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Modeling change in watershed streamflow, groundwater recharge and surface water – groundwater interactions due to irrigation and associated diversions and pumping

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The impacts of irrigation and associated surface water (SW) diversions and groundwater (GW) pumping on instream flows, groundwater recharge and SW-GW interactions are being examined using a watershed-scale coupled SW-GW flow model. The U.S. Geological Survey (USGS) model GSFLOW (Markstrom et al., 2008), an integration of the USGS Precipitation-Runoff Modeling System (PRMS) and the Modular Ground-Water Flow Model (MODFLOW), is being utilized for this effort. Processes represented in this model include daily rain, snowfall, snowmelt, streamflow, surface runoff, interflow, infiltration, soil-zone evapotranspiration, and subsurface unsaturated and groundwater flow and evapotranspiration. The Upper Smith River watershed, an important agricultural and recreational area in west-central Montana, is being used as the basis for watershed climate, topography, hydrography, vegetation, soil properties as well as scenarios of irrigation and associated practices. The 640 square kilometer watershed area has been discretized into coincident 200 m by 200 m hydrologic response units (for climate and soil zone flow processes) and grid blocks (for unsaturated zone and GW flow processes). The subsurface GW system is discretized into 6 layers representing Quaternary alluvium, Tertiary sediments and bedrock. The model is being used to recreate natural, pre-development streamflows and GW conditions in the watershed. The results of this simulation are then compared to a simulation with flood and sprinkler irrigation supplied by SW diversion and GW pumping to examine the magnitude and timing of changes in streamflow, groundwater recharge and SW-GW interactions. Model results reproduce observed hydrologic responses to both natural climate variability and irrigation practices. Periodic irrigation creates increased evapotranspiration and GW

recharge in cultivated areas of the watershed as well as SW-GW interactions that are more dynamic than under natural conditions.

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