65a

VOL.97 NO.HY9. SEPT. 1971

JOURNAL OF THE HYDRAULICS DIVISION

PROCEEDINGS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852 methods as being desirable to match observed data to a probability distribution function and say that the usual method of moments estimation (a fourth method which was used in the original paper) is too inefficient. The discussers show in their tables that a rather large discrepancy results when the method of moments estimation is compared with a best linear invariant estimation. Thus the writers agree with the discussers' statement that "from the preceding discussion, it should be evident that the ordinary methods of analysis such as the methods of moments estimation should not be used for small samples in the presence of possible outliers. A solution using maximum likelihood estimation, best linear unbiased estimation, or best linear invariant estimation methods with and without censoring from above or below, or both, may be necessary for a model selected."

The gamma distribution values shown in Tables 12 and 13 of the discussers' work have been verified. The original computer printout and program are lost, so the values in Tables 6(*a*) and 6(*b*) cannot be checked.

The inclusion or exclusion of outliers in sampled data in fitting probability distributions to the data is worthy of additional investigation and comment. Although some point does not fit the distribution selected, the writers feel this is not justification for deleting it from the sample. It would seem that an objective technique is needed to minimize the importance of the point in the selection of a distribution. Thus, for the example in question where the 1960 storm was so unusual, it might better be indicative of what to expect once in 50 yr and accordingly its value in fitting the distribution should perhaps be reduced. The writers are at a loss to suggest an objective method for accomplishing this, but perhaps Brown and Sammons have some ideas. The reductions in the 100-yr storm by censoring some of the outliers is fantastic.

Table 14 shows that the peak discharge for the 100-yr recurrence interval is reduced by 52 % (from 9,492 cfs to 5,581 cfs) by eliminating the 1960 storm from the log-Pearson Type III distribution. By the same reasoning, eliminating the dry year peak discharge of 1963 increases the 100-yr recurrence interval storm by 81 % (from 9,492 cfs to 17,193 cfs).

The computations of Tables 14 and 15 add still another valuable frequency estimate method to those presented in Table 6 of the original paper.

The comment at the bottom of Table 14 pertaining to Col. 6 undoubtedly has an error. The 1960 data were undoubtedly the other year censored in this computation in addition to the stated 1963 and 1966 data.

Errata.—The following corrections should be made to the original paper:

Page 780, Table 6(*a*), Col. 5, last line: Should read 6,550 instead of 6,650
Page 780, Table 6(*b*), Col. 6, last line: Should read 4,050 instead of 4,500
Page 780, Table 6(*b*), Col. 8, line 5: Should read 250 instead of 205

small, the D-F concepts are no longer true. From field experiments, it has been shown that the D-F well-discharge formula for unconfined flow is reasonably true when the radial distance from the well is greater than $1.5h$. The discrepancies between Higgins' experimental data and the writer's exact solution are not surprising, as the writer's solution was obtained with the assumption that the D-F concepts hold for all x and t. As the variables x and t decrease, the D-F assumptions no longer hold, as is clearly depicted in Fig. 8 in Higgins' discussion.

The Hele-Shaw model has been proved to be analogous to flow in a saturated porous medium (13). For a coarse porous medium, the capillary fringe above the water table may be ignored and therefore the use of Todd's Hele-Shaw model experimental data to verify the exactness of the writer's solution is quite reasonable.

Appendix.—References.

24. Babbitt, H. E., and Caldwell, D. H., The Free Surface Around and Interference Between Gravity Wells, University of Illinois, Bull. No. 30, Series No. 374, Vol. 45, Jan. 1948.
25. Boulton, N. S., The Flow Pattern Near a Gravity Well in a Uniform Waterbearing Medium, J. Instr. Civl. Engrs. Vol. 36, p. 34, Dec., 1951.
26. Davis, S. N., and DeWiest, R. J. M., Hydrogeology: Chapter 6, New York, John Wiley and Sons, pp. 183, 1966.
27. Hantush, M. S., On the Validity of the Dupuit-Forchheimer Well-Discharge Formula, Journal of Geophysical Research, 67: 2417-20, 1962.
28. Peterson, D. F., Jr., O. W. Israelson, and E. V. Hansen, Hydraulics of Wells, Utah Agr. Exp. Sta., Bull. 351,1952.