Dam Breach Modeling and OWRB Dam Regulations
1972 - National Dam Inspection Act

Passed as result of a series of dam incidents, including:

- Buffalo Creek Dam, West Virginia (125 deaths, $50 million)
- Canyon Lake Dam, South Dakota (230 deaths, $100 million)
- Van Norman Dam, California (near failure threatened 80,000 residents)

1973 - OWRB Dam Safety Rules

1992 - Oklahoma Dam Safety Act

Dam Safety Mission:
Ensure the proper construction, operation, and maintenance of Oklahoma’s dams
69% of dams are privately owned and dam owners are responsible for maintenance and upgrades.

Oklahoma has the second highest number of jurisdictional dams in the nation.

The average age of dams in the U.S. is more than 53 years old.

Many people are unaware of living in dam failure inundation zones.

Dam failure flood is not equal to a 100-year flood.

Oklahoma has 55,646 miles of shoreline along lakes and ponds.
Oklahoma Dam Inventory
(Jurisdictional Dams by Agency and Hazard Classification)

Jurisdictional Dams
(Agency & Hazard Class)
- OWRB - High (111)
  - Significant (41)
  - Low (2,359)
- NRCS - High (253)
  - Significant (163)
  - Low (1,692)
- Other Federal - High (45)
  - Significant (7)
  - Low (67)

The OWRB coordinates the Oklahoma Dam Safety Program to ensure the safety of over 4,700 dams in the state. The Oklahoma Dam Inventory is a collection of state jurisdictional dams as well as federally owned and operated dams. For more information please visit the OWRB's web site at (http://www.owrb.ok.gov) 2/2/2018.
Purposes of dams

• Water supply
• Agriculture
• Flood control
• Energy generation
• Pollution control
• Recreation
Why do dams fail?

- Overtopping due to inadequate spillway design, debris blockage of spillways, and settlement of dam crest (34%)
- Foundation defect including settlement and slope instability (30%)
- Piping or internal erosion due to animal burrows, woody vegetation, and seepage around hydraulic structures (20%)
### OWRB DAM SAFETY PROGRAM

#### Hazard - Potential Classification

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>No probable loss of human life and low economic losses</td>
</tr>
<tr>
<td>Significant</td>
<td>No probable loss of human life but can cause economic loss or disruption of lifeline facilities</td>
</tr>
<tr>
<td>High</td>
<td>Probable loss of human life</td>
</tr>
</tbody>
</table>

#### What is jurisdictional size?

Any sized dam determined to be of high hazard-potential.
How often should I inspect my dam?

- **HIGH** - Annually

- **SIGNIFICANT** – Every 3 years

- **LOW** – Every 5 years
Dam Safety Program Priorities/Updates

- Public awareness
- Emergency Action Planning
- Hazard-potential reclassification of dams
- Rehabilitation of structurally deficient dams
Public Awareness in 2016 - 2018

- Dam Safety for Real Estate Agents
- Dam Safety Workshop (Scheduled April 25, 2018)
- Free low hazard dam inspections
- Dam safety quarterly newsletter
- Website

Past workshops

- Earthquakes and Infrastructure (Winter 2016)
- HEC-RAS 2D workshop (Spring 2017)
Oklahoma Dam Safety Program EAP Performance

• Based **solely** on the downstream risk in the event of failure

• **NOT** based on the physical condition of the structure

• Emergency Action Plans
  – 345 High Hazard Dams out of 359 (96%)
  – Dam Breach Inundation Maps (99%)
  – Breach map 2010 and newer (90%)
Hazard Creep

April 2003

August 2003
Hazard Creep

May 2008

March 2014
Hazard Reclassification


2. Field visit

3. Simplified steady state analysis

4. Detailed study

5. Refer to OWRB hazard reclassification guidelines and ACER Technical Memorandum No. 11 by Bureau of Reclamation
Hazard Reclassification Rule of Thumb Model

High (H1) Dams with Residential and Commercial Structures
(not in backwater and not in fringe)

Dam Classification Summary

- **High High (1144)**: 48%
- **Significant (144)**: 6%
- **High Low (20)**: 1%
- **Low (844)**: 35%
- **Drained (24)**: 1%
- **Review (150)**: 6%
- **1 Structure per Dam (232)**: 44.7%
- **2-4 Structures per Dam (161)**: 30.8%
- **5-9 Structures per Dam (60)**: 11.5%
- **10-19 Structures per Dam (23)**: 4.4%
- **20-29 Structures per Dam (13)**: 2.5%
- **30 or Greater Structures per Dam (32)**: 6.1%
Field Visits
Hazard Reclassification Rule of Thumb Model
And Simplified Steady State Analysis
Detailed Study
Breach Analysis Scenarios

• Sunny Day
  • Piping Failure at Normal Pool Elevation, No Inflow

• Overtopping – Depends on Timing with Precipitation
  • Barely Overtopping
  • Maximum Water Surface Elevation Overtopping

• Non-breach Design Flood
## Design Flood

<table>
<thead>
<tr>
<th>Size</th>
<th>Hazard- Potential</th>
<th>Design Flood (% PMF)</th>
<th>Minimum Freeboard (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>Low</td>
<td>25%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Significant</td>
<td>40%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>50%</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Intermediate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediate</td>
<td>Low</td>
<td>25%</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Significant</td>
<td>50%</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>75%</td>
<td>3</td>
</tr>
<tr>
<td>Large</td>
<td>Low</td>
<td>50%</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Significant</td>
<td>75%</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>100%</td>
<td>3</td>
</tr>
</tbody>
</table>
Probable Maximum Precipitation (PMP)

Source: NOAA – Hydrometeorological Report No. 51
24 hours 10 mi²

Harvey
31.25” for 24 hour 10 mi²
ACER 11

HIGH DANGER ZONE – Occupants of most houses are in danger from floodwater.

JUDGEMENT ZONE – Danger level is based upon engineering judgement.

LOW DANGER ZONE – Occupants of most houses are not seriously in danger from flood water.

Figure 2. – Depth–velocity flood danger level relationship for houses built on foundations.
Next Step for Reclassification

• State must make a final determination of hazard-potential
• Notification to Owner
• Owner may request a hearing to present technical evidence to show that the dam should not be reclassified.

Could maintain low hazard classification if breach and non-breach flood are within one foot.
Additional Information

• OWRB’s forms, guidelines, and publications are available at
  http://www.owrb.ok.gov/hazard/dam/dam_forms.php

• FEMA dam safety publication and resources
  http://www.fema.gov/plan/prevent/damfailure/publications.shtm

• Subscribe for Dam Safety Quarterly
  • Email: emma.moradi@owrb.ok.gov