HYDROLOGIC IMPLICATIONS OF GREATER GROUND-WATER RECHARGE TO LAS VEGAS VALLEY, NEVADA

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$$r_e = 0.05(P)^{2.75} \quad (5)$$

Except where the precipitation is less than 8 inches (0.67 feet), where $r_e = 0$ and is greater than 20 inches (1.67 feet), and where $r_e = 0.25$. The amount of recharge for each precipitation value is:

$$r_i = (P)(r_e) \quad (6)$$

and the total amount of natural recharge is:

$$R = \Sigma(r_i)(A_i) \quad (7)$$

where r_e = natural recharge efficiency, P = precipitation in feet per year, r_i = recharge in feet per year, R = total natural recharge in acre-feet per year, and A_i = area in acres.

The mathematical approximation of the Maxey-Eakin efficiencies calculates about 3 percent less natural recharge than if the traditional methods and the Maxey-Eakin efficiencies (Table 3) are used. The mathematical approximation approach slightly overestimates natural recharge at lower precipitation values and slightly underestimates natural recharge at higher precipitation values. Additionally the mathematical treatment allows for rapid input in the ground-water model and potentially eliminates calculation errors.

GROUND-WATER RECHARGE

Only a small percentage of the precipitation in any valley becomes natural recharge. Estimates of this natural recharge efficiency percentage for LVV vary by author (Table 3). If Maxey and Jameson's (1948) recharge efficiencies are used with the area-altitude-precipitation tables for this study, the total ground-water recharge is about 65,000 afy, or about double the published amounts. This estimate was eliminated as too large, because the discharge is significantly less. If either the standard Maxey-Eakin efficiencies or the mathematical approximation developed for this study are used with the area-altitude-precipitation tables generated for this study, the total amount of recharge estimated is about 51,000 afy – within the confines of the Las Vegas Valley Hydrographic Basin as defined by Rush (1968). This is an area smaller than that described by Maxey and Jameson (1948) and Malmberg (1965), but identical to the area described by Harrill (1976) and Morgan and Dettinger (1994). Table 4 summarizes this analysis.

The form of the Maxey-Eakin efficiency technique was rewritten as an equation for use in conjunction with the precipitation estimation technique; however, the underlying assumptions are identical. These efficiencies were used so the results calculated from the new precipitation estimates could be compared to previous investigations. The true rate of natural recharge is, of course, dependent upon a large number of factors including, but limited to vegetative cover, lithology of the soil or rock, wind speeds, and insolation. The conditions for natural recharge in LVV are probably close to optimal to retain the maximum amount of recharge – the recharge occurs at high altitude in predominately carbonate terrain. Thus the Maxey-Eakin efficiencies may actually be conservative. Investigation of the true recharge efficiencies would be a fruitful area for future researchers but beyond the scope of this study.

Within the boundary defined by Rush (1968), approximately 51,000 afy is considered the best estimate of natural recharge (compared to the discharge at 47,000 afy), although this technique may overestimate the natural recharge in two areas – La Madre Mountain and the western slope of the Sheep Range. La Madre Mountain is a spur of the Spring Mountains transverse to the main axis of the range between Red Rock and Kyle Canyons. The distal part of this spur may not receive as much precipitation as would be indicated by elevation because, according to Piper (1969), precipitation decreases on the leeward side of mountain blocks as the distance from the mountain crest increases (a rain shadow effect). Although part of the western slope of the Sheep Range is included in the Las Vegas Valley Hydrographic Basin boundary of Rush (1968), Winograd and Thordarson (1975:C89-90) suggested that ground-water flow from this area is to the west, away from LVV, and this study assumed the ground-water flow is to LVV.

Alternatively the natural recharge may be higher because this investigation assumed a maximum recharge efficiency of 25 percent (similar to the Maxey-Eakin method), and this assumption may be unwarranted. Additionally, the regression line developed for Kyle Canyon (Figure 4) underpredicts the precipitation at the two highest altitude stations and, therefore, precipitation at or above this altitude may be higher than predicted in this investigation.

Ivanpah Valley is topographically higher than, and ground-water flow is tributary to, LVV (Glancy, 1968:30). The altitude-precipitation relationship for this area is similar to the west side of the Spring Mountains, and when the Maxey-Eakin efficiencies are applied to Ivanpah Valley it yields about 6,000 afy of ground-water recharge. This brings the total natural recharge for LVV to about 57,000 afy.

A recent geochemical investigation using stable and radioactive isotopes (Pohlmann *et al.*, 1998) of