Sandia National Laboratories

Energy, Climate, & Infrastructure Security

Hydrologic Modeling Capabilities

Sandia National Laboratories' Defense Waste Management Programs has both experience and technical knowledge to use and develop Earth systems models.

Description

Water is a critical component of the Earth's ecosystem, particularly in the desert Southwest. Understanding complex hydrologic systems requires the ability to develop, utilize, and interpret both numerical and analytical models. The Defense Waste Management Programs has both experience and technical knowledge to use and develop Earth systems models.

Test Well Drilling in SE New Mexico

Hydrological Modeling

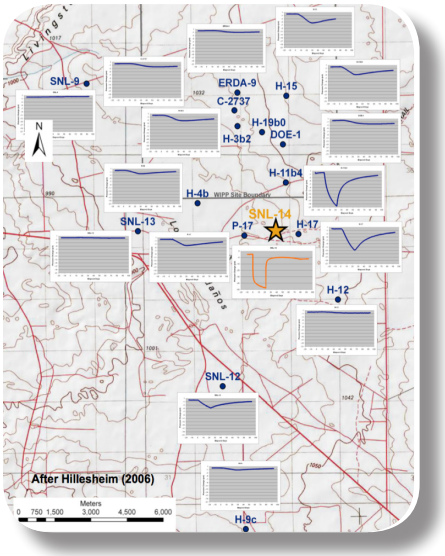
Models are simplified representations of reality, which we accept do not capture every detail of reality. Mathematical and numerical models can be used to rigorously test geologic and hydrologic assumptions, determine relative importance of competing physical processes, and perform "numerical experiments" before installing sensors and collecting real-world data, to maximize return on investment.

Stochastic groundwater modeling in a Monte Carlo framework

Groundwater flow is known to be difficult to characterize in the fractured Culebra Dolomite Member of the Permian Rustler Formation near the Waste Isolation Pilot Plant (WIPP). We have incorporated decades of historic water level, aquifer test, and geologic data into the development and calibration a groundwater model, for the purposes of making regulatory compliance predictions. Beginning with 1000 possible stochastic model realizations, we calibrated over 200 models to observed data, choosing the best 100 calibrated models to represent flow and transport in performance assessment calculations.

Aquifer Test Analysis

More than 100 pumping tests have been conducted in the Culebra and Magenta Members of the Rustler Formation at



Well Locations and responses within the vicinity of WIPP

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the WIPP. Pumping tests are conducted across a large range of scales. Low permeability wells have been characterized using pneumatic slug tests and very low flow (0.1 gal./min.) pumping tests. In higher-permeability regions we have conducted large-scale multi-well pumping tests (42 gal./min. for 21 days), observing pressure responses in dozens of wells up to 15 km away, over the course of several months. We analyze these tests using a wide variety of numerical and analytical simulation tools.

We have experts in both traditional and unconventional well test analysis. Our team has developed and published analytical solutions to well and slug testing problems, we have developed the open-source nSIGHTS well-test simulation package, and we are developing cutting-edge models and techniques to utilize geophysics during well testing to maximize observations at minimal cost. These well-test solutions provide formation hydraulic parameter estimates from observed data, using a wide range of parameter estimation and uncertainty quantification tools, including Markov chain Monte Carlo, Null-space Monte Carlo, and the more standard Marquard-Levenberg algorithm.

We are exploring the use of non-traditional impulses to characterize the flow system at its largest scales. These include natural stimuli tests like observed effects of Earth tides and barometric pressure fluctuations, as well as observed effects due to man-made stimuli beyond our control, including drilling of nearby oil and gas wells and large roof-falls in underlying potash mines.

Publications

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