# LESSONS LEARNED FROM THE 2002 DROUGHT: IMPLICATIONS FOR MUNICIPAL WATER SUPPLY PLANNING

Governor's Conference on
Managing Drought & Climate Risk

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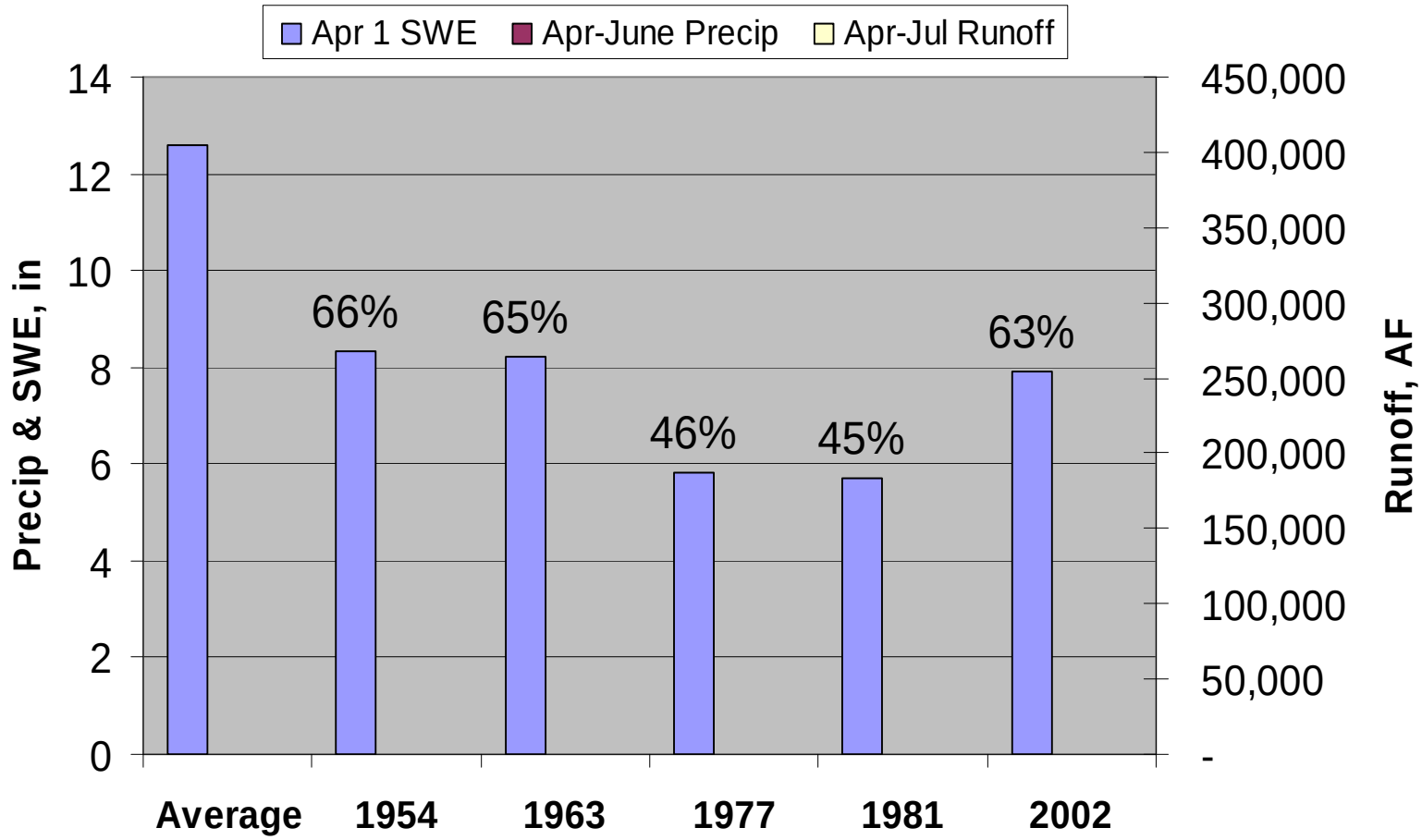
# Hydrology and Impacts of 2002 Drought

- 2002 statewide snowpack 22 percent of average
- Tree ring studies suggest:
  - *The worst year since 1703 in the South Platte Basin*
  - *The driest conditions since 1579 along the Colorado River*

# Dry Year Snow Pack, Precip, and Runoff
# Denver Water Collection System




Period: 1954-2002

Apr 1, 2002 %Full = 77% (Normal = 82%)

Source: Denver Water

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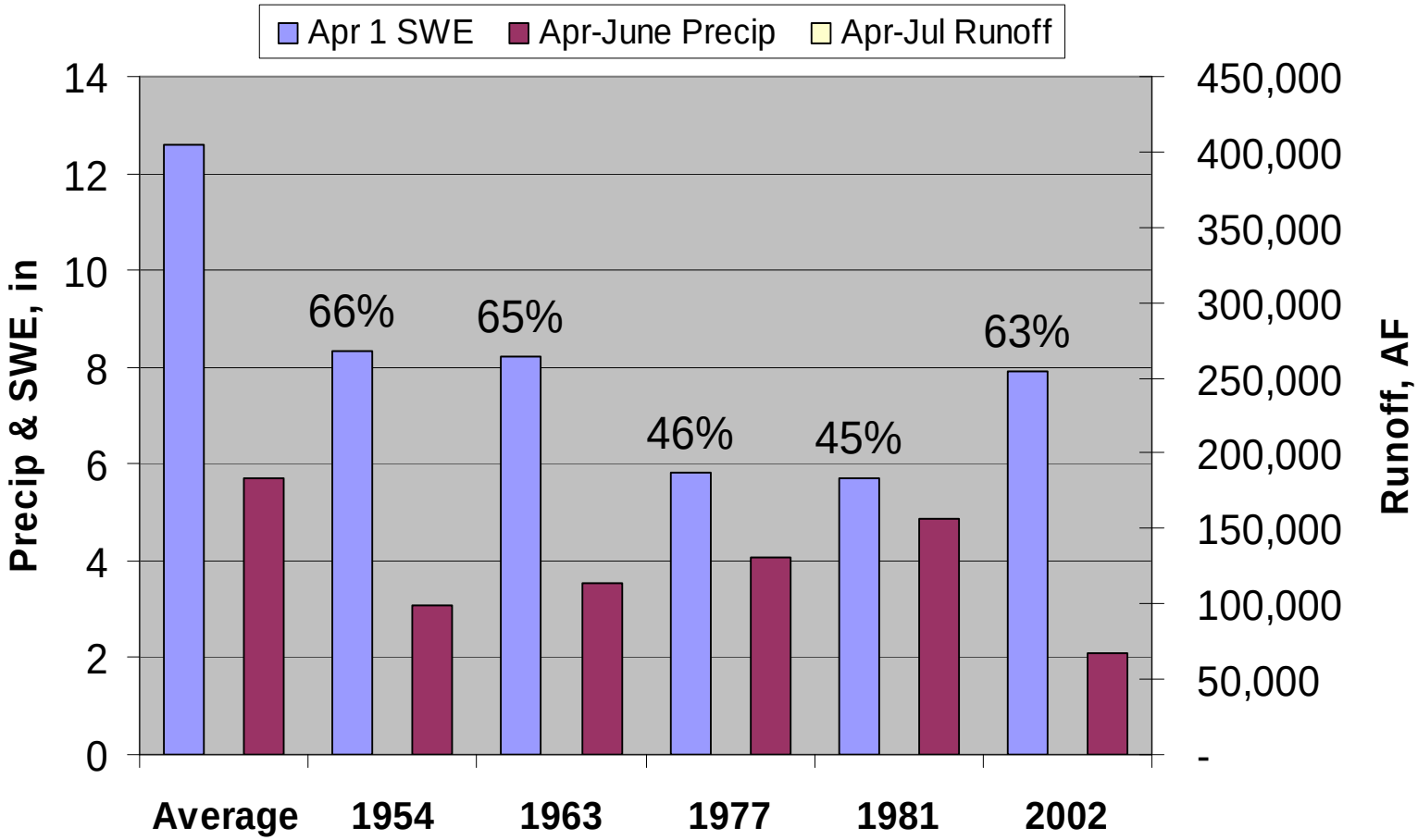


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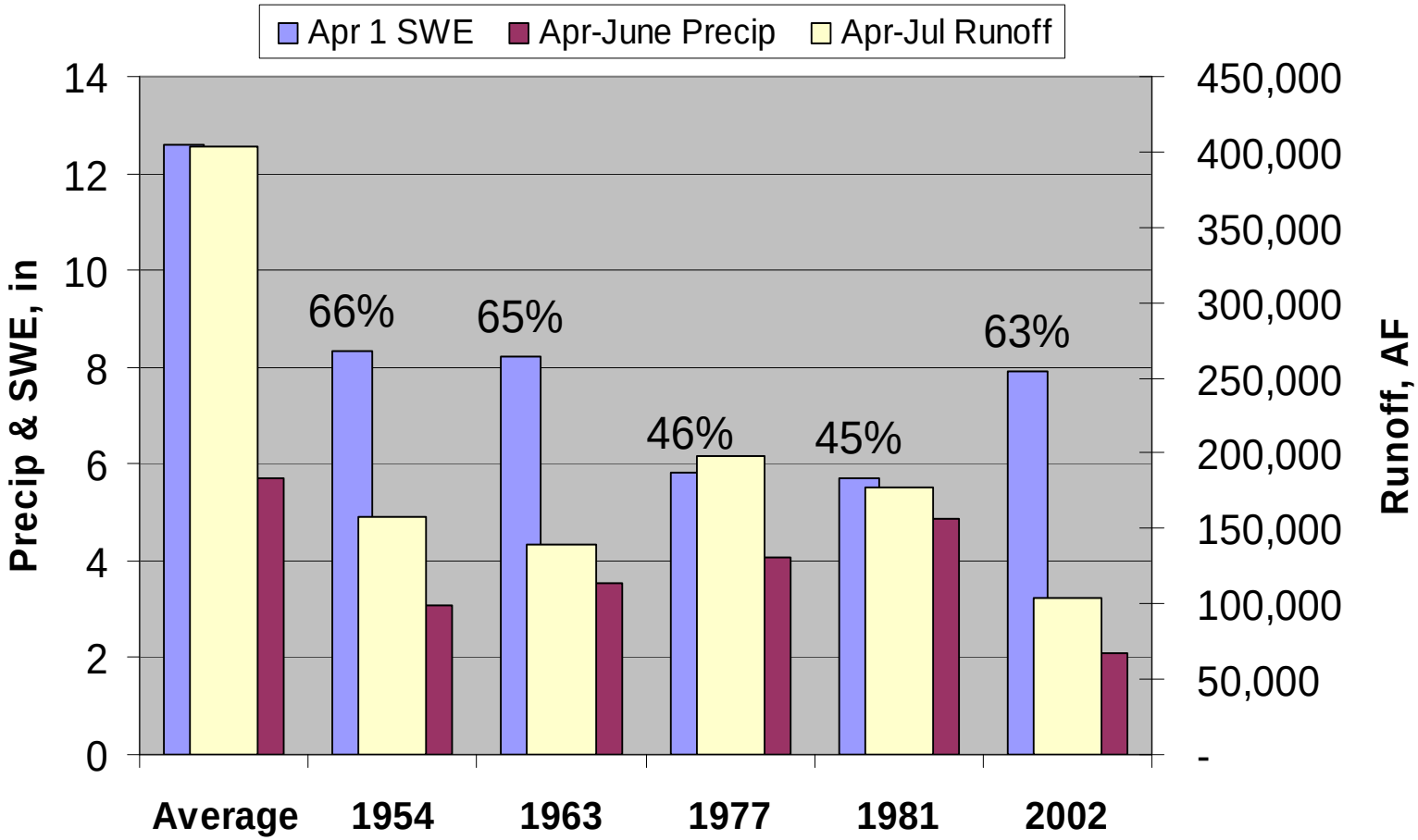


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PROVISIONAL

## Drought Ranking (1916-2002)

### 4 Gage Sum (South Platte, Blue, Williams Fork, Fraser)

| Drought Duration Yrs | Drought Years | Percent of Average | Return Period Yrs |
|---|---|---|---|
| 1 | 2002 | 34% | 250 |
| | 1954 | 43% | 69 |
| | 1963 | 46% | 48 |
| | 1981 | 53% | 22 |
| | 1977 | 53% | 22 |
| 2 | 1954-55 | 52% | 105 |
| | 1963-64 | 54% | 83 |
| | 2001-02 | 57% | 53 |
| | 1966-67 | 63% | 23 |
| | 1953-54 | 64% | 22 |
| 3 | 1954-56 | 61% | 86 |
| | 1953-55 | 63% | 58 |
| | 2000-02 | 67% | 31 |
| | 1966-68 | 70% | 22 |
| | 1976-78 | 71% | 18 |

Source: Denver Water

# Statewide Impacts of 2002 Drought

- $1.1 Billion impact to agriculture, tourism, and recreation industries
- Outfitters' visitation down 40 percent, an estimated $25 million impact
- 2,007 wildfires, 500,000 acres, $200 million impact

Source: Colorado Division of Water Resources

# Statewide Impacts of 2002 Drought

- Dryland farmers wheat production 45 percent 10-year average with 30 percent of plantings abandoned
- Irrigated corn production varied across the state from 50 to 85 percent of average
- Reduction of 40 to 50 percent of breeding stock, losses of $460 million

Source: Colorado Division of Water Resources

# Statewide Impacts of 2002 Drought

Estimated loss of 15,000 jobs and $75 million in revenue

- Impacts on urban recreation
  - *Closed athletic fields*
  - *Reduced golf rounds*
- Some permanent landscape damage
- Green Industries suffered
  - *Sod growers*
  - *Nurseries*
  - *Landscape maintenance companies*

South Fork of South Platte above Antero Reservoir ~8/31/02

(Denver Water)

Typical Reservoir Boat Ramp

# 2002 Drought
# Observations and Lessons Learned

# 2002 Drought Observations and Lessons Learned

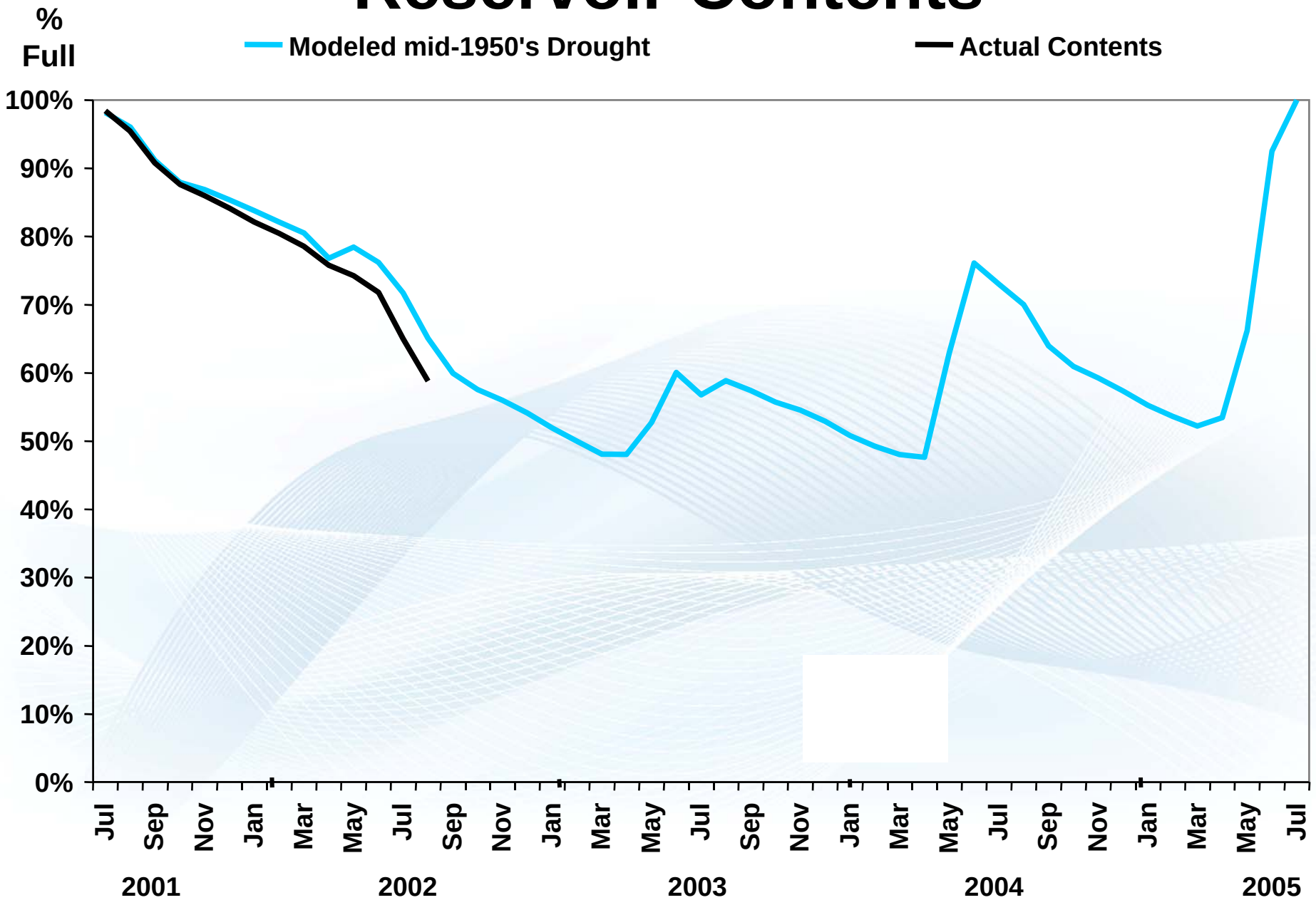
- Short-term drought exposed the vulnerability of many water supplies
  - *Many still growing into firm yield demand*

- Extraordinary raw water delivery and reservoir losses
  - *Losses greater than modeled*
- Runoff failed to materialize
- Models did not contain the 2002 hydrology

# 2002 Drought
# Observations and Lessons Learned


- Politics overruled technical recommendations
  - *Requested worst case assumptions*
  - *Willingness to sacrifice revenues to maintain storage reserves*
- Policy maker tolerance for low storage levels less than modeled assumptions for planning drought
- Trouble for providers that counted on drought restrictions to manage modeled planning drought

# Reservoir Contents



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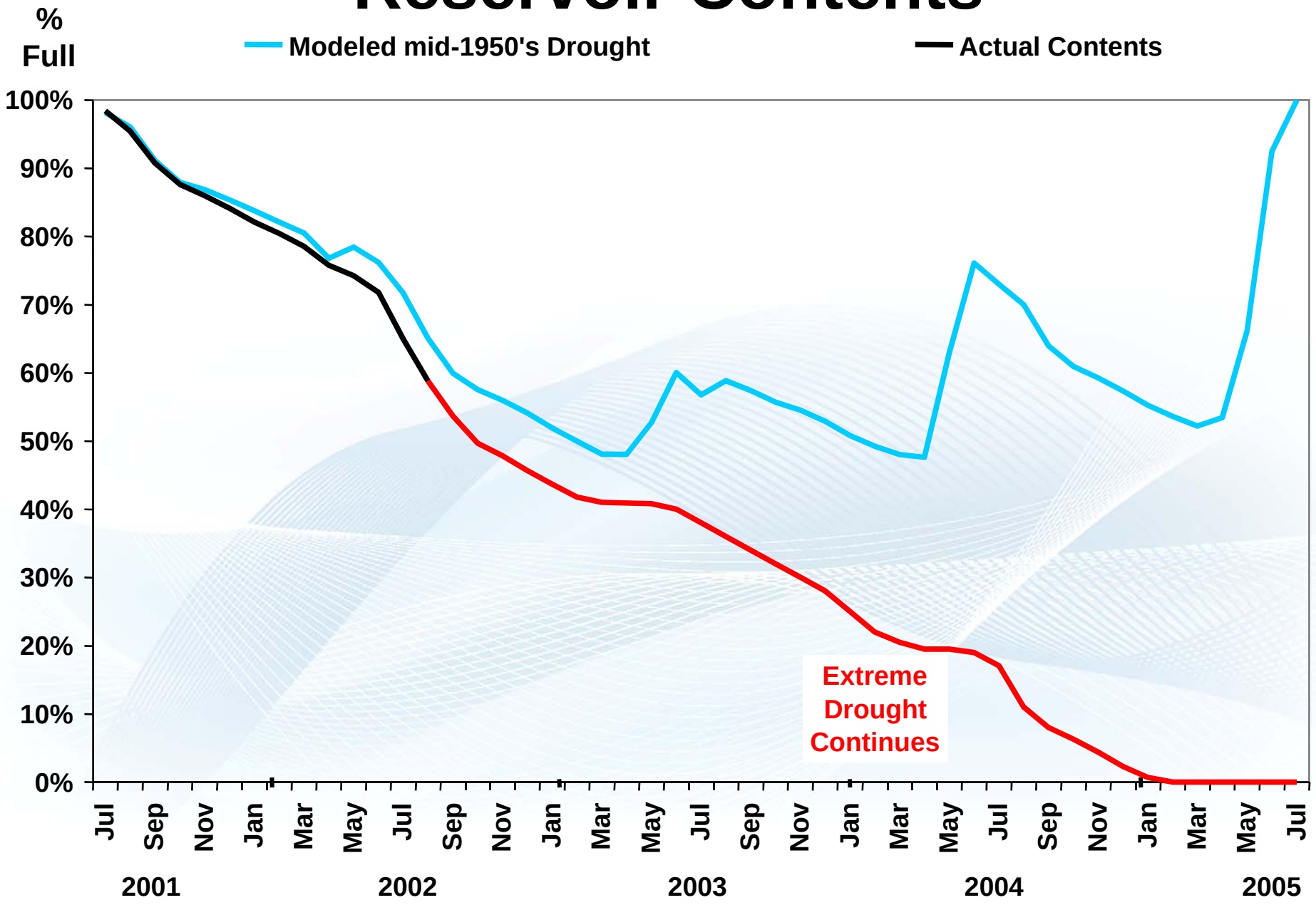


# 2002 Drought
# Observations and Lessons Learned

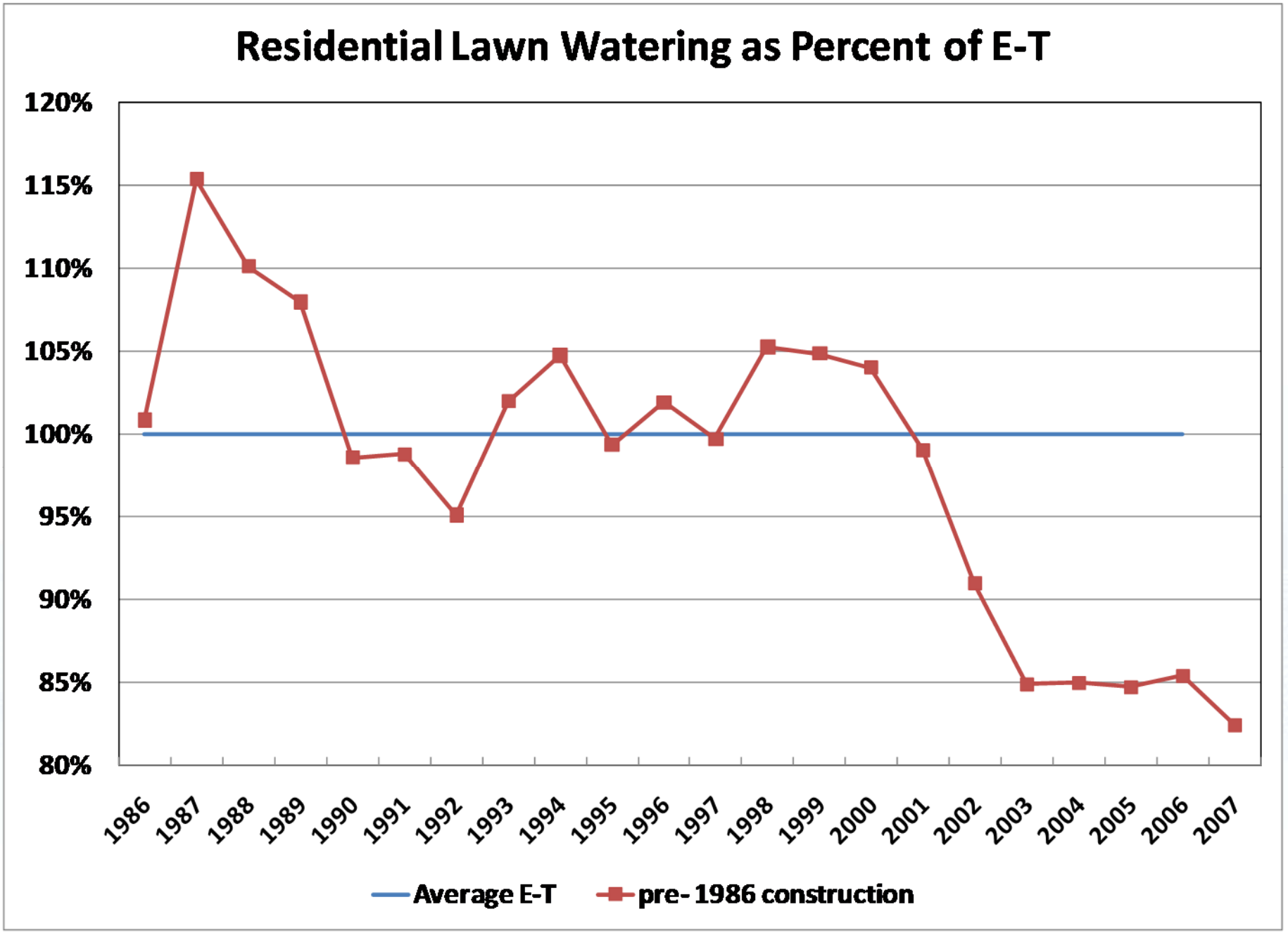
- Citizens very slow to respond to calls for voluntary water conservations
  - *Mandatory restrictions and enforcement required to meet goals*
- Operating costs increased
  - *Leasing water for direct use and return flow obligations*
  - *Pumping and treatment*
- Revenues decreased

A water witch or dowser, redrawn from a 16th Century woodcut. Adapted from Gilluly, Waters, and Woodford (1959).

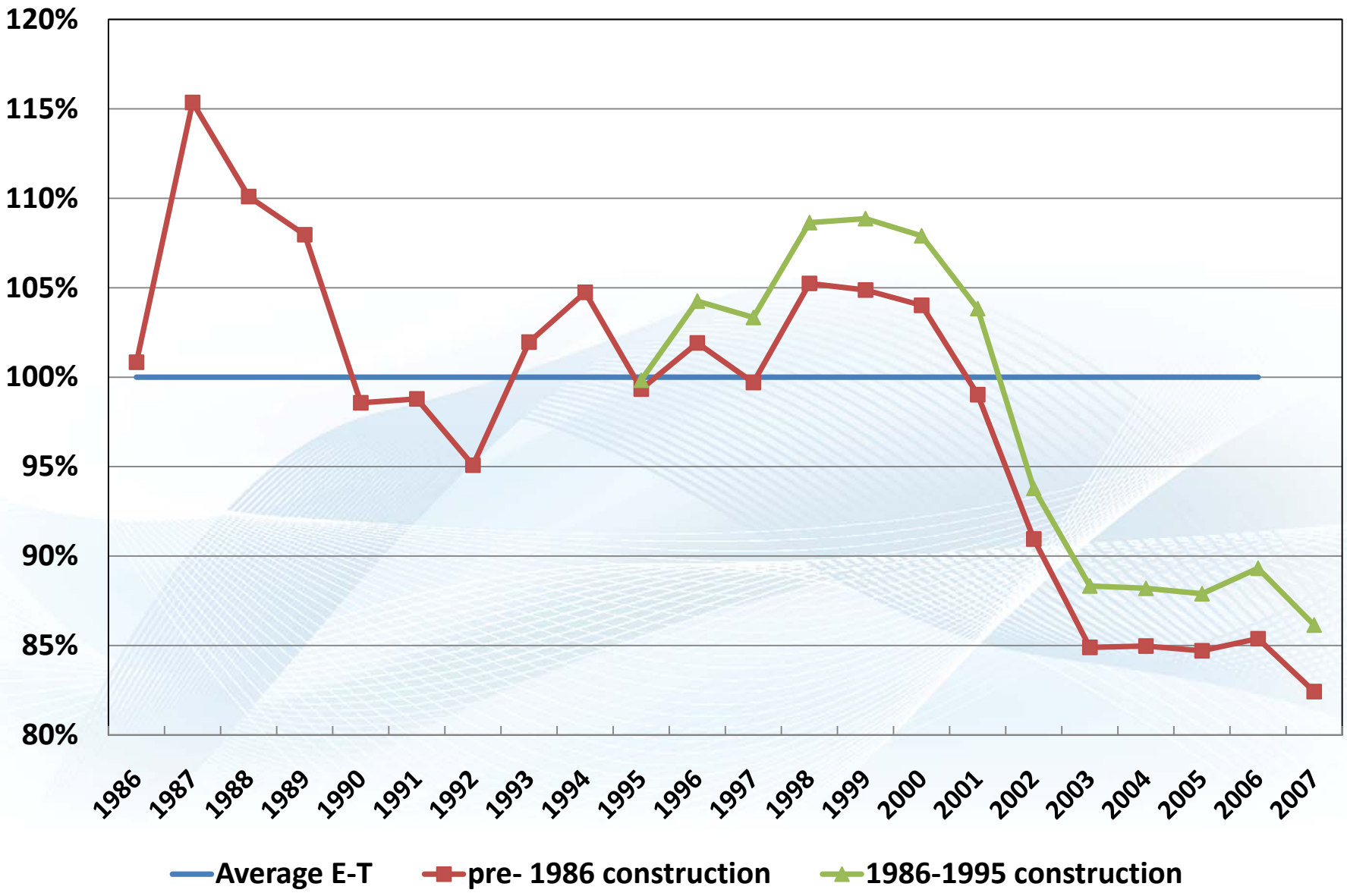
# 2002 Drought
# Observations and Lessons Learned

- Drought surcharges to maintain revenues were not well received by customers
  - *Were drought rate surcharges gouging or conservation measure?*
- Once convinced of the drought severity:
  - *Policy makers and citizens jumped on the bandwagon*
  - *Slow to get off*

**News:**
Drought Water Rates Hit Conservers and Wasters Alike


Residential Lawn Watering as Percent of E-T
120%
115%
110%
105%
100%
95%
90%
85%
80%
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Average E-T
pre- 1986 construction

# Residential Lawn Watering as Percent of E-T



# Considerations for Drought Planning

# Considerations for Drought Planning Reevaluate Safety Factor

**Denver area municipalities working on long-range planning options for water conservation**

September, 2002

**By Associated Press**

Several Denver-area cities are working on water conservation plans that may include holding a portion of their supplies back for reserve in the event of a continuing drought.

- Water rights and administration
- Extreme Drought and Climate Change
- Structural failures
- Ineffectiveness of conservation measures
- Other unforeseen circumstances, e.g. fires, contamination
- Avoid hardship to customers and developers
- Difficult to know a drought until well into it

# Considerations for Drought Planning Evaluate Role of Water Conservation

- Water conservation can serve as an effective tool for increasing drought protection
  - *Carryover of saved water (may need more storage)*
  - *Eliminates worry of predicting beginning of drought*
  - *Cost-effective*
  - *Revise rate structure for revenue protection and customer acceptance*

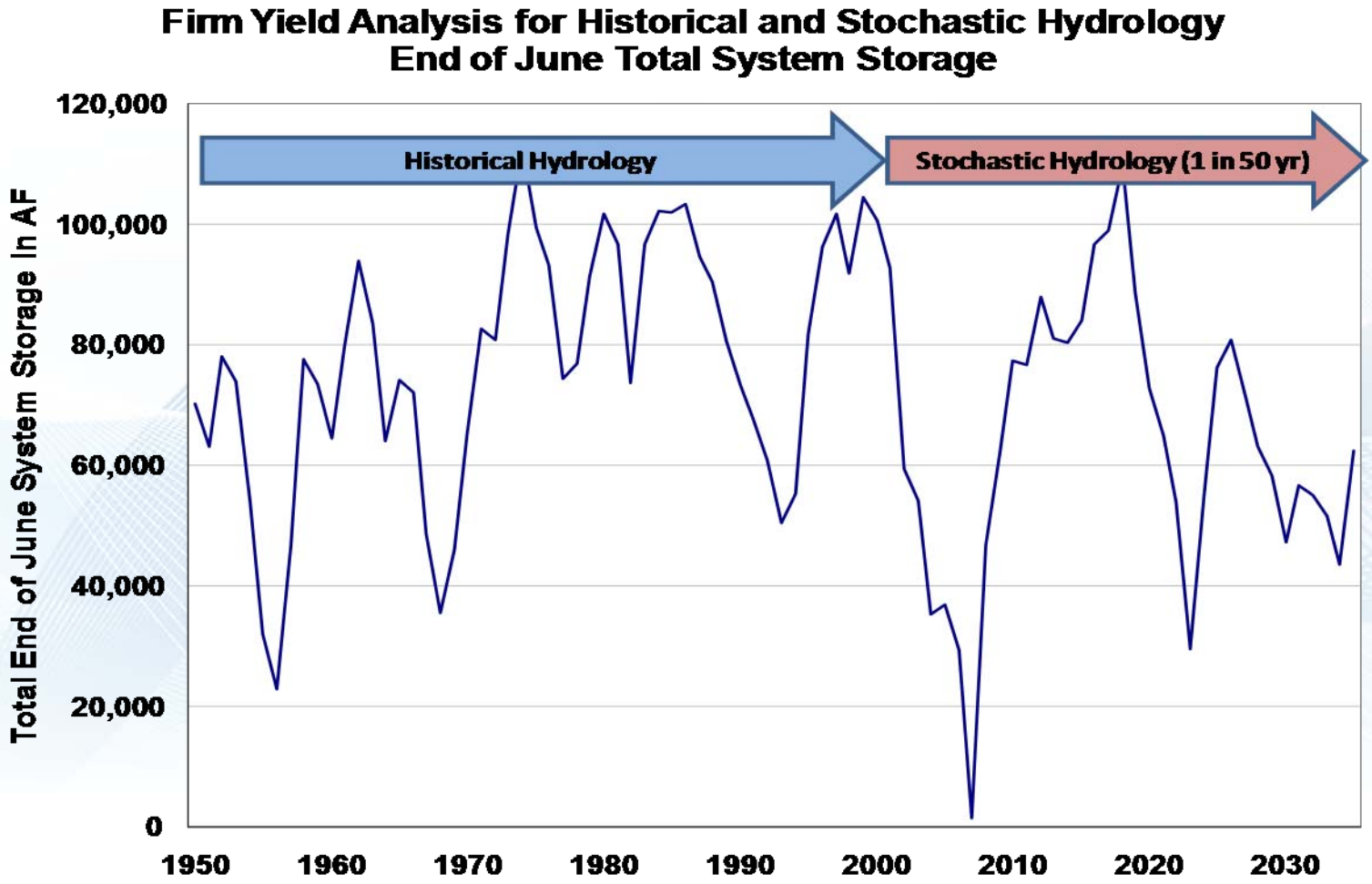
Analyze water rights impacts

- *Return flow obligations*
- *Ability to physically and legally carryover saved water*

Understand implications before using conserved water for other purposes

# Considerations for Drought Planning Stochastic Hydrology to Evaluate Reliability

- *Need probabilities to assess reliability*
- *Climate change scenarios*



# Considerations for Drought Planning Update Hydrology and Acceptable Risk

- Determine the political and psychological acceptable level of risk
  - *Example: always the possibility of another dry year*
  - *Determine minimum acceptable storage levels*
  - *Will more storage help?*

(Denver Water)

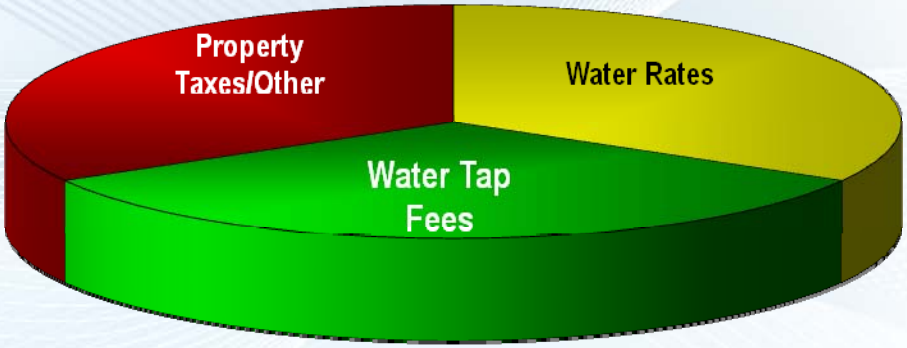
- Evaluate:
  - Incorporating climate predictions
  - Whether permanent savings through conservation must be kept in reserve or can be used for growth
  - The role of drought restrictions in long-term supply planning

# Considerations for Drought Planning
# Drought Planning Considerations

- Cost vs. Risk
  - *Drought demand reduction = Reduced revenues*
  - *Greater drought protection = Increased costs*
  - *Weigh lost revenues and other negative impacts against cost of drought protection*
  - *Weigh lost revenues and other negative impacts against cost of drought protection*
    - *Environmental*
    - *Ag Dry-up*

# Considerations for Drought Planning
# Drought Planning Considerations

- Develop a funding plan
  - *Establish drought reserve fund*
  - *Set aside excess revenues from good water revenue years for use during droughts*
  - *Determine if funding is from rates (all customers) or new growth (tap fees) or other sources*
- Develop or update drought management plans




Remember when we used to live in a semi-arid area?

# Lessons Learned From the 2002 Drought: Implications for Municipal Water Supply Planning

**Kelly DiNatale, CDM**

In 2002, nearly all of Colorado experienced the lowest snowpack and runoff on record at approximately 25% of average in many basins. Tree-ring studies suggest that the 2002 drought was the worst single year in centuries. Streamflows during historical peak runoff months were minimal, with the June flow in the Rio Grande at Del Norte only 7% of average. The drought of the early 2000's, though extremely severe, was not as severe as the 1950's year drought when comparing 2 to 3 year drought durations.

Statewide drought impacts were significant. These impacts included:

- $1.1 Billion impact to agriculture, tourism, and recreation industries
- Outfitters' visitation down 40 percent with an estimated $25 million impact
- 2,007 wildfires on 500,000 acres with a $200 million impact
- Dry land farmers wheat production at 45 percent 10-year average
- Irrigated corn production varied across the state from 50 to 85 percent of average
- Reduction of 40 to 50 percent of breeding stock with losses of $460 million
- Impacts on urban recreation included closed athletic fields and reduced golf rounds
- Green Industries suffered with sod growers, nurseries and landscape maintenance companies experiencing significant losses in employment and revenue

The 2002 drought, though short-lived, exposed the vulnerability of many water supplies. Many water providers experienced extraordinary raw water delivery and reservoir losses. These losses were greater than modeled in providers' system yield models. In addition, existing system models based on historical droughts used for planning and drought analysis did not contain hydrology as severe as 2002.

As the drought increased in severity and runoff failed to materialize, media attention intensified. Policy makers became increasingly uncomfortable and requested worst case scenarios including a second year of 2002 yields. Policy makers were also willing to sacrifice revenues by implementing mandatory demand reduction in order to maintain reserves in storage. These storage reserves were greater than used in planning models based on lesser droughts. Water providers that had based supply planning on implementing demand restrictions under mild drought conditions experienced significant hardships and implemented restrictions to achieve 40 to 70% reductions in demand.

Most providers along the front range called for voluntary conservation by early May after an April that resulted in demands 40% greater than average. Customer response to requests for voluntary reductions in demand did not result in significant reductions and by late June most providers had implemented mandatory water restrictions with enforcement and ticketing of offenders. The need to lease additional supplies for direct use or to replace return flow obligations increased operating costs at the same time that water restrictions reduced water use and revenues. A few providers implemented drought surcharges that were generally not well received. Customer resistance centered on perceived price gouging and being asked to pay more for less water.

Water demand reductions achieved by the end of 2002 has continued into later years, with savings of nearly 20% for many utilities. It is uncertain the percentage of savings achieved as a result of behavioral vs. technological changes. Analysis by several utilities indicates that many residential customers have significantly reduced their landscape watering to levels below E-T.

Considerations in developing additional water system reliability and drought protection include the high cost for protection against infrequent events, ancillary effects such as dry-up of agricultural lands and environmental impacts. Many water providers are reevaluating their planning criteria and safety factors in light of the recent drought, changed river administration in the South Platte and potential impacts from climate change. Water conservation as a tool to increase drought reliability is also under evaluation.

Potential follow up to the drought includes:

- Incorporating stochastic hydrology into modeling to assign probabilities of occurrence and assess system reliability
- Determining the political acceptable levels of risk
- The role of storage and drought restrictions
- The use of conserved water
- Development of a funding plan to implement recommendations
- Development or update of drought management plans

**Kelly DiNatale—CDM**

Kelly DiNatale is a principal and senior water resources engineer at CDM, Inc. He has served as the technical director for the Statewide Water Supply Initiative for the Colorado Water Conservation Board and the Colorado Department of Natural Resources Interbasin Compact roundtables. In addition, he has served as project manager or senior technical advisor on integrated water resources plans, environmental impact statements and water quality and water supply projects for local, regional, state and international clients. Western projects include the South Metro Water Supply Master Plan, Castle Pines North and City of Northglenn Integrated Water Resources Master Plans, Rio Grande Reservoir Multi-use Enlargement Study, Halligan-Seaman Reservoirs Enlargement EIS and the Oklahoma Comprehensive Water Plan. He previously served as Water Resources and Treatment Manager for the City of Westminster, Colorado.

He is a registered professional engineer, board certified environmental engineer and certified lake manager. Mr. DiNatale has 28 years of experience in the planning, design, construction, and operations and maintenance of raw water supply, water quality, watershed protection, reservoir management, water treatment, and wastewater treatment facilities. He has been qualified as an expert witness in Colorado Water Court and has provided expert testimony in a number of complex water court proceedings on municipal supply planning and reservoir and drinking water quality. He has provided testimony before the Colorado Water Quality Control Commission on water quality matters and has worked with several nationally recognized limnologists on reservoir water quality issues. Mr. DiNatale served as President of the Colorado Lake and Reservoir Management Association and Regional Director and Committee Chair of the North American Lake Management Society. He has presented at regional, national and international forums on water supply, water rights, water reuse, watershed protection, reservoir water quality and management issues.