



Cherry Creek Dam Safety Modification Study

Lessons Learned for the Planning Community of Practice

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US Army Corps of Engineers
**PLANNING SMART
BUILDING STRONG**

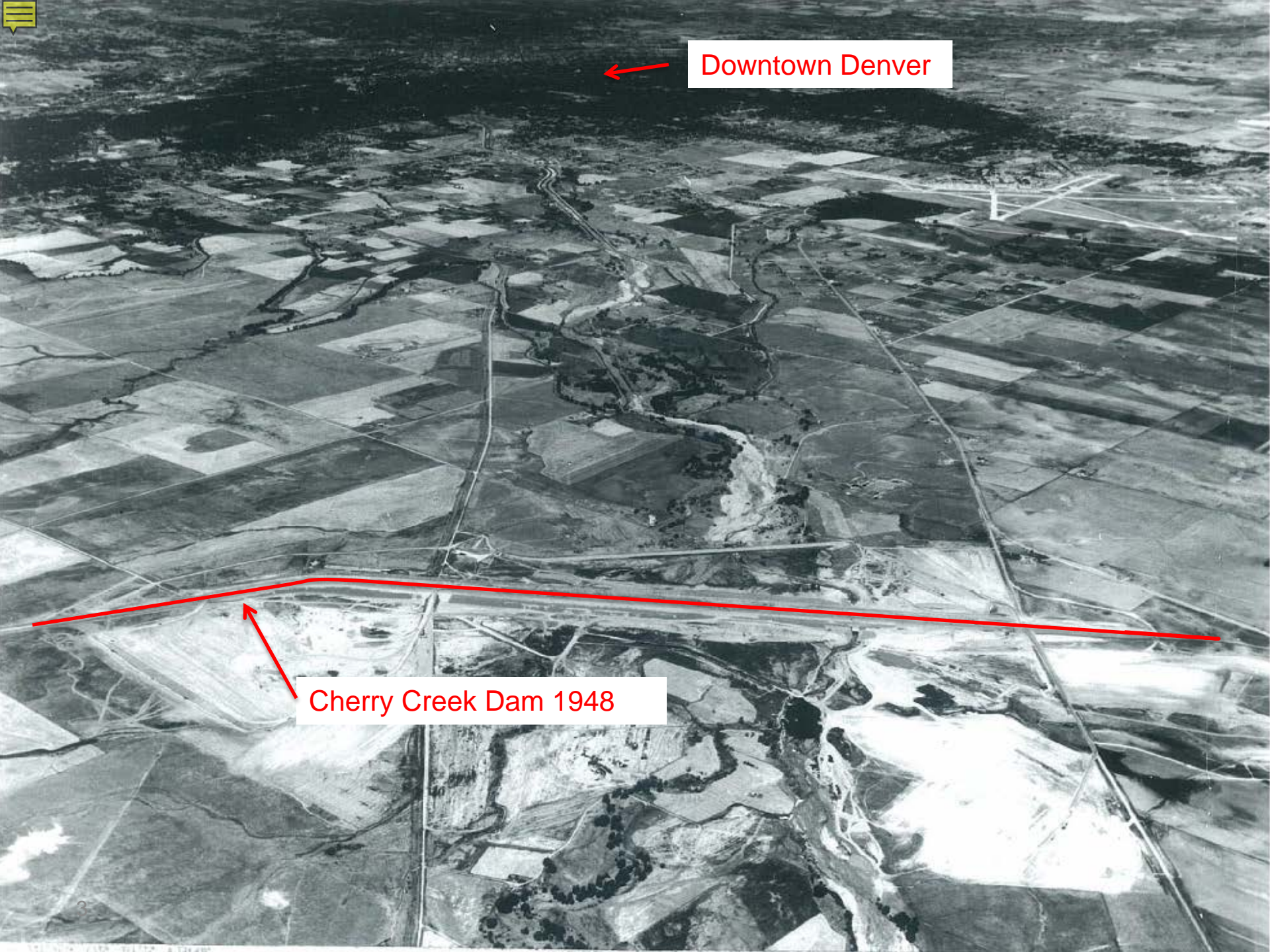




Presentation Overview

- Cherry Creek Dam Info/Background
- Topic #1: Dam Safety Modification Studies are new
- Topic #2: Formulating alternatives to address problems associated with dam failure
- Topic #3: Formulating alternatives to reduce consequences of a dam failure
- Topic #4: Public meeting tips





Downtown Denver

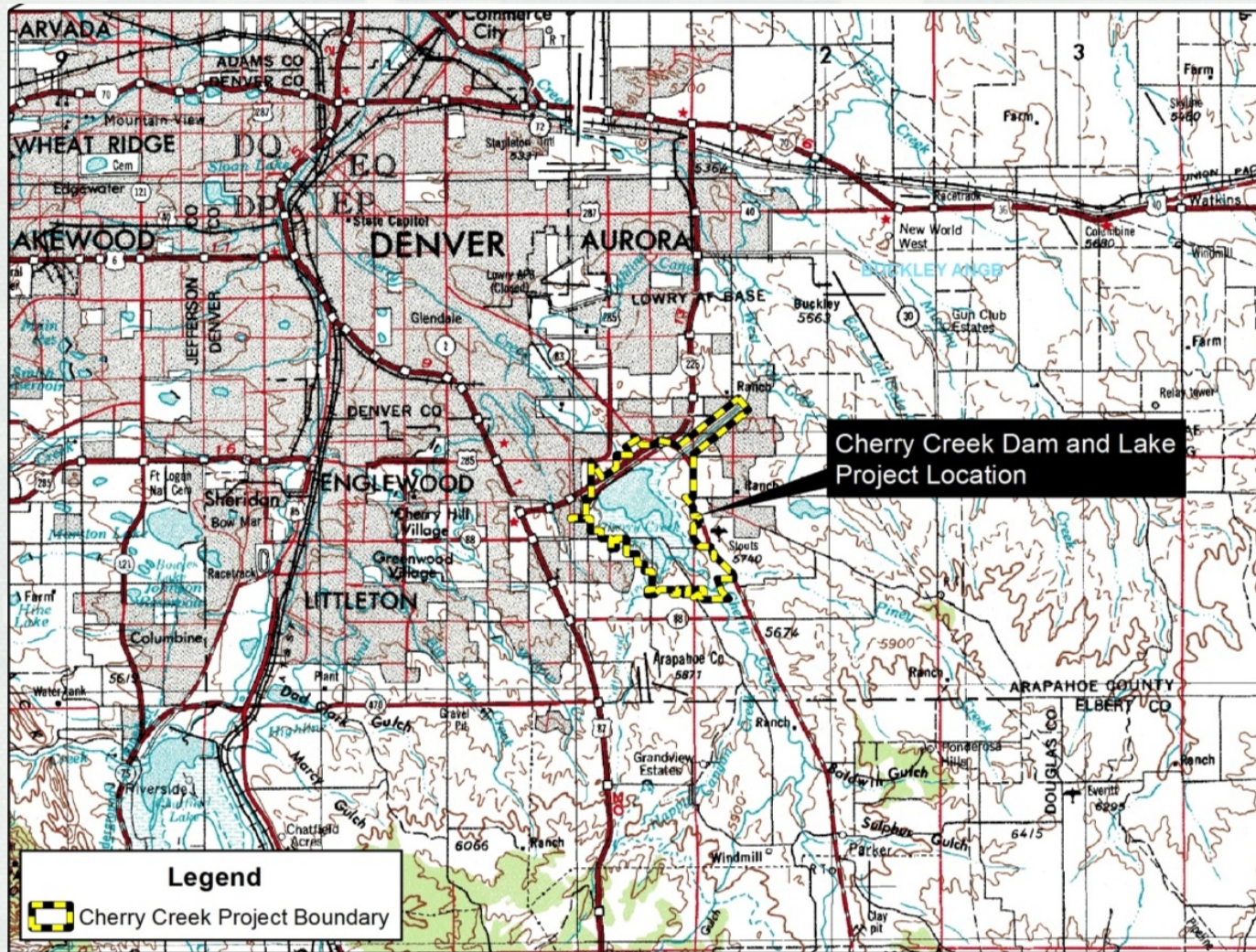
Cherry Creek Dam 1948



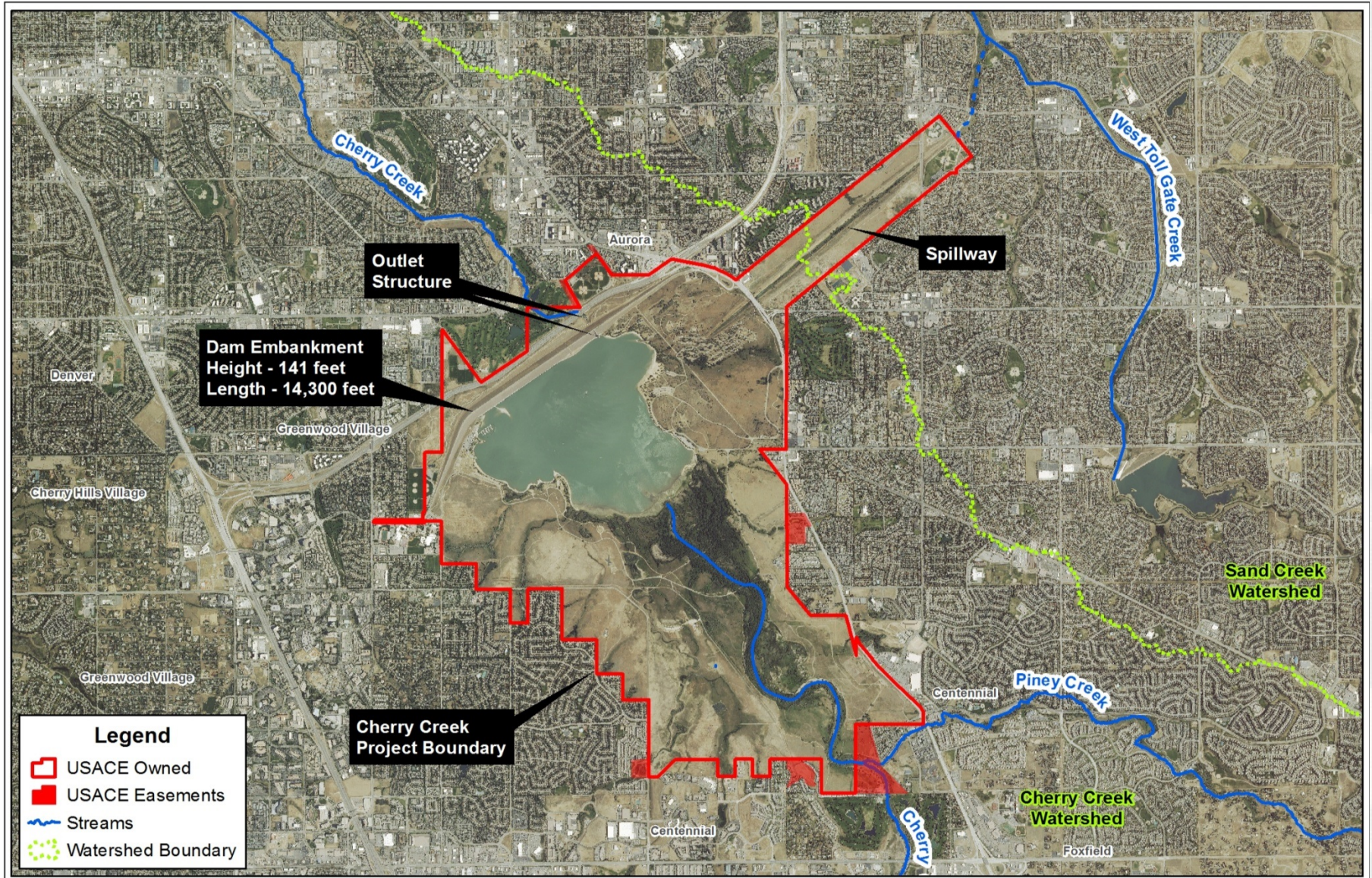
Downtown Denver

Cherry Creek Dam

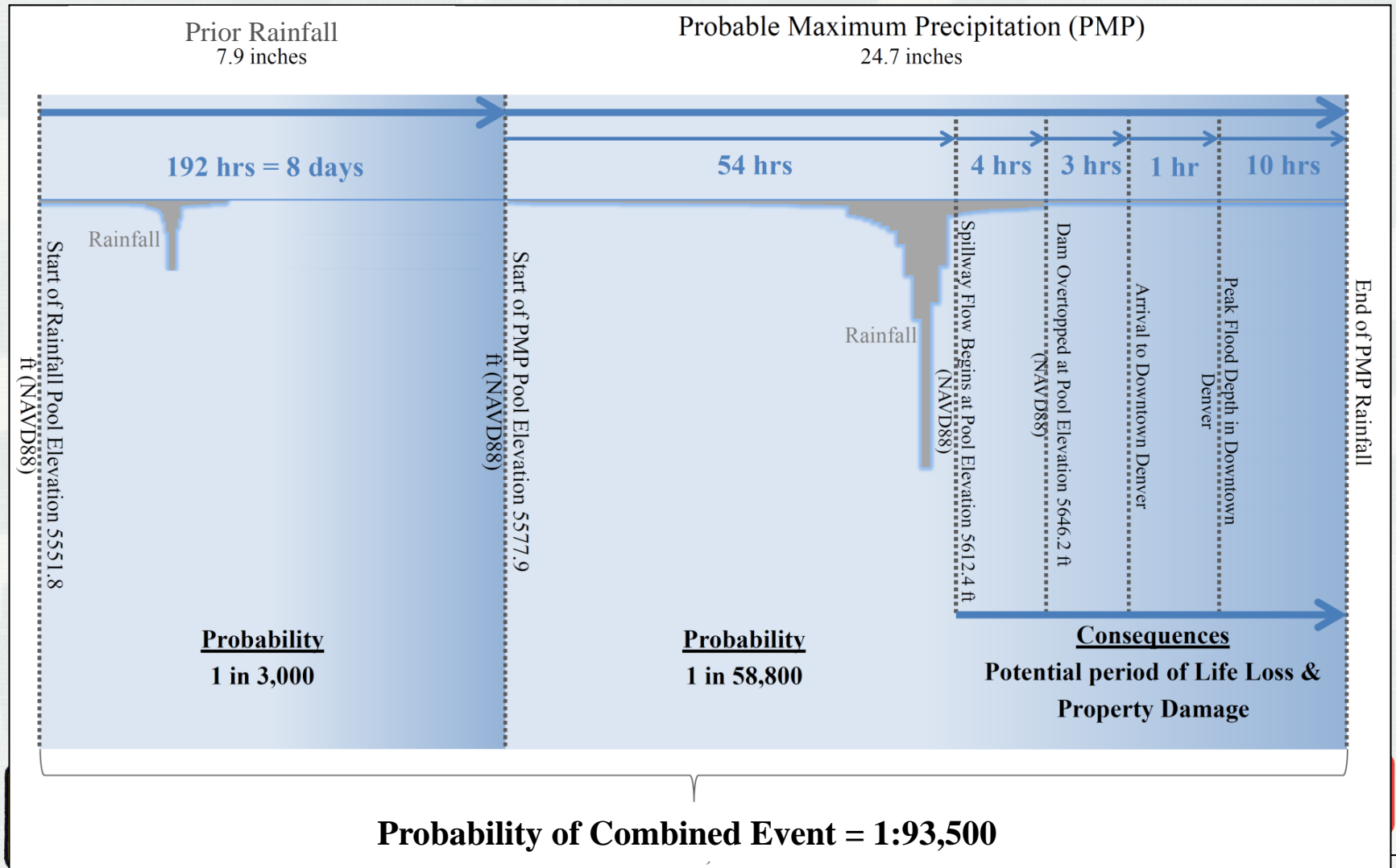
Cherry Creek Project Location Map



Cherry Creek Project Features Map



Hydrologic Sequence of Events Leading to Dam Failure

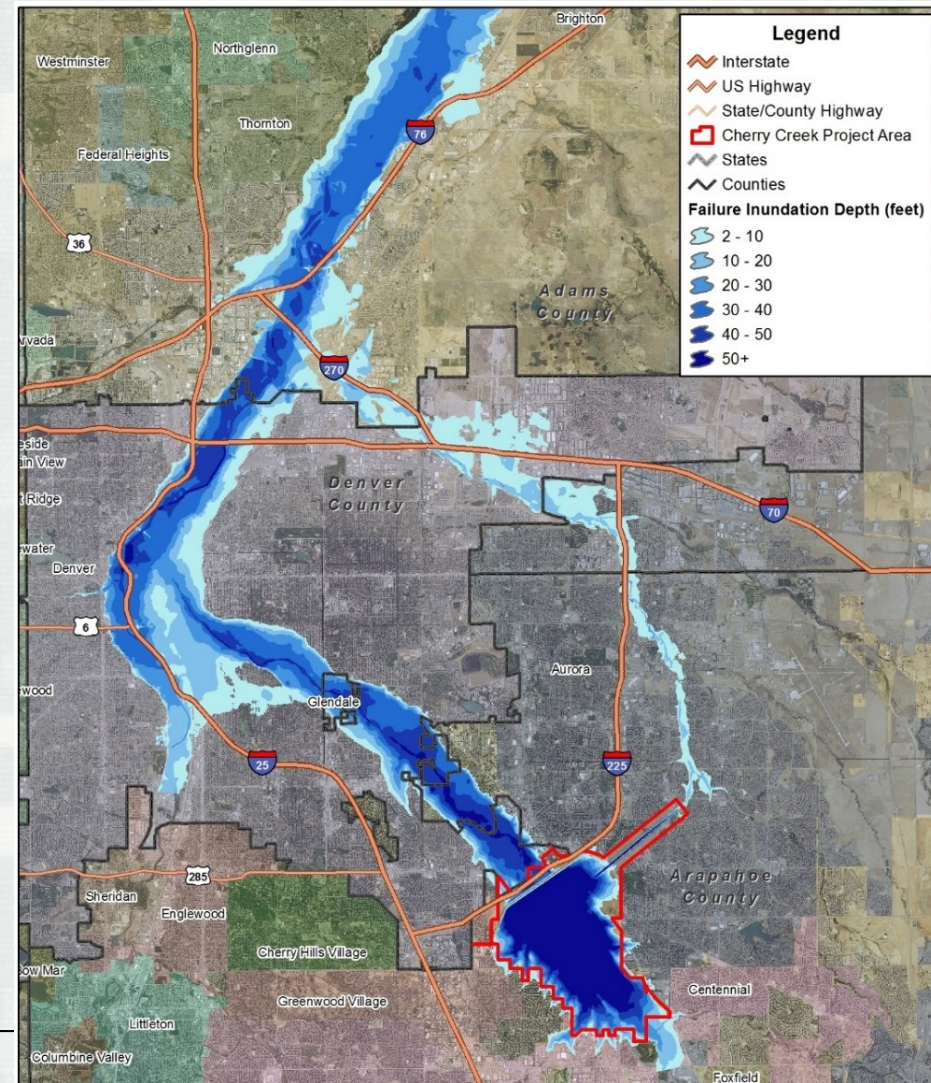


Probability of Combined Event = 1:93,500

Cherry Creek Consequences

- Dam overtops 3.5 feet
- Inundation area is:
 - > 1 mile wide
 - > 50 feet deep at deepest
- Consequences are:
 - >14,000 life loss
 - >\$12B in economic damages

Dam Failure Inundation Area



Cherry Creek Dam Study History

- Current Dam Safety Action Classification (DSAC) Rating of 2 was initially assigned in 2008
- Issue Evaluation Study (IES) conducted during 2009-2011
 - The DSAC 2 rating was confirmed by HQ in September 2011
- Dam Safety Modification Study (DSMS) began in 2013





Topic 1: Dam Safety Mod Studies are New

- New business line for Omaha Planning Branch staff
- New Engineering Regulation:
 - ER 1110-2-1156, Safety of Dams – Policy and Procedures
- Familiar Regulations:
 - ER 1105-2-100, Planning Guidance Notebook
 - ER 200-2-2, NEPA Regulations
 - Other necessary to support the decision
- Biggest change is that the focus is on reducing life safety risk



Six Step Process

Issue Evaluation Study Phase Start

1. Identify dam safety issues and risk-reduction opportunities

Dam Safety Modification Study Phase Start

2. Estimate existing and future without federal action condition risk
3. Formulate alternative risk management plans
4. Evaluate alternative risk management plans
5. Compare alternative risk management plans
6. Select a risk management plan





Major Milestones (Vertical Team Meetings)

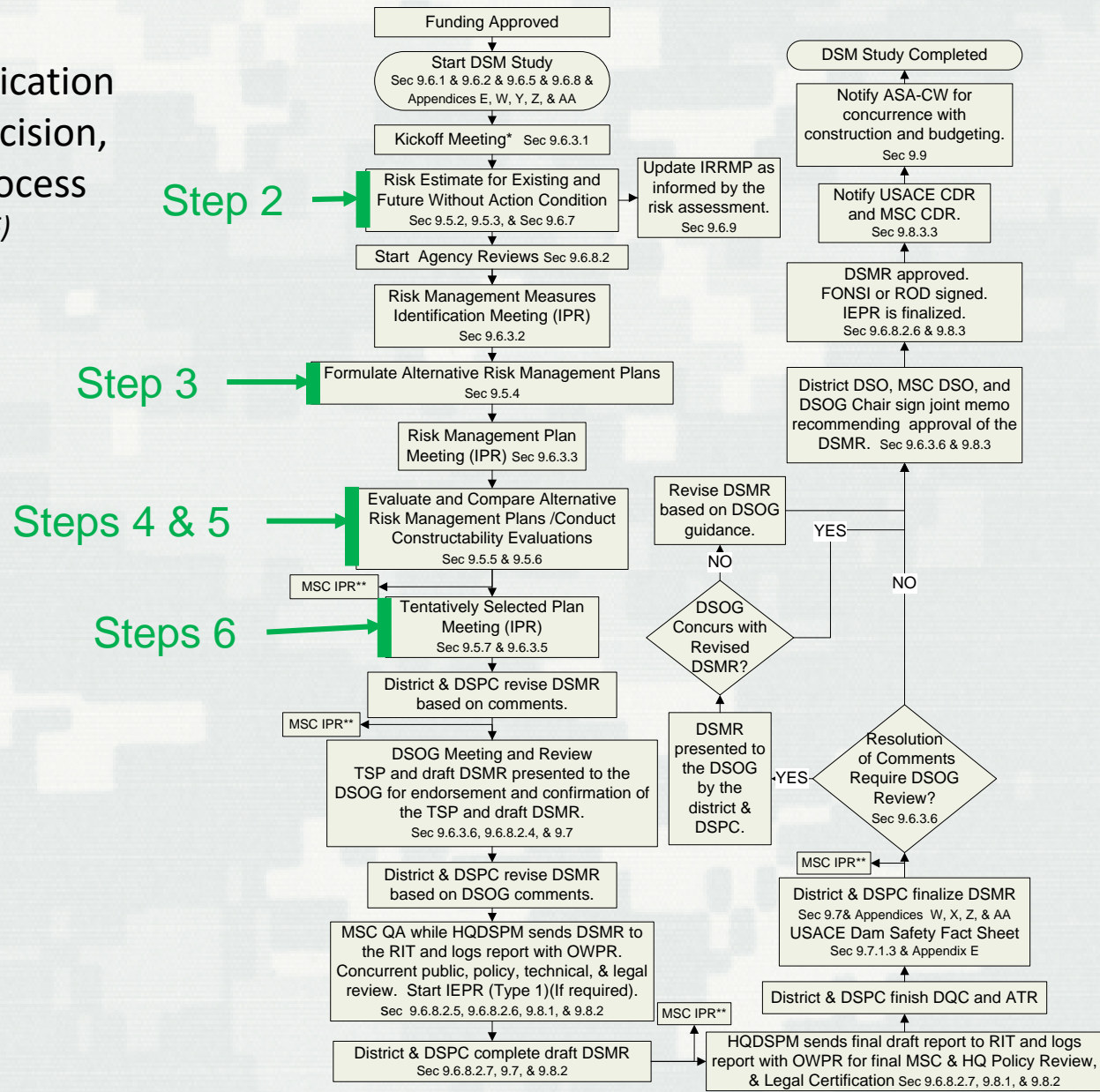
- Study Kickoff Meeting
- Risk Management Measures Identification Meeting
- Risk Management Plan Meeting
- Tentatively Selected Plan Meeting
- Dam Senior Oversight Group (DSOG) Meeting

*In-Progress Reviews as needed by:

- MSC, Risk Management Center (RMC), HQ



Figure 9.1:
 Dam Safety Modification
 Study, Review, Decision,
 and Approval Process
 (ER 1110-2-1156)





Topic 1 Lessons Learned

1. Planning process is similar to what planners are used to
2. Policies are mostly the same as other planning studies
3. Planner take the lead but share ownership with Engineering Office
4. Make sure that you have the correct PDT identified



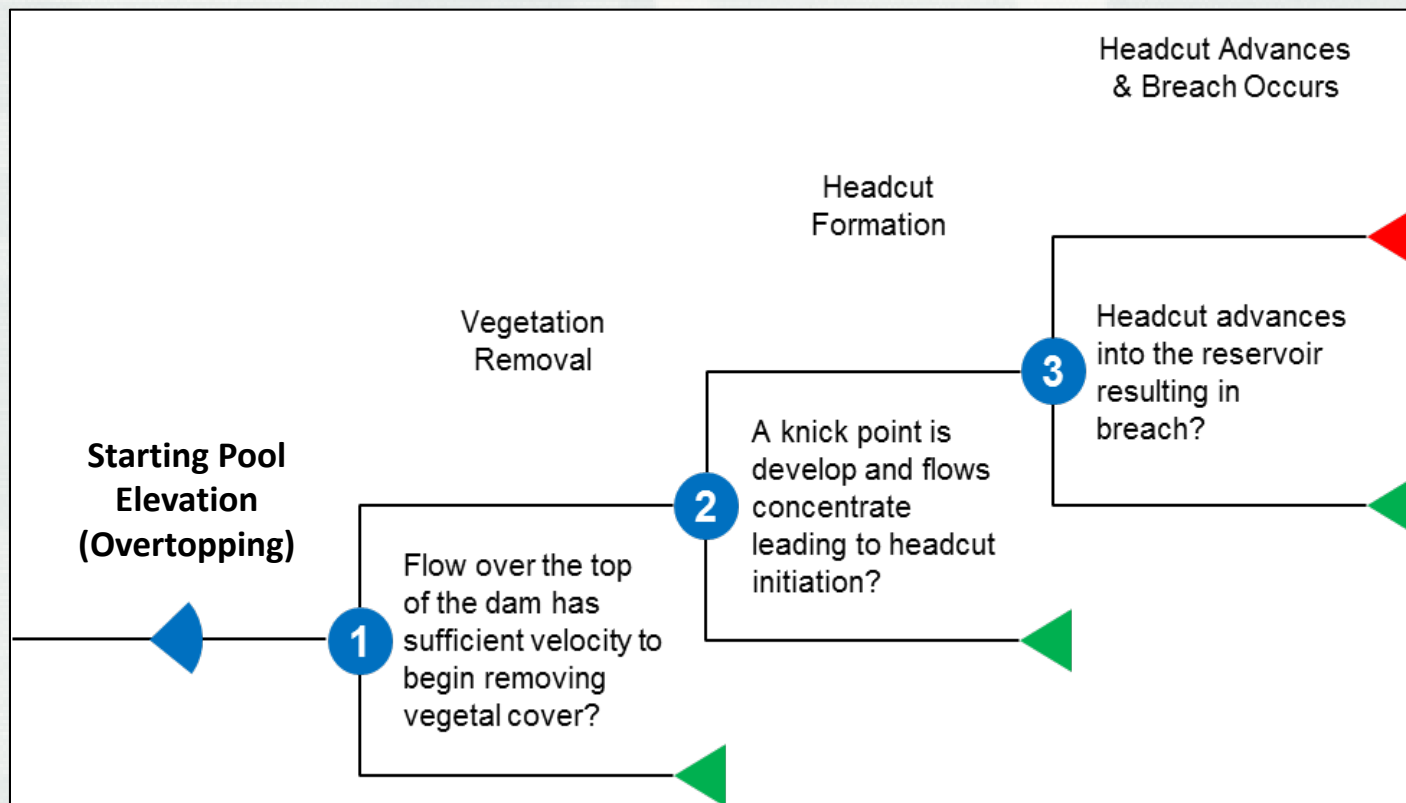
Topic 2: Formulating to Address Problems Associated with Dam Failure

- Objective of DSMS is to reduce risk
- Risk = f [(Probability of Dam Failure) X (Consequences)]
- **Probability of Dam Failure** is very technical analysis that is lead by the risk cadre
- District leads the alternative development



Formulating to Address Overtopping

- Cherry Creek's primary problem is overtopping during a Probable Maximum Flood (PMF)



Plan Formulation Process

- Formulate plans that keep dam from overtopping
 - Store more water behind the dam
 - Pass more water safely through the dam
 - 40,000 acre-feet of excess water

- Two types of alternatives:
 - Operational Alternatives**
 - Water control plan modifications

 - Structural Alternatives**
 - Dam raise
 - Excavate reservoir storage area
 - Upstream dams
 - Spillway modifications
 - Diversions
 - Etc.



Structural / Operational Alternatives Screening Criteria for Cherry Creek

P = Primary Screening Criteria

S = Secondary Screening Criteria

N/A = Not Applicable at that phase

Criteria	Measures Screening Phase	Initial Array of Alternatives Evaluation	Final Array of Alternatives
Effectiveness (Eliminate Overtopping)	P	(N/A)	(N/A)
Constructability	P	(N/A)	(N/A)
Cost	P	P	P
Non-breach consequences	S	P	P
Requires Additional Authorization	S	S	P
Quantitative Risk Assessment	(N/A)	(N/A)	P
Environmental/Social Impacts	S	S	S



Topic 2 Lessons Learned

1. Simplify the problem
2. Prioritize your screening criteria along the way
3. Work with cadres H&H/econ people to define non-breach consequences
4. Work with Office of Counsel to clearly define what activities require additional authorization

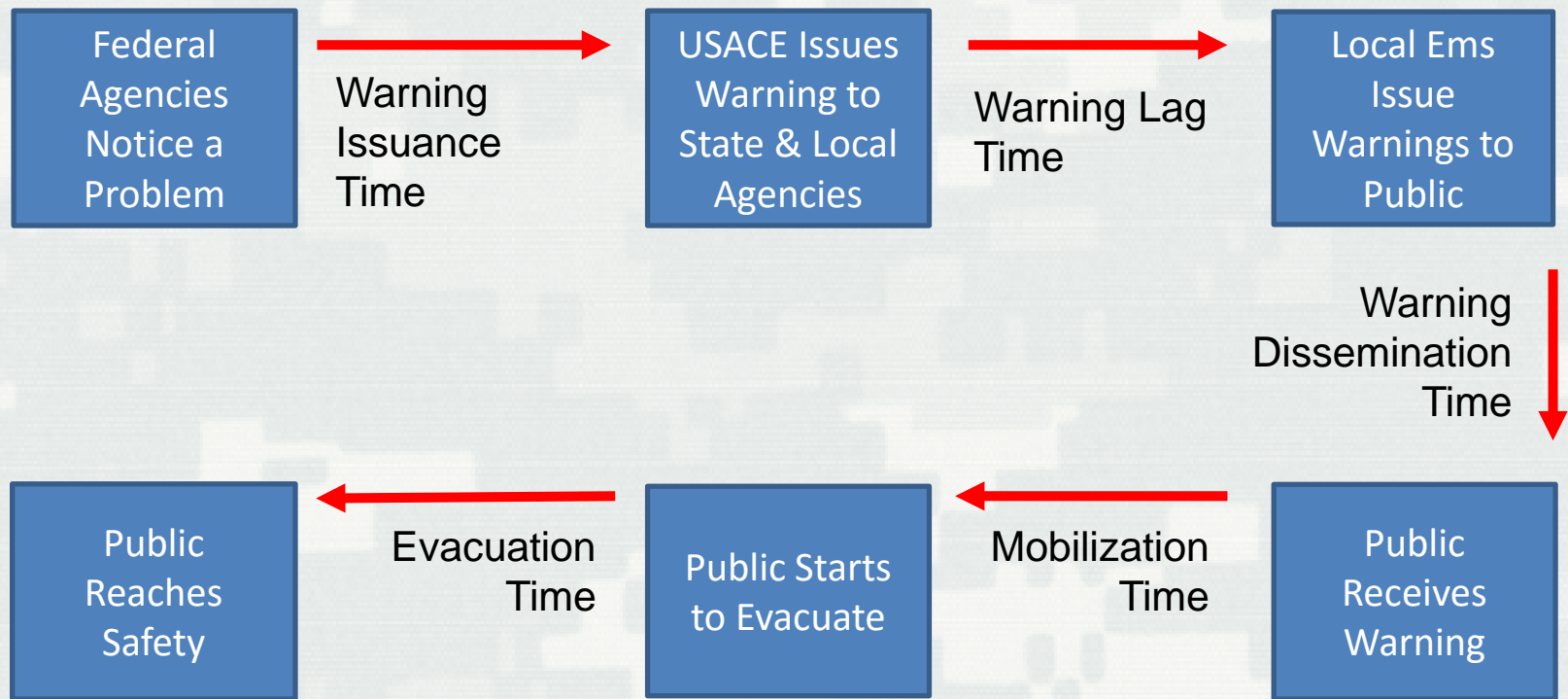


Topic 3: Formulating to Reduce Consequences

- Objective of DSMS is to reduce risk
- Risk = f [(Probability of Dam Failure) X (Consequences)]
- **Consequences** analyses require involvement from a combination of PDT members:
 - Cadre consequence modeler
 - Environmental specialist
 - Nonstructural lead



Formulating to Reduce Consequences of Dam Failure



Measures that Reduce Consequences

Nonstructural Alternatives

- Physical measures were eliminated because they did not address the life loss in the inundation area, things like:
 - Flood proofing
 - Relocation
 - Structure mitigation
- Nonphysical measures were investigated because of their potential to reduce life loss
 - Flood Warning systems
 - Evacuation plans
 - Response communications
 - Long-term flood risk preparedness



Nonphysical Nonstructural Measures Comparison

Alternative	Property Damages (\$)	Estimated Life Loss	
		Day	Night
Existing	18,470,422,360	15,300	13,500
FWAC	18,570,357,308	14,800	13,100
Response Communications	18,563,809,280	10,000	10,000
Flood Warning Systems	18,561,712,128	7,000	6,000
Evacuation Plans	18,561,712,128	7,000	6,000
Long-Term Preparation	18,561,175,552	7,000	5,000

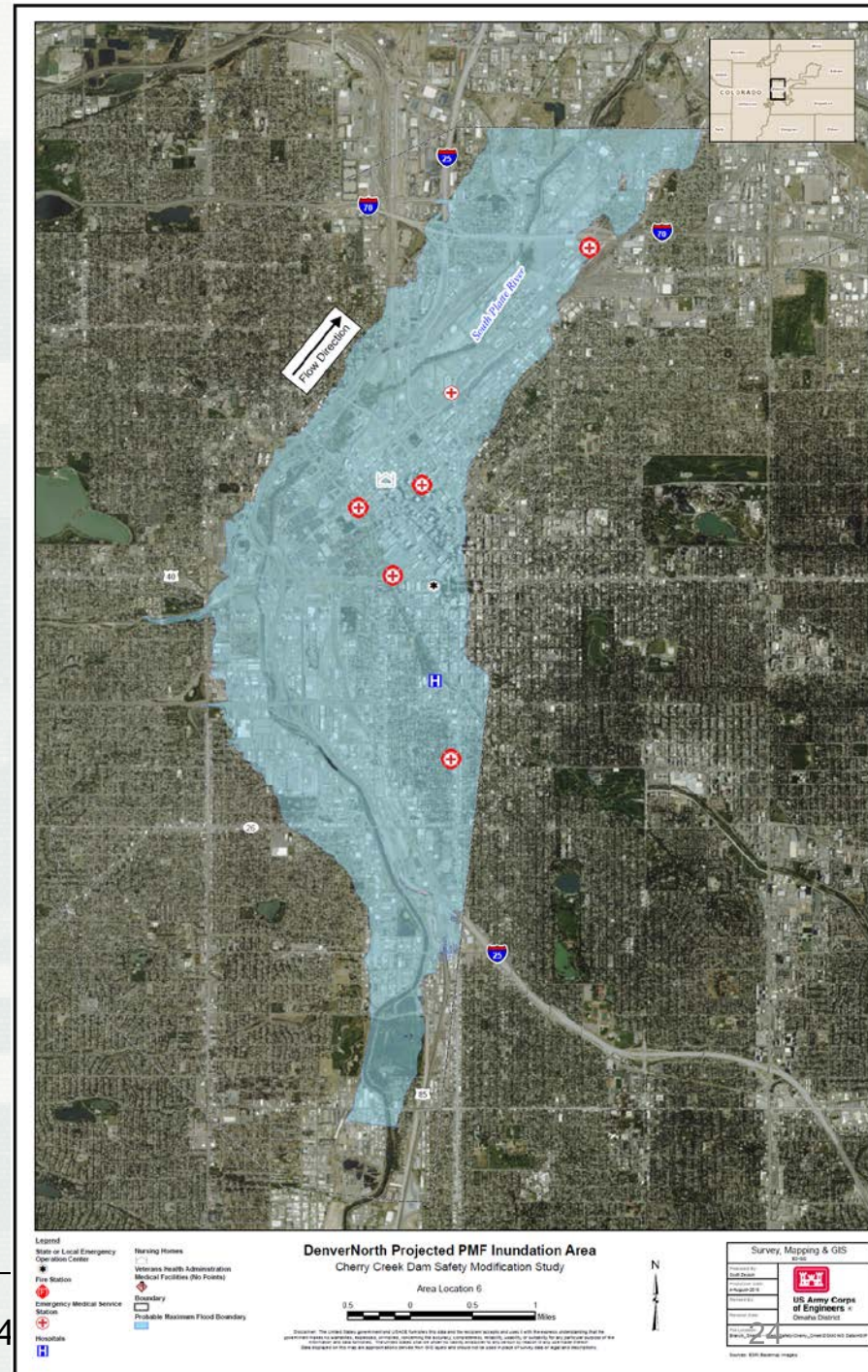
- Flood warning systems, evacuation plans, and long-term preparedness reduce life loss the most
- Next step is to look at these things by impact area



Critical Facilities and Critical Infrastructure

- Maps for local emergency managers showing:
 - Fire and Rescue Stations
 - Medical Facility
 - Emergency Operation Center
- HEC-FIA does not identify impacts associated with critical facilities/infrastructure

Note: If critical facilities become inoperable during a flood event, the area of impact extends beyond the area of flooding. For example; emergency services, utilities, communications, water and wastewater treatment plants.





Topic 3 Lessons Learned

1. Understand how the models measure consequences
(then use those inputs as your screening criteria)
2. Coordinate with local emergency management community
regularly
3. Consider impacts that the models don't measure



Topic 4: Public Meetings Lessons Learned

Presentation Materials and PPT

- Communicate risk so that the public can understand
- Go over public meeting materials with local Emergency Management Officials prior to meeting
- Establish presenters early on so they can get familiar with good risk communication techniques
- The tables and open house format, with a presentation and Q&A worked well
- Having local emergency management and Corps staff with each discipline available for discussion was good

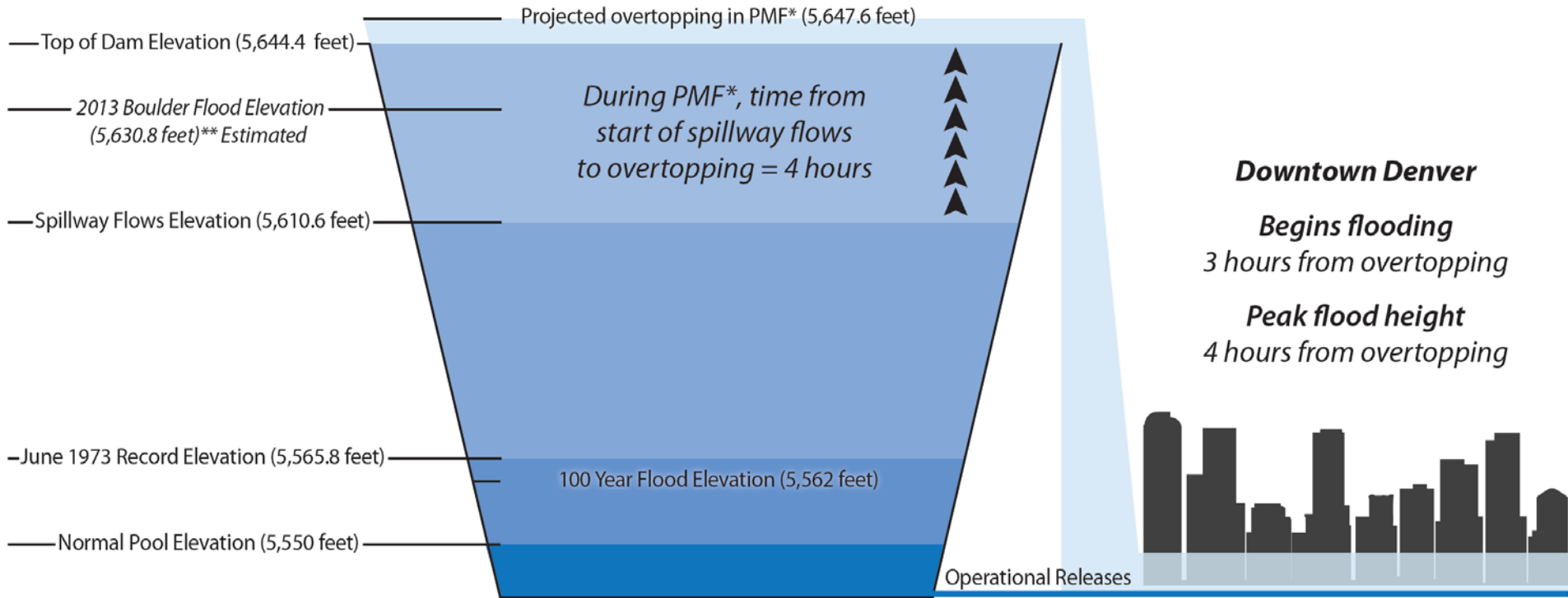
Facilitator/Q&A

- Facilitated format helped keep meeting on track
- Having facilitator to lay the ground rules, field questions, get those who wanted to speak recognized in a timely manner, and passed to the right person was very helpful
- Facilitator helped diffuse tension when the questions and answers were difficult or contentious
- Determine limited # of folks up front to answer questions worked much better



Example of more Public Friendly Overtopping Graphic

CHERRY CREEK DAM - SIGNIFICANT POOL ELEVATIONS



* Probable Maximum Flood (Maximum conceivable flooding conditions during an extremely rare rain event.)

** This estimate places rainfall from the 2013 Boulder Flood over the Cherry Creek Basin. Downstream conditions in Denver would have prevented releases from Cherry Creek Dam's gated outlets. Water would have flowed through the spillway.



Public Meeting Lessons Learned



Attendance Considerations

- Having PAO there was critical to respond to media requests immediately, on-site interviews
- Attendance at all sessions was good. However, meeting outreach should focus on communities d/s of the dam more heavily
- Expand reach to neighborhood associations, particularly downstream and upstream watershed
- Encourage leaders in other cities/counties downstream of CC and spillway, and upstream, to get word out, give them PR and links to the web early



Other Dam Safety Webinars

- Sep 2015 “***Understanding the Consequences in the Dam Safety Periodic Assessment Process***” (Buchanan)
- May 2014 “***Utilizing Risk Assessment Methodologies for Public Safety and Flood Risk Management***” (Harper & Needham)
- Feb 2014 “***Dam Safety & Planning: Examples of Collaboration & Lessons Learned***” (Halpin, Wegner et al.)

Available on the Planning Toolbox at:

<http://planning.usace.army.mil/toolbox/resources.cfm?Id=0&Option=Planning%20Webinars>



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Questions?

Type questions in the chat box.
We will answer as many
as time allows.

For more information:
<http://www.corpsplanning.us>



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