Appendix U. Efflorescence Persistence

Since the surface of Mono Lake was lowered by diversion of the tributary streams, large areas of the relicted lands have exhibited ongoing salt efflorescence. The persistence of efflorescence around much of the eastern lakeshore is a limiting factor to the colonization of relicted lands by plants and to the eventual reduction in severe dust storms. Because inflowing saline groundwater from basin sediments is the probable cause of efflorescence, an estimate of the time required for the groundwater table to equilibrate with the drawn-down lake surface can provide a reasonable order-of-magnitude estimate of its duration.

ESTIMATE OF GROUNDWATER RESPONSE PERIOD

A simple model of the groundwater in the basin sediments can be developed and applied for this purpose (Figure U-1) although the sediments are, in fact, a complex sequence of aquifers and aquitards. Assuming the lowering of the lake surface by 41 feet must be followed by a similar lowering of the water table near the lake, with a gradual lessening of the water table lowering toward the upper edge of the adjacent basin sediments, the volume of water (per unit cross-sectional area) to be drained in this wedge is:

0.5 x 41 ft x 4-8 miles x average sediment specific yield

The specific yield of silts, which make up the bulk of the observed lakebeds (LaJoie 1966), is generally about 20-35% (Davis and DeWiest 1966). A value of 30-45% holds for fine sands.

The rate at which groundwater drainage occurs (per unit cross-sectional area) is proportional to the slope of the groundwater table (where unconfined), as well as to the transmissivity (K) of the medium. Measured groundwater slope at a piezometer transect near Ten-Mile Road is now about 0.8% (NAS 1987), and the groundwater levels estimated several miles east of the lake suggest an average water table slope to the lakeshore of 0.6% (Lee 1969).

Transmissivity of sediments can vary substantially, but a range of average values can be estimated. Transmissivities of silts have been reported as 0.2-0.3 darcys, or 10^{-5} feet per second (Davis and DeWiest 1966). In order-of-magnitude terms, clayey sands and fine sands have transmissivities of 10^{-5} to 10^{-8} feet per second, as opposed to higher values for "clean sands" (Davis and DeWiest 1966). A transmissivity of 10^{-5} feet per second can therefore be used as the maximum estimated value.

The time period for equilibration is obtained from the water volume drained divided by the average discharge rate. The formula thus becomes:

T(sec) = [specific yield (%) s discharging sediment distance (ft)]/
[transmissivity (ft/sec) X averange slope (ft/ft)]

(where factors of 0.5 in both unit volume and average discharge rate cancel.)

Employing the values for these variables described above, recognizing the groundwater slope after equilibration will be only slightly greater and using the fact that 1 year = 3.1×10^7 sec, the calculated equilibration period is:

T (yrs) = 3,500-7,000 years

Because of the uncertainty in assumed transmissivity, the uncertainty of this estimate is probably one order of magnitude.

It is concluded that the efflorescence process initiated by the drawdown of Mono Lake by stream diversions will persist for at least hundreds of years. During this period, the band of efflorescence will gradually narrow toward the current shoreline, gradually allowing the higher elevations to support vegetative colonization.

CITATIONS

Printed References

Davis, S. N., and R. J. M. DeWiest. 1966. Hydrogeology. John Wiley and Sons. New York, NY.

LaJoie, K. R. 1968. Quaternary stratigraphy and geologic history of Mono Basin, Eastern California. Ph.d. dissertation. Department of Geology and Geophysics, University of California. Berkeley, CA.

Lee, K. 1969. Infrared exploration for shoreline springs, a contribution to the hydrogeology of Mono Basin, California. Ph.D. dissertation. Stanford University. Stanford, CA.

Mono Basin Ecosystem Study Committee of the National Research Council, National Academy of Sciences. 1987. The Mono Basin ecosystem: effects of changing lake level. National Academy Press. Washington, DC.

NAS. 1987. See Mono Basin Ecosystem Study Committee of the National Research Council, National Academy of Sciences.