

# Infrastructure Research Thrust Area

## Risk Analysis for Dam Safety



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13 Mar 2001

# Risk Analysis For Dam Safety

## Problem

- **64% of Corps' Dams are Over 30 Years Old**
- **28% Have Reached or Exceeded Their 50-yr Design Life**
- **65 of the Corps' 569 Dams Have Been Identified as Being Hydrologically or Seismically Deficient, Based on Current Methodologies**
- **The Cost to Fix These Deficiencies Ranges Between \$ 1.3 and \$ 6.5 Billion with Limited Funds Available**

# Risk Analysis For Dam Safety

## Objective

**Develop methodologies, framework and software tools necessary for Districts, Divisions and USACE to proactively manage (REDUCE) the overall level of human and economic risk of the USACE inventory of flood control projects**

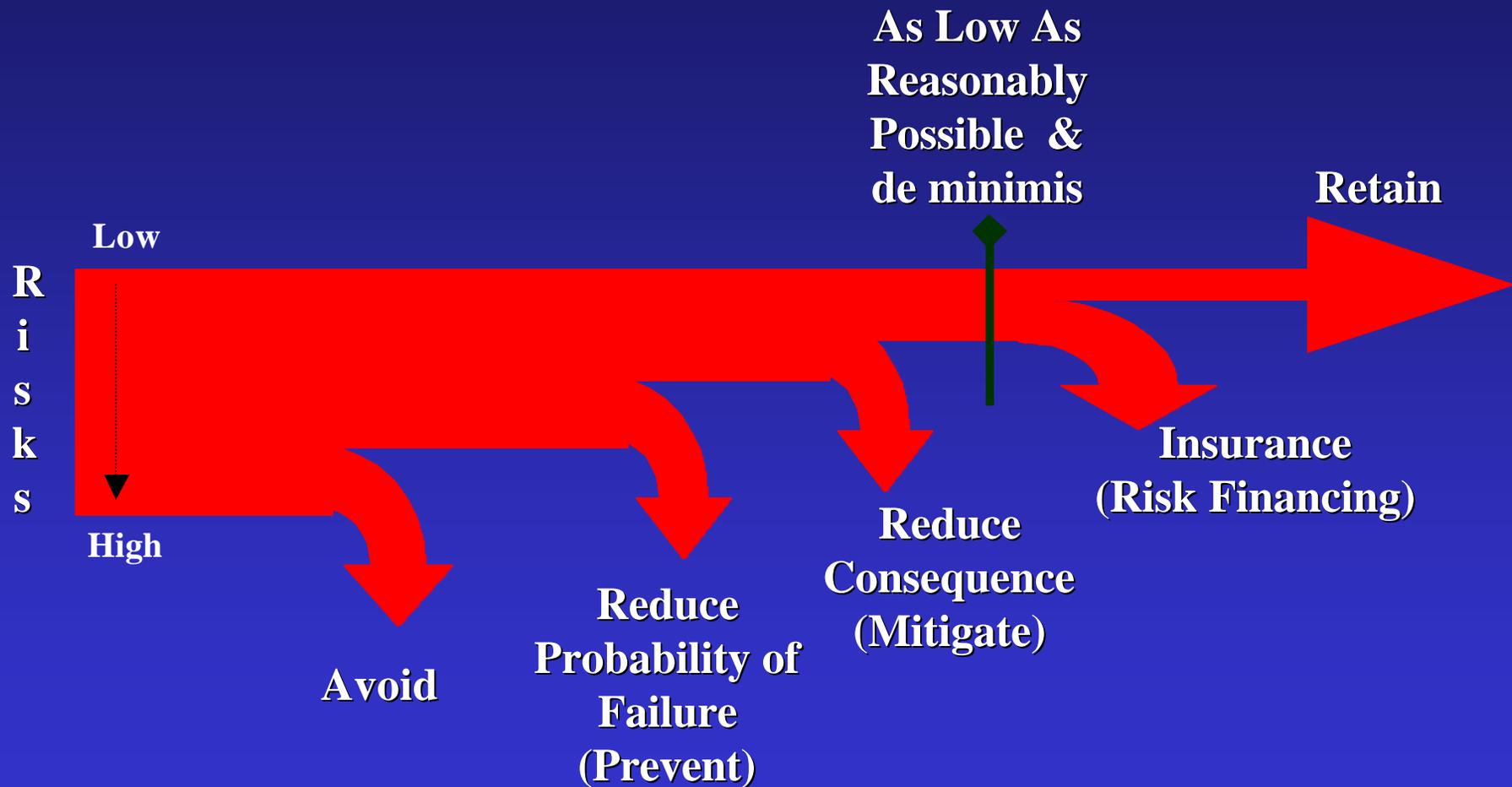
# Civil Works & Research Thrusts Business Programs

<ul style="list-style-type: none"> <li>• Navigation</li> <li>• Hydropower</li> </ul>	Nav...	<b>Infrastructure</b> Risk Analysis for Dam Safety		
<ul style="list-style-type: none"> <li>• Flood &amp; Storm Damage Reduction</li> <li>• Emergency Management</li> <li>• Recreation</li> </ul>	Flood...			
<ul style="list-style-type: none"> <li>• Environmental Protection, Restoration, and Management</li> <li>• Water Supply</li> </ul>	Env...			
<ul style="list-style-type: none"> <li>• Regulatory</li> <li>• Support for Others</li> </ul>				

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# Risk Management Philosophy



# Risk Management Philosophy



— *Best Return on investment scenario*

# Work Unit Interaction Strategy



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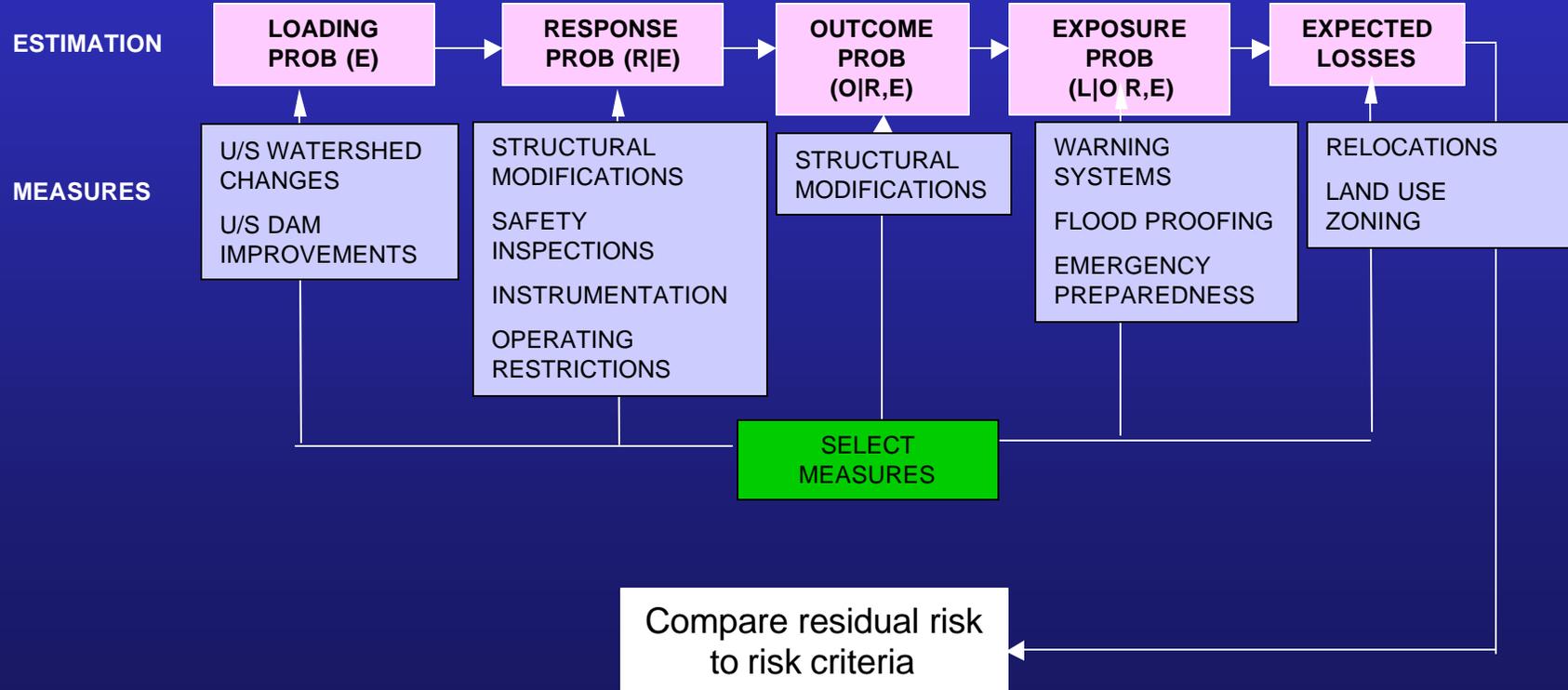
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# Priority R&D Thrust Areas

- **Risk-based analysis framework**
  - Inventory prioritization
  - Site specific risk assessments
- **Software tools to be used by District engineers to conduct risk analyses**
- **Framework for evaluating risk reduction potential of modification alternatives**

# SITE-SPECIFIC FRAMEWORK FOR RISK ASSESSMENT

	INITIATING EVENT	SYSTEM RESPONSE	OUTCOME	EXPOSURE	CONSEQUENCES
<b>IDENTIFICATION</b>	<ul style="list-style-type: none"> <li>• STATIC LOADING</li> <li>• FLOOD</li> <li>• EARTHQUAKE</li> <li>• U/S DAM FAILURE</li> <li>• LANDSLIDE</li> </ul>	<ul style="list-style-type: none"> <li>• OVERTOPPING</li> <li>• SLOPE FAILIURE</li> <li>• CRACKING</li> <li>• PIPING</li> <li>• STRUCT/FND FAILURE</li> </ul>	<ul style="list-style-type: none"> <li>• BREACH</li> <li>• PARTIAL BREACH</li> <li>• NO BREACH</li> </ul>	<ul style="list-style-type: none"> <li>• TIME OF DAY</li> <li>• SEASON</li> <li>• WARNING TIME</li> </ul>	<ul style="list-style-type: none"> <li>• LOSS OF LIFE</li> <li>• ECONOMIC</li> <li>• ENVIRONMENTAL</li> <li>• SOCIAL</li> </ul>



# **R&D Efforts**

## **Site Specific Risks Analysis**

- **Determine Likelihood of**
  - **Dam Failure**
  - **Failure of Gates and Equipment Associated with Normal Use and Deterioration**
  - **Major Hydrologic and Seismic Events**
- **Quantify**
  - **Human Risks (LOL)**
  - **Economic Risks**
  - **Other Downstream Consequences (Environmental, societal, etc)**

# **R&D Efforts Inventory Prioritization**

- **Methodology for District, Division and Nationwide Portfolio (Inventory) Risk Analyses**
  - Level of detail and data available
  - Rapid, yet effective
- **Regional Impact on System-wide Flood Control of Site Specific Dam Safety Issues**
- **Quantifying Regional Benefits and Impacts**
- **Decision Support Tools**

# Products to Address R&D Issues Under Development

## Compatible, interoperable framework for

- Site specific risk assessments
- Portfolio prioritization
- LOL estimates
- Economic consequences

# Products to Address R&D Issues Under Development

## Probabilistic models for

- Rate and extent of erosion in soil- and rock- lined spillways
- Quantifying hydrologic loading uncertainty
- Estimating extreme floods
- Quantifying seepage & piping in embankment dams, levees, and soil foundations
- Quantifying failure of gates and operating equipment
- Quantifying failure mechanisms of concrete dams
- Quantifying uplift uncertainties in rock foundations
- Estimating uncertainties for breaching parameters of embankment dams

# Technology Infusion Plan

- **Workshop to Initiate the Program (FY98)**
- **Demonstration Projects**
  - Site specific and Portfolio
  - Illustrative of procedures
  - Validation/Improvement
- **Workshops/Seminars to Train field on Portfolio and site specific procedures and guidance**

# **Risk Analysis for Dam Safety Demonstrations**

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# Site Specific Demo - Hills Creek Dam

- **Hills Creek Dam**
  - **Portland District**
  - **Upper Willamette River, Oregon**
  - **earthfill structure with a gated concrete spillway and outlet works**
  - **Completed in 1961**



# **Site Specific Demo – Hills Creek Dam Risk Issues**

- **Spillway gate reliability**
- **Embankment seepage**
- **Changed regional seismic risk**
- **Three reservoirs in series**
- **Stability of left abutment**

# Site Specific Demo – Hills Creek Dam Status

- **First team meeting, Sep 1999**
  - Site visit
  - Review of risk and consequence issues
  - Review of available data
- **Delay to negotiate Portland District responsibilities, supporting technical studies, and cost-sharing**
- **Technical study meeting Dec 2000**

# Portfolio Demo: Baltimore District

- **15 dams**
- **Initiated with background training and intro to PRA 15-16 Jun 1999**
- **Phases Completed**
  - **Perform engineering assessment of existing dams**
  - **Conduct risk assessment of existing dams**

# Portfolio Demo: Baltimore District

- **Phases Underway**
  - **Conduct risk assessment of risk reduction alternatives (Apr 01)**
  - **Integrate PRA results and prepare final report (Jul 01)**
  - **Completion (Jul 01)**

# Portfolio Demo: Huntington District

- **Initiated Sep 00**
  - 35 dams
- **Initial screening to 15 dams for PRA**
- **District conducting supporting studies**

# Portfolio Demo: Huntington District Status

- **Phases Completed**
  - Define overall PRA objectives and detailed work plan
- **Phases Underway**
  - Perform engineering assessment of existing dams (Feb 01)
  - Develop inputs for risk assessment of existing dams (Jun 01)

# Portfolio Demo: Huntington District Status

- **Future Phases**
  - **Conduct risk assessment of existing dams and risk reduction alternatives (Aug 01)**
  - **Integrate PRA results and prepare final report (Sep 01)**
  - **Completion (Sep 01)**

# Expected Benefits

- **Improved decision making in the DSAP, more effective use of limited funds**
- **Reduction in human and economic risks**
- **Software tools for conducting site specific and portfolio RA, reduced cost of DSAP reports**
- **Extend the safe operating life of USACE flood control projects**

# Primary Users

- **Decision Makers at Districts, MSCs and HQUSACE**
- **Dam Safety Engineers at the Districts and Divisions**
- **Federal Agencies (FERC, USBR)**
- **States and Private Firms**



# Programmatic Issues

- Program originally 5 years/ \$15 M
- Program must be extended to offset funding shortfall
- Funding stream uncertainty requires reassessment of the program priorities and work units each year

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