

Denver Water's Use of Climate Products for Water Management

Colorado Climate Workshop

Golden, Colorado

December 1, 2005

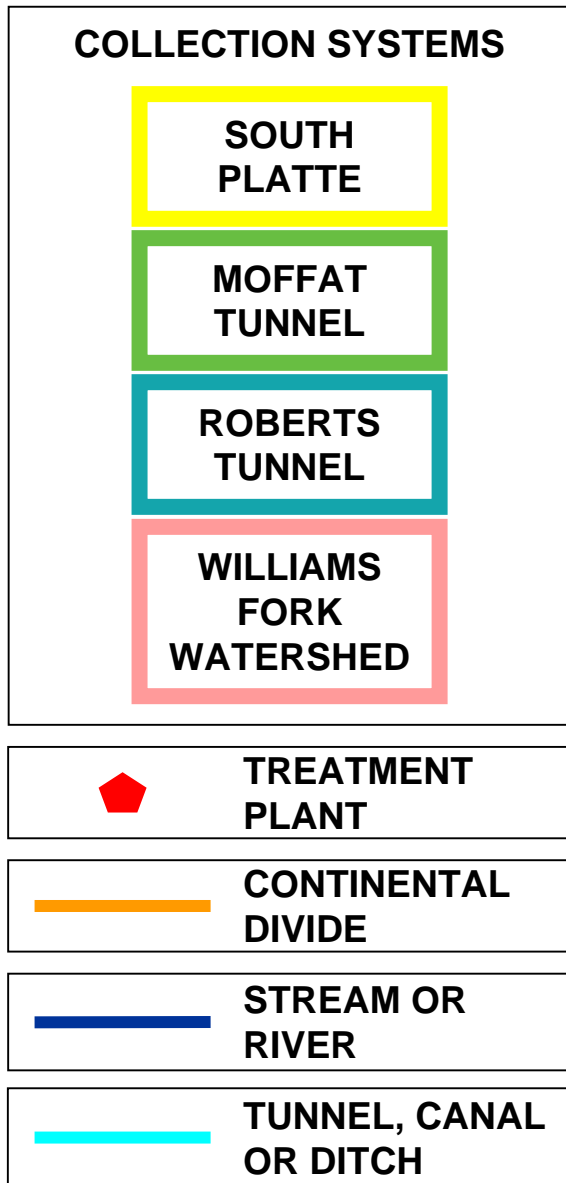
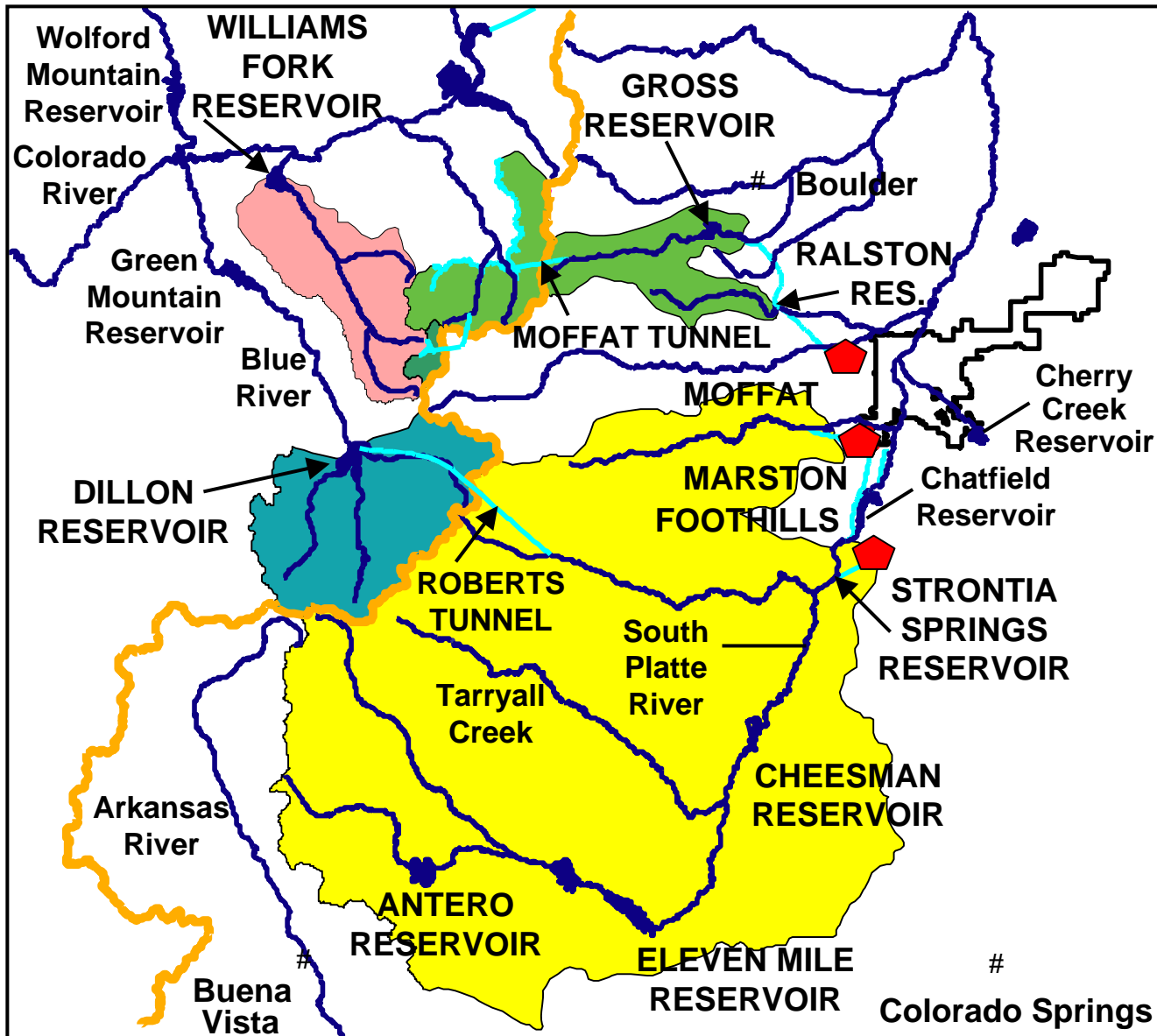
Bob Steger

Water Resource Engineer



Denver Board of Water Commissioners

Water Collection System



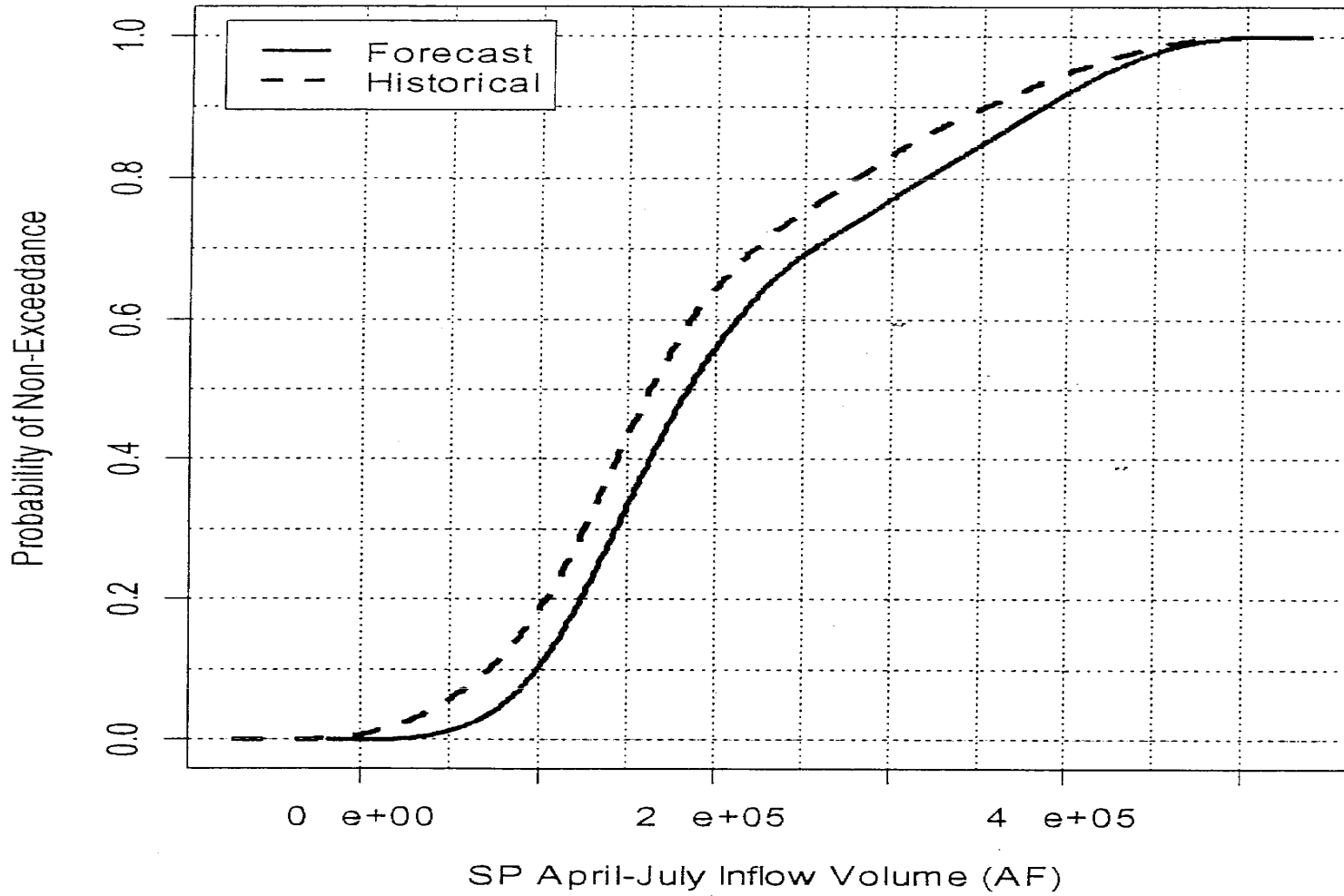
WATER MANAGEMENT QUESTIONS AND USEFUL CLIMATE PRODUCTS

October and November

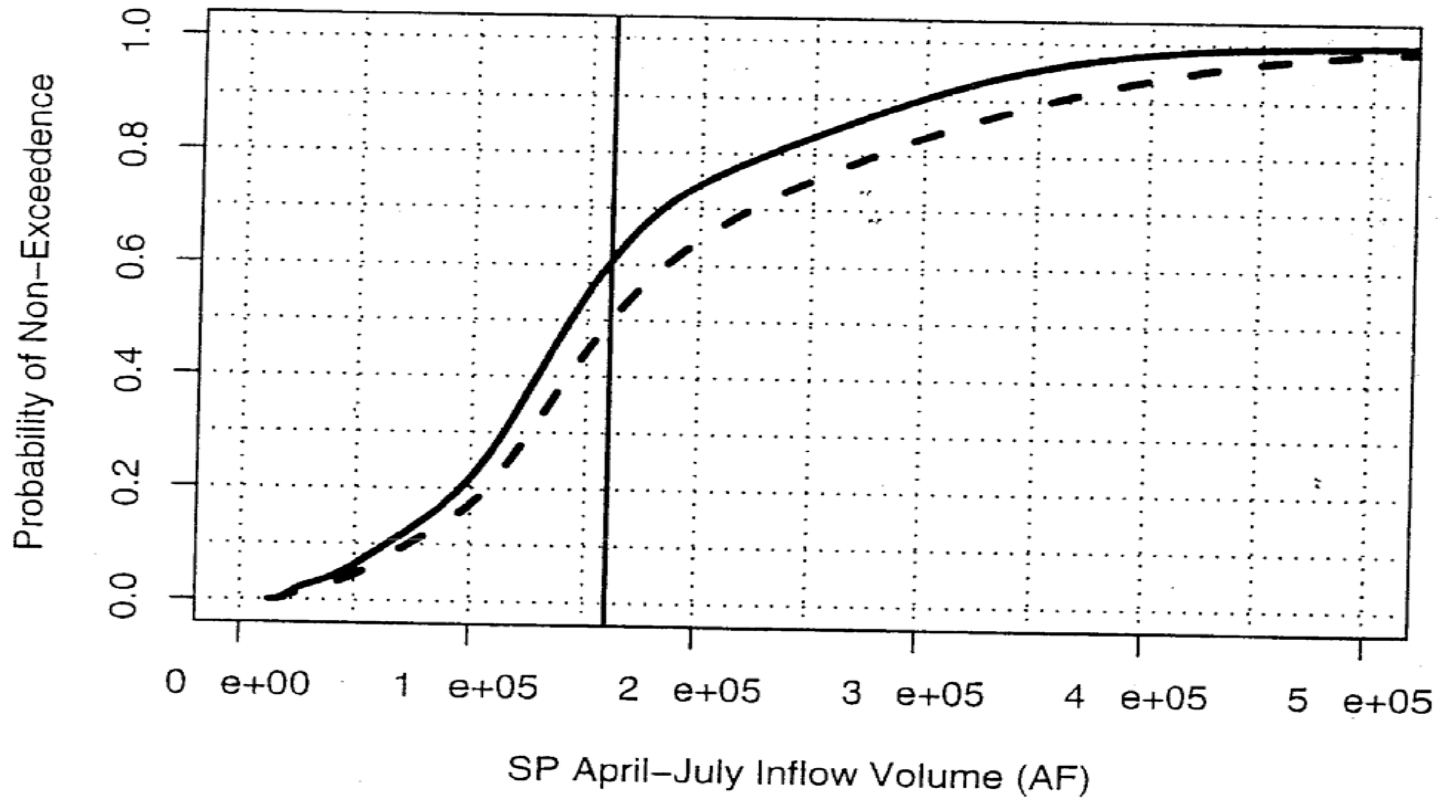
Questions	Useful Climate Products
<p>1. Should we release extra water for secondary benefits such as hydropower, recreation or the environment?</p> <p>2. Should we re-position our stored water to maximize capture of runoff water?</p>	<p>A. Forecasts of spring runoff for each major watershed. (Connely Baldwin, Vidya Inc.)</p> <p>B. Forecasts of winter and spring precipitation. (NOAA, Klaus)</p>

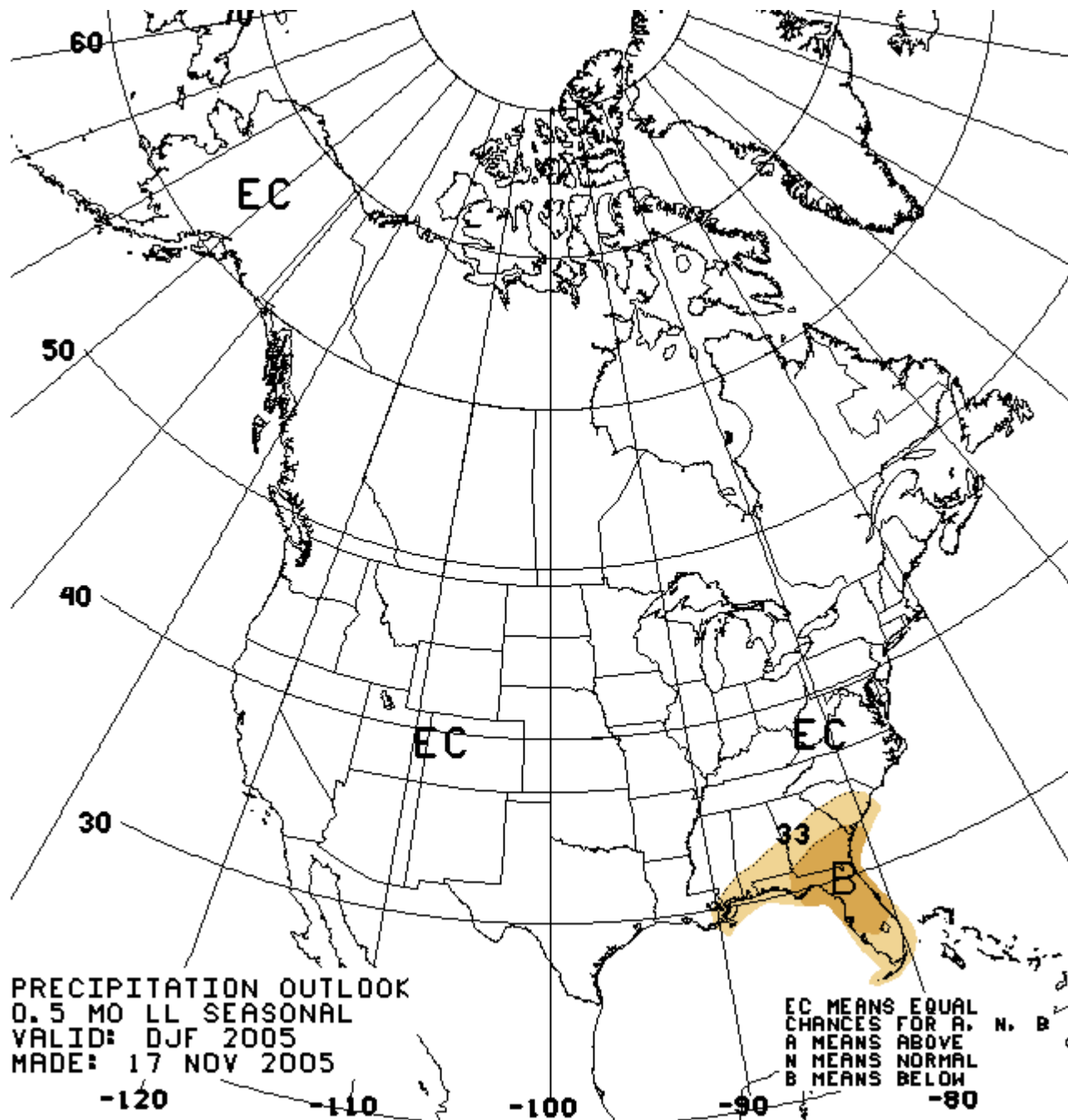
Constraints: Minimum releases and bypasses, downstream senior water rights, decrees and agreements.

Forecast for 2005 Using October Atmospheric Predictors Only



Cross-validated Forecast for SP for Year: 1951 Using October Atmospheric Predictors Only





PRECIPITATION OUTLOOK
0.5 MO LL SEASONAL
VALID: DJF 2005
MADE: 17 NOV 2005

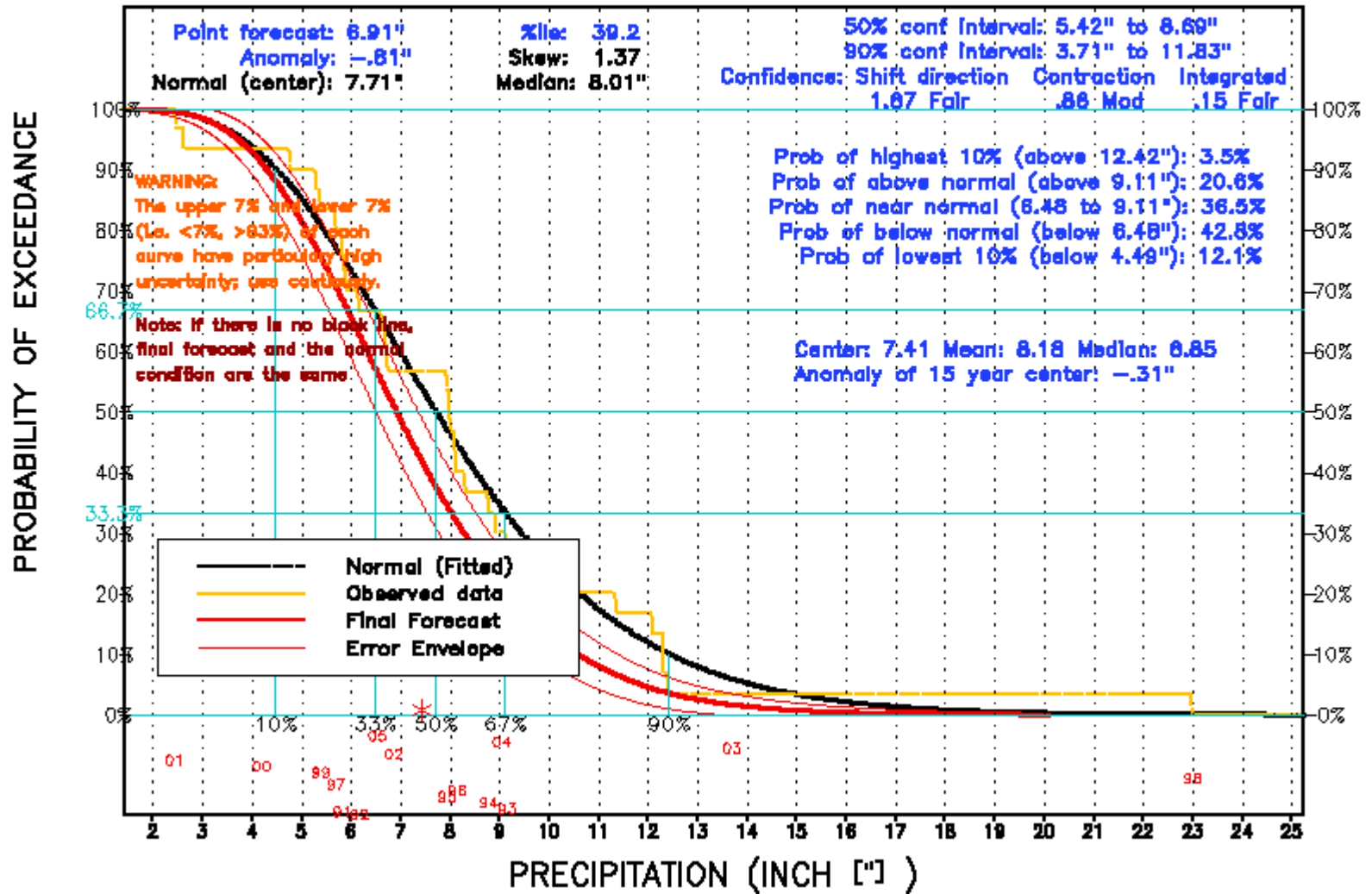
EC MEANS EQUAL
CHANCES FOR A. N. B
A MEANS ABOVE
N MEANS NORMAL
B MEANS BELOW

-120 -110 -100 -90 -80

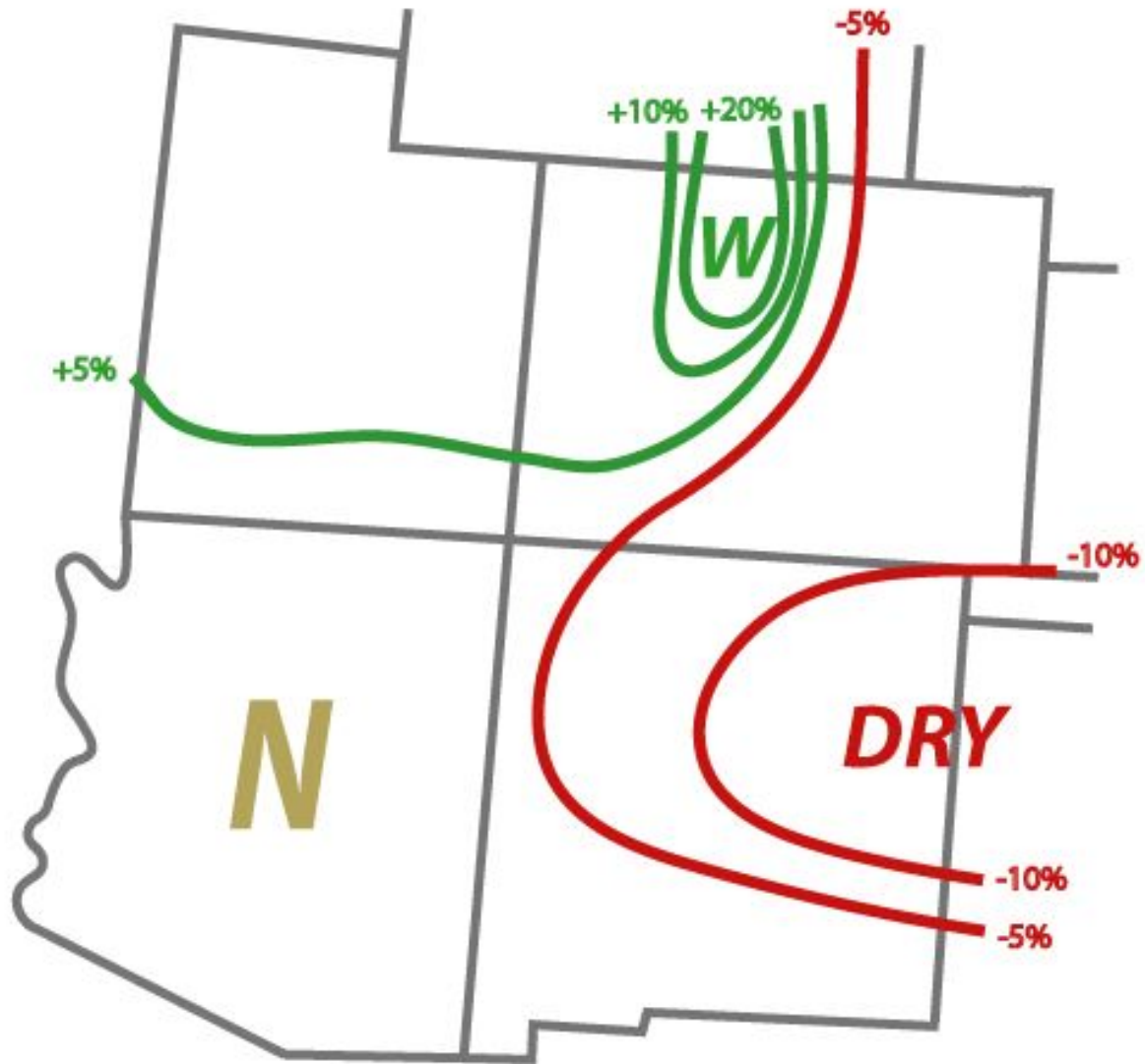
PRECIPITATION OUTLOOK FOR DJF 2005-06

0.5 MONTH LEAD OUTLOOK - MADE November 17 2005

Climate Division 67 (Central Florida)



EXPERIMENTAL CDC PRECIPITATION FORECAST GUIDANCE JAN-MAR 2006 (issued October 17, 2005)



WATER MANAGEMENT QUESTIONS AND USEFUL CLIMATE PRODUCTS

December - April

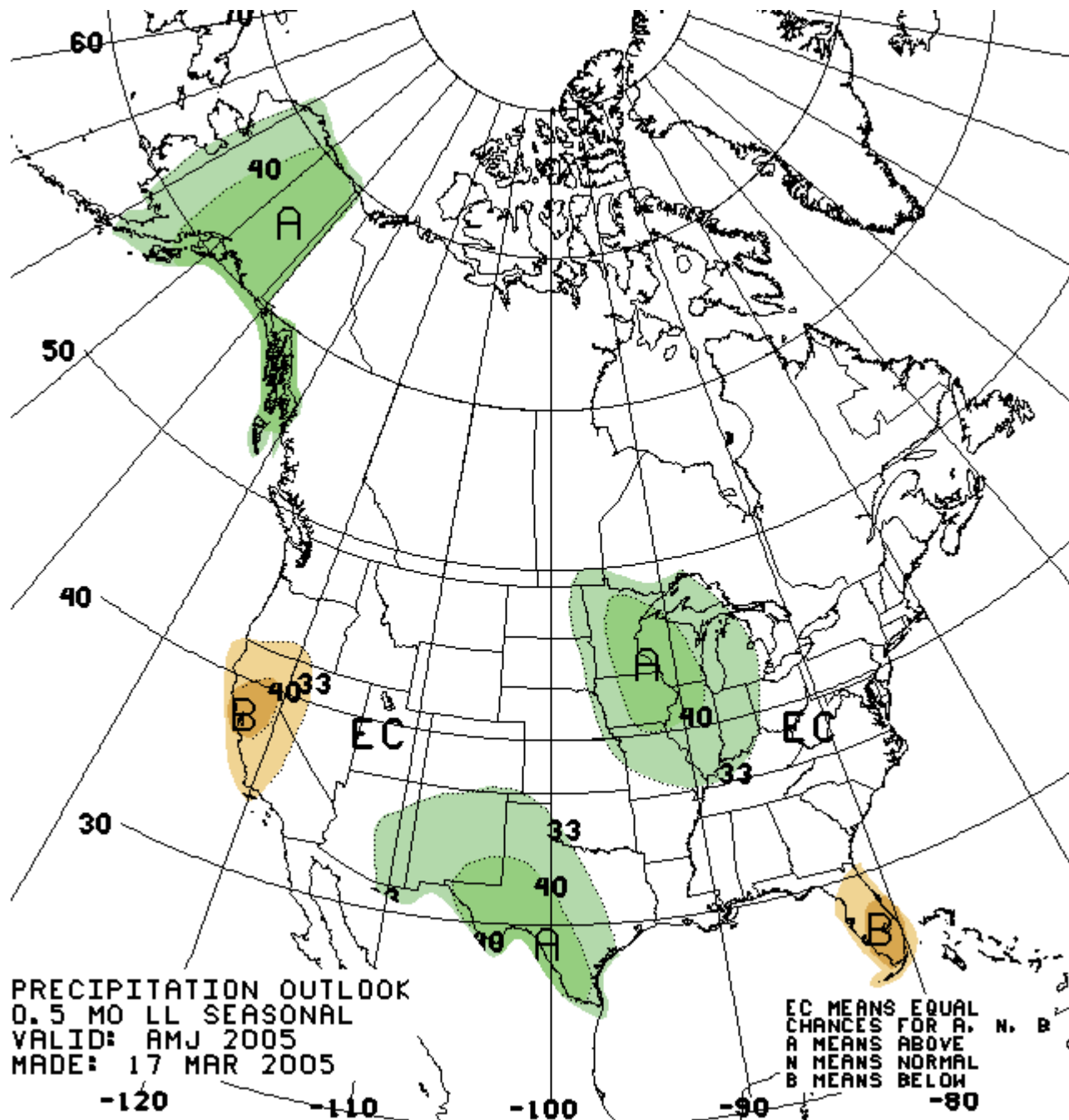
Questions	Useful Climate Products
<ol style="list-style-type: none">1. Should we release extra water for secondary benefits such as hydropower, recreation or the environment?2. Should we re-position our stored water to maximize capture of runoff water?3. Should we take out parts of our system for maintenance this coming summer?4. Should we begin making releases to prepare for unusually large inflows (like 1995)?5. Should we begin designing our water use restriction program?	<p>A. Runoff forecasts (NRCS, CBRFC, USBR, NCWCD)</p> <p>B. Forecasts of spring precipitation. (NOAA, Klaus)</p>

Constraints: Minimum releases and bypasses, downstream senior water rights, decrees and agreements.

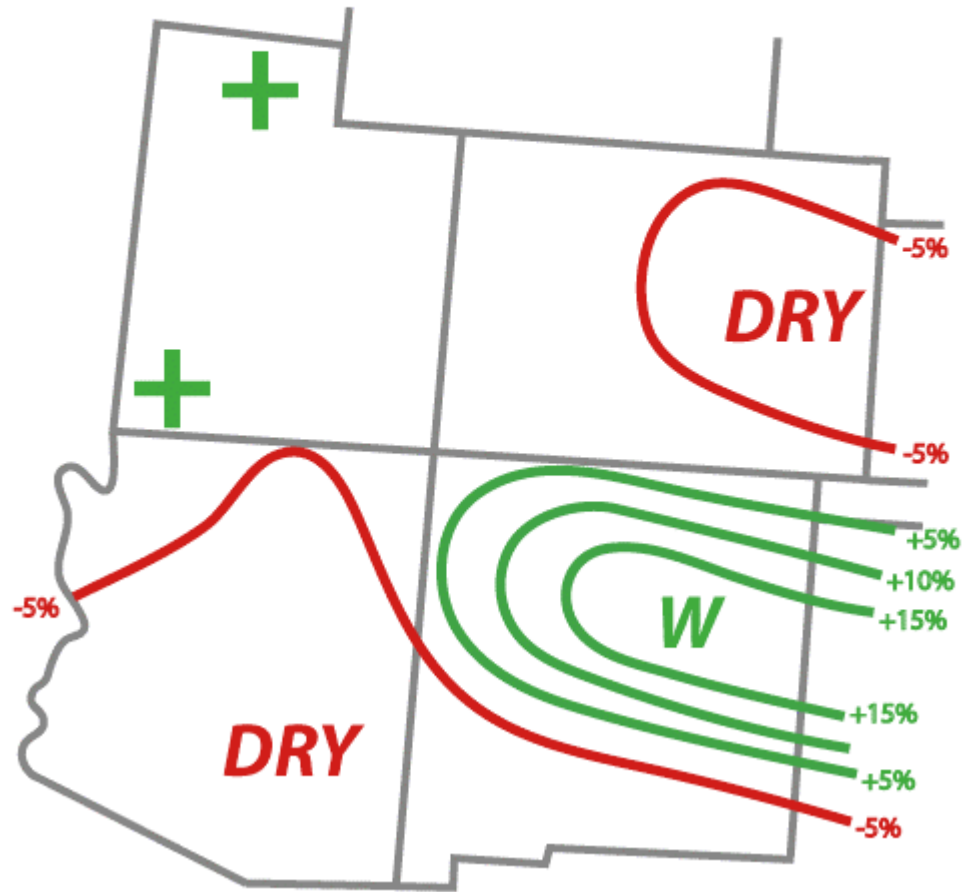
February 1, 2005 Streamflow Forecasts

Natural Resources Conservation Service

Forecast Point	90% Ex (1000 AF)	70% Ex (1000 AF)	50% Ex (1000 AF)	30% Ex (1000 AF)	10% Ex (1000 AF)	30-Yr Avg (1000 AF)
Dillon Reservoir Inflow (April - July)	68	108	135	162	203	167
Williams Fork Reservoir Inflow (April - July)	59	71	80	90	105	95



EXPERIMENTAL CDC APR-JUN 2005 PRECIPITATION FORECAST
(issued February 14, 2005)



WATER MANAGEMENT QUESTIONS AND USEFUL CLIMATE PRODUCTS

May - July

Questions	Useful Climate Products
<ol style="list-style-type: none">1. Should we release extra water for secondary benefits such as hydropower, recreation or the environment?2. Should we re-position our stored water to maximize capture of runoff water?3. Should we cancel any construction or maintenance projects?4. Should we begin or continue making releases to prepare for unusually large inflows (like 1995)?5. Should we declare a drought and begin water restrictions?	<p>A. Runoff forecasts (NRCS, CBRFC, USBR, NCWCD)</p> <p>B. Forecasts of spring and summer precipitation. (NOAA, Klaus)</p>

Constraints: Minimum releases and bypasses, downstream senior water rights, decrees and agreements.

WATER MANAGEMENT QUESTIONS AND USEFUL CLIMATE PRODUCTS

August and September

Questions	Useful Climate Products
Where should I go on vacation?	Weather forecasts for San Juan Islands, Playa del Carmen, Grand Tetons, etc.

Constraints: Boss has other ideas.

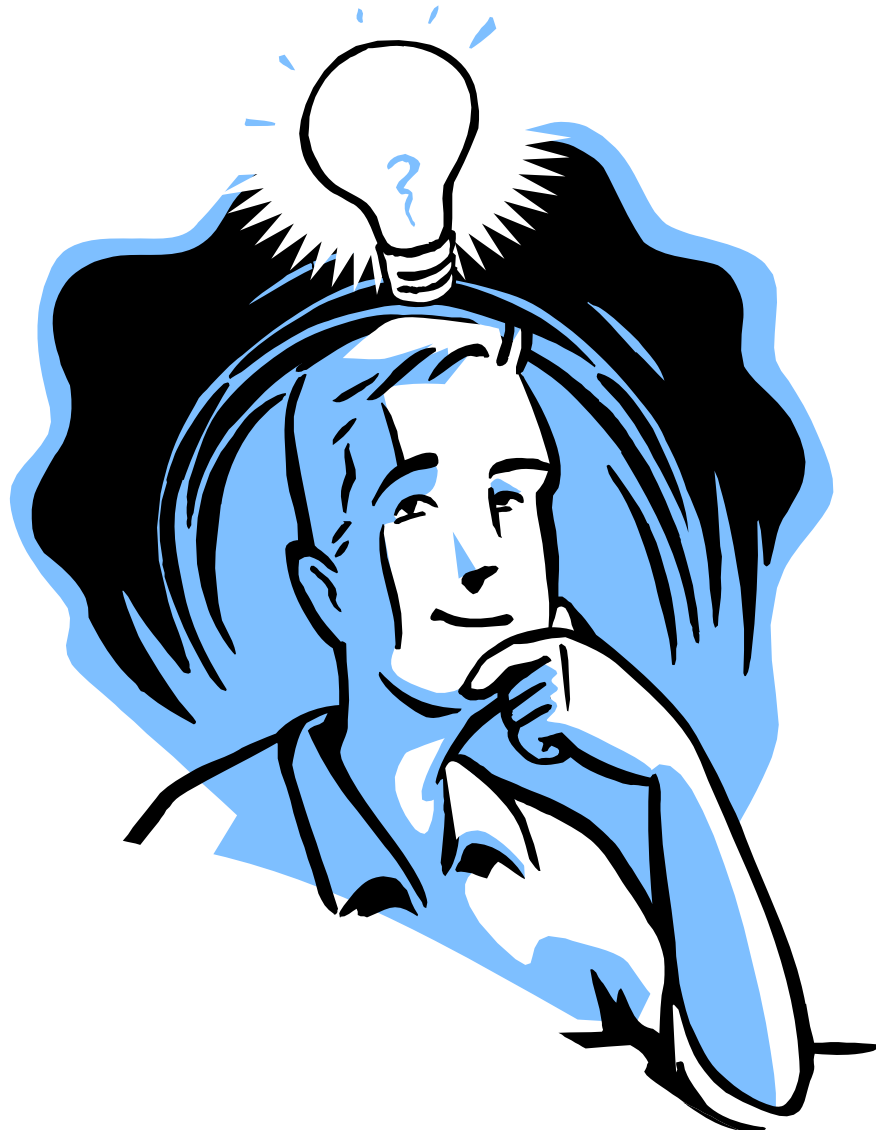
Conclusions

- Climate products help Denver Water to:
 - Reposition stored water to maximize capture of spring runoff.
 - Decide whether to make releases for power, recreation, environment, flood control, etc.
 - Decide whether to take parts of system out of service for construction and maintenance.
 - Make drought preparations.

More Conclusions

- Climate products are most useful when forecasts are presented in probabilistic terms with information on accuracy.
- As forecasts get more accurate they will become more useful.

Questions? Comments?

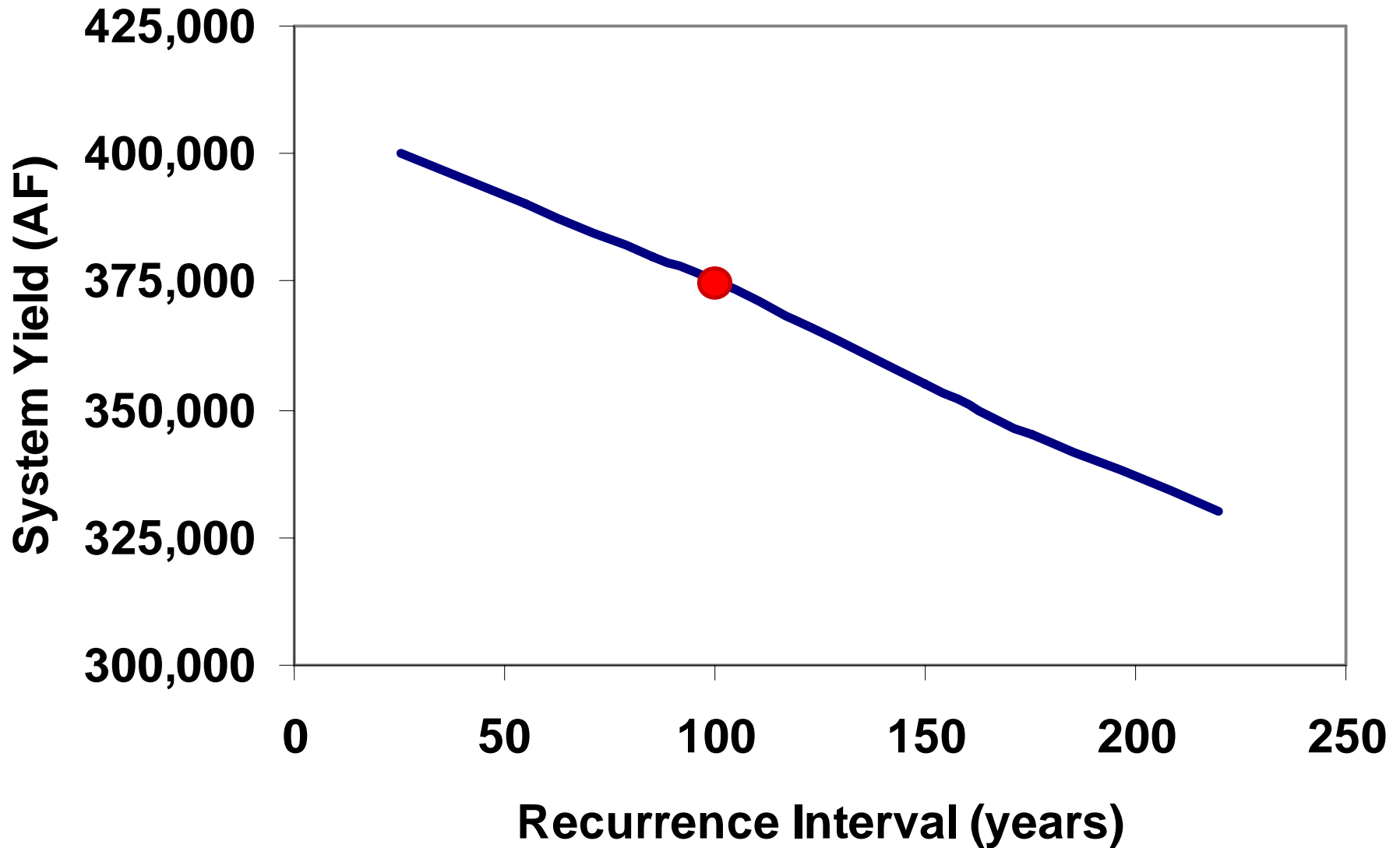


Streamflow Reconstructions Using Tree Rings

- Better understanding of system reliability and yield.
- Estimate frequency of various levels of water use restrictions.
- Estimate frequency of low reservoir levels.

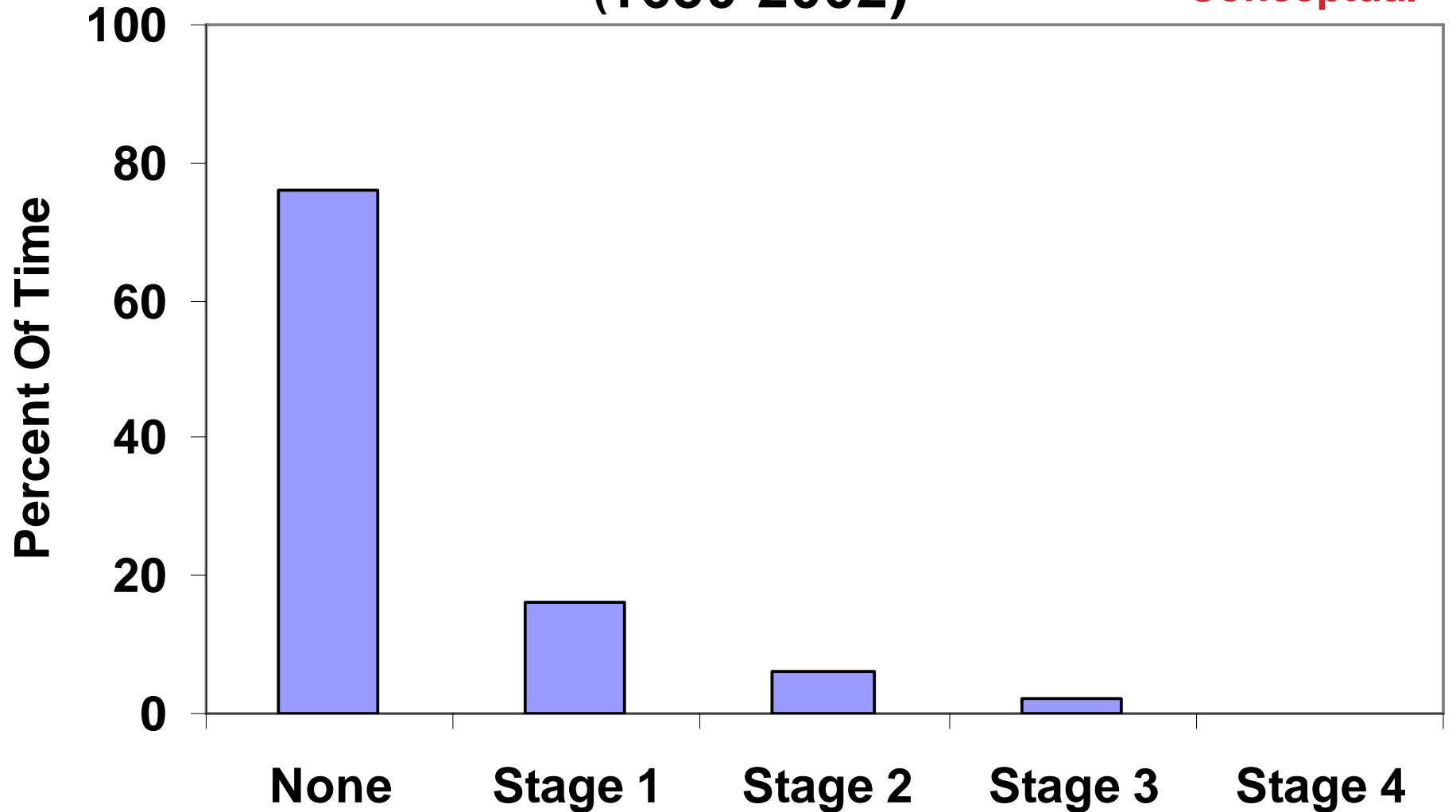
System Yield Based on Tree Rings (1650-2002)

Conceptual



Frequency of Drought Stages Based on Tree Ring Reconstruction (1650-2002)

Conceptual



Frequency of Reservoir Storage Based on Tree Ring Reconstruction (1650-2002)

Conceptual

