

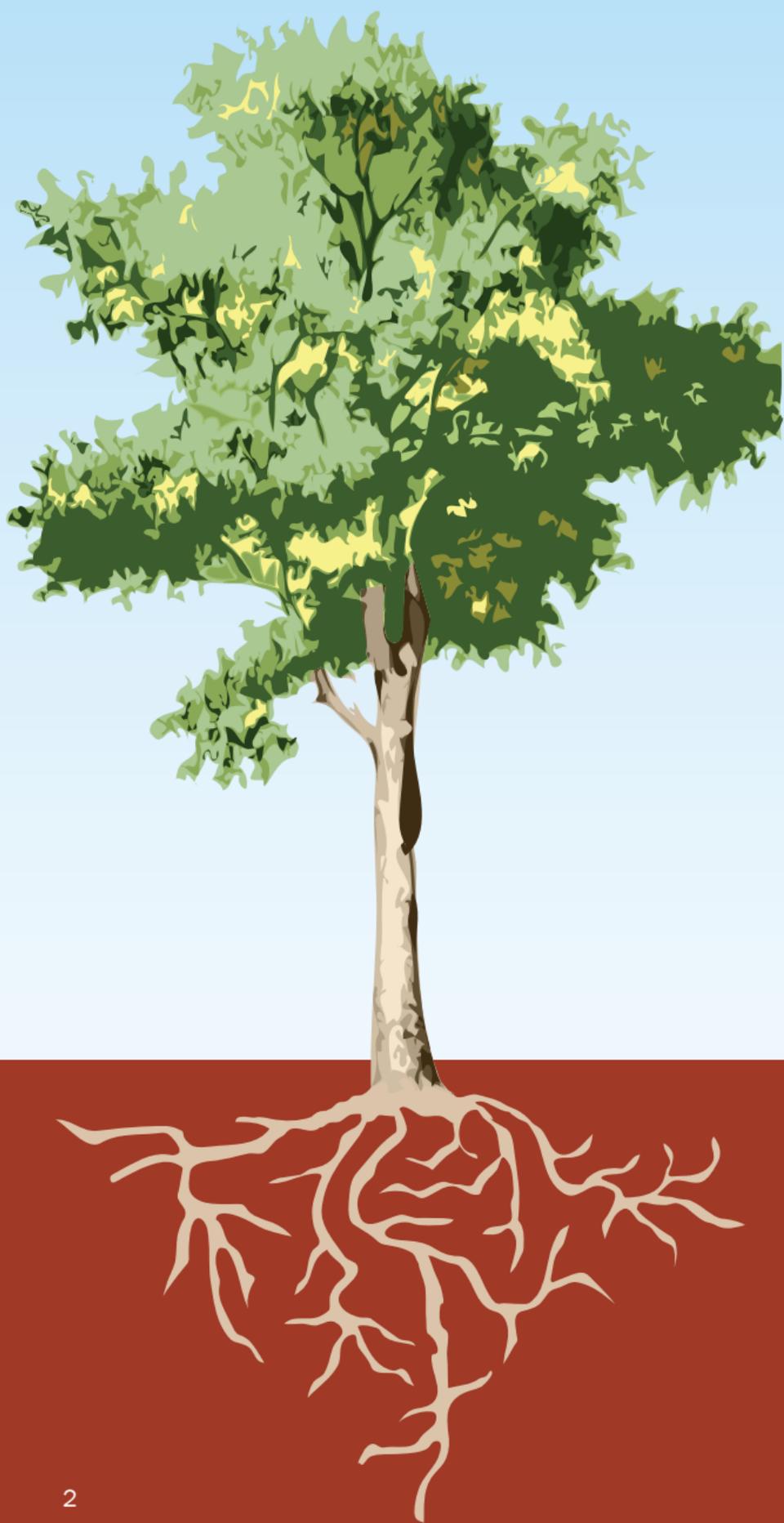


Dam Owner's Guide To Plant Impact On Earthen Dams

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Introduction

The Trouble With Trees

One would not have to look further than down one's own street to appreciate the benefits of trees. From shade to habitat, urban wilderness to visual interest, communities nationwide are enhanced by the enduring presence of trees. While trees enhance most corners of a community, it is important to understand their limitations, especially relating to earthen embankment dams. Located on dams, trees and other woody vegetation that would otherwise bring charm to a city park could interfere with adequate inspection or safe operation of dams, or even cause dam failure.

Private landowners and state and federal agencies use earthen embankment dams as reservoirs to store water for farm and city water supplies, hydropower, navigation, and recreation. Earthen embankments are also used as wastewater lagoons. Composed of compacted earthen fill and often near water sources, embankment dams are naturally conducive to vegetation growth. As such, a troublesome condition can arise if problem vegetation, such as trees, brush,



Tree roots distress an emergency spillway sidewall.

ivy, and other deep-rooted plants, become established. Out of 48 states, 29 document problem vegetation as the cause of dam failures or unsafe dam operations in their states. The U.S. Army Corps of Engineers, the National Park Service, and the Natural Resources Conservation Service document several similar cases at the federal level. State dam safety officials and other experts agree that trees and woody plants on dams are a major concern, one which can cause substantial and costly damage if not properly dealt with.

You, the dam owner, are the first line of defense towards the appropriate maintenance and safe operation of dams nationwide. Towards these goals, this brochure was developed to inform federal, state, and private dam owners on the dangers and identification of problem vegetation on earthen embankment dams. This brochure describes how problem vegetation can adversely affect dams and offers dam owners a quick quiz to determine whether their dam may be at risk for problems related to inappropriate vegetation.

Some states estimate that trees are present on 90–95% of their regulated earthen dams and on a substantial number of their smaller, unregulated dams.



A disappearing act: inappropriate vegetation overgrows an embankment dam, now obscured.

The Roots Of The Problem

Trees and brush rely on an extensive root system to provide oxygen, nutrients, and moisture as they grow. In the beginning, the tap root stabilizes the young plant. Once secure, the tree or brush develops a root ball and a lateral root system that extends from the now less important tap root. In general, the root ball is located below the trunk, and the lateral root system extends outward from the trunk to the “drip line” of the plant’s canopy. The large root ball and extensive roots of trees and brush easily penetrate earthen dams; while the roots stabilize the plant, they destabilize the dam. Though low-growing ground cover plants such as kudzu and crown vetch do not establish deep root systems, they provide a dense cover that can obscure the dam surface.

Many dam owners plant woody vegetation on their dams to provide pleasing landscape effects, and others opt not to remove existing trees and vegetation to avoid related expenses or environmental permitting issues. Moreover, many dam owners believe false

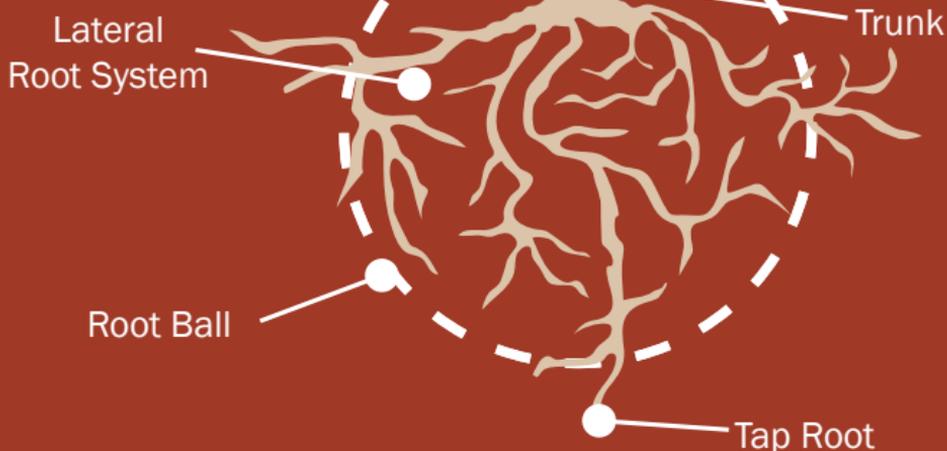
The Truth Is...

Tree roots do not stabilize soil masses, but instead loosen embankment soils and create seepage paths.

Dense, low-growing groundcover or tall grasses are not desirable embankment plants, and can actually obscure serious dam problems.

Even one tree on any size dam is cause for concern.

benefits of woody vegetation on dams or simply do not see it as a threat to the safe operation of their dam. The truth is, problem vegetation can cause a cascade of adverse effects that undermine the integrity of earthen dams. Specifically, erosive conditions, adverse hydraulic effects, and obscured dam inspections can result from problem vegetation on earthen dams, and can lead to maintenance difficulties and potentially dam failure.



Adverse Effects Of Problem Vegetation

Erosion Impacts: Constructed of local, non-organic material, earthen dams can function effectively for many years as long as erosion, the largest threat to an earthen dam, is controlled. Though there can be several causes of earthen dam erosion, the most common and widespread is problem vegetation growth. Trees and woody vegetation can make a dam susceptible to erosion in several ways:

- The decaying roots of dying vegetation create a seepage path in the embankment for stored water or wastewater. This path can lead to internal erosion (piping) of the embankment.
- Woody vegetation shades the embankment and reduces dense grass coverage, which can make affected areas more prone to erosion.
- Woody vegetation loosens compacted soils of the embankment.
- Roots can penetrate existing cracks and joints in the foundation rock and embankment, potentially leading to internal erosion and seepage.

Hydraulic Impacts: Like any other type of dam, earthen dams are designed to manage a certain amount of water or wastewater. Proper reservoir management requires that all the hydraulic structures work to their design capacity. Trees and woody



vegetation can impair the hydraulic efficiency of the dam in several ways:

- Uprooted or overturned trees and large brush reduce the freeboard of the reservoir.
- Vegetation in the emergency spillway reduces the spillway capacity.
- Uprooted trees displace a large amount of soil, lowering the dam crest and reducing the effective width of the dam.
- Falling trees and large vegetation can damage dam facilities, such as the emergency spillway and outlet structures.

Dam Inspection Impacts: Operational inspections are conducted regularly to ensure proper function and integrity of the dam crest, slope, outlets, channel, spillway, and toe. The inspection relies heavily on observation to determine seepage, cracks, slumps, and similar hazards. As such, problem vegetation can decrease the effectiveness of an inspection in many ways:

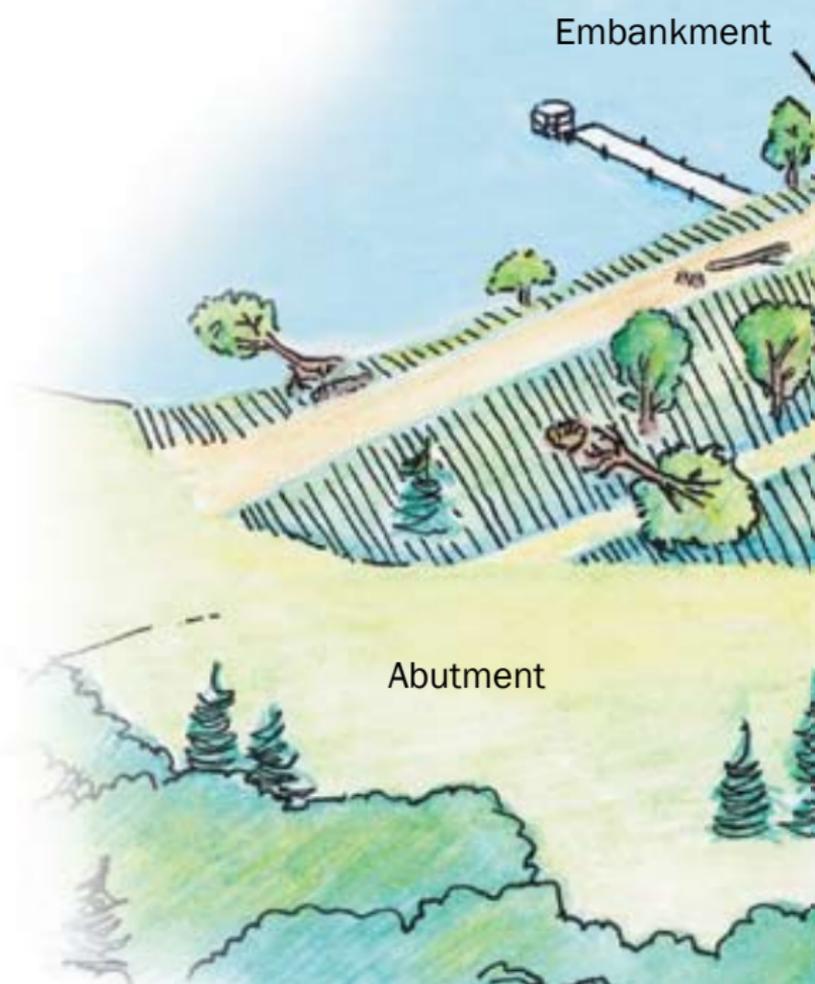
- Dense ground cover obscures animal burrows, which can undermine dam integrity.
- Dense ground cover obscures dam defects.
- Heavy vegetation limits access to critical inspection areas.

How Is Your Dam Doing?

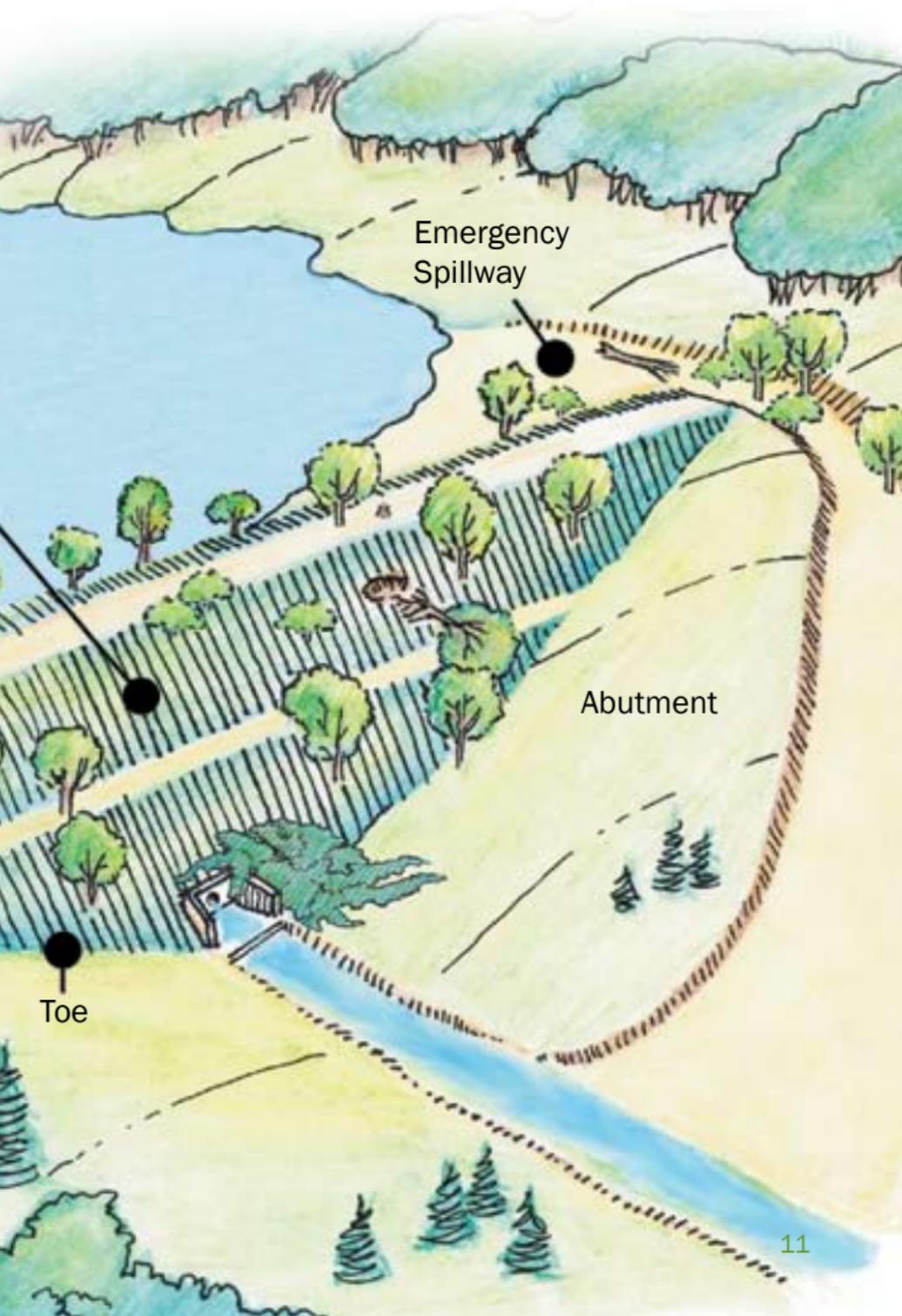
Even though earthen dams are common across the U.S., a national policy regarding woody vegetation management on earthen dams is not in place.

Moreover, over half of the states do not have a specific policy for managing problem vegetation on dams; those states with policies typically rely on case-by-case evaluations before recommending vegetation remediation approaches. Combine this with an intermittent state inspection schedule, and clearly the dam owners are the first line of defense in protecting their dams. The quick quiz on the following pages will assist dam owners in determining whether their dam is at risk for problems relating to inappropriate vegetation.

1. Does your dam look like this?



Dam owners should check their dam frequently—vegetation that is acceptable now can grow into or support problem vegetation over time.



2. Does your dam support the following vegetation?



Trees and shrubs.



Vines such as kudzu or ivy.



Arid-region plants such as cacti, sagebrush, desert broom, salt cedar, mesquite, cypress, cottonwood, paloverde, or palm trees.



Dense, perennial plants such as crown vetch.



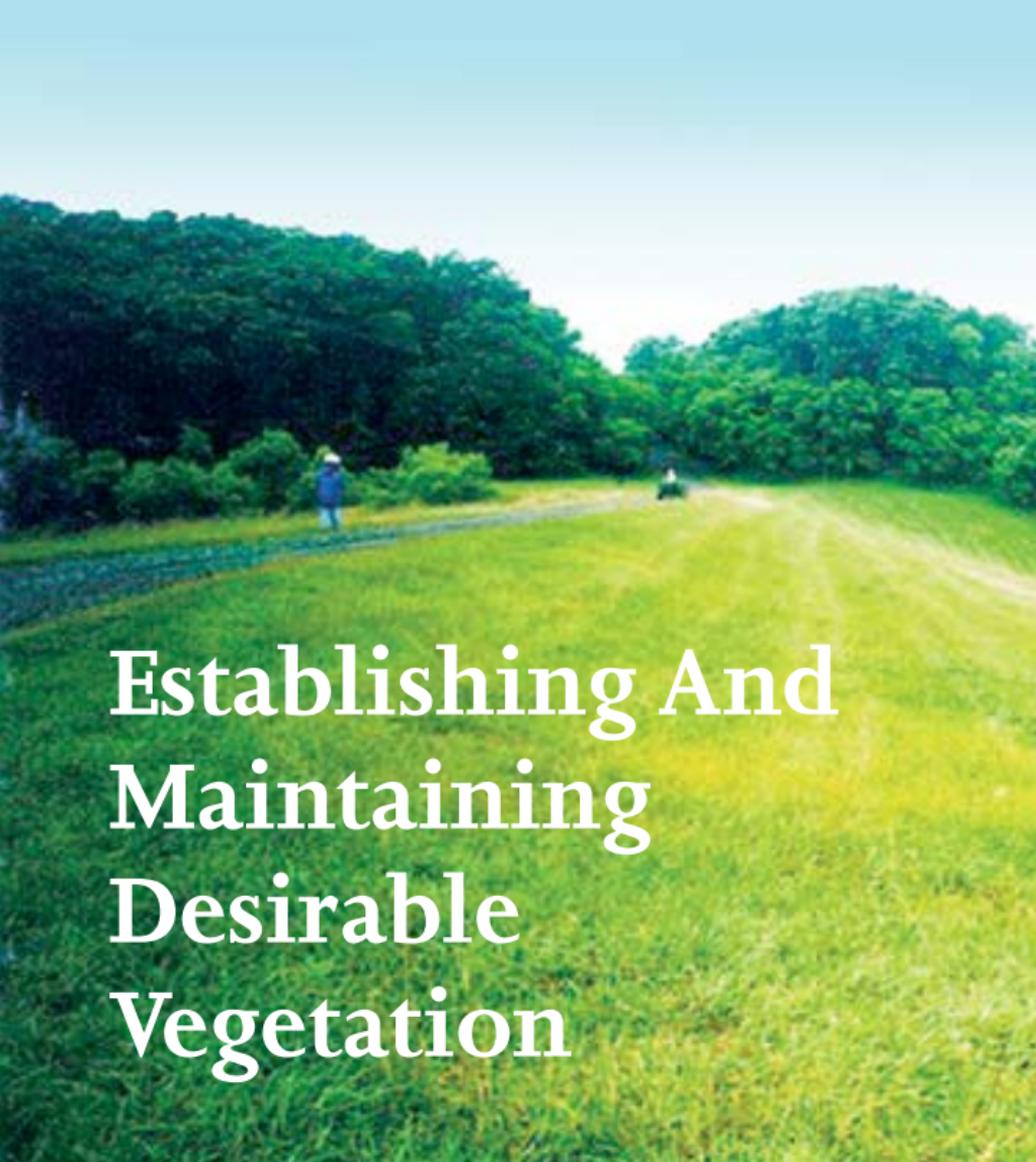
Tall vegetation.

3. Do the following buffer areas contain problem vegetation?

- A 25- to 50-foot buffer beyond the embankment, abutment, and toe.
- A 15-foot buffer around buried pipe systems.

If you answered “yes” to any of the these questions, then you should contact your State Dam Safety Official to determine whether inspection and mitigation is required. Based on this inspection, the official will develop the most appropriate remediation approach based on the extent and type of vegetation and the condition of the dam.

Often, problem vegetation is too extensively established, or trees and brush are simply too large for removal by the dam owner. For example, removal of large trees sometimes also requires removal of their stumps and roots, which can leave large voids in the dam. In these and similar cases, the input of a qualified professional engineer is necessary to remediate vegetation while preserving dam integrity. Conversely, some state policies allow dam owners to remove smaller trees and other vegetation on their own, but some amount of dam repair, such as filling with compacted soils, is usually necessary. Coordination with the State Dam Safety contact is advised before any vegetation removal begins.



Establishing And Maintaining Desirable Vegetation

In addition to regular inspections, proper vegetation maintenance is key to reducing the risks associated with problem plants. Planting and mowing (at least twice yearly) of regionally appropriate species of low-growing grass, such as Bermuda or fescue, prevents problem vegetation from moving in. A recent survey indicates that many dam owners consider the costs of regular mowing too high. However, if one considers the costs of woody vegetation remediation, which is a potential outcome of avoiding grass cover and annual mowing, the economics of grass establishment and maintenance becomes more desirable. For example, though variable based on dam size, site conditions, and regional costs, a rational estimate for annual mowing maintenance equals about \$100 per acre, compared to about \$2,500 per acre for tree removal, clearing, and grubbing.



Conclusion

Maintenance of appropriate earthen dam vegetation reduces several risk factors that contribute to dam failure such as erosion, hydraulic inefficiency, and inadequate inspections. Moreover, maintaining desirable vegetation will prevent problem vegetation from becoming established and is more affordable than remediation, which may be necessary if problem vegetation is allowed to take root. This brochure is intended to help dam owners nationwide identify and mitigate problem vegetation before adverse effects occur.

For information on obtaining a print, CD, or online version of this publication or the technical manual go to www.fema.gov/fima/damsafe.

