ENVIRONMENTAL
Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

29 Hazen Drive, Concord, New Hampshire 03301 • (603) 271-3503 • www.des.nh.gov

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# Typical Failure Modes of Embankment Dams

Failures of earthen embankment dams or dikes can generally be grouped into three classifications: hydraulic, seepage, and structural.

## Hydraulic Failures

Hydraulic failures from the uncontrolled flow of water over and adjacent to the embankment are due to the erosive action of water on the embankment slopes. Earth embankments or dikes are not normally designed to be overtopped and therefore are particularly susceptible to erosion. A well vegetated earth embankment or dike may withstand limited overtopping if its top is level and water flows over the top and down the face in an evenly distributed sheet without becoming concentrated in any one area.

Hydraulic failures may be related directly or indirectly to the following:

- *Overtopping* - Discussed above
- *Wave Erosion* - Notching of upstream face by wave action reduces the embankment cross section thickness and weakens embankment material.
- *Top Erosion* - Erosion of downstream toe of the earth slope caused by misdirected spillway outlet discharge.
- *Gullying* - Rainfall erosion of embankment slopes. Also caused by traffic from people and vehicles.

## Seepage Failures

Most embankments exhibit some seepage. However, this seepage must be controlled in velocity and quantity. Seepage occurs through the earthen embankment or dike and/or through its foundation. Seepage, if uncontrolled, can erode fine soil material from the downstream slope or foundation and continue moving towards the upstream slope to form a pipe or cavity to the pond or lake often leading to a complete failure of the embankment. This action is known as “piping.” *Seepage failures account for approximately 40 percent of all embankments or dike failures.*

Seepage can also cause slope failures by saturating the slope material, thereby weakening the adhesive properties of the soil and its stability. Burrows or holes created by animals such as the groundhog, woodchuck, or muskrat create voids in the embankment or dike, which weaken the structure and may serve as a pathway for seepage.

Tree roots can provide a smooth surface for seepage to travel along. When trees die, their decaying roots may leave passageways for seepage to concentrate in. Pipes through the embankment may also provide smooth surfaces for seepage to concentrate along as well.

Structural Failures

Structural failures involve the separation (rupture) of the embankment material and/or its foundation. This type of failure is more prominent in large embankment dams. However, it is not exclusive to large dams and similar occurrences may be seen on earthen embankments or dikes in New Hampshire. Structural failure of an earthen embankment may take on the form of a slide or displacement of material in either the downstream or upstream face. Sloughs, bulges, cracks or other irregularities in the embankment or dike generally are signs of serious instability and may indicate structural failure.

Other

Tree growth on an earthen embankment or dike can be a contributing factor in the failure of an earthen structure and part of any one of the three previously described type of failures. Tree growth directly on the crest or top of the structure could lead to a hydraulic failure should the tree be blown over. This may displace embankment material within the root ball creating a low area susceptible to flows from the impoundment. Tree root systems may also create seepage paths through an earthen embankment or dike and structural failure of an upstream or downstream slope could occur with the displacement of a large tree implanted within the earth slope.

For more information relative to the design, construction, maintenance and operation of dams, please contact the DES Water Division Dam Bureau at (603) 271-3406 or email damsafety@des.state.nh.us. General information is available at www.des.nh.gov/Dam/. You may also visit our office at 29 Hazen Drive in Concord, New Hampshire.