GeoHydros LLC

Specialized Geological Modeling

GROUNDWATER FLOW MODELING

PROJECT NAME & LOCATION	DATE STARTED	DATE COMPLETED
Pennridge Wellhead Protection, Bucks Co. PA	January 2005	May 2007

ACTIVITY TITLE	APPROXIMATE CONTRACT VALUE
Geological & Groundwater Flow Modeling	$85,000

CLIENT NAME & ADDRESS	TECHNICAL CONTACT
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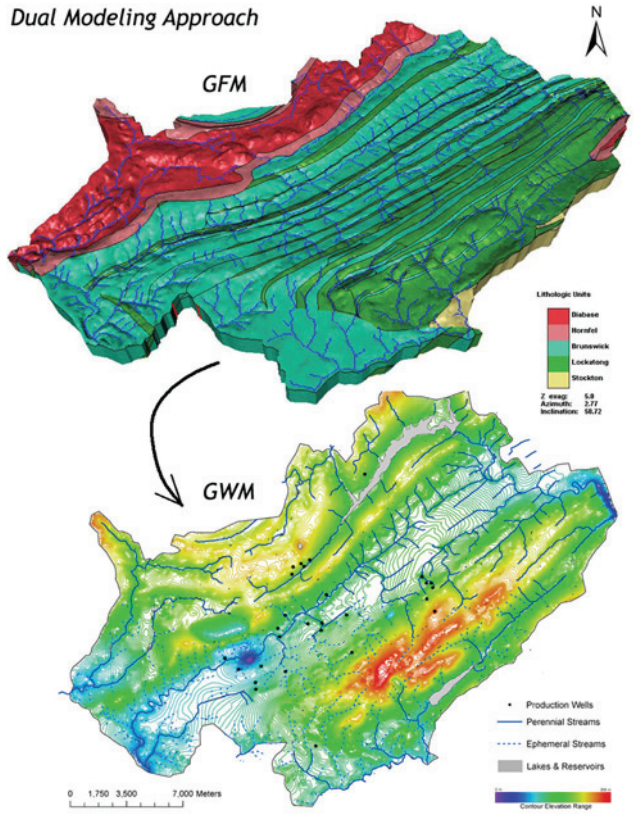
PROJECT DESCRIPTION

The GeoHydros modeling group developed a numerical groundwater flow model to assist six Philadelphia area municipalities managed by the Bucks County Planning Commission with the design of a comprehensive aquifer protection strategy. The basic objectives of this project were to: (1) compile and synthesize all available geologic and hydrologic data into a comprehensive Geologic Framework Model (GFM) describing structural controls on groundwater flow through the regional fractured rock aquifer; (2) convert the GFM into a basin-scale numerical groundwater flow model (GWM); and (3) use the GWM to develop wellhead protection zones (WHPZ) for 19 Bucks County municipal wells.

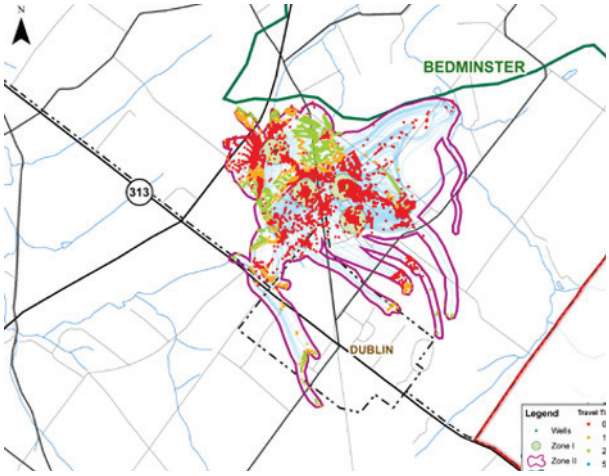
These objectives were achieved through numerical modeling using FEFLOW™ that was based on a detailed geological framework model (GFM) developed in EarthVision™. The GFM correlated fracture controls on groundwater flow throughout the basin with bedding orientations and contacts separating three geologic units: the Brunswick and Lockatong Formations and a diabase intrusion. The model incorporated strike and dip data and outcrop boundaries from geologic maps and cross-sections, borehole logs, and soil survey data to simulate 60 interbedded lithologic units of varying thickness, geometry, and permeability that have been structurally tilted the framework was then exported to FEFLOW for groundwater modeling where the geologic structure could be seen to exert significant control on simulated groundwater flow paths and velocities across the basin. Particle tracks were used to define well capture zones and then integrated back into the GFM in 3D to define the specific recharge areas contributing flow to the municipal water supply wells, which were used together to define the EPA Zone II WHP Zones.

GeoHydros successfully generated rapidly updatable, very high resolution, 3D models (0.05 foot vertical interval) of soil contamination that were considered by the project management and the regulatory agency to significantly expedite an effective rapid site characterization (Triad) approach that saved money and time and facilitated better decision making.

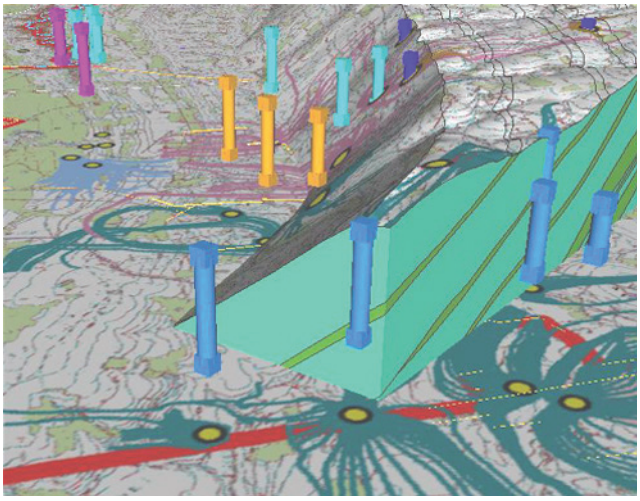


(Top) Geologic framework defining the 3D orientation of 60 dipping interbedded stratigraphic units intruded by an igneous dike and dissected by streams.

(Below) Simulated groundwater flow field based on the hydrostratigraphic framework from the GFM and hydraulic conditions created by streams, quarry dewatering, and municipal groundwater pumping.



Delineation of standard EPA Zone II WHP boundaries (purple line) as defined by 2D particle tracks and alternate Zone II boundaries (colored points) defined by 3D particle tracks intersecting the bedrock surface.



Orientation of water bearing (blue) and confining units (green) relative to the position and depth of municipality water supply wells and the well capture zones simulated in FEFLOW.

Deliverables included: (1) delineation of wellhead protection zones based on 3D particle tracks, (2) incorporation of model results & wellhead protection zones into appropriate ordinance language, (3) four quarterly presentations to the Municipality authorities and project management on the status and results of the modeling effort, and (4) a final report on model development, calibration, results, and wellhead protection zone delineation in a synclinal basin, faulted at one end, and then intruded by the diabase.

SELF ASSESSMENT

GeoHydros successfully developed a regional 3D model of groundwater flow bounded by established no-flow boundaries. The model was developed with sparse data but calibrated well to water levels measured in 19 municipal groundwater supply wells under both static and pumping conditions. Particle tracks exported from the pumping conditions model were used to define well capture zones that were, in turn used to delineate standard EPA Zone II WHP boundaries for all the well fields. The modeling, particle track exports, and reporting were all completed on time and on budget. After the modeling was completed and our budget exhausted, we continued to support the project during a lengthy public review and comment period. Part of that support included developing an alternative set of Zone II boundaries that encircled the recharge areas for the wells as defined by the intersection of 3D particle tracks with the bedrock surface. In the end, the model was well received and the Pennsylvania Department of Environmental Protection stated that it marked a new standard for wellhead protection projects in Pennsylvania.