Dam Safety Program, IDF, Spillway Requirements and Proposed Rule Changes

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Reservoir Storage

	Current Storage	Restricted Storage* Total a-f	(#dams)
Division 1	1,787,810 a-f	95	48,997
Division 2	893,544 a-f	23	71,309 *13,218
Division 3	297,261 a-f	3	9,800
Division 4	1,447,948 a-f	32	3,956
Division 5	1,166,040 a-f	17	1,881
Division 6	165,387 a-f	10	667
Division 7	665,356 a-f	6	949
Total	6,423,345 a-f	186	137,559 (2%)

- January 2005
- **1990-2004 : 57 New dams with a combined storage of 120,000 a-f**
- Div 2 Two Buttes 31,500 a-f and Cucharas 33,000 a-f - very expensive reconstruction necessary.

Statutory Authorities
Title 37Article 87

- 37-87-105-Approval of Plans for Reservoir-Notice of Modification
  - » Rules and Regulations
  - » New, Construction, Alteration, Modification, Repair and enlargement-general maintenance excluded
- 37-87-107- Safety Inspections-Amount of Water to be Stored
  - » Inspections
  - » Safe Storage Amount

Dam Safety Program

- The mission of Colorado's Dam Safety Program, is to prevent loss of life and property damage, determine the safe storage level and protect the state's water supplies, from the failure of dams, within the resources available.
- Dam Safety and Security

Dam Incidents

- **Total number of incidents** (1990-2003) 48
  - Class 1- 23 Class 2 - 10; Class 3 - 15
- **Summary by year**
  - 1990 - 1 1991 - 0 1992 - 2 1993 – 1
    1994 - 1 1995 - 2 1996 - 2 1997 – 3
    1998 - 2 1999 - 9 2000 – 2 2001 – 7
    2002 – 5 2003 – 11 2004 - 0
- **The greatest risk is most often associated with overtopping or static load (operational) conditions resulting in seepage piping and erosion**

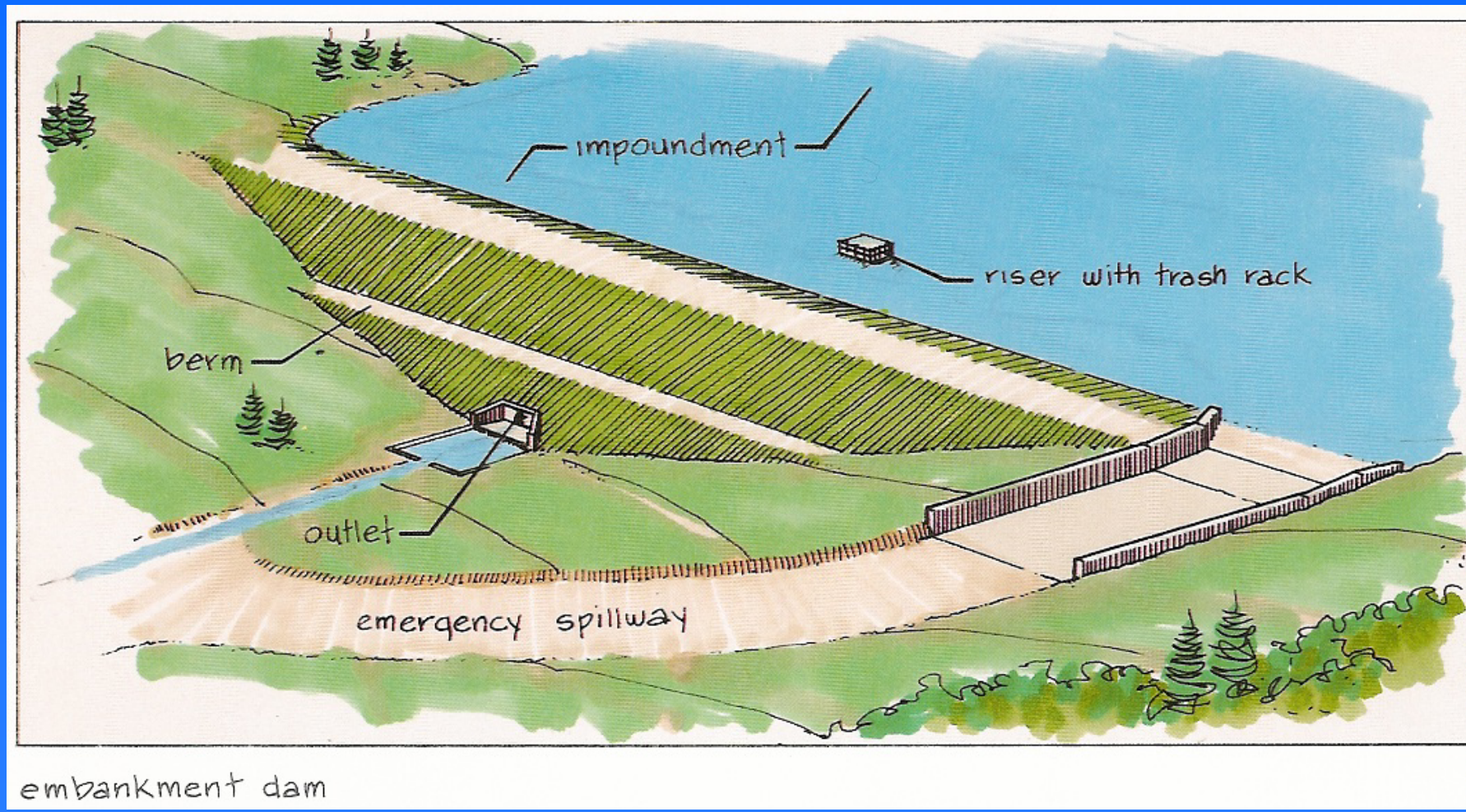
Dam Safety Program Activities

- **2004**
  - 5 new dam plans and specifications reviewed and approved.
  - 34 plans for alteration, modification or enlargement reviewed and approved.
  - $40 million in construction
  - Additional storage as a result of these actions, 13,500 AF
  - 12 hydrology studies for IDF reviewed and approved.
  - 621 dam safety inspections performed.
  - 238 construction inspections.
  - 163 special inspections.
- **2005**
  - Revision of Dam Safety Rules
    - » PMP reduction based on elevation (10-30 % reduction PMP).
    - » Risk-based decision making integration in program implementation.

Dam Safety and Spillway Requirements

- Program implementation has been guided by industry standards and court action. Specifically Barr v Game Fish and Parks Commission, 497 P.2d 340 (Colo.App. 1972), which held that the defendant was negligent for failing to design the spillway to pass the maximum probable flood that could have been determined through modern meteorological techniques.

Typical Dam


impoundment
riser with trash rack
berm
outlet
emergency spillway
embankment dam

Spillway Design Requirements

- A spillway is designed to pass the "inflow design flood", a flood determined through state-of–the-art techniques, Precipitation, runoff and infiltration and flood storage such that the dam is not overtopped. overtopping and spillway failure account for 49% of all dam failures.
  (UNICIV 1998) (Piping accounts for 47% of all failures)

- The "inflow design flood", IDF, used to determine the spillway capacity requirements, is often characterized as a percentage of the probable maximum precipitation (PMP). However there are other methods and analysis available for determining the IDF and necessary spillway capacity.

Spillway Capacity Requirements

Inflow Design Flood (IDF) Determination

- **Alternative Methods**
  - **Site Specific Hydrometeorologic Analysis**
    - » Current scientific methods to determine the probable intensity and duration of an extreme storm for the drainage basin for the dam.
    - » Generally results in a 10 to 30 percent reduction in the PMP value. The results vary with basin size, elevation and storm duration and in some cases the resulting storm is greater than PMP values.
    - » 14 site specific studies have been approved since 1992; three are currently being reviewed; and one is in progress.
  - **Incremental Damage Analysis (IDA)**
    - » Determination of an IDF less than the minimum requirements associated with PMP methodology.
    - » A comparison of the downstream damage resulting from design flood without a dam and damages as a result of a failure of the dam due to overtopping during the design flood event.
    - » 19 IDA's have been approved since 1999, six resulted in reduction in the PMP requirements.

Proposed Revisions to the Rules and Regulations for Dam Safety and Dam Construction

- Key Changes
  - Hazard Classification Terminology
  - Elimination of Intermediate Dam Size
  - Inflow Design Flood
  - IDF Reduction for Elevation
  - Hazard Classification Nomenclature
  - General update and clean-up

Proposed
INFLOW DESIGN FLOOD REQUIREMENTS

Hazard Classification	High	Significant	Low	NPH
Dam Size				
Large	.9 PMP	.75 (.9 PMP)	100 YR	50 YR
Small	.9 PMP	.50 (.9 PMP)	100 YR	25 YR
Minor	.50 (.9 PMP)	100 YR	50 YR	25 YR

Proposed Reduction for Elevation

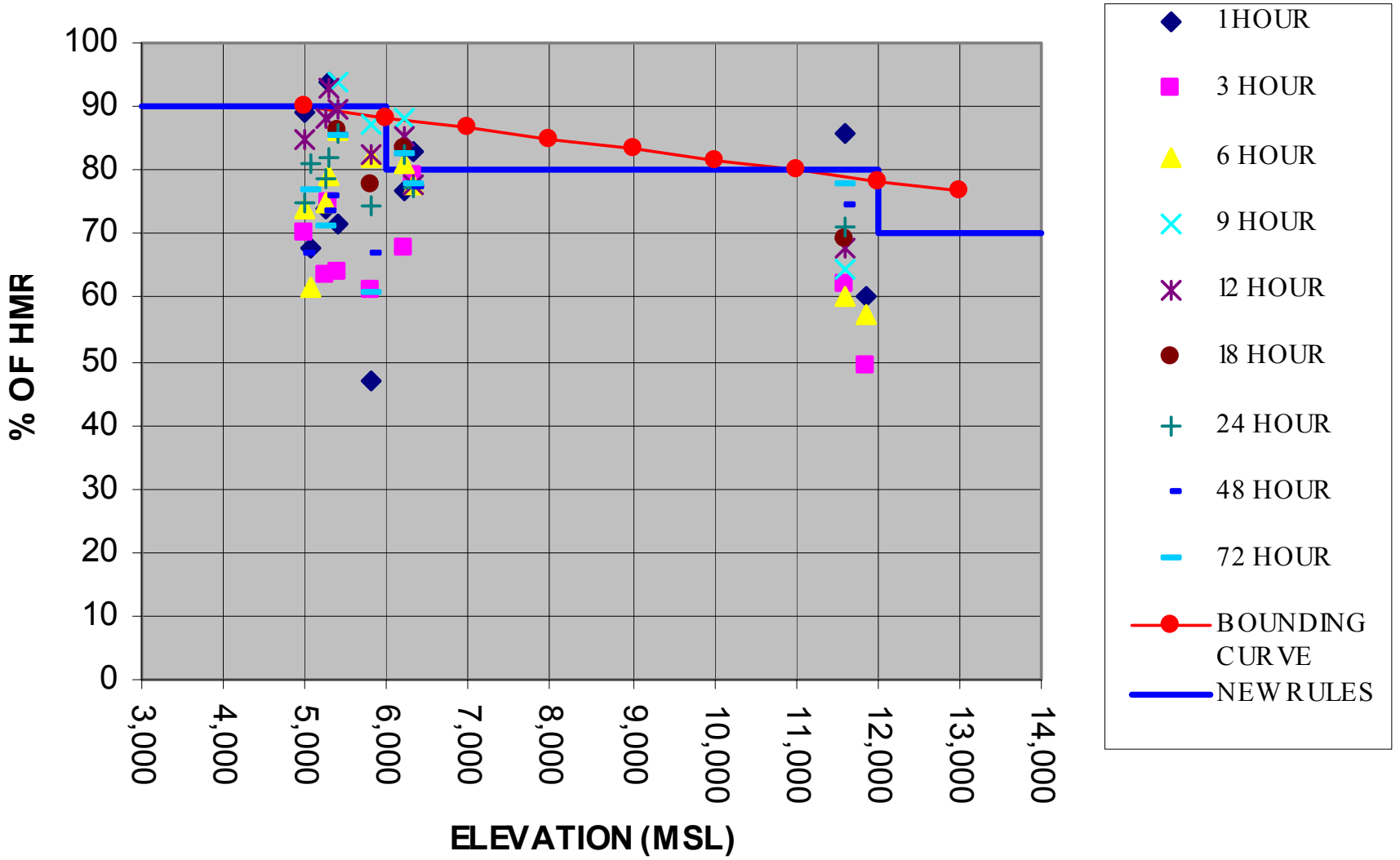
- ***General Storm***
- East of the Continental Divide

Elevation (ft)	%Reduction
6,000 to 12,000	20
Above 12,000	30

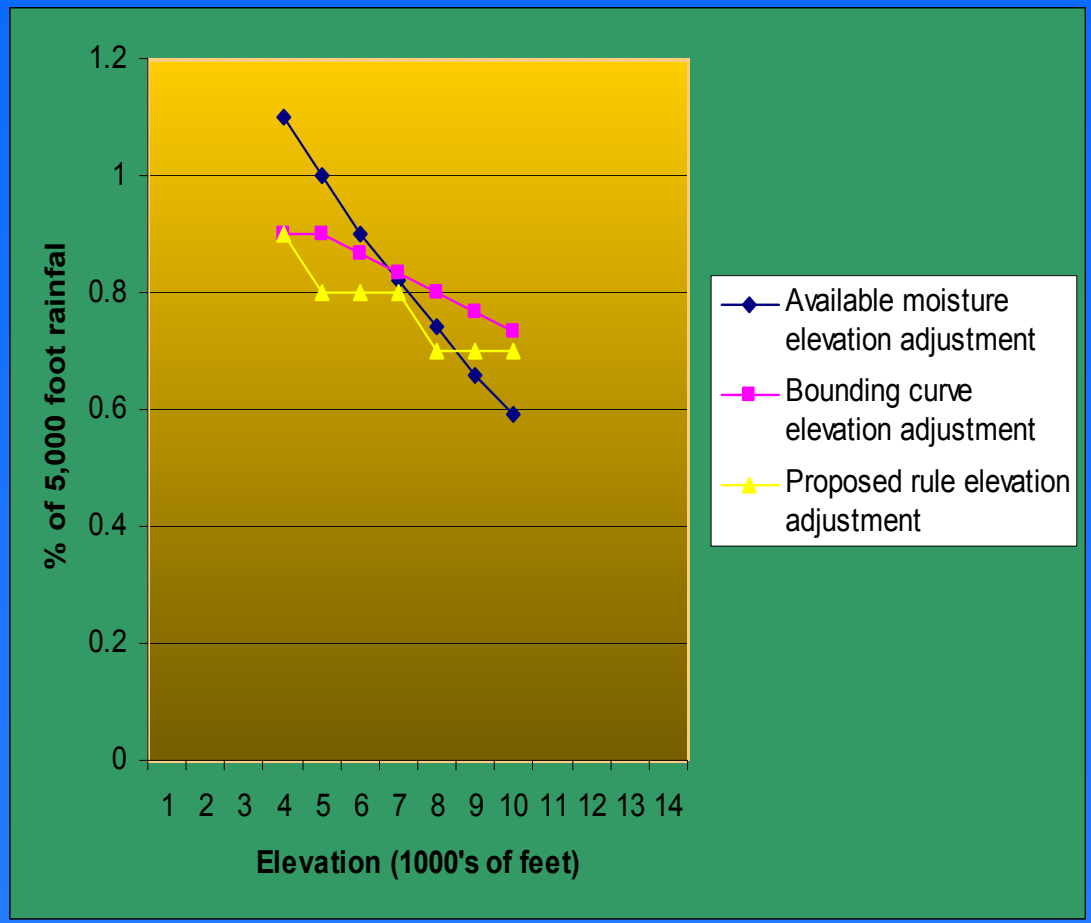
- West of the Continental Divide

Elevation (ft)	% Reduction
5,000 to 8,000	20
Above 8,000	30

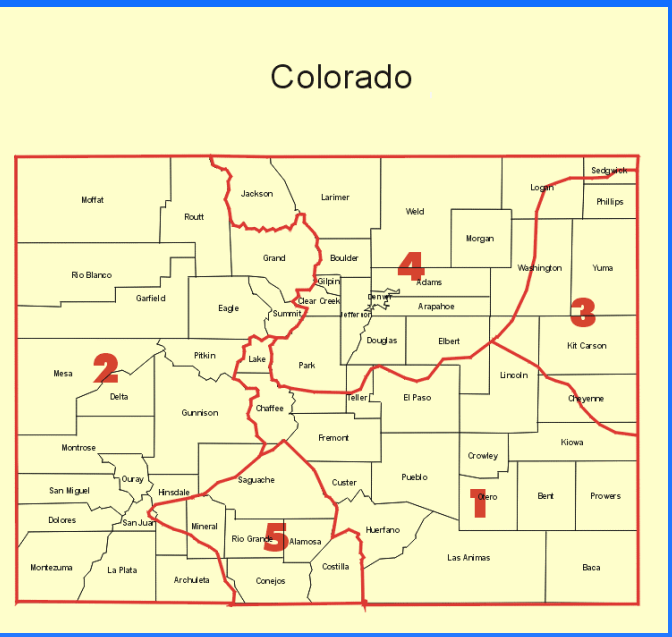
HMR 55A GENERAL STORMS VERSUS SITE SPECIFIC (EASTERN SLOPE)

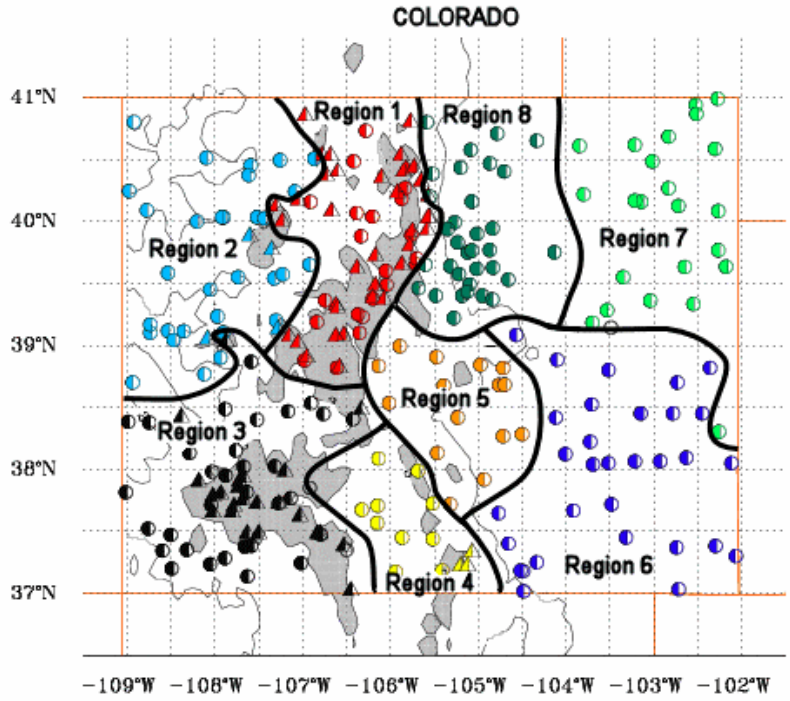


Proposed Elevation Adjustments HMR 49



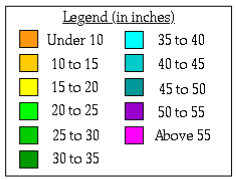
Micro-Climates

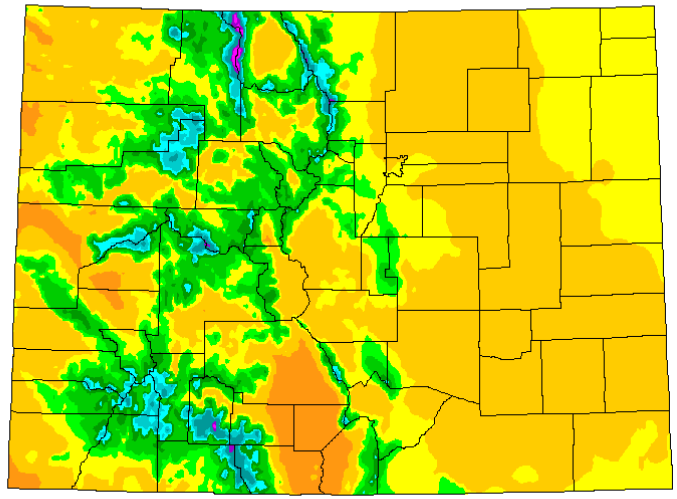




Average Annual Precipitation

Colorado





This is a map of annual precipitation averaged over the period 1961-1990. Station observations were collected from the NOAA Cooperative and USDA-NRCS SnoTel networks, plus other state and local networks. The PRISM modeling system was used to create the gridded estimates from which this map was made. The size of each grid pixel is approximately 4x4 km. Support was provided by the NRCS Water and Climate Center.

For information on the PRISM modeling system, visit the SCAS web site at http://www.ocs.orst.edu/prism

The latest PRISM digital data sets created by the SCAS can be obtained from the Climate Source at http://www.climatesource.com

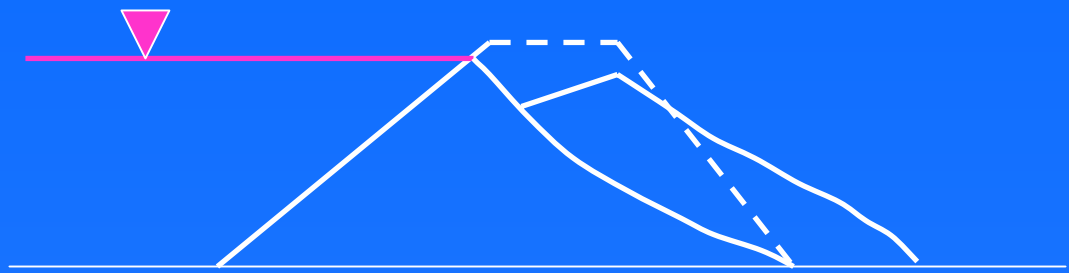
Tentative Schedule for Rule Revision

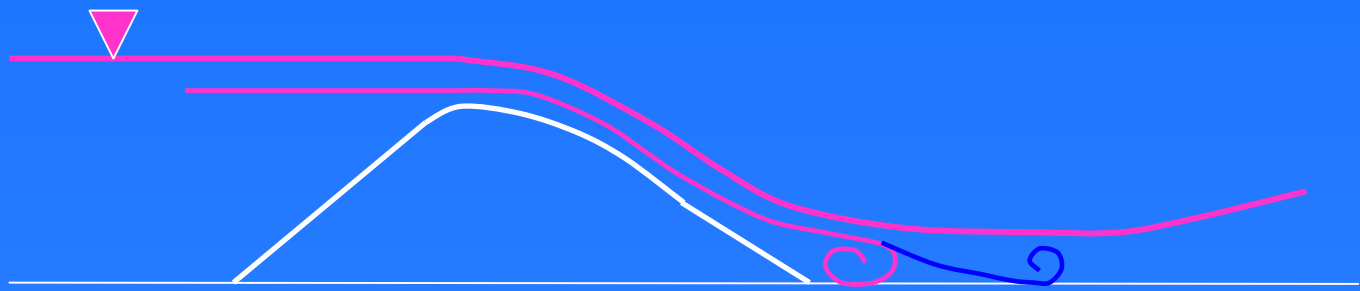
- January and February – Informal discussion and workshops: 3 statewide
- March – May - Additional Research
- June – Revised Draft Rules
- July - Informal meetings
- September - Begin Rulemaking
- December – Effective date

Questions?

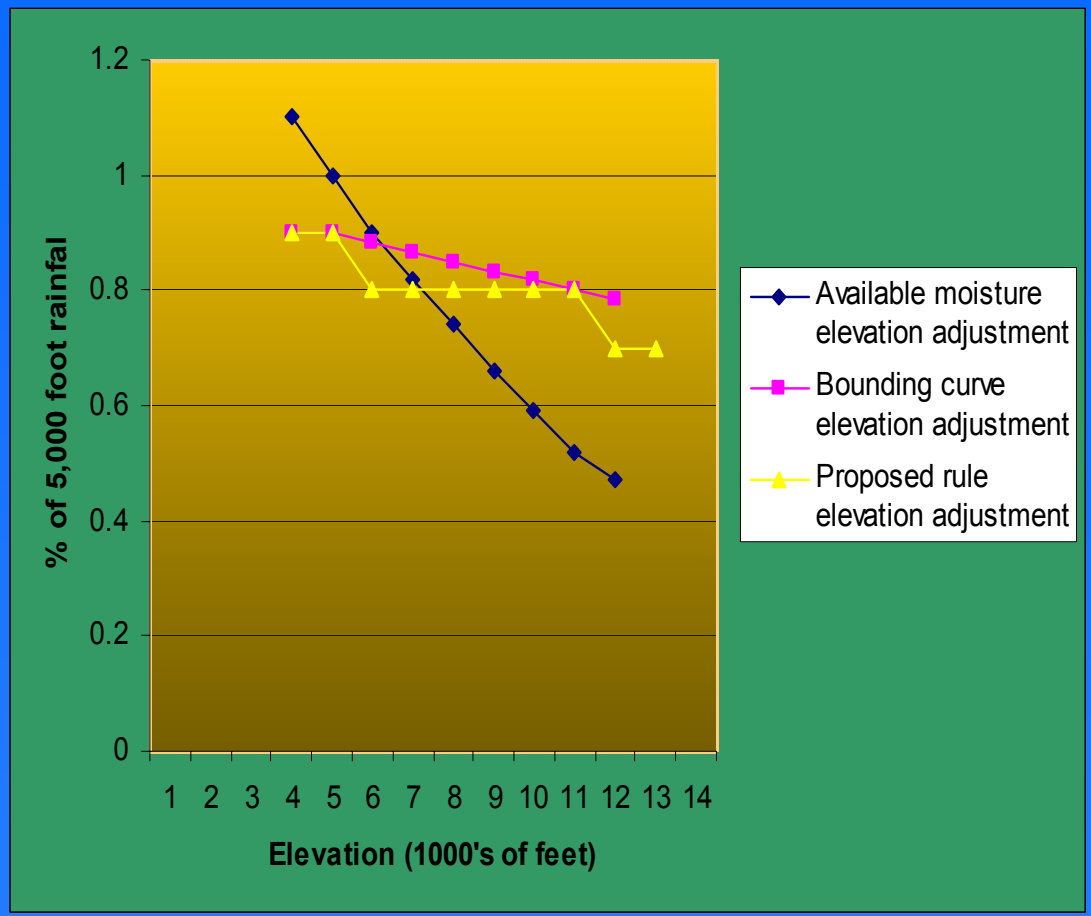
The End

Overtopping





Proposed Elevation Adjustments HMR 55A

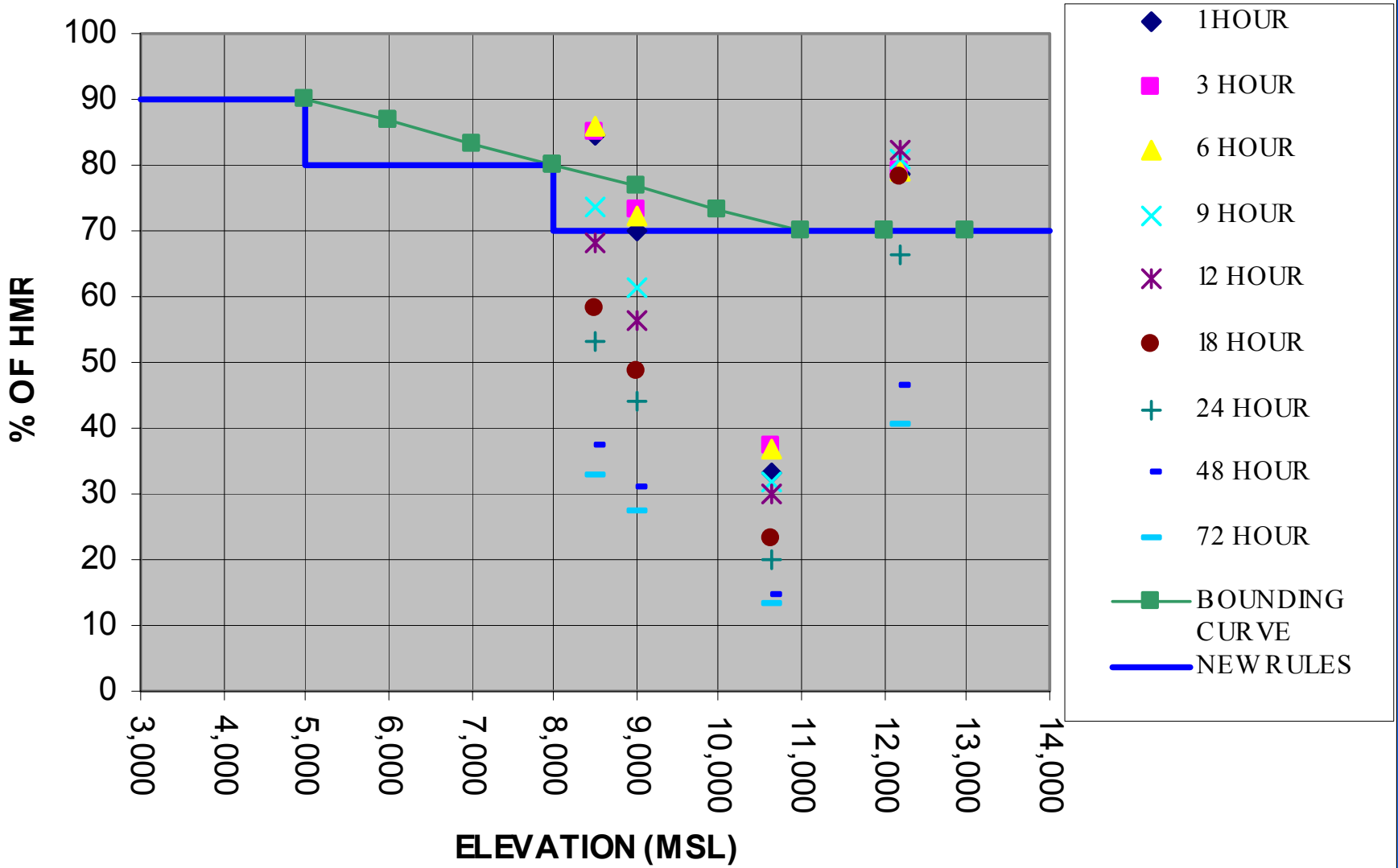


Proposed reduction for Elevation

- ***Local Storm***
- Statewide

Elevation (ft)	%Reduction
10,000 to 11,500	20
11,501 to 13,000	30
Above 13,000	40

HMR49 GENERAL STORMS VERSUS SITE SPECIFIC (WESTERN SLOPE)



HMR 49 AND 55A LOCAL STORMS VERSUS SITE SPECIFIC (ALL STATE)