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### **Safety Evaluations of Hidden Dam – Seepage Models meet Reality**

Hidden Dam is a 180-ft high zoned earthfill embankment built by the U.S. Army Corps of Engineers (USACE) in 1975. Significant seepage was first documented in the right abutment of the dam in 1978 during the first filling of the reservoir. Seepage areas have been reported during most “high pool” inspections and the problems appear to enlarge with each subsequent event. Observation wells at the downstream toe indicate that water pressures in the foundation are significantly higher than estimated during the design. Seepage evaluations were completed by Harry Cedergren in 1980. Using a hand-drawn flow net, Cedergren estimated upward seepage exit gradients along the downstream toe to be in excess of 0.7. The Screening Portfolio Risk Assessment completed by USACE in 2006 classified Hidden Dam as DSAC II (Dam Safety Action Class). Seepage and piping through dam foundation was the primary potential failure mechanism identified at Hidden Dam.

To evaluate seepage-related issues at Hidden Dam, the authors completed a study that included site explorations, instrumentation installation, a laboratory testing program, and seepage analyses at several representative cross-sections. The study concluded that weathered granitic foundation at the site is very complex and variable. Approximating actual seepage flow regime with computer models proved to be a challenge. Thirty years of instrumentation records and well-documented visual observations provided an opportunity for extensive calibration. On the other hand, the vast amount of data made it difficult to approximate multiple, often conflicting, trends. Variable foundation conditions further complicated the process. This paper will discuss the approach to seepage analyses and model calibration. Computer models were ranked by their ability to simulate the observed behavior under various loading conditions. In addition, a series of sensitivity analyses were performed to simulate variations in the cross-section characteristics and properties. The original model developed by Cedergren was modified to include rock fracture flow and a confining layer. Once the models had been sufficiently calibrated, seepage analyses were performed for the pool at a 300-year flood and the probable maximum flood levels to make an initial estimate of seepage pressures and exit gradients for future risk evaluations.