

## Introduction

Butte County is currently working with the state of California on a plan for the management of conjunctive use of surface and groundwater resources in the county for the state water project. Efforts need to be made to ensure that the proposed state water project operations do not harm county interests. In order to ensure that no county interests are harmed, it is necessary to have a watershed model capable of quantifying impacts of various conjunctive use management scenarios within the county. One of the potential impacts of the proposed conjunctive use project is the depletion of baseflow water for streams. Without aquifer support for the streams, it is possible that the streams can dry up which may impact migrating salmon that use the creeks as spawning grounds. Decreases in streamflow can also impact sediment, nutrient, and pesticide movement in the system. Another potential impact would be changing the flow and hydraulic head in the aquifer to a significant extent. Wells within the county could go dry or could have decreased ability to pump as a result of the pumping for the state water project.

In order to effectively address the concerns of the county, it is necessary to utilize a watershed model to quantify the impacts of various pumping scenarios on county interests. As noted in the progress report, information has been collected on the three watershed models: the USGS PRMS model, the MIKE-SHE model, and the WEHY model. All three models are distributed parameter watershed models that have been used in California. The MIKE-SHE and WEHY models are physically based models while the USGS PRMS model is a conceptual model.

Physically-based hydrologic models are those that are based upon the conservation of mass, momentum and/or energy equations of water flow in various flow

domains. These conservation equations are in general partial differential equations (PDE) that describe the evolution of water flow in time and space over a watershed. Therefore, the hydrologic variables of interest are forecasted by these models not only at the watershed outlet but at any spatial location within a watershed. Since these models use conservation equations, their resulting parameters make physical sense, and are measurable in the field. Therefore, contrary to the lumped, black-box or conceptual hydrologic models which need to be calibrated from historical rainfall-runoff data, the physically-based model parameters can be estimated independently from field experiments. Also, since the physically-based model parameters are based upon physical properties (such as the soil hydraulic conductivity being strongly related to soil texture), it is possible to estimate these parameters from the readily available information on regional soil maps, vegetation, topography, geology and land-use conditions. Consequently, it is possible to utilize the physically-based models for hydrologic forecasting not only in well-gauged watersheds, but also in ungauged or sparsely-gauged watersheds.

In the earlier progress report, it was noted that the USGS PRMS model did not have a detailed enough groundwater model component to adequately simulate the surface-groundwater interaction processes central to Butte County's water resources issues. This point is reiterated here in Table 1 shown below. Table 1 lists the watershed processes, identified in the progress report, that are important to Butte County's water resources. Table 1 below is different from Table 1 in the progress report in that snowmelt has been added as a surface water process since snowmelt impacts aquifer recharge and flooding potential in the county. The representation of the processes listed

in Table 1 by each of the three models is described in later sections of this report.

Information presented in this report on the USGS PRMS model comes from Leavesley et al. (1983). Information on MIKE-SHE comes from Abbot et al. (1986), Bathurst (1986) and DHI (2003). Information on WEHY comes from Chen et al (2004a, b) and Kavvas et al. (2004).

In order to effectively address the water resources development concerns of Butte County, it is important to have a strategy for carrying out any watershed modeling studies. This report starts with such a strategy. Included in this strategy is a prioritization of the elements needed to implement this strategy for Butte County. This allows the work to be carried out in a focused manner. Following the watershed modeling strategy is a work plan that identifies the steps and resources needed for implementing the strategy. In this section, modeling and data needs are identified which provide the framework for the review of the watershed models. Once this framework is in place, a general overview of each model is presented, followed by a detailed comparison of the processes shown in Table 1. From this comparison, the appropriate model to perform the watershed modeling studies for Butte County to address their concerns is identified.