DESIGN CRITERIA FOR TERMINAL STORAGE RESERVOIRS

Joint Booster Pump Station #3 Reservoir

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May 29, 2014

PROJECT BACKGROUND

Integrated Pipeline Project
• 149 miles of pipeline
• 3 booster pump stations
• 3 lake pump stations
• 4 reservoirs

Joint Booster Pump Station #3 Reservoir (JB3R)

JB3R OVERVIEW
**Applicable Design Criteria**

- Texas Commission on Environmental Quality (TCEQ) design criteria
- Probable Maximum Flood (PMF)
- 100-year storm event
- Pumped inflows

**TCEQ Requirements**

- JB3R is classified as a dam
- Requirements for design of new dams:
  - Design Storm (PMF)
  - Wave Runup
  - Freeboard
  - Erosion Protection
  - Seepage Protection

**TCEQ – Size and Hazard Classification**

<table>
<thead>
<tr>
<th>Small Size Dam</th>
<th>High-Hazard Dam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max height: 30 feet</td>
<td>More than 3 habitable structures</td>
</tr>
<tr>
<td>Max storage: 291 acre-feet</td>
<td>FM 877</td>
</tr>
<tr>
<td></td>
<td>JB3 pump station</td>
</tr>
</tbody>
</table>

*Inundation mapping resulting from a simplified breach analysis.*
**TCEQ Requirements – Design Storm/PMF**

- **Probable Maximum Flood**
  - Greatest possible theoretical flood in a geographical area
- **Texas Administrative Code 299.15** requires a small size, high-hazard dam to pass 75% of the PMF

**TCEQ Results – Wave Runup/Freeboard**

- **Wave runup at maximum operating elevation**
  - 1.39 feet
- **Results in minimum overflow weir crest elevation**
  - 533 ft-msl + 1.39 ft = 534.39 ft-msl
  - (weir crest elevation set at 535 ft-msl)
- **Wave runup must also be considered during PMF event**

**TCEQ Results – Design Storm**

- Wave runup during PMF event = 0.71 feet
- Peak elevation during PMF event less than:
  - 537 feet-msl – 0.71 feet = 536.29 feet-msl

*RESULTS:*
- Exterior weir crest length – 10 feet
- Interior weir crest length – 5 feet
**100-YEAR DISCHARGES**

- Avoid flooding downstream due to dam presence
- 100-year water surface elevation in reservoir = 534 feet-msl (below minimum weir crest elevation determined by wave runup analysis)
- No discharges from the reservoir will occur

**DO WE STOP WITH TCEQ MINIMUMS?**

- Regulatory obligation has been met, but what about obligation to protect downstream residents and property?

**CASE STUDY: TAUM SAUK RESERVOIR FAILURE**
### CASE STUDY: TAUM SAUK RESERVOIR FAILURE

- December 14, 2005
- Reynolds County, MO
- Taum Sauk Hydroelectric Power Station
- No emergency spillway
- Water level readings incorrect; embankment overtopped
- 600-foot section of reservoir failed, 1.5 billion gallons of water released
- No fatalities, but several injuries, damage

#### Pumping Scenarios

- Normal operating conditions
  - JB3R will receive pumped inflows from upstream in the IPL system
  - Discharges from the reservoir will be made via the JB3 pump station
- Operational errors are possible

<table>
<thead>
<tr>
<th>Pumping Scenario</th>
<th>Inflow (MGD)</th>
<th>Inflow (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Buildout (one pipeline)</td>
<td>350</td>
<td>542</td>
</tr>
<tr>
<td>Two Pipelines</td>
<td>700</td>
<td>1,083</td>
</tr>
<tr>
<td>Ultimate Buildout (three pipelines)</td>
<td>1,050</td>
<td>1,625</td>
</tr>
</tbody>
</table>

#### Pumping Scenarios - Results

<table>
<thead>
<tr>
<th>Design Criteria</th>
<th>Inflow (MGD)</th>
<th>Inflow (cfs)</th>
<th>Weir crest length (ft)</th>
<th>Pumping Duration (h:mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Flows (one pipeline)</td>
<td>350</td>
<td>542</td>
<td>10</td>
<td>0:40</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>65</td>
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<td>10</td>
<td>0:20</td>
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<td>125</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>∞</td>
<td></td>
</tr>
<tr>
<td>Final Buildout (three pipelines)</td>
<td>1,050</td>
<td>1,625</td>
<td>10</td>
<td>0:15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>185</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>∞</td>
<td></td>
</tr>
</tbody>
</table>
**WEIR CREST ELEVATION/LENGTHS**

<table>
<thead>
<tr>
<th>Design Criteria</th>
<th>Minimum Weir Length (ft)</th>
<th>Minimum Weir Crest Elevation (ft-msl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wave Runup at Maximum Operating Elevation</td>
<td>N/A</td>
<td>534.39</td>
</tr>
<tr>
<td>TCEQ – PMF Event (including wave runup)</td>
<td>10</td>
<td>535</td>
</tr>
<tr>
<td>100-Year Event</td>
<td>N/A</td>
<td>534</td>
</tr>
<tr>
<td>Pumping Scenario – Initial Flows</td>
<td>65</td>
<td>535</td>
</tr>
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<td>Pumping Scenario – Two Pipelines</td>
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<td>Pumping Scenario – Final Buildout</td>
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<td>535</td>
</tr>
</tbody>
</table>

**ULTIMATE WEIR DESIGN**

- Based on pumped inflows
  - Weir crest length – 185 feet
  - Weir elevation – 535 feet-msl
- Uncontrolled discharges through weir, but no breach of embankment

**CONCLUSIONS**

- Meeting minimum regulatory requirements may not result in most appropriate design
- Weir crest length = relatively small impact on overall cost
- Protection of downstream residents, homes, and roads must be top priority