Dam Inspections
The What and Why

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Objectives
- Types of inspections
- Preparation for inspection
- Inspection documentation
  - What to look for and why
  - Deficiency condition rating
  - Examples of deficiencies
Why Inspect?

- Ensure safe operation of the dam
- Discover deficiencies early
- Prioritize and schedule maintenance
- Promote good stewardship of funds
- And...

Because I Said So
Regulations and Policies

- State of Kansas
  - K.A.R. 5-40-90 through 5-40-94
- USDA-NRCS
  - NEM 210-503 Subpart D – Dam Safety

Inspection Types

- Formal
- Operation and maintenance
- Surveillance
- Special
Inspection Types

- **Formal**
  - Required for significant and high hazard dams
  - Completed by Professional Engineer
  - Significant hazard dams every 5 years
  - High hazard dams every 3 years

- **Operation and maintenance**
  - Annual inspection

- **Surveillance**
  - Monitoring an ongoing issue

- **Special**
  - Flood event or spillway flow
  - Seismic events??
Preparation for Inspection

- Materials to review—or have available—prior to inspection
  - Inspection reports from previous year(s)
  - O&M Plan
  - Photos
  - As-built drawings

- Equipment to have available
  - Inspection forms
  - Camera
  - Tape measure
  - Shovel/spade
  - T-wrench to operate drawdown valve
  - Flashlight
  - Other?
Inspection Form

KS-ADS-8, Dam Inspection Report - 12/15 Version

Inspection Form Completion

- Condition
  - 1. Adequate – No maintenance required
  - 2. Potential Problem – Monitor
  - 3. Deficient – Repairs required within one year—Include anticipated completion date.
  - 4. Deficient – Immediate repairs required—identifies a problem that immediately threatens the dam or safety or is an unauthorized modification of the structure
What to Look For and Why

- Damage to embankment by waves, erosion, rodents, livestock, or vehicles
- Sloughing, sliding, or slumping of fill
- Seepage, boils, or wet areas at abutments or along downstream toe
- Cracking and displacement of fill
- Observable settlement of fill
- Presence of trees or shrubs
- Adequacy of grass vegetation
Instability (slides)

Non-uniform crest & slopes
- Can identify by sighting along dam from one end and from a point partway down the side slope of embankment
- May indicate slides or non-uniform settlement
Instability (slides) caused by:
- Soil compaction deficiency
- Slope too steep for soil type
- Uncontrolled seepage
- Sudden pool drawdown
- Saturation of embankment

Transverse cracks
Transverse cracks

- Perpendicular to length of dam
- Caused by differential settlement
- Can result in high seepage rates and piping through dam, especially if they extend into core of dam

Longitudinal cracks
- **Longitudinal cracks**
  - Parallel with length of dam
  - Caused by drying and shrinkage of surface material or
  - Downward movement or settlement of zoned fill
  - Can be early warning of potential slide

- **Seepage**
Seepage

- All embankment dams experience movement of water through the embankment and/or foundation soils.
- Seepage may be controlled by drains, embankment cores, and cutoff trenches.
- Seepage becomes a problem when:
  - Embankment or foundation soils are moved by the water flow—results in internal erosion or "piping".
  - Or when excessive pressure builds up within dam or foundation—results in instability.

Other signs of seepage problems

- When seepage appears in a location you have not noticed previously or is substantially larger.
- When seepage flows appear cloudy, carrying soil particles out of the embankment or a downstream boil point.
Vehicle traffic on embankment

- Should be limited, especially during wet weather
- Results in vegetation damage and erosion
- Ruts that pond water increase embankment saturation, decreasing stability
- ATV’s travelling up and down slopes are particularly damaging—dam overtopping will likely breach here.

Burrowing animal activity

- Eradicate burrowing animals from dam
- May require excavation prior to filling holes with compacted material
- Reseed disturbed area
Trees – Public Enemy #1

- Hinder inspections (limit visibility)
- Can cause structural instability
- Lead to internal erosion and piping, especially as roots decay
- Can clog subsurface drains
- Shadow and impede grass vegetation
- Embankment is vulnerable to damage when trees are uprooted during storms
- Attract burrowing animals
- Impede flow when present in auxiliary spillway

Trees

- Remove all trees on the dam, auxiliary spillway, stilling basin, outlet channel, or within 25 feet of toes
- Larger trees increase risk of failure
- Large tree removal should include excavation of roots and proper backfill—consult an engineer
Adequacy of vegetation on dam

- These slopes need attention—livestock exclusion, possible reseeding, weed control

Slope protection

- Riprap, sand, or vegetation

- Presence of trash, logs, and limbs
- Displacement or excessive breakdown of riprap, sand, or other materials
- Condition of water-tolerant vegetation
- **Slope protection**
  - Vegetation on 12:1 slope ("wave berm")
  - Requires healthy, water-tolerant vegetation, and livestock exclusion
  - Can be damaged by extended periods of low reservoir levels since vegetation type depends on sufficient water

- **Slope protection**
  - Rock riprap
- Riprap Slope Protection
  - Look for breakdown of rock—may need replacement

- Auxiliary spillway
  - Adequacy of grass vegetation
  - Sloughing, sliding, or erosion of slopes
  - Damage by livestock, vehicles, or poor drainage
  - Erosion of bottom and exit channel
  - Obstructions by woody plants or fences
Auxiliary spillway
- Vegetation condition

Obstructions impede flow. Discontinuities cause higher stress during flow; these and bare paths are the first areas to erode during spillway flow.
A Stable Spillway

- **Principal spillway**
  - Damage, obstruction, or corrosion of trash rack
  - Obstruction to barrel entrance
  - Damage or corrosion of ladder
  - Observable horizontal or vertical misalignment of pipe
  - Condition of concrete in riser
  - Damage, corrosion, or leakage of drawdown works
  - Leaky pipe joints and joint number
- Principal spillway
  - Debris and timber should be removed promptly
- **Principal spillway**
  - Operate the valve annually if possible
    - Tests the functionality of valve and any stem extension hardware
    - Cleans dirt and debris within valve
    - Helps flush sediment accumulation at inlet of drawdown pipe

- **Principal spillway**
  - Pipe needs some repair patching to prevent corrosion of steel cylinder and reinforcement
Principal spillway

- Some sites have an air vent—typically a 4" galvanized steel pipe extending above top of dam
- This one has been damaged—possibly by a mower. Need to investigate to determine if pipe is kinked, preventing air flow

Principal spillway

- Cathodic protection on corrugated metal pipes
  - Extends life of pipe if kept in functional condition
  - System should be tested once every 5 years (request engineering assistance)—NRCS State Office has equipment available
  - Anode and appurtenances need periodic replacement
  - Reference: NEH 650, Engineering Field Handbook, Chapter 6, Kansas Supplement
Cathodic protection

Record tests on NRCS Form KS-ENG-30

Principal spillway

Occasionally, the interior of a pipe needs to be accessed to check pipe joints or pipe integrity.
- Stilling basin and outlet channel

- Slumping or sliding of slopes
- Displacement or excessive breakdown of riprap materials
- Erosion or siltation of outlet channel
- Seepage or surface runoff into basin
- Excessive vegetation in outlet channel
- Pipe support

- Stilling basin and outlet channel

- Look for breakdown of rock—may need replacement
- Stilling basin and outlet channel
  - Erosion and sediment deposition blocking outlet channel may signal need for additional rock riprap

- Stilling basin and outlet channel
  - Drain pipe outlet submerged
  - Outlet channel likely has debris that is blocking discharge
- Stilling basin and outlet channel
  - Trees should be removed

- Drain outlets
  - Obstructions at outlet
  - Condition of rodent guard
  - Pipe damage
  - Indicate whether drain is flowing, and describe flow ("drip," "trickle," "1/4 depth of pipe," etc.)
Drain outlets—importance of recording flow

- No flow could mean there is no seepage in area served by drain
- If it flowed previously but not now with comparable pool level, it could mean that the drain is plugged and could lead to slope instability
- A sudden increase in drain flow may indicate that the embankment is less water-tight, possibly due to transverse cracking
- Recording drain flow rates and reservoir levels over time will help in assessing seepage conditions if problems develop

Drain outlets

Remove rocks and debris so pipes can freely discharge
Drain outlets

Needs to be cleaned out

Drain outlets

Needs to be cleaned out and needs new rodent guard
Drain outlets

- Drain outlets
  - Drain outlet pipe is tilted above its support—can happen if additional rock riprap is dumped on slope, fracturing pipe and tilting it up at the end

Drain outlets

- Drain outlets
  - Drainfill (sand) should not be present in outlet pipe…could mean that collection pipe is damaged or fine sand is entering collection slots
Drain outlets
- Know where to look
- Usually located at the stilling basin, but are sometimes located near the base of abutment at a small headwall

Rock fence barriers
- Displacement or excessive breakdown of rock materials
- Tied in to end of fence with sufficient rock
- Rock fence barriers
- Fences – a constant battle
  - Gates–open or closed
  - Posts–loose, bent, or broken
  - Tension and condition of wires
  - Trash on fence
Fences

- Any new houses, roads, utilities, etc., downstream that will affect the dam classification.
**Inspection Form Completion**

- KS-ADS-9, Mitigation Area Inspection Report

- Trees and shrubs
  - Appropriate species with adequate stand
  - Invasion of undesirable species
  - Damage by livestock and/or wildlife
  - Disease affecting stand or individuals
  - Perimeter fence condition
KS-ADS-9, Mitigation Area Inspection Report

- Designed wetlands in reservoir area
  - Invasive species
  - Woody or undesirable debris
  - Damage by vehicles or livestock

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