Approaches for Assessing Ground-Water Availability Under Competing Demands and Climate Change


Introduction:

Many areas of the American West struggle with the allocation of diminishing water supplies between growing municipal and agricultural demands. In the Pacific Northwest, surface-water supplies are additionally stressed by increased flow requirements mandated for environmental protection of endangered species. The Yakima River Basin, along with many other basins in the region, is experiencing a rise in abstraction of ground water for irrigation and other uses, and ongoing litigation to describe the influence of ground-water pumping on surface-water flows led to U.S. Geological Survey involvement in a comprehensive assessment of ground water.

A. Basin-Management Tools

- Water balance modeling system (WBS) (Bureau of Reclamation)
- Hydrologic Unit Flow (HUF) package of MODFLOW-2000 (Bureau of Reclamation)
- Precipitation-Runoff Modeling System (PRMS)
- Ecosystem Diagnostic and Treatment Model (EDT)
- 1-D Hydraulic Model (Bureau of Reclamation)
- Monthly Planning Model (Bureau of Reclamation)
- Watershed Models and Watershed and Stream Flow (WRSF)
- Riverware Watershed and River System Management Program (ARSM)
- Constructed with HUF and Stream Flow Routing (SFR) packages

B. Recharge

Model recharge was estimated using process-based watershed models by calculating water balance for 81,667 Hydrologic Response Units (HRUs). For each HRU, model simulated annual accumulation and ablation interactions of precipitation and snow and variations in vegetation, evapotranspiration, surface runoff, infiltration, water storage in the root or soil zone, and recharge.

C. Pumpage

Between 1900 and 2001, 18,728 new wells were drilled in the Yakima River Basin, primarily for agricultural and domestic use.

D. Ground-Water Model Construction

Discretization of subbasin hydraulic units was implemented using the Hydrologic Unit Flow (HUF) package of MODFLOW-2000 (2000), in which threedimensional geologic structure is defined independently from model layer geometry. Multi-flow start transients were utilized as a consistent reporting sequence of hydraulically-conductive zones and low-conductivity confining layer interface.

The Yakima River Basin:

- Area of 6,204 square miles covering eleven counties and the Yakama Nation Reservation
- Three counties and the Yakama Nation Reservation
- Approximately 300,000 people and 600,000 irrigated acres

- Precipitation between 6 and 120 inches per year
- Minimum flow requirements during spawning season conflict with irrigation season.

Climate Models indicate warming temperatures, which will lower flow and reduced late-spring and summer runof.

Climate change impacts will likely increase capture of some flows at storage.

Yakima River Basin:

- Junior surface-water rights (assigned prior to 1906) take precedence over junior surface-water rights.
- Ground-water pumping is predominately from senior users, but are not curtailed like surface-water users.
- The Yakima Nation is exercising its Senior Surface-Water Treaty rights for the protection of endangered species.

Contacts:

Matt Bachmann
U.S. Geological Survey
934 Broadway
SEATTLE, Washington 98122
Telephone (206) 553-1852
Fax (206) 553-1982
mbachmann@usgs.gov
http://www.wa.water.usgs.gov/

Matt Els
U.S. Geological Survey
934 Broadway
SEATTLE, Washington 98122
Telephone (206) 553-1852
Fax (206) 553-1982
mels@usgs.gov
http://wa.water.usgs.gov/

John Vaccaro
U.S. Geological Survey
934 Broadway
SEATTLE, Washington 98122
Telephone (206) 553-1852
Fax (206) 553-1982
jvaccaro@usgs.gov
http://wa.water.usgs.gov/