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Water Budgets for Pine Valley, Carico Lake Valley, and Upper Reese River Valley Hydrographic Areas, Middle Humboldt River Basin, North-Central Nevada—Methods for Estimation and Results

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Table 5. Estimated average annual runoff, evapotranspiration, and subsurface flow from piedmont-slope areas in Pine Valley, Carico Lake Valley, and Upper Reese River Valley Hydrographic Areas, middle Humboldt River Basin, north-central Nevada

[All values rounded to nearest 100 acre-feet per year. Bold symbols (in footnotes) correspond to those used in table 1 and fig. 3. PRISM, precipitation–elevation regressions on independent slopes model (Daly and others, 1994); RAWS, remote automatic weather station; TM, Thematic Mapper]

Hydrographic area	Average annual runoff[1] (acre-feet per year)	Average annual evapotranspiration[2] (acre-feet per year)	Average annual evapotranspiration from vegetated flood plains[3] (acre-feet per year)	Average annual subsurface flow[4] (acre-feet per year)
Pine Valley	0–2,500	306,300–333,800	3,200–4,100	52,500–79,300
Carico Lake Valley	0–700	105,400–107,600	1,100–1,200	21,700–23,400
Upper Reese River Valley	0–3,000	308,100–354,500	10,900–11,700	71,400–110,000

[1] **ROps**, estimated assuming runoff generated in piedmont-slope areas represents 0 to 10 percent of total annual runoff generated in hydrographic area.

[2] **ETps**, evapotranspiration of precipitation and soil moisture estimated as ranging from 10.5 inches per year, which is average rate derived by applying Penman–Monteith equation (Monteith, 1965) to 1987–95 RAWS data, to total precipitation on piedmont slope as simulated by PRISM.

[3] **ETrps**, estimated from Landsat TM data (Nichols, 2000).

[4] From basin-fill aquifer beneath piedmont slope to basin fill in valley lowland (**SFps**), estimated as sum of (1) subsurface flow from bedrock aquifer in mountain block that remains in hydrographic area (**SFmb**), (2) difference between sum of mountain-block runoff (**ROmb**) plus piedmont-slope runoff (**ROps**) and surface-water outflow at hydrographic-area boundary (**SWtot**), (3) difference between precipitation on piedmont slope (**Pps**) and sum of average annual runoff (**ROps**) and average annual evapotranspiration, including that from vegetated flood plains (**ETps** and **ETrps**), and (4) subsurface inflow from adjacent hydrographic areas (**SFin**).

For each basin, PRISM-simulated average annual precipitation values were distributed into four precipitation zones: at least 8 but less than 12 in, at least 12 but less than 16 in, at least 16 but less than 20 in, and at least 20 but less than 34 in. Multiple-regression analysis was used to develop recharge coefficients to describe the relation between precipitation (as independent variable) and ground-water recharge (as dependent variable) in each zone. The regression equation that best approximates this relation (Nichols, 2000) can be written as

$$R_{gw} = 0.008(P_a) + 0.130(P_b) + 0.144(P_c) + 0.158(P_d)\,, \quad (3)$$

where R_{gw} is average annual ground-water recharge based on estimates of ground-water discharge, in acre-feet per year;

P_a is average annual volume of precipitation in hydrographic area in zone of at least 8 but less than 12 in, in acre-feet per year;

P_b is average annual volume of precipitation in hydrographic area in zone of at least 12 but less than 16 in, in acre-feet per year;

P_c is average annual volume of precipitation in hydrographic area in zone of at least 16 but less than 20 in, in acre-feet per year; and

P_d is average annual volume of precipitation in hydrographic area in zone of at least 20 but less than 34 in, in acre-feet per year.

Similar to the original Maxey–Eakin method, this revised relation (eq. 3) assumes ground-water recharge is negligible if annual precipitation is less than 8 in. The recharge coefficients derived by Nichols (2000) for estimating average annual ground-water recharge are applicable only to the distribution of precipitation simulated by PRISM and acquired from G.H. Taylor (Oregon Climate Service, Oregon State University, written commun., 1997).

Mass-Balance Approach

A mass-balance calculation for estimating ground-water recharge yields a budget showing the sources from which ground water is derived. Total ground-water inflow to a basin consists of the sum of recharge derived within each landform and net inflow from adjacent areas that ultimately reaches the saturated basin fill.

Ground-water recharge to bedrock aquifers in the mountain block is from direct infiltration of precipitation or indirect infiltration of runoff. For this investigation, ground-water recharge in mountain-block areas is determined as the residual between estimates of runoff (eq. 1) and water yield (eq. 2).

Beneath piedmont-slope areas, ground-water inflow to the basin-fill aquifer consists of (1) subsurface flow from the mountain block (determined as the residual between estimates of runoff and water yield), (2) the quantity of runoff that originates in the moun-