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Flood Risk Management Utilizing Levee Fragility Curves

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Managing and prioritizing flood risk for urban basins protected by earthen levees can be accomplished in various ways including: (1) physical monitoring of weaknesses during major events and focusing “flood fighting” efforts at the worst locations, (2) expert opinion elicitation of individuals with institutional knowledge of past performance and problematic areas, and (3) geotechnical assessment of levee fragility to ascertain stage-risk relationships for levee performance.

This paper focuses on implementation of the third approach, which uses known geotechnical failure modes and associated engineering properties to determine their influence on levee performance in containing flood flows while maintaining geometric integrity. This paper describes the process of developing and using fragility curves to: (a) prioritize problematic segments of the levee system, (b) identify critical locations requiring immediate or expeditious attention, (c) classify the nature of the vulnerability (seepage, stability, external erosion, or combination of any/all of these), and (d) provide a guidance tool in the decision process to mitigate or remediate vulnerabilities and performance deficiencies.

Derivation of levee fragility curves requires data collection and geotechnical evaluation of seepage, erosion, and slope stability. Data is collected to characterize the stratigraphy of the levee foundation soils and past flood performance. Geotechnical analyses evaluate the levee prism against a range of water stage loadings. The historical performance records are used to calibrate the analyses results.

By identifying the likely nature of the vulnerabilities (seepage, stability, external erosion, or combination of deficiencies) and the severity of the deficiencies, fragility curves provide planners, decision makers, and engineers with a risk-performance tool to quickly identify and prioritize problematic levee segments and provide the ability to compare the effectiveness of different mitigation measures.