Mossyrock Dam/Spillway Piers

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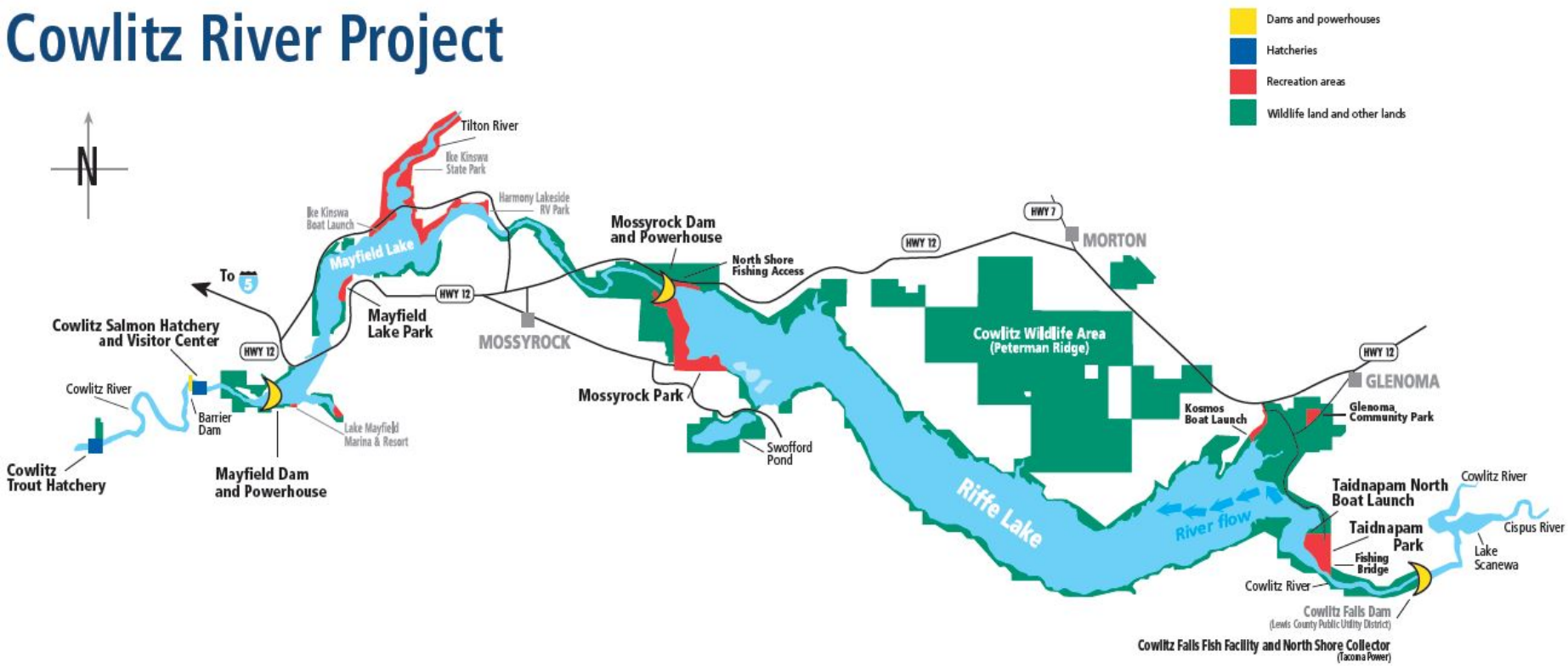
AGENDA

- Overview
- Background
- Mossyrock Dam and Spillways
- Seismicity and Potential Impacts
- Current Risks
- Temporary Risk Reduction Methods
- Approvals and Path Forward
- Finite Element Modeling Uncertainties
- Need to Calibrate Models
- Questions

BACKGROUND



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MOSSYROCK DAM

MOSSYROCK SPILLWAY PIERS

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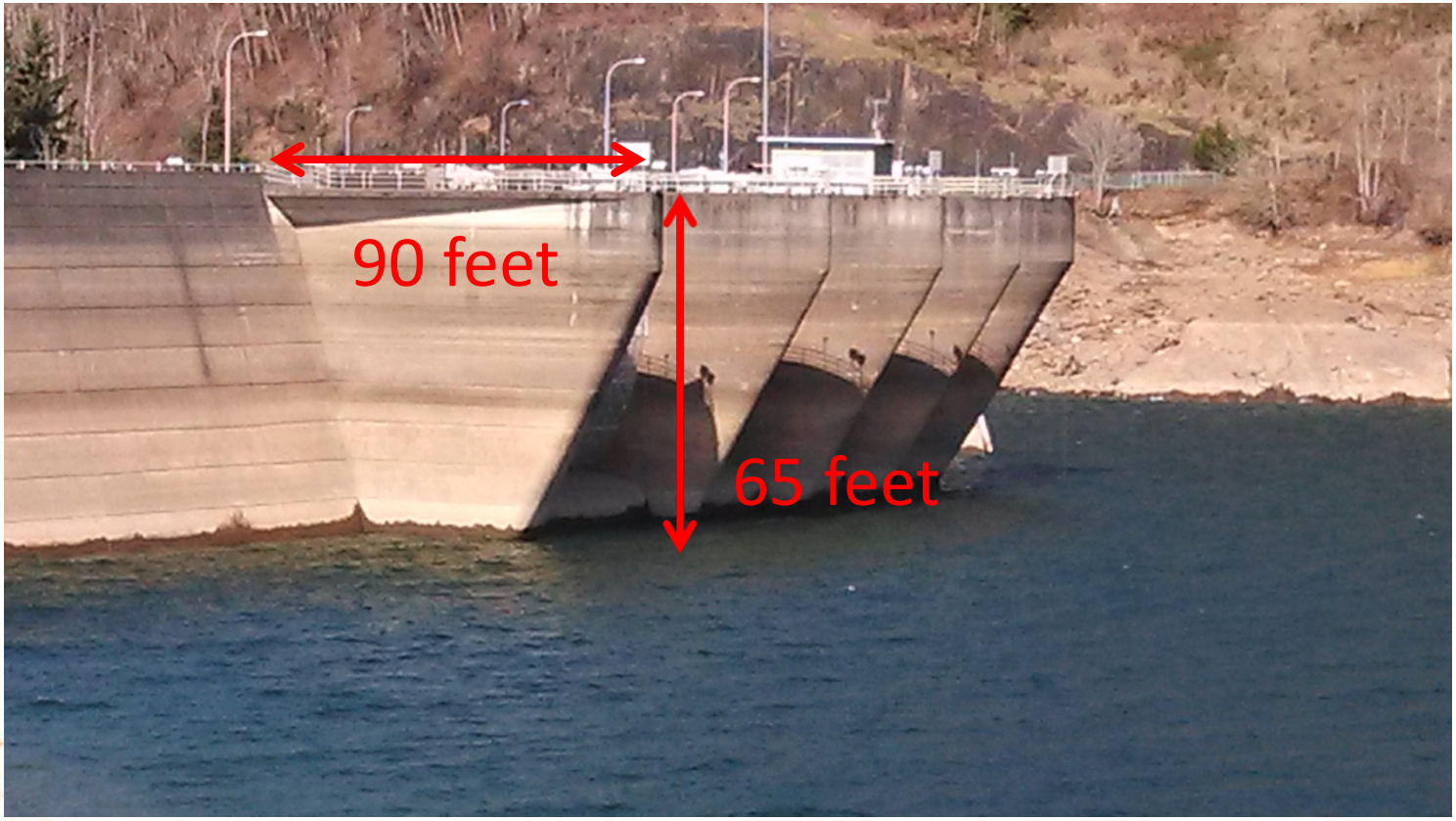
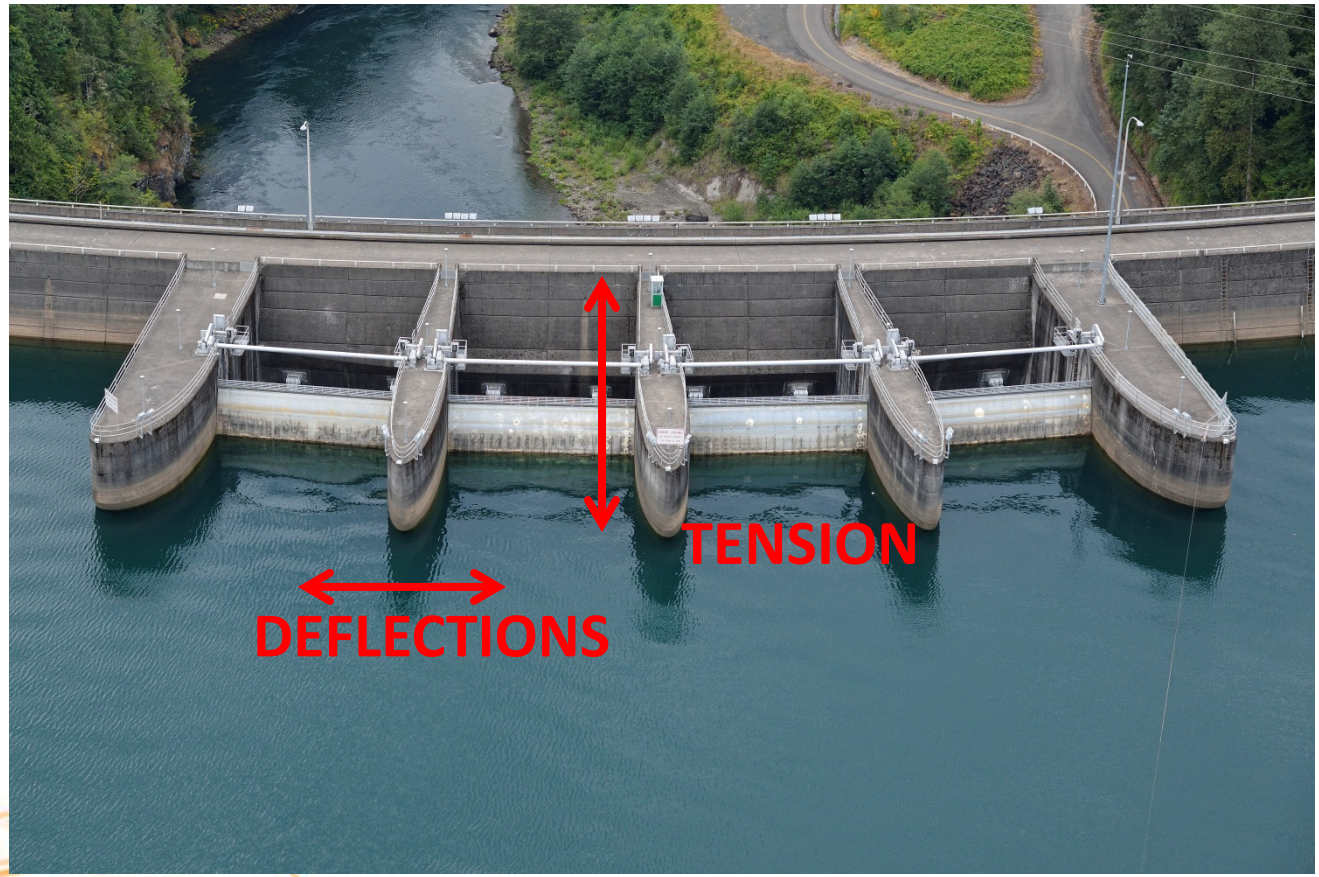


SEISMICITY AT MOSSYROCK DAM

MCE – Maximum Credible Earthquake
PGA – Peak Ground Acceleration
SMA – Strong Motion Accelerometer

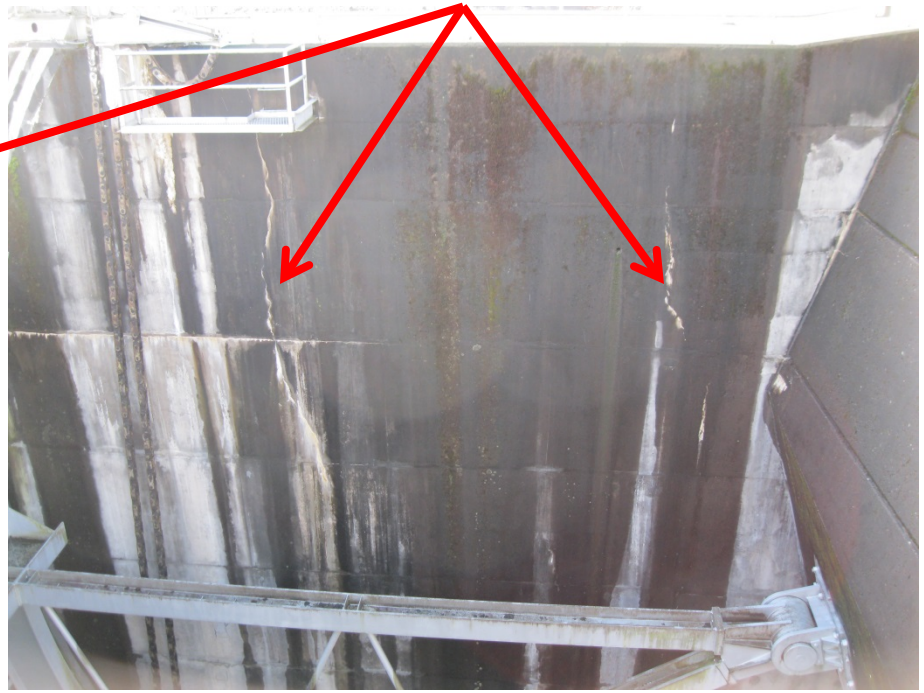
- **MCE For Mossyrock Dam**
  - 2001 – PGA: 0.38g (Intra-Slab Event, M 7.5)
  - 2007 – PGA: 0.55g (Local Event, M 6.5)
  - 2016 – PGA: 0.62g (Intra-Slab Event, M 7.5)
  - 13% Increase but Longer Duration
- **SMA Recorded Height Amplification Factor of 3**

EXPECTED PIER DEFLECTIONS AND LOADINGS



MOSSYROCK SPILLWAY RISKS

- **Pier failure**
  - If piers fail, gates may fail



MOSSYROCK SPILLWAY RISKS

- **Gate failure**
  - Slender Gate Arms
  - Designed for 0.15g Loading
  - No Amplification Factor

CURRENT RISKS

- **If Reservoir is at Full Pool, 778.5 feet**
  - Release of approximately 230,000 cfs
  - 1995 Flood of Record was 60,000 cfs
  - Flooding of Mossyrock Powerhouse
  - Immediate Opening of Mayfield Spillway (Full)
  - Flooding of Mayfield Powerhouse
  - Flooding of Salmon and Trout Hatcheries
  - Overtopping and Failure of Barrier Dam
  - Potential Flooding of Toledo, Castle Rock, Kelso and Longview
  - Downstream Recreationalist / Anglers

RISK REDUCTIONS

- **Modify Flood Control Curve to Maintain Reservoir Around 749-ft**
  - Allowance for short term storm events (similar to winter rule curve)
  - Limits discharge to approximately 60,000 cfs
  - Limits flooding impacts
  - Provides short term option – Allows future structural modifications
  - Recreational and cultural resources impacts
- **Complete Additional Engineering Analyses**
  - FERC concurrence of the new seismicity
  - New analyses of the arch, piers and embankment (higher PGA)

MODIFIED FLOOD CONTROL - CURVE

➢ Mid-February through Late November

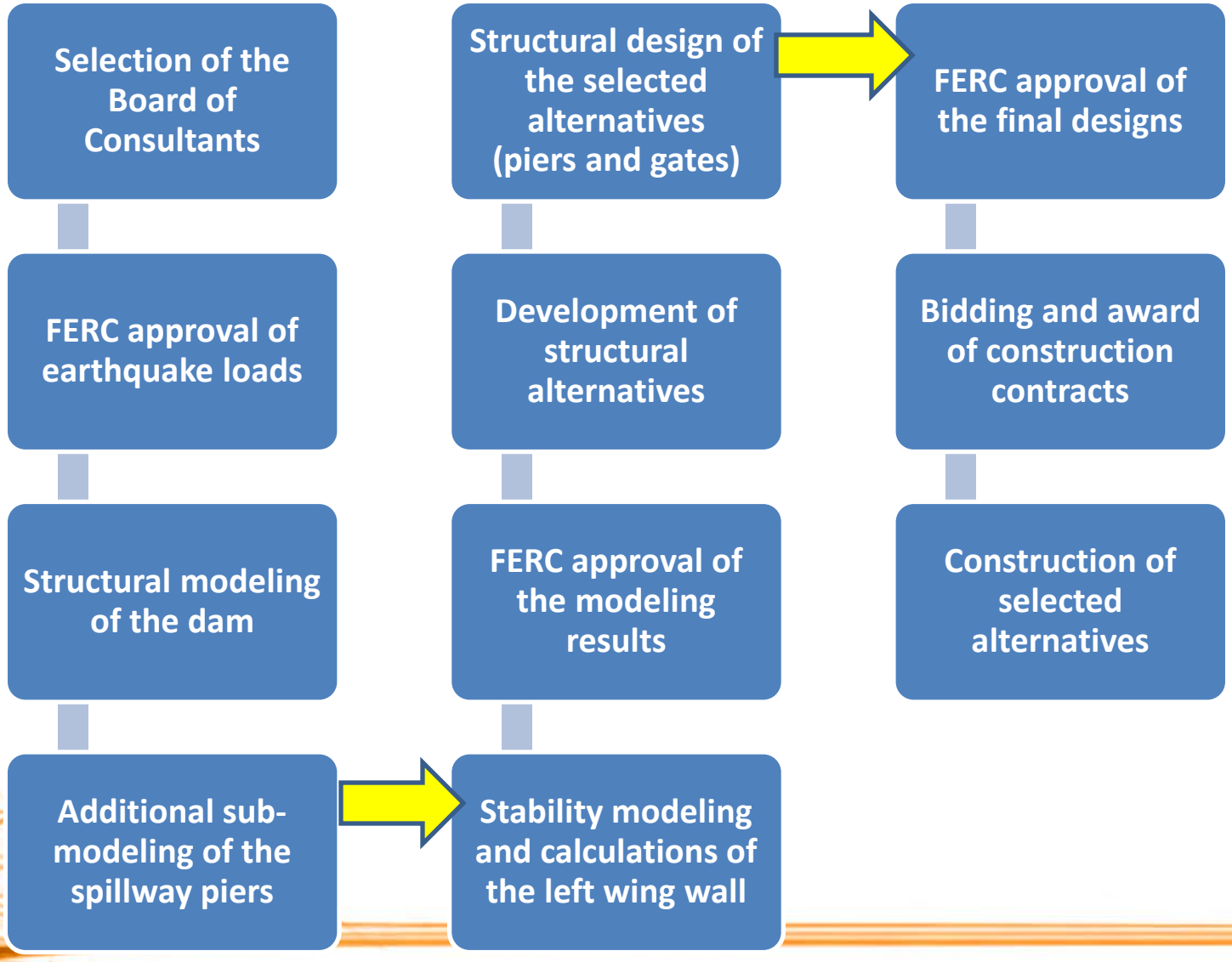
- Restrict Maximum Lake Elevation to 749-feet
- Allowance for Short Term Storm Events (similar to winter rule curve of 745-feet)
- If above 749-feet, Full Generation to get the Reservoir Back Down Once Flows in the Lower Valley Subside
- Eliminates the Need to Potentially Flood Homes to Prevent Flooding Homes
- Creates a Slightly Higher Short Term Risk

APPROVALS

➢ FERC Approved the Plan

- Establish a Board of Consultants
- Coordinate with Local Emergency Management Agencies
  - ❖ Review EAP
  - ❖ Revised Inundation Maps
- Submit a Plan to Mitigate Impacts;
  - ❖ Recreation
    - ✓ New Mossyrock Park Swim Beach
    - ✓ Modify Mossyrock Park Boat Ramp
    - ✓ Close Some Boat Ramps
  - ❖ Cultural Resources

PATH FORWARD – STRUCTURAL EVALUATIONS



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FINITE ELEMENT MODELING UNCERTAINTIES

- **Finite Element Modeling of the Dams**
  - Models are Developed
    - Foundations and Rock Types
    - Concrete Properties
    - Reservoir Interaction Assumptions
- **Seismic Time Histories**
  - In-Stream, Cross-Stream and Vertical Accelerations
- **Estimated / Predicted Behavior is Determined**
- **But the Models Don't Match Reality**
  - Limited Seismic Events to Calibrate the Models

FINITE ELEMENT MODELING UNCERTAINTIES

- **Computer Models are Predicting Structural Failures**
- **No Concrete Arch Dam has ever Failed due to a Seismic Event.**
- **Why?**
- **Is it Because Computer Models are not Calibrated and are they Overly Conservative?**
  - Foundation Interaction?
  - Energy Absorption?
  - Reservoir Interaction?
- **Or Have We Just Been Lucky?**

NEED TO CALIBRATE MODELS

- Mossyrock Dam
  - ANSYS Predicted a Crest Amplification Factor of 6
  - SMA's Captured a Seismic Event; Crest Amplification Factor of 3
  - With a Base Acceleration of 0.55g,
  - The Crest Amplification of 3.3 g went down to 1.6g
- Justified the Calibration of the Computer Model
- We need More SMA Data

NEED TO CALIBRATE MODELS

- 2016 and 2017 USSD Workshops
  - Monticello Dam Study
    - No Predictions Were Correct
  - There May be a Need For More Scaled Models
    - But There are Issues with Scaled Models
  - SMA Records may Exist but Hesitancy to Share
  - Are Concrete Numerical Models too Complex?
  - Are the Structures More Complicated than We Can Model?

NEED TO CALIBRATE MODELS

- Association of State Dam Safety Officials
  - California Division of Safety of Dams Created Models of Lower Crystal Springs and Pacoima Dams
  - Used Accelerations from the Loma Prieta (M6.9) and Northridge (M6.7) earthquakes and they were able to Validate their Models
  - Validation / Calibration of the Models is Possible but we Need More SMA Data

NEED TO CALIBRATE MODELS

- CEATI Dam Safety Interest Group
  - Seismic Workgroup / Task Force
  - EDF has SMA data from Japanese Events – But Not the Structural Details of their Dams
  - SMA's Captured a Seismic Event; Crest Amplification Factor of 3
- Actual events could be used to Calibrate and/or Validate the Computer Models
- Confidence in the Models will Increase
- We need More SMA Data

QUESTIONS

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