# Modeling of Stockton University Geothermal System Using COMSOL Multiphysics® and the Subsurface Flow Module

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## Abstract

Introduction:
Stockton University has one of the largest closed loop geothermal system in North America. It provides heating and cooling for about 410,000 square feet of academic facilities. The well field of the geothermal system comprises of a grid of four hundred wells bored to a depth of 130 m over an area of about 11,000 m2. The well field is buried under one of the university's main parking lots. The ground for the well field is composed of three aquifers of saturated sand sandwiched between confining beds and transition layers of sand and clay. Underground water flows in the aquifers at a speed of 3 to 4 in/day. See figure 1 for the details of the well field. Because of the regional climate, the amount of heat delivered to the ground during the hot season is higher than the amount of heat extracted from the ground during the cold season. This can cause the warming up of the ground and may result in long term thermal and biological impacts on the ground and the aquifers.

The Model:
The purpose of this work is to model the temperature variations in the ground due the heating and cooling and project on the long term thermal effect of the system. To capture the heat variation due the underground water flow, the model is stretched to about 500 m beyond the well field in the direction of the underground water flow and includes all ground layers as defined by the hydrogeological analysis of the well field ground. The model is using the COMSOL Multiphysics® Subsurface Module to model the heat transfer in the porous media with Darcy's law to model the underground water flow in the aquifers.

Preliminary Results:
The attached two figures show the steady state results of the model. Figure 2 shows the 3D iso-surface temperature distribution for the modeled region. The small rectangular box in the image is the well field. The underground water flow is along the y-direction. Figure 3 shows the temperature variation on two vertical slices of the modeled region; one at the middle of the well field and the second is close to the edge of the well field. The results are consistent with observed data. We are currently working on adding more details to the model and the time dependent study.

Conclusion:
This study shows the temperature variation and long term thermal effects of Stockton University's geothermal system on the well field region and the surrounding ground. We expect to expand the study in the future to include effects of different boundary conditions as well as transient behavior. This study and the COMSOL model utilized in the study are expected to have an impact on the planning of future large geothermal systems and modeling their long term thermal effects on aquifers and underground water.

## Figures used in the abstract

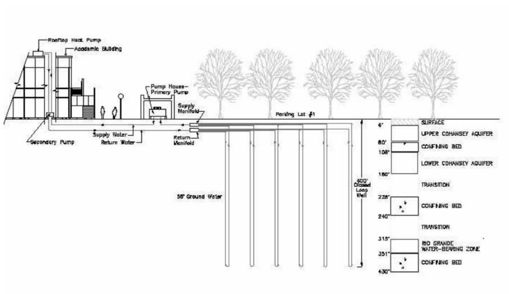

**Figure 1**: The Well Field and the Hydrogeological Details of the Region

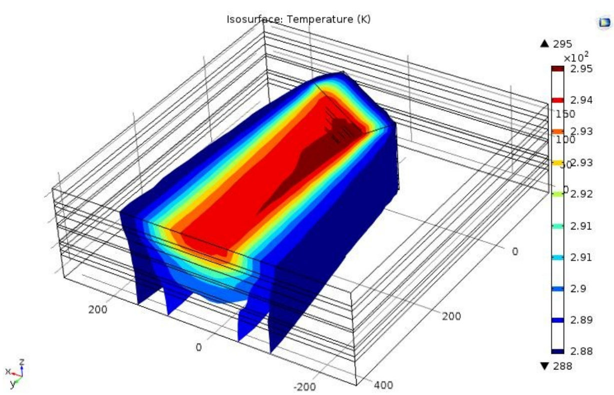


**Figure 2**: 3D Isosurface Temperature Variation in the Model

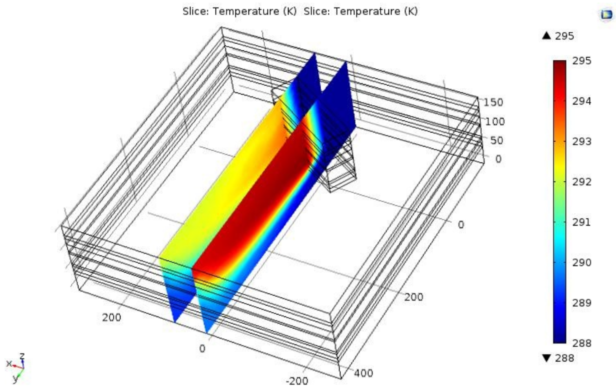


**Figure 3**: Temerature variation on vertical planes; one in the middle of well field and the second at the edge of the field.

**Figure 4**