SIMULATION OF GROUNDWATER FLOW IN PART OF THE ESPAÑOLA BASIN FROM BLACK MESA TO COCHITI, NEW MEXICO

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ABSTRACT

This poster describes a three-dimensional numerical model of groundwater flow in part of the Española Basin from Black Mesa to Cochiti, New Mexico. The principal aquifer system of the modeled area consists of the Santa Fe Group. The primary water bearing formations are the Tesuque Formation and the Los Alamos area main aquifer.

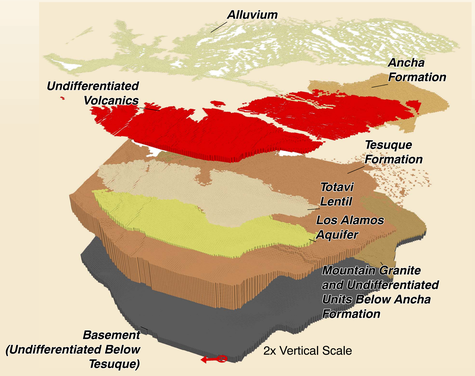
We compiled data from various available sources to provide information for the construction of a three-dimensional hydrogeologic unit solids model. The solids model provides a framework for specifying hydrologic parameter zones. Model parameter zones are generalized so that each hydrogeologic unit (Tesuque Formation, Los Alamos Aquifer, etc.) is represented with a constant set of parameters.

The groundwater system is represented by a grid with 63 layers, 216 rows and 175 columns. In plan view, the model grid is constructed out of square cells 1,056 feet (1/5 mile) long on a side. Each grid layer is 200 feet thick. The grid covers an area of 1,100 square miles and ranges in thickness from 2,000 to 12,000 feet thick. The layer structure of the model grid follows the idea conceived by the U.S. Geological Survey (Hearne, 1985). Hearne's grid represented the Tesuque Formation by incorporating a geologic dip in the model grid layers. The grid developed for the model herein builds on that approach by incorporating the dip defined by a structurally interpolated surface generally representative of the base of the Santa Fe Group. The Tesuque Formation consists of inter-bedded deposits of sediments with contrasting permeability. The dip of the beds creates a preferential pathway for groundwater flow. That condition creates steep hydraulic gradients (50 to more than 100 feet per mile) where the movement of water is across, rather than parallel to, the dipping beds (Spiegel and Baldwin, 1963, pgs. 131-132). The grid layering approach provides a generalized method to inspect the influence that the structural beds have on the groundwater flow system.

A combination of parameter estimation and trial-and-error techniques resulted in model parameters in the range of other published values. The Tesuque Formation aquifer is generally simulated with K_x = 1.0 ft/d and K_z = 0.003 ft/d (as simulated by Hearne (1985)) and includes a reduction in permeability with depth. Other primary water producing formations have a horizontal to vertical anisotropy factor of 10.0 to 1.0 for hydraulic conductivity with K_x in the range of a few feet per day. Specific storage and specific yield are 2.0 x 10^{-6} per foot and 0.15 everywhere for all primary water bearing formations.

Model results indicate that the structural dip of the Tesuque Formation aquifer is an important factor that affects the groundwater flow system. Incorporation of the modeled Tesuque Formation with the dipping bed structure appears to provide a generalized method to account for the observed condition of steep regional head gradients, in areas such as the Pojoaque River Basin, and for a flattening of head gradients as observed near Aqua Fria. The model is capable of representing observed field conditions and provides a tool to assist with regional water planning.

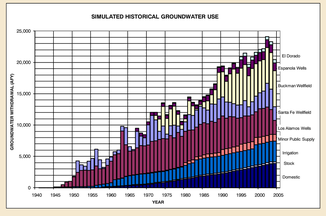
MODEL STRUCTURE AND SPECIFICATIONS



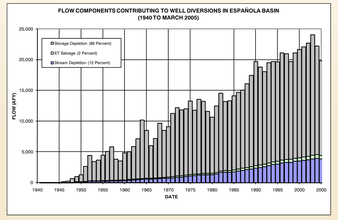
SPECIFICATION OF HYDROLOGIC PARAMETERS

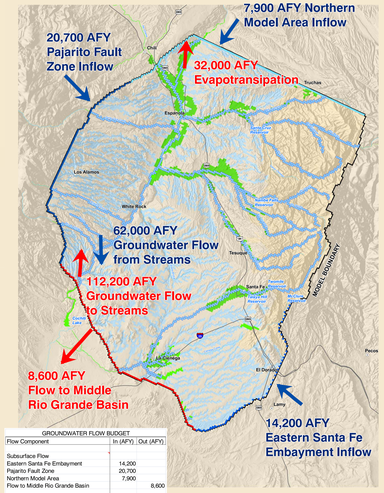
Hydrogeologic Unit	Horizontal Hydraulic Conductivity (ft/d)	Vertical Hydraulic Conductivity (ft/d)	Thickness (ft)	Horizontal Hydraulic Conductivity Decrease with Depth[1]
Alluvium	50.0	50.0	30 to 80	No
Tesuque Formation	1.0	0.003	250 to 12,000	Yes
Ancha Formation	15.0	15.0	50 to 300	No
Undifferentiated Volcanics	0.01	0.01	100 to 2,000	No
Totavi Lentil	5.0	0.5	10 to 200	No
Los Alamos Aquifer	2.0	0.2	500 to 1,400	Yes
Mountain Granite	0.05	0.05	500 to 1,000	No
Mountain Granite w/ Other bedrock (El Dorado Area)	0.01	0.01	500 to 1,000	No
Undifferentiated Units (Below Ancha Formation where Tesuque Formation is not present)	0.05	0.05	500	No
Basement	0.001	0.001	2,000 to 2,500	No

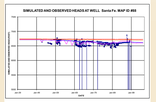
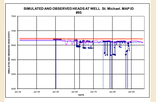
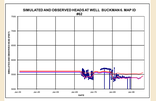
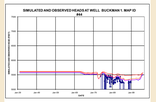
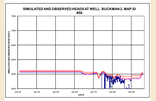
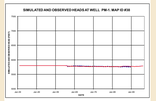
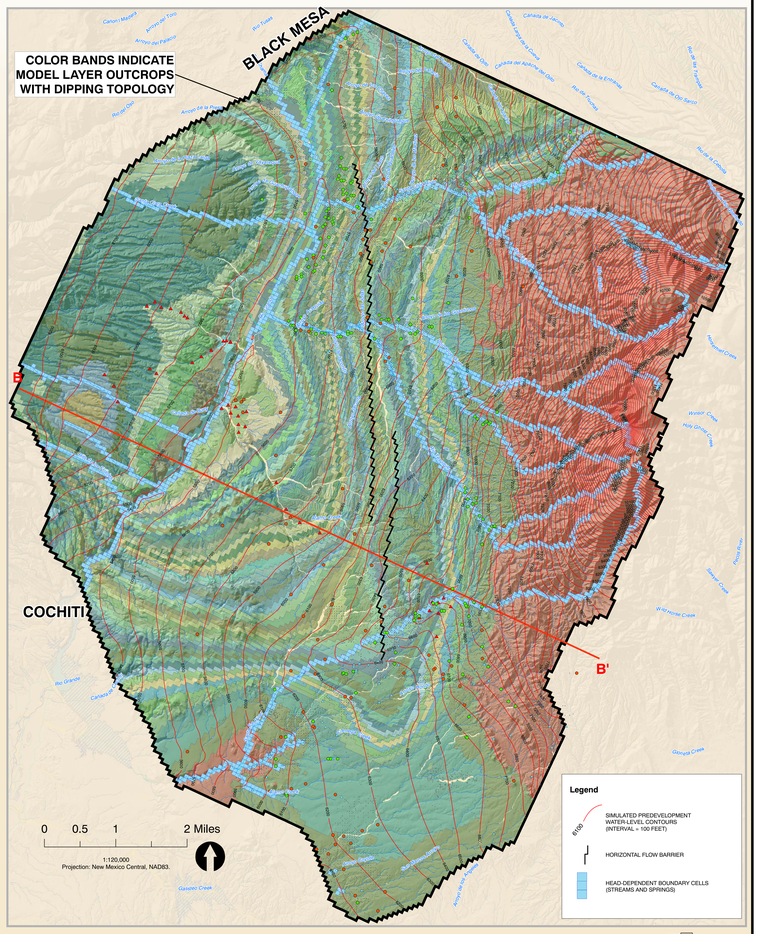
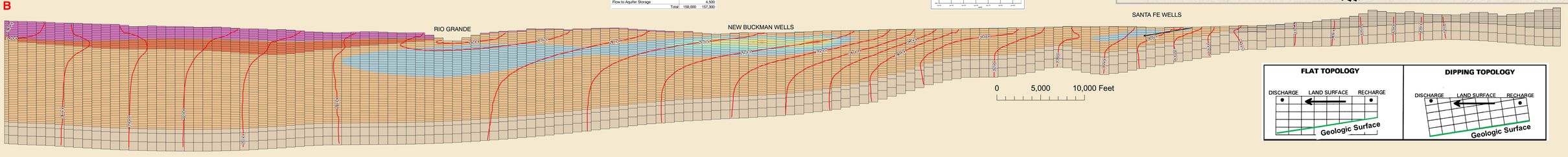
[1] A decline in hydraulic conductivity with depth of a hydrogeologic unit can occur and has been described by Hanneberg (1998) for Santa Fe Group sediments. The Tesuque Formation aquifer and the Los Alamos aquifer are simulated with a hydraulic conductivity decrease with depth. The rate of decrease is based on an exponential decay curve based on Hanneberg (1998, fig. 3, Drives 208, 278 and 318).



MODEL RESULTS





GROUNDWATER FLOW BUDGET

Flow Component	In (AFY)	Out (AFY)
Subsurface Flow		
Eastern Santa Fe Embayment	14,200	
Pajarito Fault Zone	20,700	
Northern Model Area	7,900	
Flow to Middle Rio Grande Basin		8,600
Recharge to Arroyos	2,300	
Recharge to Sangre de Cristo Mountains	19,900	
Return Flow from Irrigation	31,000	
Groundwater Interaction with Streams		
Groundwater Recharge	62,000	
Groundwater Discharge		112,200
Evapotranspiration		32,000
Flow to Aquifer Storage		4,500
Total	158,000	157,300