Dam Safety Work Group
Department of Conservation & Recreation
Division of Soil & Water Conservation

Impounding Structure Maintenance

Presented by:

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What Will Be Covered

- Maintenance Related Liability
- What causes dams to fail
- Class Objectives
- Maintenance Responsibility

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What will be covered, continued

- General Understanding of Maintenance
- Maintenance Activities
- Dam Maintenance Factors
- Dam Maintenance Activities
- Undesirable vegetation
- Examples of Good & Bad Maintenance

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Learning Objectives

- Why Dams Fail
- What maintenance is needed
- The difference between well maintained & poorly maintained

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Why should I worry about maintenance?

If being a good steward of the environment is not enough of a reason then consider this,

LIABILITY

Under the law the dam owner is liable for damage downstream if their dam breaks and someone dies or property damage occurs. Legal penalties for negligence are much higher.

Proper maintenance of a dam is like that of an older vehicle in need of extensive repair:

- If left unmaintained, repair is expensive.
- If maintenance and repair are performed as needed, costs are minimized.

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What causes embankments to fail?

- A. **Erosion** caused by **Overtopping** of the Embankment

  Timberlake Dam in Campbell County, VA 2 Dead, >$1 Million
- B. **Erosion** due to **Piping** through the Embankment

  Grand Teton Dam in Idaho 11 Dead, >$1 Billion
- C. **Problems** that cause the dam to not function as designed.
- D. **External Issues** like **Earthquakes** or **Terrorism** that the dam was not designed to survive.

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Maintenance Responsibility

The responsibility for proper operation, maintenance, and inspection of most dams falls upon **dam owners.**

Dam Maintenance Factors

- Factors that affect proper maintenance of dams:
  - Type of dam – earthen vs concrete
  - Function of dam – flood control, water resource
  - Size of dam – 6 ft. vs 70 ft. and storage volume
  - Classification -- the higher the hazard class the higher the standard of duty and standard of are required

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Dam Maintenance Factors (Cont.)

- Factors that affect proper maintenance of dams:
  - Watershed characteristics – debris producer or not
  - Spillway system characteristics – earthen or concrete
  - Prevailing climatic conditions – subject to ice damage

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Dam Maintenance Activities

- Nurturing (growing) and mowing grassed areas
- Removal of woody vegetation
- Removal of floating debris from outlet works
- Repair of eroded/scoured areas
- Control and repair of wildlife or animal damage

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Dam Maintenance Activities (Cont.)

- Opening and closing of outlet gates to ensure operability
- Painting and repair of metal components
- Grouting and sealing concrete joints/cracks
- Removal and protection of spalling concrete
- Repair of embankment surface erosion

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Dam Maintenance Activities (Cont.)

- Stabilization of outlet channels
- Repair and replacement of warning signs
- Maintenance of instrumentation/ monitoring systems
- Repair of wave berm erosion

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Dam Maintenance Activities (Cont.)

- Removal of diseased trees on lake rim
- Removal of sediment deposits at inlet
- Control and removal of aquatic growth
- Maintenance of emergency access routes

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Typical Issues Beyond an Owners Capability

- Seepage (piping)
  - Through the embankment
  - From around the outfall pipe or cradle
- Leaking into the outfall pipe
- Separated joints in the outfall pipe
- Deep seated slope failure
- Structural fill
- Cracks, bulges or depressions

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Undesirable Vegetation: Tall Grass, Brush & Noxious Weeds

- Weeds Make Inspections more difficult
- Weeds also provides a haven for borrowing animals
- Grass that attracts wildlife (deer). Deer & cattle take the same path and kill grass.

Undesirable Vegetation: Trees

- Trees can blow over in high winds and severely damage the embankment.
- Tree roots penetrate the embankment and alter its structural integrity.
- Tree roots can become pathways for seepage, especially if the tree dies and roots rot.

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Embankments
Upstream, Downstream & Top

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Tree Problems

Trees on Upstream Embankments

Trees on Downstream Embankments

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Trees & Roots

Trees within 25’ of the Toe

After Removal

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Trees & Roots (Cont.)

Trees within 25’ of the Groins

Mower Sliding on Roots Damaged Embankment

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Erosion

Damage from Animal Grazing Terresetting

Erosion Rills

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Erosion (Cont.)

Wave Erosion
Wake or Wind

4 x 4 or ATV Damage

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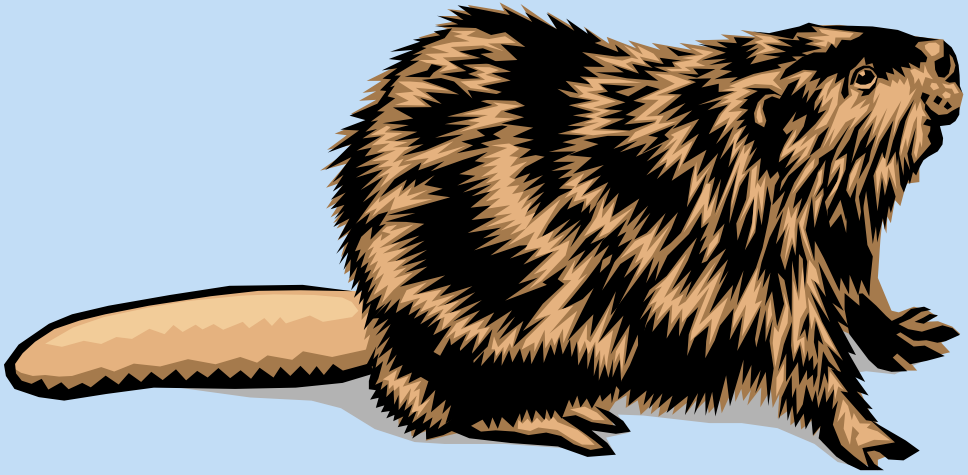
Erosion (Cont.)



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Animal Paths & Motorcycle Trails

Groundhog, Muskrat, Skunk, or Fox Damage

Skunk Den

Groundhog Burrow

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Ground Cover or Unusual Plant Growth

Sparse Vegetation

Wetland Plants/Color Change

Seepage and/or Wet Spots on the Toe

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Debris on Embankment

Decks, Docks Etc.

Trees pieces parts

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Driveways

No grass on top of dams

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Slope Failures & Wet Areas

Slope Failure Beginning

Wet areas on embankment above toe

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Slope Failures (Cont.)

Deep-seated Slope Failure

Not an Owner repair issue.

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Embankments, Maintenance Review

A. Repair Erosion in any form
B. Ground Cover – Good Fescue Sod 2”-6” long optimum
C. Remove Trees (on the dam or within 25’)
D. Remove Burrowing Animals, fill dens
E. Cracks, Settlement, Bulges, Slope Failure – Call Engineer
F. Seepage or Wet Areas on Toe – Call Engineer
G. Seepage in Groins – Call Engineer

Note: Trees on the dam with roots larger than 1” in diameter must be grubbed out, lost material replaced, & the disturbed areas stabilized.

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Principal Spillways A.K.A. Riser Towers

2 Stage Baffled Concrete Riser

2 Stage Concrete Open Top Design

Riser Towers

Debris Blocking/Surrounding Riser Tower

Single Stage Concrete Riser Tower with Solid Top

Concrete Pipe Riser with Trash Rack & Anti-vortex Device

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Principal Spillway

CMP Riser

Single Stage Solid Top Riser

Tower with Debris on Top & In Riser Tower Weir Opening

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Riser Towers, Maintenance Review

A. Repair Spalling or Broken Concrete
B. Rebar exposed?
C. Repair Rusting Parts
D. Clear Debris in Openings
E. Keep Gate Operable
F. Repair Leaks
G. Clear Sediment at Gate

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CAUTION

OSHA has safety standards regarding entry into confined spaces. Training & special equipment is required. Perhaps, it would be better to have a professional inspect & repair damage to risers and large outfall structures.

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CAUTION

Another extreme hazard in working around riser pipes is that flowing water can exert high pressure on things around it. I once saw a video of a jon boat being pulled into a 30 inch riser pipe. Please consider that when removing debris blocking the pipe if the water level is elevated.

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Auxiliary Spillways
A.K.A. Emergency Spillways

Entrance to ES

ES Downstream
From Control Section

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Emergency Spillway

Obstructions in Spillway

Gravel Road Through ES

Entranced Blocked with Trees

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Fence at Control Section

Obstruction in Lower Section

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Obstruction & Severe Cattle Damage

Electric Pole, Tree & Garden Plot

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Trees blocking ES Outfall Channel

Depressed Dirt Road Through ES & Power Pole with Guy Wire

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Low Level Outfall, A.K.A. Bottom Draw Gate

Stop Logs

Low Head Gate by Waterman

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Low Level Outfall Gate, cont'd

High Pressure Gate
(Rodney Hunt)

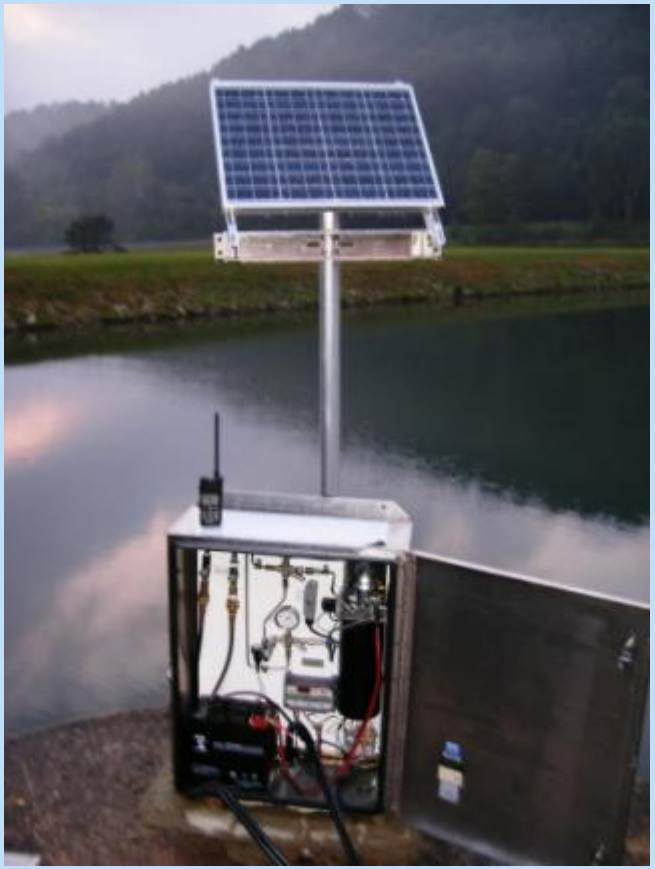
Poorly
Maintained

Typical Gate Operators

Low Level Outfall Gate

Hydraulically Activated Knife Gate

Gate Controls



CAUTION

An extreme hazard in working around low level gates is that flowing water can exert high pressure on things around it. I once saw a small deer pulled through a 12” x 12” rebar screen, into an 18” pipe, through an 18” valve and deposited into the plunge pool over 300’ from the entry point. Please consider that when working near an open gate.

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Plunge Pool Outfall Channels

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Plunge Pool

Rip - Rap Displaced by Tree Stump and Roots

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Plunge Pool & Outfall Channel

Rip Rap Missing Or Displaced

Toe Drains are Not Plugged And Have Rodent Guards

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**Toe Drain Blocked –
Not flowing freely**

Spalling Concrete

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Beaver Damage

Photo By Don Nelson

High Water Level, Note Dead Trees in Background

Water Backing Up into Outfall Pipe

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Unseen Issues: Inside the riser not visible from the outside. Under water pyramid of debris.

Beaver Damage

Outfall Pipe, Plunge Pool & Outfall Channel, Maintenance review

A. Repair Spalling, cracking or scaling
B. Exposed rebar
C. Joints displaced or offset, contact engineer
D. Leaking into pipe
E. Leaking under pipe
F. Plunge pool rip rap in place
G. Erosion around edge of pool
H. Erosion of channel banks

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Unusual Structures

Potential Piping Sources
Sluice Gate to Mill

Air Vent Pipe

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Instrumentation

IFLOW Device

Monitoring Well

Staff Gauge

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Questions?

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The End