Use of USGS National Seismic Hazard Mapping Program Products in USACE Dam and Levee Safety Programs and USACE Civil Works Projects

ATC – USGS NSHMP Users Workshop
September 21, 2015

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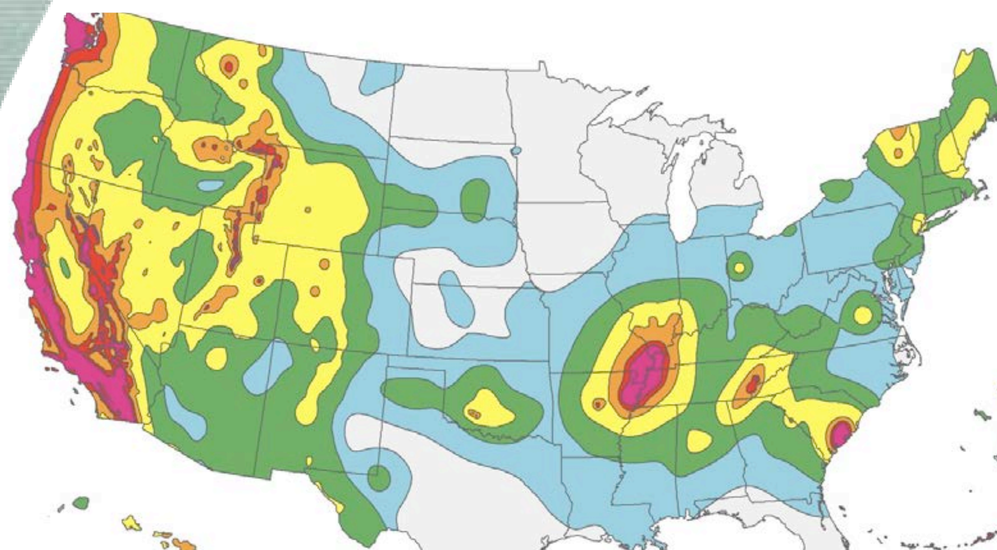

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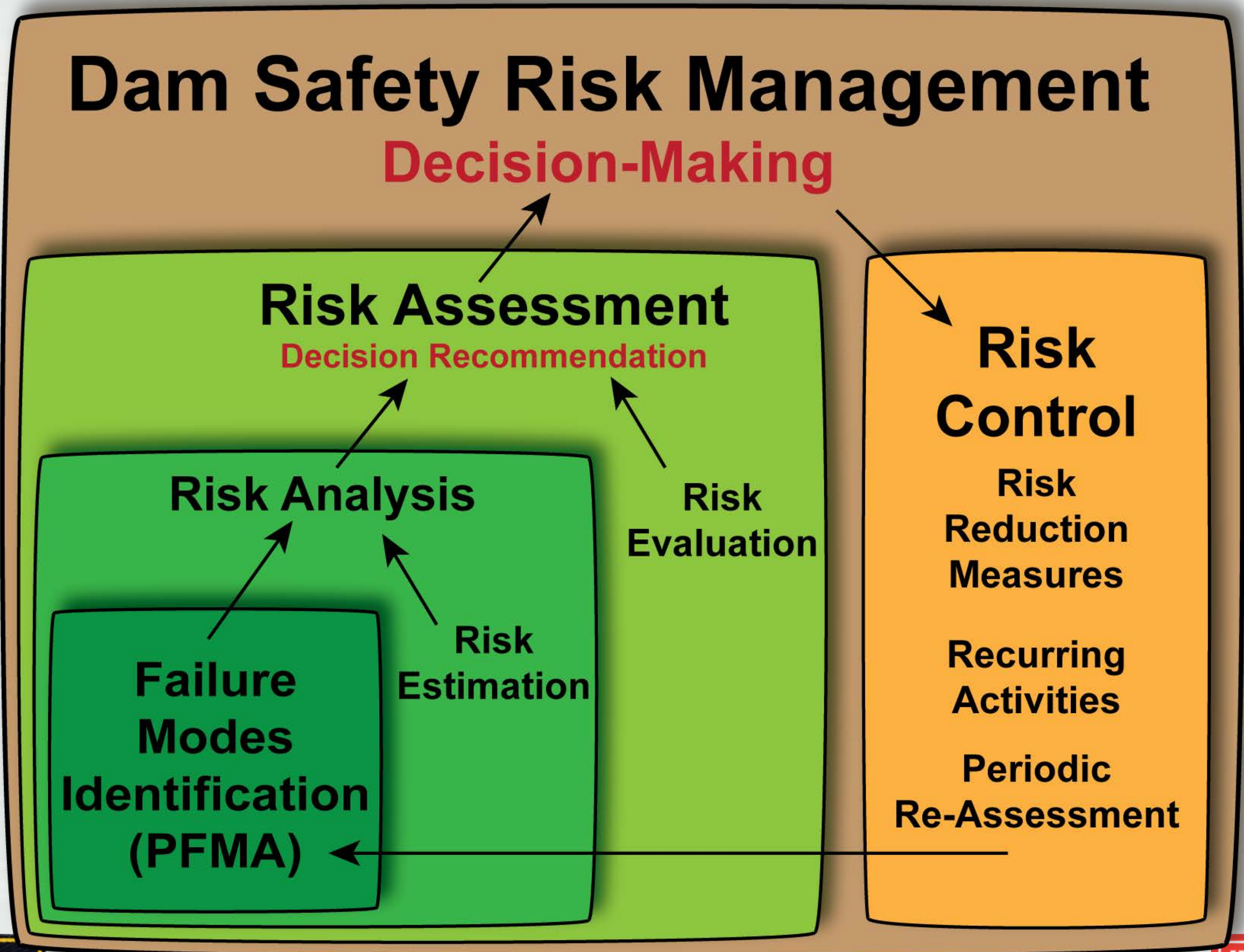
Workshop Goals

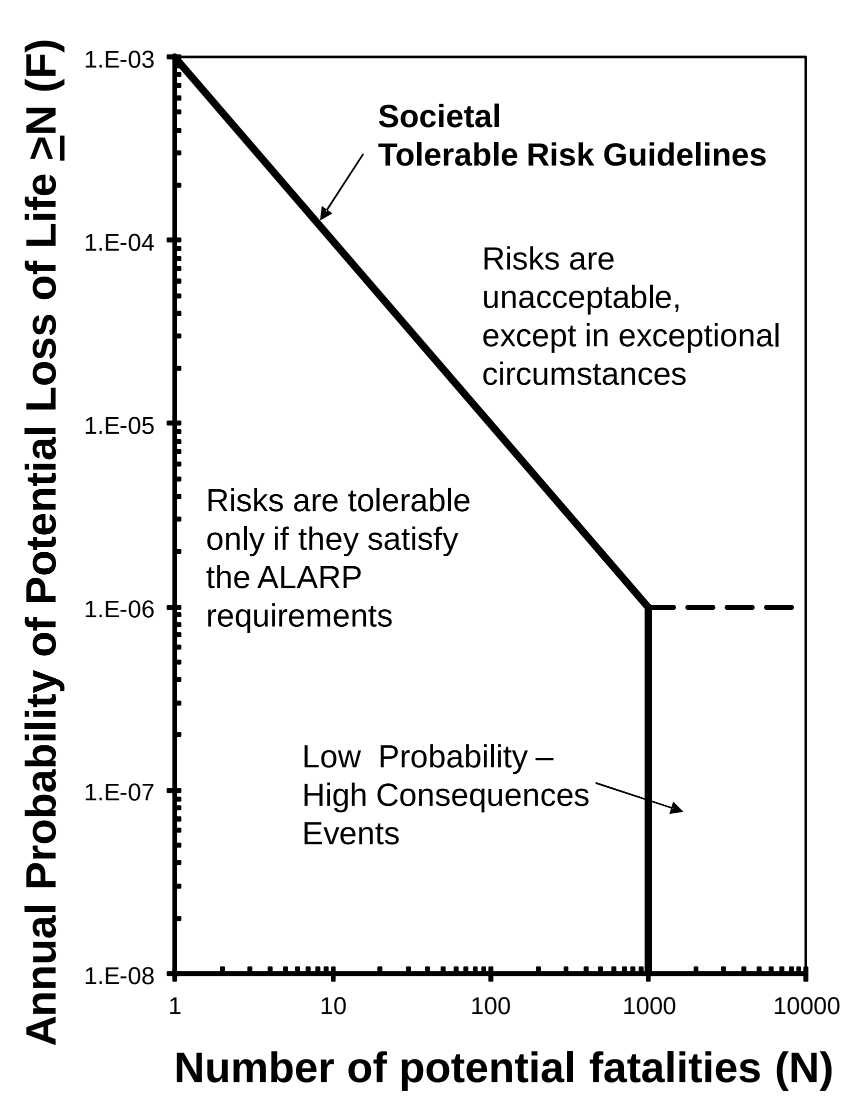
- Elicit feedback from NSHMP users
- Provide a forum for EQ engineering community to transfer seismic hazard results into:
  - Engineering practice
  - Seismic risk analysis
  - Public policy
- Make practical recommendations to the USGS NSHMP

Presentation Outline

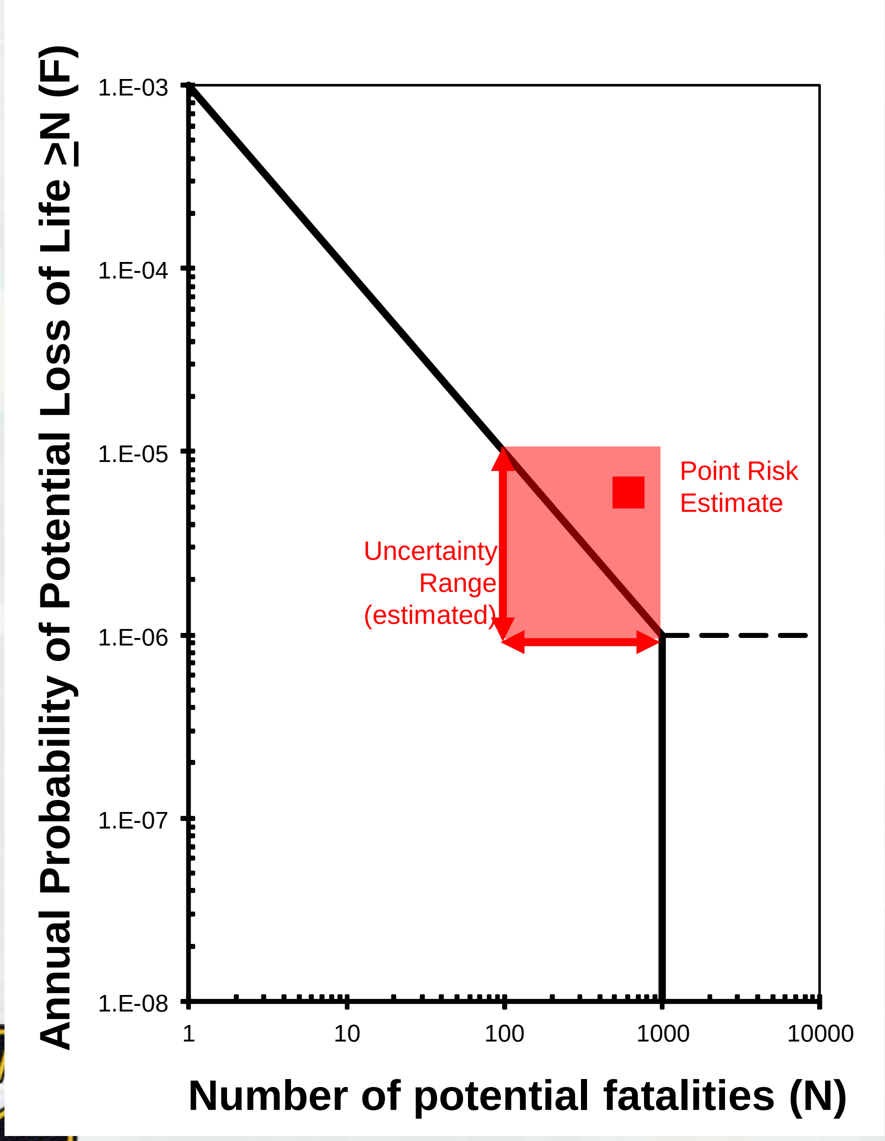
- Overview of USACE Risk-informed Decision Framework
- How does the USACE use NSHMP products?
  - Seismic Hazard Nationwide Screening
  - Semi-Quantitative Risk Assessments
  - Issue Evaluation Studies / Site-Specific PSHA
  - Induced Seismicity Considerations
- USACE Wish List for future NSHMP products


Dam Safety Risk Management
Decision-Making
Risk Assessment
Decision Recommendation
Risk Analysis
Risk Evaluation
Failure Modes Identification (PFMA)
Risk Estimation
Risk Control
Risk Reduction Measures
Recurring Activities
Periodic Re-Assessment

USACE Tolerable Risk Guidelines



USACE Risk-Informed Decision Making



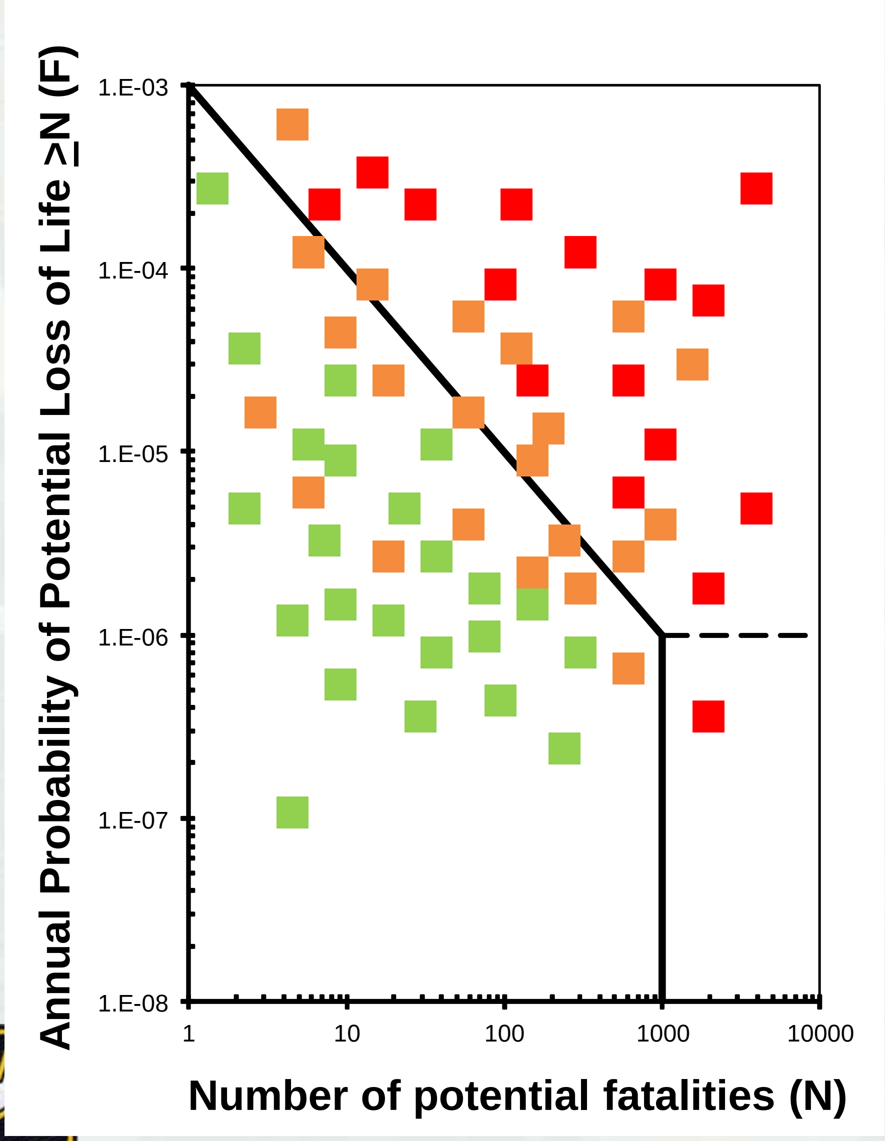
Information Needed

- Risk Estimate
- Estimated Range of Uncertainty (and Confidence)
- Case to Support Risk Estimate
- Recommended Course of Action

Strategy

- Use risk estimate and Tolerable Risk Guidelines to develop rational recommended actions

Overall Goal: Portfolio Risk Reduction



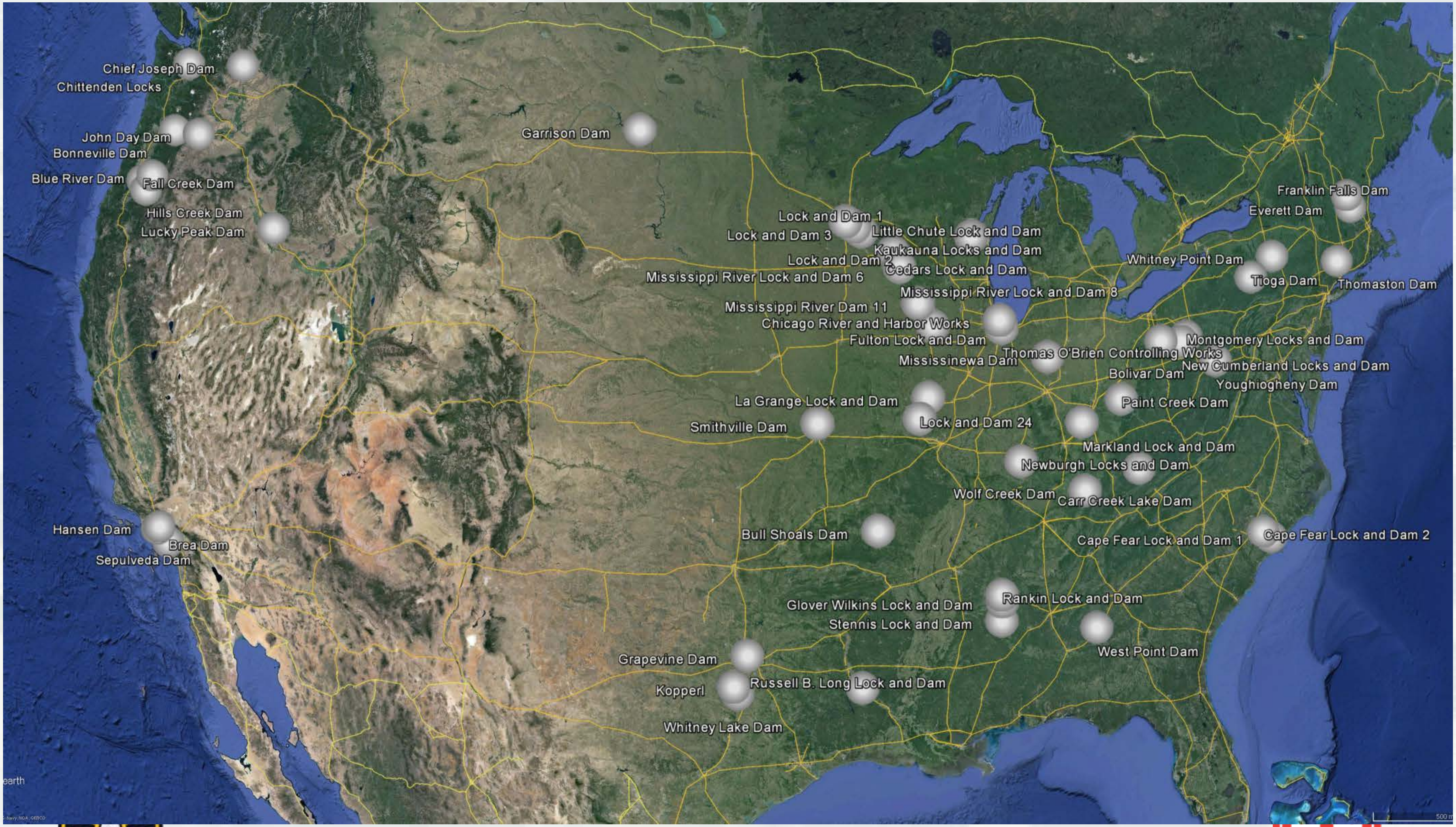
Decrease Probability of Failure

- Mitigation schemes (i.e., berms, component replacements, cutoff walls)
- Intervention (dams)
- Flood fighting (levees)

Decrease Potential Loss of Life

- Improved evacuation plans
- Improved warning systems
- Revised land use

Screening-level Seismic Hazard Classes



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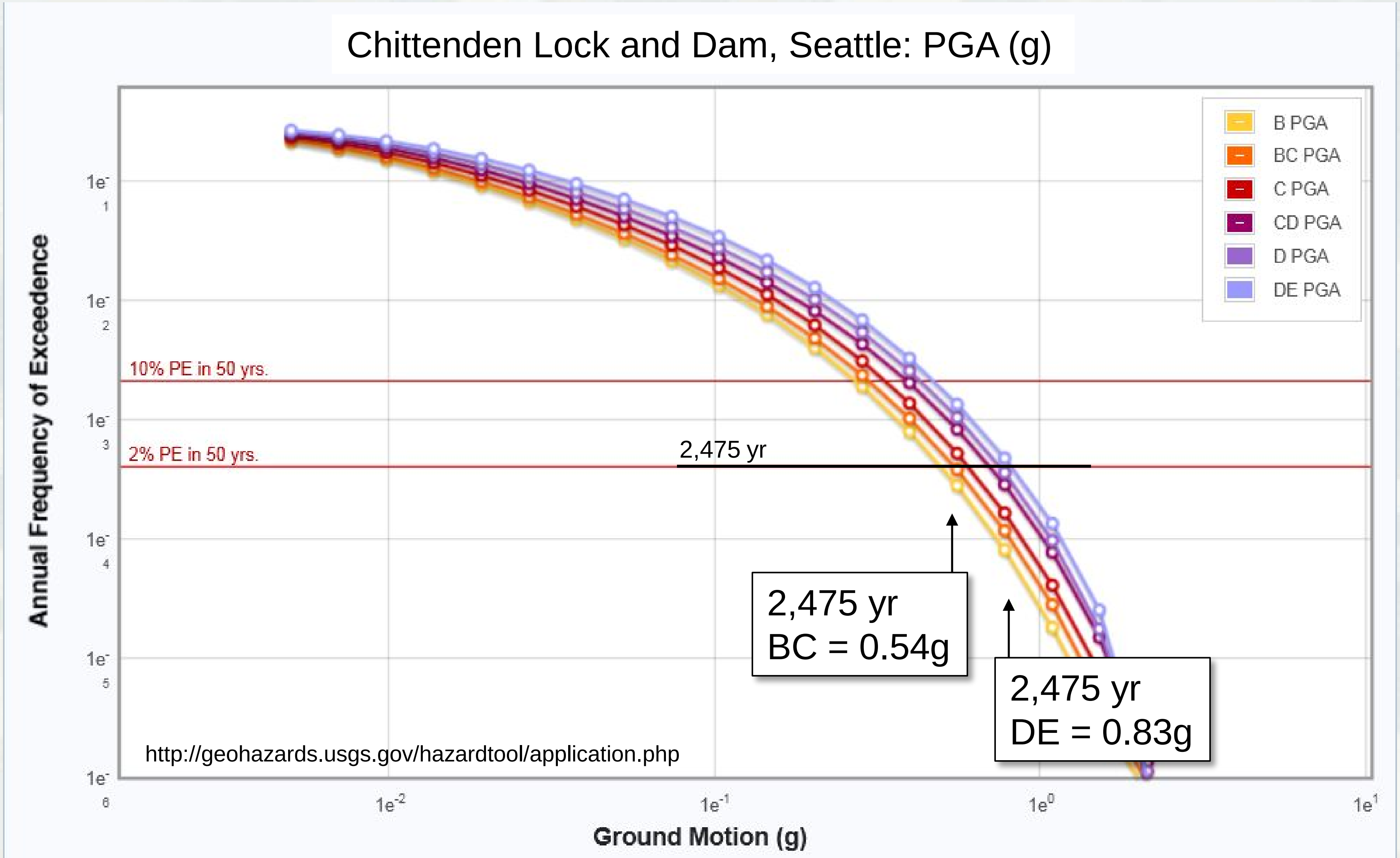
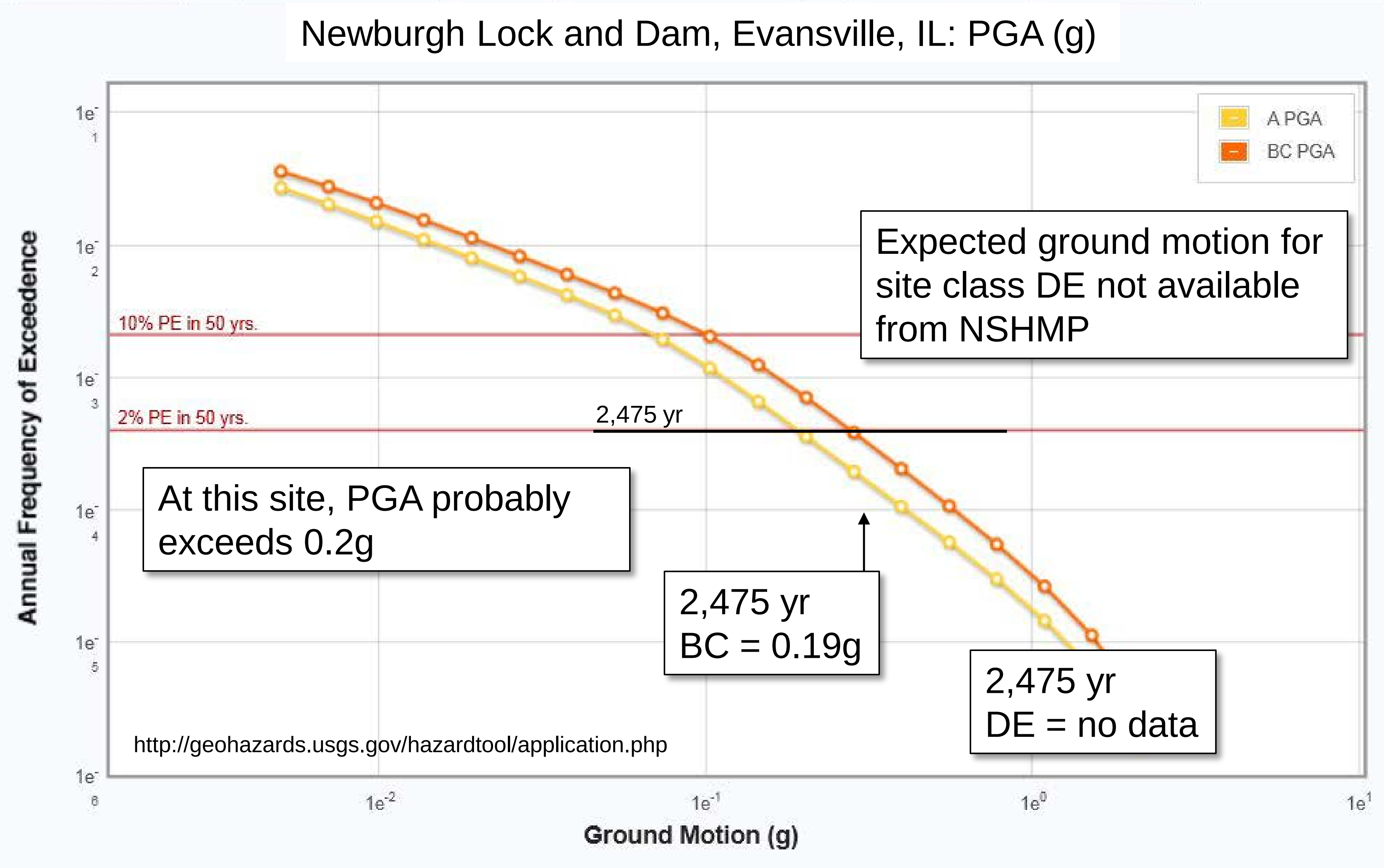
NSHMP Hazard Curve and PGA



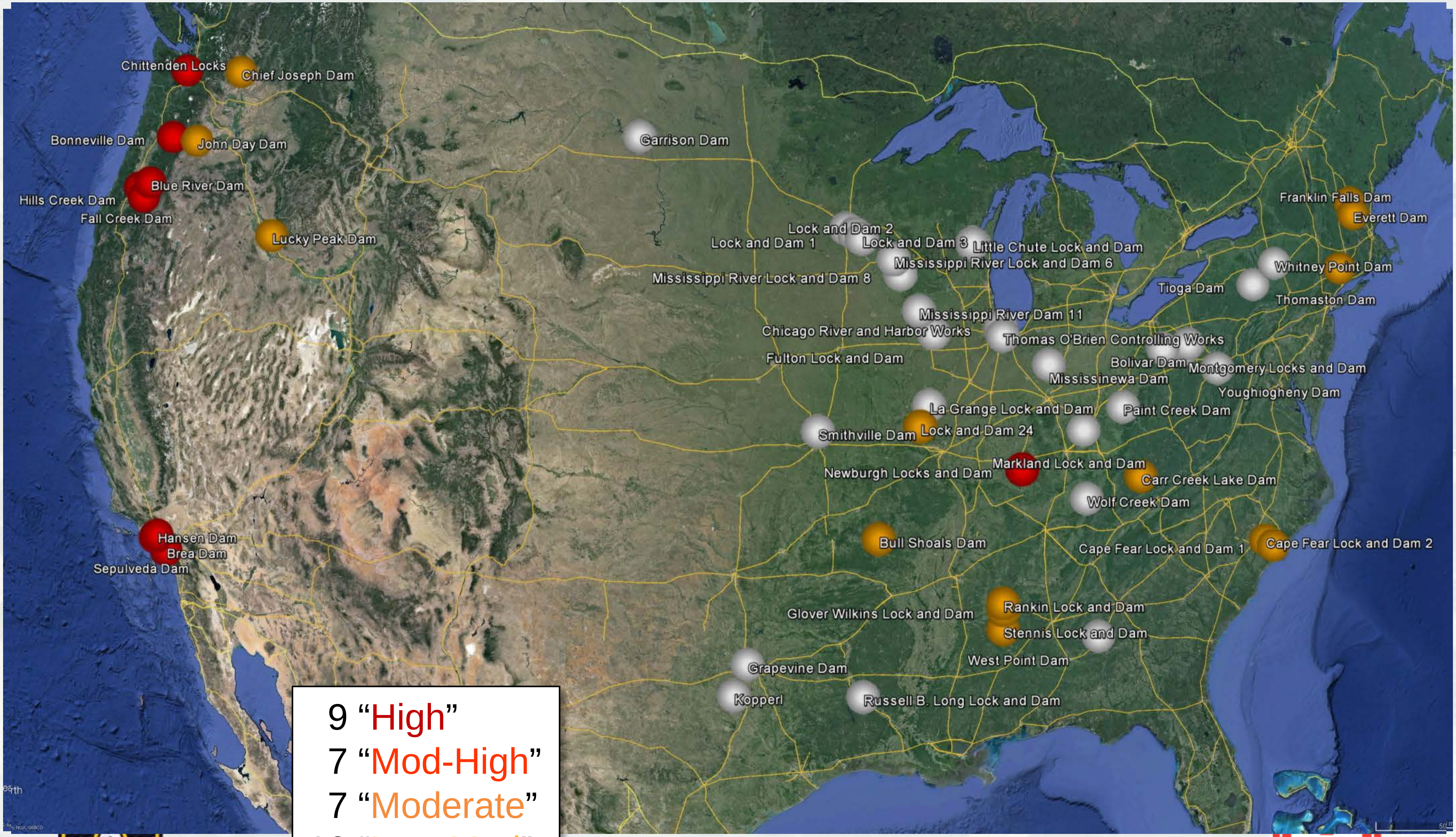
NSHMP Hazard Curve and PGA



Preliminary Seismic Screening

- Limited technical effort; readily available data
  - NSHMP seismic hazard mapping
    - 2475-yr and 9975-yr PGA
    - High, Moderate, Low qualitative hazard classes
  - Geotechnical site soil classes, estimated by:
    - Regional seismic velocity data (Vs30 est.)
    - General geologic/geomorphic interpretation
  - Adjusted qualitative hazard classes
    - High, Mod-High, Moderate, Low-Mod, Low

Screening-level Seismic Hazard Classes



9 "High"
7 "Mod-High"
7 "Moderate"
10 "Low-Mod"
19 "Low"

Seismic Analyses
for Individual Dams and Levees

- Semi-Quantitative Risk Assessments
  - ▸ Dam Periodic Assessments (10-yr)
  - ▸ Levee Screening Tool
- Initial Evaluation Study
- Dam Safety Modification Study
- Preliminary Engineering and Design

Semi-Quantitative Risk Assessments

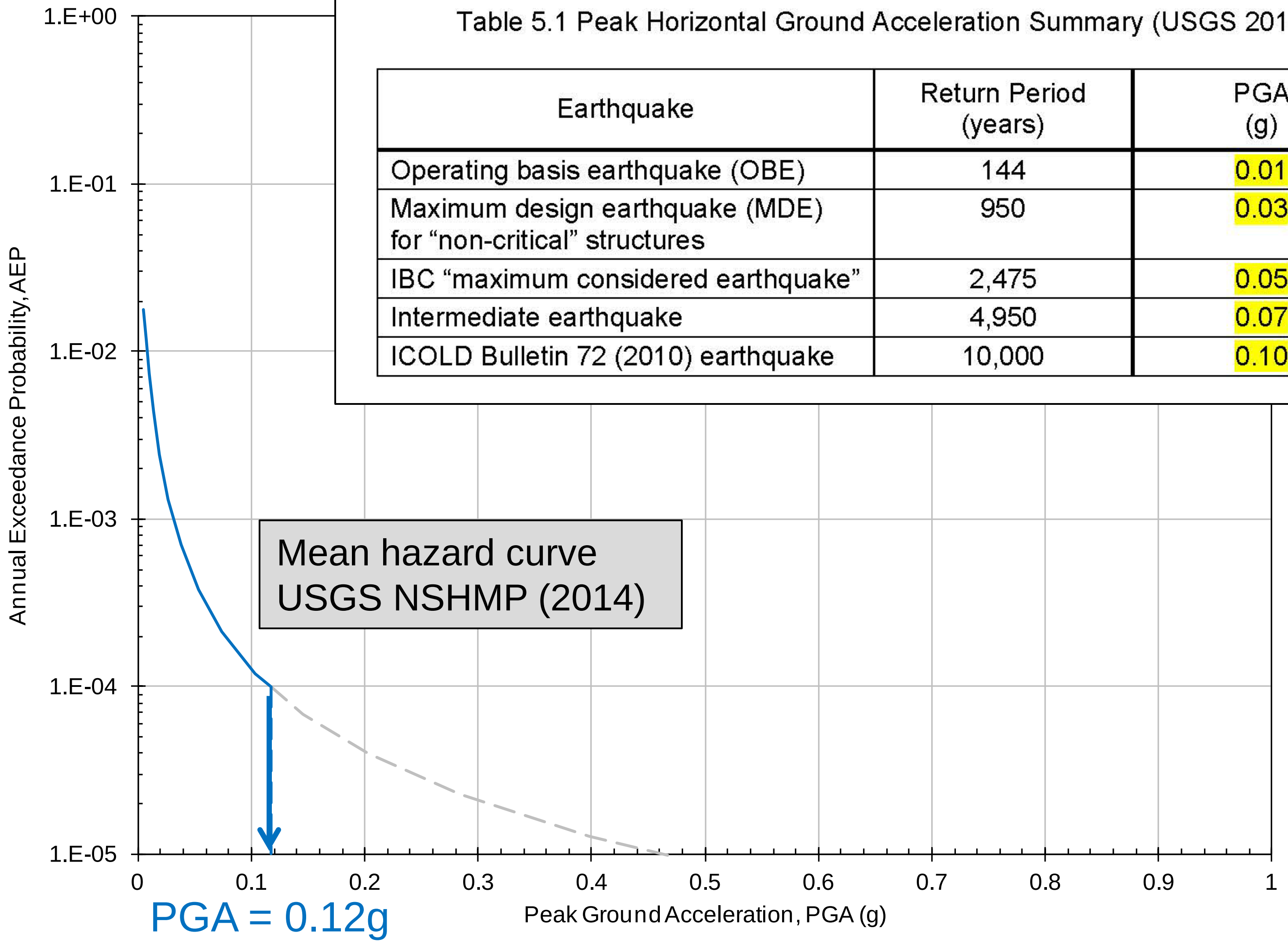
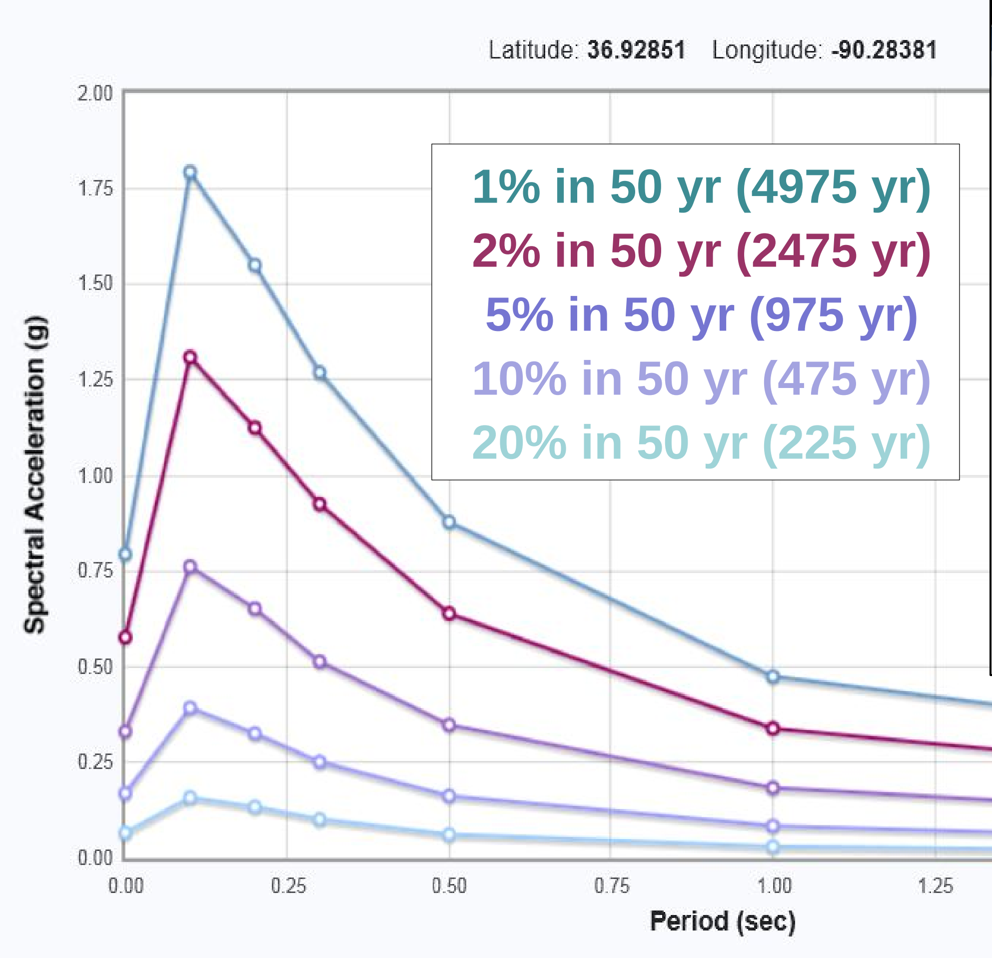


Table 5.1 Peak Horizontal Ground Acceleration Summary (USGS 2014)

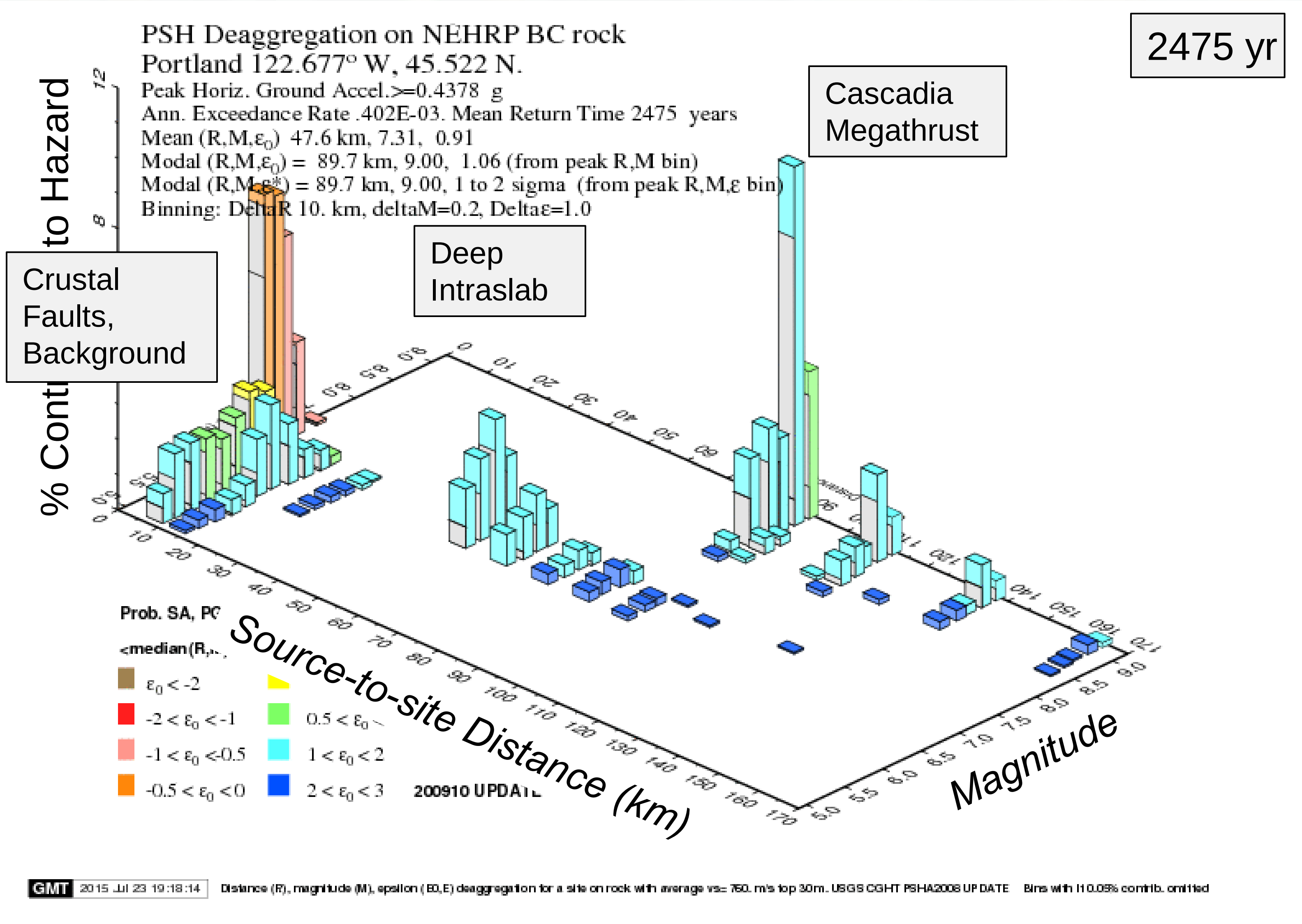
Earthquake	Return Period (years)	PGA (g)
Operating basis earthquake (OBE)	144	0.01
Maximum design earthquake (MDE) for "non-critical" structures	950	0.03
IBC "maximum considered earthquake"	2,475	0.05
Intermediate earthquake	4,950	0.07
ICOLD Bulletin 72 (2010) earthquake	10,000	0.10

Uniform Hazard Spectra

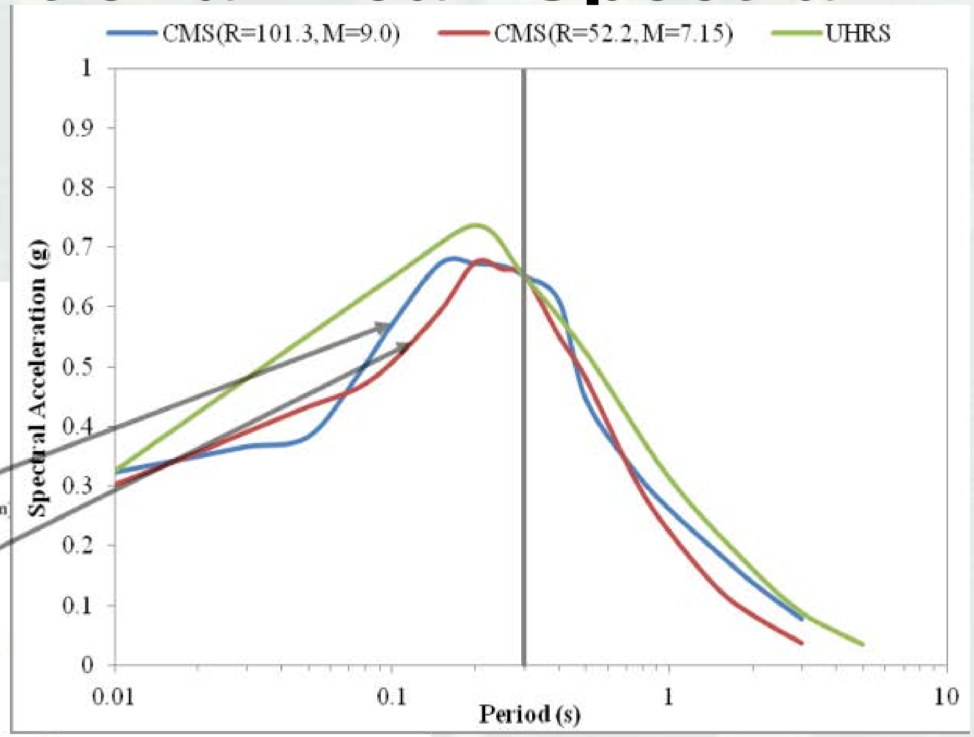


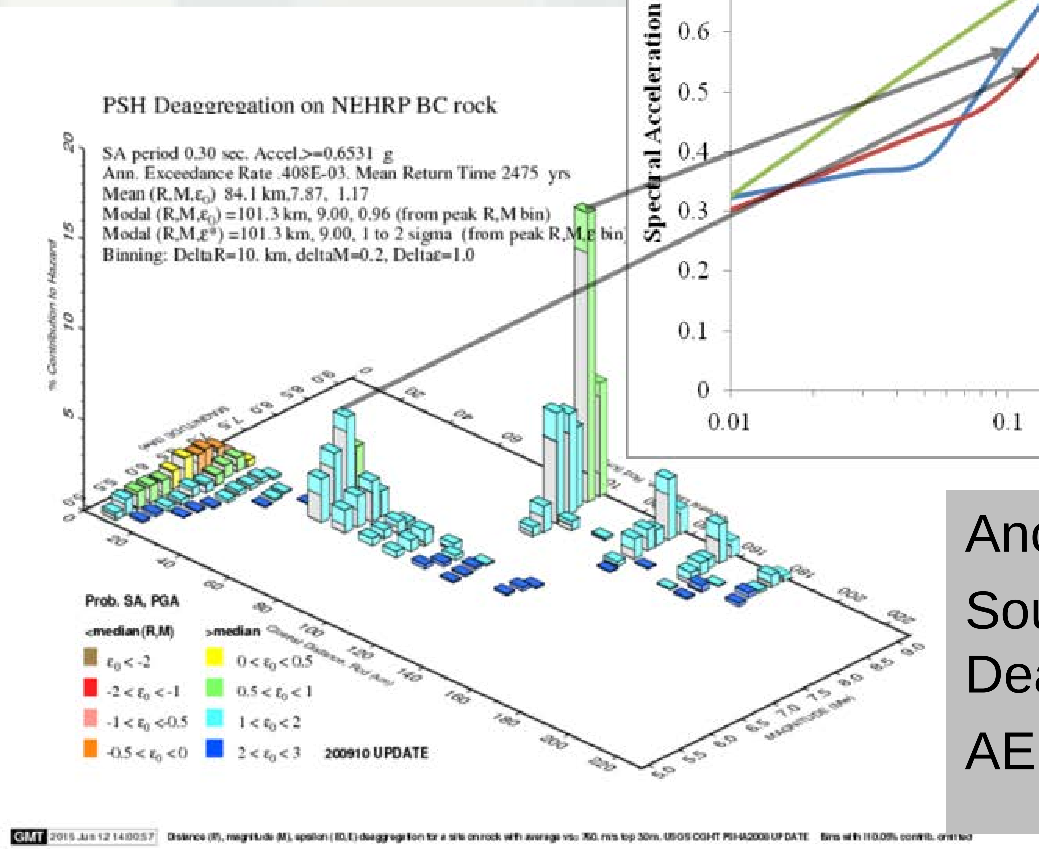
http://geohazards.usgs.gov/hazardtool/application.php

Seismic Source Deaggregation



Deaggregation and Conditional Mean Spectra



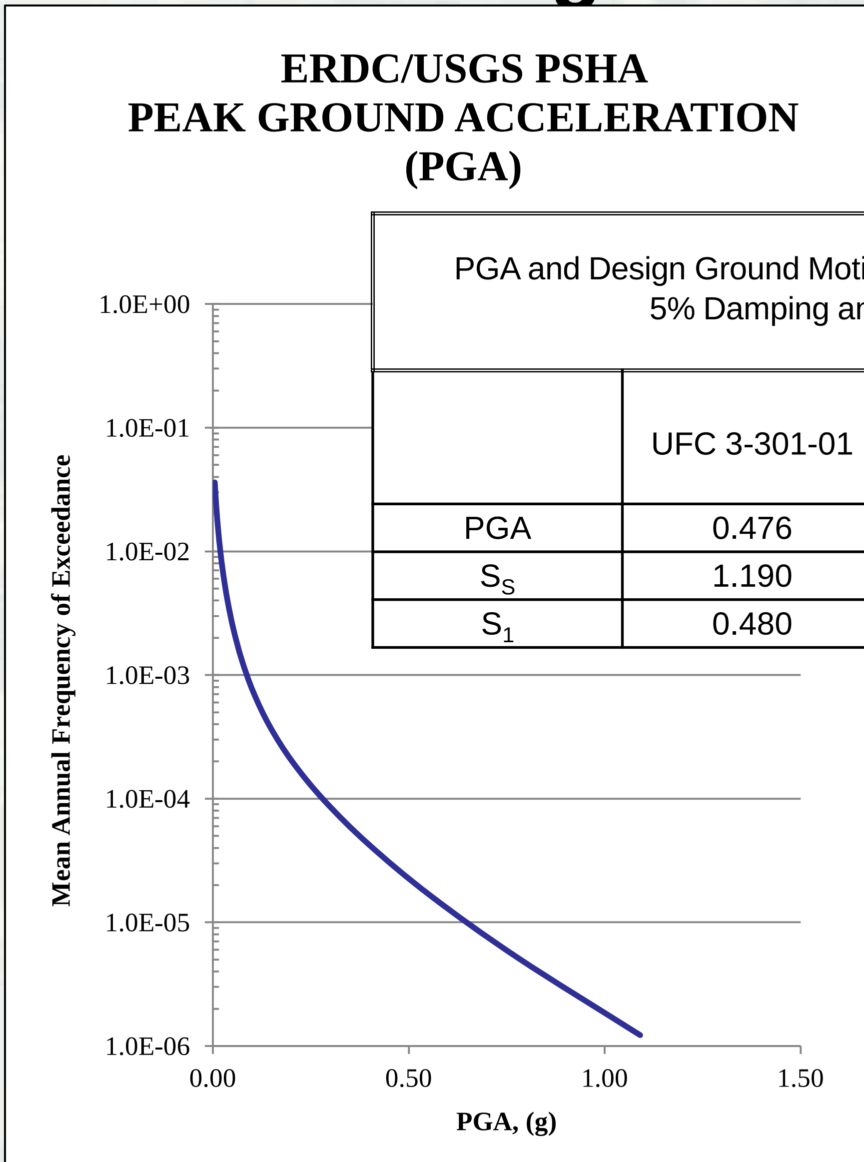


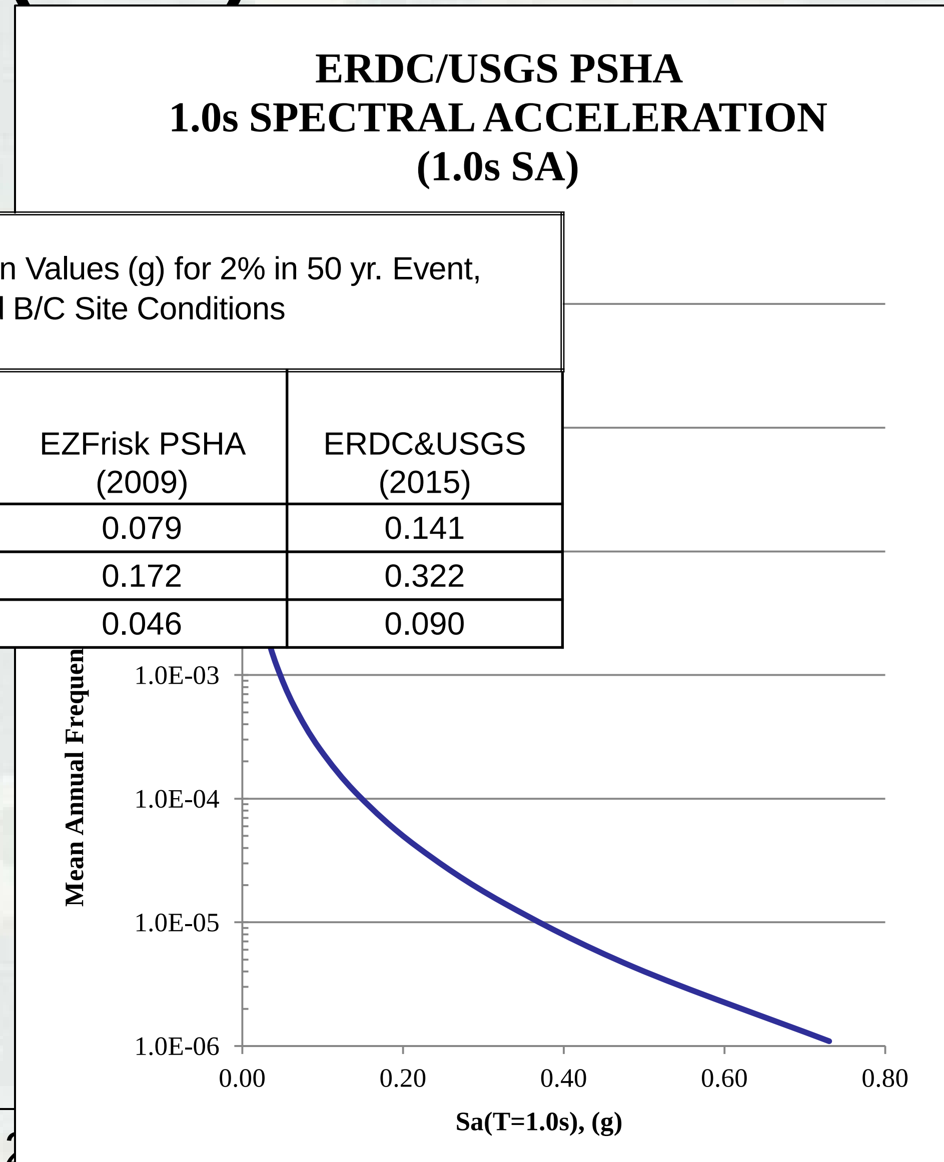
Anchored for 0.3s spectral accel.

Sources identified using 2008 USGS Deaggregation tool

AEP: 2% in 50 yrs; RP: 2,475 yr

Site-specific PSHA using USGS (2014) models

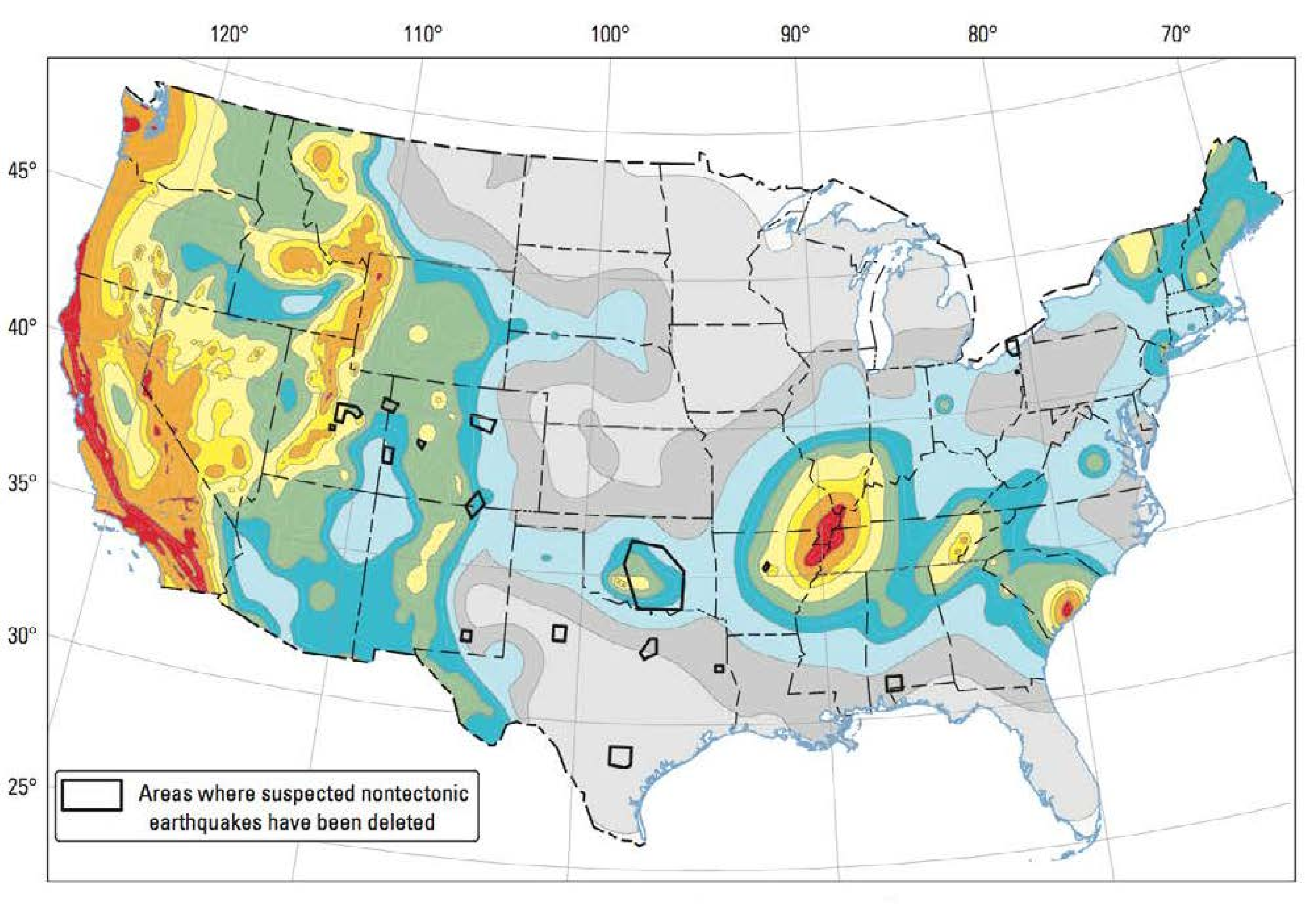




PGA and Design Ground Motion Values (g) for 2% in 50 yr. Event, 5% Damping and B/C Site Conditions

	UFC 3-301-01	EZFrisk PSHA (2009)	ERDC&USGS (2015)
PGA	0.476	0.079	0.141
S_S	1.190	0.172	0.322
S_1	0.480	0.046	0.090

Areas of Induced Seismicity: Excluded from USGS NSHMP



Qualitative Risk Analysis

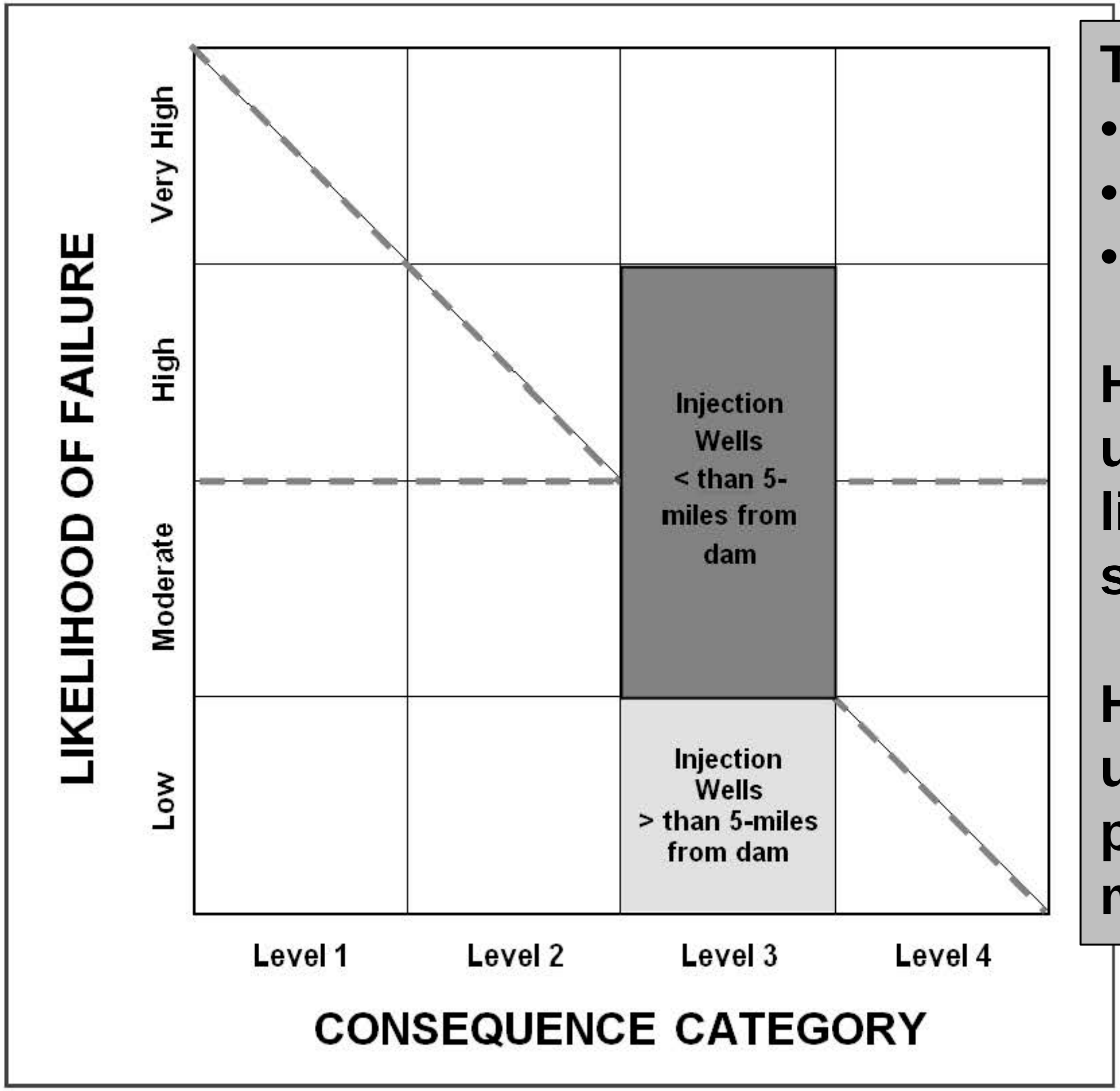


Figure 4.18. SQRA Risk Matrix for PFM 5: Injection (Induced Seismicity)

Three types of PFMs:

- **Fracking**
- **Extraction**
- **WW Injection**

How well do we understand the likelihood of induced seismicity?

How well do we understand resulting potential failure modes?

Induced Seismicity (Injection) unknowns

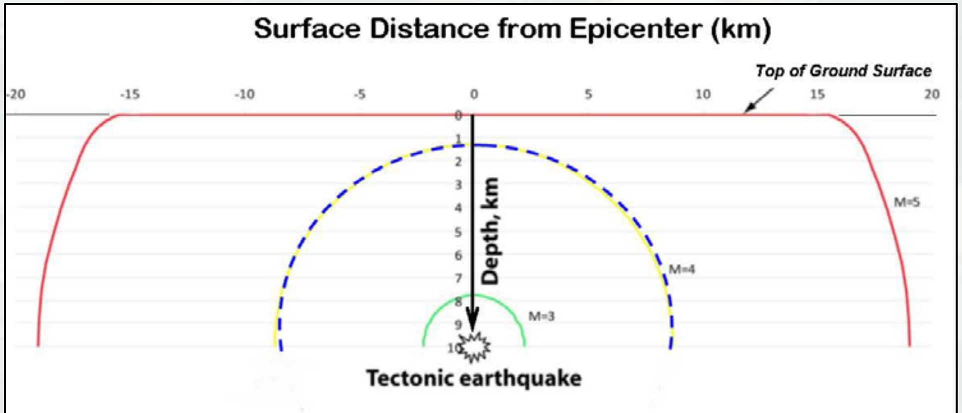


Figure 4.15a. Because naturally occurring earthquakes usually occur at depths that are greater than EQs that are induced, the energy for smaller natural events (< M4) is usually dissipated before shaking can be felt at the ground surface. For a naturally occurring EQ having a magnitude of 5 (M5), the shaking can occur at the ground surface within a radius of approximately 15km (9 miles).

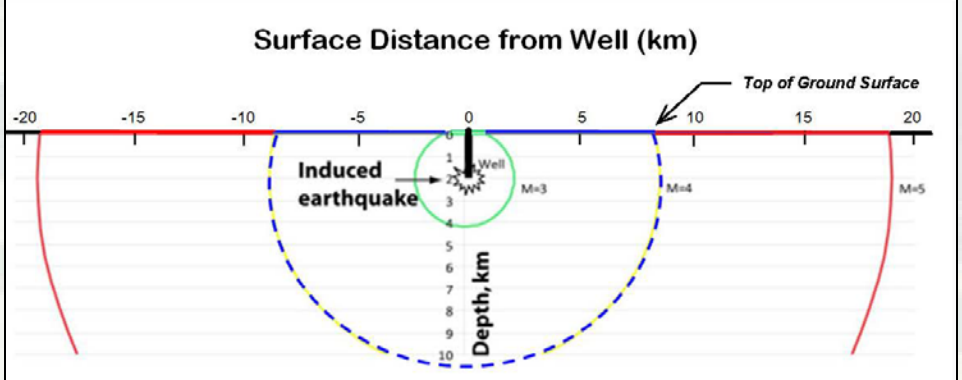


Figure 4.15b. An induced earthquake that occurs near the bottom of a well is too shallow for energy from the event to dissipate before it reaches the ground surface. As a result, even small induced EQs (M3) can generate shaking that can be felt at the surface within 1km (0.6 miles) of the well. The shaking from larger induced earthquakes (≥M4) can be felt at substantially greater distances than those with deeper focal depths. An M5-induced EQ can be felt up to 20km (12 miles) from the well, while an M4 can be felt up to 8km (5 miles).

Injection

- Rate
- Volume

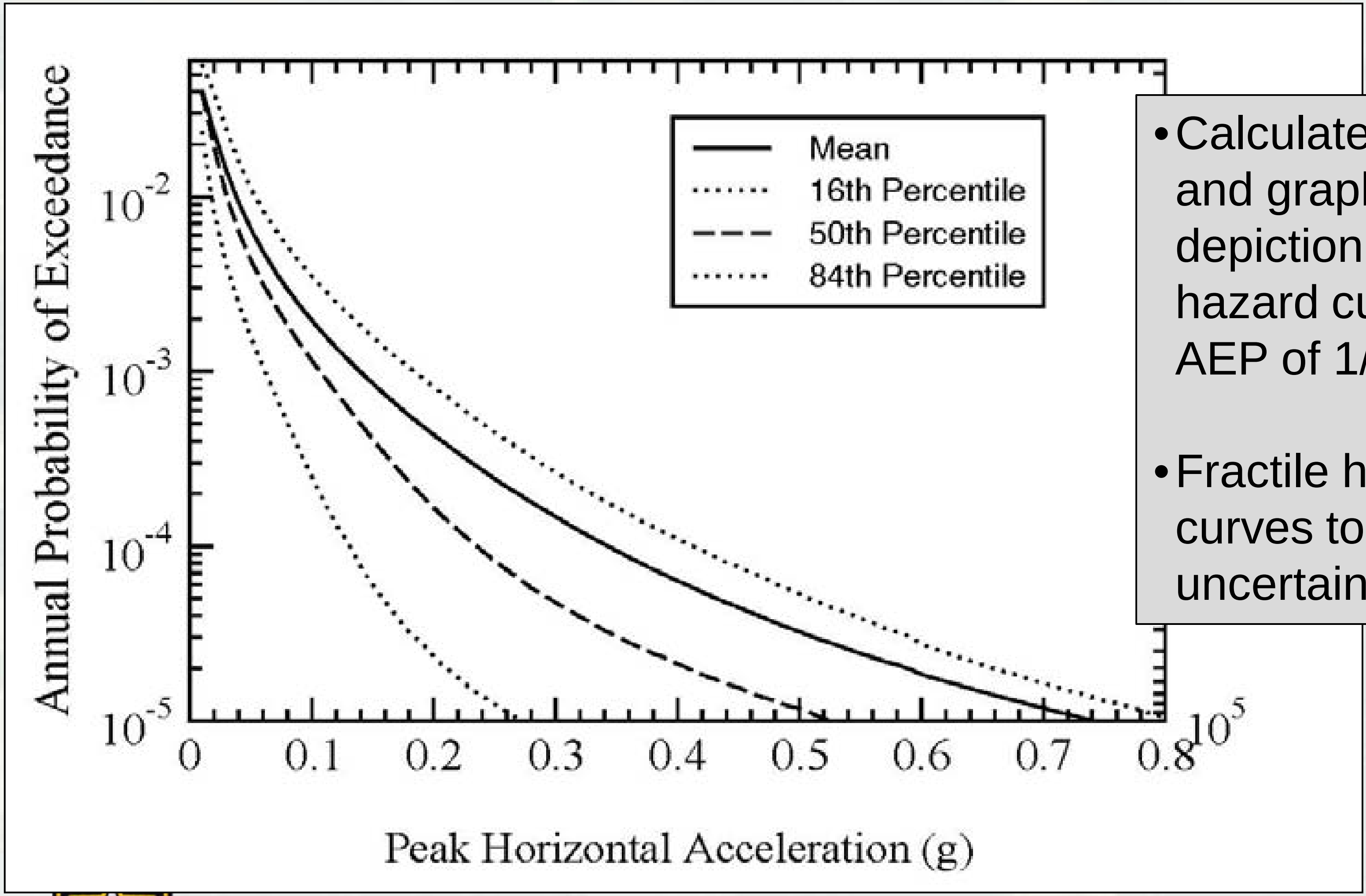
(short term, cumulative)

Earthquakes

- Mmax
- Stress Drop
- Depth/Distance

(specific GMPEs?)

USACE Wish List (example)



- Calculated data and graphical depiction of mean hazard curve to AEP of 1/100,000
- Fractile hazard curves to illustrate uncertainties