

## UPDATING THE CUMULATIVE HYDROLOGIC IMPACT ASSESSMENT: GROUNDWATER<sup>1</sup>

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**Abstract:** The Cumulative Hydrologic Impact Assessment (CHIA) update of energy related hydrologic impacts is currently underway at the University of Wyoming under an interagency cooperative agreement. Participating federal and state agencies include the Wyoming State Engineers Office, the Wyoming State Geologic Survey, the Wyoming Department of Environmental Quality/Land Quality Division, United States Department of Interior, Office of Surface Mining, United States Department of Interior, Bureau of Land Management, and the University of Wyoming. Work to date has focused on the identification, acquisition, update and QA/QC of available data sources; identification of a data management system; delineation of cumulative impact areas (CIAs), and selection of a pilot study area; development of the conceptual model; and initial modeling of a proposed Coal Bed Methane (CBM) development.

The Coal Permit and Reclamation (CPR) database is a primary source for surface mine related data. Activity has focused on the QA/QC and update of the database to present. Other identified hydrologic data sources include the Wyoming State Engineers AREV database, and data available from the Wyoming Oil and Gas Commission. Data coverage in areas down dip of the surface coal operations is sparse. The western extent of monitoring in these areas is the outer ring of surface coal monitor wells for the most part. CBM development will be located primarily down dip of the mines and are not required to monitor to the extent that surface coal operations are.

The groundwater modeling effort that will be a part of the CHIA will, by necessity, need a data management system that will allow the development, manipulation, and graphical display of large, spatially distributed data sets. For example, bedrock geology, surficial geology, faults and folds, and clinker distribution are important to the development of the individual model layers, groundwater boundaries, aquifer thickness and the extent and location of recharge. Geographical Information Systems (GIS) provides such a data management system, and in addition allows the ready development of groundwater grids. GIS interfaces to the groundwater portion of the CHIA are being investigated in the Jacobs Ranch/Black Thunder/North Rochelle pilot study area.

CBM impacts are already being seen in CIA 3. The Marquiss project has been actively producing methane from 63 wells since 1992 and the Lighthouse project is well into the permitting process. Since the area of the Lighthouse project was devoid of *in situ* aquifer testing, it was necessary to develop a method to allow numerical groundwater modeling in areas of sparse data. Relating aquifer hydraulics to micro-relief in the Wyodak coal seam allowed development of input data arrays using conditional simulation. Conditional simulation is a stochastic geostatistical method that may be used to develop model input arrays. The method insures that known values are honored, while interpolating data in areas of limited or non existent data. Statistical constraints specified by the modeler constrain the model arrays. Multiple runs with MODFLOW allowed an assessment of the range of possible CBM related impacts. Utility of the method was validated by accurately predicting the two year drawdowns at the Marquiss CBM project. The method appears well suited to the development of input data arrays for the CHIA effort, and to the continued use of conditional simulation.

**Additional Keywords:** Groundwater Modeling, Cumulative Impact Assessment, Database Management, GIS, Surface Coal Mining, Coal Bed Methane, Powder River Basin, Conditional Simulation.

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