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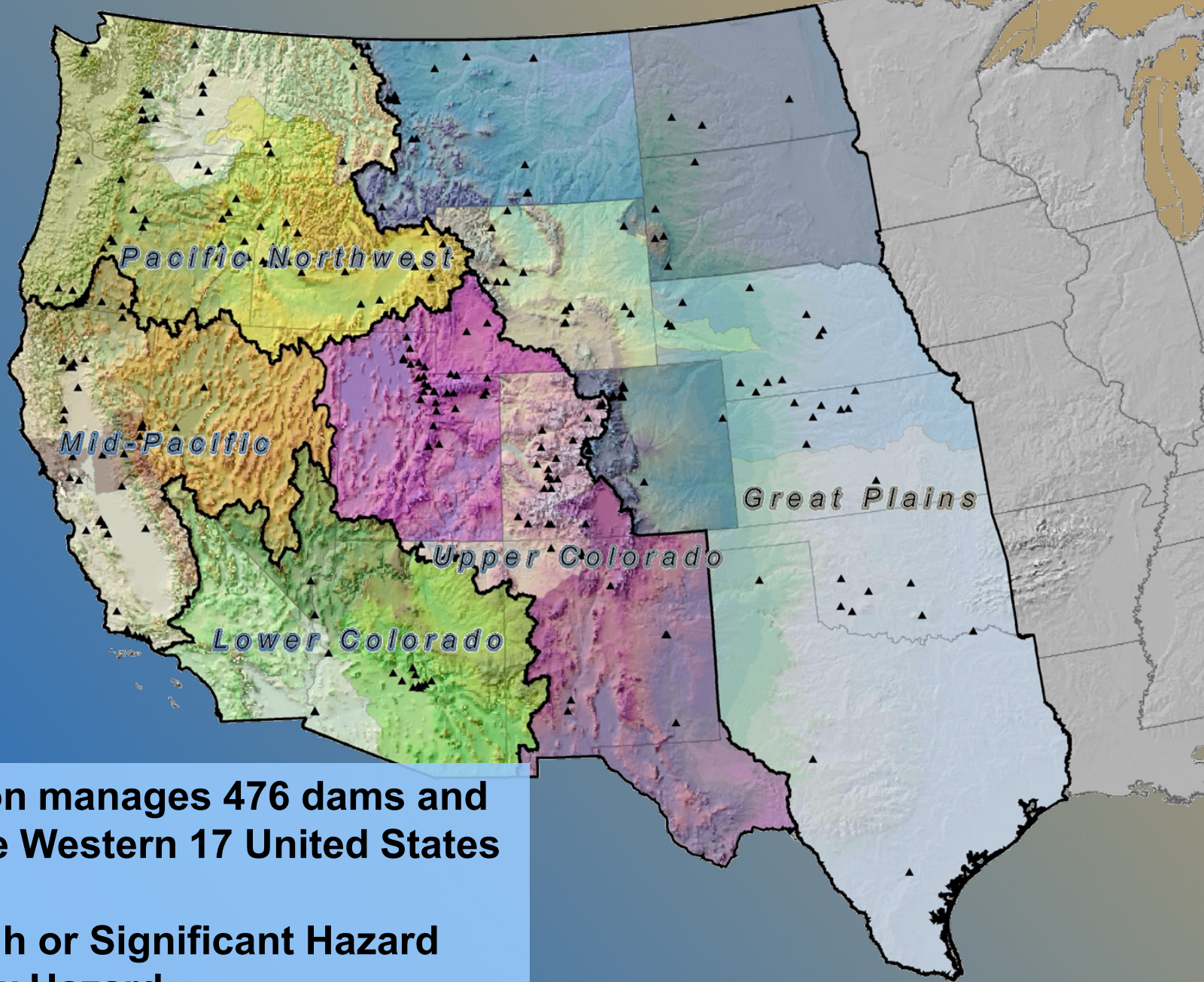
Managing Water in the West

Dam Safety Program

Managing Risk to Support the Core Mission



U.S. Department of the Interior
Bureau of Reclamation



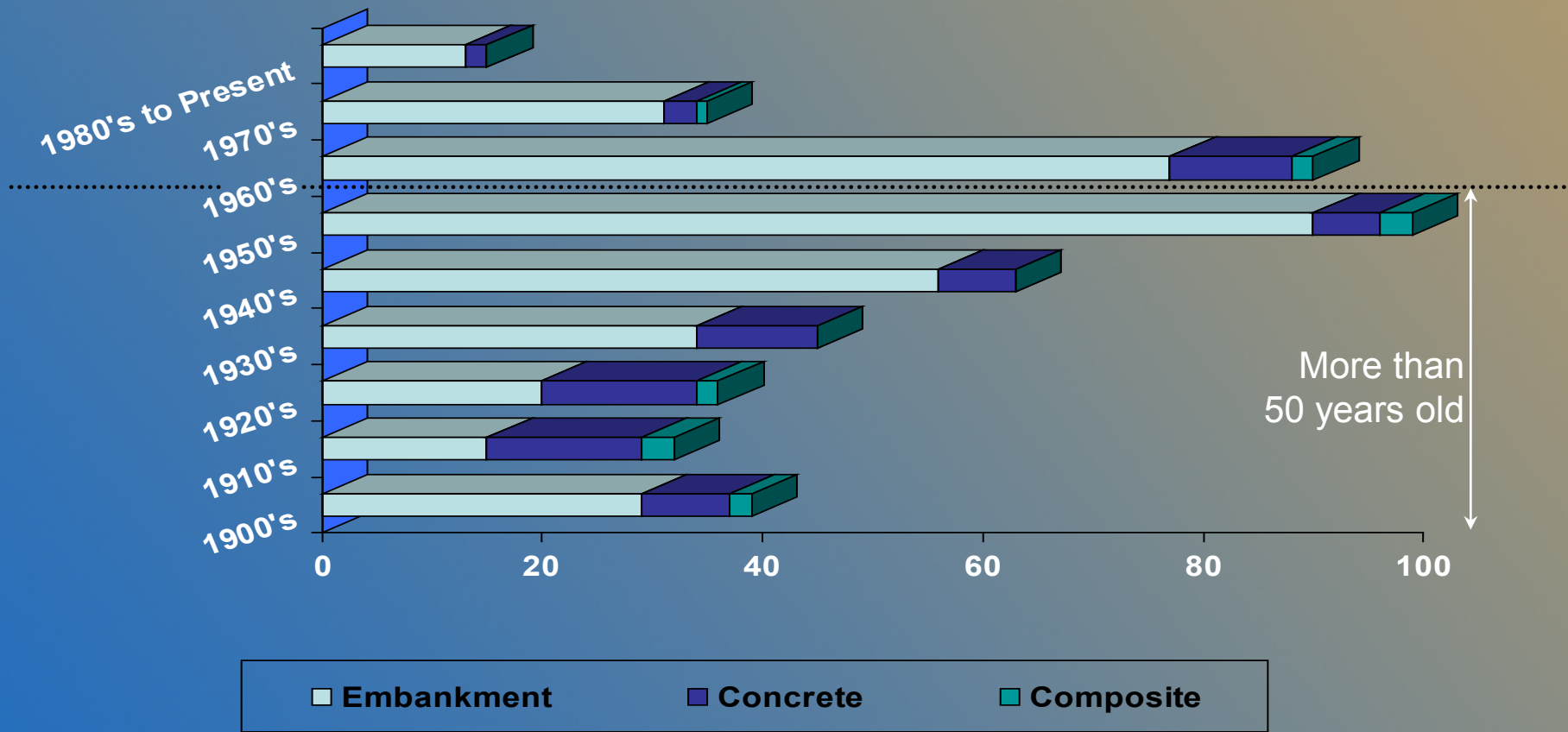
**Reclamation manages 476 dams and
dikes in the Western 17 United States**

**370 are High or Significant Hazard
106 are Low Hazard**

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Bureau of Reclamation

Original Construction Dates



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Teton Dam Failure – 1976

11 killed, ½ billion dollars property damage

- Prompted new federal legislation on dam safety
- Reclamation's dam safety program established soon after



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Dam Safety Related Legislation

- National Dam Inspection Act (1972)
(COE)
- Reclamation Safety of Dams Act (1978)
Amended (1984, 2000, 2002, 2004)
- National Dam Safety Program Act (2002)
(FEMA)
- Dam Safety and Security Act (2002)
(FEMA)

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Reclamation Safety of Dams Act

“In order to preserve the structural safety of Bureau of Reclamation dams and related facilities, the Secretary of the Interior is authorized to perform such modifications as he determines to be reasonably required.”

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The Act:

- Authorizes modification of Reclamation dams “the cause of which results from new **hydrologic** or **seismic** data or **changes in the state of the art** criteria...deemed necessary for safety purposes”
- Does **not** address conditions “resulting from age and normal deterioration or from nonperformance of reasonable maintenance”
- 75 dams repaired to date under Safety of Dams Act

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Dam Safety Program Processes

- **Safety Evaluation of Existing Structures (SEED) Process**
Non-reimbursable
Risk identification and evaluation phase
- **Initiate SOD Corrective Action (ISCA) Process**
Reimbursable
Risk reduction phase

What is Risk?

Reclamation Dam Safety Definitions

Annualized failure probability

- $P(\text{failure}) = P(\text{load}) \times P(\text{response to the load})$

Annualized loss of life (risk)

- $\text{Risk} = P(\text{load}) \times P(\text{response}) \times \text{Consequences}$

What is Risk Analysis?

The procedure to identify and quantify risk by establishing potential failure modes, providing numerical estimates of the likelihood of an event in a specified time period, and estimating the magnitude of the consequences.

What is Risk Assessment?

The use of risk estimation (analysis) in decision-making

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Risk Analysis Process

- Determine Failure Modes
- Construct event tree
- Discuss nodes
- List what's known/unknown
- Estimate probability
- Examine conclusions

Estimate Load Probabilities and Consequences

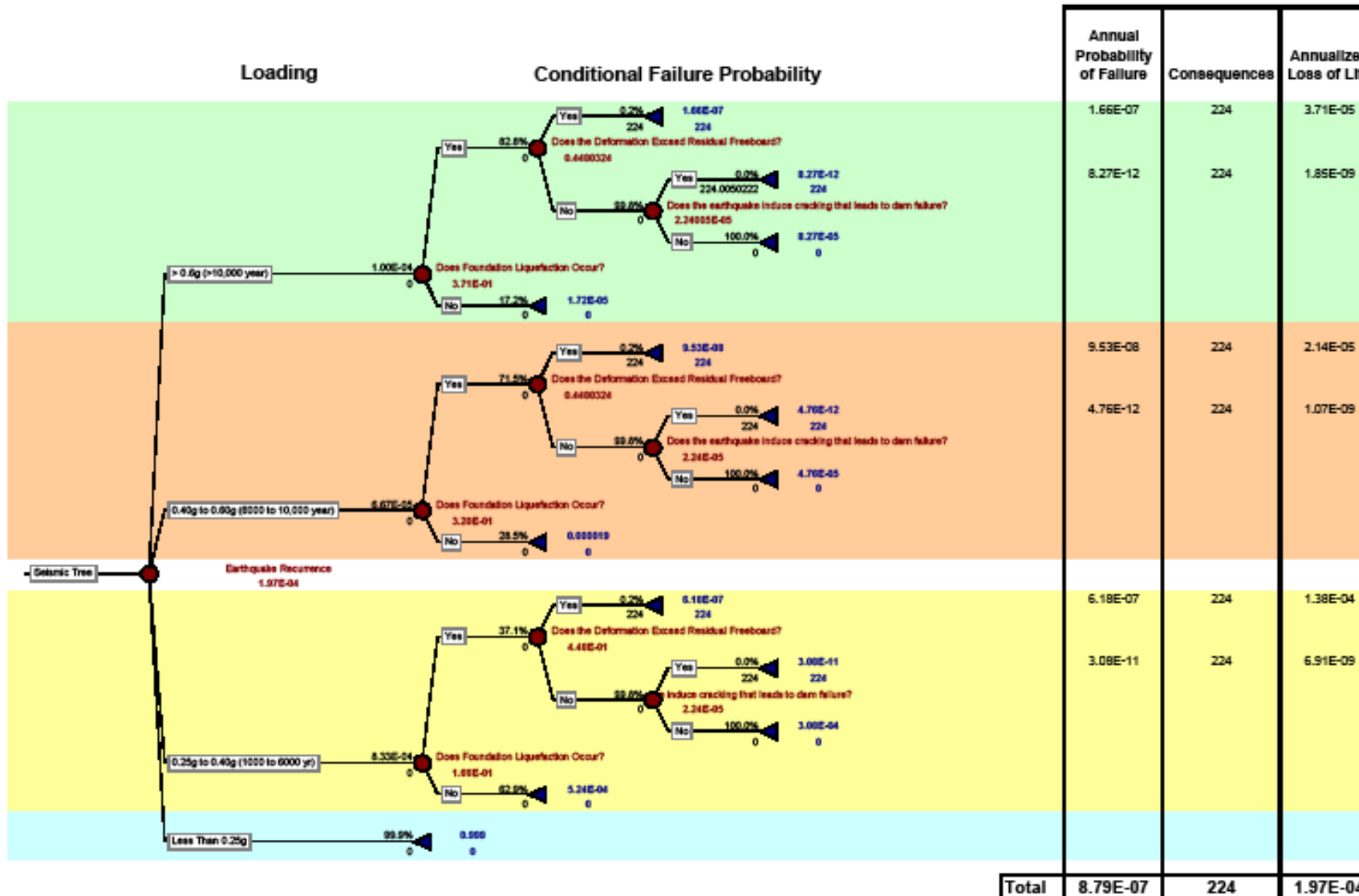
- Estimates made by specialists in most situations
- Seismic hazards estimated by seismologists (input from geologists)
- Hydrologic hazards estimated by flood hydrologists (input from meteorologists and geologists)
- Consequences estimated by specialists with inundation and dam failure expertise

Estimate Response Probabilities

- Usually a very difficult part of the process
- Estimates made by those most familiar with the behavior of the dam
- Break down the overall dam responses into smaller steps that are easier to understand and estimate
- “Toolboxes” have been and continue to be developed
- See Reclamation and USACE Best Practices in Dam Safety Risk Analysis trainings

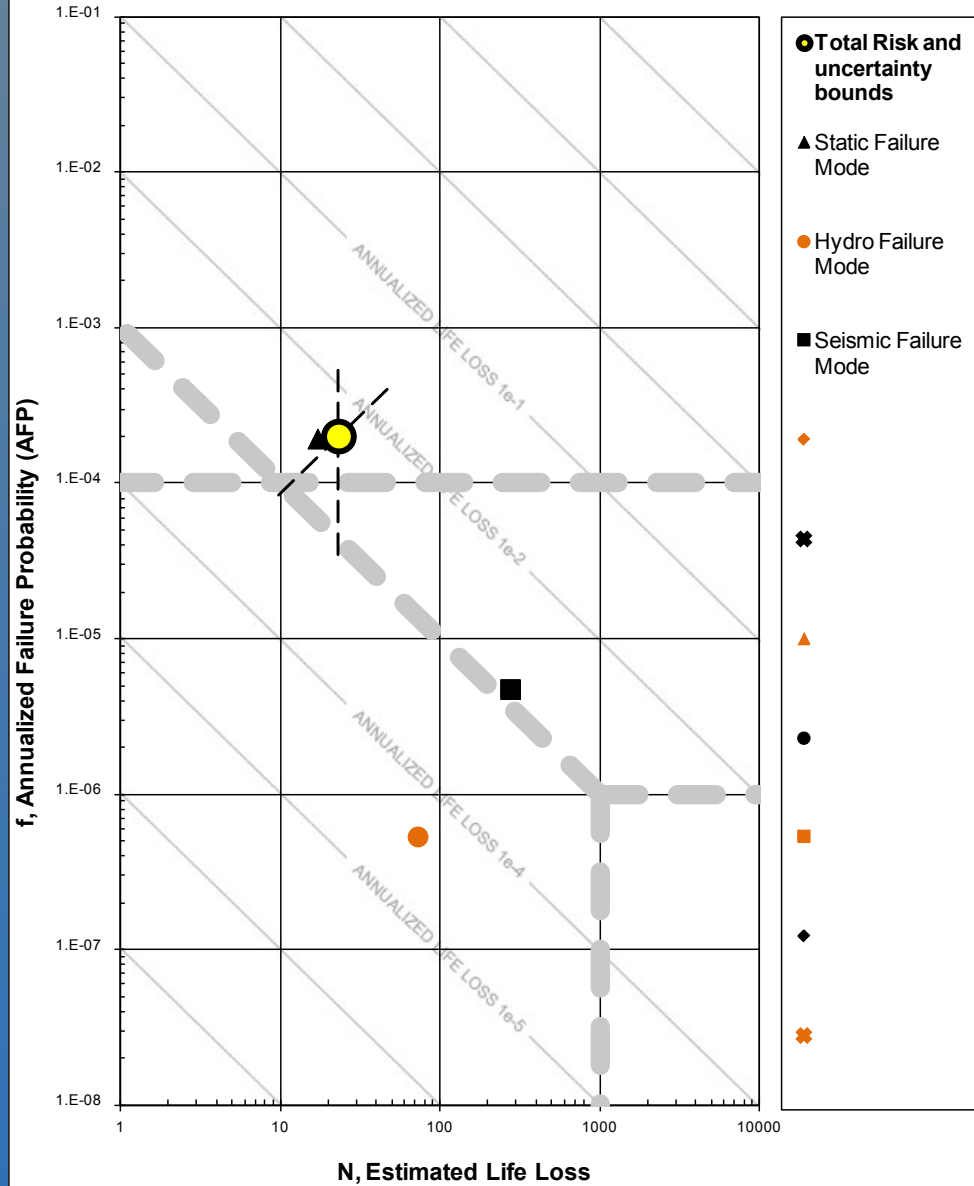
<http://www.usbr.gov/ssle/damsafety/Risk/methodology.html>

Event Tree Construction



Noname Dam

Notes:



Guidelines for Achieving Public Protection in Dam Safety Decision Making

- Guidelines ensure consistent and adequate levels of public protection when evaluating and modifying existing dams and designing new structures
- Define how to incorporate risk-based evaluations into the dam safety decision making process

Guidelines consider:

- Annual Probability of dam failure or condition that results in an unintentional release of reservoir
- Expected Loss of Life

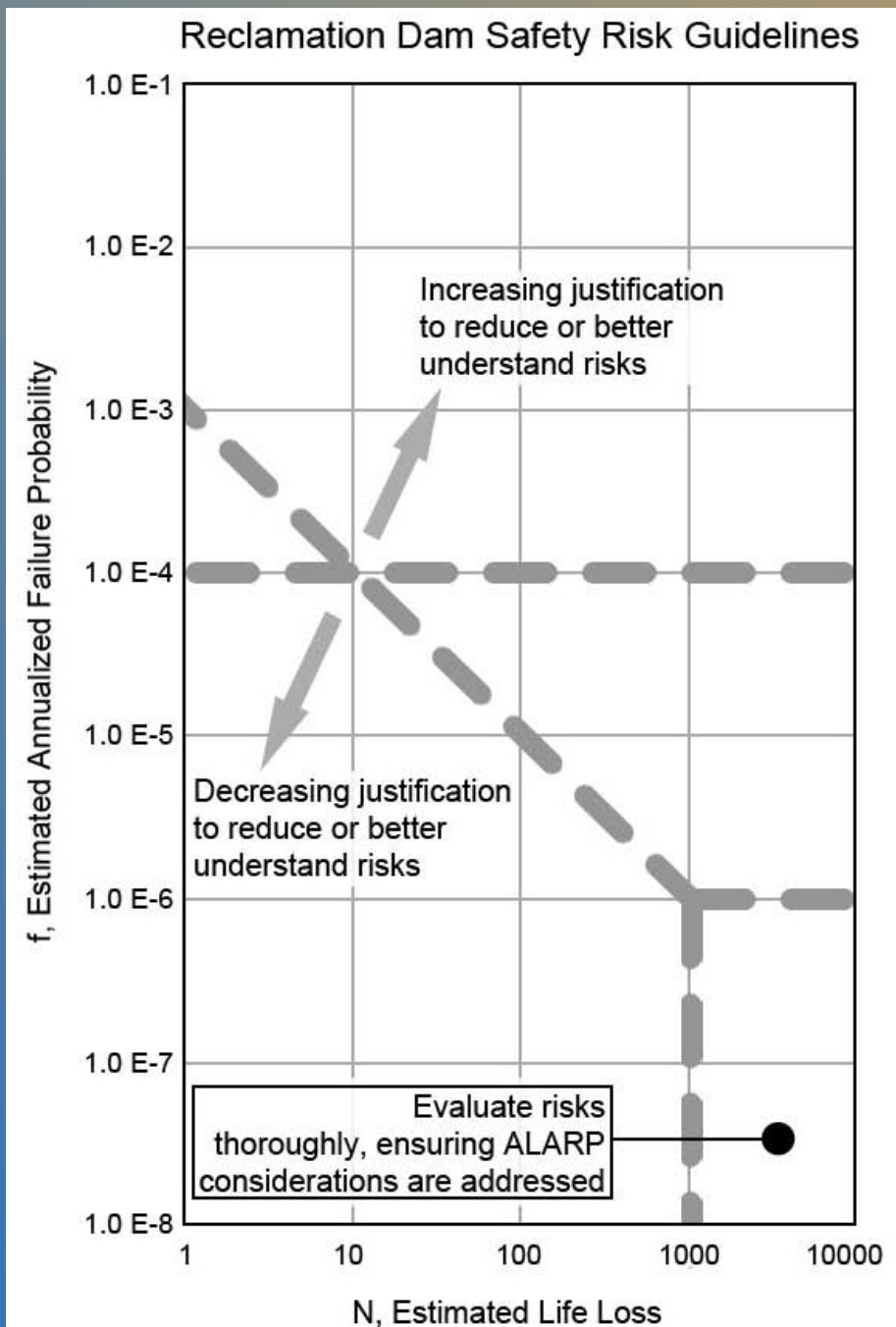
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Reclamation (2011)

Public Protection Guidelines

Rationale

Examples of Use



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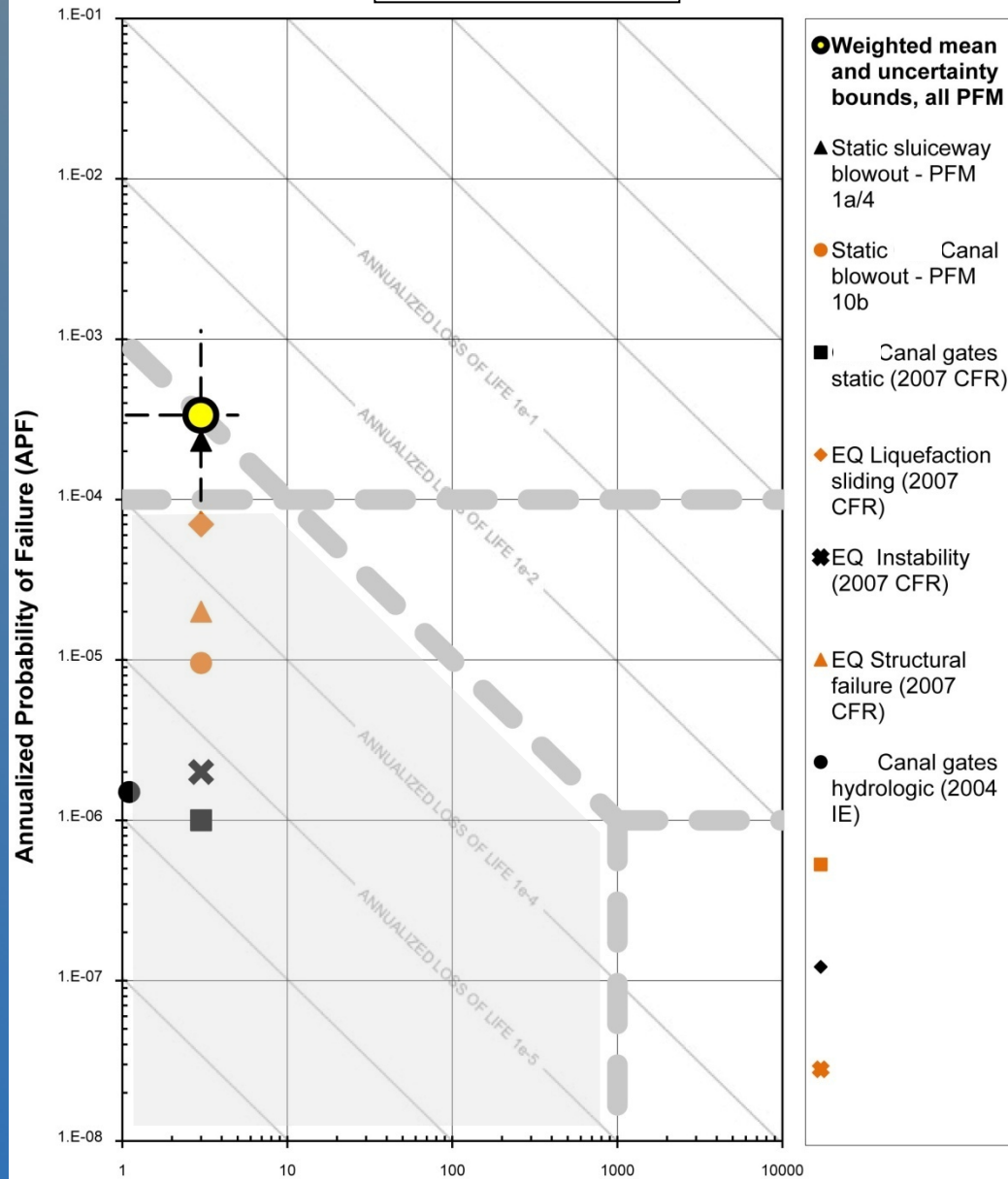
Issue Evaluation

- More detailed studies of the loadings
- Field Exploration
- Analyses
- Team Risk Analysis
- Recommendations
 - Risks below guidelines
 - Proceed with corrective action
- Decision Document

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No-Name Dam

Notes:



Dam Safety Program Processes

- **Safety Evaluation of Existing Structures (SEED) Process**

Non-reimbursable

Risk identification and evaluation phase

- **Initiate SOD Corrective Action (ISCA) Process**

Reimbursable

Risk reduction phase

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Examples of Risk Reduction Actions

- Short-term actions
 - Investigation of uncertainties
 - Reservoir restrictions
 - Increased monitoring
 - Operational changes
 - Interim Repairs
 - Upgraded EAP

**A.V. Watkins Dam Emergency Repair
Upstream Berm**



**Deer Flat Dam Interim Repair
Upstream Berm**

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Examples of Risk Reduction Actions

- Long-term actions
 - Load definition
 - Data collection
 - Structural modification
 - Long-term reservoir restriction



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Why Risk Based Decisions?

- Limited resources

Where can the funds be most efficiently expended to protect the population downstream of our facilities?

- Understanding of Uncertainty

How much do we really know about a structure?
Will it affect our understanding about its health?

Why Risk Based Decisions?

- Risk estimates focused on identified failure modes are easier to understand for decision makers, management, our customers and the public.
- Risk is now the primary justification for prioritizing and pursuing work activities.
- Risk is a convincing tool to explain why the dam safety program takes actions and how funds are being expended.

Benefits of Risk Based Decisions

- **Complies with Federal Guidelines for Dam Safety**
- **More comprehensive and consistent evaluations - less subjectivity**
- **Better focus on process of data collection**
- **Improved consistency in decisions**
- **Better focus in recommendations**
- **Better definition of objectives in scoping out work products**
- **Resource prioritization**
- **Project Justification**

Questions?

Reclamation's Dam Safety Program

- Public Protection Guidelines
- Rationale
- Examples of Use

Revised 2011

<http://www.usbr.gov/ssle/damsafety/references.html>

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