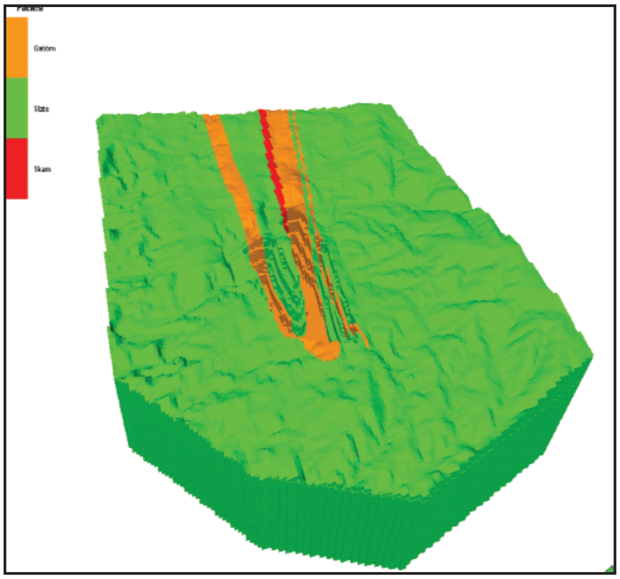
Case Study

Aggregate Quarry Hydrogeologic Investigation

Walltown, Northern California



Mine design incorporated into 3D geological model

Highlights:

- Advanced geophysical logging for fracture characterization
- 3D geologic modeling
- Integrated 3D hydraulic test analysis
- 3D saturated and unsaturated flow simulation

Background

The Schlumberger Water Services team was contracted to conduct a hydrogeologic investigation at a potential future aggregate quarry site located in the western foothills of the Sierra Nevada in Northern California, approximately 30 miles from a major metropolitan area and not far from existing suburban development. To proceed, the mining operation will require significant quantities of process water which, if not available on location, will have to be trucked in at tremendous expense and significant environmental impact. Dewatering wells also required for mining operations may produce significant quantities of water to offset other production requirements; however, the potential effect of excessive groundwater pumping on local streams is unknown.

Challenges

The quarry project will investigate a number of key water issues, primarily:

1. Water supply: How to supply the operational needs of the quarry.
2. Management of excess water: How to dewater the pit during mining.
3. Impact on water resources: What impact will the mining operation have on local/regional ground and surface water and how can adverse impacts be mitigated?
4. Reclamation: What will happen to the abandoned mine pit after decomissioning? Will it fill with water, how fast, and to what level? What will be the water quality of the resulting lake?

The unknown nature of the underlying groundwater system, compounded by the fact that the site has a fractured rock groundwater system creates uncertainty that makes it impossible to answer these questions. The hydrogeologic investigation will reduce this uncertainty, and enable a more robust and defensible mine design and predictions of future water conditions.

About Schlumberger Water Services

We offer innovative groundwater solutions through professional expertise to meet the advancing technological requirements of today's professionals.

Schlumberger's Water Services division specializes in assessing, developing, and managing groundwater resources using some of the finest, advanced and cost-effective technologies available today.

Whether you're looking for field-scale data collection, data management, modeling, or resource decision-making solutions, our teams of specialists are here to help you address all your groundwater projects safely and efficiently.

Applied Technologies:

- Westbay System
- Pressure Profiling
- Discrete Sampling
- Hydraulic Testing

For additional information, contact:

Schlumberger Water Services
980 9th Street - Suite 1480
Sacramento, California
U.S.A 95814
Tel: +1 916 329 9199
Fax: +1 916 329 9191
Email: info@water.slb.com

Case Study: Aggregate Quarry Hydrogeologic Investigation

These predictions will help to develop a mining strategy that is commercially successful while minimizing adverse impact on the environment.

Solution

Installing a water level monitoring network in May 2003, the team deployed Diver groundwater dataloggers in nine wells and at three locations along a nearby creek to monitor water level variations. These probes continuously measured standing groundwater level in the wells and the surface water level at a variable sampling rate up to three hours, as well as electrical conductivity. They routinely downloaded the water level data from the probes by connecting a laptop computer to a direct read cable at the wellhead. The team used this data to generate contour plots of groundwater elevation, and to develop records of the surface water level and electrical conductivity in the creek.

Well testing

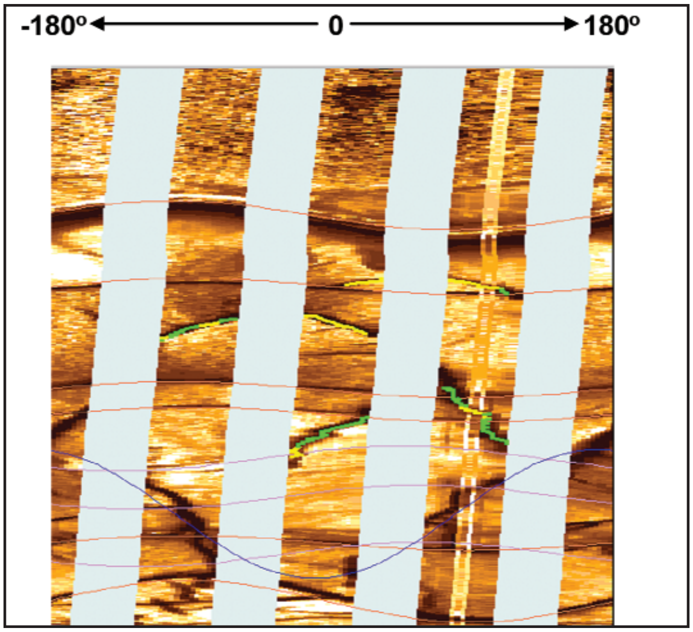
To obtain information about subsurface hydrologic properties, the team performed both medium and high rate well tests. Due to the complex geometry and fractured nature of the intrusion, they could not use analytical techniques to analyze pump test data. Instead, they used Schlumberger's Eclipse Welltest 200 software package to perform 3-dimensional numerical modeling of pump tests, to accurately determine the aquifer's hydraulic properties. Welltest 200 facilitates the creation of 3-dimensional conceptual aquifer models from geologic control data, or import of an existing model. It tightly integrates the conceptual model and Eclipse finite difference simulator. Welltest 200 also provided reliable estimates of hydraulic properties for complex drawdown data from observation wells.

Wireline logging

The team performed advanced borehole wireline logging in five of the existing rotary reverse air wells to obtain depth-specific data about:

- The extent, apertures and orientation of fracturing
- Rock porosity, rock type and mineralogy

The logs were acquired using a suite of poducts including the Formation Micro Scanner (FMS), Electron Capture Spectroscopy (ECS), Induction Resistivity, Neutron, and the RST geochemical log. Spinner logs were also run in 2 wells during pump tests to determine the vertical flow profile. Key information from the FMS log enabled Schlumberger geophysicists to estimate fracture orientation, aperture, and intensity continuously along the borehole. These data, along with whole core laboratory analyses, were used to capture spatial variations in fracture parameters for use in geological modeling.



Borehole geophysical image log allows interpretation of individual fractures

Geologic modeling

From the well data and the project surface geology map, the team constructed a detailed 3D geologic model as the framework for a groundwater flow simulation model for the project. The geologic structure (contacts, faulting, fracture distribution/orientation) greatly impacts the fractured bedrock groundwater system encompassing the site. The geologic contacts determined from drillers logs are represented by surfaces in the model. A detailed 3D grid that conforms to the geologic structure was created and populated with initial estimates of hydraulic conductivity and fracture porosity.

The hydrogeologic investigation is an iterative process. The information will be used to improve the understanding of the hydrogeologic components, in turn enabling refinement of the predictions to the key water issues and, correspondingly, a reduction in their uncertainty.

Results

The work performed by the project team integrated commercial, operational, technical and environmental criteria to develop an optimal mining solution. The information provided by the characterization of the key hydrological components will be used to predict future water conditions through groundwater flow simulation.

Schlumberger WATER SERVICES

Schlumberger Water Services | 980 9th Street - Suite 1480
Sacramento, California, U.S.A 95814 | Ph: +1 916 329 9199 | Fax: +1 916 329 9191 | info@water.slb.com