U.S. DEPARTMENT OF THE INTERIOR
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DOUGLAS COUNTY UTILITY DIVISION

WATER-RESOURCES INVESTIGATIONS REPORT 94-4126
Depth to water, specific yield, and soil characteristics—SHEET 2 OF 4
Maurer, D.K. and Peltz, L.A., 1994, Potential for, and possible effects of, artificial recharge in Carson Valley, Douglas County, Nevada

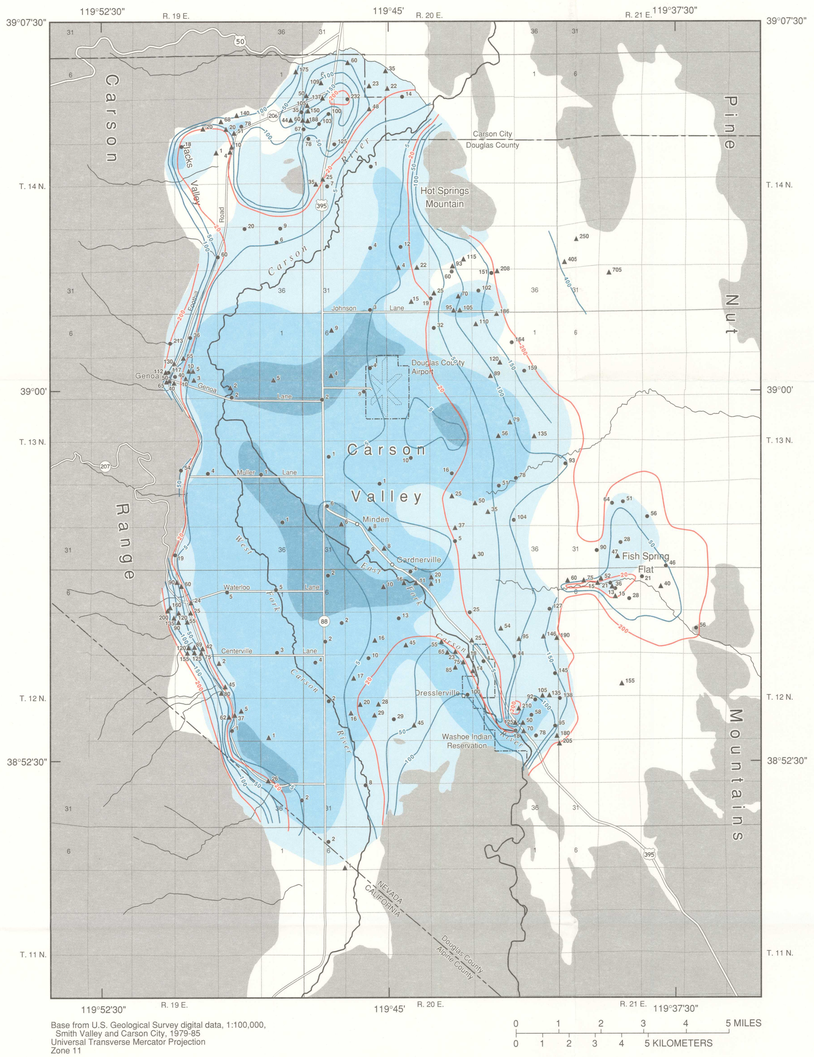

Figure 3. Approximate depth to water and distribution of specific yield. Specific yields are from Dillingham (1980, pl. 2) and were estimated where control points are sparse.

Table 1. Criteria used to define the potential for artificial recharge (shown in figures 5-8)

[Symbols: >, greater than; <, less than; —, not applicable for injection]

Method of recharge	Potential for recharge	Map reference	Criteria: Depth to water (feet below land surface)	Criteria: Specific yield (percent)	Criteria: Infiltration rate (inches per hour)
Infiltration	high	figure 5	20 to 200	>10	6 to 20
	moderate	figure 6	20 to 200	>10	2 to 6
	low	figure 7	20 to 200	<10	0.2 to 6
Injection[1]	high	figure 8	<20	>20	—
	moderate	figure 8	<20	10-20	—
	unknown	figure 8	>200	unknown	—

[1] Infiltration is preferred for depths to water of 20 to 200 feet.

Depth to Water

Recharge by infiltration is considered feasible where depth to water is from 20 to 200 ft below land surface (table 1). In Carson Valley, where depth to water is less than 20 ft, ground water is most likely to discharge by evapotranspiration or leak to streams and ditches. Also, most flowing wells that tap semiconfined aquifers are located where depth to water is less than 20 ft. Thus, depth to water of 20 ft or less is a general indicator of discharge areas and may indicate the presence of semiconfined aquifers. As discussed previously, 10 to 20 ft is considered a minimum depth to water to allow supplemental ground-water storage above the water table. Also artificial recharge by infiltration is most efficient in areas of natural recharge and maximum specific storage. For these reasons, a depth to water of 20 ft was selected as the minimum for efficient recharge by infiltration in Carson Valley.

Where depth to water is great, recharge can be lost in perched or partially saturated zones above the water table. On the basis of observed changes in water levels in response to infiltration, Maurer and Fischer (1988, p. 24) estimated a travel time of about 30 to 60 days for water to percolate about 200 ft to the water table beneath an alluvial fan near Carson City. From 40 to 60 percent of the infiltrated water was estimated to have reached the water table (Maurer and Fischer, 1988, p. 27). Consequently, a depth to water of 200 ft below land surface was selected as a maximum for efficient artificial recharge through infiltration.

Recharge by injection is considered feasible where depth to water is less than 20 ft, although semiconfined conditions might limit the volume that can be injected. Also, because shallow depth to water indicates an area of natural discharge, water may be lost to evapotranspiration and by seepage to the surface-water system. However, with increased pumping, injection might provide a means to maintain pressure head over large parts of the valley floor where flowing wells are the source of domestic and stock water.

EXPLANATION

SPECIFIC YIELD OF BASIN-FILL DEPOSITS

- Greater than 20 percent
- 15-20 percent
- 10-15 percent
- Less than 10 percent
- CONSOLIDATED ROCK

DEPTH TO WATER

- —100— Line of equal depth to water. Interval, in feet below land surface is variable. Approximately located
- —200— Line of equal depth to water, in feet below land surface, used as criterion for recharge potential. Approximately located
- Depth to water, in feet below land surface. Circle, measured by U.S. Geological Survey; triangle; reported by well driller

Where depth to water is greater than 200 ft, recharge by injection is probably more efficient than recharge by infiltration. However, few wells exist in areas where depth to water is greater than 200 ft, and subsurface data are sparse for those areas. Thus, the storage capacity, hydraulic conductivity, and potential for recharge are largely unknown.

Where depth to water is from 20 to 200 ft, recharge by injection is feasible but costly compared to infiltration. In these areas, the potential for recharge by injection is greater where specific yield is greatest.

The approximate depth to water in Carson Valley is shown in figure 3. Control points are a combination of measurements made by the U.S. Geological Survey from 1981 to 1991 and depths reported by drillers after well construction. The depths are approximate because of seasonal fluctuations in water levels (Maurer, 1986, p. 22) and the probability that not all water levels reported by drillers are from fully developed wells that accurately reflect the standing water level in the surrounding aquifer.

Specific Yield

Specific yield depends on grain size, sorting, consolidation, and cementation of aquifer materials. Data on sorting, consolidation, and cementation of aquifer materials in Carson Valley are not available; however, 260 lithologic logs reported by well drillers were used by Dillingham (1980, pl. 2) to estimate specific yield for the upper 400 ft of basin-fill sediments in Carson Valley (fig. 3).

Using the specific-yield value of 10 percent reported by Mitten (1982, p. 10) as a limit for infiltration systems, areas where specific yields of aquifers are greater than 10 percent are estimated to have high to moderate potential for recharge. Where specific yields are less than 10 percent, potential for recharge is estimated to be low.

For injection systems, areas where specific yields of aquifers are greater than 20 percent are estimated to have high potential for recharge. Where specific yields are 10 percent to 20 percent, potential for recharge is estimated to be moderate. In areas where specific yields are less than 10 percent, the depth to water is generally from 20 to 200 ft below land surface and recharge by infiltration is probably the most efficient method.

Infiltration Rate

Soils in Carson Valley have been mapped by the U.S. Soil Conservation Service and divided into hydrologic groups with fast, moderate, slow, and very slow infiltration rates for the upper 60 in. of sediment (fig. 4) (U.S. Soil Conservation Service, 1983, p. 209 and table 15). The U.S. Soil Conservation Service (Jim Doty, written commun., 1991) supplied digitized soils data that are described by the U.S. Soils Conservation Service (1983). These infiltration rates are used in this study to subdivide areas where depth to water is 20 to 200 ft below land surface into areas with high, moderate, and low potential for recharge by infiltration. Areas where specific yield is greater than 10 percent and infiltration rates are rapid (6 to more than 20 in/h) are estimated to have high potential; areas where specific yield is greater than 10 percent and infiltration rates are moderate (2 to 6 in/h) are estimated to have moderate potential; and areas where specific yield is less than 10 percent and infiltration rates are slow to very slow (0.2 to 6 in/h) are estimated to have low potential. The ranges of infiltration rates are approximate and they overlap because they vary for each soil type from place to place and for different soil layers. For example, soils that are classified as having slow infiltration rates could have layers with rates as high as 6 in/h, but have a slow infiltration rate over the entire 60 in. of soil depth. Soils that have shallow impermeable layers of clay or zones of indurated or cemented sediments in the upper 2 to 3 ft would require excavation for recharge by infiltration (fig. 4). The assumption that percolation rate varies with infiltration rate may be inaccurate at some sites. For this reason, a site-specific investigation would determine the actual rate of percolation to the water table before construction of an operational site.

EXPLANATION

- RAPID INFILTRATION RATE (6 to 20 inches per hour)
- RAPID INFILTRATION RATE BENEATH SHALLOW IMPERMEABLE LAYERS (6 to 20 inches per hour)
- MODERATE INFILTRATION RATE (2 to 6 inches per hour)
- MODERATE INFILTRATION RATE BENEATH SHALLOW IMPERMEABLE LAYERS (2 to 6 inches per hour)
- SLOW TO VERY SLOW INFILTRATION RATE (0.2 to 6 inches per hour)
- SLOW TO VERY SLOW INFILTRATION RATE BENEATH SHALLOW IMPERMEABLE LAYERS (0.2 to 6 inches per hour)
- BASIN-FILL DEPOSITS NOT CLASSIFIED IN THIS FIGURE AS TO INFILTRATION RATE
- CONSOLIDATED ROCK

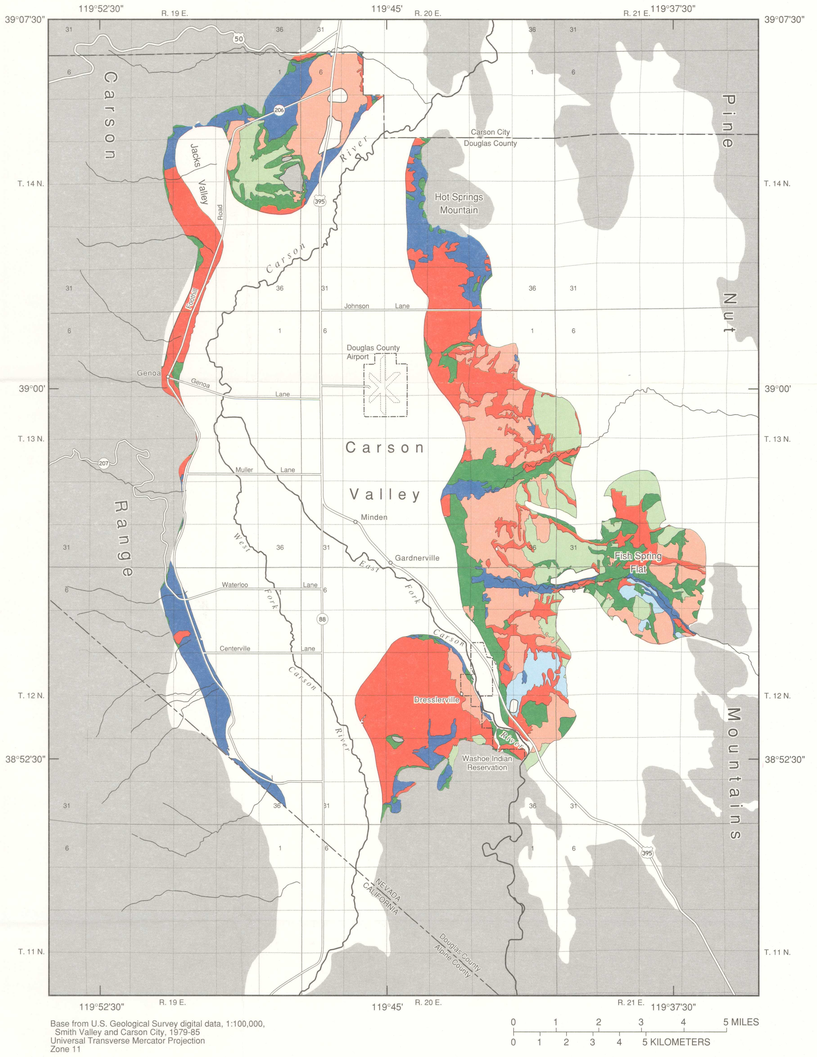

Figure 4. Distribution of soils with rapid, moderate, and slow to very slow infiltration rates in Douglas County. (From U.S. Soil Conservation Service, l983, table 15.) In these areas, depth to water is 20 to 200 feet below land surface and unconsolidated sediments are exposed. Shallow impermeable layers (in the upper 2 to 3 feet of soil) would need excavation for recharge by infiltration.

POTENTIAL FOR, AND POSSIBLE EFFECTS OF, ARTIFICIAL RECHARGE IN CARSON VALLEY, DOUGLAS COUNTY, NEVADA

By

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1994

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