USACE LEVEE RISK ASSESSMENT PROCESS –
LESSONS LEARNED

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WHY RISK ASSESSMENTS?

- Deterministic standards don’t address all of the potential failure modes.
- Lack of information to address deterministic standards
- Standards have changed since the structure was designed and built
- It is industry best practice for dams and becoming a best practice for levees
- Best Practice to manage and prioritize portfolio of dams and levees for owners
- Help determine where money should be spent for improvements for a large inventory of over 700 dams and 4000 miles of levees using a systematic approach – Which structures have the highest risk for loss of life
RISK ASSESSMENT PROCESS

Potential Failure Modes Analysis
   Brainstorm PFMs
   Screen PFMs
   Estimate probabilities of PFMs

What do you need to do this?
   Good understanding of Hydrology & Hydraulics
   Knowledge of the structure and foundation
   Engineering and Geological experts
   Understanding of past levee failures/near failures
   Most likely failure modes
   How to fully develop risk driving PFMs
   Understanding of the consequences
SIMILARITIES BETWEEN DAMS AND LEVEE RISK ASSESSMENTS

• The basic PFMA process
• The basic potential failure modes
  • Overtopping
  • Seismic
  • Internal Erosion (Seepage and Piping)
  • Conduit PFM’s
  • Structure Interfaces
  • Structural Failures
  • Erosion
  • Stability
• The science and engineering
  • Hydraulic loading
  • Seismic loading
  • Failure probability estimation
## WHAT IS DIFFERENT BETWEEN DAM AND LEVEE RISK ASSESSMENTS

<table>
<thead>
<tr>
<th></th>
<th>Dams</th>
<th>Levees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Seismic Loading</td>
<td>Highly variable</td>
<td>Highly variable if at all</td>
</tr>
<tr>
<td>Design Hydraulic Loading</td>
<td>Probable Maximum Flood</td>
<td>25-2500 ACE</td>
</tr>
<tr>
<td>Duration of Hydraulic Loading</td>
<td>Hours to Permanent</td>
<td>Hours to Months</td>
</tr>
<tr>
<td>Number of conduits</td>
<td>1 typical, occasionally 2 always designed</td>
<td>None to &gt;100 – many not designed and details frequently unknown</td>
</tr>
<tr>
<td>Locations</td>
<td>Across a valley at a selected site</td>
<td>Along a river, or coast, at drainages</td>
</tr>
<tr>
<td>Purpose</td>
<td>Retain Water for water supply, flood damage reduction, power, navigation</td>
<td>Exclude Water during floods</td>
</tr>
<tr>
<td>Inundation Areas</td>
<td>One stream or river channel</td>
<td>Could be multiple areas depending on geology, variability of levee construction, etc.</td>
</tr>
<tr>
<td>Spillways or designed overtopping locations</td>
<td>Always</td>
<td>Rare</td>
</tr>
<tr>
<td>Foundations</td>
<td>Selected and designed</td>
<td>Highly variable fluvial and coastal geology</td>
</tr>
<tr>
<td>Seepage Control</td>
<td>Foundation cutoffs, grout curtains, internal drainage, relief wells, berms</td>
<td>Berms and relief wells</td>
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<tr>
<td>Closure structures</td>
<td>Very rare</td>
<td>Very common</td>
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<tr>
<td>Ownership / Interest</td>
<td>Single Entity</td>
<td>Multiple entities</td>
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</tbody>
</table>
DESIGN AND DURATION OF HYDRAULIC LOADINGS

Dams

Levee Crest

Landside

Levee Toe

Levee Risk Assessments Lessons Learned
CONDUITS 2 VERSUS >100

187 known conduit penetrations through and under the Rt. Bank of San Gabriel River
Uncertain on number of unknown penetrations

<table>
<thead>
<tr>
<th></th>
<th>Side Drains</th>
<th>Sewer Siphons</th>
<th>Water Lines</th>
<th>Gas/Oil Lines</th>
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<tbody>
<tr>
<td>CMP</td>
<td>30</td>
<td>4</td>
<td>0</td>
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<tr>
<td>RCB</td>
<td>13</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>RCP</td>
<td>63</td>
<td>0</td>
<td>4</td>
<td>0</td>
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<tr>
<td>CI</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Stl P</td>
<td>3</td>
<td>0</td>
<td>15</td>
<td>2</td>
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<tr>
<td>VCP</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Unknown Material</td>
<td>21</td>
<td>0</td>
<td>3</td>
<td>26</td>
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<tr>
<td>Total</td>
<td>132</td>
<td>5</td>
<td>22</td>
<td>28</td>
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</tbody>
</table>
LOCATIONS

Keystone Dam, west of Tulsa, OK

Levees around Sand Springs and Tulsa, OK
PURPOSE

Retention for water supply, irrigation, hydro power, flood control

Mohawk Dam, Ohio

Sacramento, California levee
SPILLWAYS OR DESIGNED OVERTOPPING LOCATIONS

Whittier Narrows Spillway

Los Angeles River Overtopping Section

Oroville Dam Spillways (Google Earth)
Typical Dam Abutment Bedrock Geology Section

Typical Levee Alluvial Foundation
Typical Dam section with central low permeability core, cutoff trench, grout curtain, more pervious shells with upstream slope protection, chimney drain and blanket drain.

Typical Levee section with shallow cutoff, seepage berm, relief wells.

Protected side

Cutoff

Seepage berm
CLOSURE STRUCTURES

Tell City, ID

Memphis, TN

New Orleans, LA

Levee Risk Assessments Lessons Learned
OWNERSHIP / INTEREST
Local Drainage and Flood Control District
County Government
City Government
State Government

• Any of the above can be a local sponsor for USACE flood control projects including levees for joint construction cost sharing – These levee projects are then turned over to the local sponsor for O&M. Some local sponsor have their own consultants, or engineering staff in addition to maintenance staffs.

• Federal Levee Systems – These vary from large ones that are part of the Mississippi River and Tributaries (MR&T) to pieces of local projects that for various reasons O&M remained with USACE. Some other federal agencies also have levee systems

• Locally built levees are eligible for repair and rehabilitation through PL84-99 once they are accepted into the system by USACE. These levee systems require annual inspections after initial acceptance.

  ▪ Public Law (PL) 84-99 enables USACE to provide technical assistance for flood preparedness, response & recovery to include consequences reduction measures
OTHER DIFFERENCES BETWEEN DAMS AND LEVEES

• Heights – Levees are typically 20 feet or less; while dams are up to 100’s of feet in height
• Levee certification for FEMA flood plain mapping
• Pump stations