

The Applicability of Filter Compatibility Evaluation Procedures for Existing Embankment Dams - Hearthstone Lake Dam Case Study and General Evaluation and Design Considerations

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Filter gradation evaluation procedures, such as the NRCS NEH, Part 633, Chapter 26 'Gradation Design of Sand and Gravel Filters,' were developed as a design basis for new embankment filters. However, these procedures are often utilized to evaluate existing embankment filters and can lead to overly-conservative conclusions. This paper highlights an existing zoned embankment that was determined to have satisfactory filter compatibility between embankment zones despite not meeting NRCS NEH requirements for filter design, and presents general considerations for evaluation of existing filters.

Hearthstone Lake Dam was constructed in the mid-1960s in Augusta County, Virginia, under the administration of the USDA-SCS. Virginia NRCS developed a 95% design to upgrade the dam to meet current NRCS seismic stability criteria and address several operational and maintenance needs. The NRCS National Design, Construction & Soil Mechanics Center (NDCSMC) performed an independent review of the design and identified potential issues with filter compatibility between and internal instability of multiple embankment zones, raising concerns about possible internal erosion failure modes.

Based on the results of their filter compatibility evaluation performed using available original investigation and design information, the NDCSMC recommended that a chimney filter drain be installed in the dam to collect seepage and prevent the potential progression of internal erosion of the embankment zones and foundation soils. The proposed full-height chimney drain was estimated to increase the rehabilitation construction costs by about 500%.

Schnabel Engineering was retained to perform a subsurface exploration to characterize the embankment, evaluate the filter compatibility of the various embankment zones, and design the modifications. The filter compatibility analyses, which were completed in accordance with NRCS NEH procedures, demonstrated that the embankment zones generally met NRCS filter compatibility requirements. However, the materials did not meet other NRCS requirements, such as uniformity and maximum particle size. These criteria are required of new filters to prevent gap grading and segregation of the filter material during placement. The potential for segregation did not exist because the embankment was already in-place, and the results of the subsurface exploration indicated that signs of gap grading were not generally present. In addition, no apparent signs of internal instability were observed during the structure's lifetime. As a result, a full-height chimney drain was determined to be unnecessary. A toe drain to replace the existing rockfill toe was installed to provide an adequate filter for the embankment and foundation soils. The resulting construction cost savings exceeded \$2M.