Regional groundwater mapping and model

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The Grand River forms one of the largest drainage basins in the southwestern portion of the Province of Ontario. The drainage area of the Grand River is approximately 6800 square kilometres, representing 10 percent of the direct drainage to Lake Erie. Agricultural and rural land use predominate, with urban land uses concentrated in the central portion of the watershed. Most of the basins’ 800,000 residents reside within this central portion. It is estimated that 82% of the watershed’s population are reliant on groundwater for their drinking water supply.

The Grand River Conservation Authority began updating their overall watershed management plan in 1996. This update is ongoing. A key objective of the plan is to develop a good technical understanding of the groundwater system throughout the watershed. Of particular interest are the linkages between the groundwater and surface water systems. Better understanding of these linkages allows for more effective resource management and better incorporation of groundwater issues and concerns into the planning process.

To help provide a technical understanding of the groundwater system, a systematic approach was taken in the assembling of geology, groundwater, topographic, and biological information. The deliverables of this effort will include regional scale groundwater mapping and a regional scale MODFLOW groundwater model. These tools will be used to assist with decision-making related to groundwater management.

To date, the regional scale groundwater mapping has been completed along with a detailed technical report describing the mapping. Furthermore, an uncalibrated regional scale MODFLOW model has been constructed using 200-metre cells across the entire watershed.

As was previously mentioned, a systematic process was followed to assemble the necessary background information for the project.

The first step was to compile and review all available geologic information. Geology significantly affects the underlying physics of a watershed and will impose a dominant control on the system. Ultimately, a seamless digital coverage representing the quaternary geology of the watershed was constructed. This work was done with the co-operation and assistance of the Ontario Geological Survey.

The next step in the process was to obtain and update water well information for the watershed. This information was obtained from the Ontario Ministry of the Environment. The Conservation Authority worked closely with the Ministry to update the existing data and to structure the water well information into an MS-Access database.

As the water well information was being updated, the Conservation Authority, in co-operation with the Ontario Ministry of Natural Resources, created a hydrologically conditioned Digital Elevation model for the watershed. This model was based predominantly on elevation data contained within 1:10,000-scale Ontario base mapping.
Once the majority of the background work had been completed, a two-member team including a hydrogeologist and GIS expert was assigned to produce the regional scale groundwater mapping and the accompanying technical report.

A key tool used in the development of the regional scale mapping was Viewlog borehole data management software. This software is designed for the management and analysis of borehole information and for the construction of MODFLOW groundwater models. Once the regional scale mapping had been completed, the mapped information was then used to construct an uncalibrated regional scale MODFLOW model.

The regional scale mapping series includes fifteen different maps. These include:

**Physical Setting**

1) Quaternary Geology  
2) Bedrock Geology  
3) Major Moraines (Figure 1)  
4) Ground Surface  
5) Bedrock Surface  
6) Overburden Thickness  
7) Sand & Gravel Thickness

**Hydrogeology**

8) Water Table Surface  
9) Potentiometric Surface  
10) Upward Vertical Hydraulic Gradients  
11) Downward Vertical Hydraulic Gradients  
12) Depth to Water Table  
13) Depth to Uppermost Aquifer

**Sensitivity**

14) Vulnerability to Contamination  
15) Potential Discharge Areas

As part of mapping the bedrock surface, bedrock valleys were delineated as is illustrated by Figure 2. Bedrock valleys may represent important controls on the groundwater system and have the potential to serve as excellent sources for municipal water supplies.

All the above maps were used to gain a fuller understanding of how the groundwater system functions throughout the watershed.
Figure 1. Major moraines of the Grand River Watershed.
Figure 2. Bedrock valleys of the Grand River Watershed.