



BART TBT Seismic Retrofit TBT Reanalysis COC Briefing

January 19, 2022

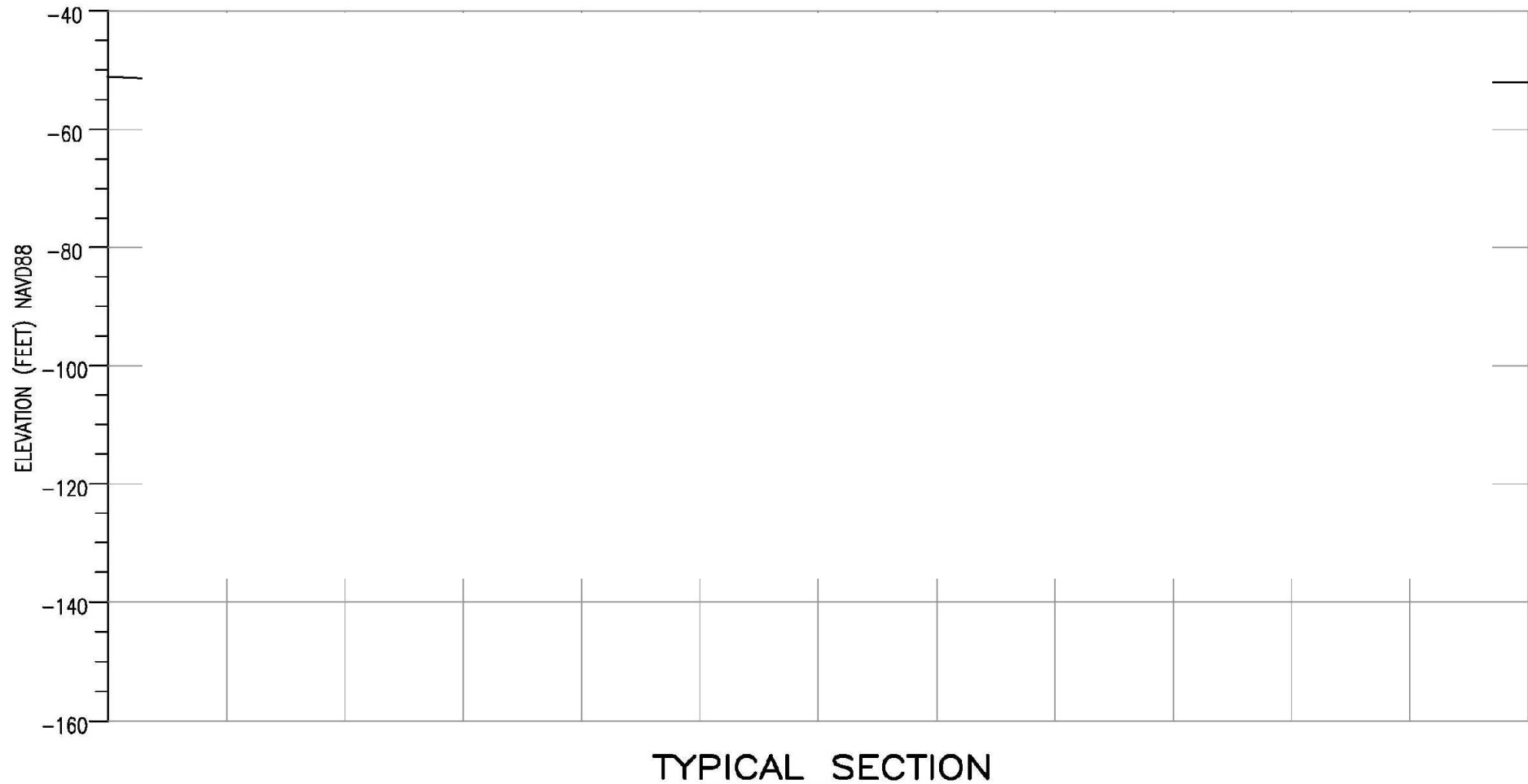
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TBT



Typical Section

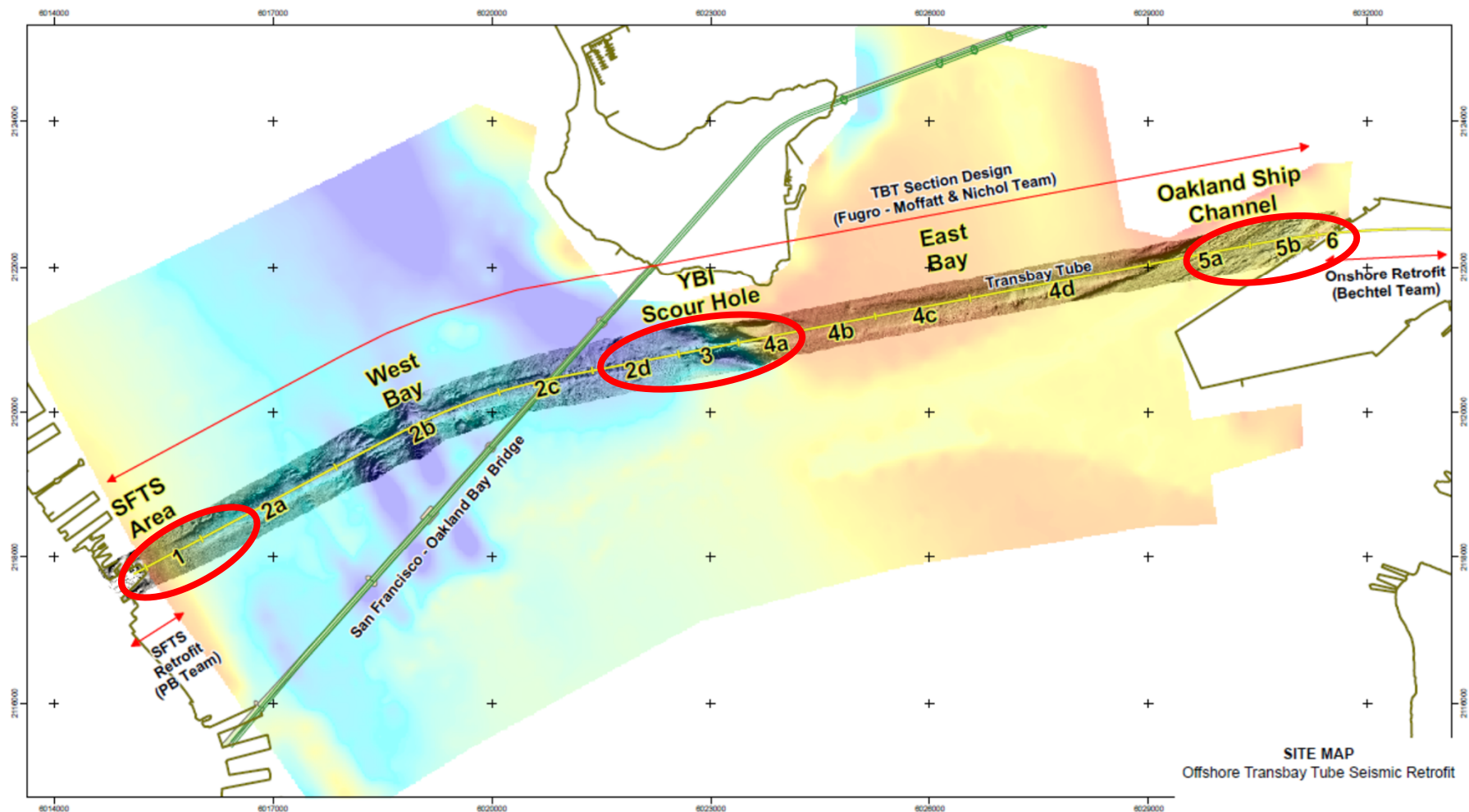




Primary Seismic Vulnerabilities

- Discovered panel weld defects
 - May crack and leak, in areas with large soil movements
- Water intrusion issue only
- Structural integrity is preserved
 - Circumferential cracking of outer shell does not cause collapse

MODULE SIXTH WEEK





2016 Retrofit Solution





Purpose of TBT Reanalysis

Objectives:

- Remove conservatisms in ground motions
- Use latest science and engineering – peer reviewed
- Confirm descoping
- ❖ Quantify uncertainty and risk

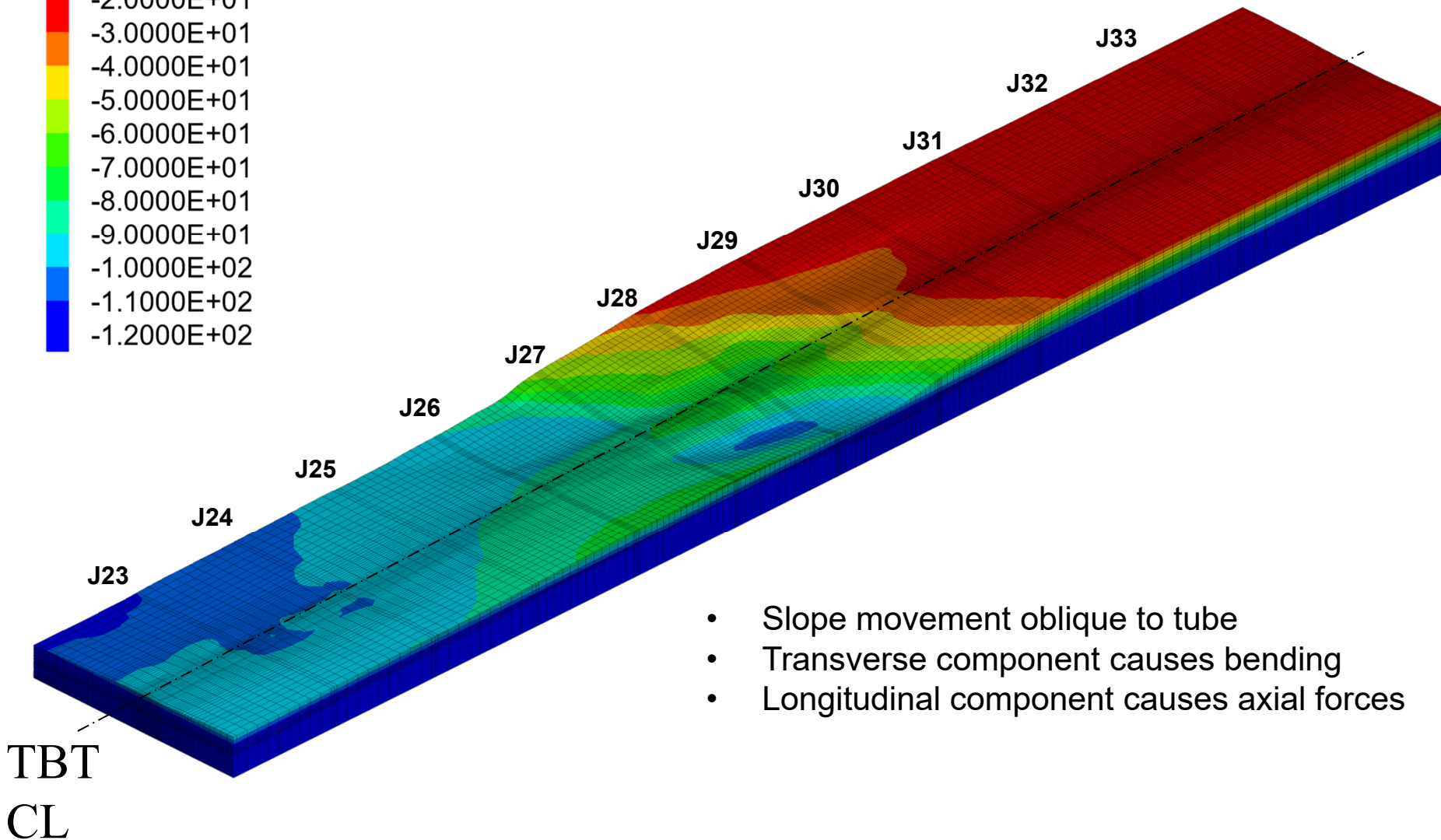
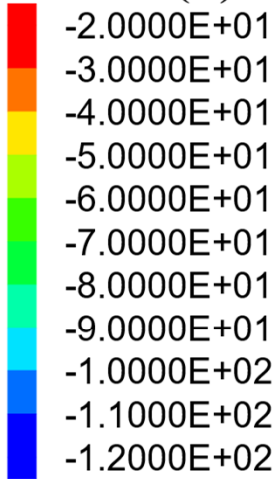


Status as of January 2021

Tentative findings as of January 2021:

- Leakage in west/middle portion of TBT is small
- Retrofit of Tubes 51 to 53 is necessary
- Reanalysis so far supported the descoped retrofit
- Slope movement checks were in progress

Elevation (ft)



- Slope movement oblique to tube
- Transverse component causes bending
- Longitudinal component causes axial forces



Discovered Zone 3 Issues

- Additional potential vulnerability not previously identified: Longitudinal slope movement in Zone 3
- High axial strains in previously low-strained tube segments
- Majority of inflow is now in Zone 3
- High uncertainty due to limited critical soil data

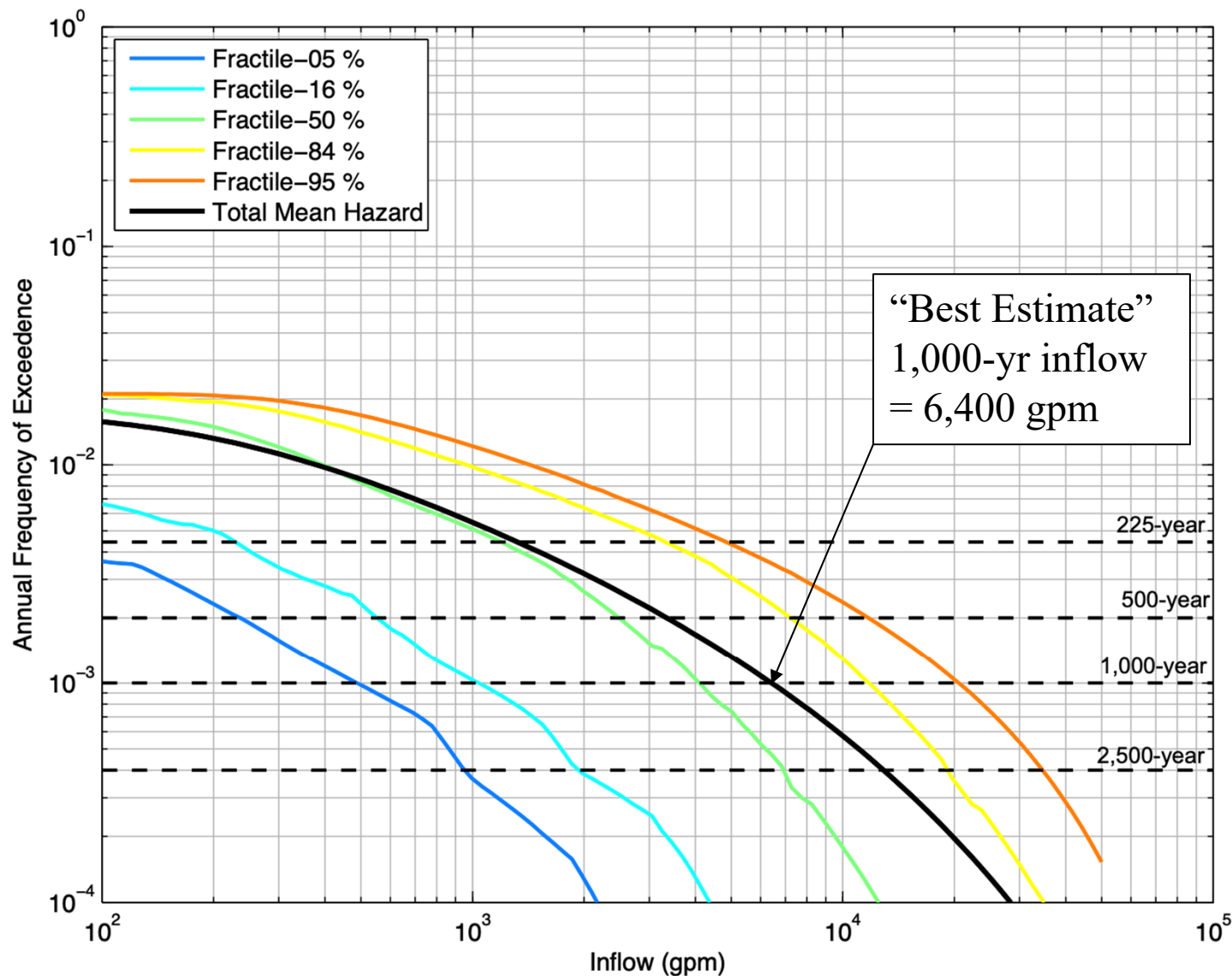


Leakage Hazard Analysis

- Probabilistic Leakage Hazard Analysis
 - Useful to quantify high uncertainties
- Considers *ranges* of key parameters and their probabilities:
 - Earthquake intensities
 - Soil conditions
 - Size and distribution of flawed welds
 - Crack leakage rates
- Informs *risk* of different leakage inflow levels
 - Hazard curves
 - Confidence levels

Zone 3 Leakage Hazard Analysis

- Hazard Curves – Zone 3 Inflow





Egress Scenario

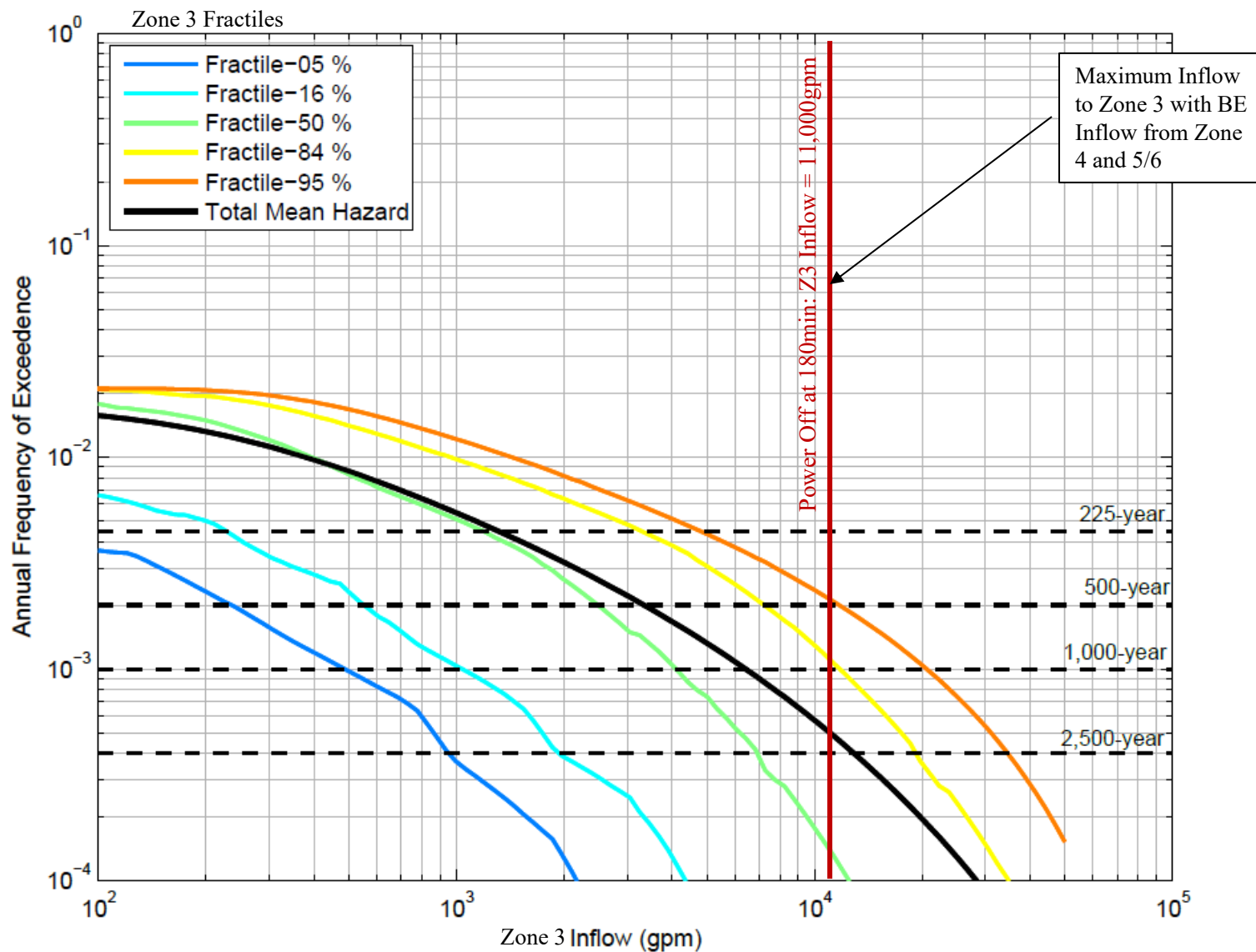
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Hazard Analysis Observations





Conclusions from Reanalysis

Key Findings

- Reduced inflow in Zone 1
- Increased inflow in Zone 3 due to longitudinal slope
- ✓ Current retrofit addresses most vulnerable area (Zone 5/6)
- Wide range of predicted inflows due to high uncertainties
- “Best Estimate” 1000-yr inflow:
 - ✓ gives more than twice the time needed for egress
 - ✓ consistent with original ESP retrofit performance goals for egress
- Higher fractiles (> 84%) or longer return periods:
 - Egress goals will not be met without additional retrofit



Recommendations and Considerations

Control and mitigate the risk by:

- Alternative or supplemental lighting
- Advance planning, drills, signage for egress
 - Estimated egress times already assume efficient egress
- Continued maintenance and testing of emergency systems
 - Pumping, lighting, communications

Benefits of obtaining additional data:

- ✓ Improve confidence in Zone 3 soils data
- ✓ Improve confidence in condition of panel welds
- ✓ Reduce uncertainty, provide more robust information
- ✓ Possibly reduce best estimate inflows