be used as the GUI. The model will be built using MODFLOW-96 to allow use of John Doherty's dry cell correction option. The model could then be converted to MODFLOW-2000 for use by others. Tim Cowdery noted that the grid refinement option is only available in MODFLOW-2005. Ray responded by stating that the model might, therefore, be translated from MODFLOW-96 directly to MODFLOW-2005.

All model outputs will be provided as ESRI grid, point or line coverages. The model files and documentation will be provided in a web-based format and also on CD. Tim Cowdery commented that he would particularly like to see information detailing the creation of model input files, including original data sources, the coverages used, what simplifications and assumptions were made, etc. Bill Olsen also stressed the need for others to be able to duplicate both the model and PEST files. Chris Elvrum suggested that this group might help document the process of porting these MODFLOW files into other GUIs models.

Steve Robertson asked if the model report will include how the model will be used to assess water supply availability. Brian LeMon responded that this was the second part of Barr's contract, and that the model would be the foundation for this subsequent assessment.

Stu Grubb asked what lake information would be included in the model. Ray responded with: stage/elevation, bathymetry in deeper lakes, bed conductance, and some seasonal fluctuation in water level (where it exists). The river package would be used to define most lakes, but deeper lakes like Lake Elmo would be defined as constant head boundaries.

Chris Elvrum asked if the Metro Model recharge values will be used as a check on the recharge values determined using the SWB method. Andrew Streitz agreed that this would be a good idea, but

he cautioned that the SWB method sounds more advanced than the method used for the Metro Model.

Chris Elvrum asked about the SWB method's ability to realistically handle winter precipitation when the temperature is above freezing. Ray responded that this would be somewhat problematic, but he believes someone has dealt with this problem by creating a temperature 'buffer' to prevent winter precipitation from falling as rain. Tim Cowdery, Andrew Strietz, and Chris Elvrum all mentioned that precipitation in April, when soils are still frozen could lead to an overestimation of recharge.

Steve Robertson asked if Ray planned to compare the SWB analysis results to recent USGS recharge estimates. Ray said that this would be possible where the two methods overlap. Tim Cowdery cautioned that the USGS recharge estimates were pretty crude.

Bob Tipping asked if Ray planned to characterize the unconsolidated material below the soil zone like Barr did in southern Washington County. Ray responded that the model would assume that as soon as water moves below the root zone, it does not come back to the surface.

Steve Robertson asked if, based on the stated scope, Ray had any concerns about using a porous media approach. Ray said yes, but he knows of no way to get around these concerns. Steve asked if fracture zones could be represented as discrete layers. Ray said this would be possible, if these fracture zones were mappable. Bob Tipping noted that mapping of this kind has begun in Scott County.

Ray Wuolo suggested that certain hydrostratigraphic units be lumped in this initial model. A sub-regional model could then be modified to test our ability to add a discrete fracture zone. Tim Cowdery commented that a benefit of using MODFLOW's local grid refinement is the ability to add layers, as well.

Bill Olsen noted that he would like a coverage of the model's predicted discharge rates to rivers and a coverage of leakage volumes per layer to be included in model outputs.

Chris Elvrum asked what the group thought about a review process. Is this advisory group sufficient? Andrew Strietz responded that this advisory group follows the method used for the Metro Model, which worked well for that effort. Tim Cowdery commented that it was difficult to get through the nuts and bolts of a model in this setting. Mindy Erickson suggested searching for someone at the University who would be willing and able to review the model. Chris asked if it made sense to hire someone to do a formal review, perhaps the USGS. Tim responded that the USGS would be interested in helping to review the model.

Tim Cowdery asked for clarification about how the model would be updated. Would updates be restricted to calibration sets, or would new geologic data be included? Ray's intention is to design the model for straightforward updates of calibration data; changes in hydrostratigraphy would require considerable additional effort.

Chris noted that MODFLOW seems to be the best fit to ensure future use of the model. Andrew Strietz noted that the real battle seems to be between GMS (Groundwater Modeling System) and GWV (Groundwater Vistas). Currently, MCES is using GWV. The USGS and the MPCA use GMS. The MDH uses GWV, GMS and Visual MODFLOW.

Lanya Ross noted that she has been compiling baseflow data for the metro area and asked that everyone share any data they have. She currently has data for approximately 150 sites, primarily from the USGS, DNR and MCES. Tim Cowdery noted that the 1988 USGS report on baseflow in the Mississippi River (Payne) is less credible than we would like for baseflow estimates. This data should be taken with a grain of salt.

The group agreed that a meeting during the development of model, perhaps in September/October would be a good idea.

Ray referred to three papers:

Hunt, Randall J., John Doherty, and Matthew J. Tonkin. "Are Models too Simple? Arguments for Increased Parameterization." Ground Water Vol. 45. No. 3 (2007): 254-262.

Doherty, John. "Improved Calculations for Dewatered Cells in MODFLOW." Ground Water Vol. 39 No.6 (2001): 863-869.

Dripps, W. R. and K. R. Bradbury. "A simple daily soil-water balance model for estimating the spatial and temporal distribution of groundwater recharge in temperate humid areas." Hydrogeology Journal Vol. 15 (2007): 433-444.

Attendees
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