Water Planning and Management in El Paso, Texas

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Water Resources Manager
El Paso Water Utilities

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Topics

- El Paso Water Supply
- Updated View of Hueco Bolson
- Wastewater Effluent Groundwater Recharge
- Climate Change Impacts
- Desalination

Current El Paso Water Supply

- Hueco Bolson Groundwater
- Mesilla Bolson Groundwater
- Rio Grande Diversion
- Reclaimed Water

Current El Paso Water Supply

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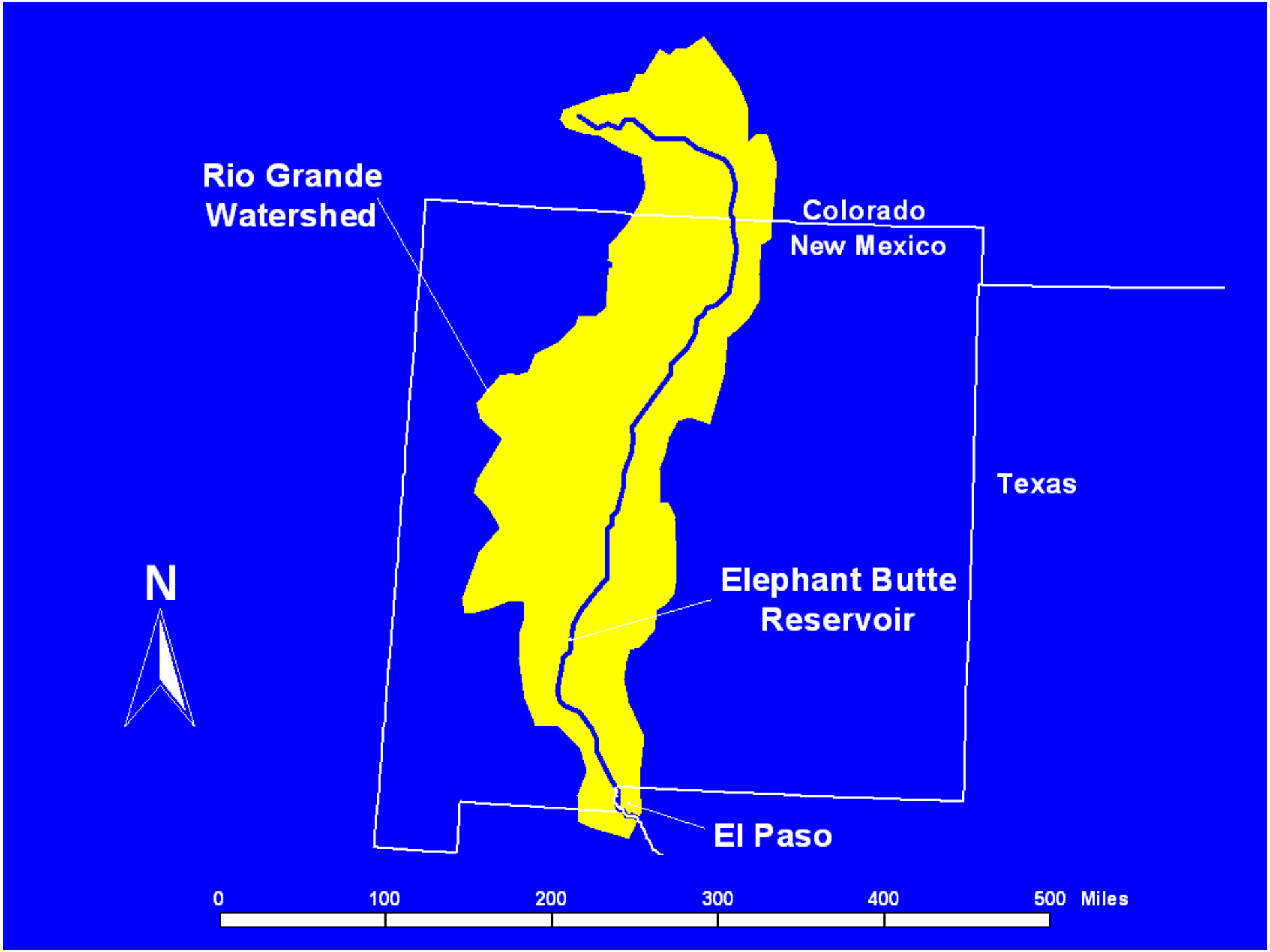
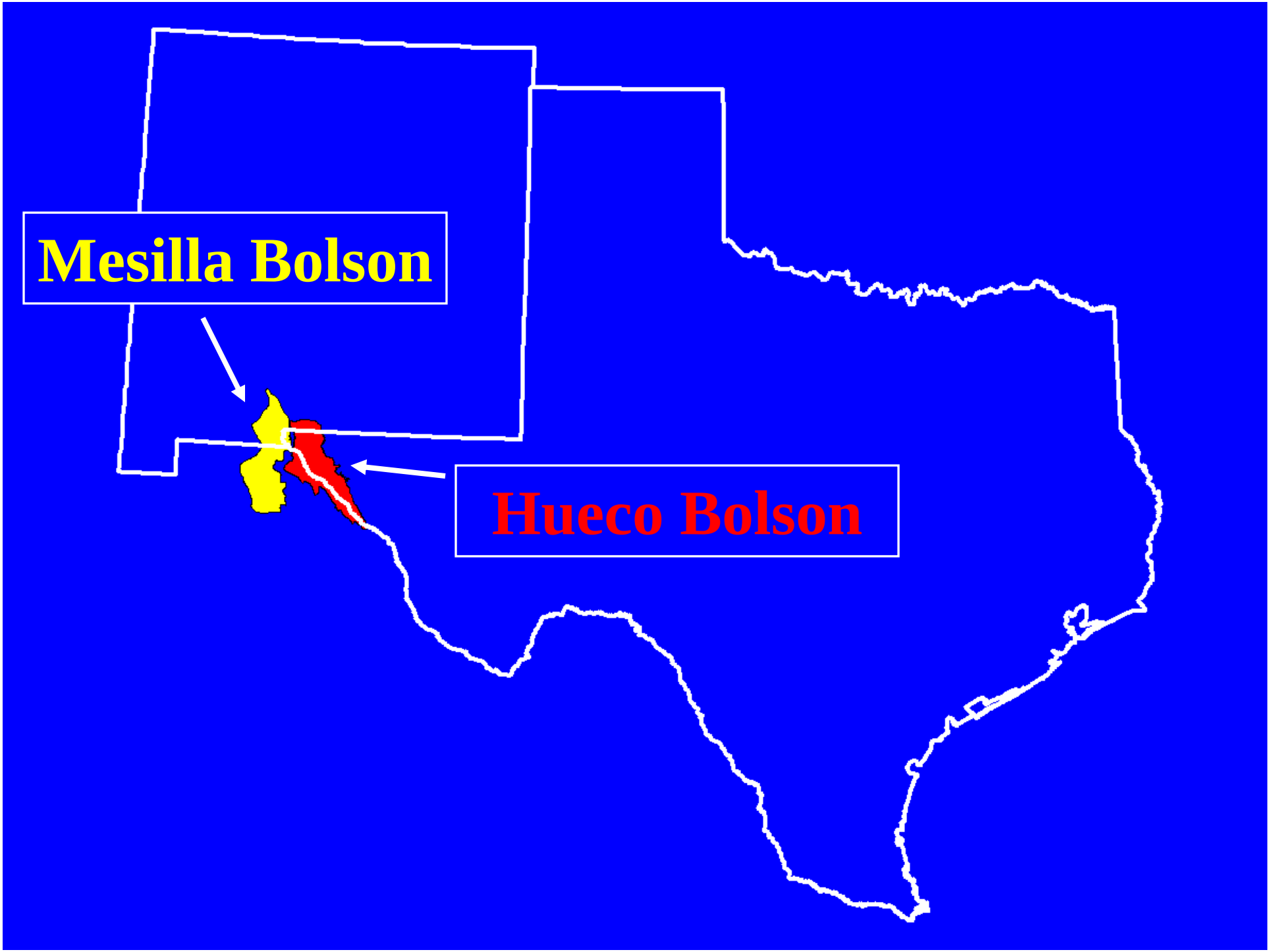
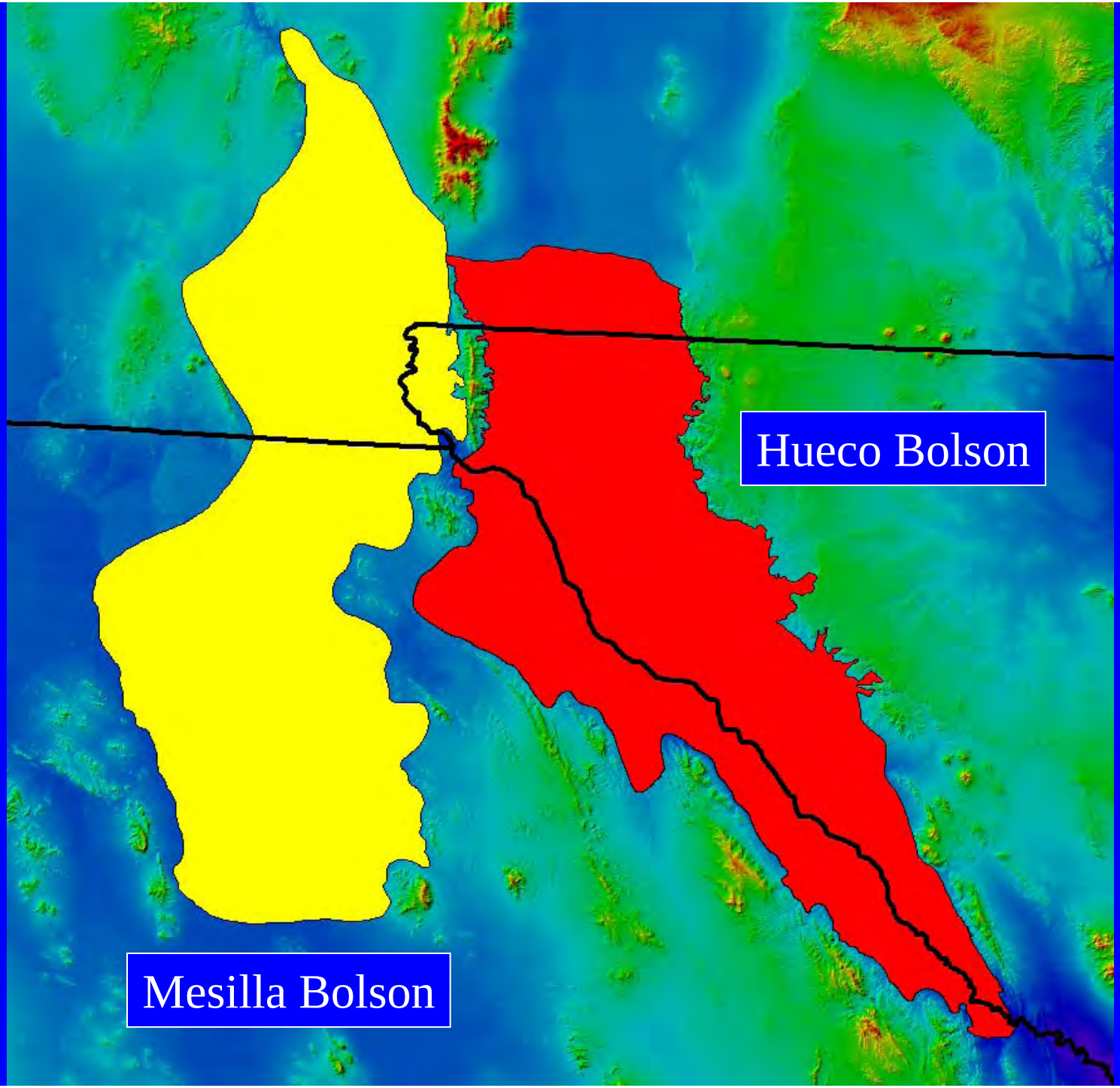
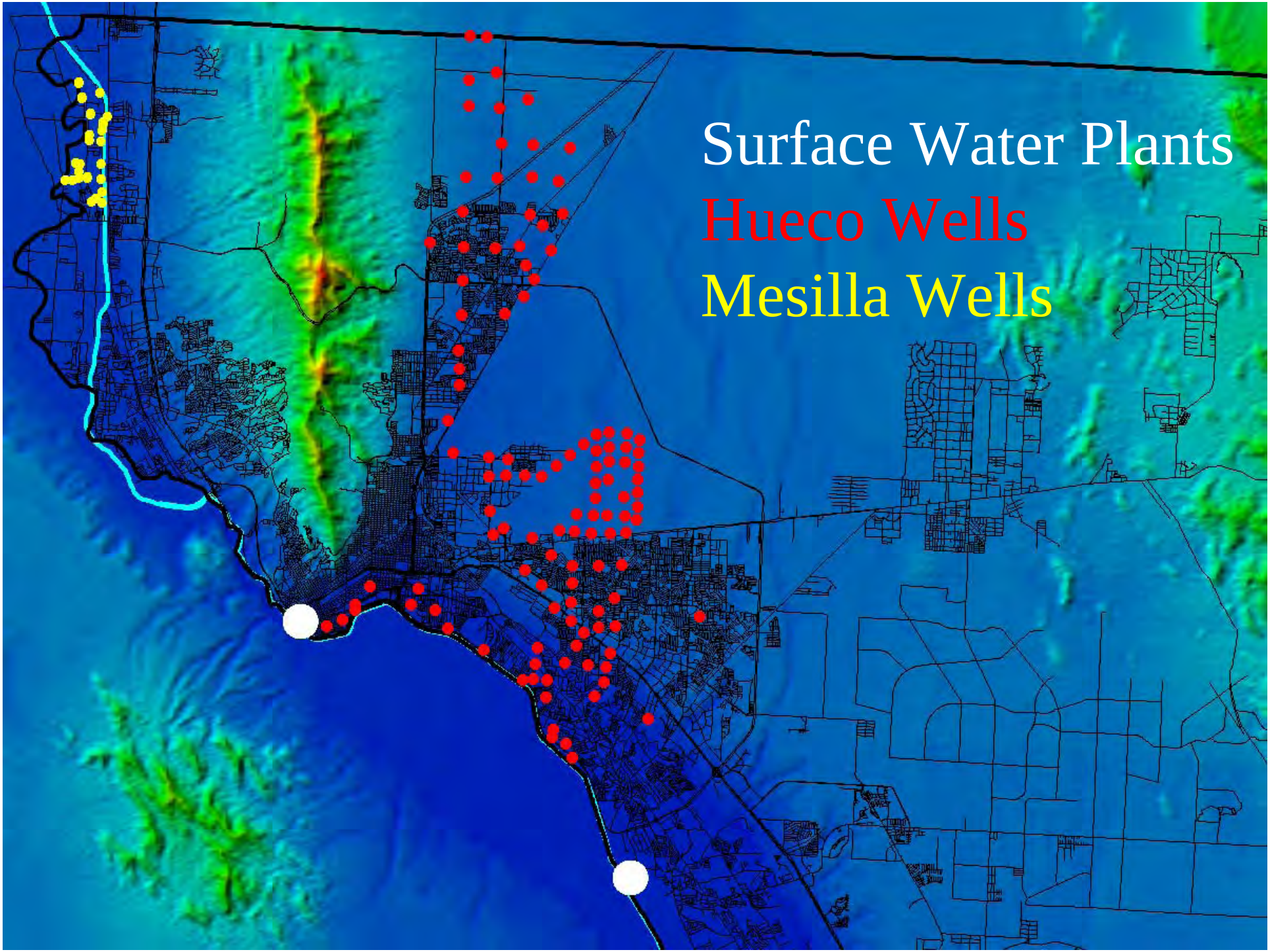
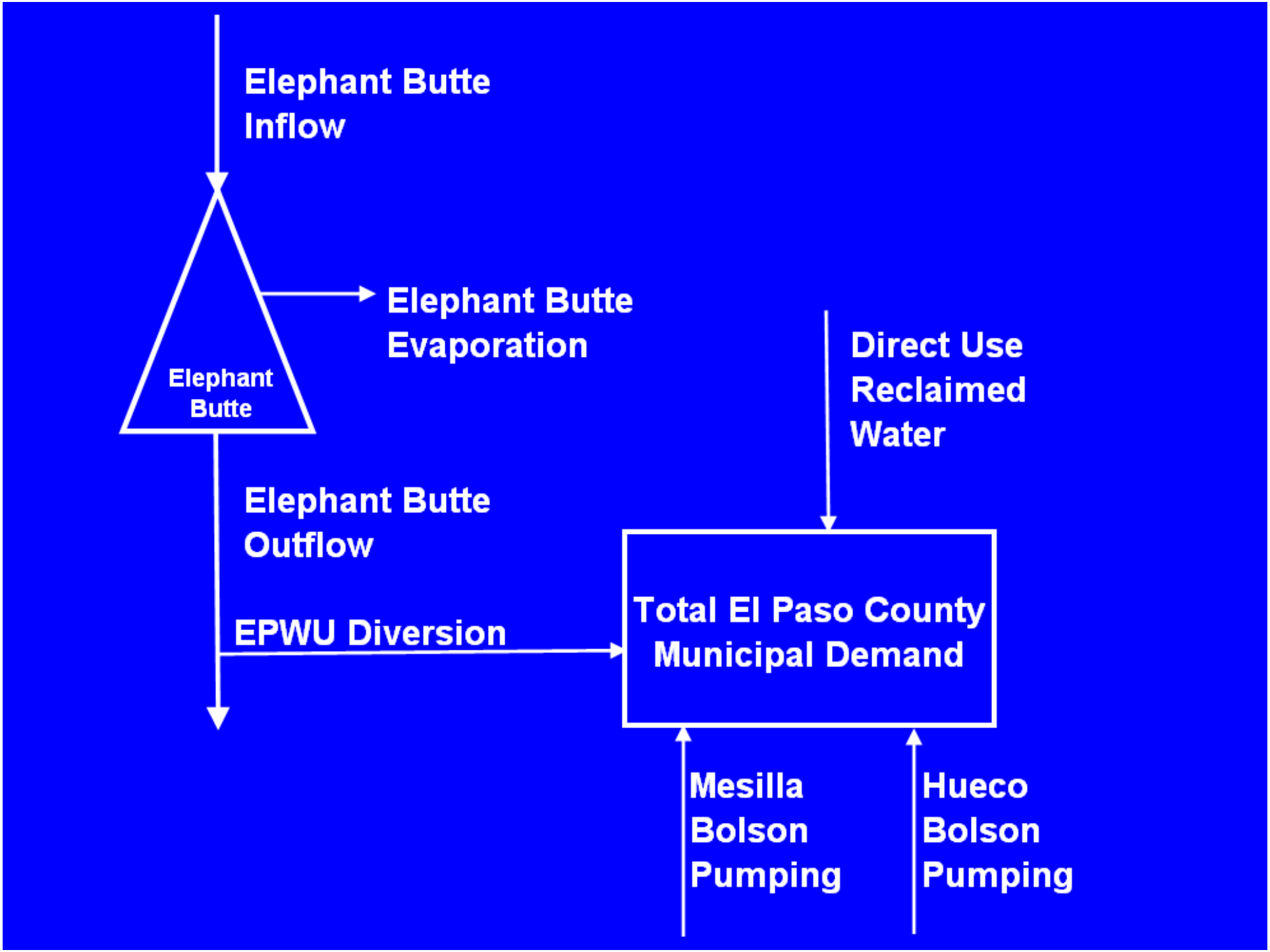
Conjunctive Management of Surface Water and Groundwater

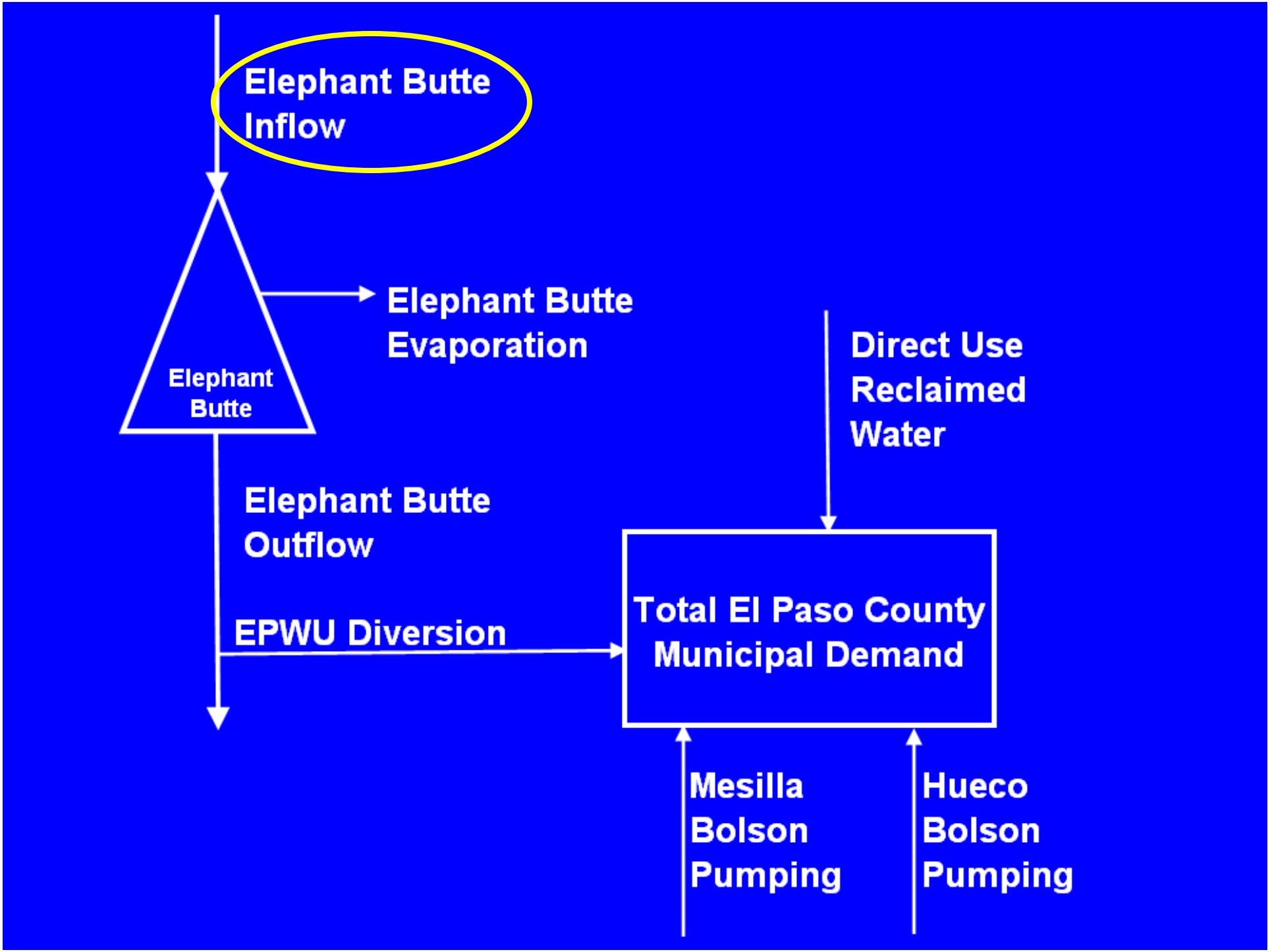

Rio Grande
Watershed
Colorado
New Mexico
Texas
N
Elephant Butte
Reservoir
El Paso
0
100
200
300
400
500
Miles


Mesilla Bolson
Hueco Bolson


Hueco Bolson
Mesilla Bolson


Surface Water Plants
Hueco Wells
Mesilla Wells


Elephant Butte Inflow
Elephant Butte
Elephant Butte Evaporation
Direct Use Reclaimed Water
Elephant Butte Outflow
EPWU Diversion
Total El Paso County Municipal Demand
Mesilla Bolson Pumping
Hueco Bolson Pumping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Elephant Butte
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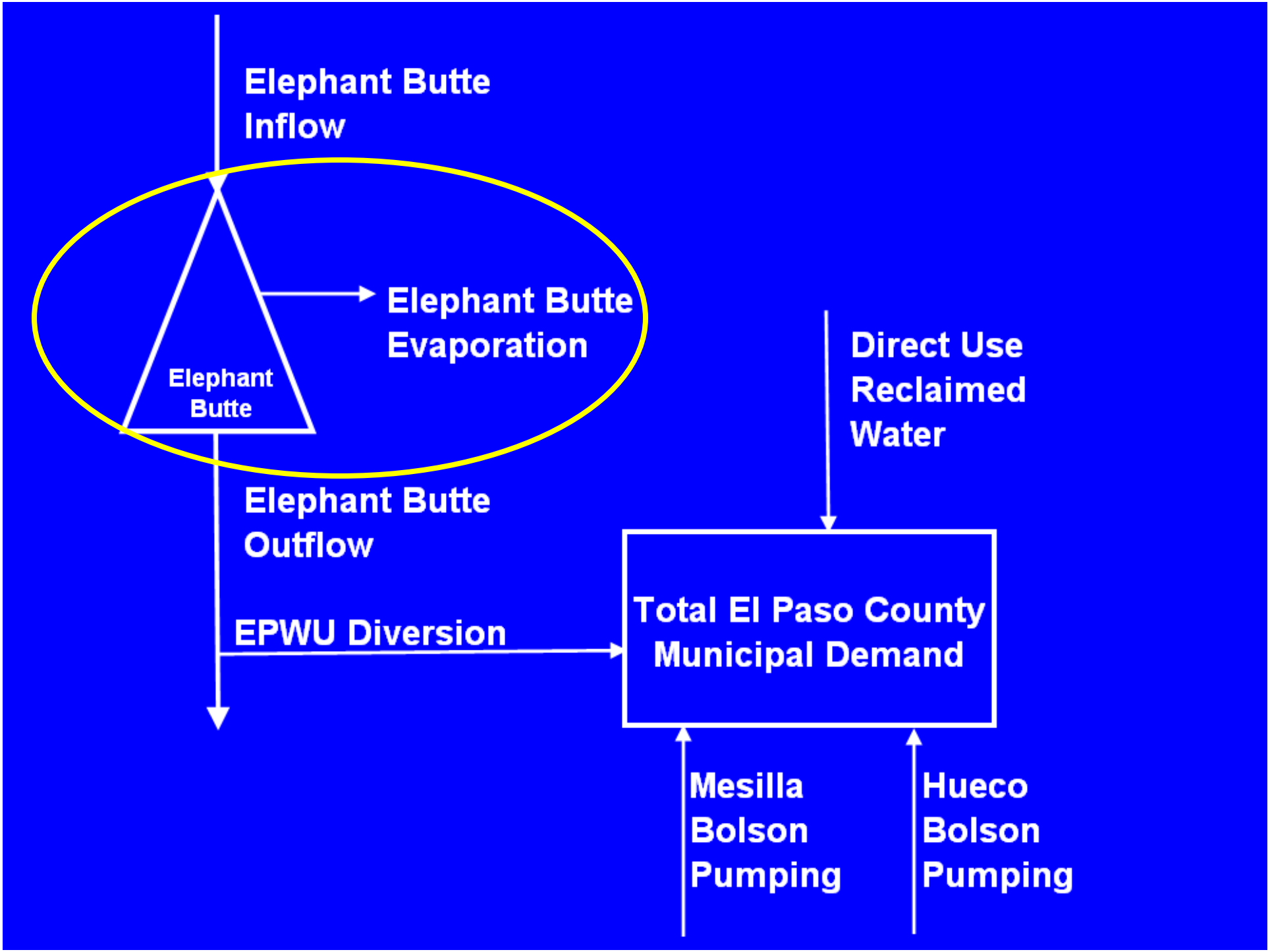
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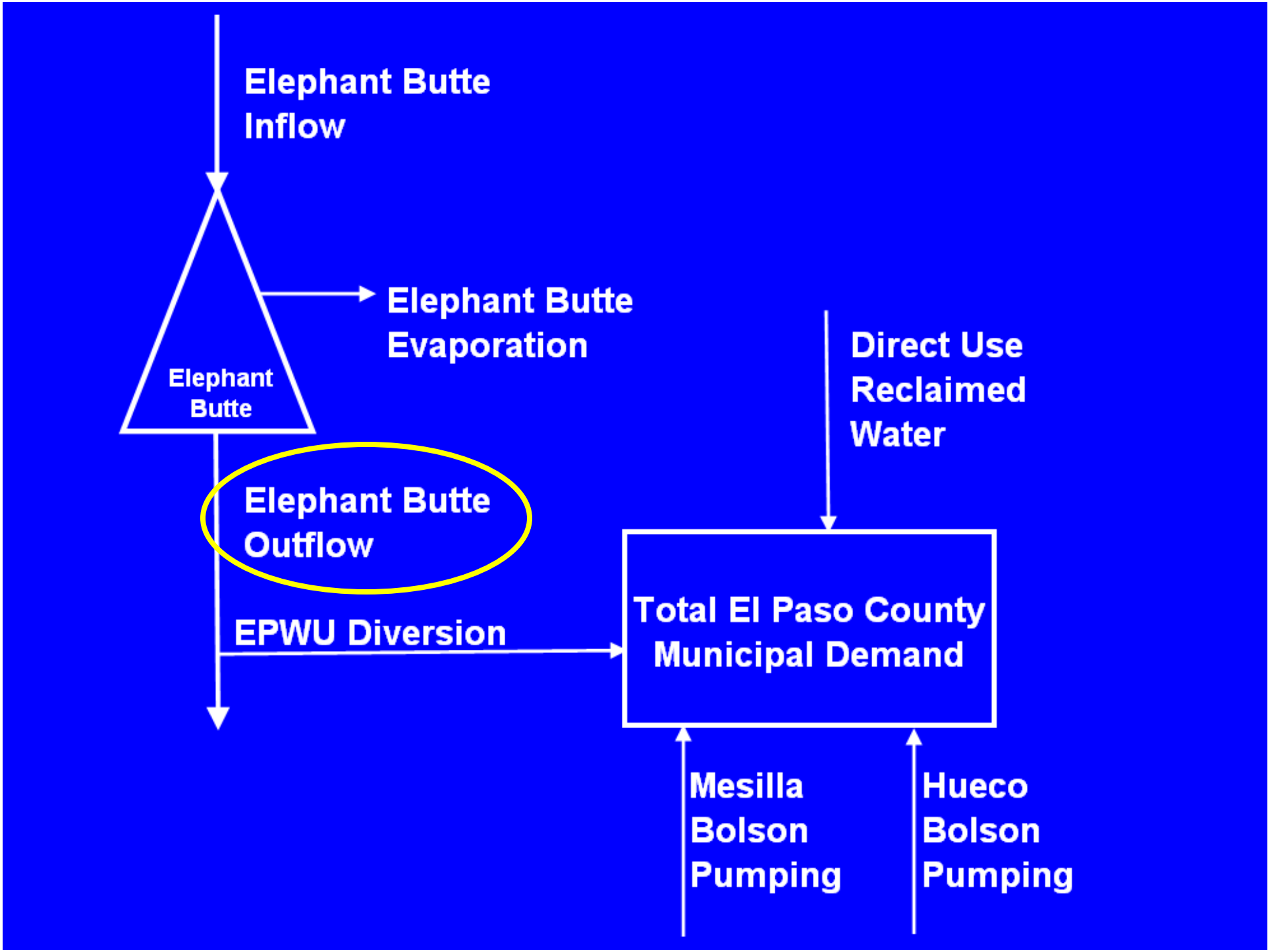
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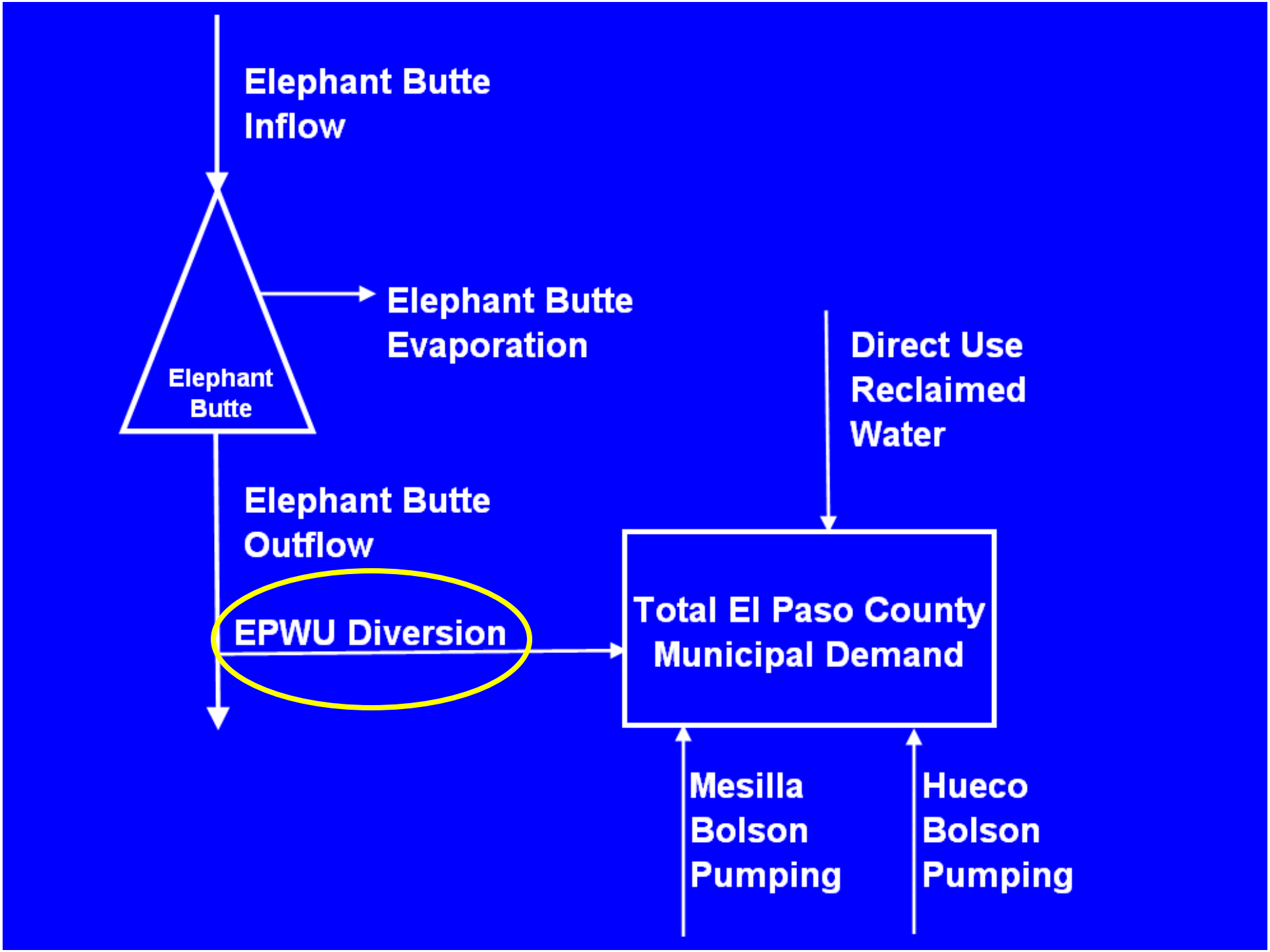
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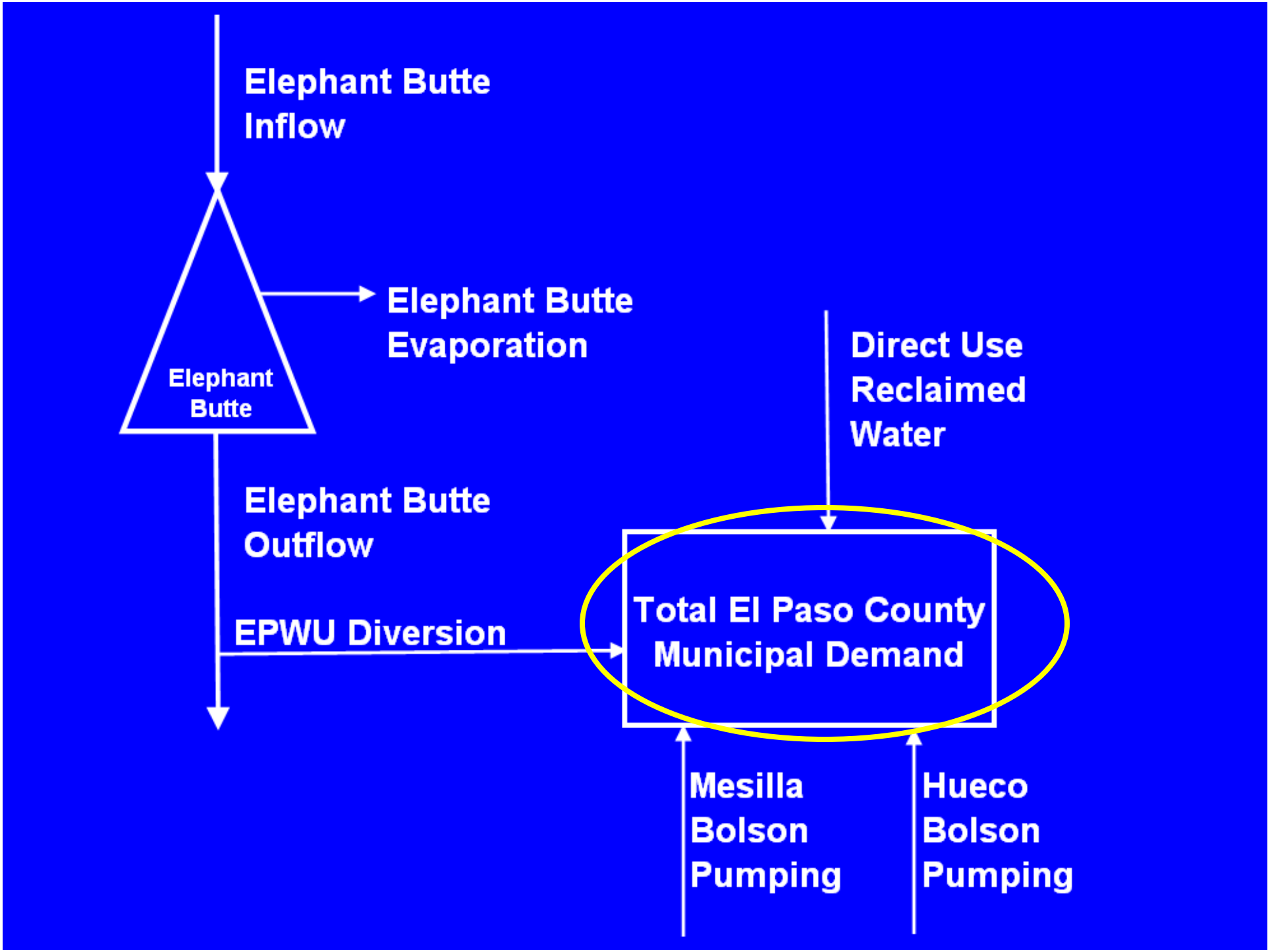
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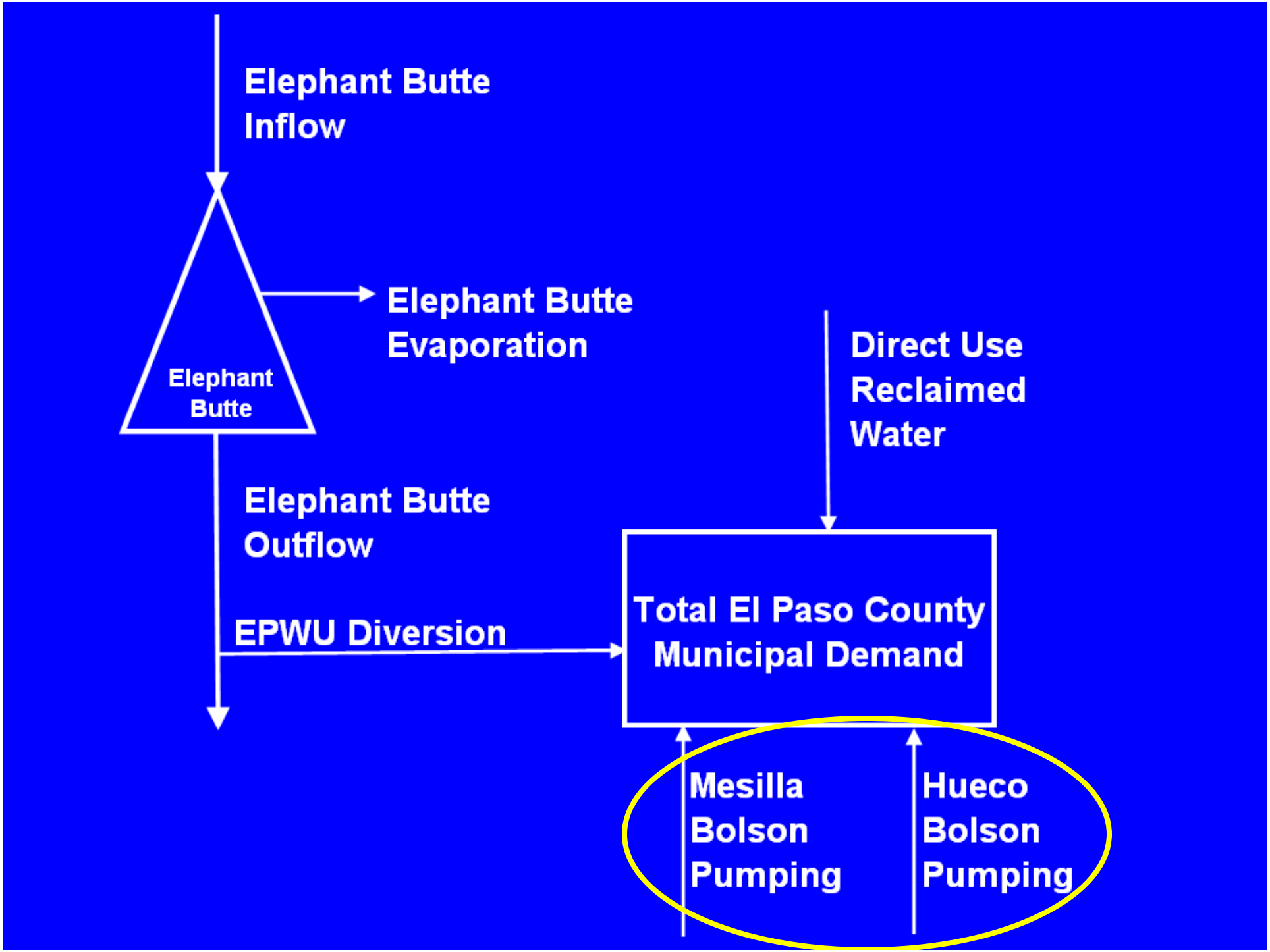
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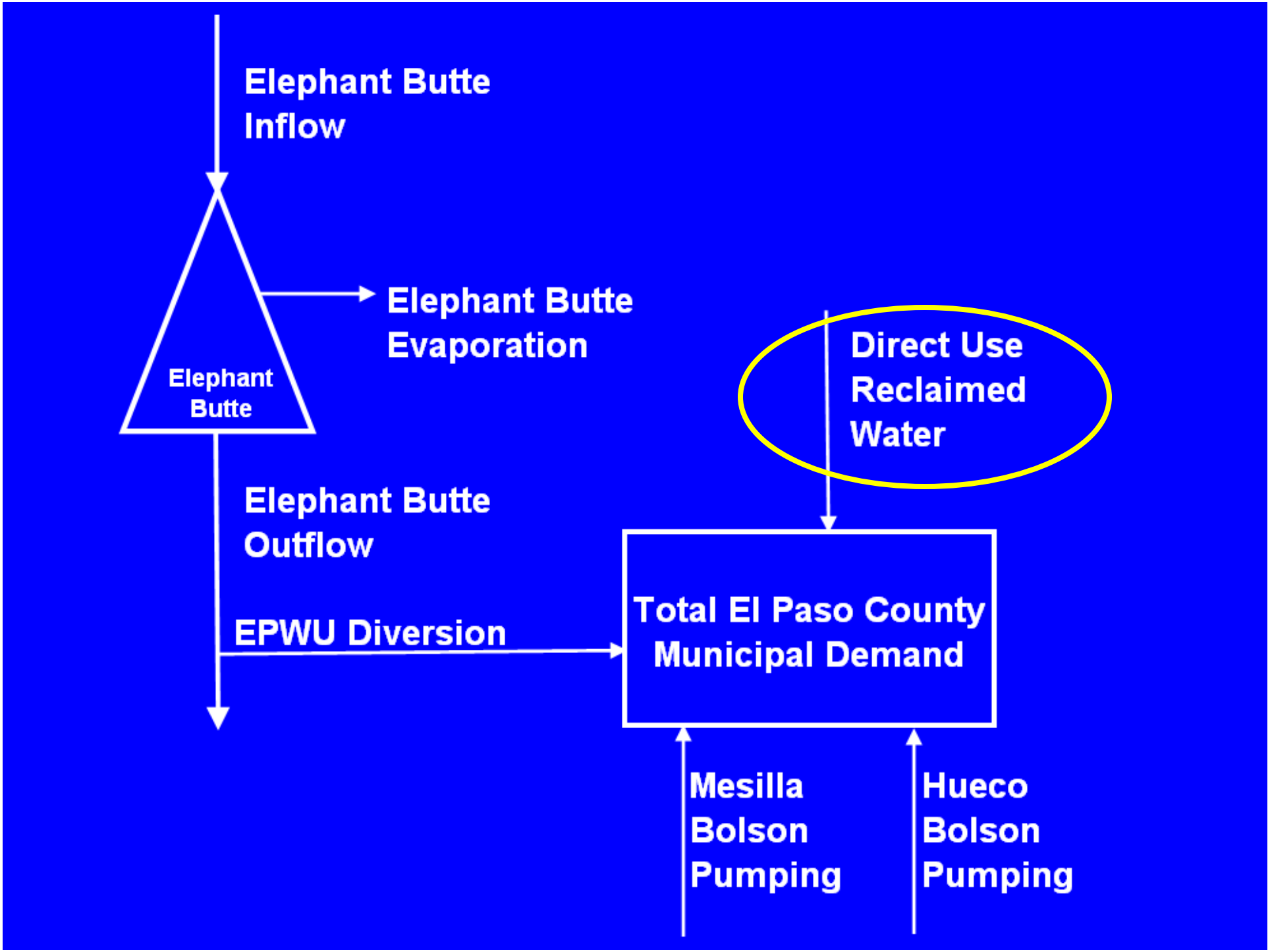
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Elephant Butte
Elephant Butte Evaporation
Direct Use Reclaimed Water
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EPWU Diversion
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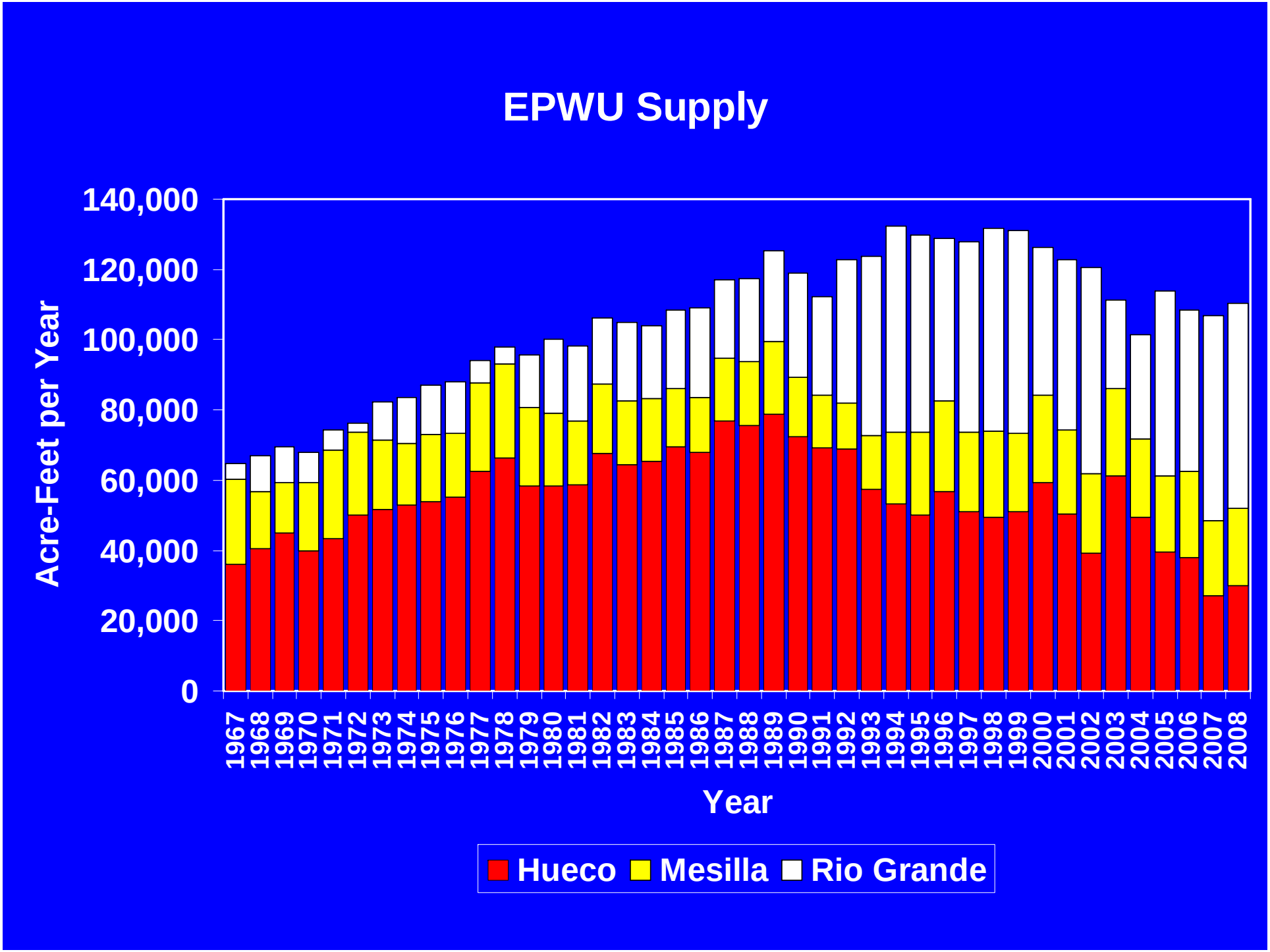
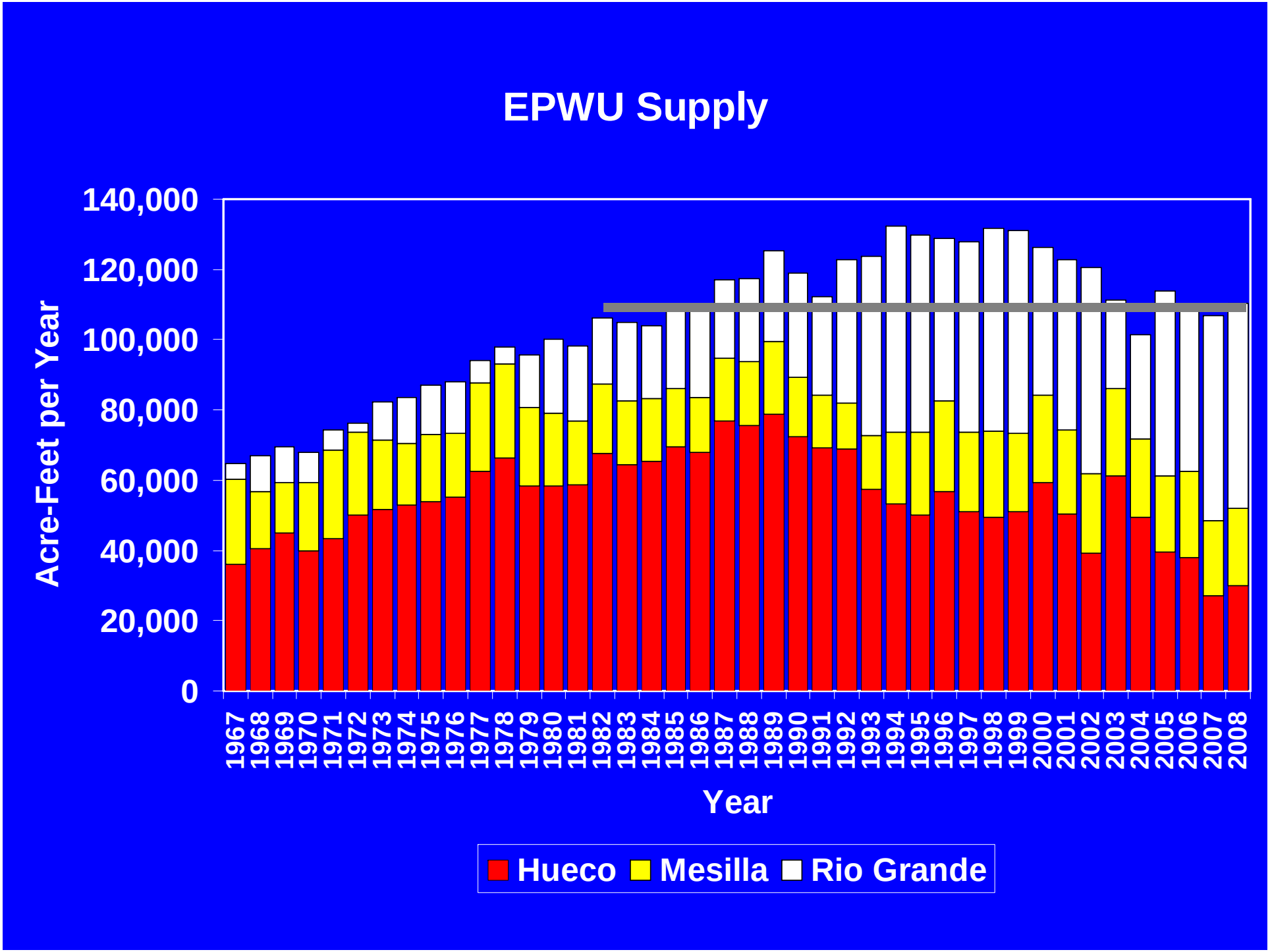
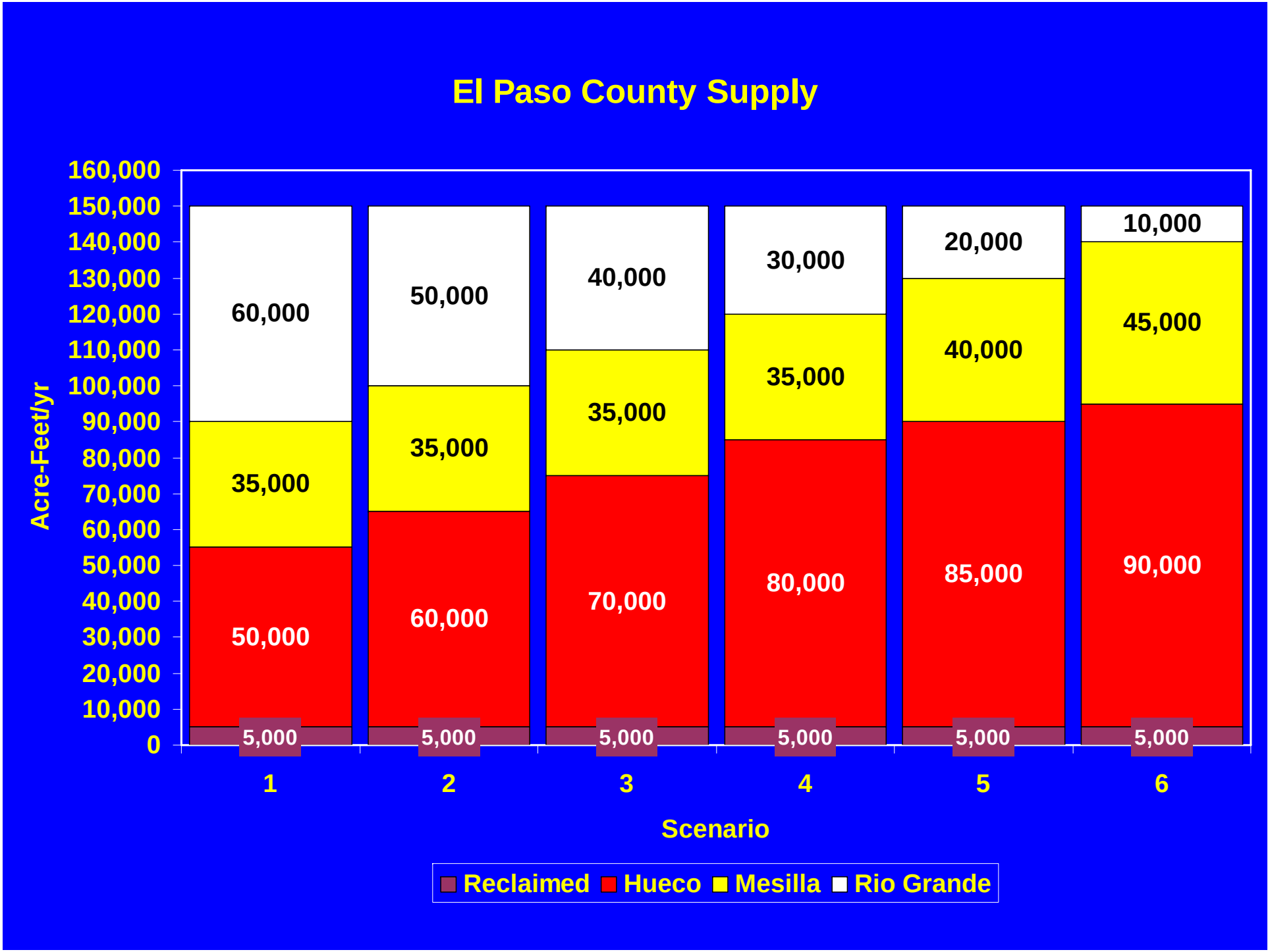
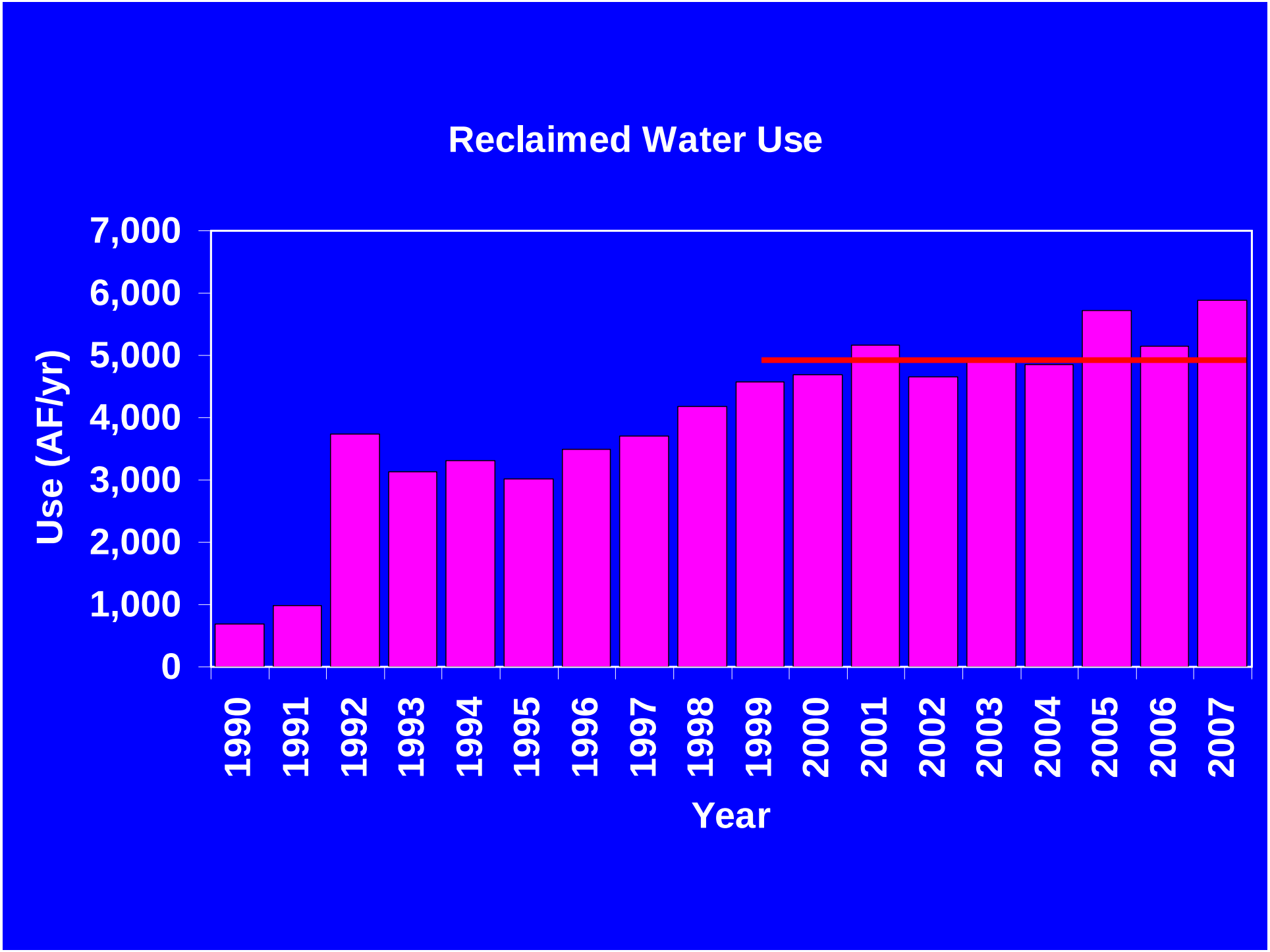
Hueco Bolson Pumping


EPWU Supply
Acre-Feet per Year
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
Year
Hueco
Mesilla
Rio Grande

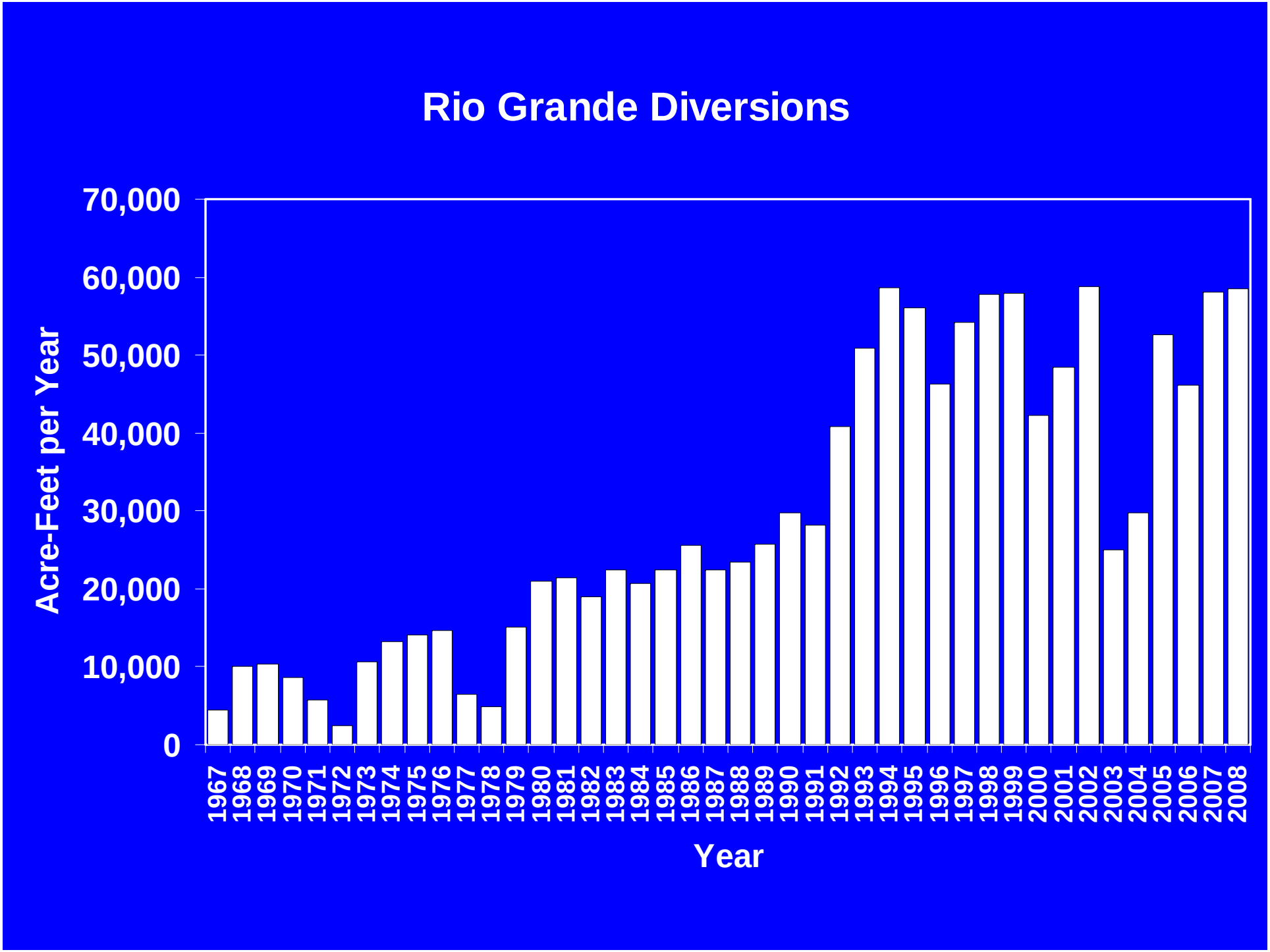

EPWU Supply
Acre-Feet per Year
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
Year
Hueco
Mesilla
Rio Grande

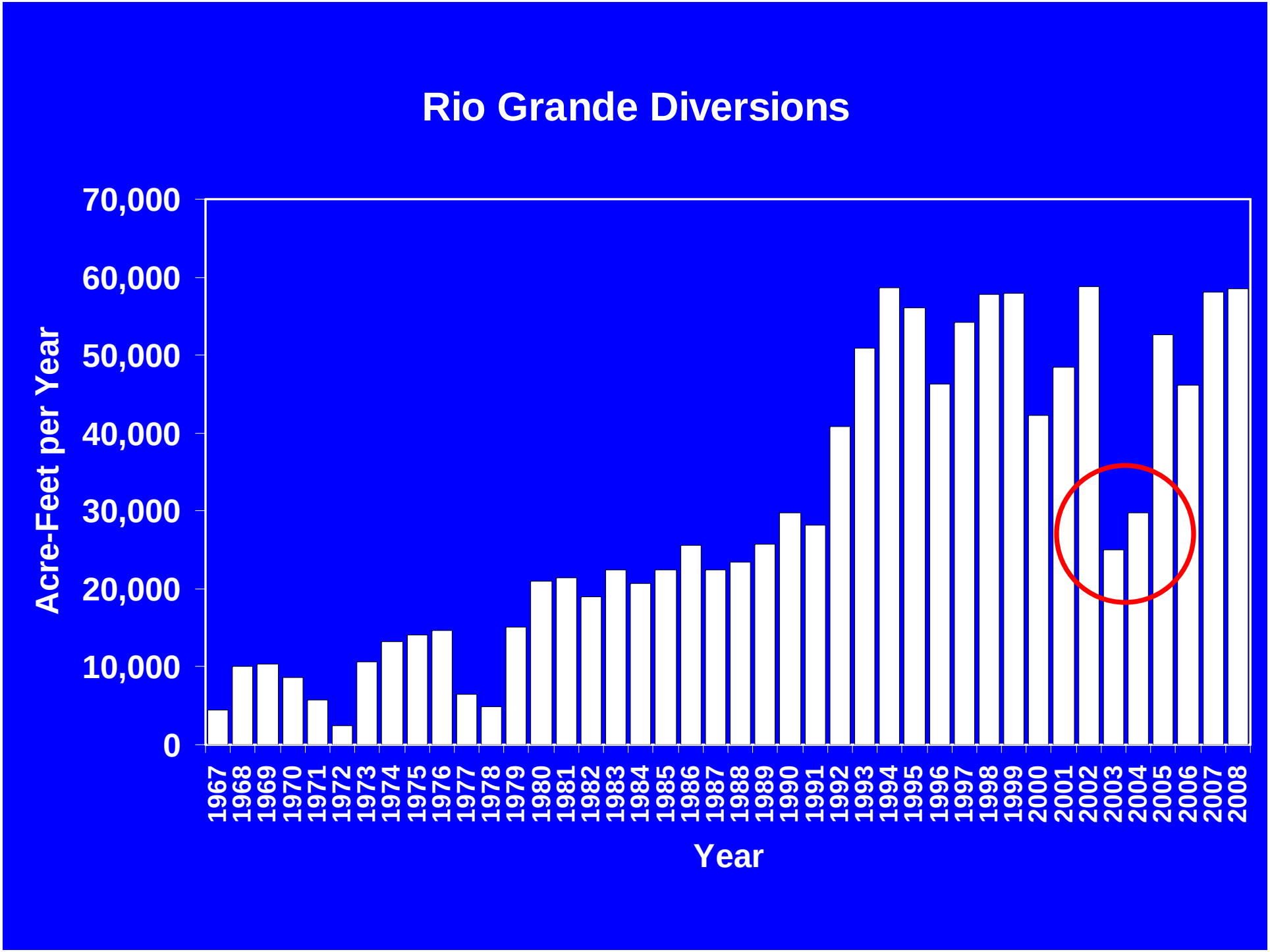

El Paso County Supply
Acre-Feet/yr
160,000
150,000
140,000
130,000
120,000
110,000
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
60,000
35,000
50,000
5,000
50,000
35,000
60,000
5,000
40,000
35,000
70,000
5,000
30,000
35,000
80,000
5,000
20,000
40,000
85,000
5,000
10,000
45,000
90,000
5,000
1
2
3
4
5
6
Scenario
Reclaimed
Hueco
Mesilla
Rio Grande


Reclaimed Water Use
Use (AF/yr)
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year

Key Reclaimed Water Issues

- Irrigation District
- Project Identification
- Project Cost


Rio Grande Diversions
Acre-Feet per Year
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
Year


Rio Grande Diversions
Acre-Feet per Year
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
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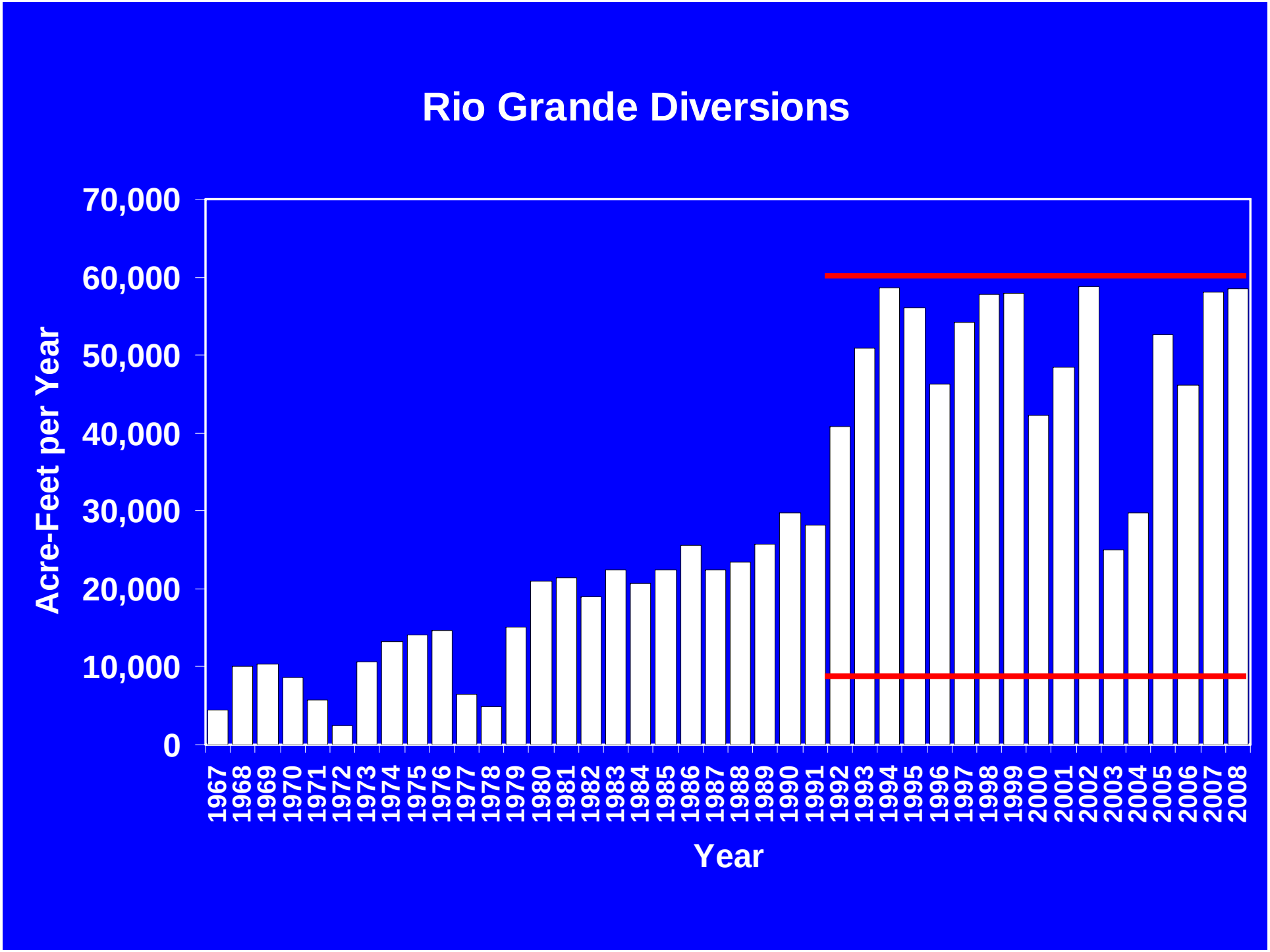
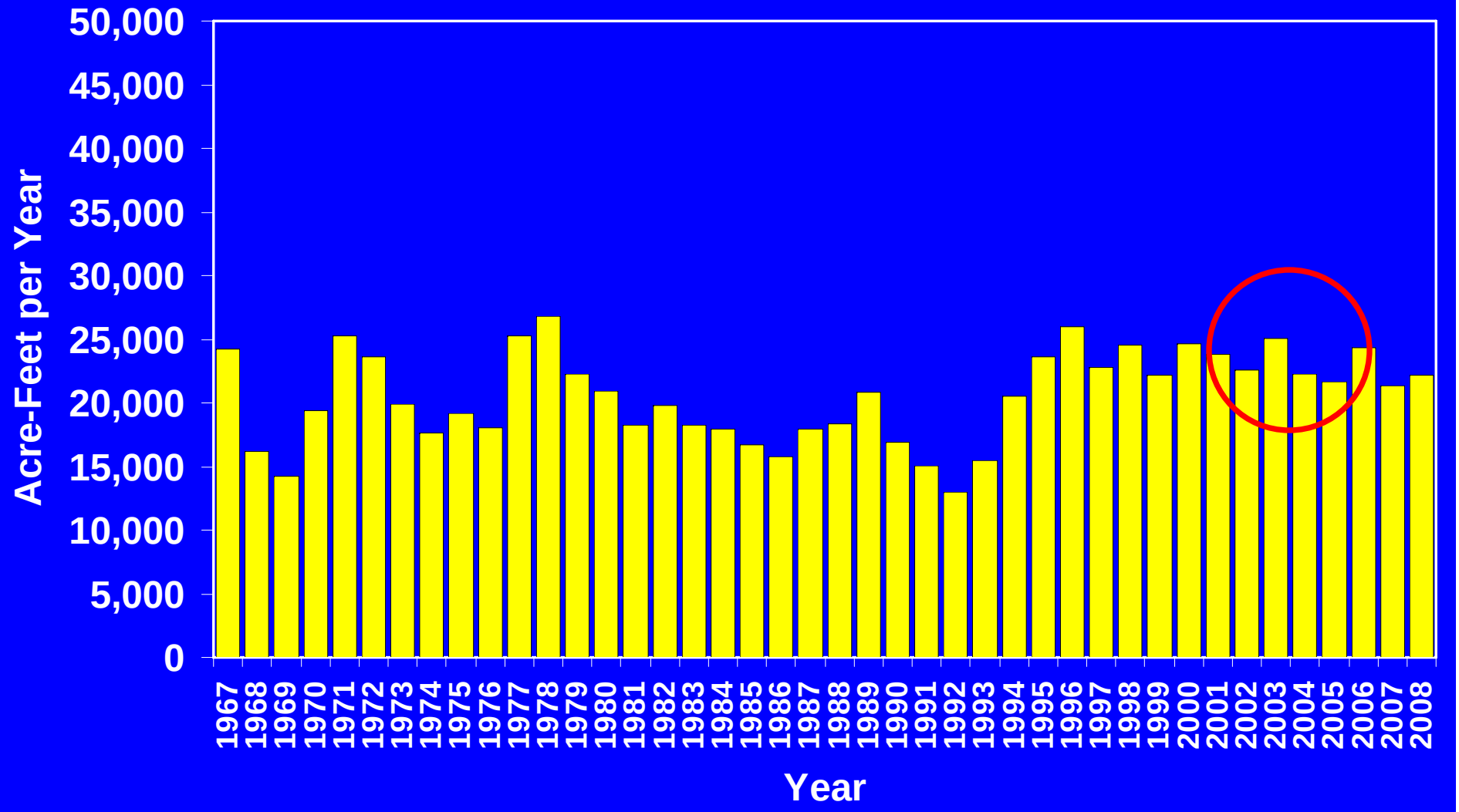
2004
2005
2006
2007
2008
Year


Rio Grande Diversions
Acre-Feet per Year
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
Year

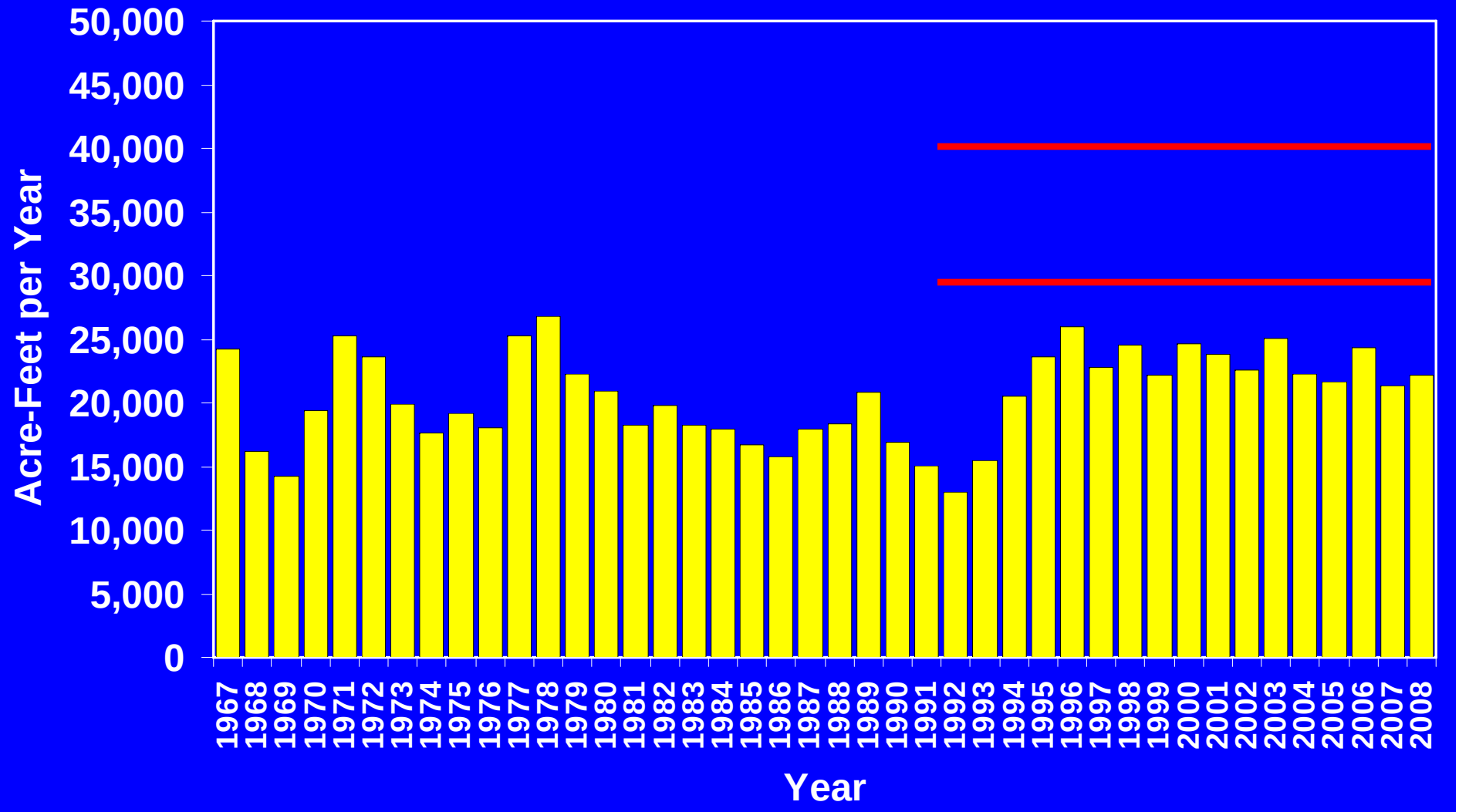
Key Rio Grande Issues

- Drought
- Climate Change
- Water Rights vs. Treatment Capacity

Mesilla Bolson Pumping



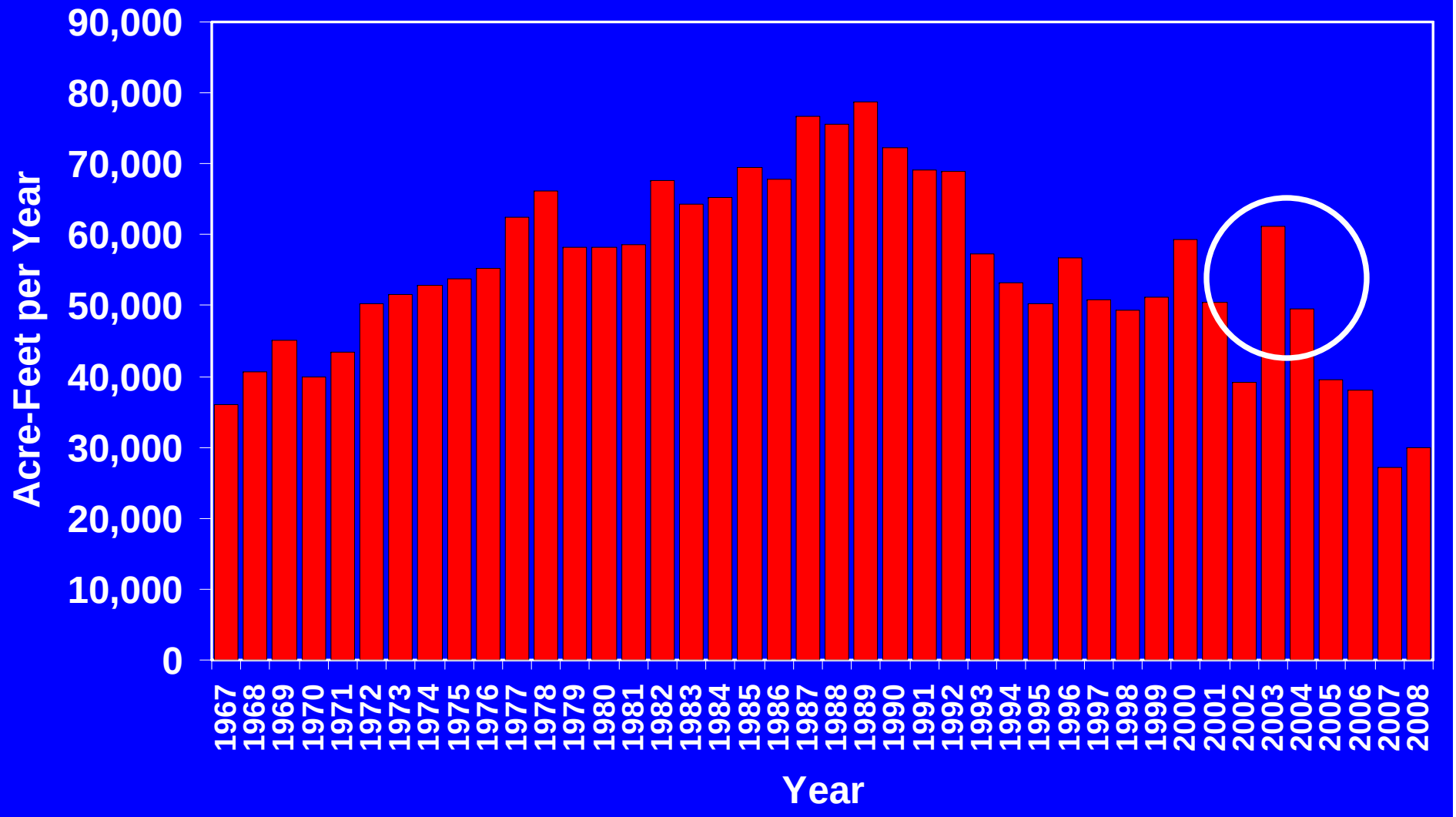
Mesilla Bolson Pumping



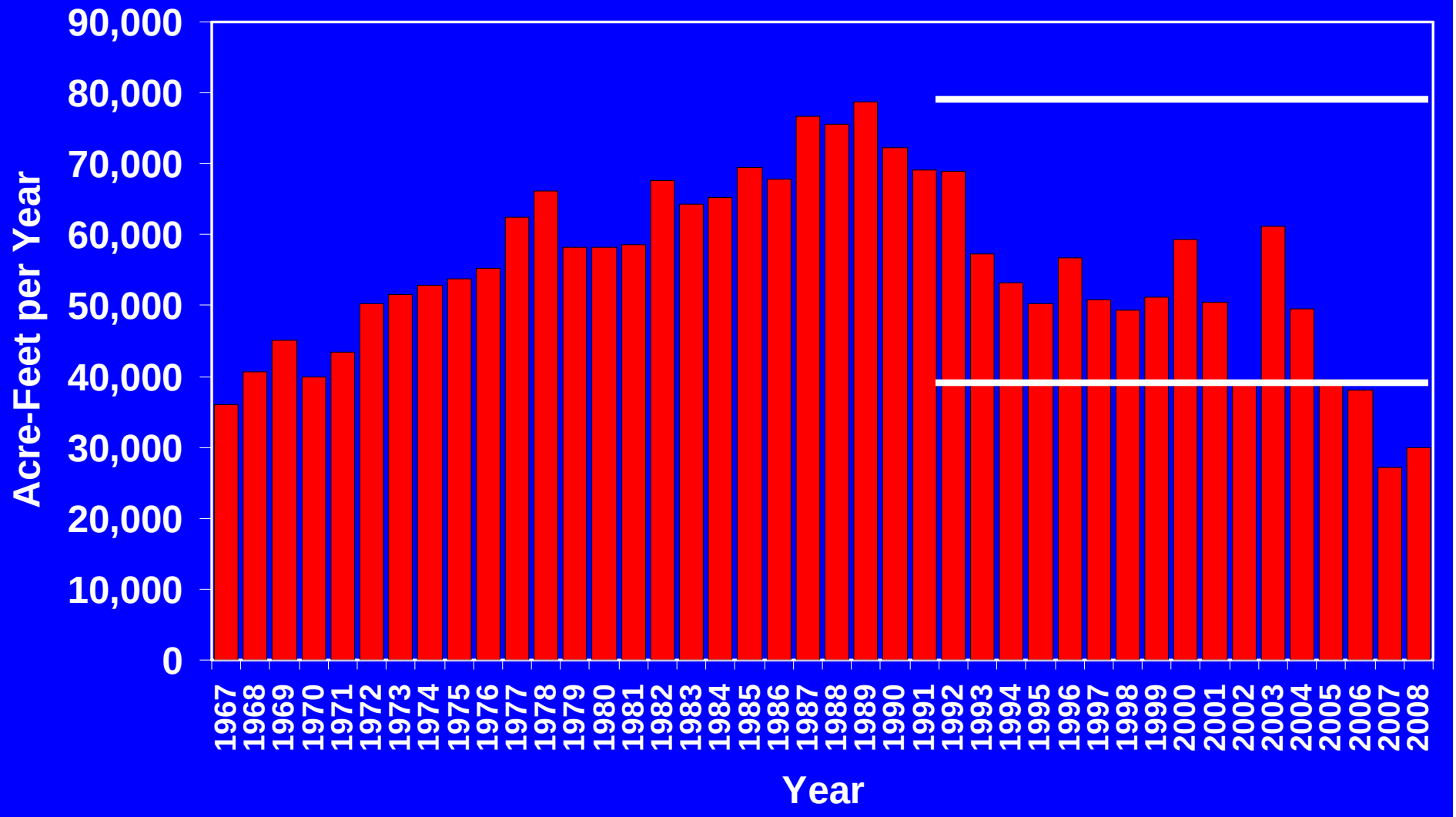
Key Mesilla Bolson Issues

- Pumping Rate Increase?
- Groundwater/Surface Water Interaction
- Climate Change

Hueco Bolson Pumping



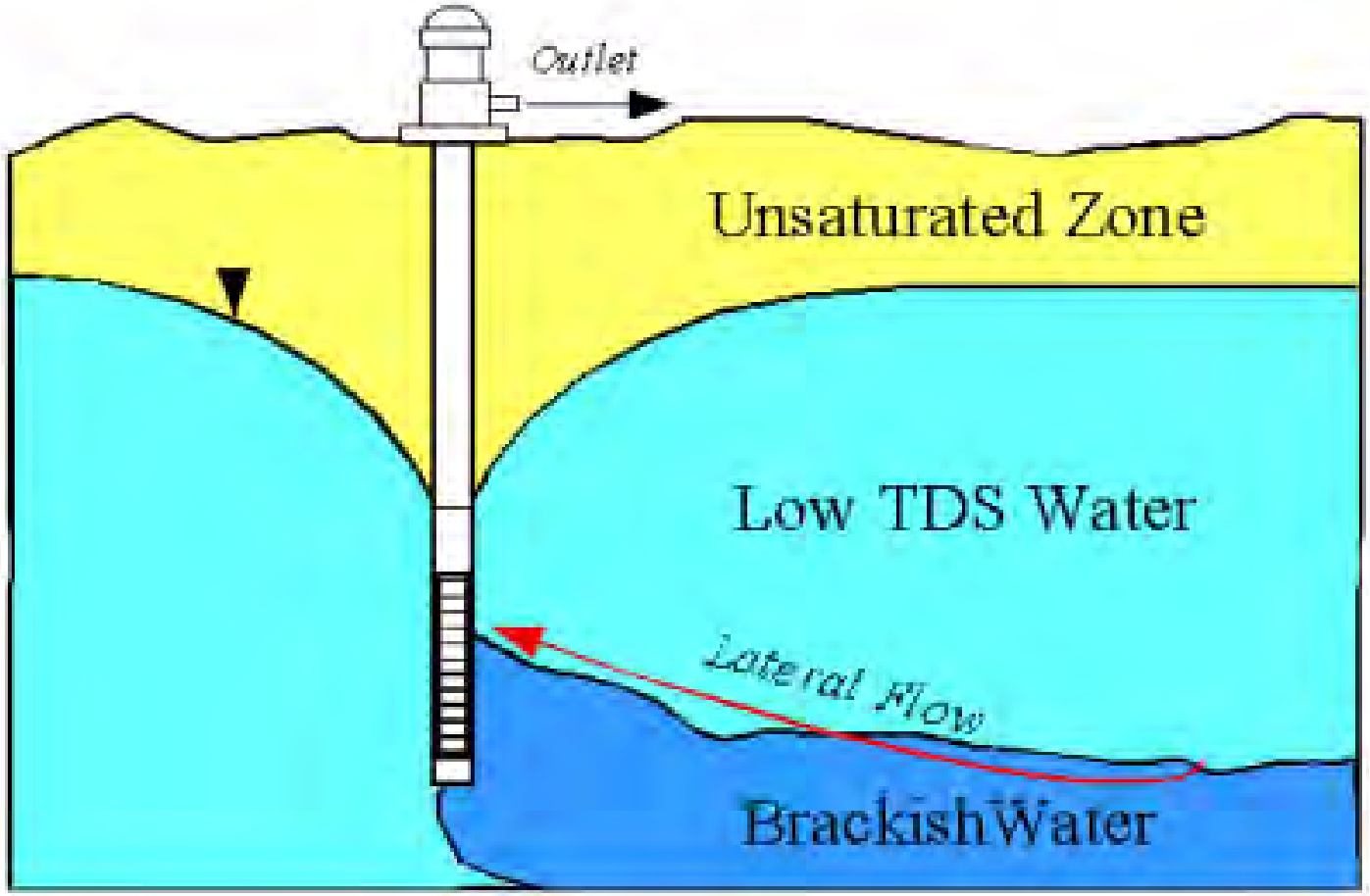
Hueco Bolson Pumping

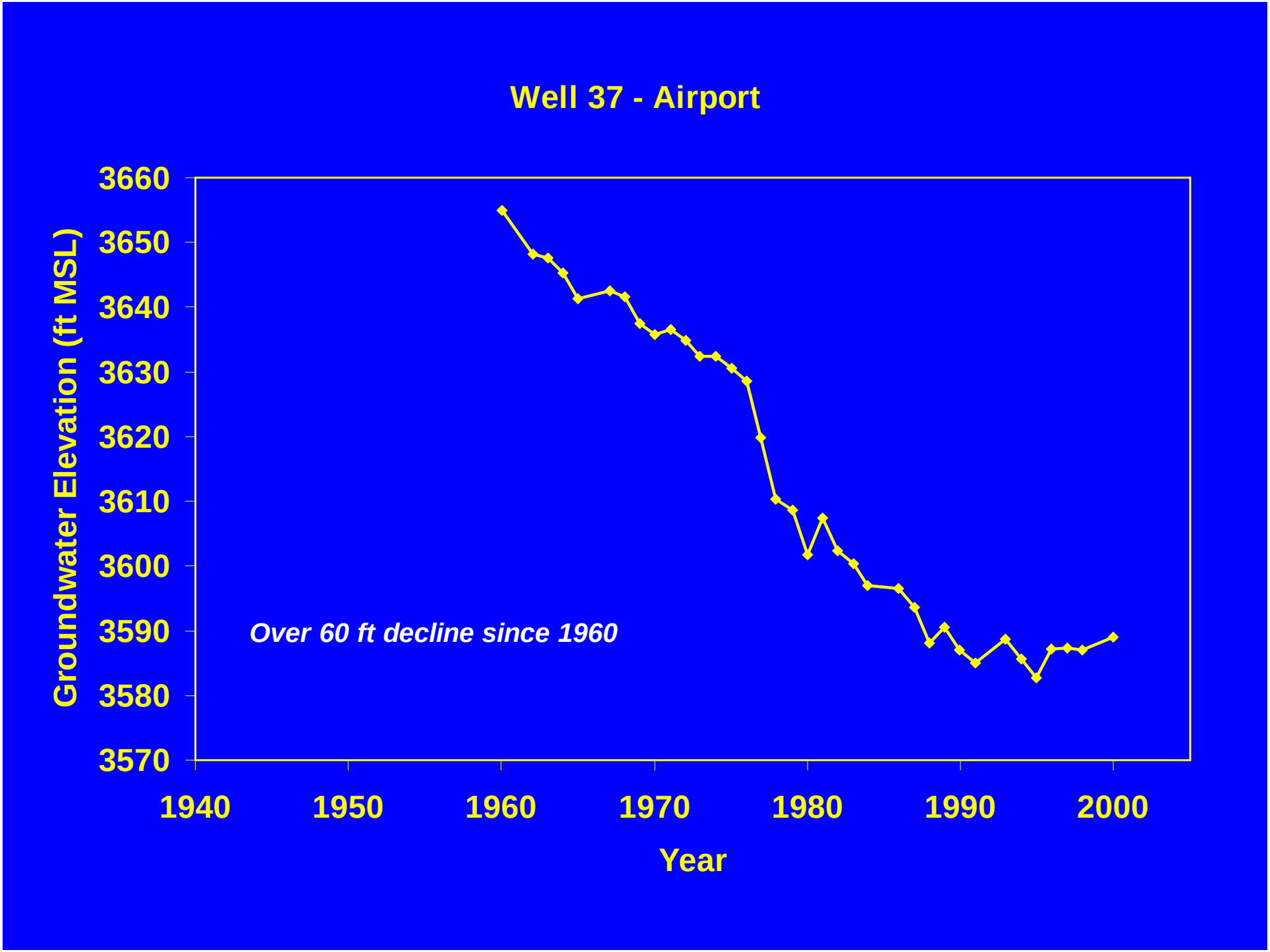


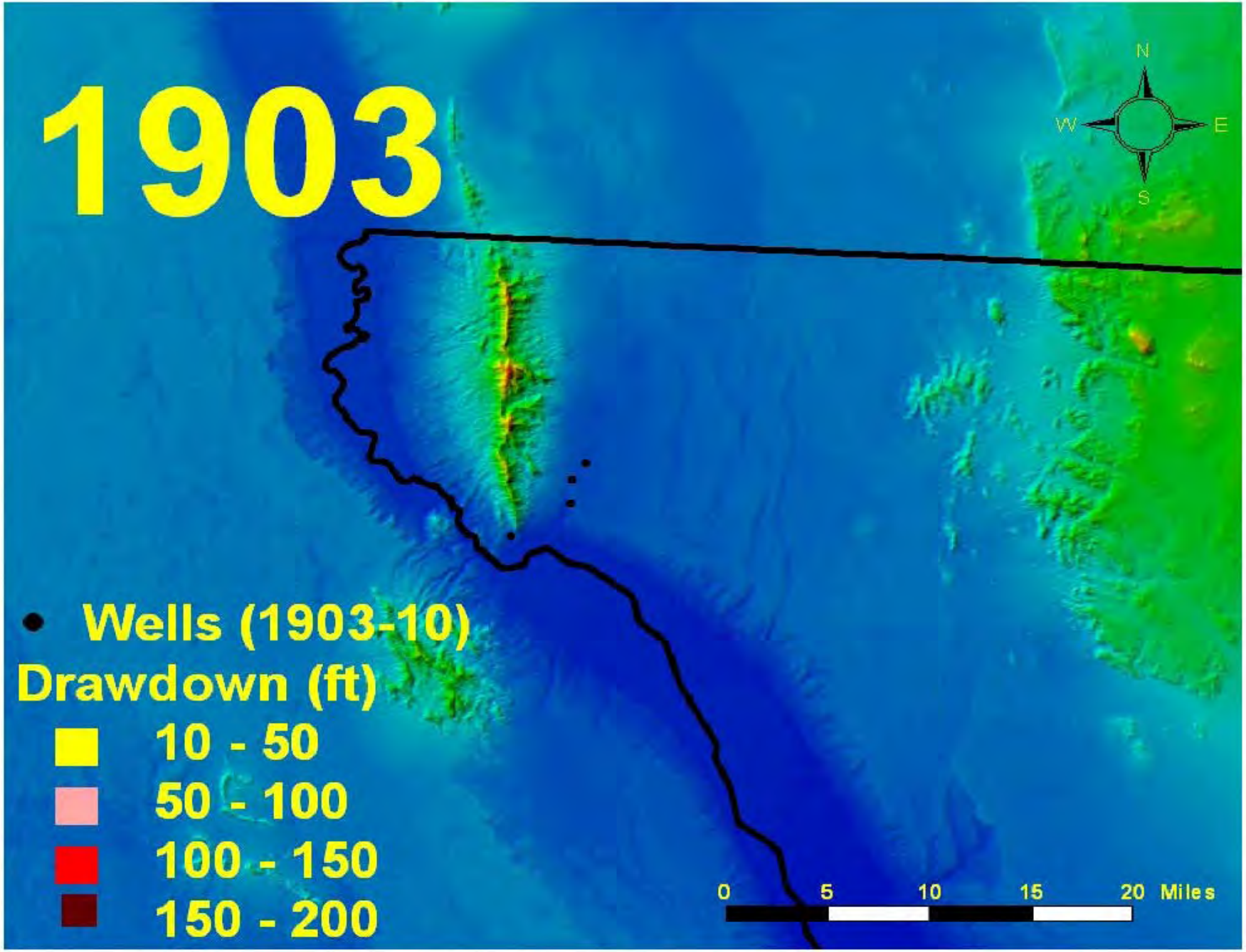
Key Hueco Bolson Issues

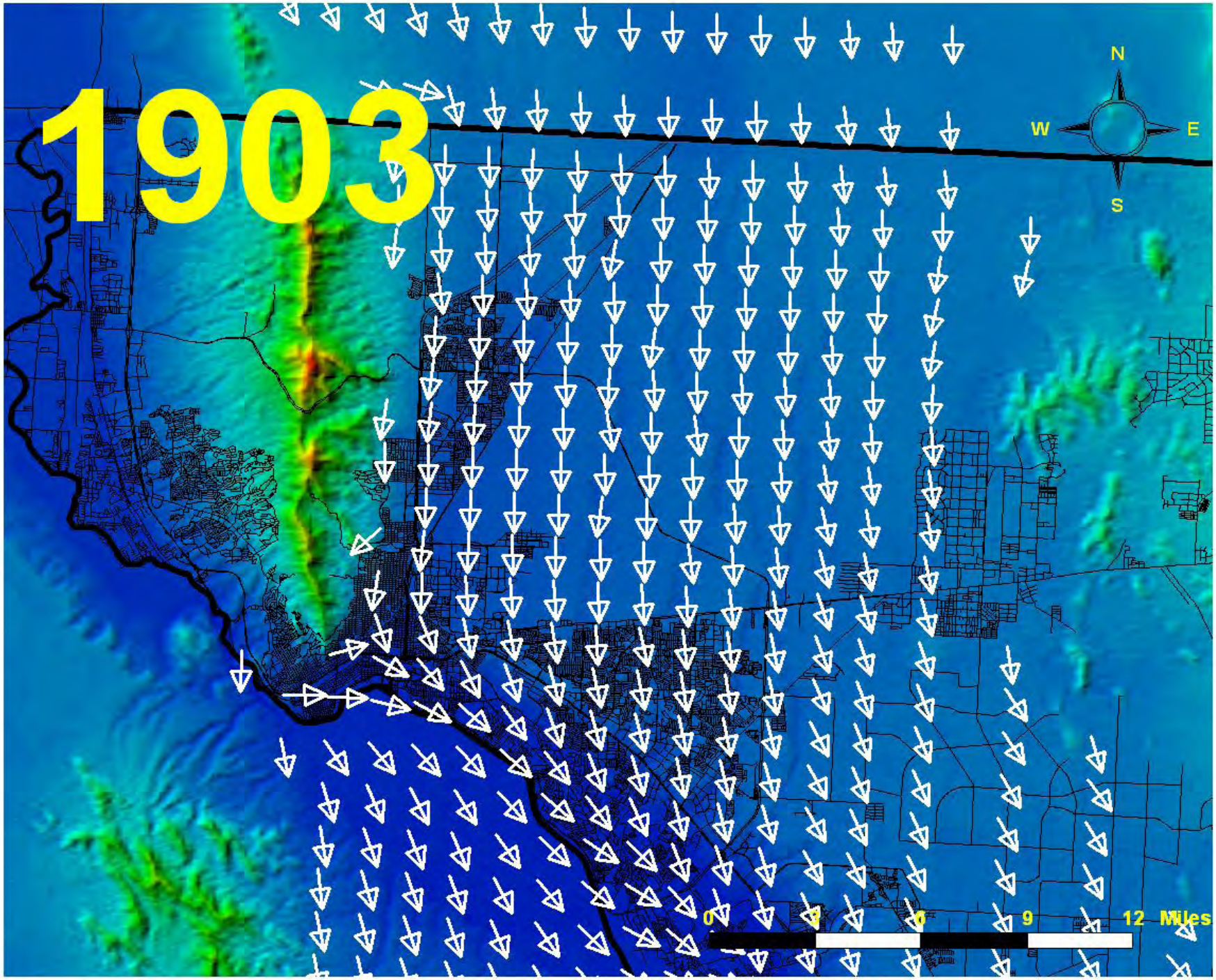
- Groundwater Levels
- Brackish Groundwater Intrusion
- 2030 Myth
- Future Conditions Under Climate Change

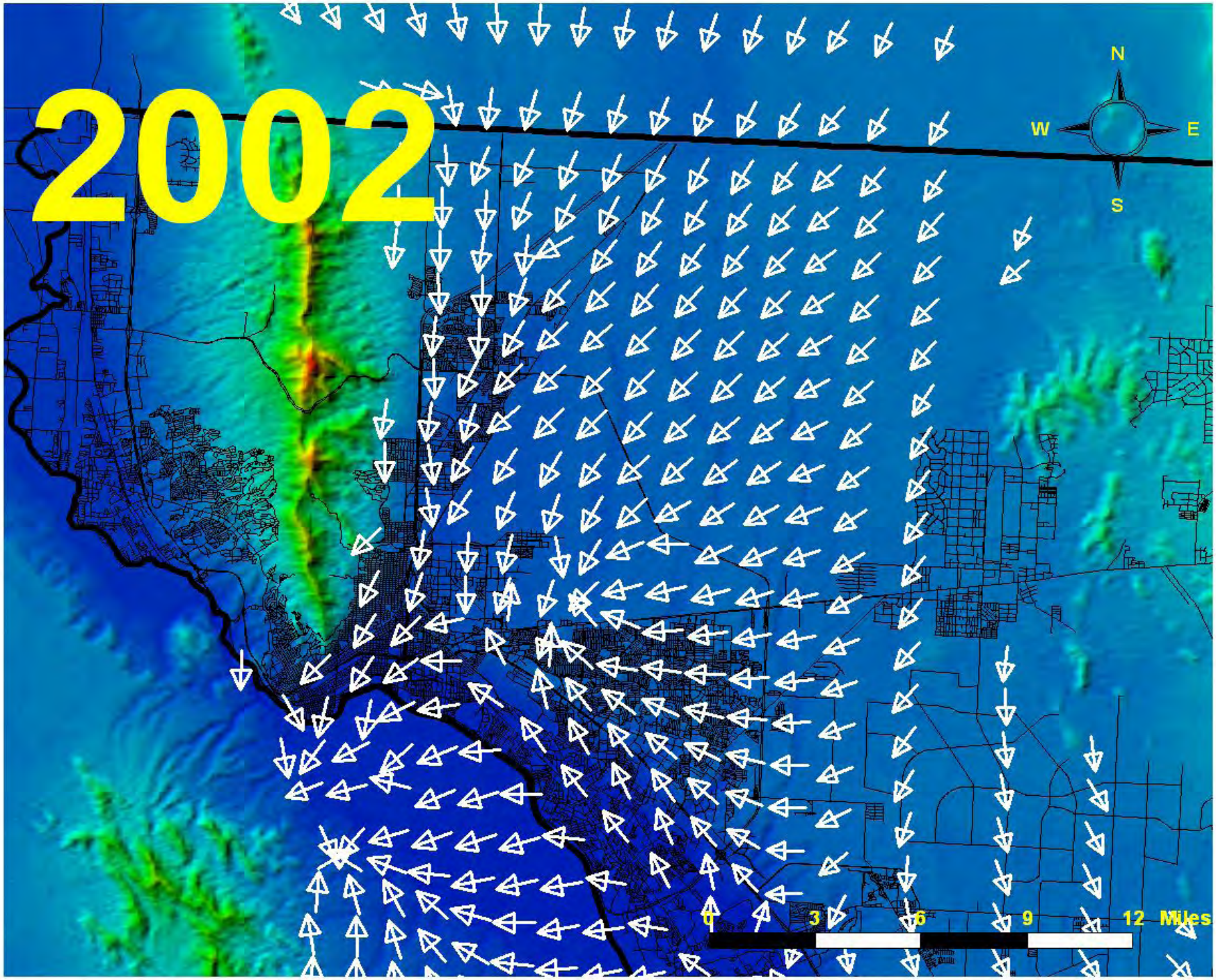
Groundwater Management Issues




Well 37 - Airport
Groundwater Elevation (ft MSL)
3660
3650
3640
3630
3620
3610
3600
3590
3580
3570
Over 60 ft decline since 1960
1940
1950
1960
1970
1980
1990
2000
Year


1903
N
W
E
S
Wells (1903-10)
Drawdown (ft)
10 - 50
50 - 100
100 - 150
150 - 200
0
5
10
15
20
Miles


1903
N
W
E
S
0
3
6
9
12 Miles

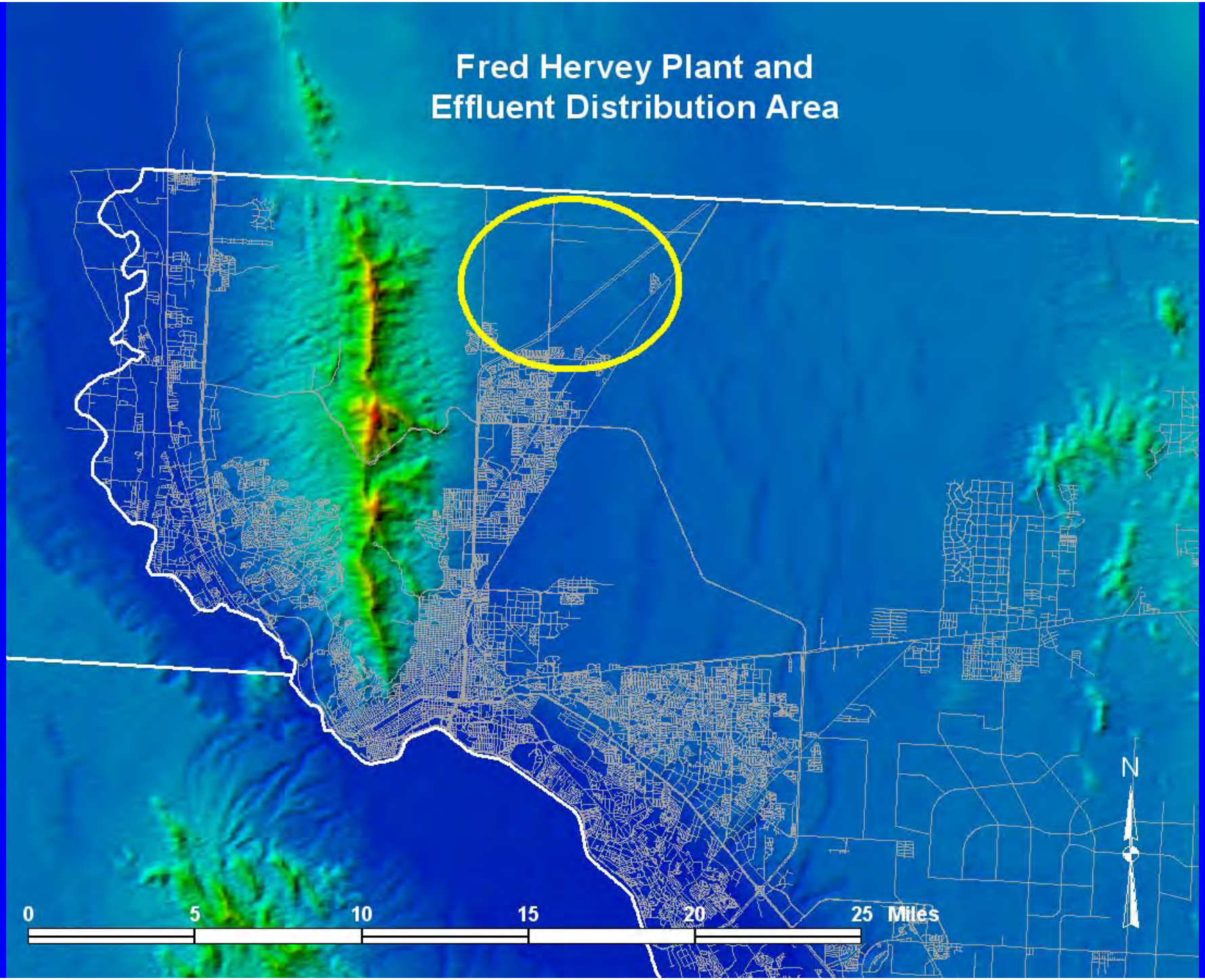

2002
N
W
E
S
0
3
6
9
12 Miles

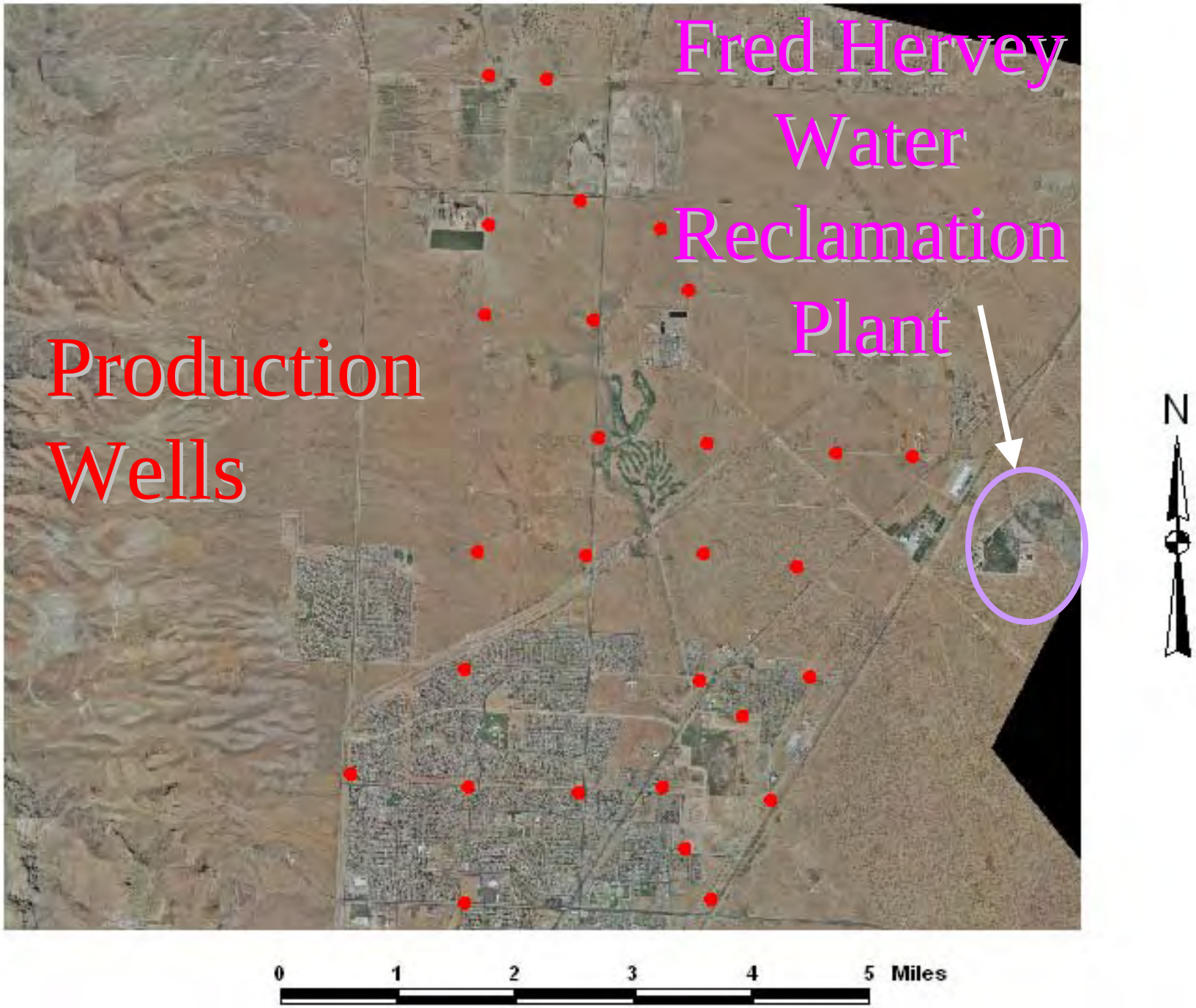
Well 39
Chloride (mg/l)
200
180
160
140
120
100
80
60
40
20
0
1950
1960
1970
1980
1990
2000
2010
Year

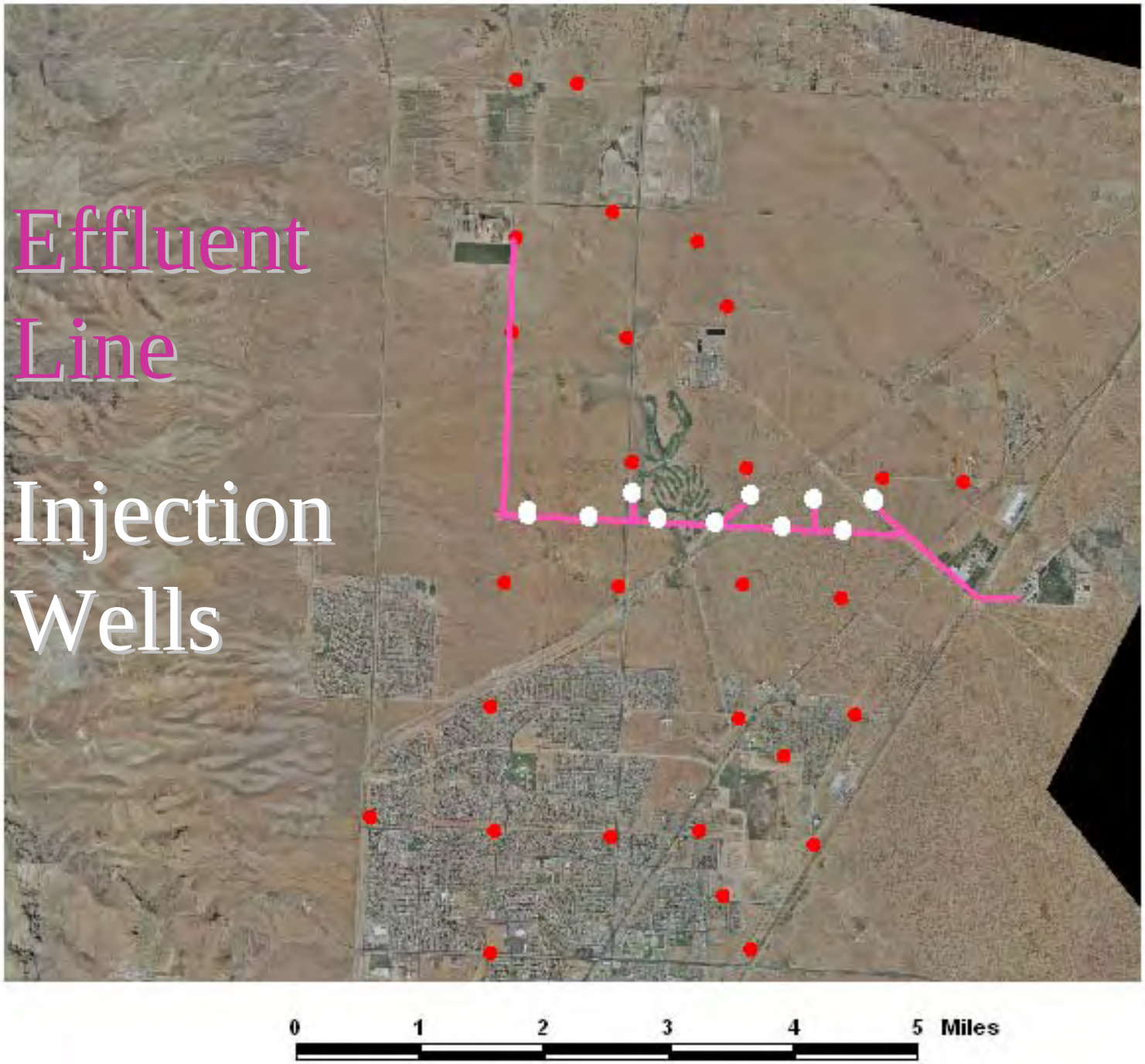
Wastewater Effluent Groundwater Recharge Project

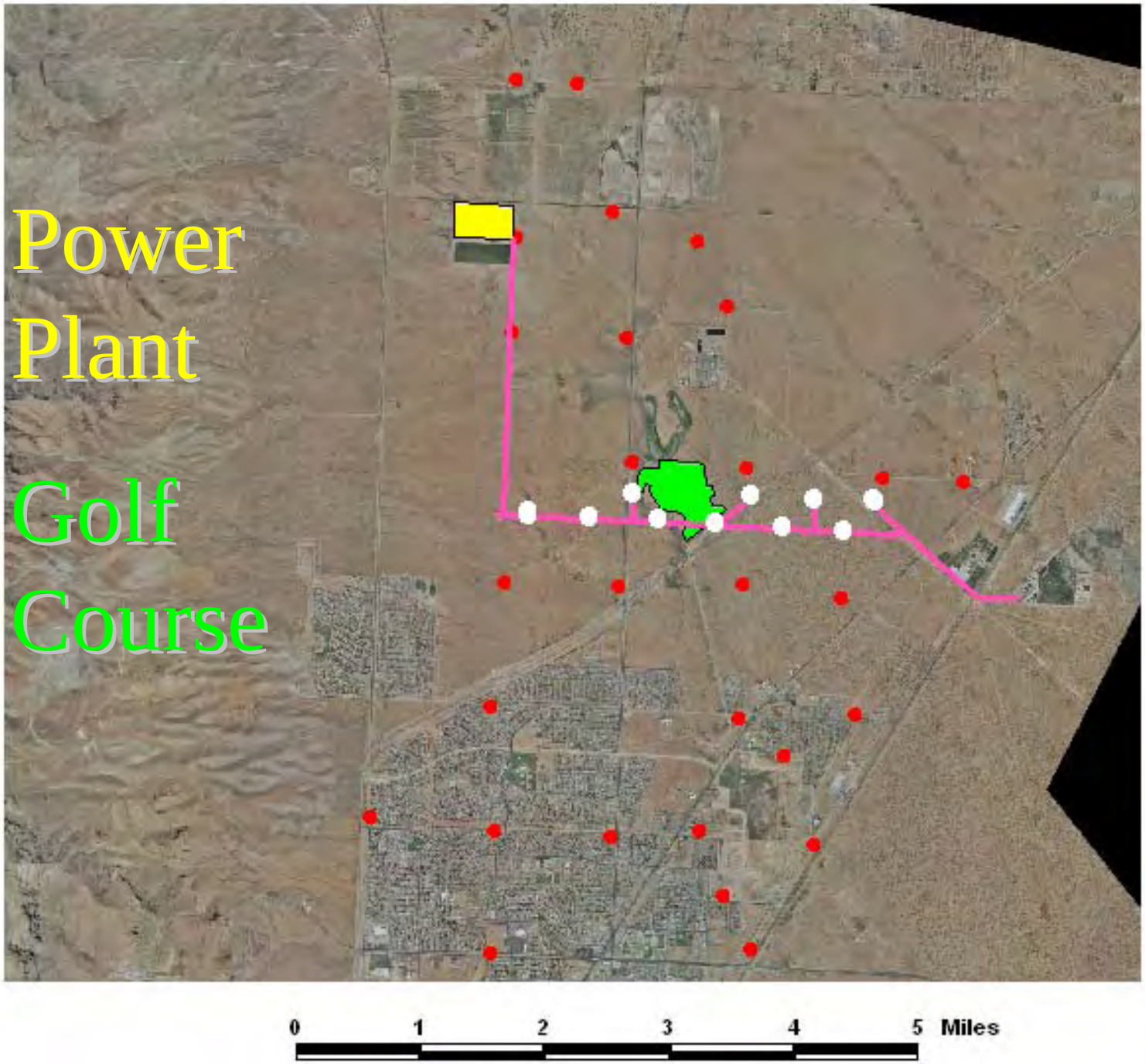
- Fred Hervey Water Reclamation Plant
- Project started in 1985
- Effluent used for:
  - Power Plant Cooling
  - Golf Course Irrigation
  - Hueco Bolson Recharge

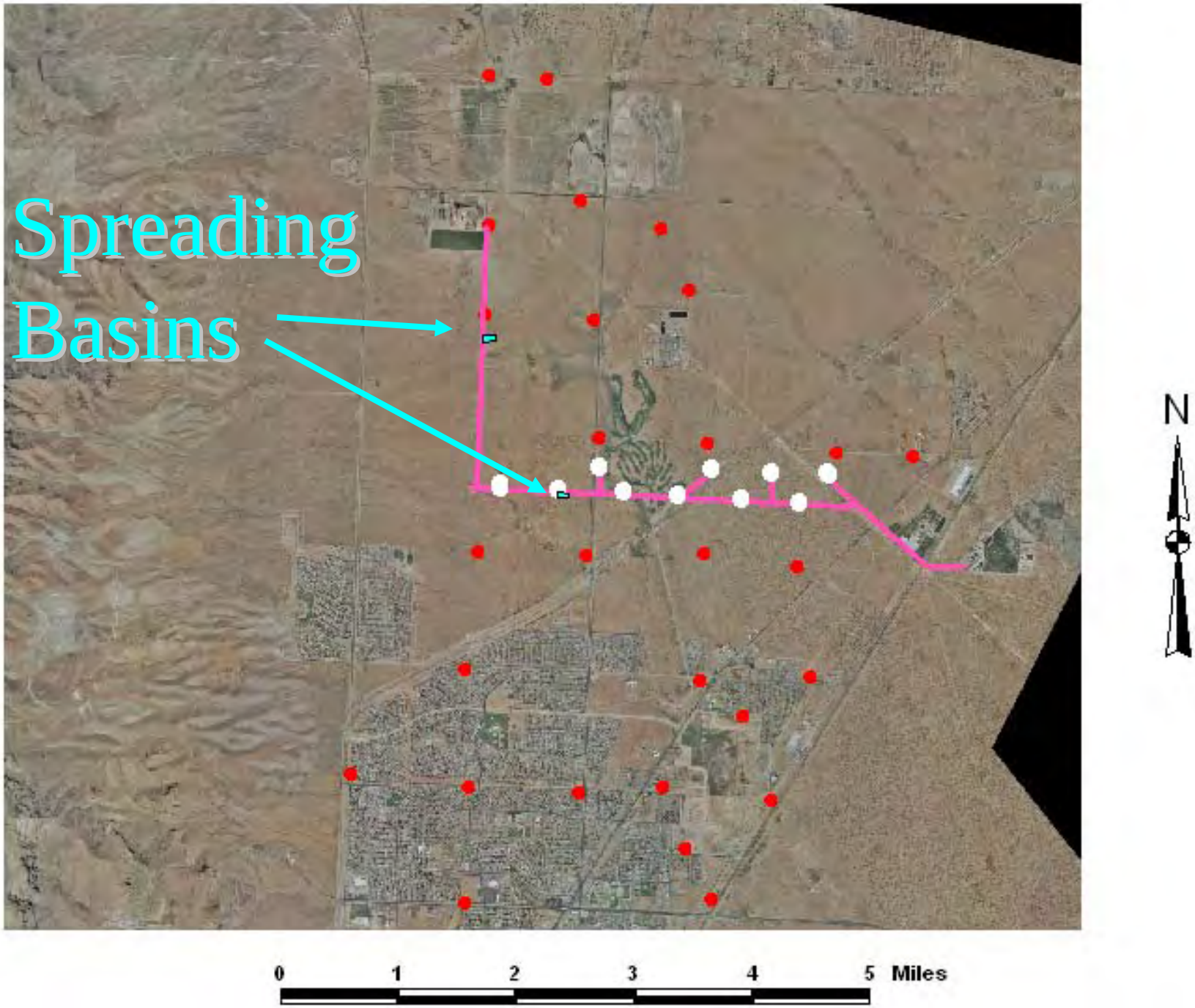
Fred Hervey Plant and Effluent Distribution Area



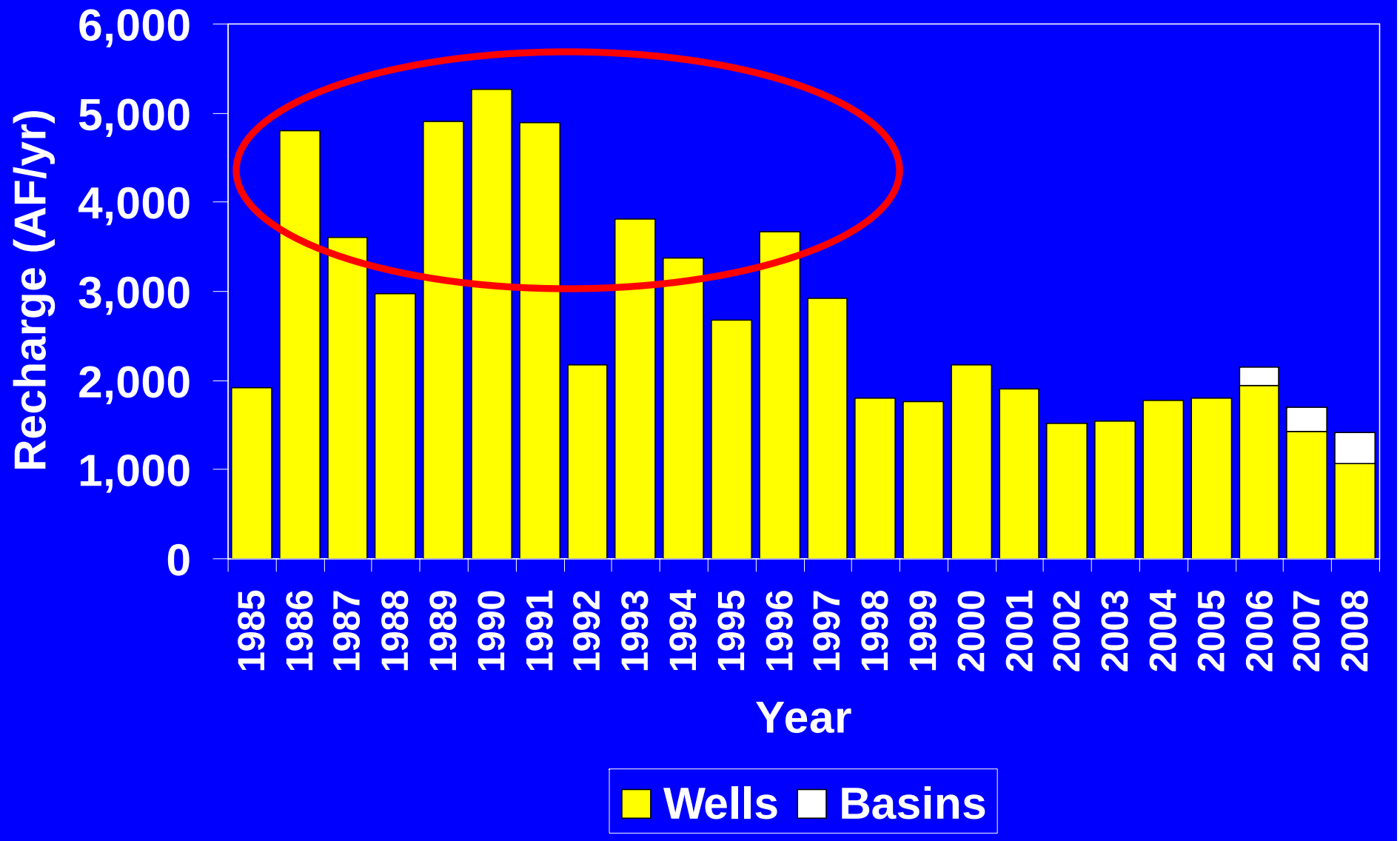

Fred Hervey
Water
Reclamation
Plant
Production
Wells
N
0
1
2
3
4
5
Miles


Effluent Line
Injection Wells
N
0
1
2
3
4
5
Miles

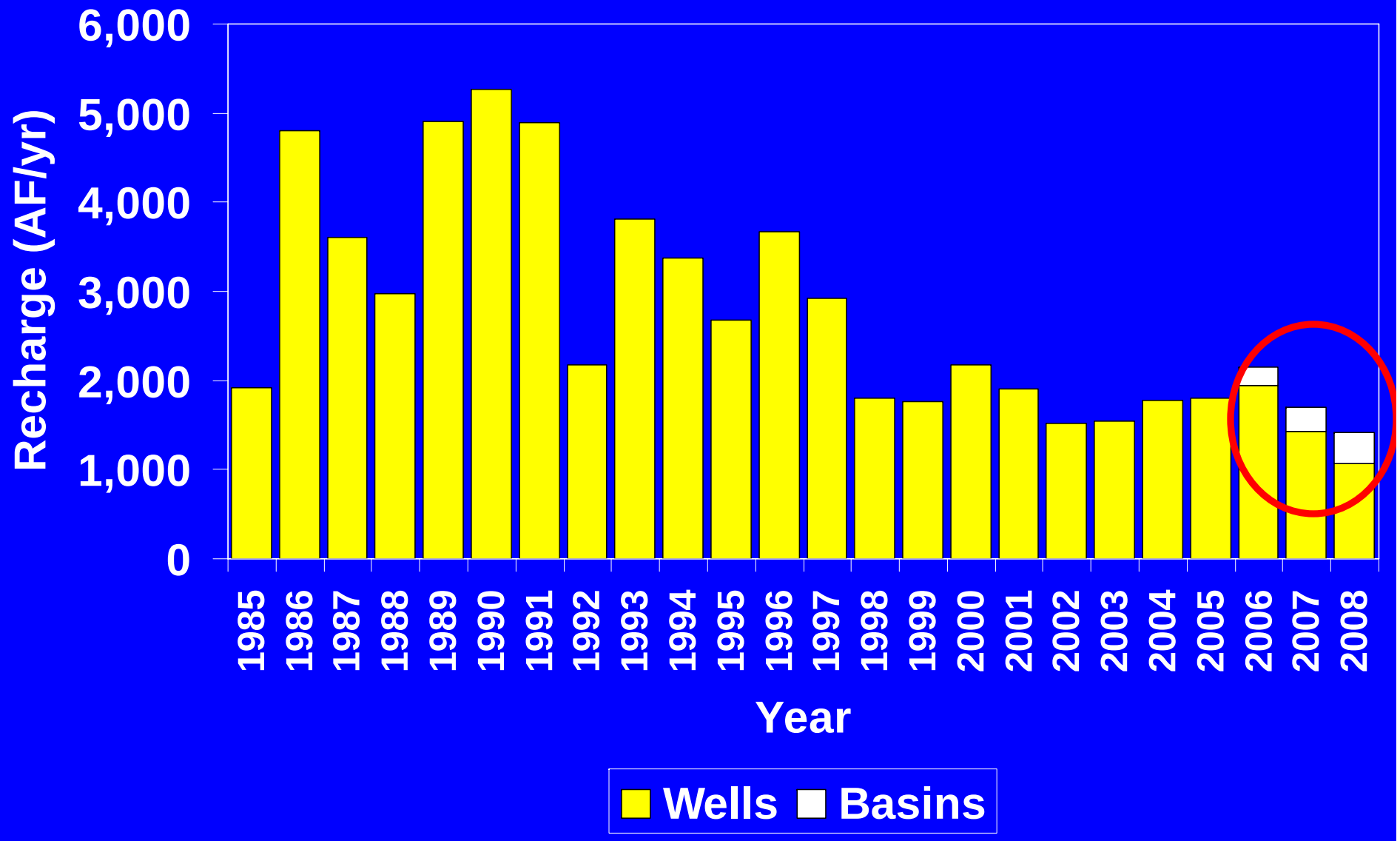

Power
Plant
Golf
Course
N
0
1
2
3
4
5
Miles


Spreading
Basins
N
0
1
2
3
4
5
Miles

Reclaimed Water Recharge

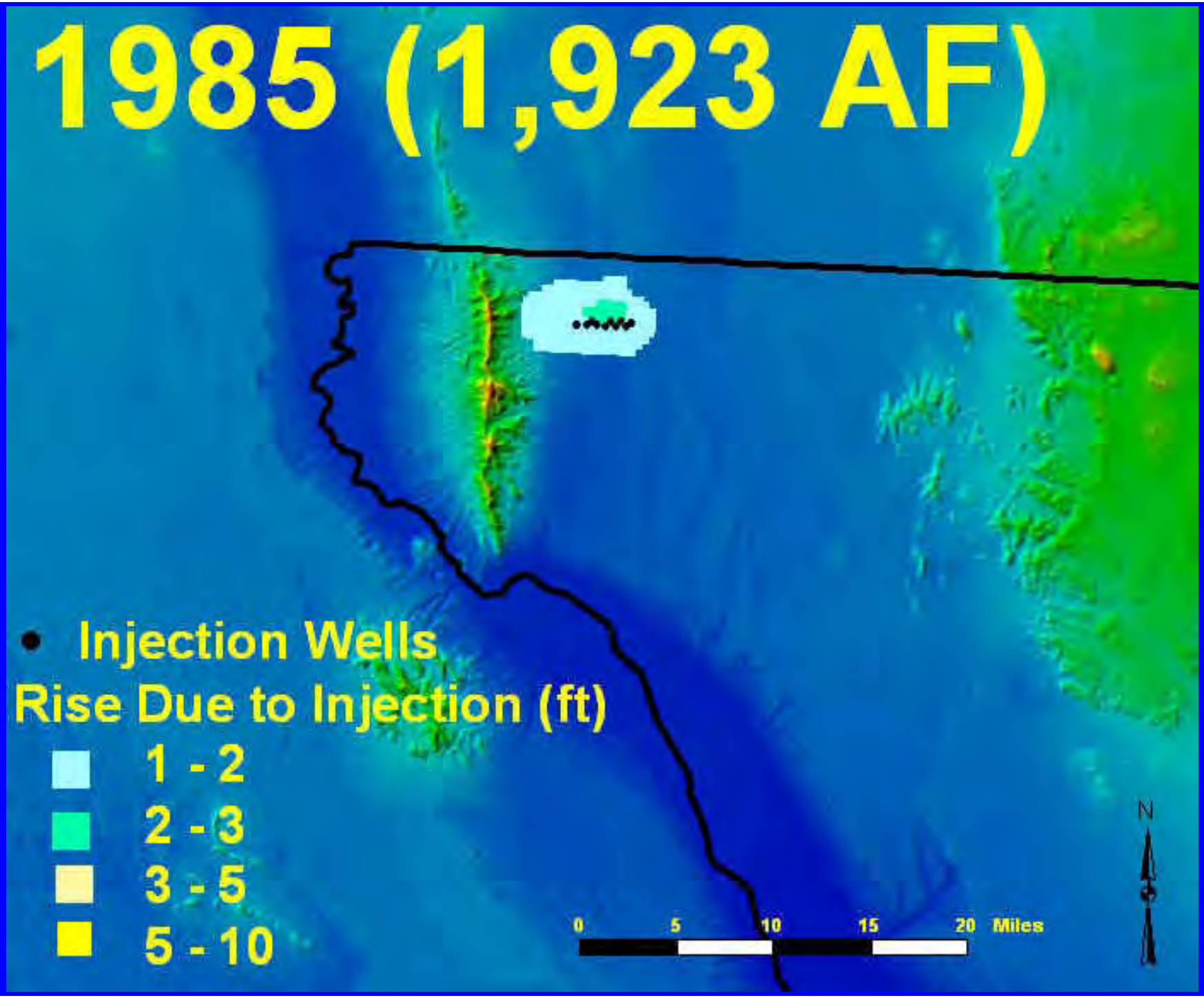


Reclaimed Water Recharge



Impacts of Recharge

- Groundwater Levels
  - Simulated with groundwater model (with and without recharge)
- Groundwater Quality
  - TDS

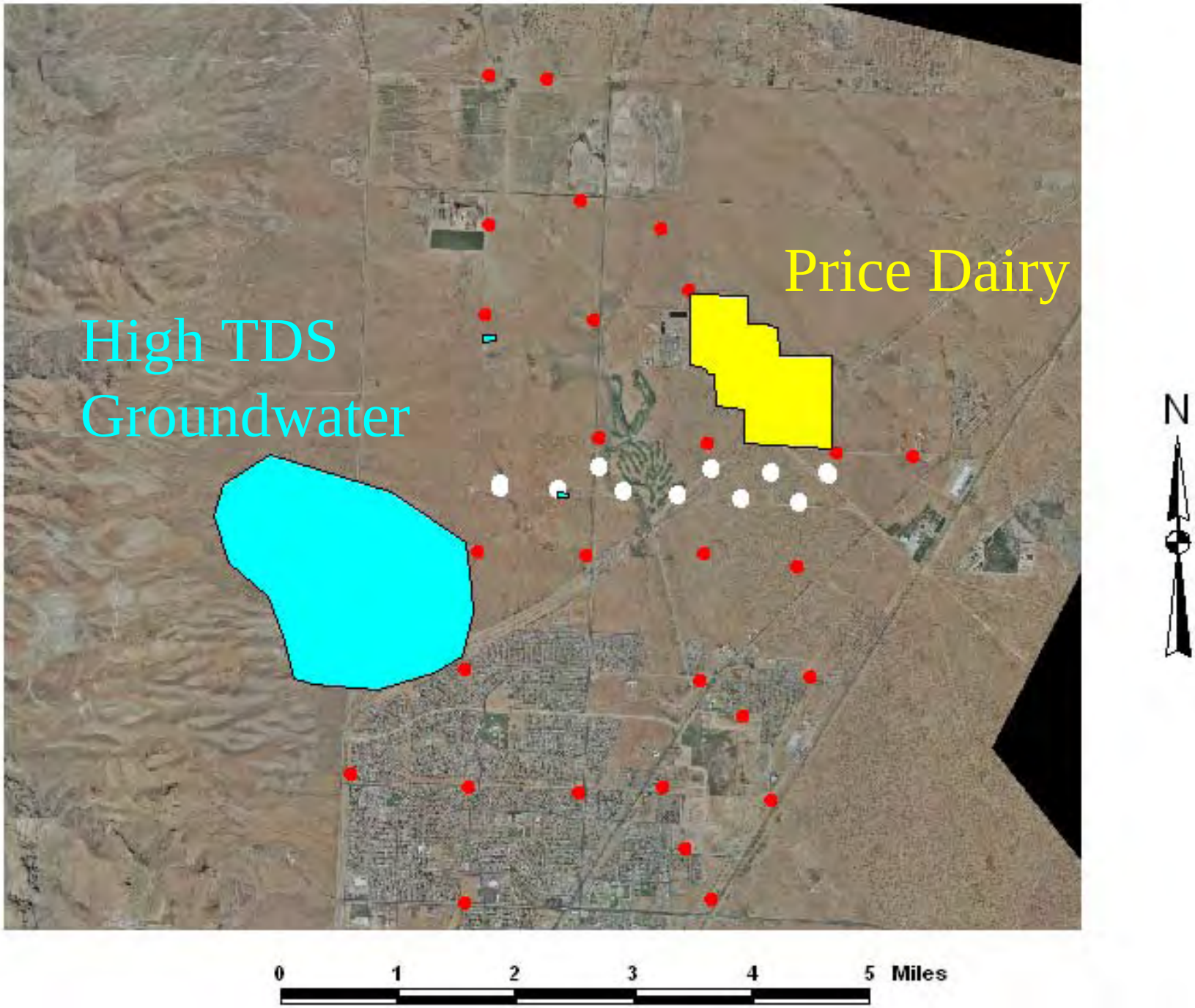

1985 (1,923 AF)
Injection Wells
Rise Due to Injection (ft)
1 - 2
2 - 3
3 - 5
5 - 10
0
5
10
15
20
Miles
N

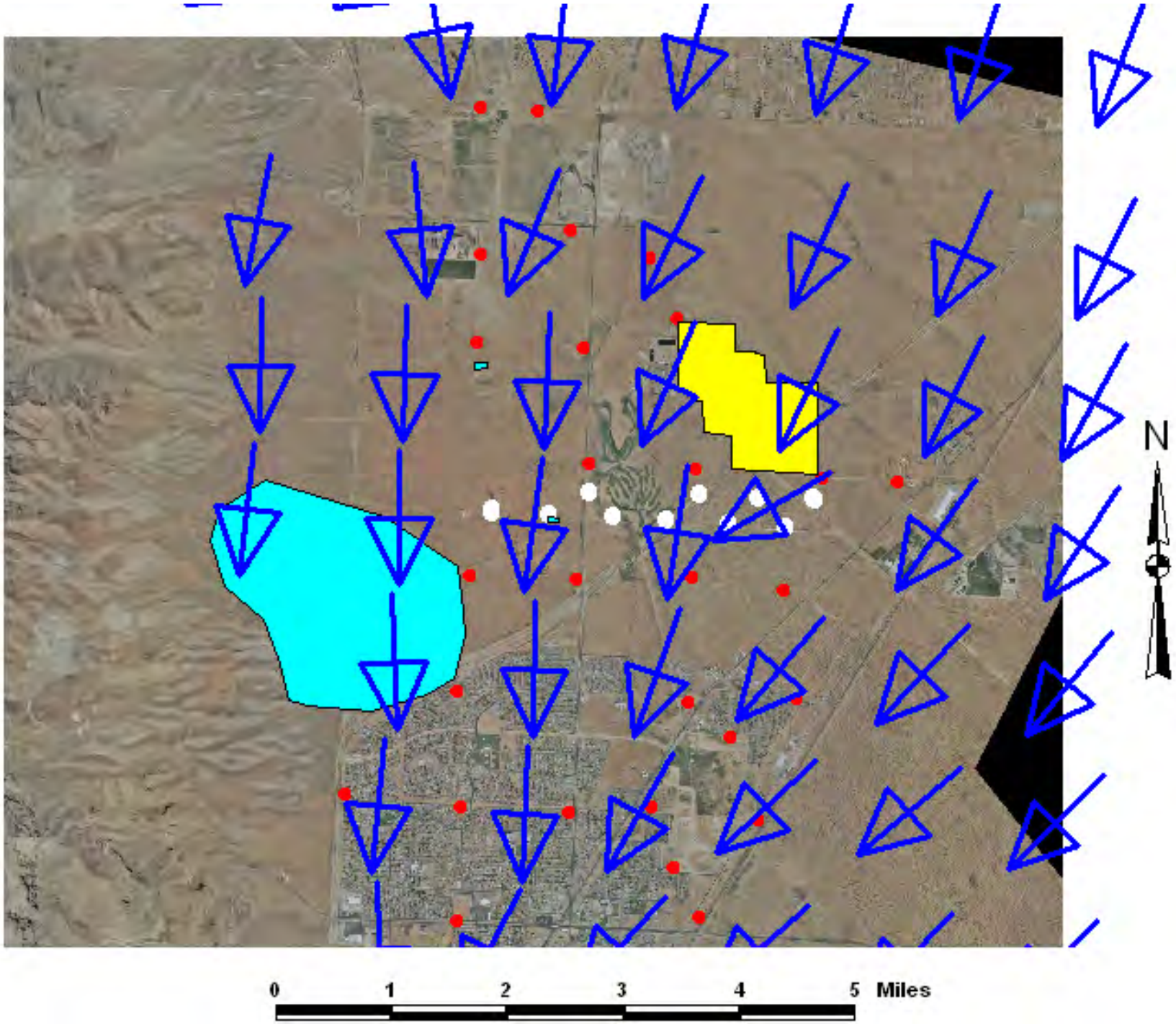
Groundwater Level Impact

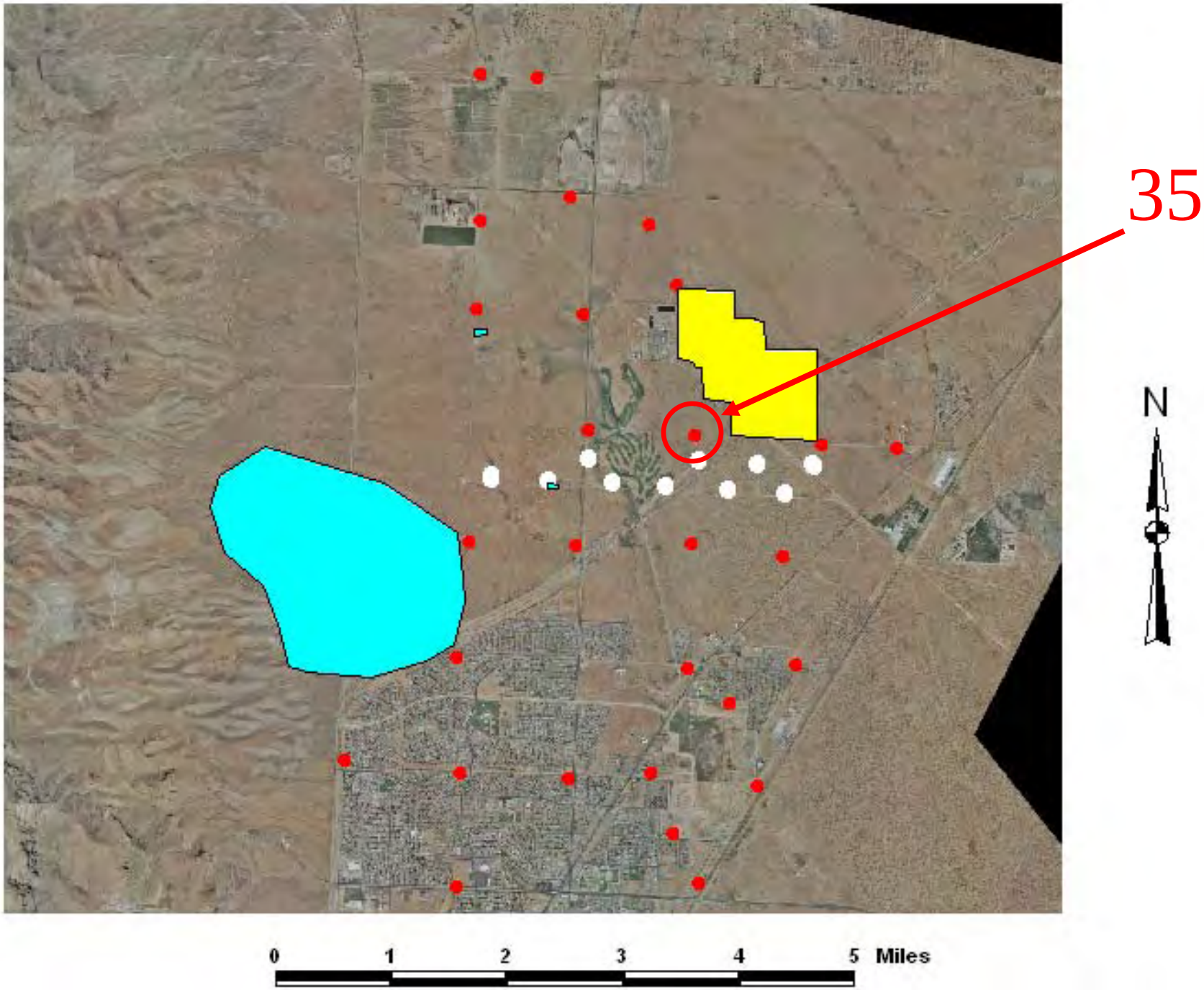
- Typically less than 6 ft
- Reduction in recharge has slowed advancement of “mound”

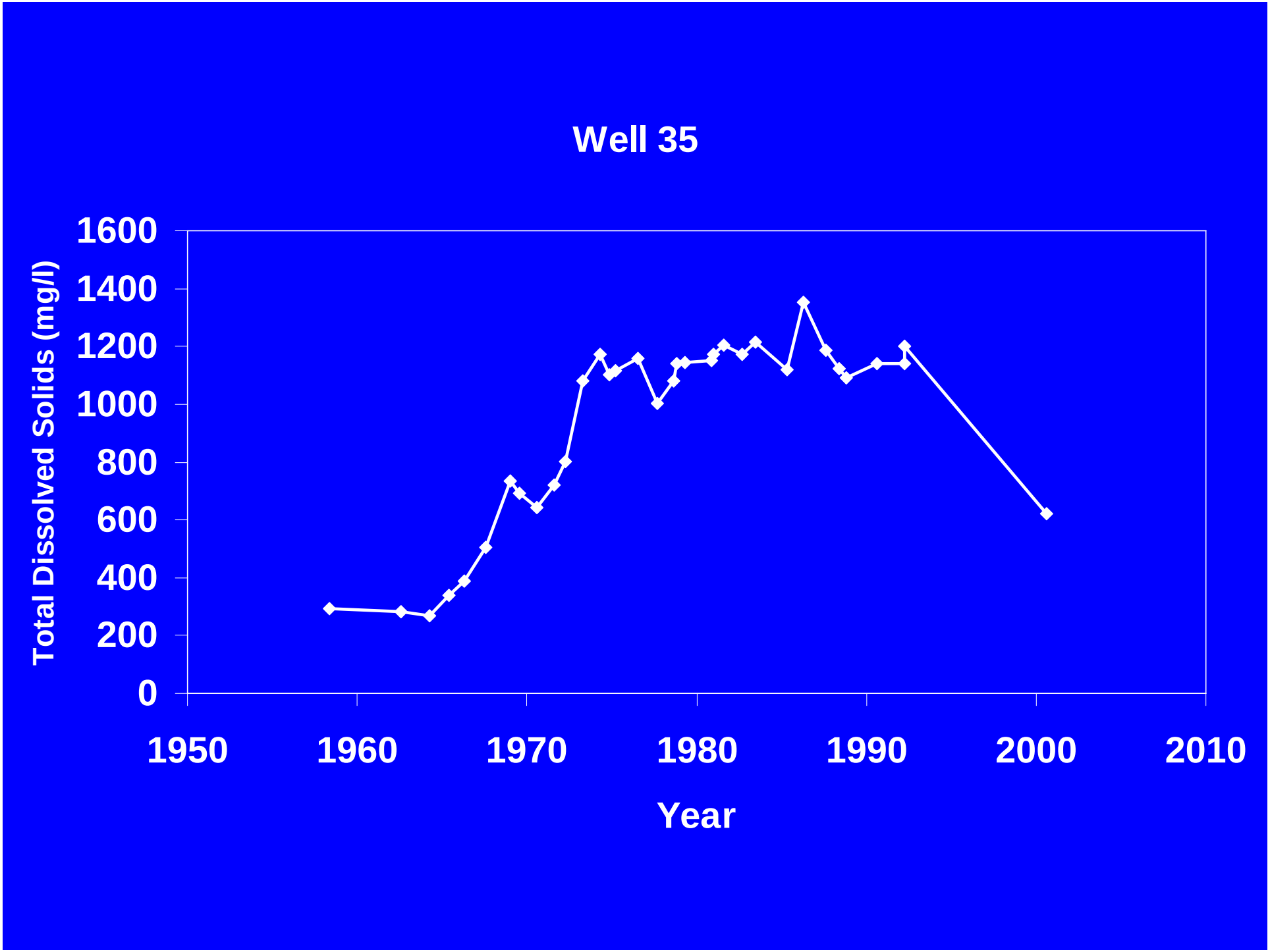
Groundwater Quality Impact

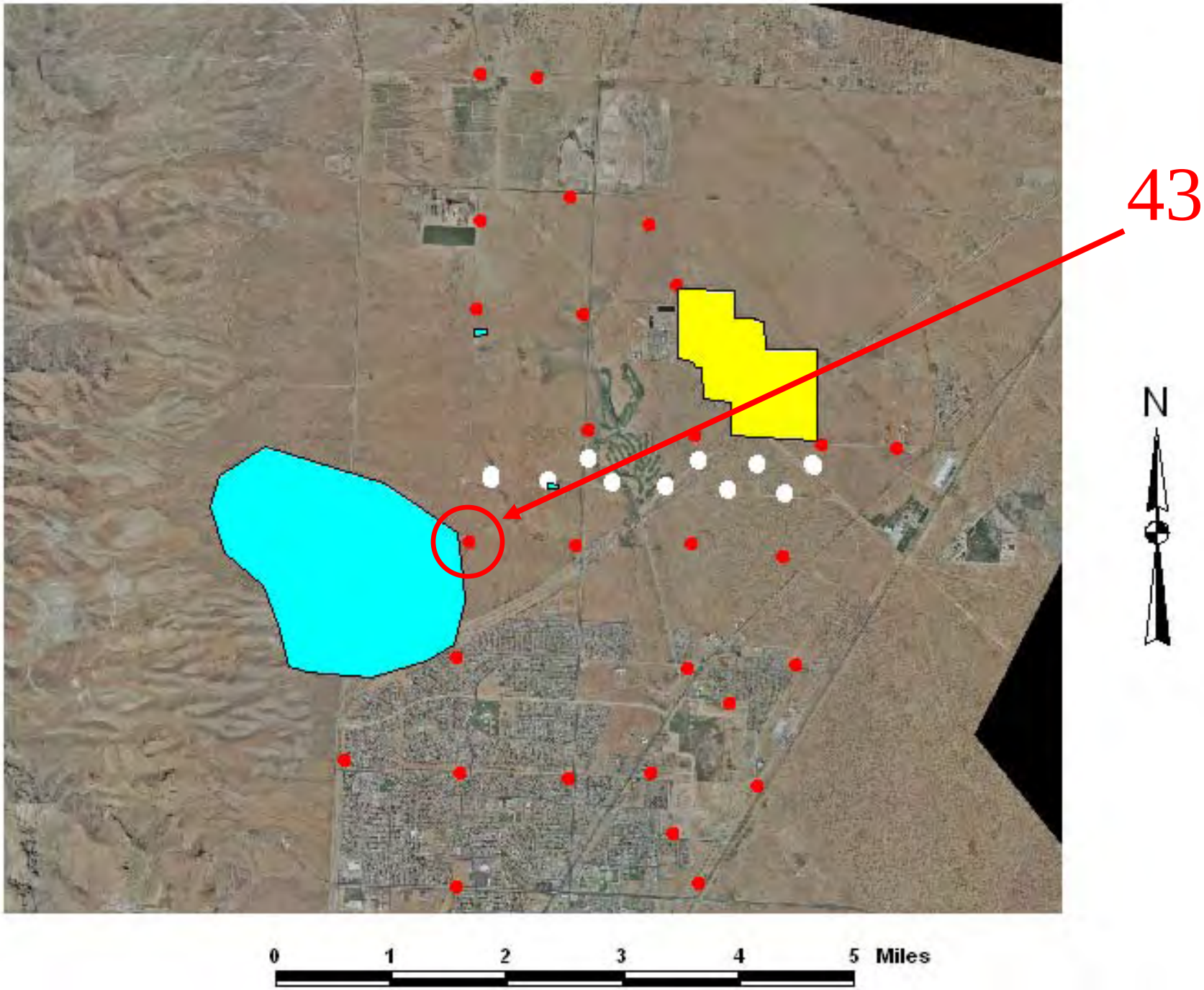
- Complex Interpretation
  - Recharge water TDS ~ 600 to 700 mg/l
  - Inflow from New Mexico ~ 18,000 AF/yr
  - Native groundwater is variable, including a pocket of high TDS water nearby
  - Price Dairy impacts from 1960s and 1970s just now abating

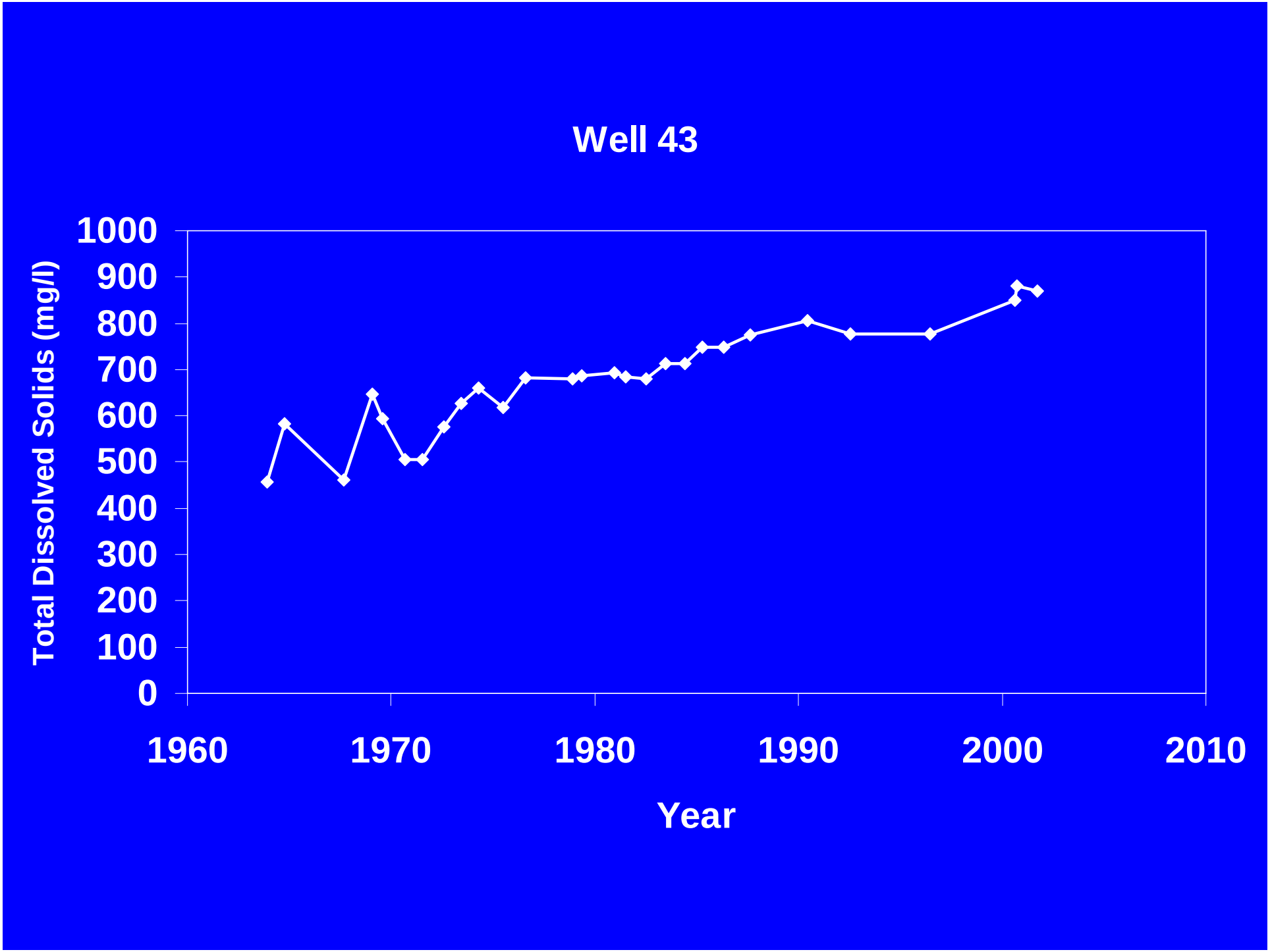

Price Dairy
High TDS
Groundwater
N
0
1
2
3
4
5
Miles

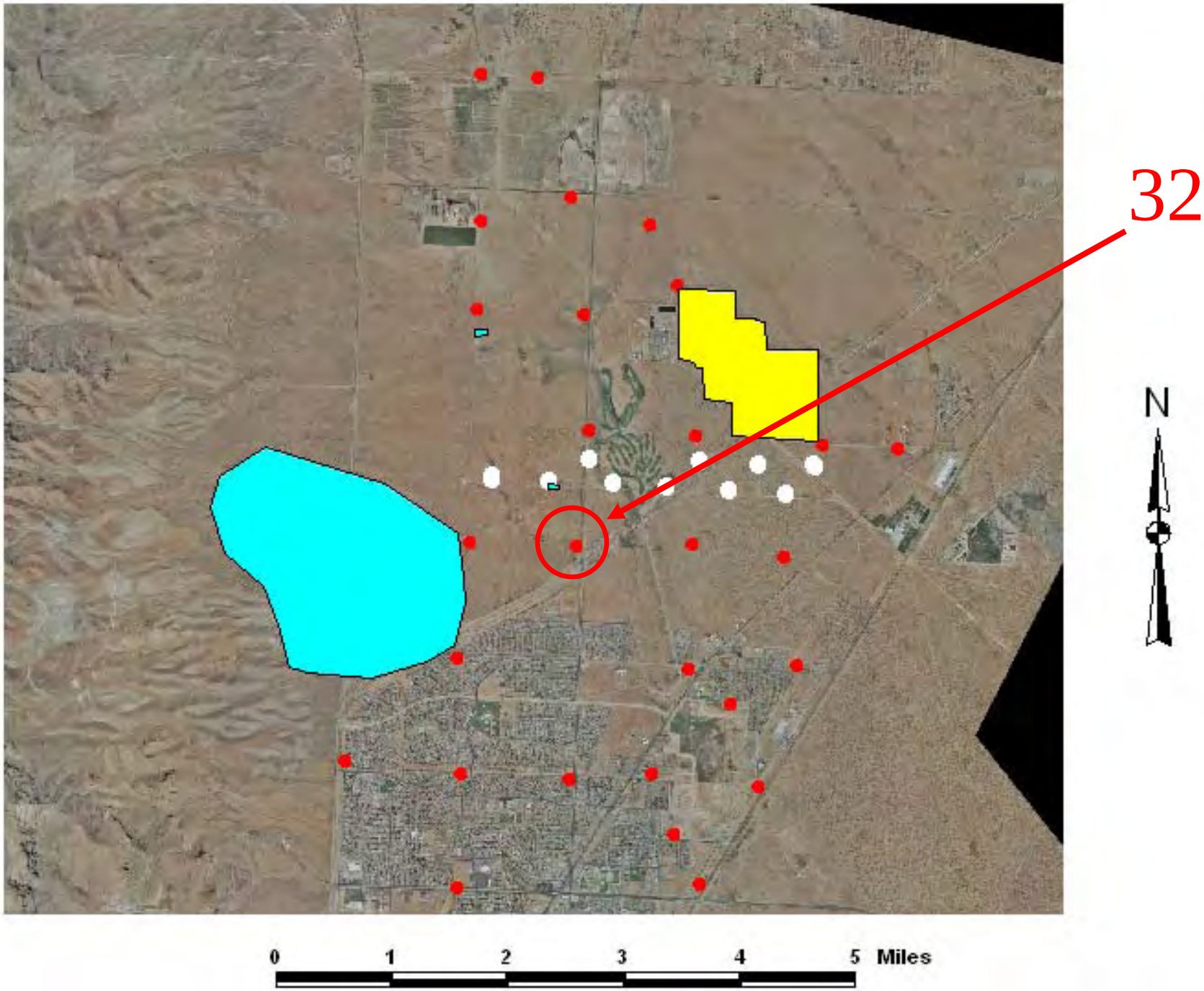

N
0
1
2
3
4
5
Miles

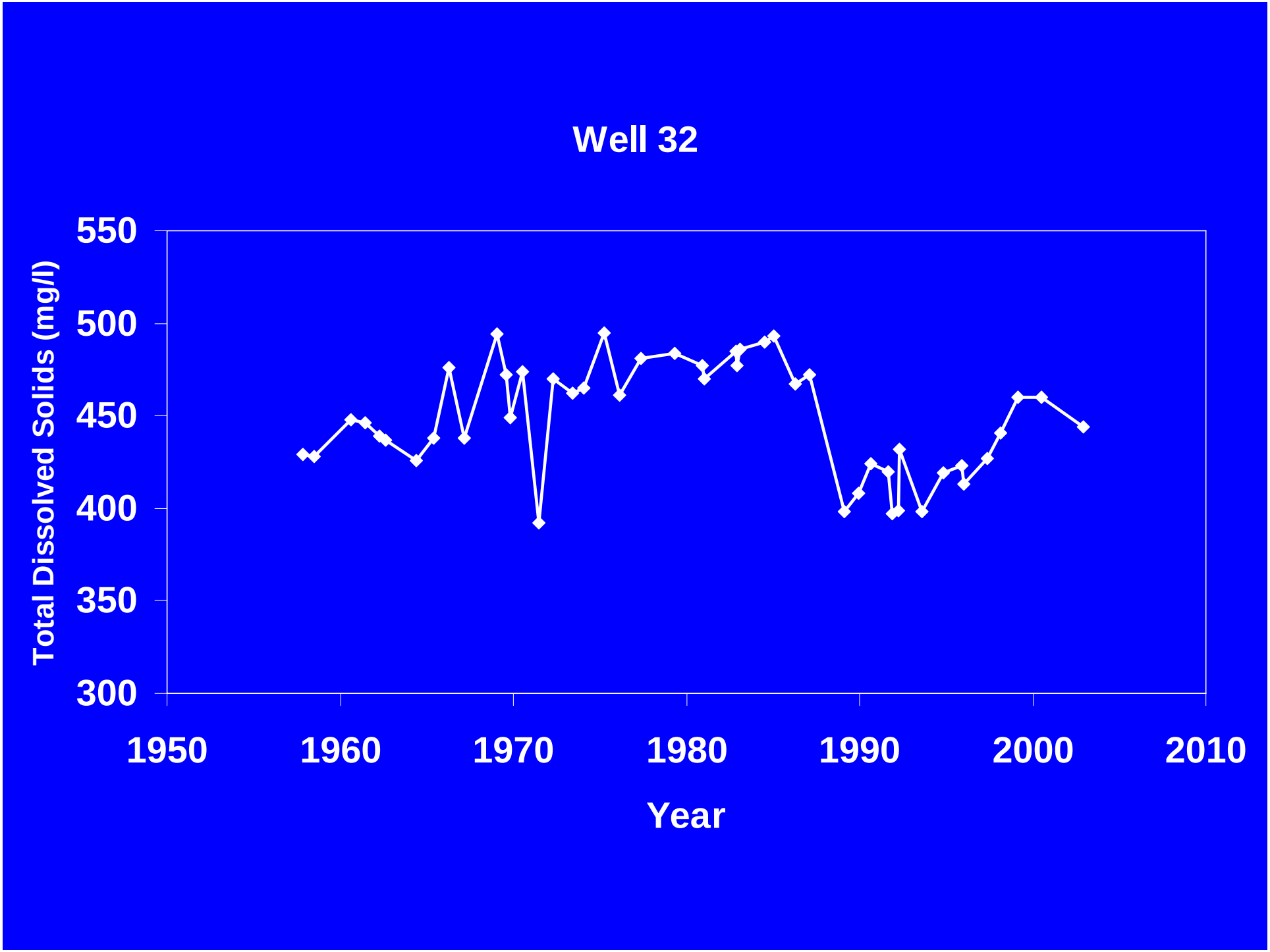

35
N
0
1
2
3
4
5
Miles

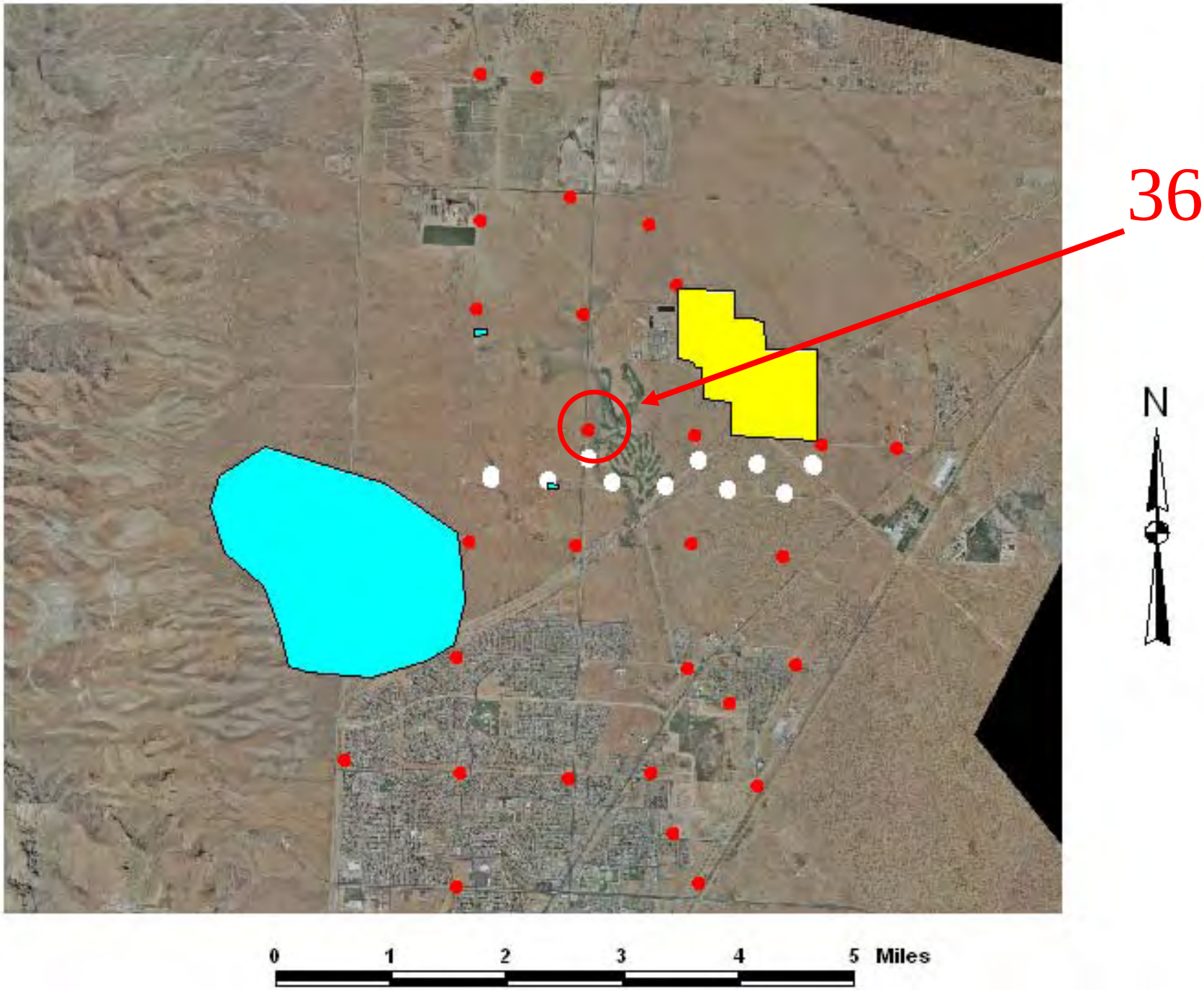

Well 35
Total Dissolved Solids (mg/l)
1600
1400
1200
1000
800
600
400
200
0
1950
1960
1970
1980
1990
2000
2010
Year

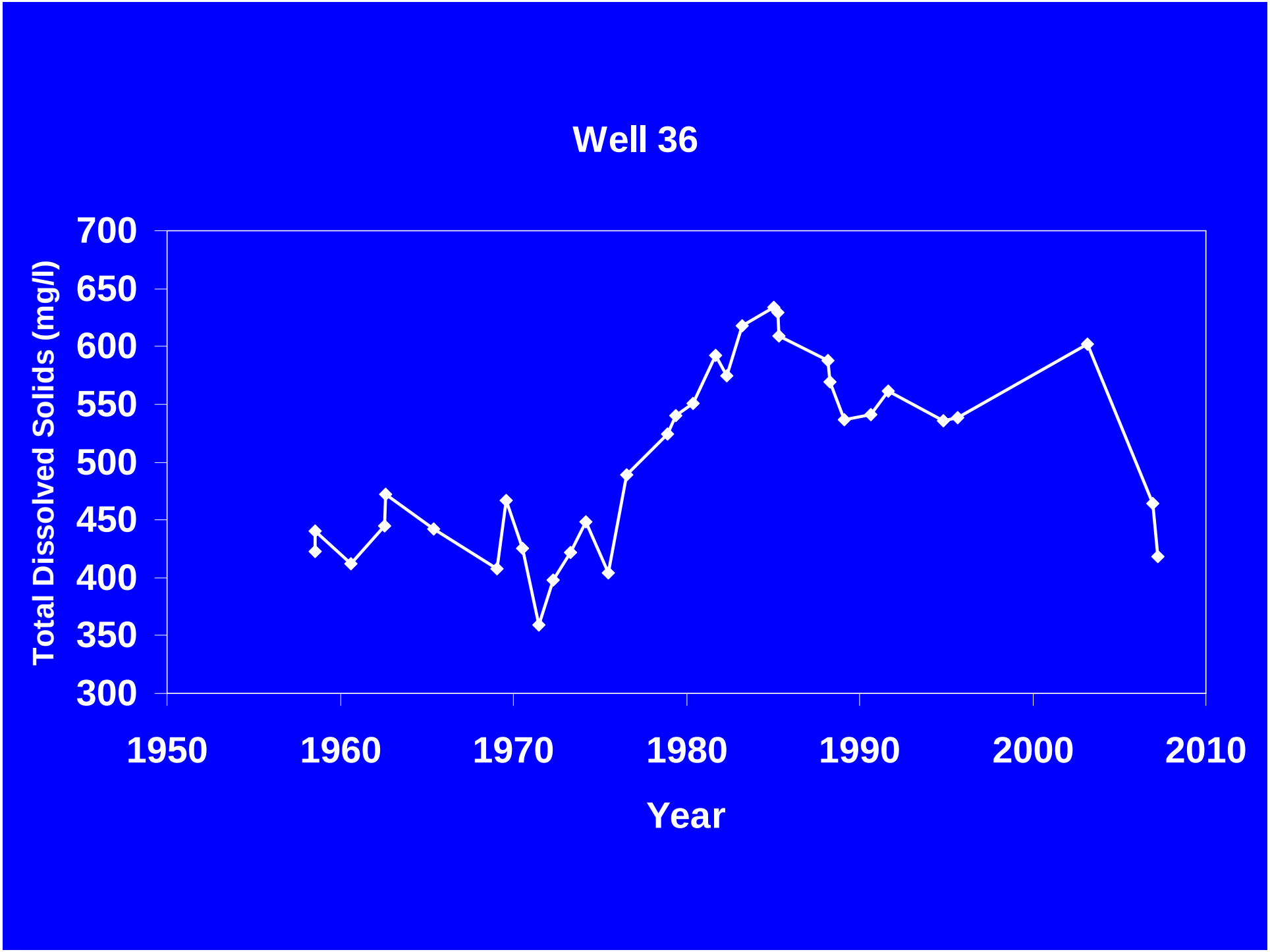

43
N
0
1
2
3
4
5
Miles


Well 43
Total Dissolved Solids (mg/l)
1000
900
800
700
600
500
400
300
200
100
0
1960
1970
1980
1990
2000
2010
Year


32
N
0
1
2
3
4
5
Miles


Well 32
Total Dissolved Solids (mg/l)
550
500
450
400
350
300
1950
1960
1970
1980
1990
2000
2010
Year


36
N
0
1
2
3
4
5
Miles


Well 36
Total Dissolved Solids (mg/l)
700
650
600
550
500
450
400
350
300
1950
1960
1970
1980
1990
2000
2010
Year

Arsenic and Other Metals

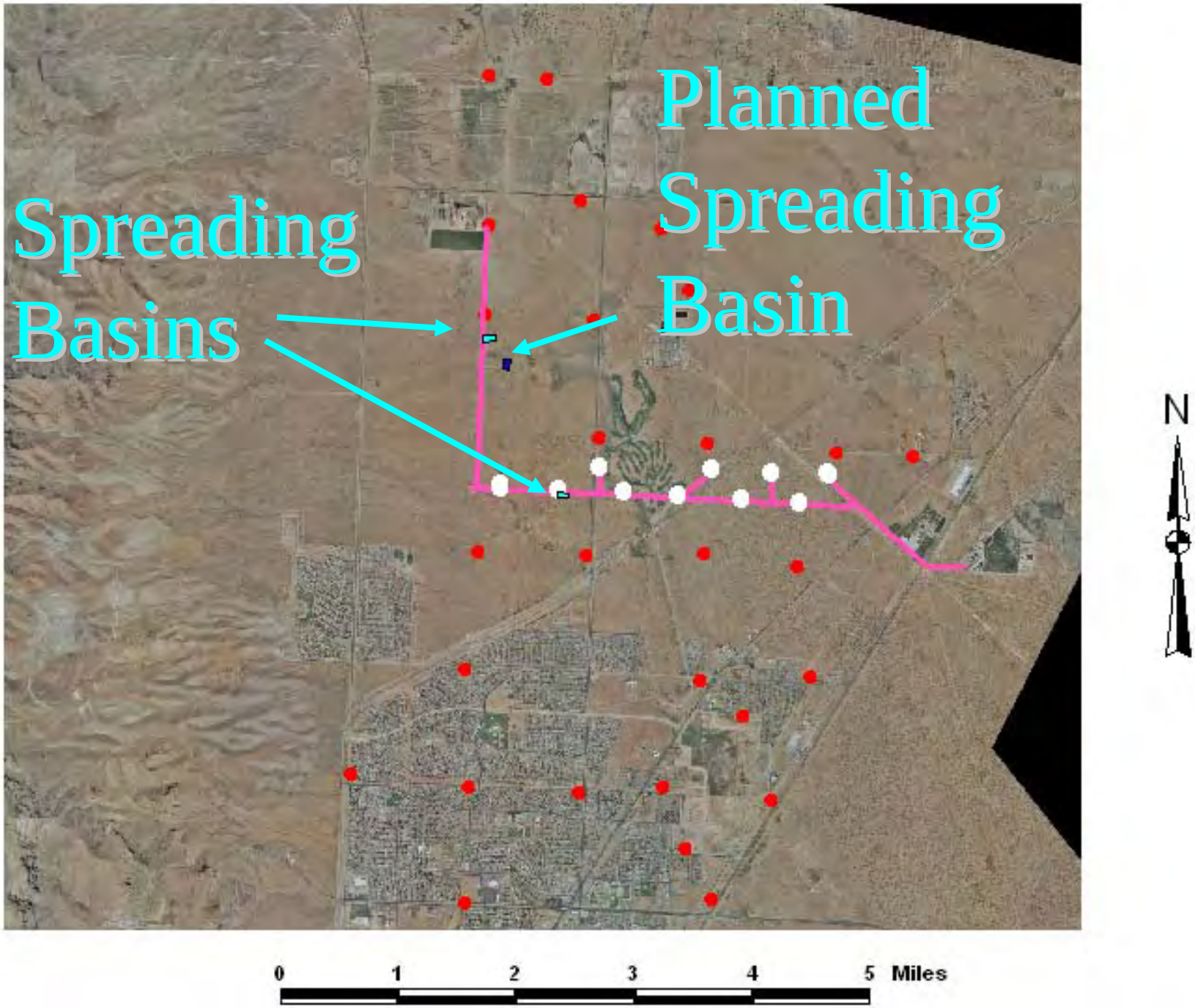
- Sampling for trace constituents began in 1985
- No trend in data
- Concentrations of Arsenic ~ 7 ppb

Challenges

- Effluent Demands Limit Recharge
  - Golf Course
  - Power Plant
- Recharge is Effective
- Alternative Source?

Store Treated Surface Water in Hueco Bolson (Feasibility Study)

- Water rights for 65,000 AF/yr
- Maximum annual diversion ~ 58,000 AF/yr
  - Early irrigation season supply vs. demand


Planned Spreading Basin
Spreading Basins
N
0
1
2
3
4
5
Miles

Conceptual Analysis

- Assume:
  - 5,000 AF/yr of additional diversion (in full allocation years)
  - Yield = 3,200 AF/yr (Full allocation 80%)
  - Extend lines to spreading basins
  - Store water and pump as groundwater later

Conceptual Cost - Capital

- Construction Cost = $830,000
  - 10,000 ft of 16-inch line @ $70/ft
  - 6 valves @ $5,000/valve
  - New basin @ $100,000
  - Use 2 existing basins

Conceptual Cost - Annual

- Operations Costs ($300/AF to $450/AF)
  - $300/AF (surface water treatment)
  - $150/AF (groundwater pumping)

Conceptual Unit Cost

- Undiscounted Unit Cost (50-years)
  - $305/AF to $455/AF

Status

- Conceptual Study Nearly Complete
  - Additional Groundwater Simulations
- Funding Decision (Fall 2009)
- Design and Construction
  - no sooner than 2010

Hueco Bolson Conditions

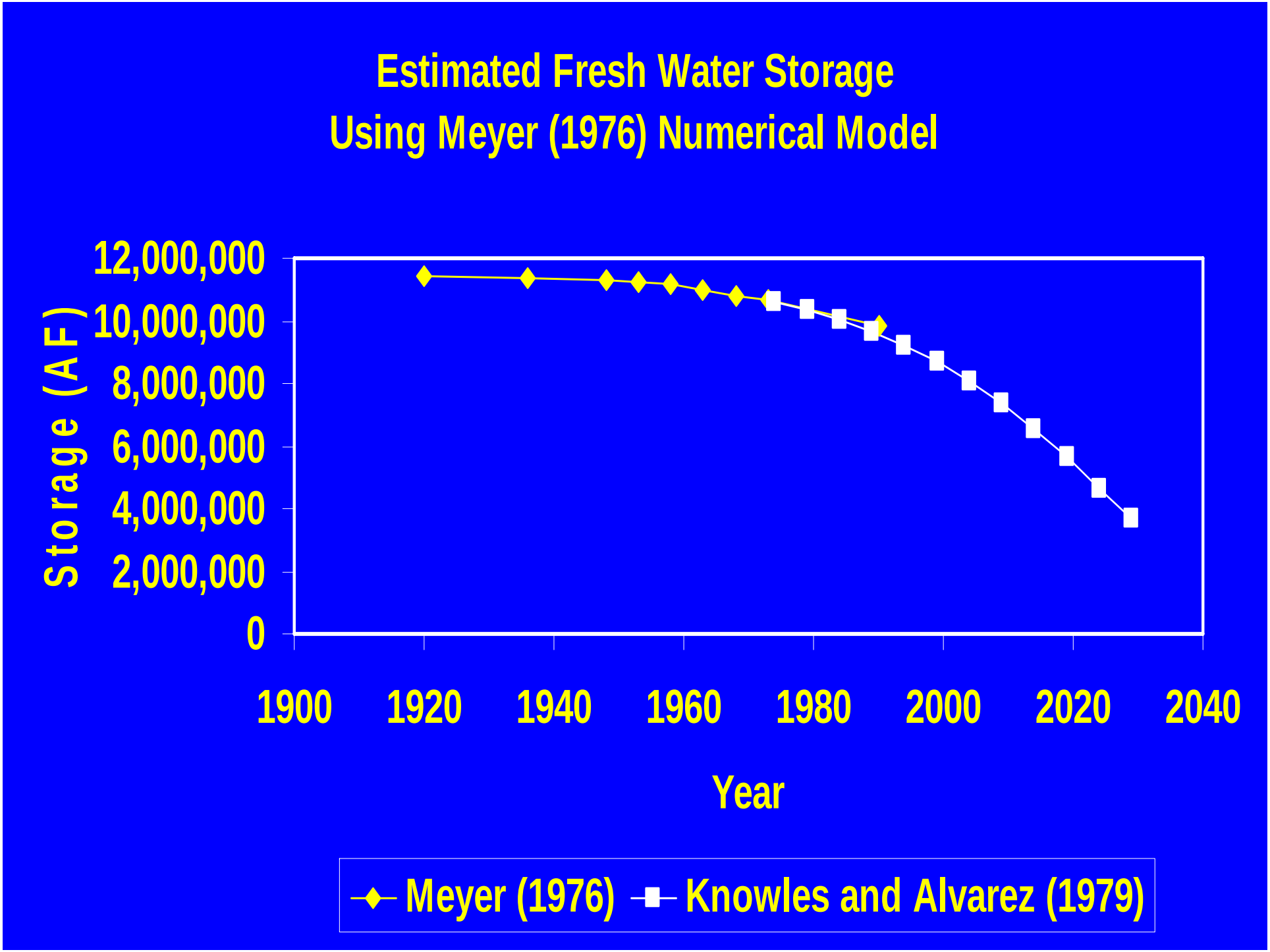
- Pumping Reductions
  - Conjunctive Use
  - Conservation
  - Reclaimed Water Use
- 2030 Myth
- Climate Change Impacts
- Desalination Project

1979 TWDB Assessment

- Muller and Price (1979) estimated "availability" of groundwater in the Hueco
- Relied on USGS model (Meyer, 1976) and its application (Knowles and Alvarez, 1979)
- Conclusion: Fresh groundwater would be depleted by 2030 (2030 Myth)

Summary of 1979 Approach

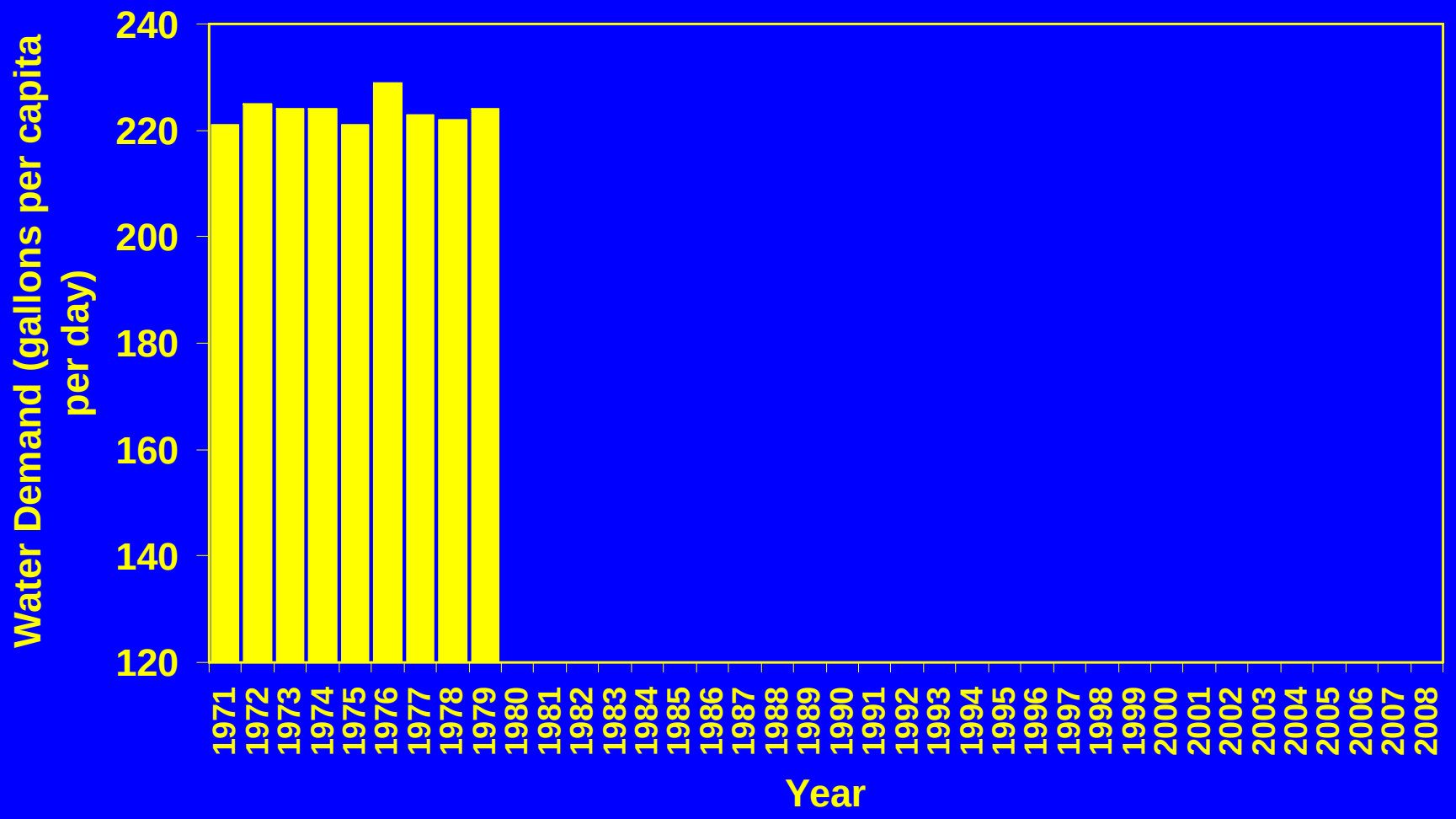
- Groundwater storage in 1974 was 10.6 MAF
- Pumping exceeds recharge
- "Mining" is causing depletion of storage
- Constraint – "…only 75 percent of the fresh water in storage will be pumped" (pg. 28)
  - Due to "proximity of poor quality ground water"


Estimated Fresh Water Storage
Using Meyer (1976) Numerical Model
Storage (AF)
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
1900
1920
1940
1960
1980
2000
2020
2040
Year
Meyer (1976)
Knowles and Alvarez (1979)

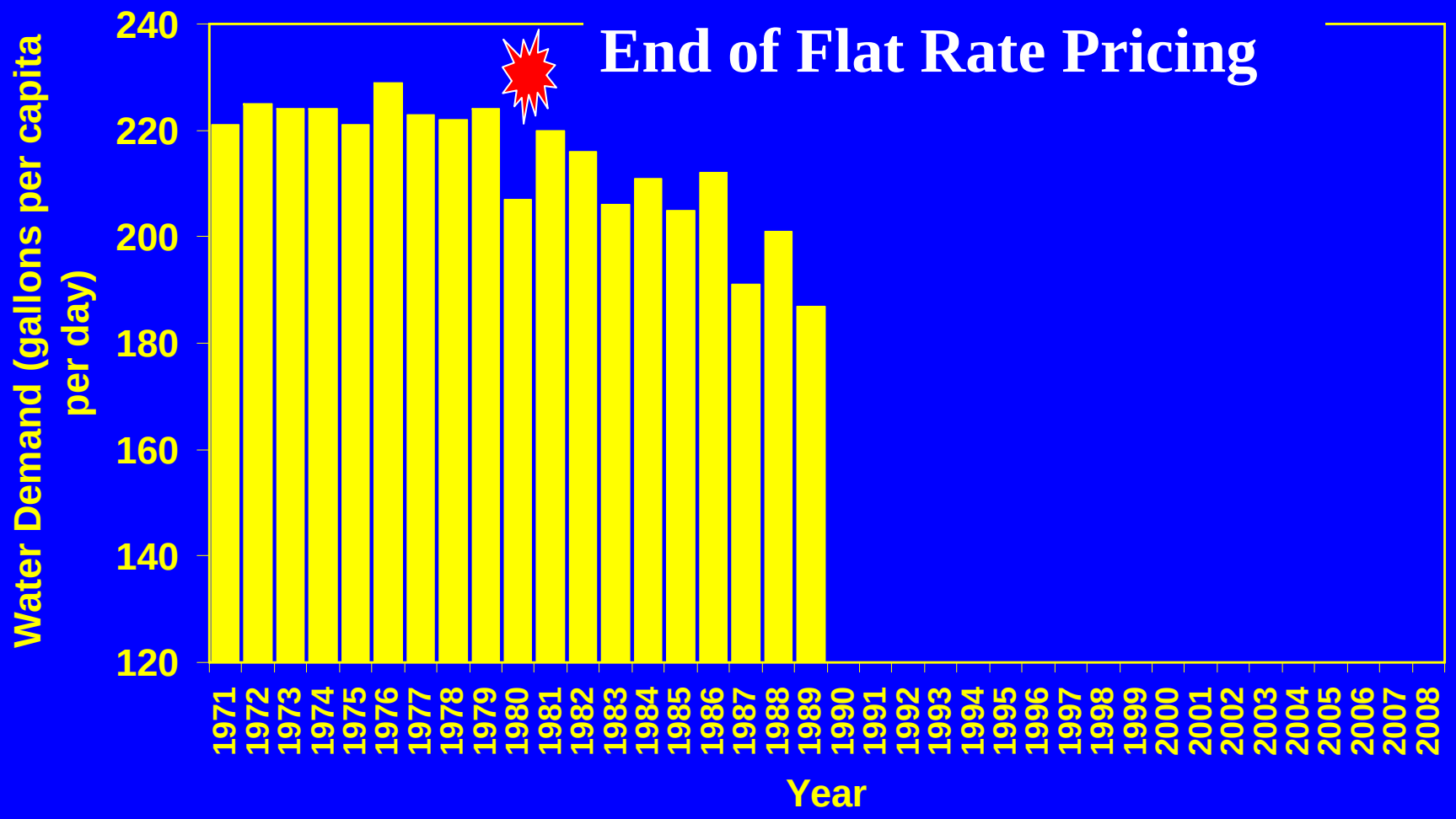
1979 Assumptions

- Increasing population
- No change in per capita demand
- No change in surface water diversion capacity
- Increased demand met through groundwater pumping

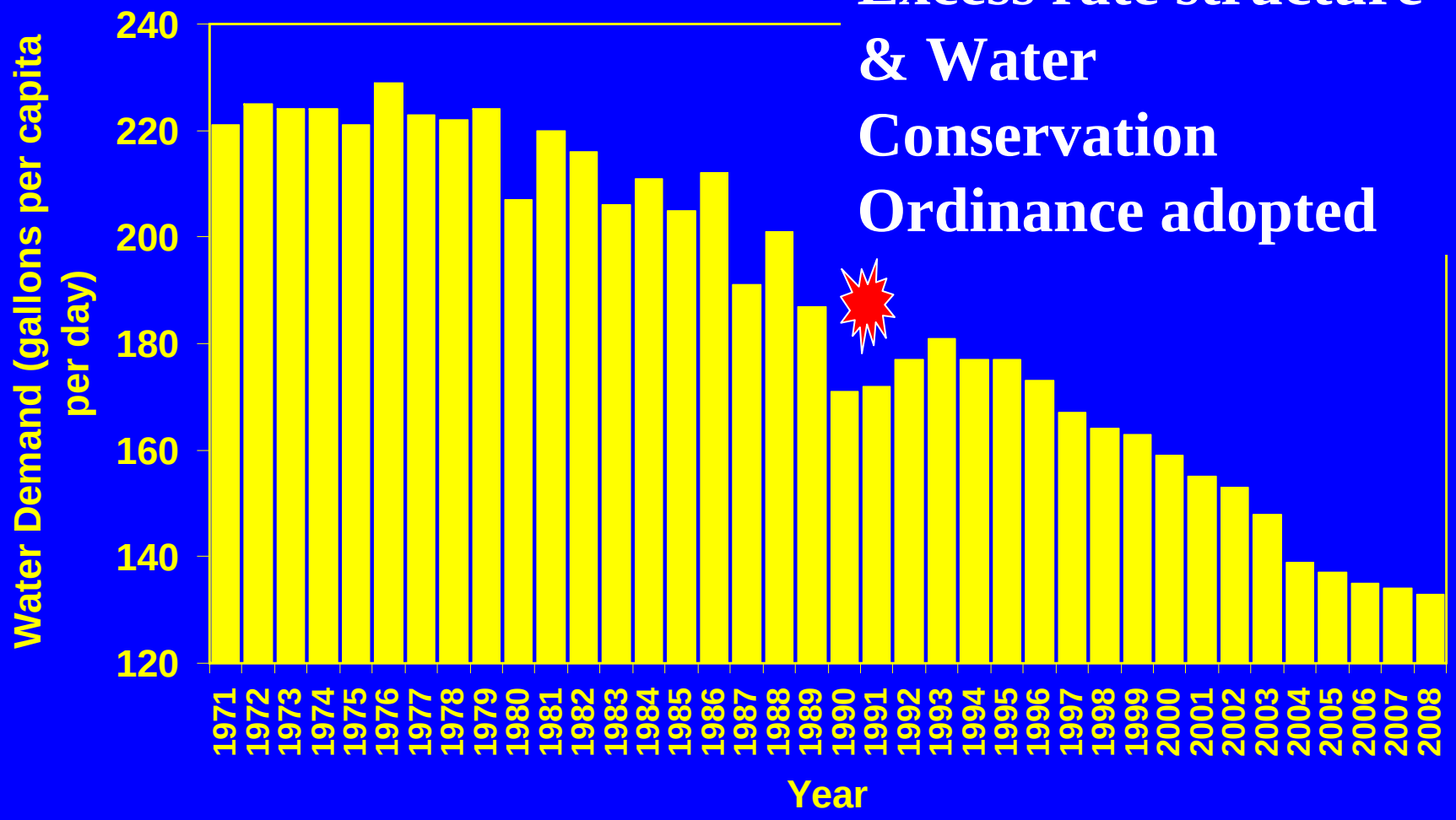
EPWU Per Capita Demand

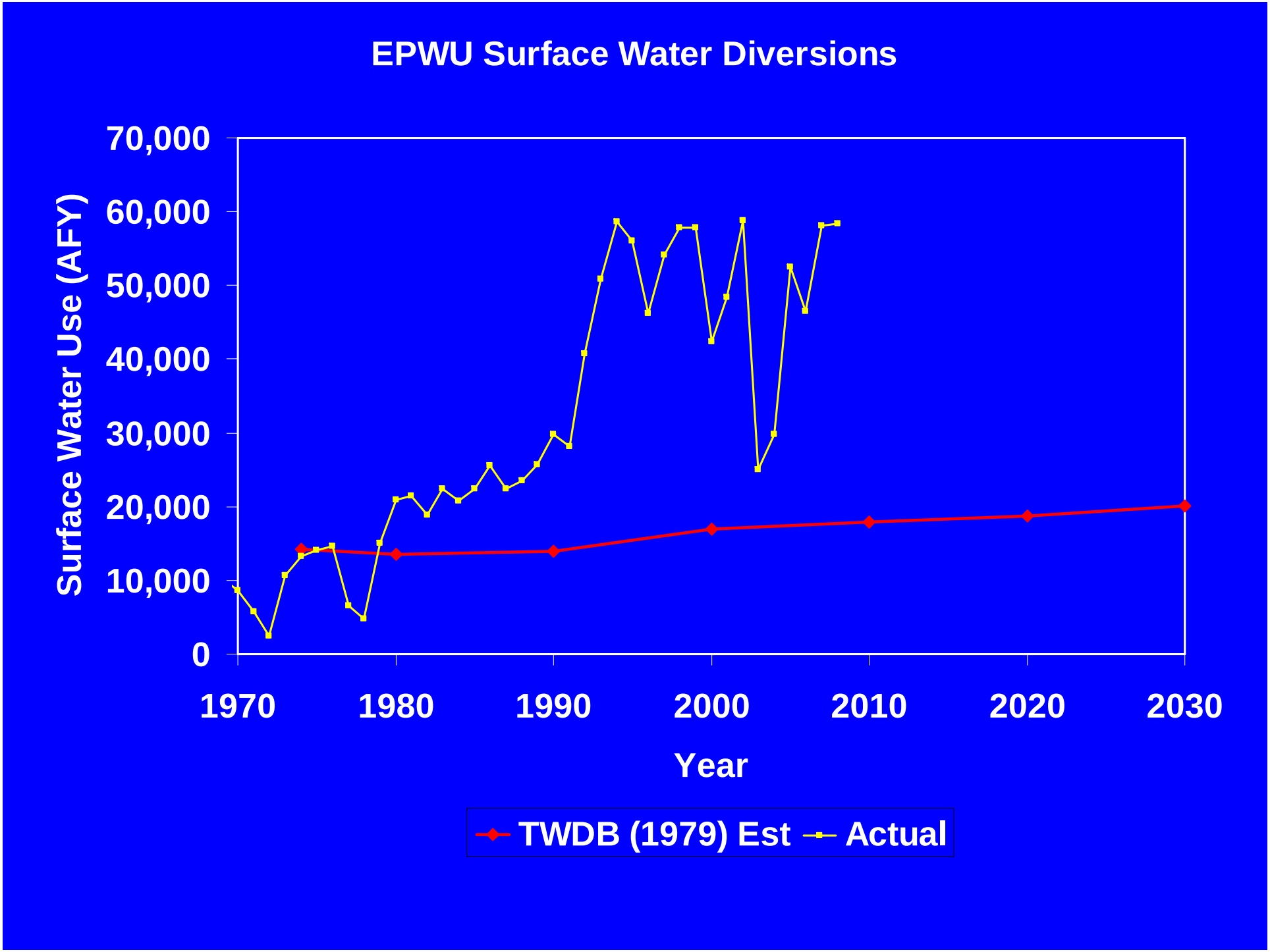


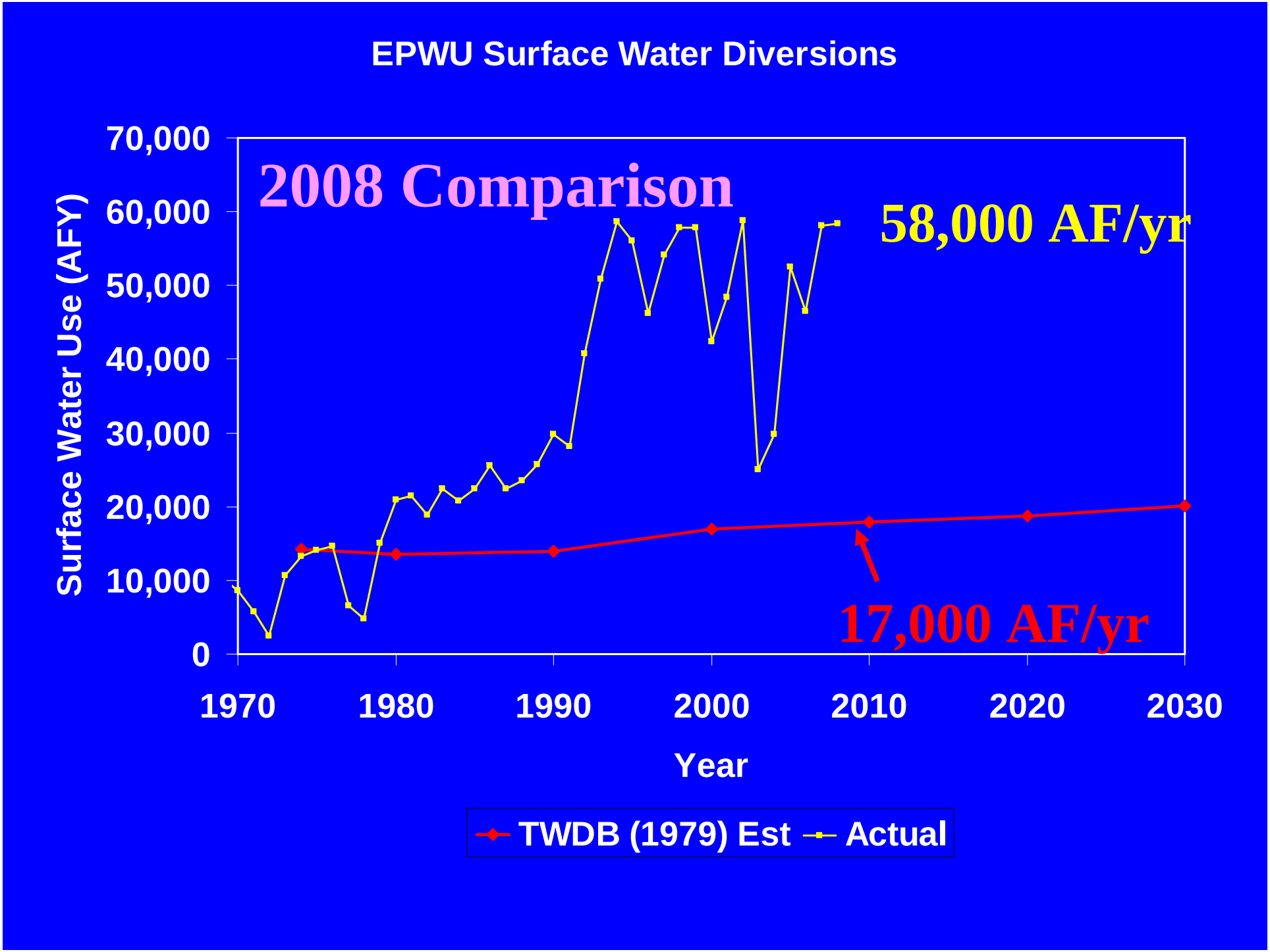
EPWU Per Capita Demand

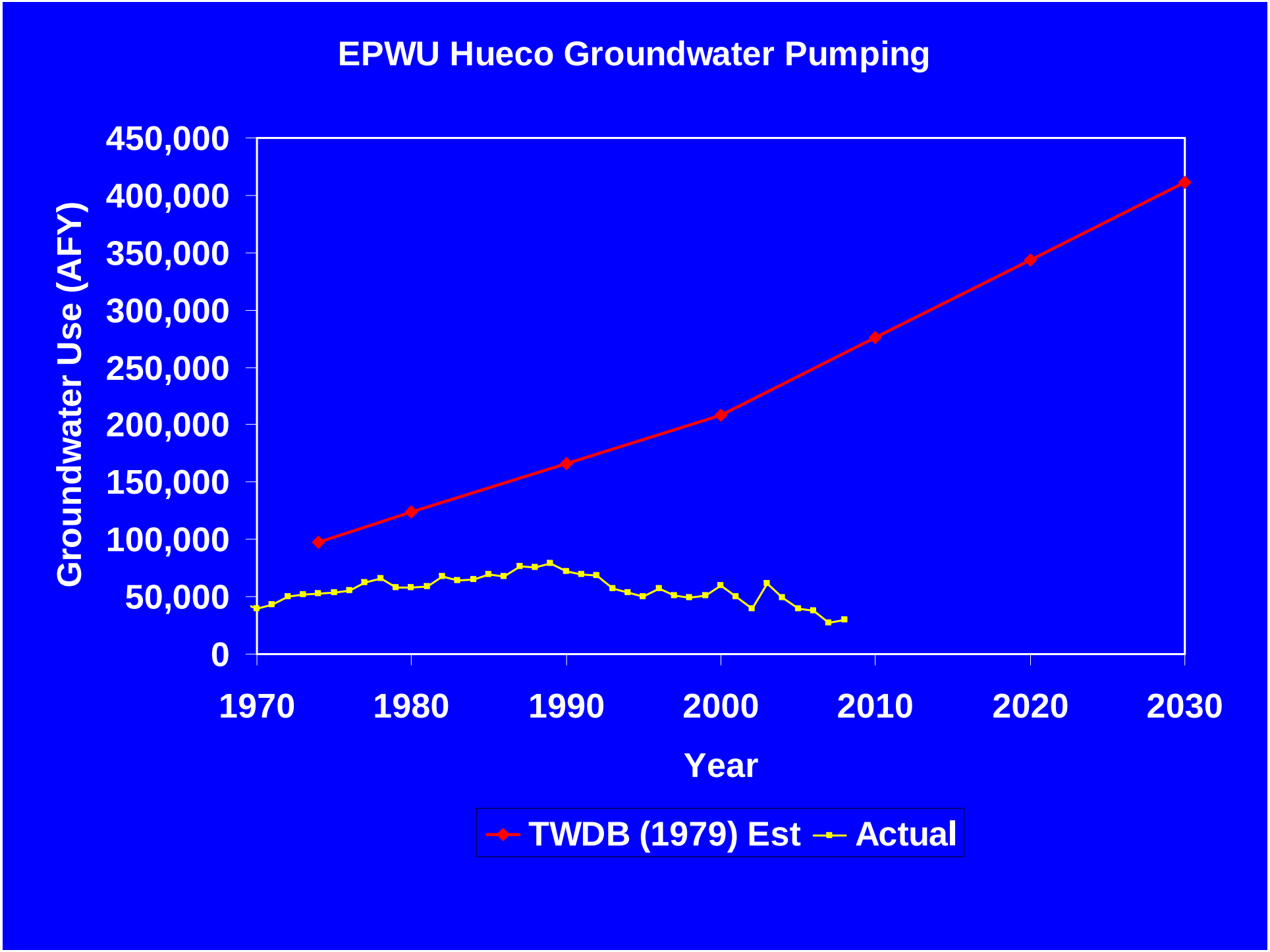


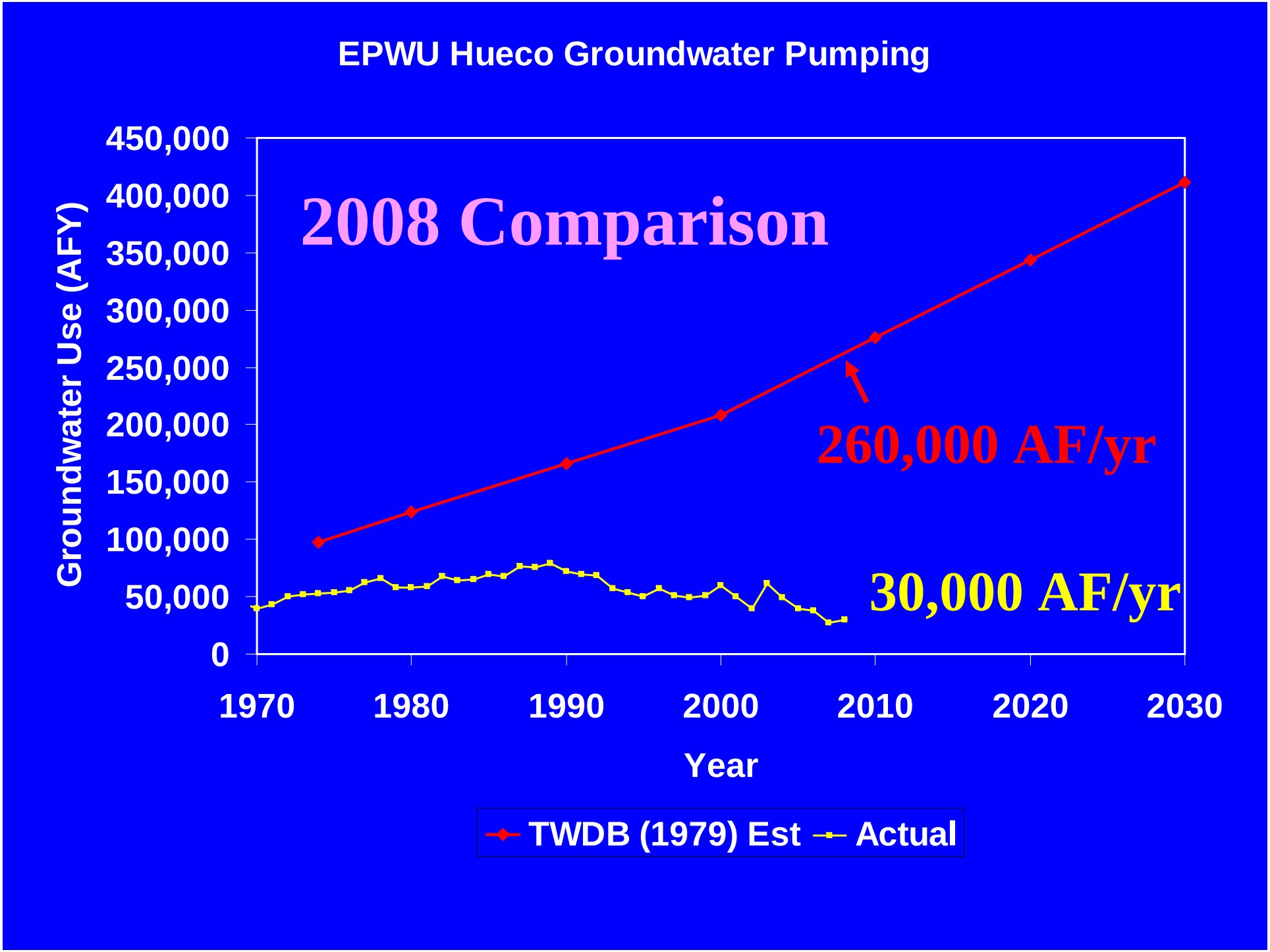
EPWU Per Capita Demand




EPWU Surface Water Diversions
Surface Water Use (AFY)
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
1970
1980
1990
2000
2010
2020
2030
Year
TWDB (1979) Est
Actual

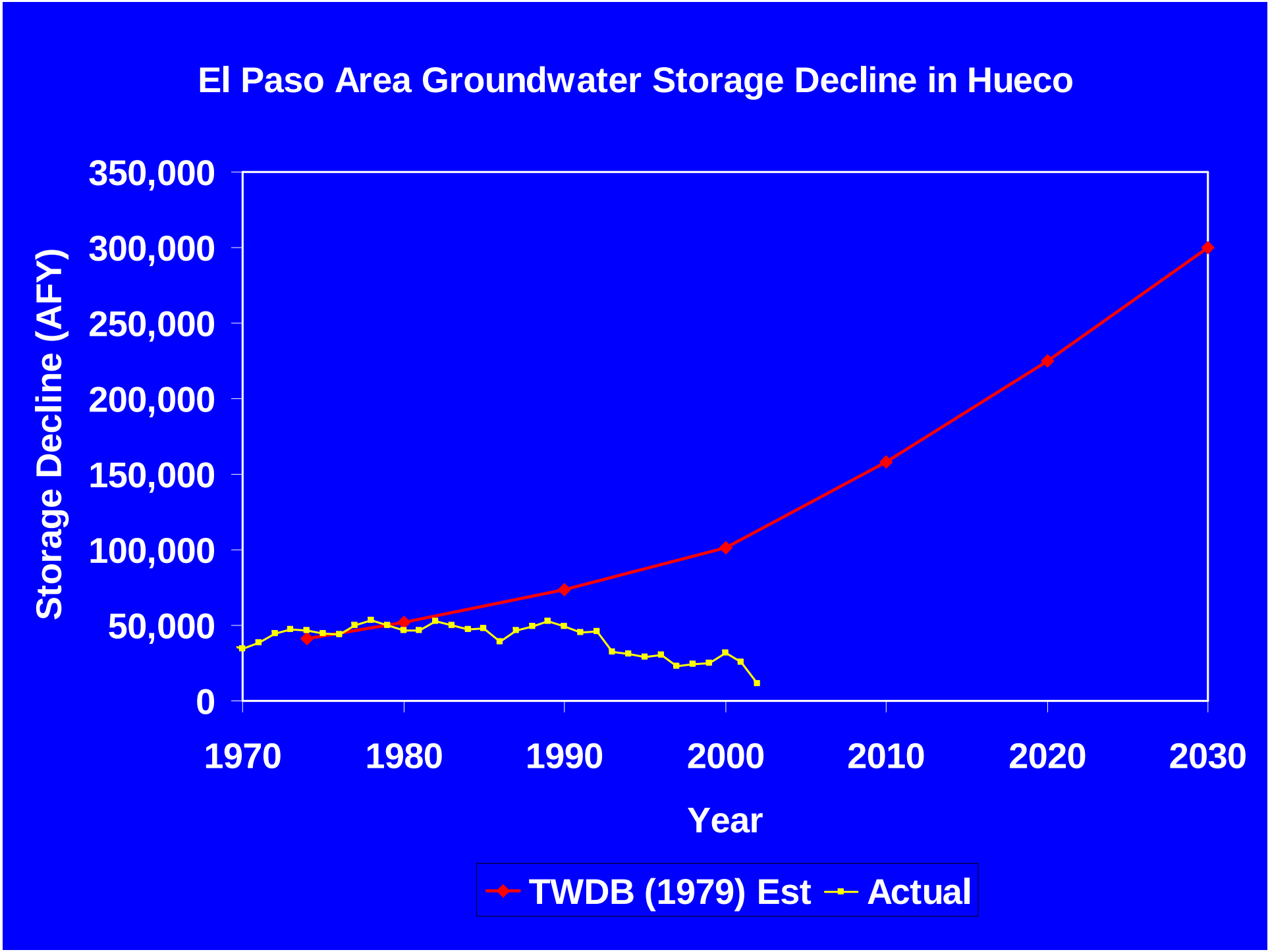

EPWU Surface Water Diversions
2008 Comparison
58,000 AF/yr
17,000 AF/yr
Surface Water Use (AFY)
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
1970
1980
1990
2000
2010
2020
2030
Year
TWDB (1979) Est
Actual

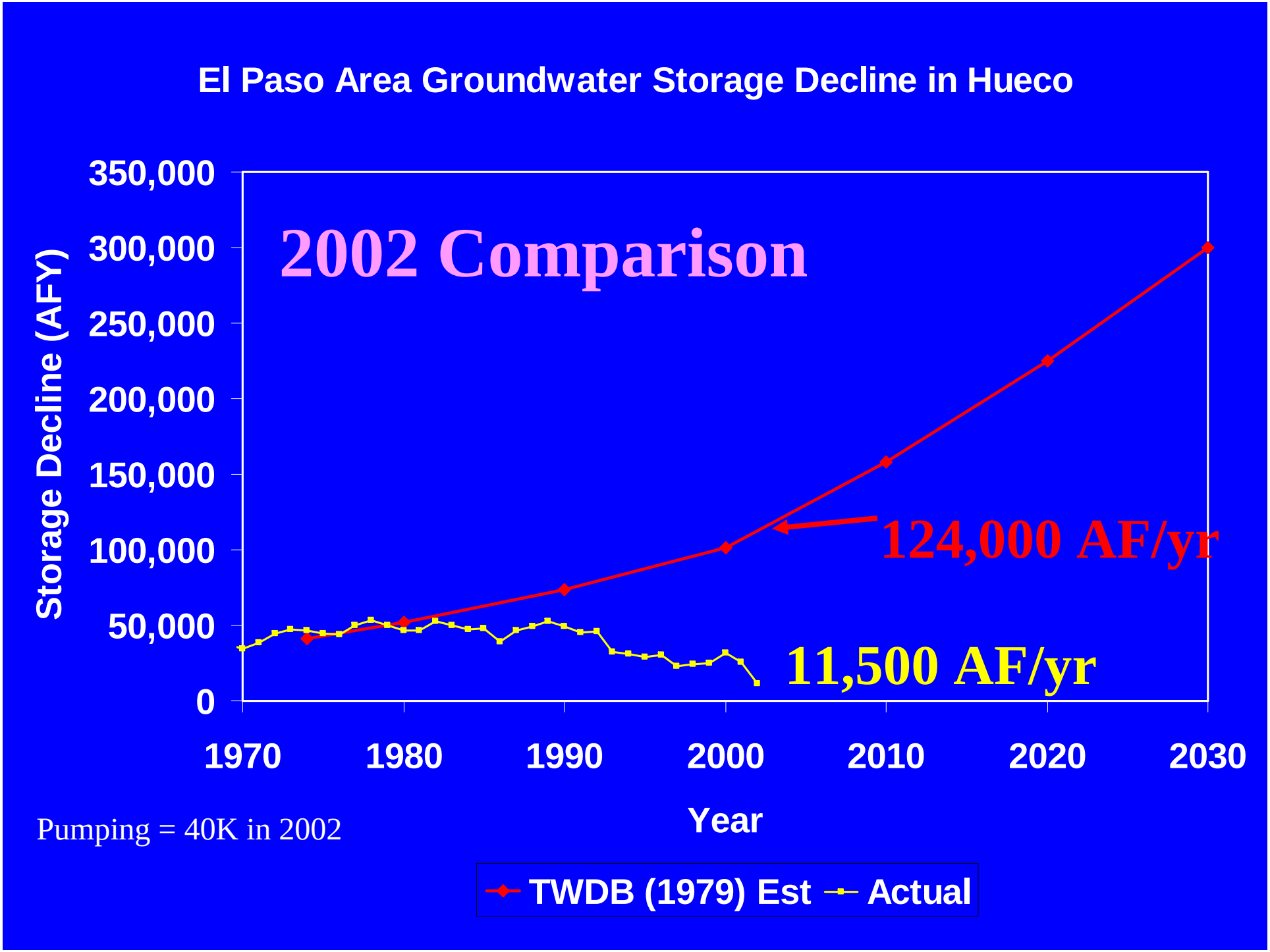

EPWU Hueco Groundwater Pumping
Groundwater Use (AFY)
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
1970
1980
1990
2000
2010
2020
2030
Year
TWDB (1979) Est
Actual


EPWU Hueco Groundwater Pumping
2008 Comparison
260,000 AF/yr
30,000 AF/yr
Groundwater Use (AFY)
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
1970
1980
1990
2000
2010
2020
2030
Year
TWDB (1979) Est
Actual

Summary of Supply & Demand After 1980

- Per Capita Demand Decreased
  - Total Demand in 2008 is about equal to total demand in early 1980s
- Surface Water Diversions Increased
- Groundwater Pumping Decreased


El Paso Area Groundwater Storage Decline in Hueco
Storage Decline (AFY)
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
1970
1980
1990
2000
2010
2020
2030
Year
TWDB (1979) Est
Actual


El Paso Area Groundwater Storage Decline in Hueco
2002 Comparison
124,000 AF/yr
11,500 AF/yr
Storage Decline (AFY)
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
1970
1980
1990
2000
2010
2020
2030
Year
Pumping = 40K in 2002
TWDB (1979) Est
Actual

Assessment of 1979 Conclusion

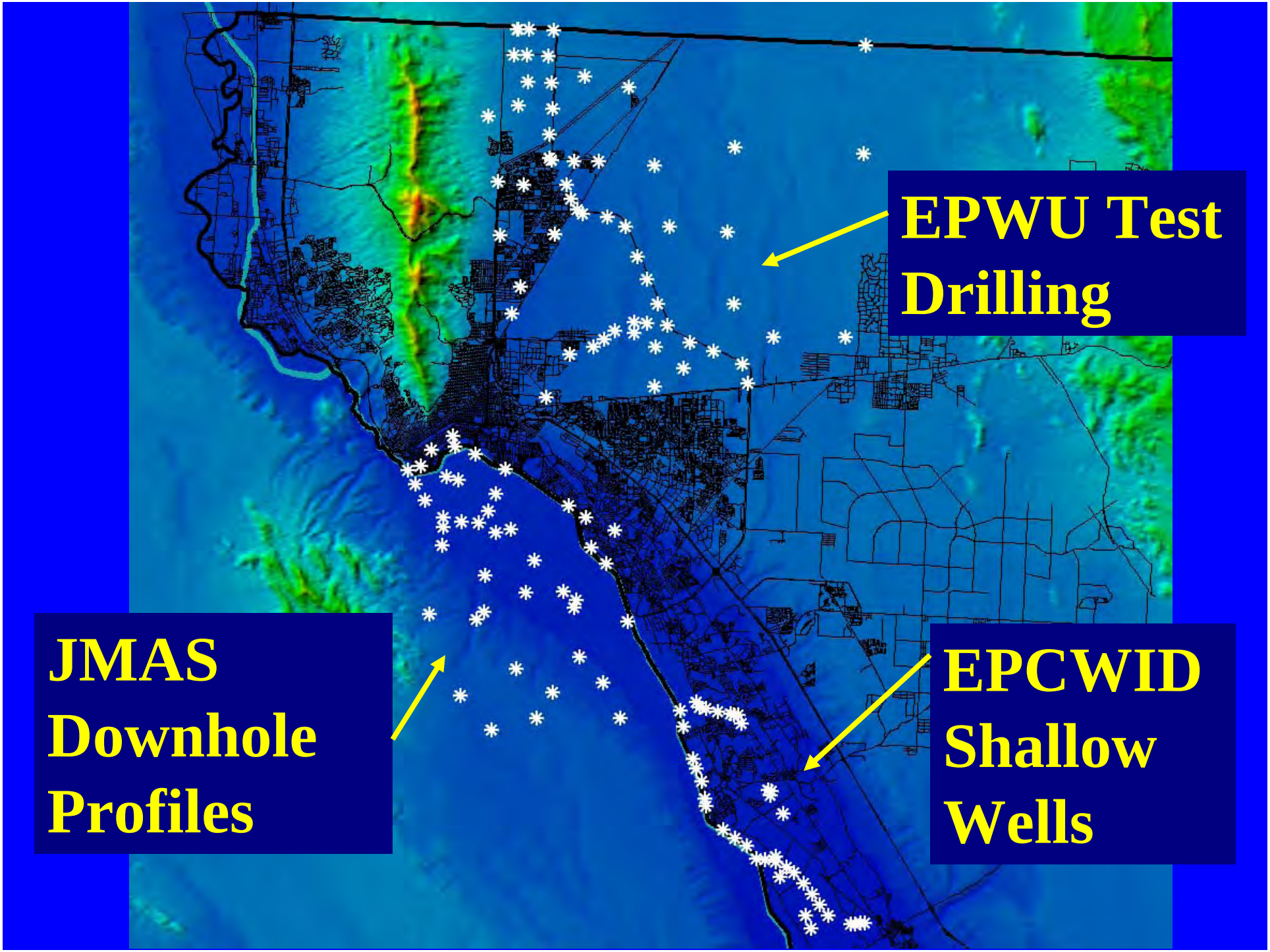
- Fundamental changes were initiated by PSB after publication of the report
- Pumping at rates assumed in 1979 would have resulted in severe problems

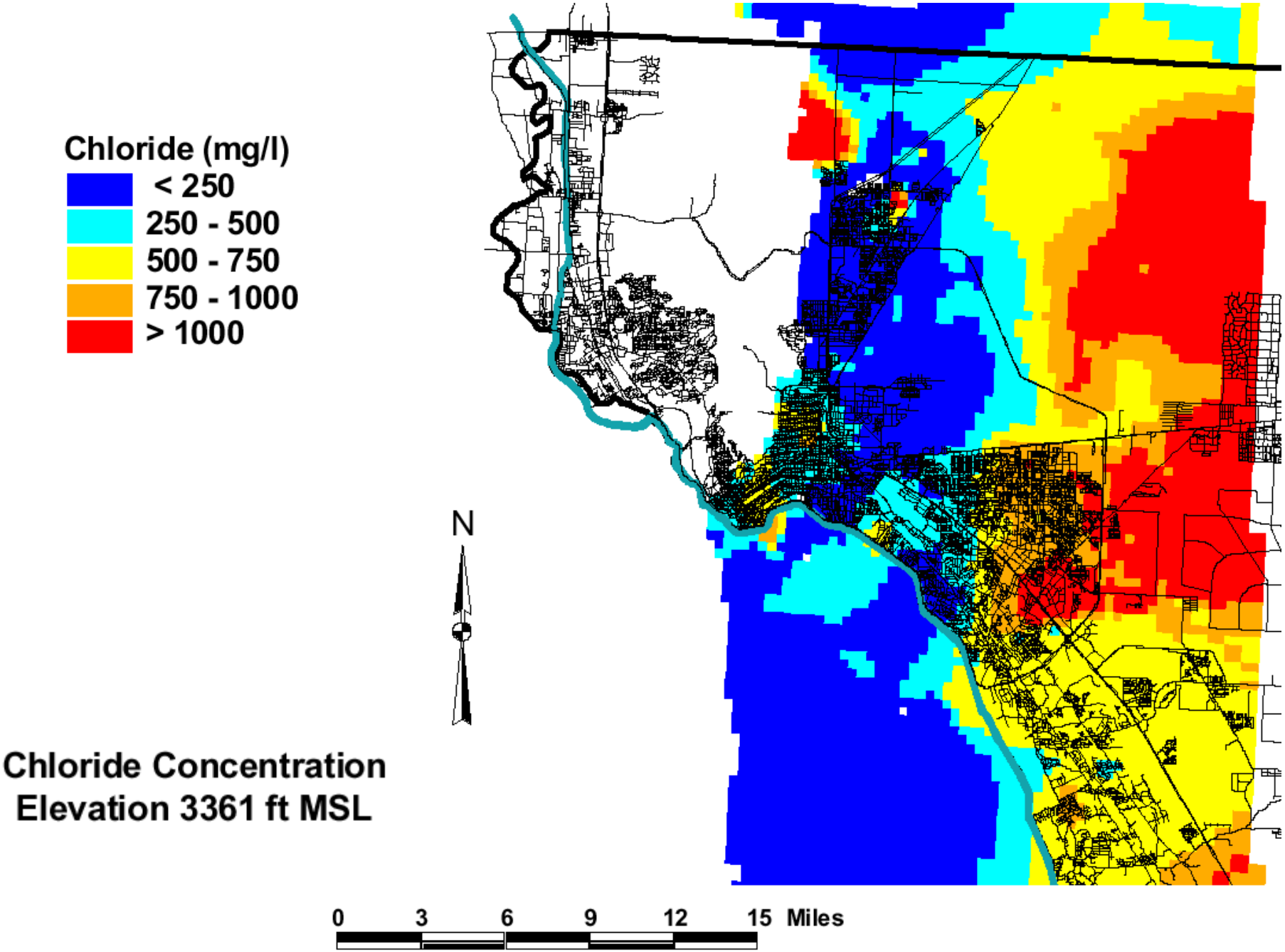
Assessment of 1979 Conclusion

- Fundamentals of the hydrogeology of Hueco was well understood in 1976 (USGS model)
- Resulting decrease in pumping resulted in stabilized groundwater levels
- Brackish groundwater intrusion remained an issue

3-Dimensional Groundwater Quality (2003-2004)

- New data to characterize groundwater quality in Hueco Bolson
- Test drilling (EPWU)
- Shallow drilling (EPCWID)
- Downhole profiles (JMAS)


EPWU Test Drilling
JMAS Downhole Profiles
EPCWID Shallow Wells



Chloride Concentration
Elevation 3361 ft MSL

Estimated Volume of Groundwater El Paso and Juarez Area (2002) (Million AF)

Chloride (mg/l)	Groundwater Storage in El Paso Area (million AF)	Groundwater Storage in Juarez Area (million AF)
< 250	9.4	8.5
250-500	7.0	2.7
500-750	5.3	0.4
750-1000	4.6	0.7
> 1000	19.2	0.9
Total	45.5	13.2

Fresh Groundwater Storage in El Paso

- USGS Estimate (1974)
  - 10.6 Million AF
- USGS Model (2003)
  - 1.2 Million AF storage decline (1974 to 2002)
- 10.6 – 1.2 = 9.4 Million AF
- Independent Analysis based on Actual Test Hole Data = 9.4 Million AF in 2002

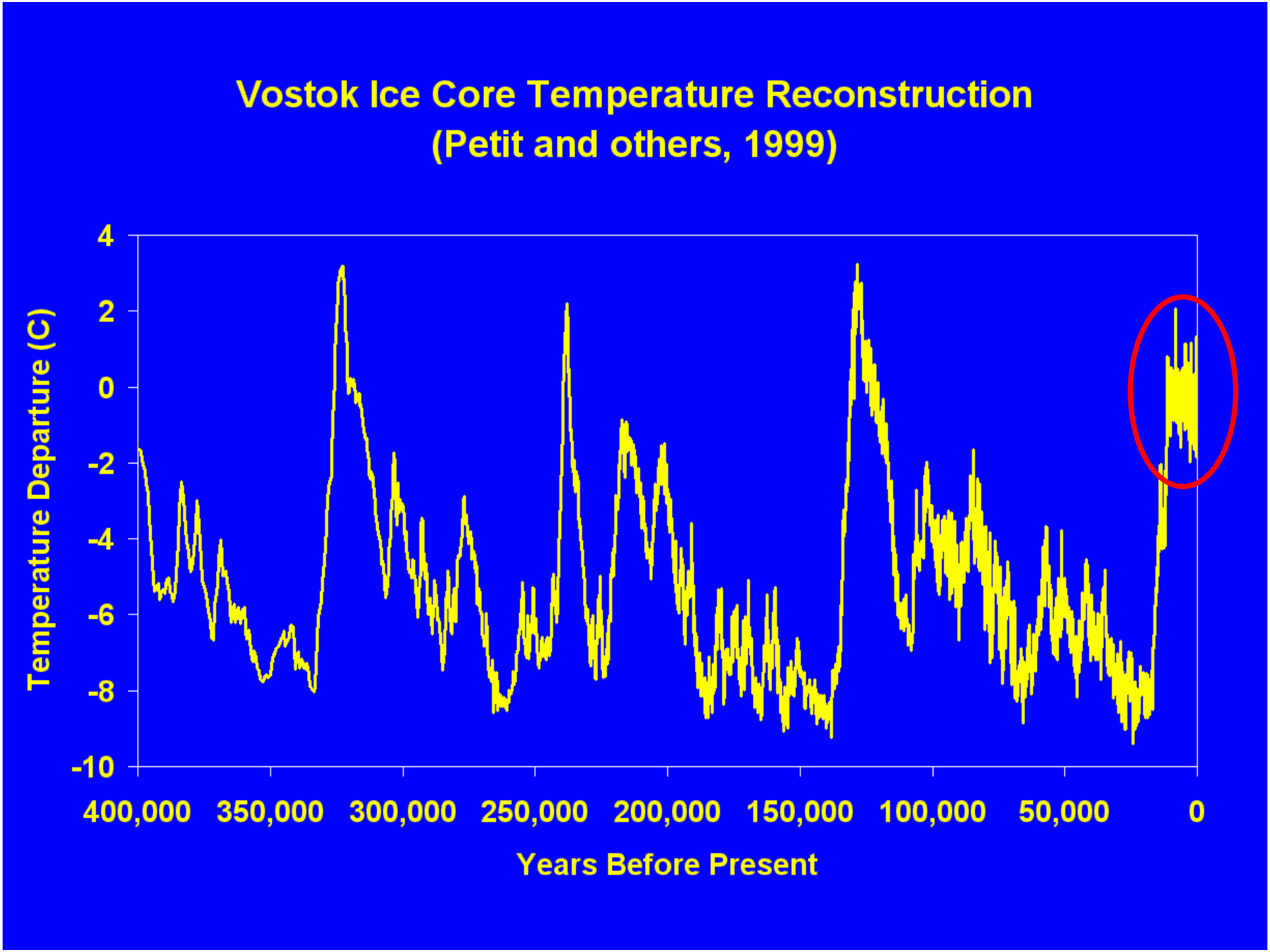
Potential Impacts of Climate Change

- Past actions have resulted in stabilization of groundwater levels
- El Paso's water infrastructure and water management approaches have been designed with climate variability in mind
- How will predicted climate change affect water management approaches and groundwater levels?

Climate Change in the Media

- "… global temperature is falling precipitously"
- "… the cooling in 2007 was even faster that in typical glacial transitions. If it continued for 20 years, the temperature would be 14°C cooler in 2027."
- "… my guess is that the odds are at least 50-50 that we will see significant cooling rather than warming in coming decades"

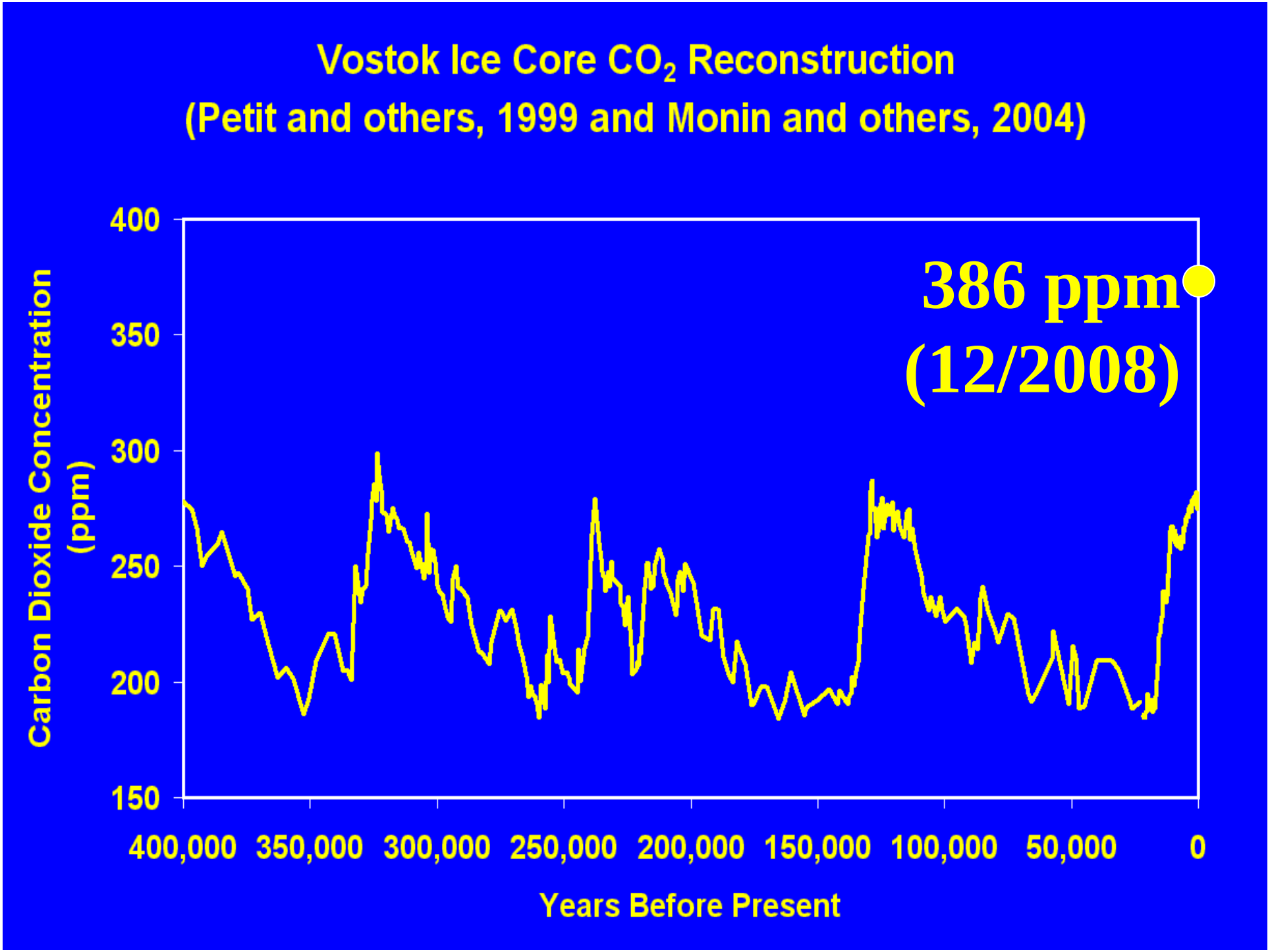
Phil Chapman, geophysicist and former astronaut as quoted in The Australian, 4/23/2008


Vostok Ice Core Temperature Reconstruction
(Petit and others, 1999)
Temperature Departure (C)
4
2
0
-2
-4
-6
-8
-10
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
Years Before Present

Climate Change in the Media

- "We'll be eight degrees hotter in 30 to 40 years and basically none of the crops will grow"
- "Most of the people will have died and the rest of us will be cannibals"
- "Civilization will have broken down. The few people left will be living in a failed state – like Somalia or Sudan – and living conditions will be intolerable"

Ted Turner as quoted in Atlanta Constitution-Journal 4/3/2008


Vostok Ice Core CO_2 Reconstruction
(Petit and others, 1999 and Monin and others, 2004)
386 ppm
(12/2008)
Carbon Dioxide Concentration (ppm)
400
350
300
250
200
150
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
Years Before Present

Climate Change and Water Management

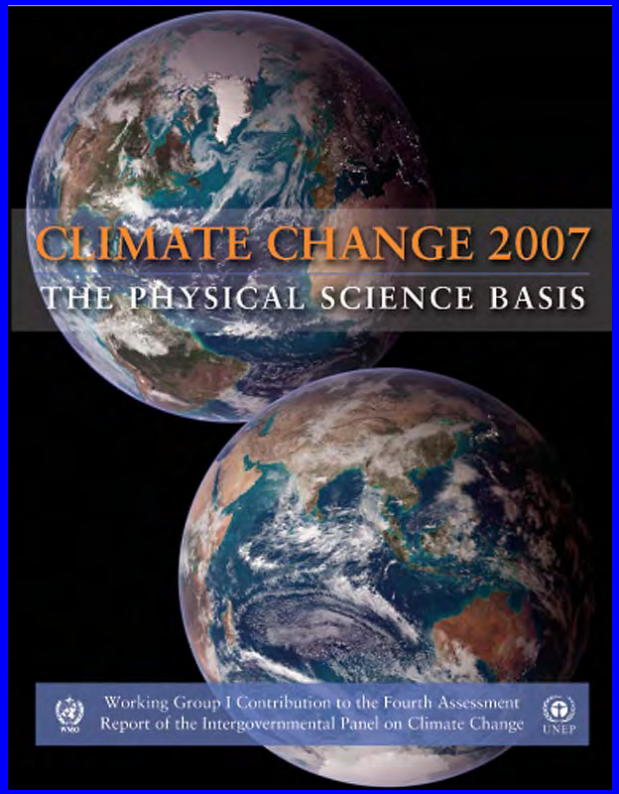
- Climate change:
  - Natural variability
  - Increase in greenhouse gases

Objective

- Evaluate vulnerability of El Paso's water infrastructure to climate change:
  - Wetter/Drier
  - Hotter/Cooler
  - More Variable/Less Variable

Intergovernmental Panel on Climate Change (IPCC, 2007)

- 21 General Circulation Models
  - Temperature
  - Precipitation
- Cited literature
- Website to access data used in report



Qualitative Assessment

- Increased Temperatures
  - Increase in EB Evaporation
  - Decrease in EB Storage
  - Decrease in EB Outflow
  - Decrease in EPWU Diversion
  - Increase in EPWU Pumping
  - Decrease in Groundwater Levels

Qualitative Assessment

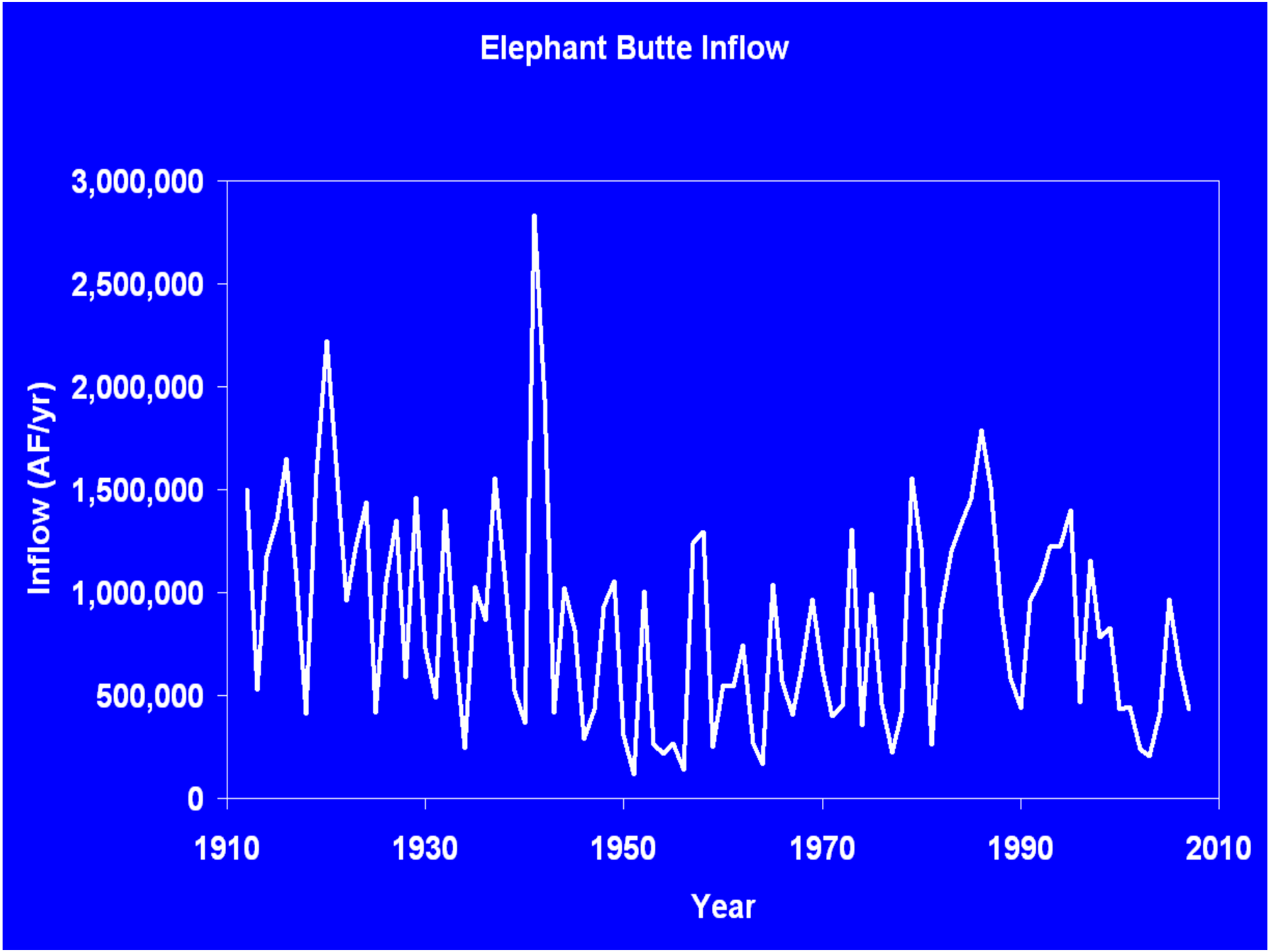
- Decreased Precipitation in Upper Reaches of RG Watershed
  - Decrease in EB Inflow
  - Decrease in EB Outflow
  - Decrease in EPWU Diversion
  - Increase in EPWU Pumping
  - Decrease in Groundwater Levels

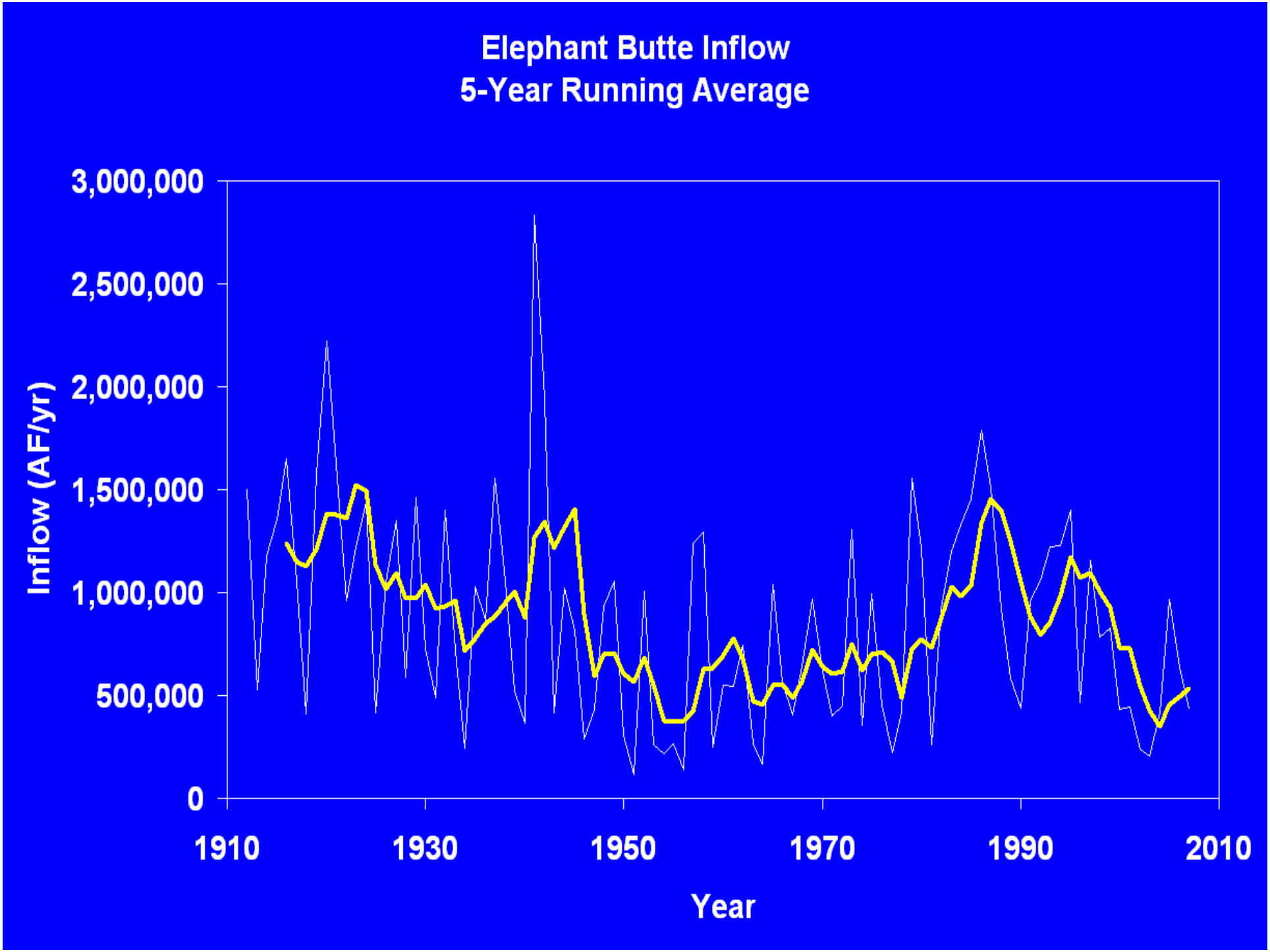
Quantitative Assessment

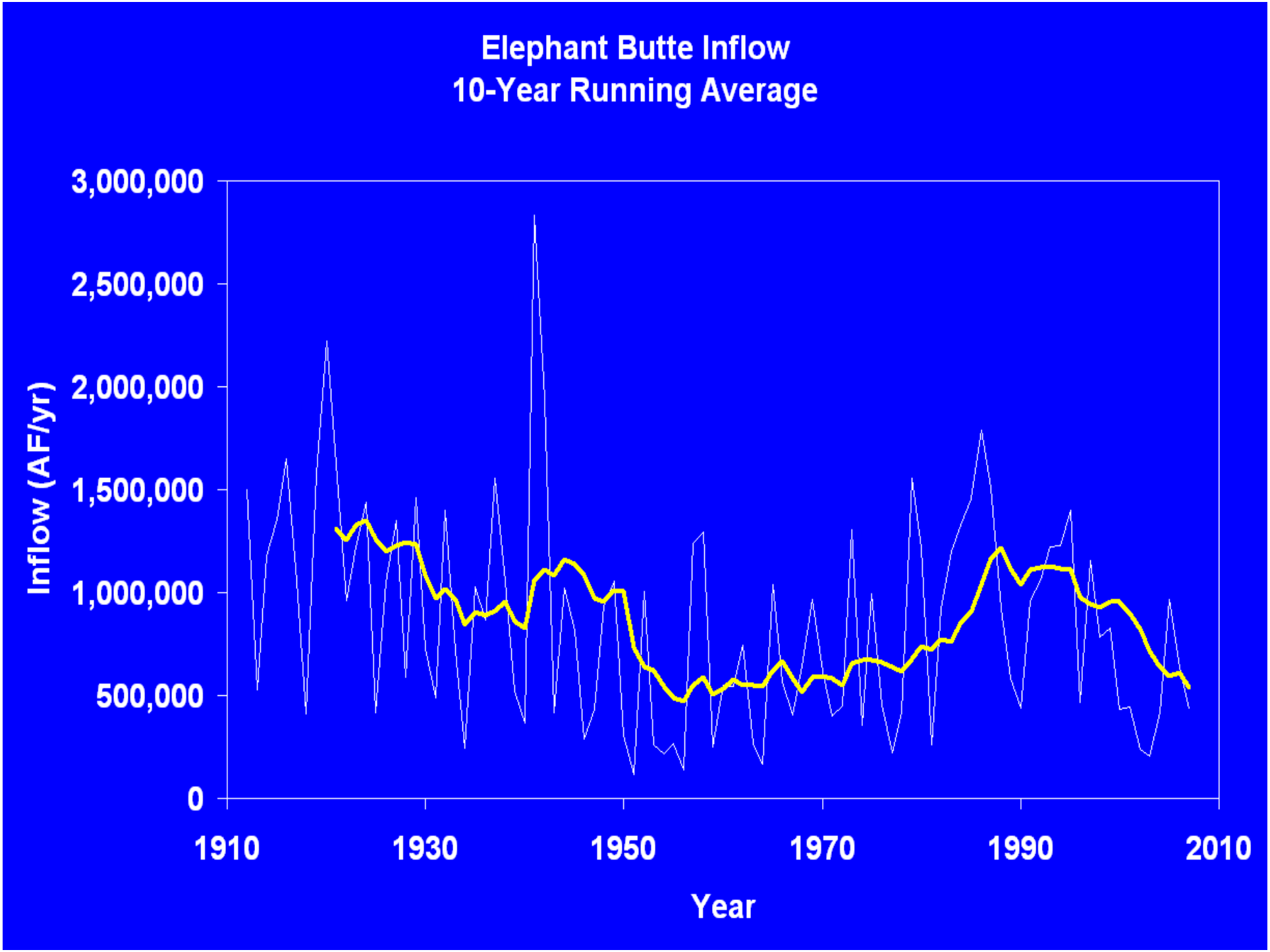
- Use IPCC report and associated data
- Evaluate natural variation and impacts of IPCC predictions on
  - EB Inflow
  - EB Evaporation
  - EB Outflow
  - EPWU Diversions
  - EPWU Pumping
  - Groundwater Levels/Groundwater Storage

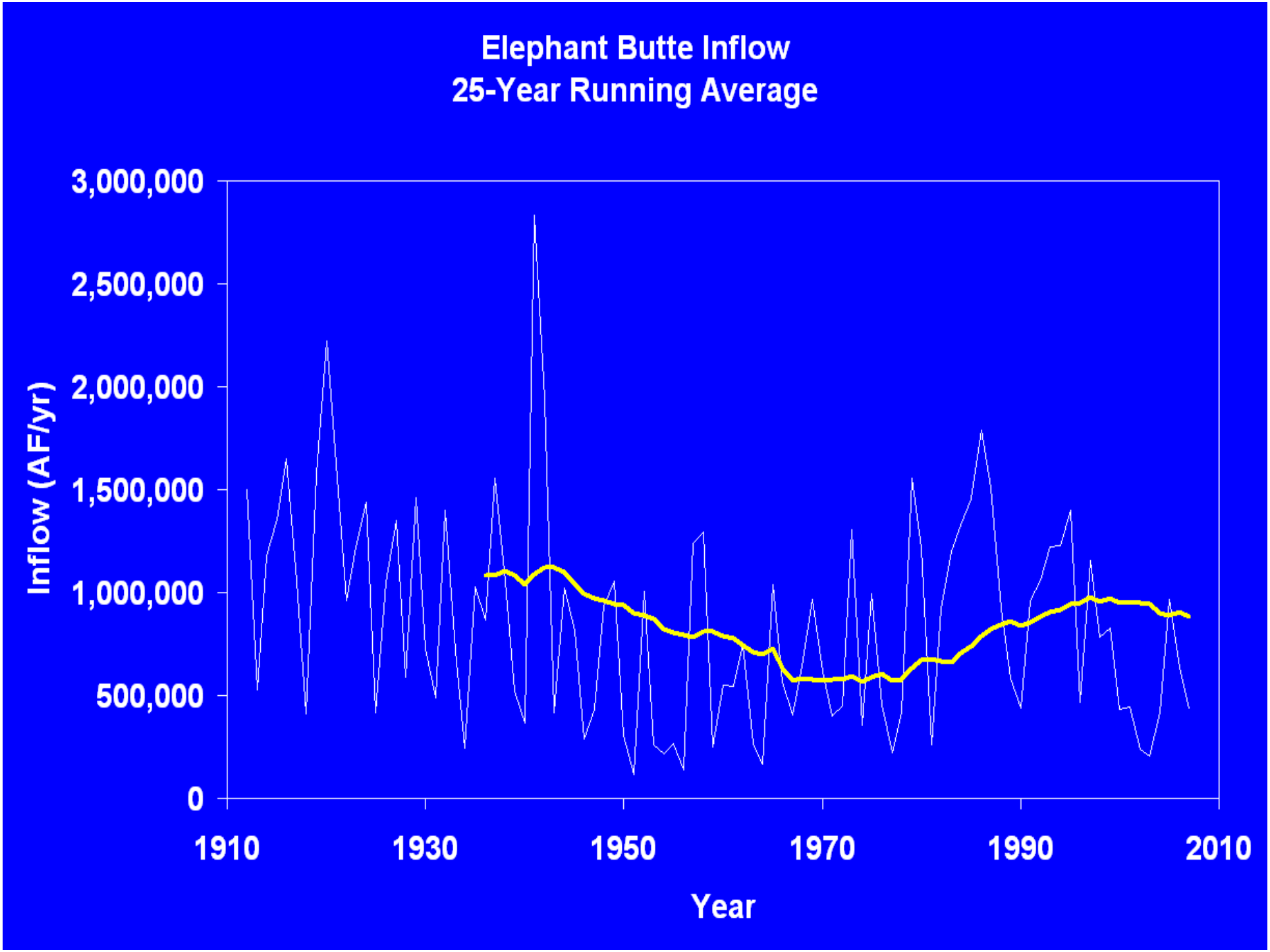
Elephant Butte Inflow

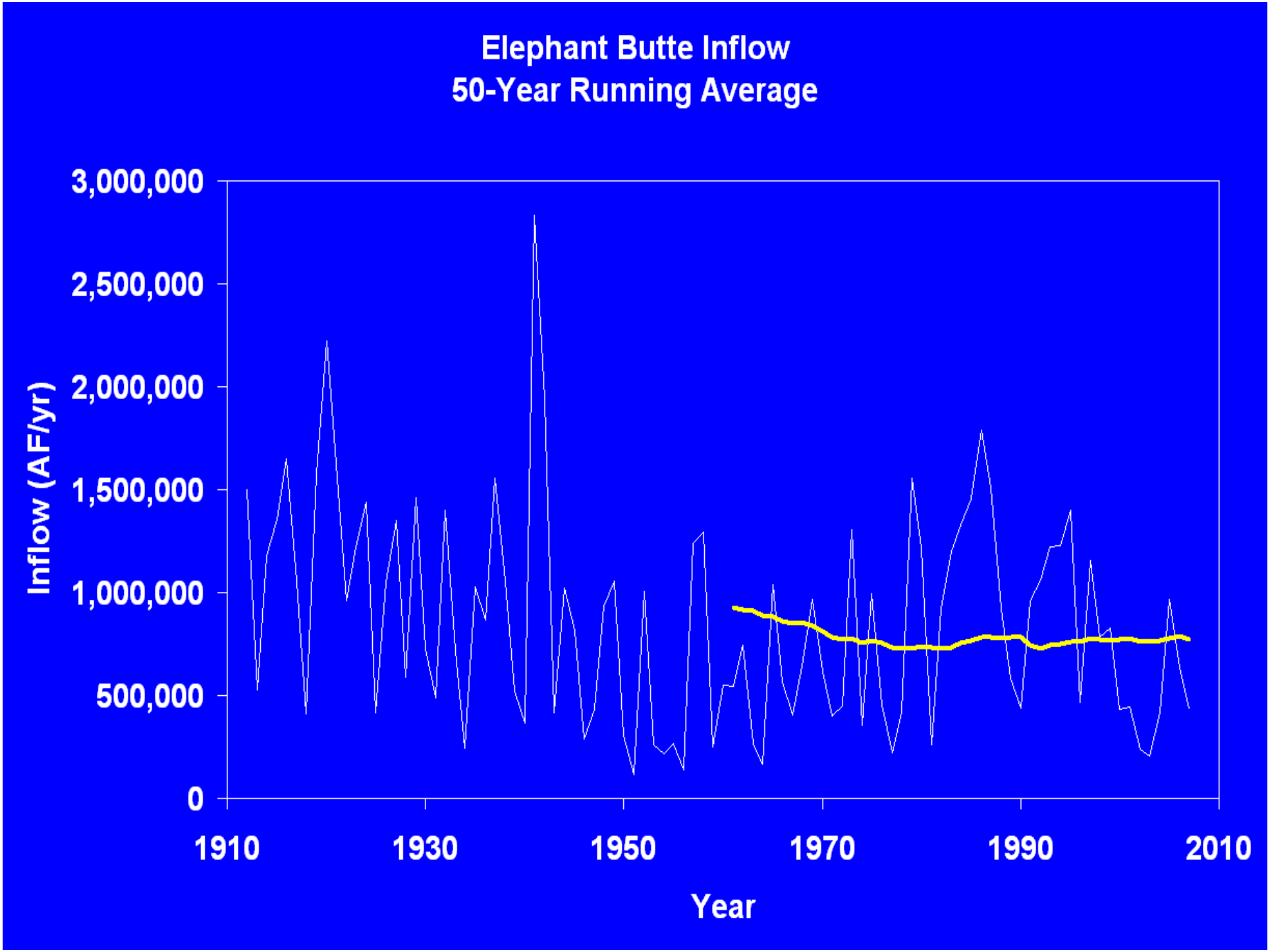
- Historic (1912 to 2007)
- Simulated (1001 to 2007)


Elephant Butte Inflow
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
Inflow (AF/yr)
1910
1930
1950
1970
1990
2010
Year


Elephant Butte Inflow
5-Year Running Average
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
Inflow (AF/yr)
1910
1930
1950
1970
1990
2010
Year


Elephant Butte Inflow
10-Year Running Average
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
Inflow (AF/yr)
1910
1930
1950
1970
1990
2010
Year


Elephant Butte Inflow
25-Year Running Average
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
Inflow (AF/yr)
1910
1930
1950
1970
1990
2010
Year


Elephant Butte Inflow
50-Year Running Average
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
Inflow (AF/yr)
1910
1930
1950
1970
1990
2010
Year

Ni and others (2002)

- Estimated cool-season precipitation from tree rings in NM and AZ
- 1000 to 1988
- Used Data from Northern New Mexico to reconstruct EB inflow

Regression Equation

$$\text{EB Inflow} = 0.18(\text{PCP-1})^3 + 0.46(\text{PCP})^3$$

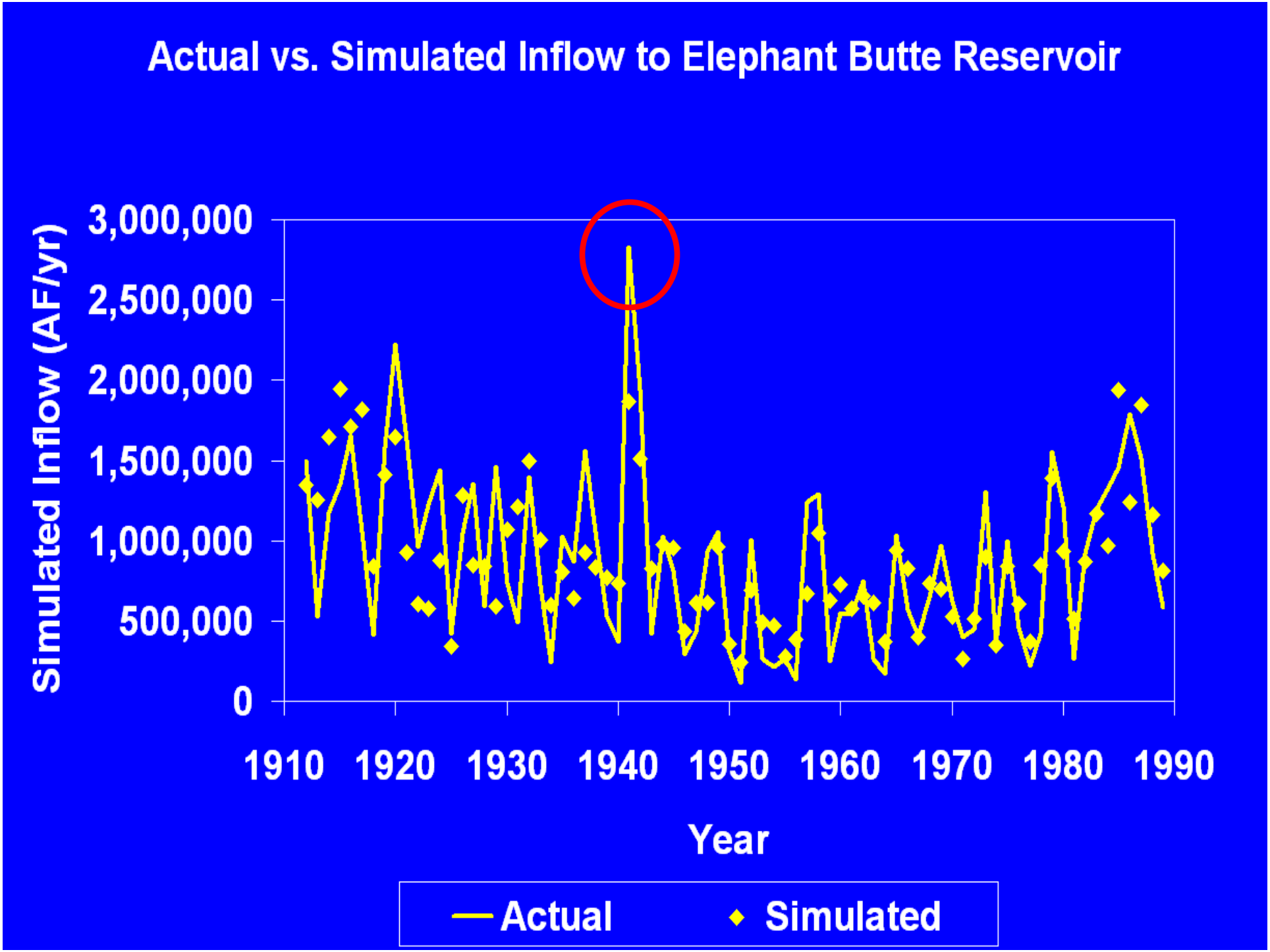
where:

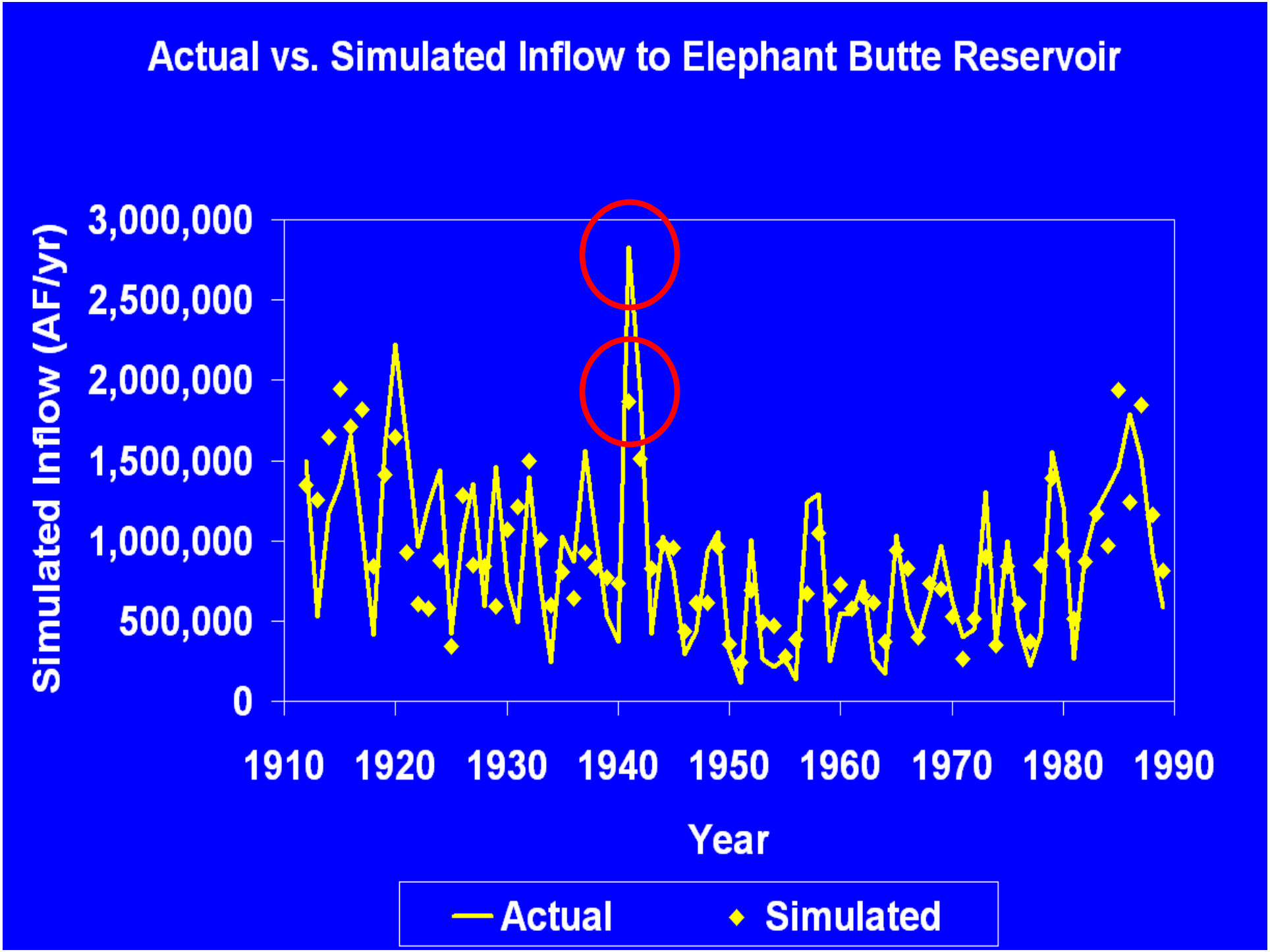
EB Inflow = Elephant Butte Inflow (AF/yr)

PCP = Annual Precipitation (% Average)

PCP-1 = Annual Precipitation from the preceding year (% Average)

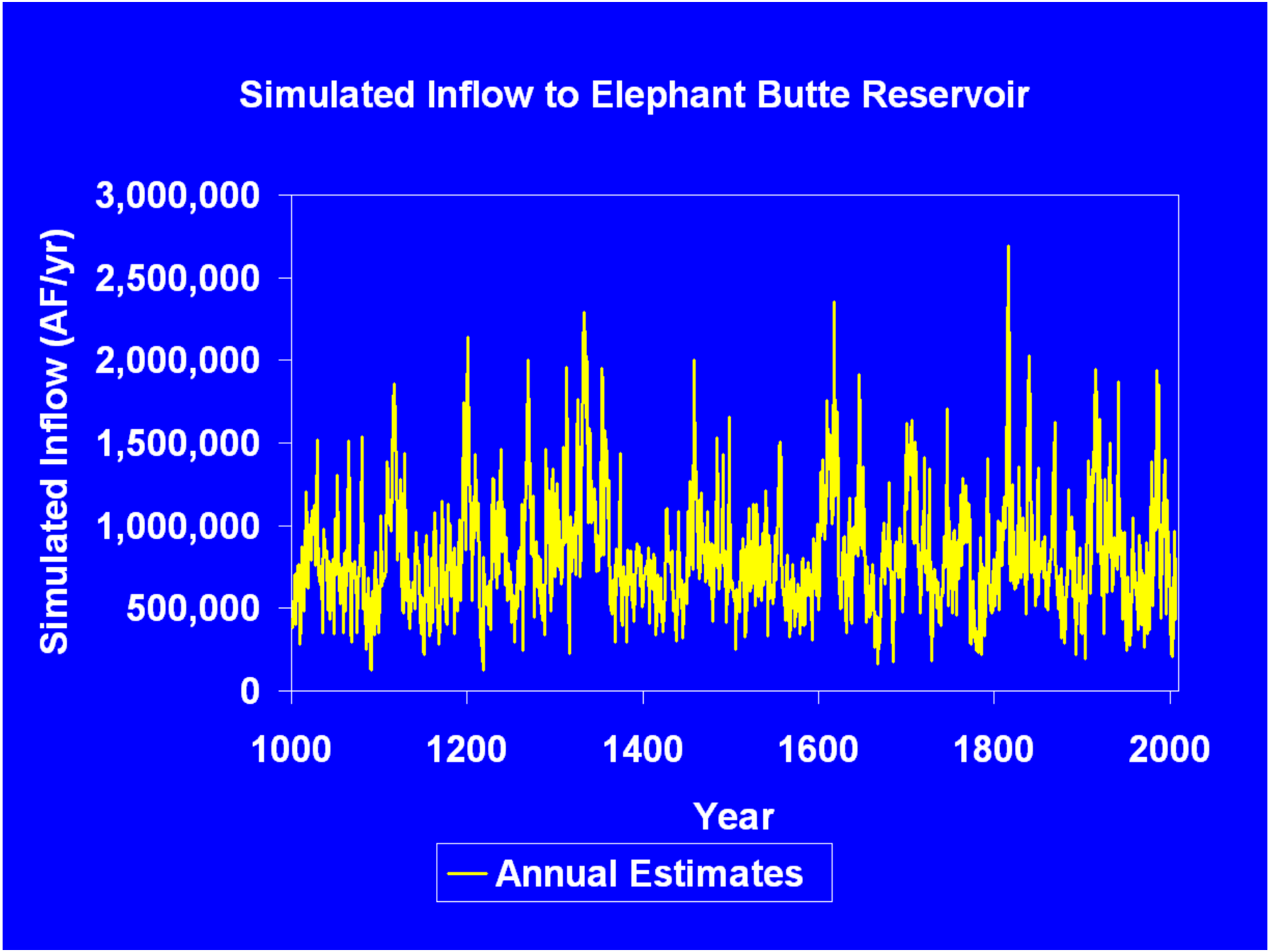
Adjusted $r^2 = 0.821$

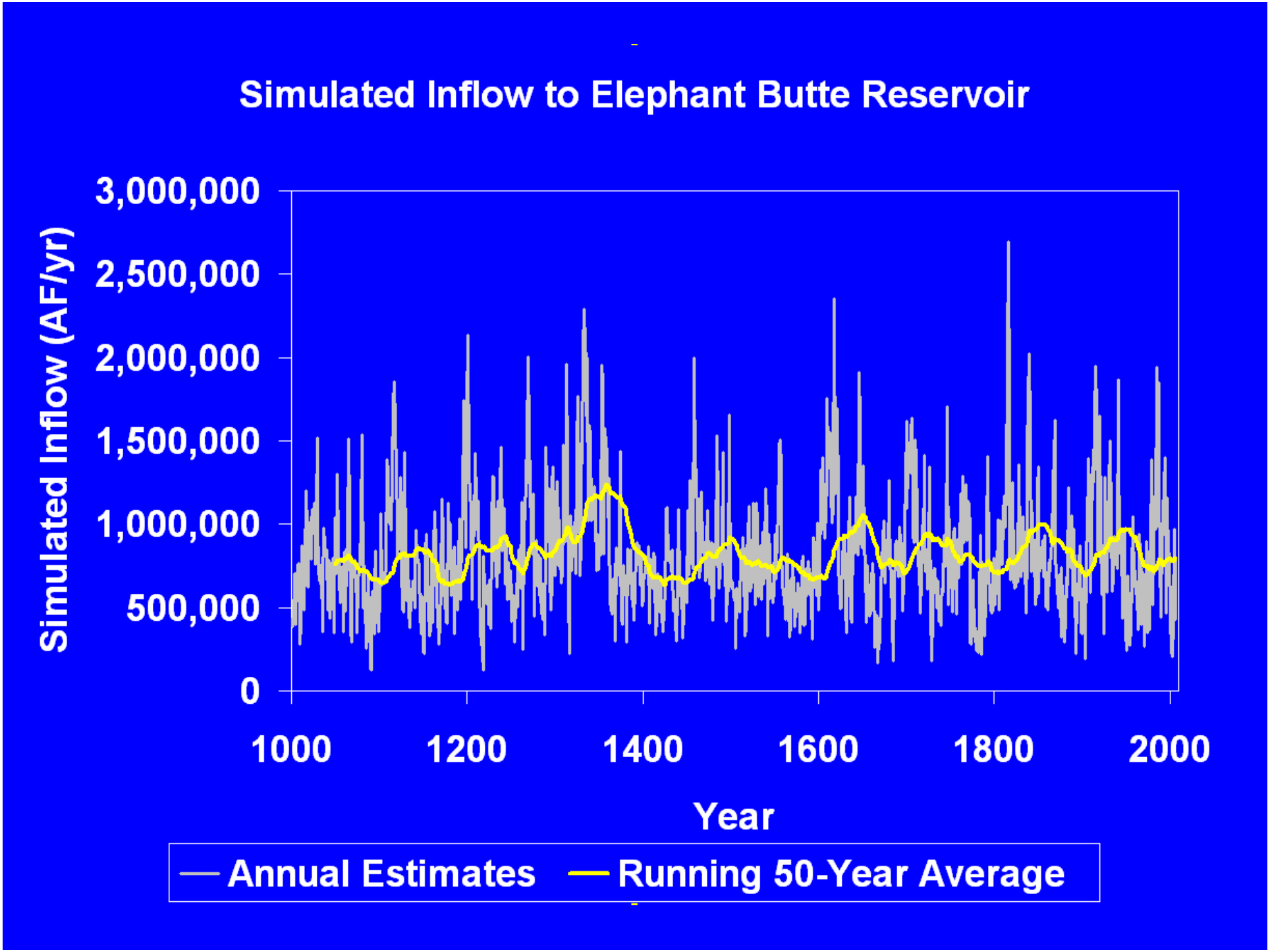

Actual vs. Simulated Inflow to Elephant Butte Reservoir
Simulated Inflow (AF/yr)
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
1910
1920
1930
1940
1950
1960
1970
1980
1990
Year
Actual
Simulated

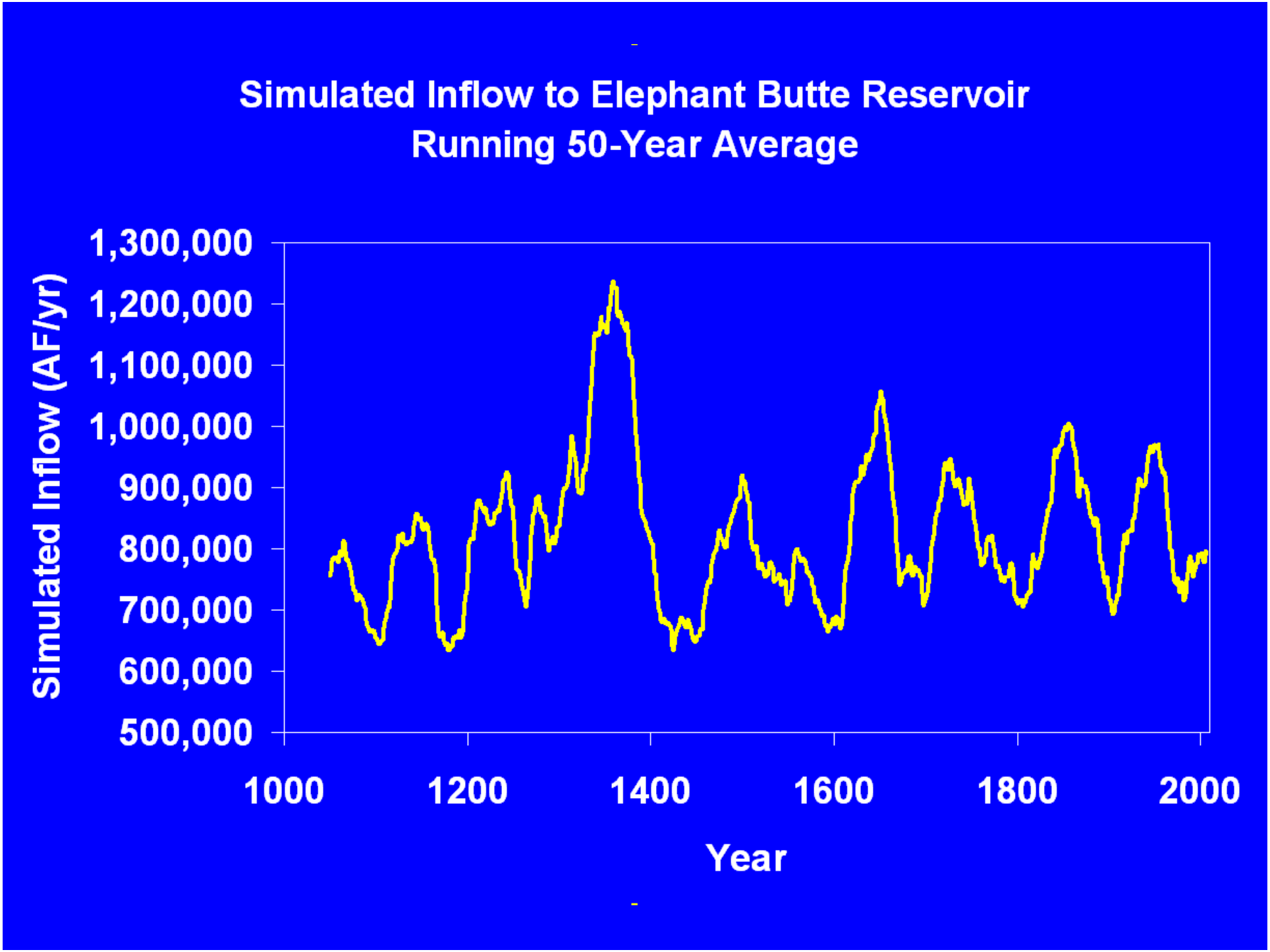

Actual vs. Simulated Inflow to Elephant Butte Reservoir
Simulated Inflow (AF/yr)
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
1910
1920
1930
1940
1950
1960
1970
1980
1990
Year
Actual
Simulated

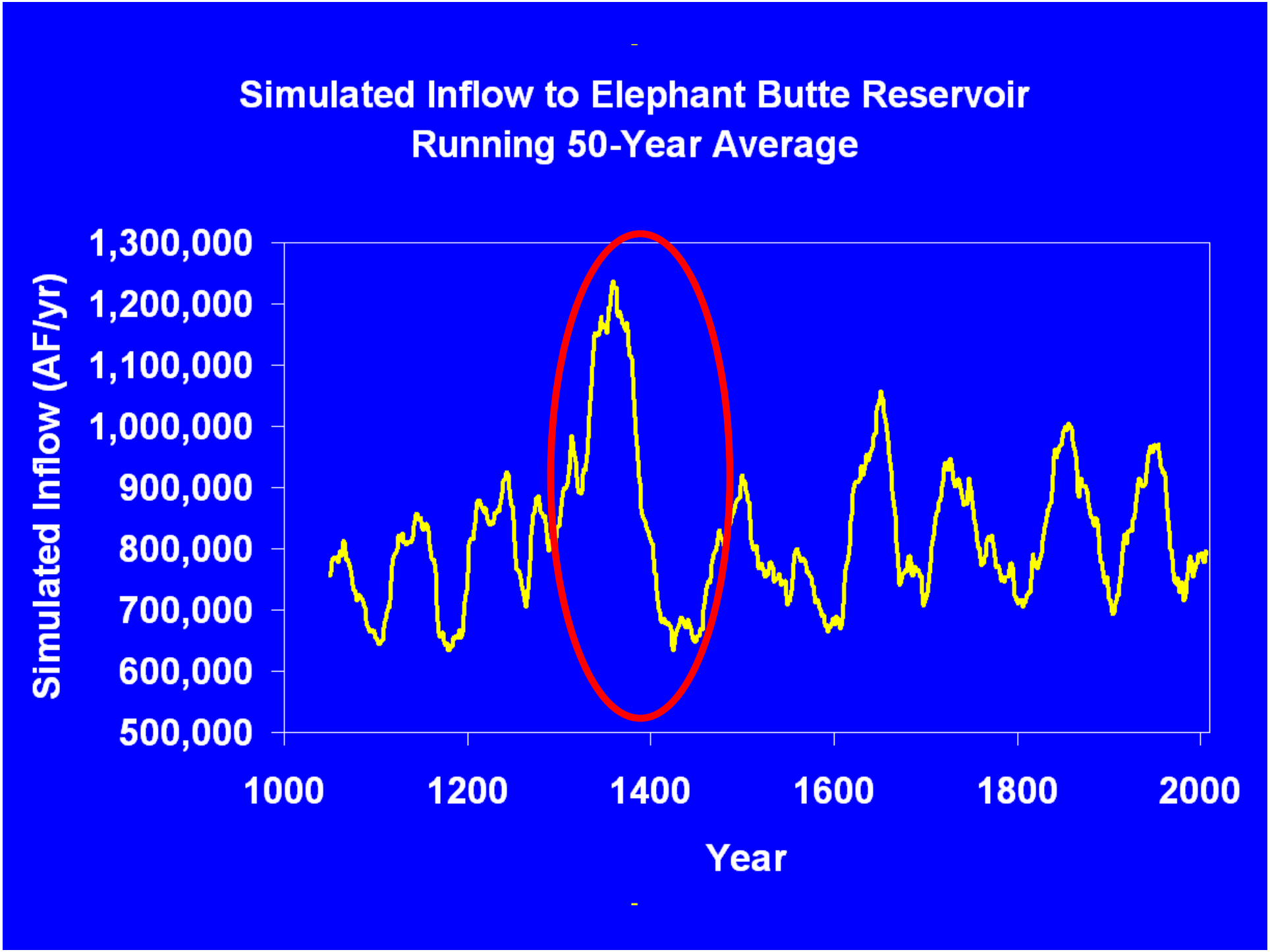
Simulated Elephant Butte Inflows

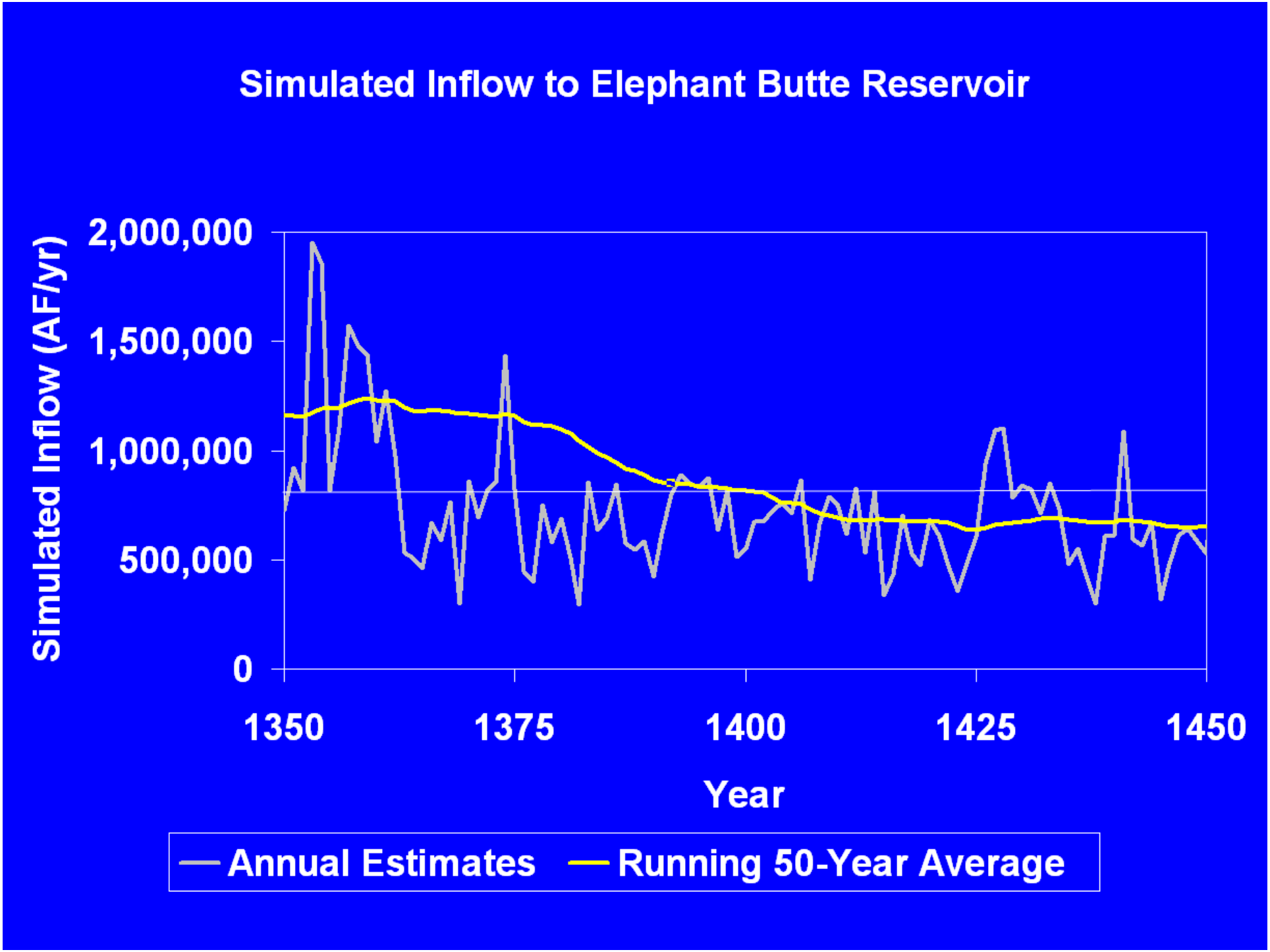
- Regression Equation (1001 to 1989)
- Actual Data (1990 to 2007)

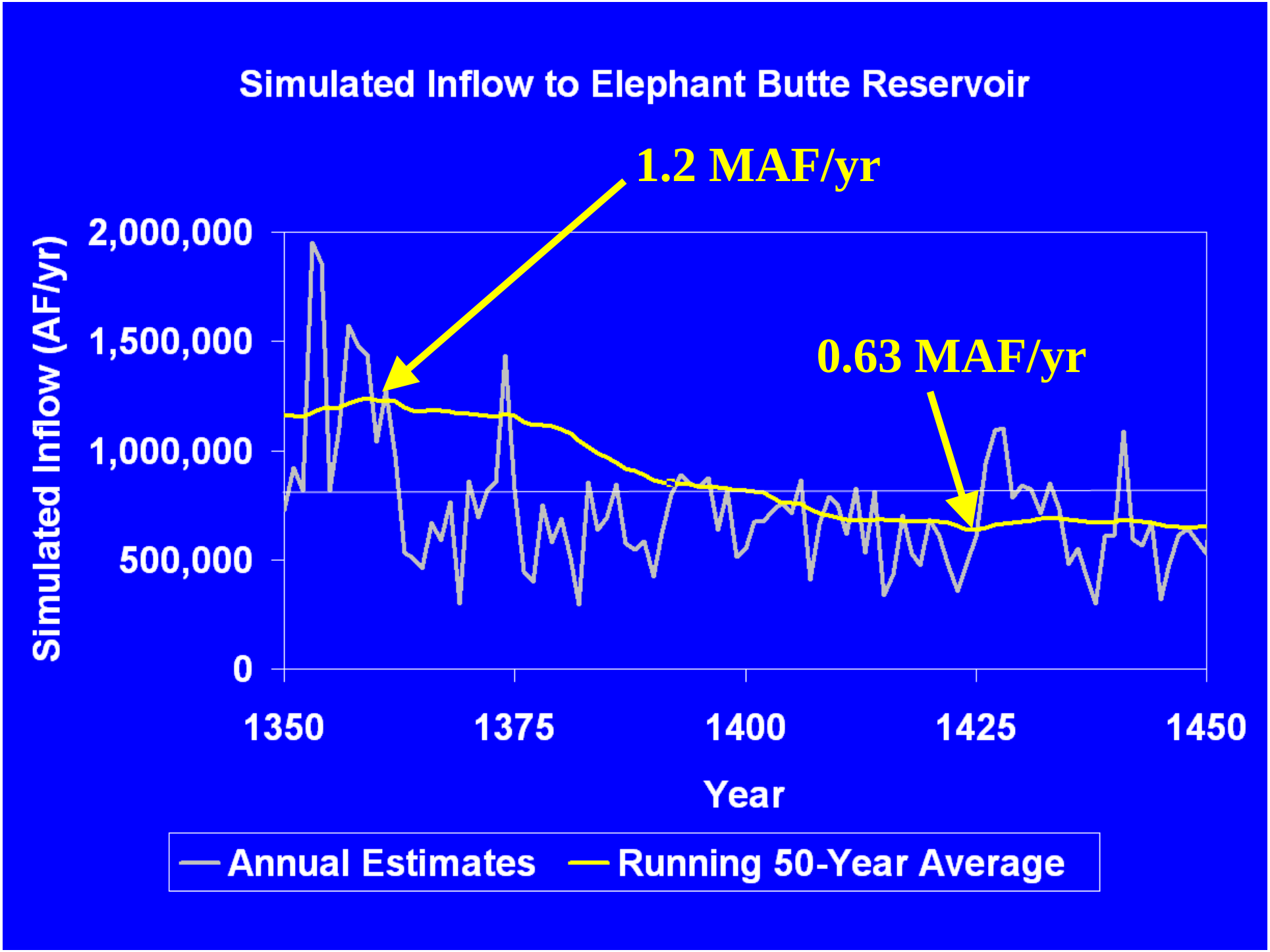

Simulated Inflow to Elephant Butte Reservoir
Simulated Inflow (AF/yr)
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
1000
1200
1400
1600
1800
2000
Year
Annual Estimates


Simulated Inflow to Elephant Butte Reservoir
Simulated Inflow (AF/yr)
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
1000
1200
1400
1600
1800
2000
Year
Annual Estimates
Running 50-Year Average


Simulated Inflow to Elephant Butte Reservoir
Running 50-Year Average
Simulated Inflow (AF/yr)
1,300,000
1,200,000
1,100,000
1,000,000
900,000
800,000
700,000
600,000
500,000
1000
1200
1400
1600
1800
2000
Year


Simulated Inflow to Elephant Butte Reservoir
Running 50-Year Average
Simulated Inflow (AF/yr)
1,300,000
1,200,000
1,100,000
1,000,000
900,000
800,000
700,000
600,000
500,000
1000
1200
1400
1600
1800
2000
Year


Simulated Inflow to Elephant Butte Reservoir
Simulated Inflow (AF/yr)
2,000,000
1,500,000
1,000,000
500,000
0
1350
1375
1400
1425
1450
Year
Annual Estimates
Running 50-Year Average


Simulated Inflow to Elephant Butte Reservoir
1.2 MAF/yr
0.63 MAF/yr
Simulated Inflow (AF/yr)
2,000,000
1,500,000
1,000,000
500,000
0
1350
1375
1400
1425
1450
Year
Annual Estimates
Running 50-Year Average

Simulated EB Inflow (1001-2007)

- 958 50-Year Periods

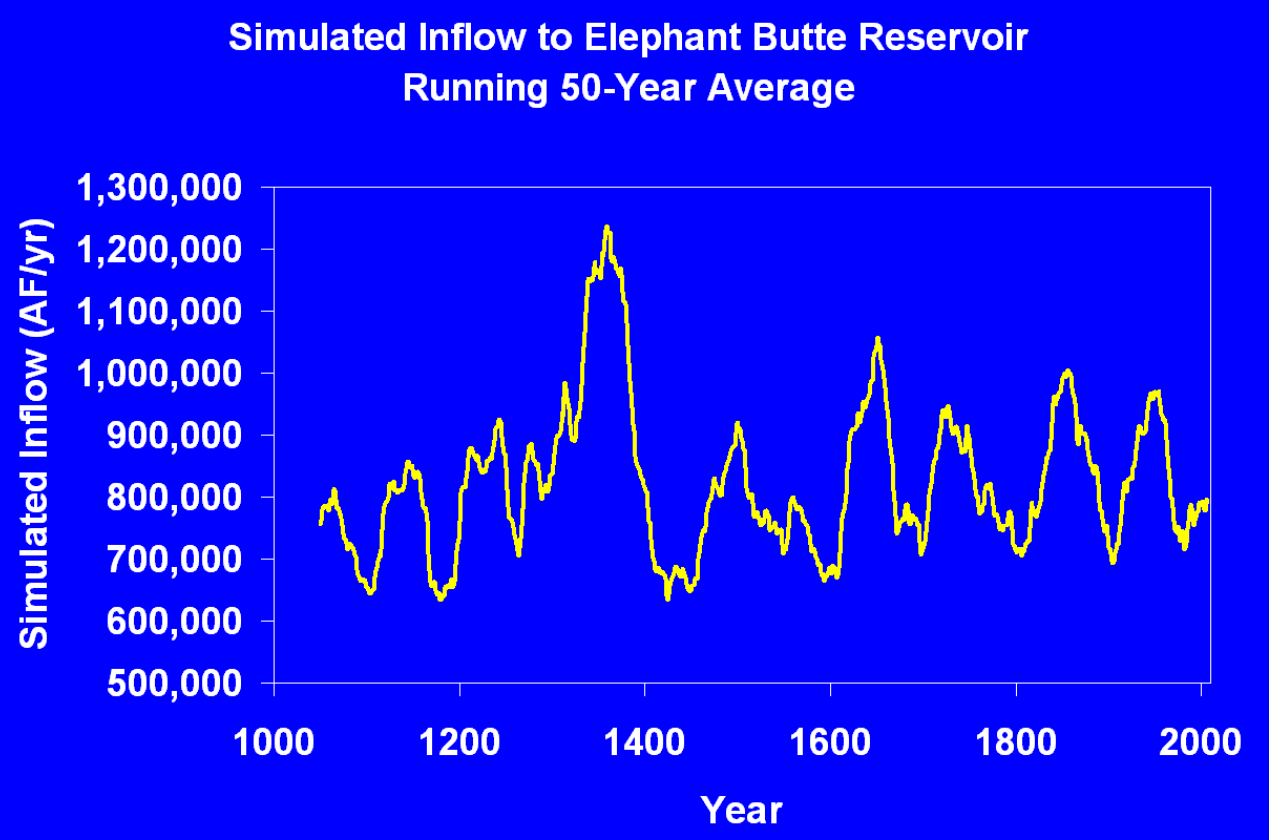
  1001 to 1050

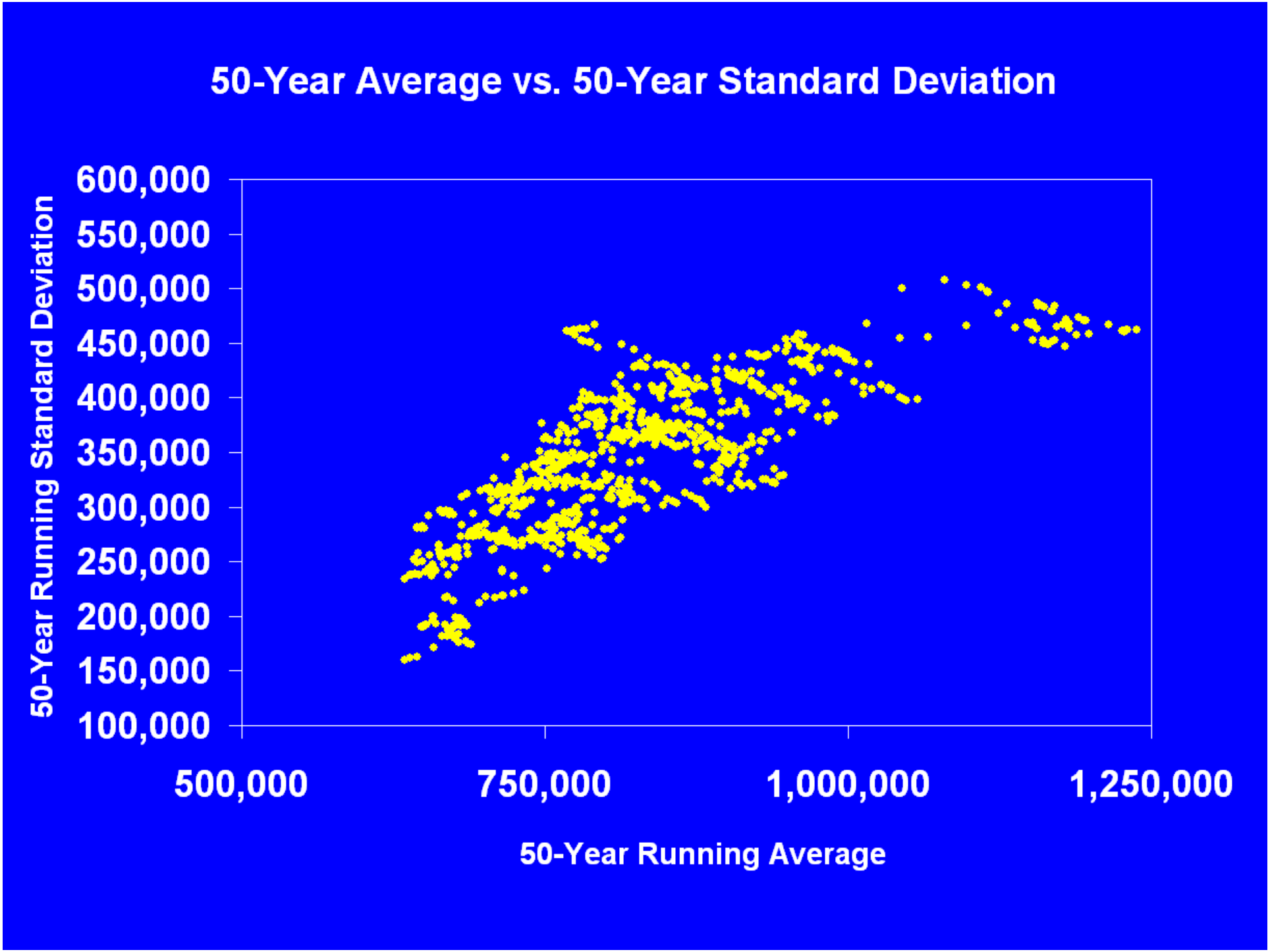
  1002 to 1051

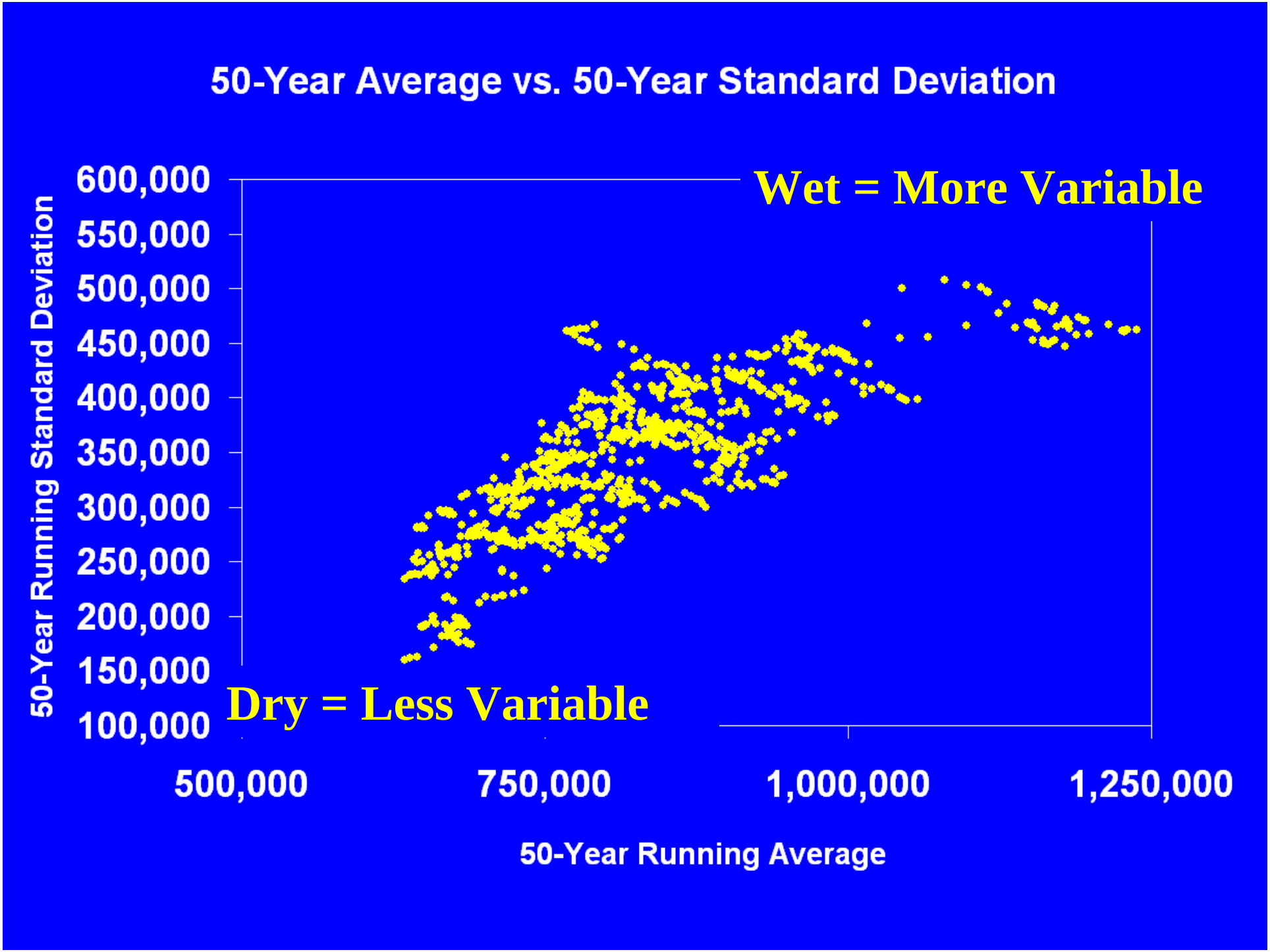
  ⋮

  1957 to 2006

  1958 to 2007



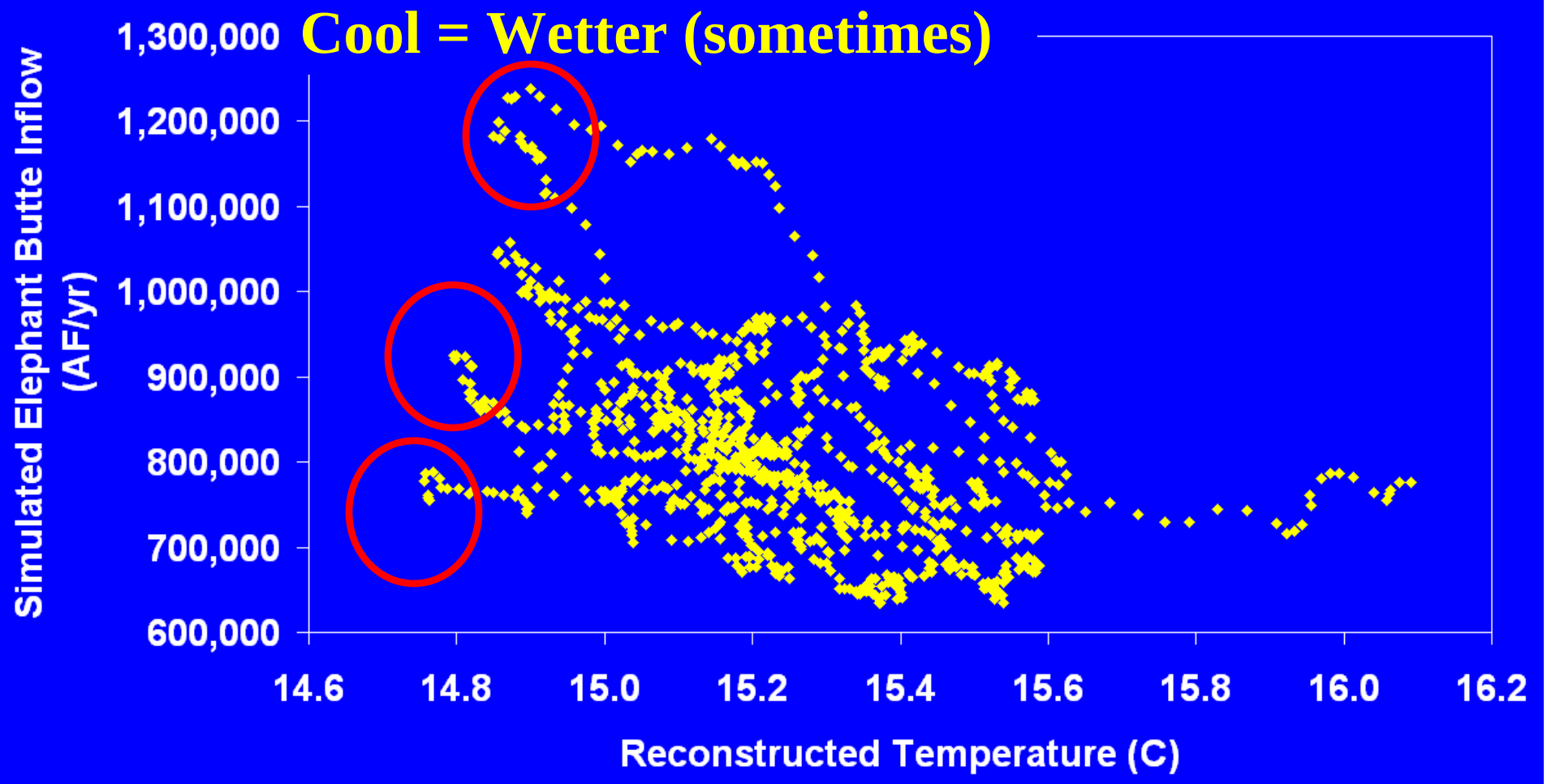

50-Year Average vs. 50-Year Standard Deviation
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50-Year Running Standard Deviation
500,000
750,000
1,000,000
1,250,000
50-Year Running Average

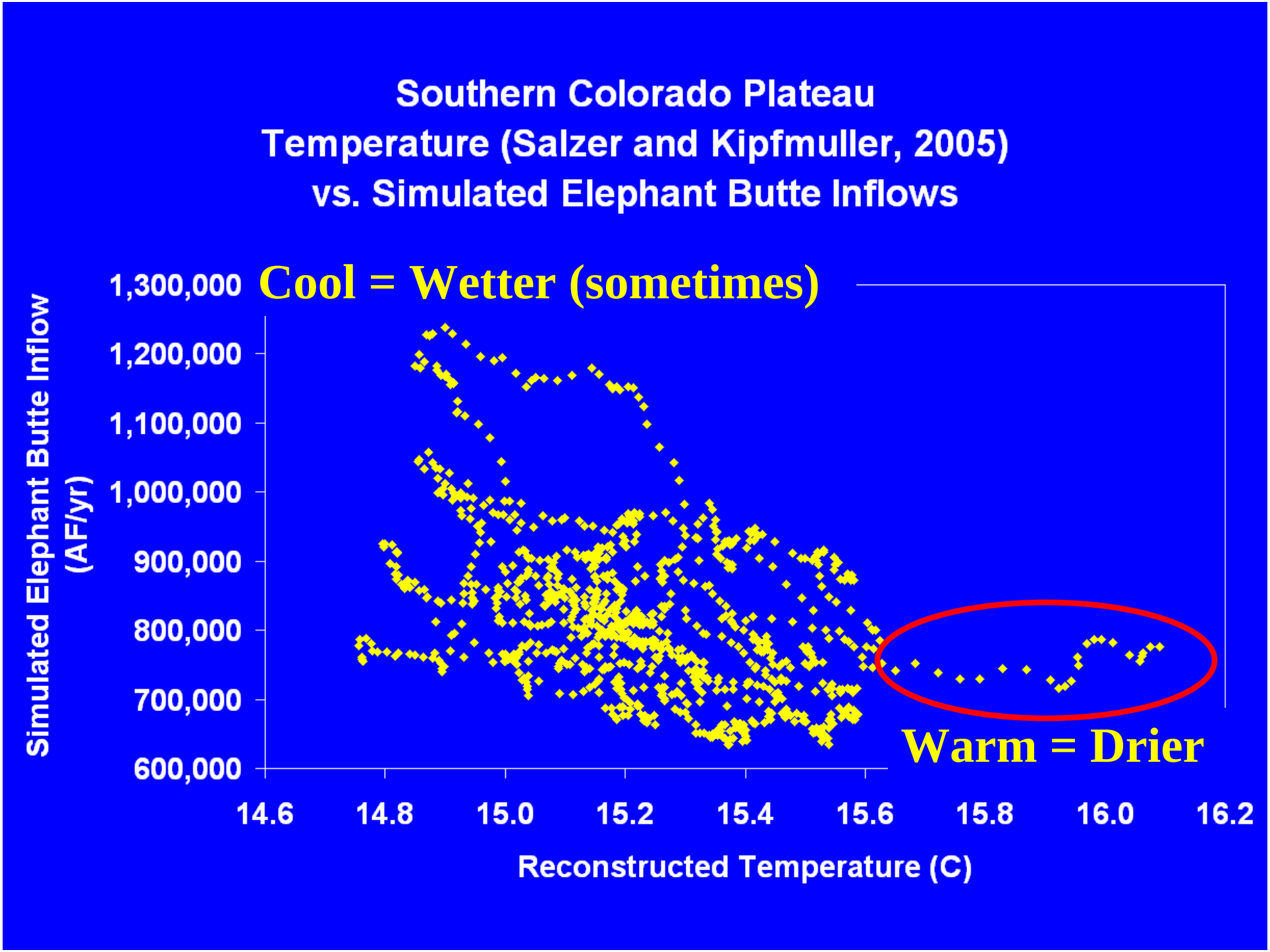

50-Year Average vs. 50-Year Standard Deviation
Wet = More Variable
Dry = Less Variable
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50-Year Running Standard Deviation
500,000
750,000
1,000,000
1,250,000
50-Year Running Average

Temperature vs. EB Inflow

- Reconstructed temperature from Southern Colorado Plateau Area
  - 570 to 1987
  - Salzer and Kipfmuller (2005)
- Compare with Simulated Elephant Butte Inflow

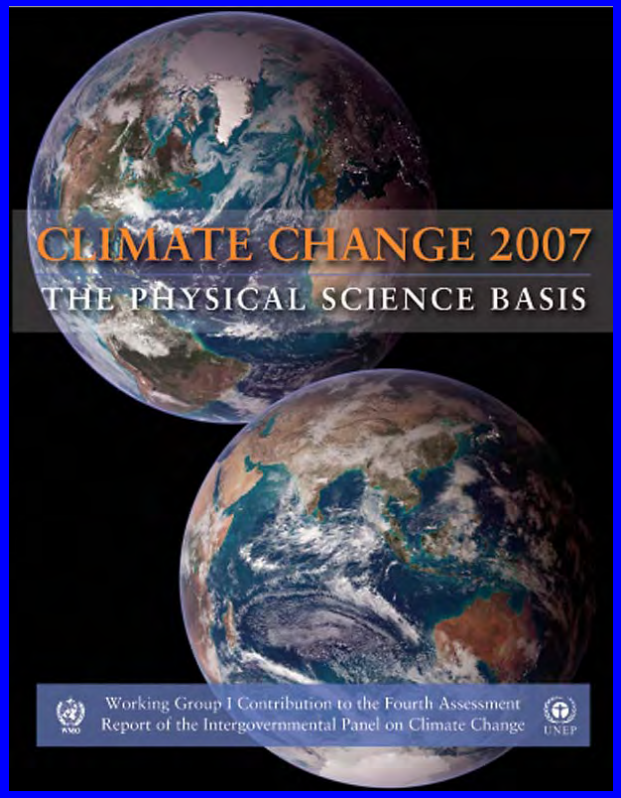
Southern Colorado Plateau Temperature (Salzer and Kipfmuller, 2005) vs. Simulated Elephant Butte Inflows

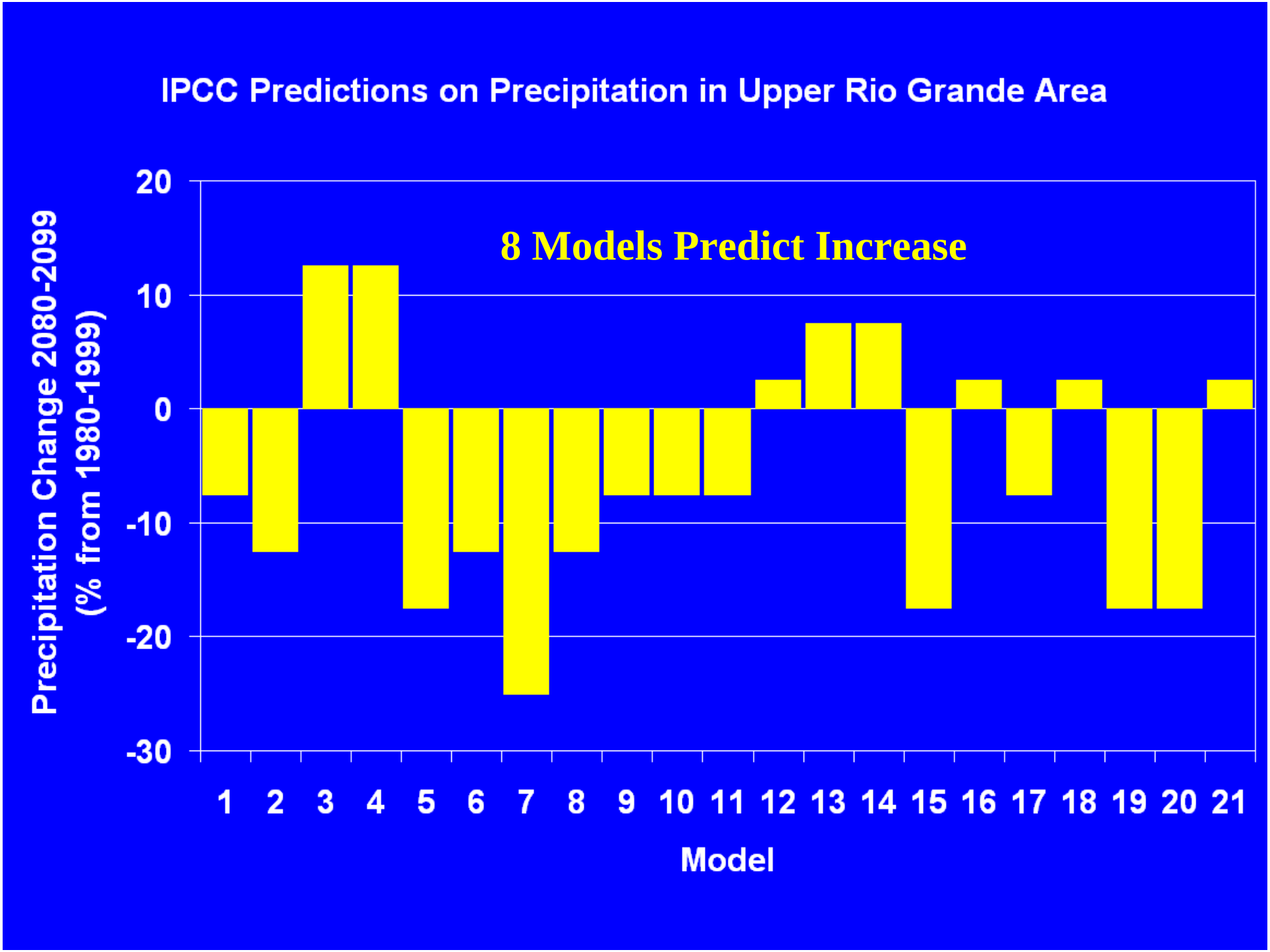


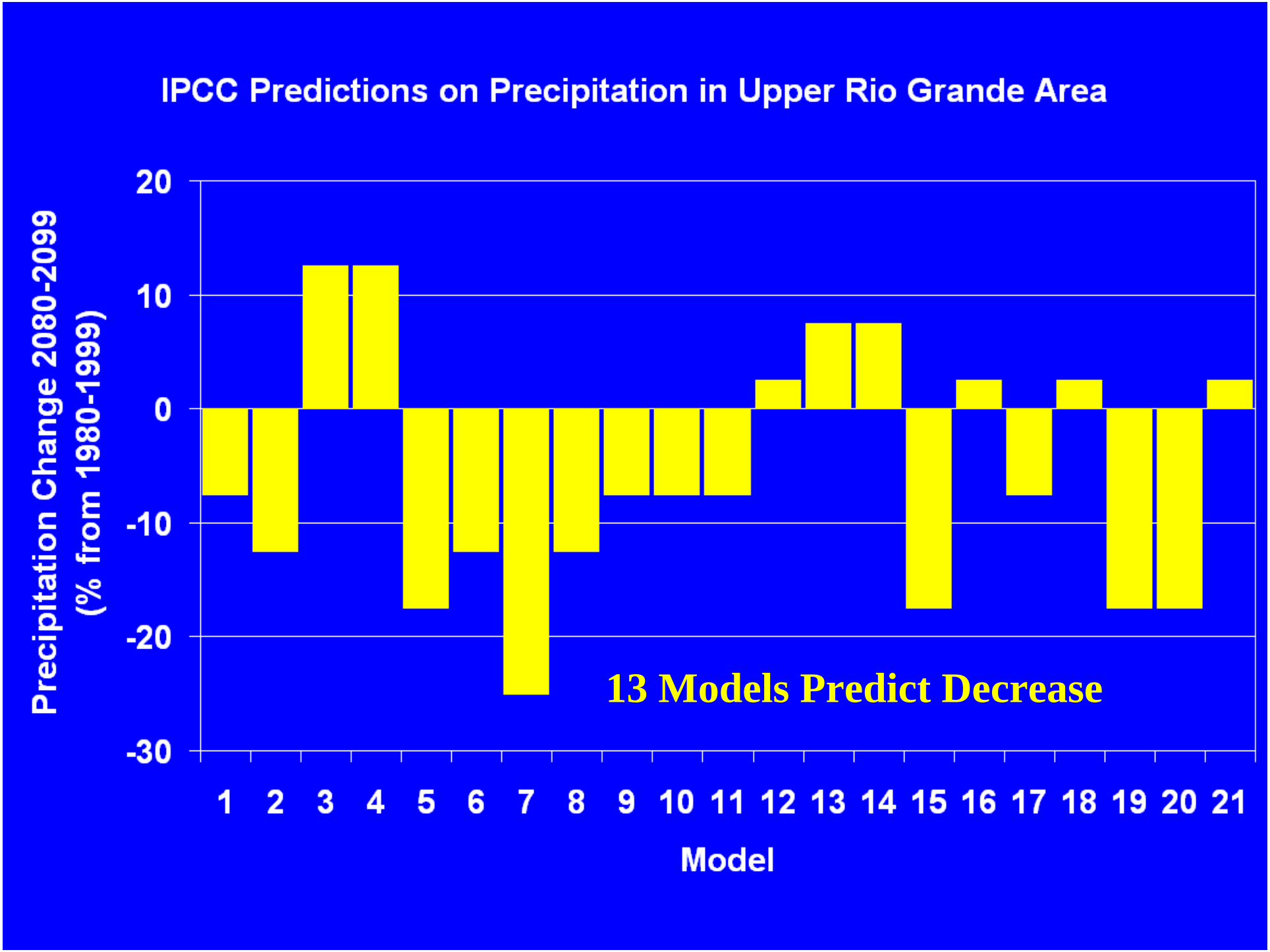

Southern Colorado Plateau
Temperature (Salzer and Kipfmuller, 2005)
vs. Simulated Elephant Butte Inflows
Cool = Wetter (sometimes)
Warm = Drier
Simulated Elephant Butte Inflow (AF/yr)
1,300,000
1,200,000
1,100,000
1,000,000
900,000
800,000
700,000
600,000
14.6
14.8
15.0
15.2
15.4
15.6
15.8
16.0
16.2
Reconstructed Temperature (C)

21 IPCC General Circulation Models

- All 21 predict temperature increase (range = 1 to 5°C)
- Precipitation predictions are mixed
  - GCM limitation associated with rugged topography of Rocky Mountain region




IPCC Predictions on Precipitation in Upper Rio Grande Area
8 Models Predict Increase
Precipitation Change 2080-2099
(% from 1980-1999)
20
10
0
-10
-20
-30
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
Model


IPCC Predictions on Precipitation in Upper Rio Grande Area
Precipitation Change 2080-2099
(% from 1980-1999)
20
10
0
-10
-20
-30
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
Model
13 Models Predict Decrease

10 Precipitation/Inflow Scenarios (1 to 7 based on IPCC report)

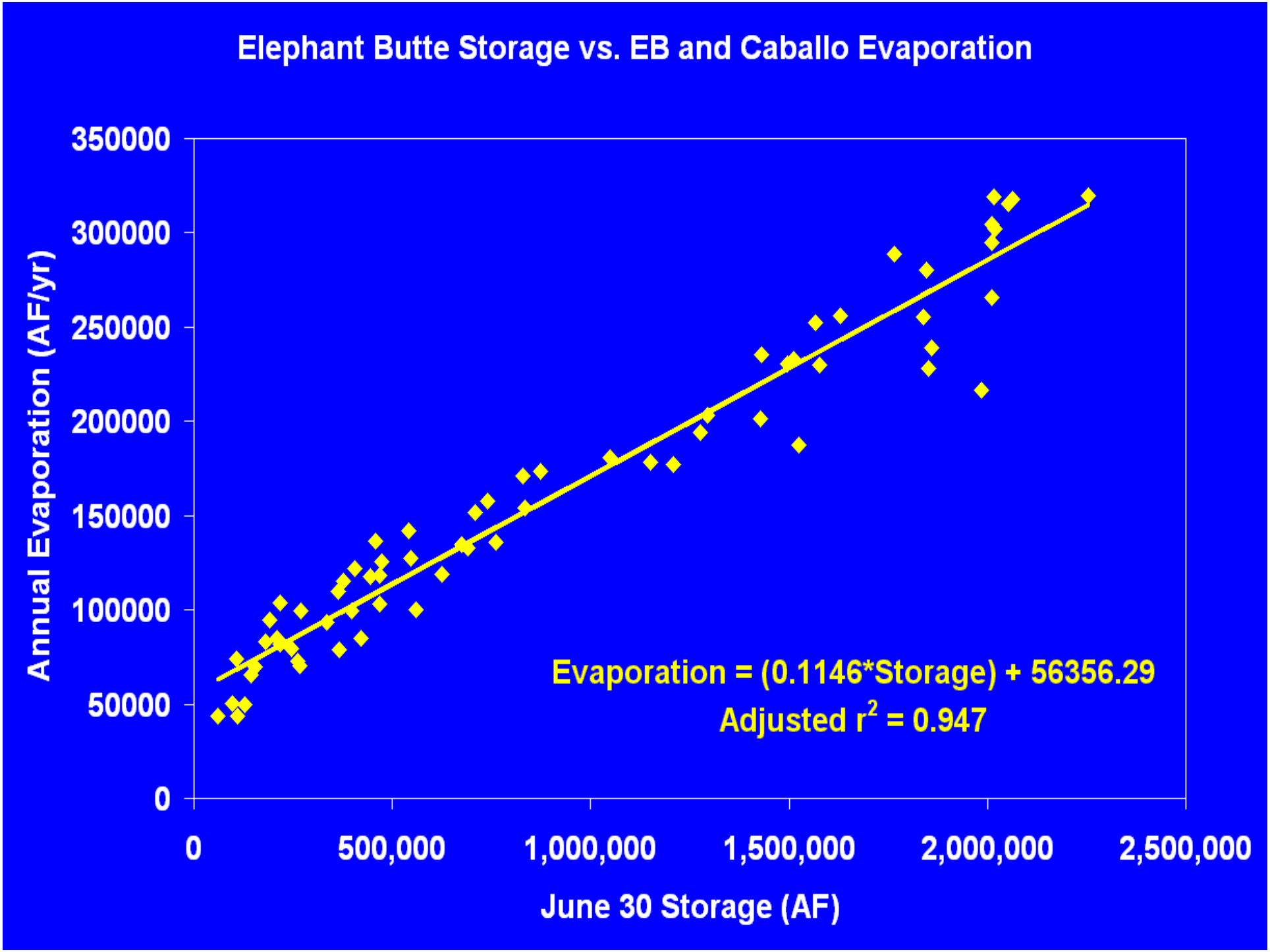
1. Base case (1001 to 2007)
2. 5% Decrease (Average of 21 IPCC models)
3. 10% Decrease (8 IPCC models)
4. 20% Decrease (4 IPCC models)
5. 25% Decrease (1 IPCC model)
6. 5% Increase (4 IPCC models)
7. 10% Increase (4 IPCC models)

10 Precipitation/Inflow Scenarios (8 to 10: Assess Increased Variation)

8. Wet+5%, Dry-5%
9. Wet+10%, Dry-10%
10. Wet+20%, Dry-20%

Temperature and Evaporation

- Elephant Butte Evaporation:
  - 3% increase in evaporation for every degree (C) in temperature


Elephant Butte Storage vs. EB and Caballo Evaporation
Annual Evaporation (AF/yr)
350000
300000
250000
200000
150000
100000
50000
0
0
500,000
1,000,000
1,500,000
2,000,000
2,500,000
June 30 Storage (AF)
Evaporation = (0.1146*Storage) + 56356.29
Adjusted r2 = 0.947

6 Evaporation Scenarios

1. Base Evaporation
2. Base Evap+3% (1°C)
3. Base Evap+6% (2°C)
4. Base Evap+9% (3°C)
5. Base Evap+12% (4°C)
6. Base Evap+15% (5°C)

Scenario Development Summary

- 60 Scenarios
  - 10 EB Inflow
  - 6 EB Evaporation
- Each scenario: 958 50-year simulations
- Total of 57,480 50-year simulations

Application of 2006 Region E Plan

- EPWU diversion increase over 50-year period
  - 62,000 AF/yr in 2010
  - 82,000 AF/yr in 2060
- Associated increase in local groundwater pumping
- EPWU reclaimed use increase over 50-year period
  - 7,600 AF/yr in 2010
  - 23,000 AF/yr in 2060

Approach – Surface Water

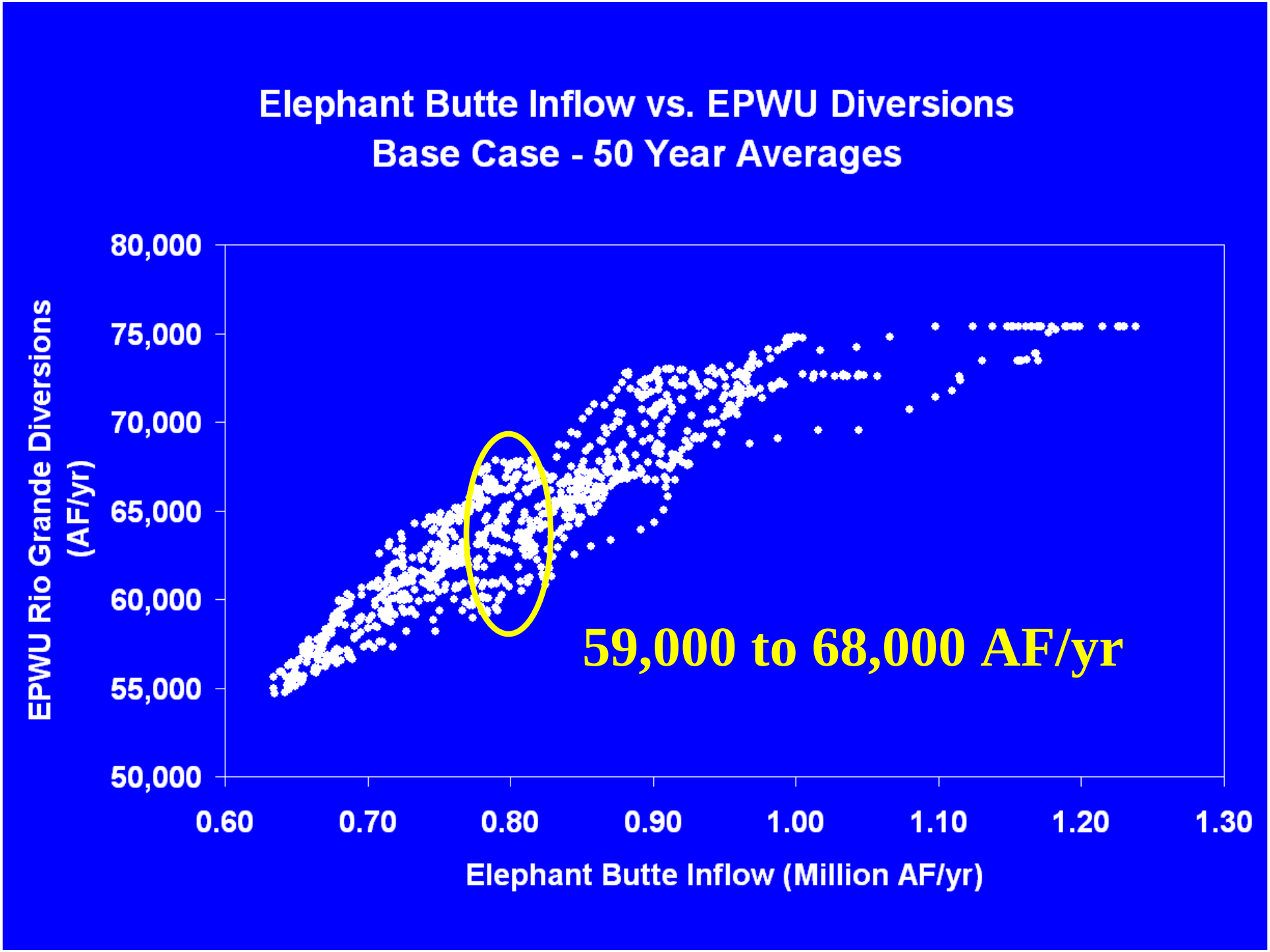
- EB outflow based on EB inflow, storage, and evaporation
  - Simple reservoir operations model
  - “Full” Release = 790,000 AF/yr
- EPWU diversion based on EB outflow
  - Percentage of full release

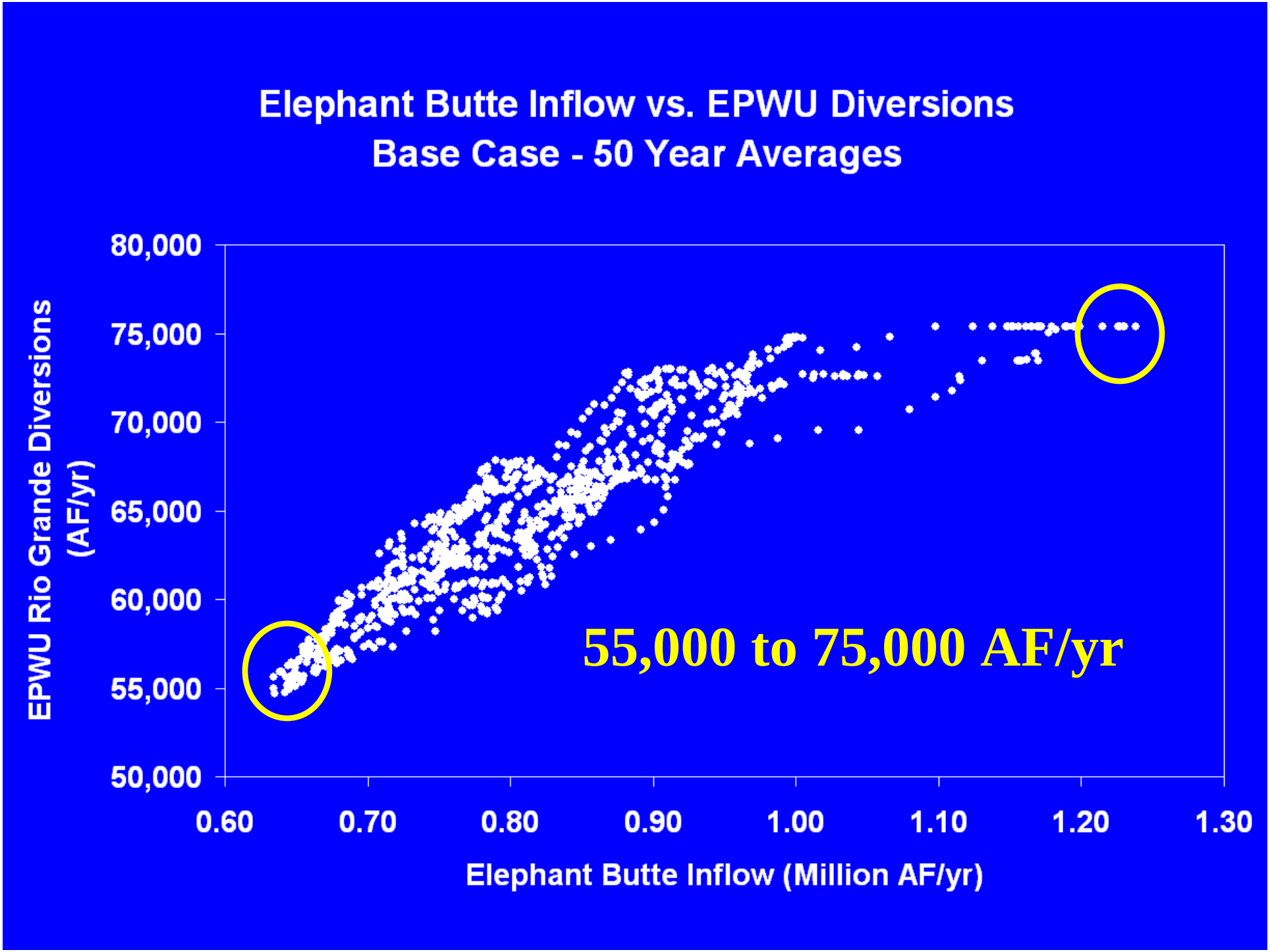
Approach - Groundwater

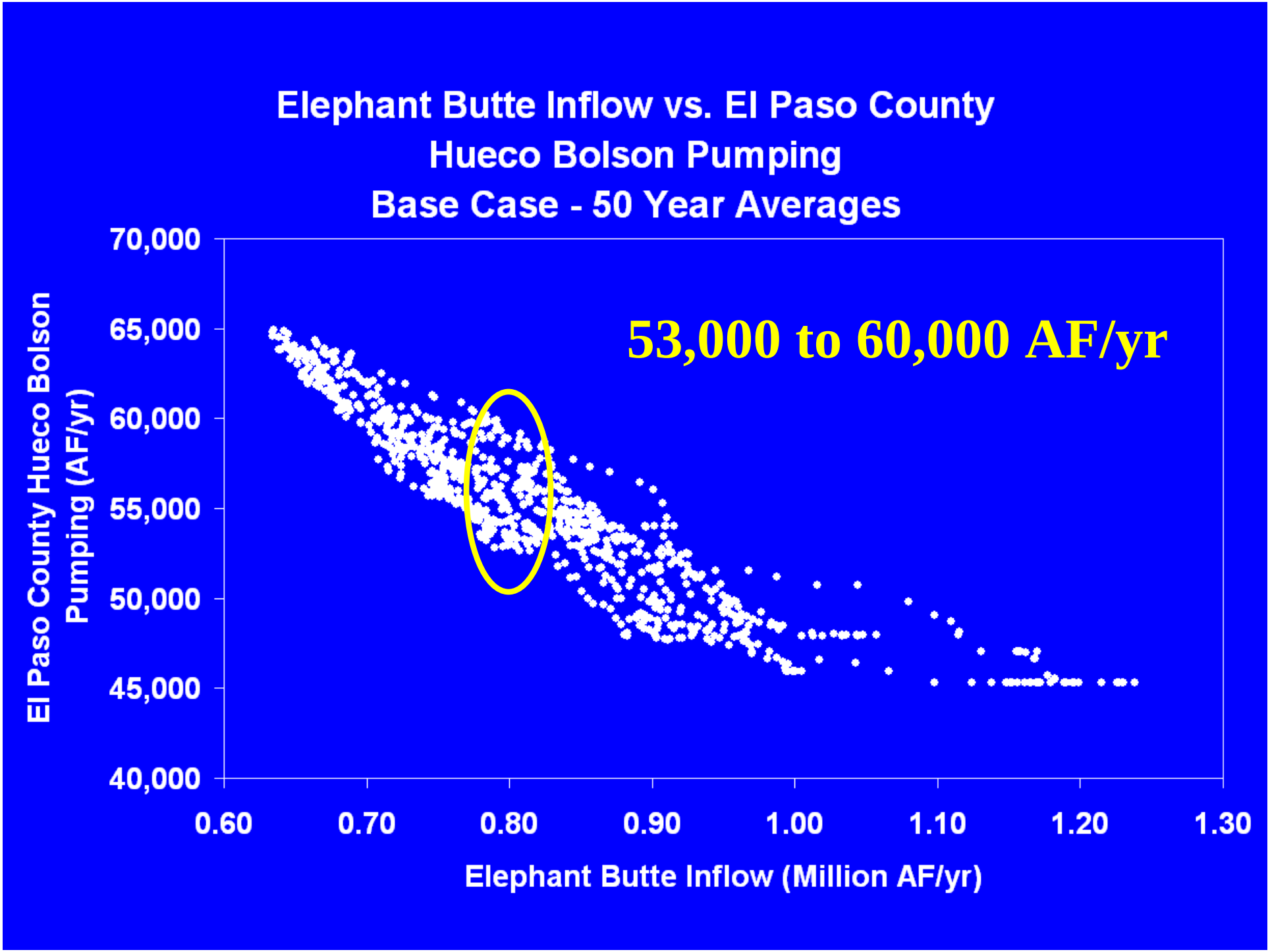
- EPWU pumping based on EPWU diversion
  - Based on conjunctive use strategy in Region E Plan
- Simulate estimated groundwater pumping and Rio Grande flows
  - USGS groundwater model of Hueco Bolson
  - Groundwater storage affected mostly by surface water flow (recharge) and pumping

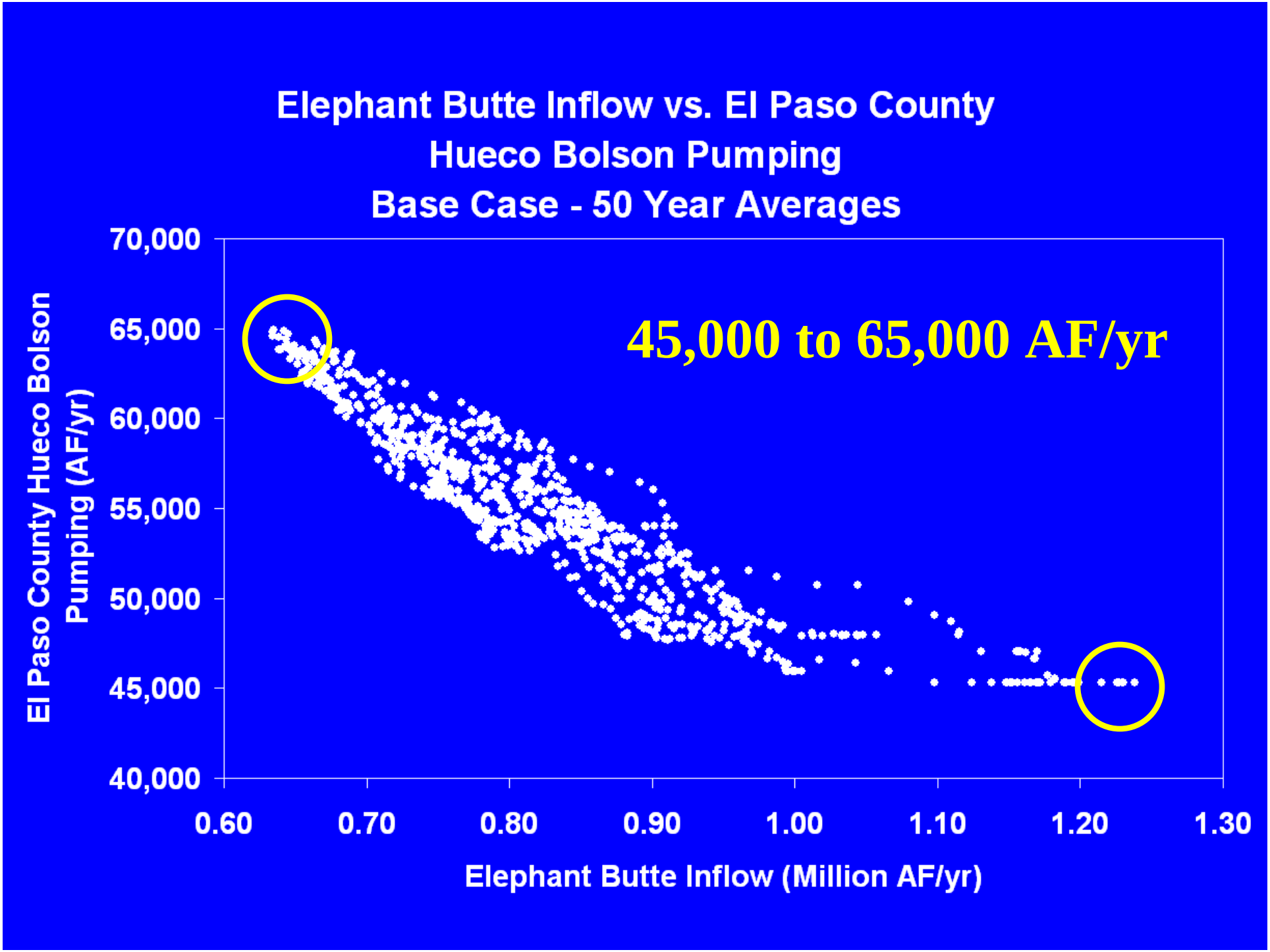
Results

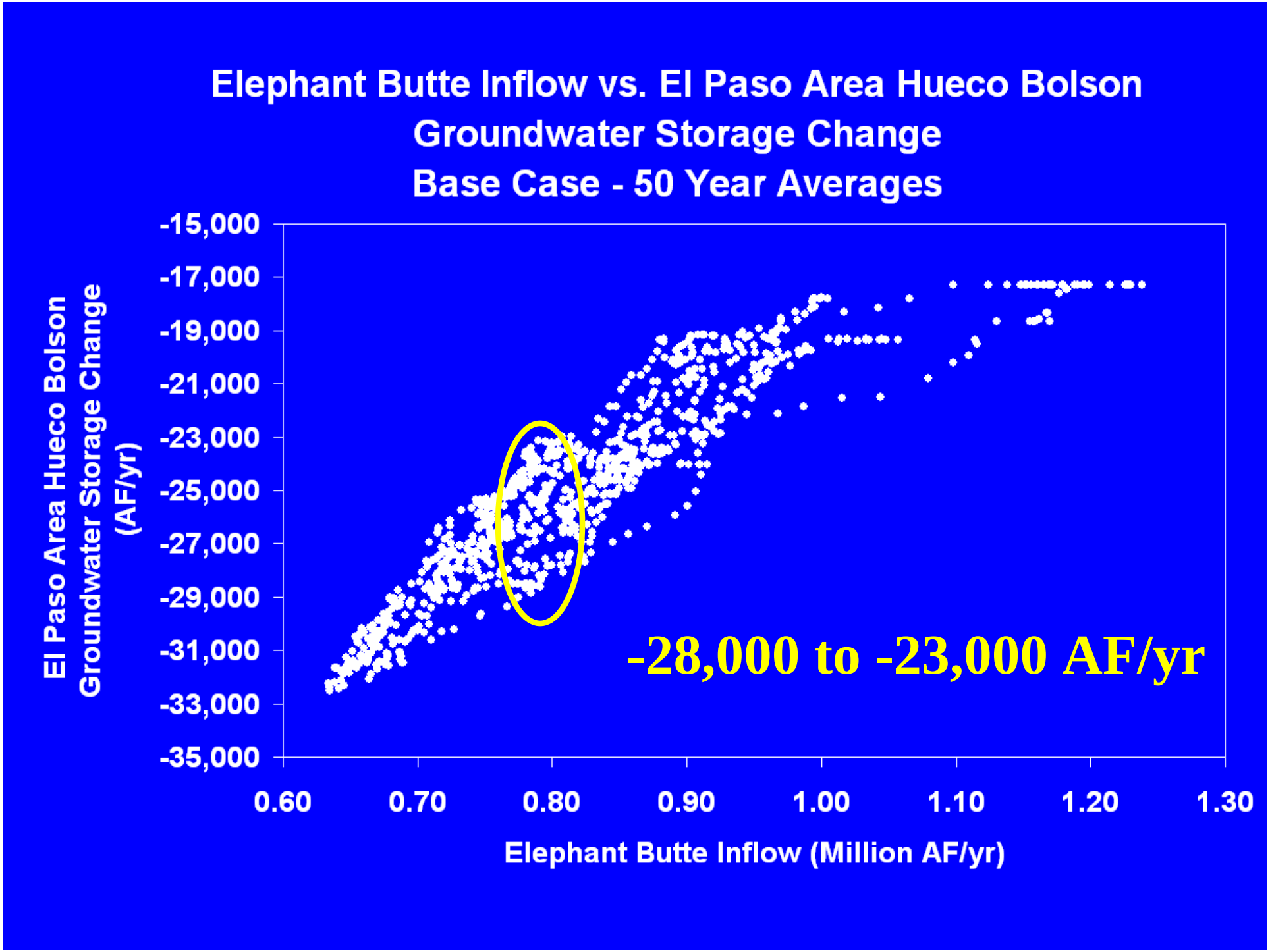
- Base Case - Impacts of Varied EB Inflow on:
  - EPWU Diversions
  - El Paso County Hueco Bolson Pumping
  - Hueco Bolson Groundwater Storage
- Base Case vs. Decreased Inflow Scenarios
- Base Case vs. Increased Inflow Scenarios
- Base Case vs. Higher Variability Scenarios
- Higher Evaporation Impacts

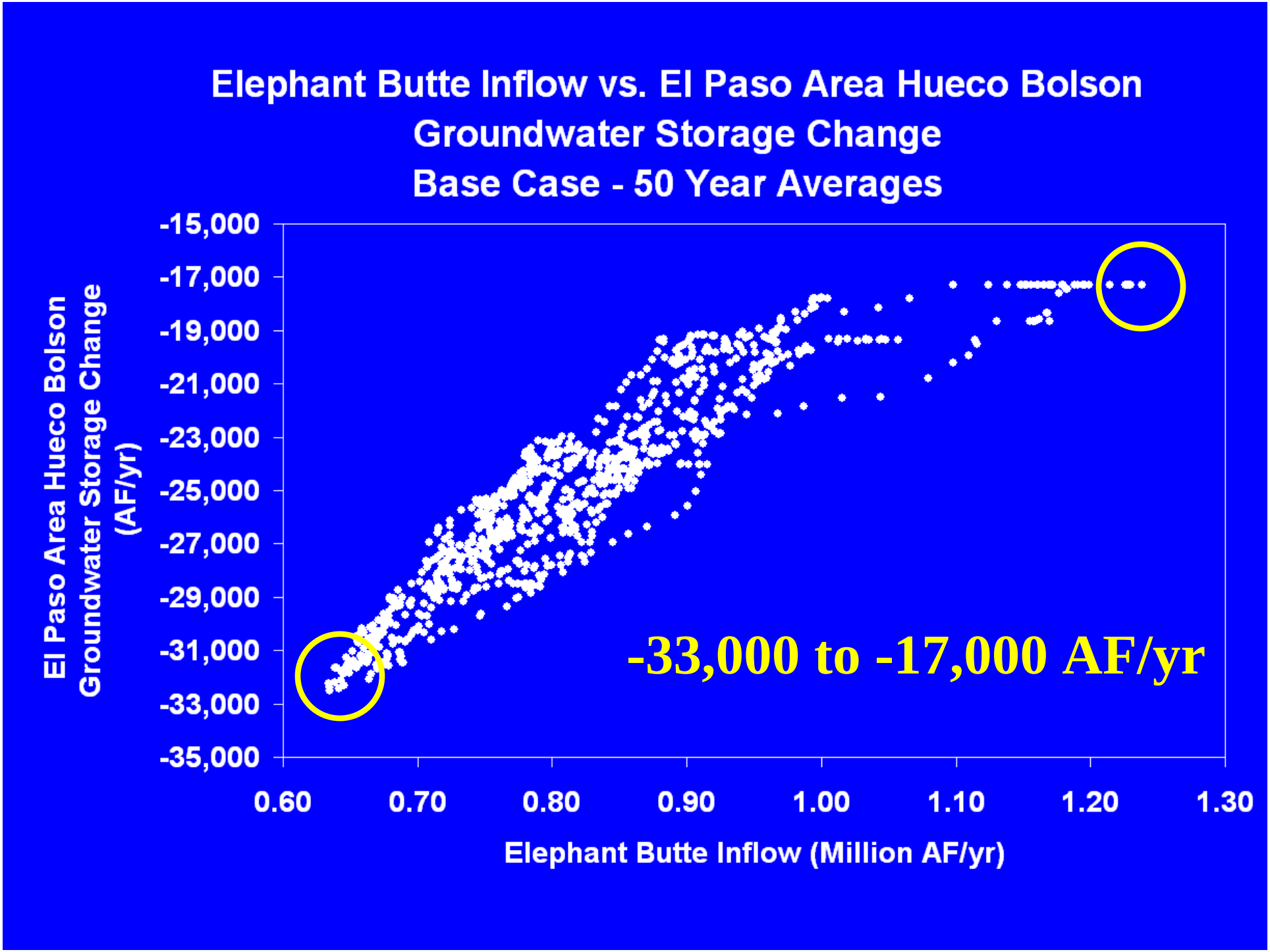

Elephant Butte Inflow vs. EPWU Diversions
Base Case - 50 Year Averages
EPWU Rio Grande Diversions (AF/yr)
80,000
75,000
70,000
65,000
60,000
55,000
50,000
0.60
0.70
0.80
0.90
1.00
1.10
1.20
1.30
Elephant Butte Inflow (Million AF/yr)
59,000 to 68,000 AF/yr


Elephant Butte Inflow vs. EPWU Diversions
Base Case - 50 Year Averages
EPWU Rio Grande Diversions (AF/yr)
80,000
75,000
70,000
65,000
60,000
55,000
50,000
0.60
0.70
0.80
0.90
1.00
1.10
1.20
1.30
Elephant Butte Inflow (Million AF/yr)
55,000 to 75,000 AF/yr


Elephant Butte Inflow vs. El Paso County
Hueco Bolson Pumping
Base Case - 50 Year Averages
53,000 to 60,000 AF/yr
El Paso County Hueco Bolson Pumping (AF/yr)
70,000
65,000
60,000
55,000
50,000
45,000
40,000
0.60
0.70
0.80
0.90
1.00
1.10
1.20
1.30
Elephant Butte Inflow (Million AF/yr)

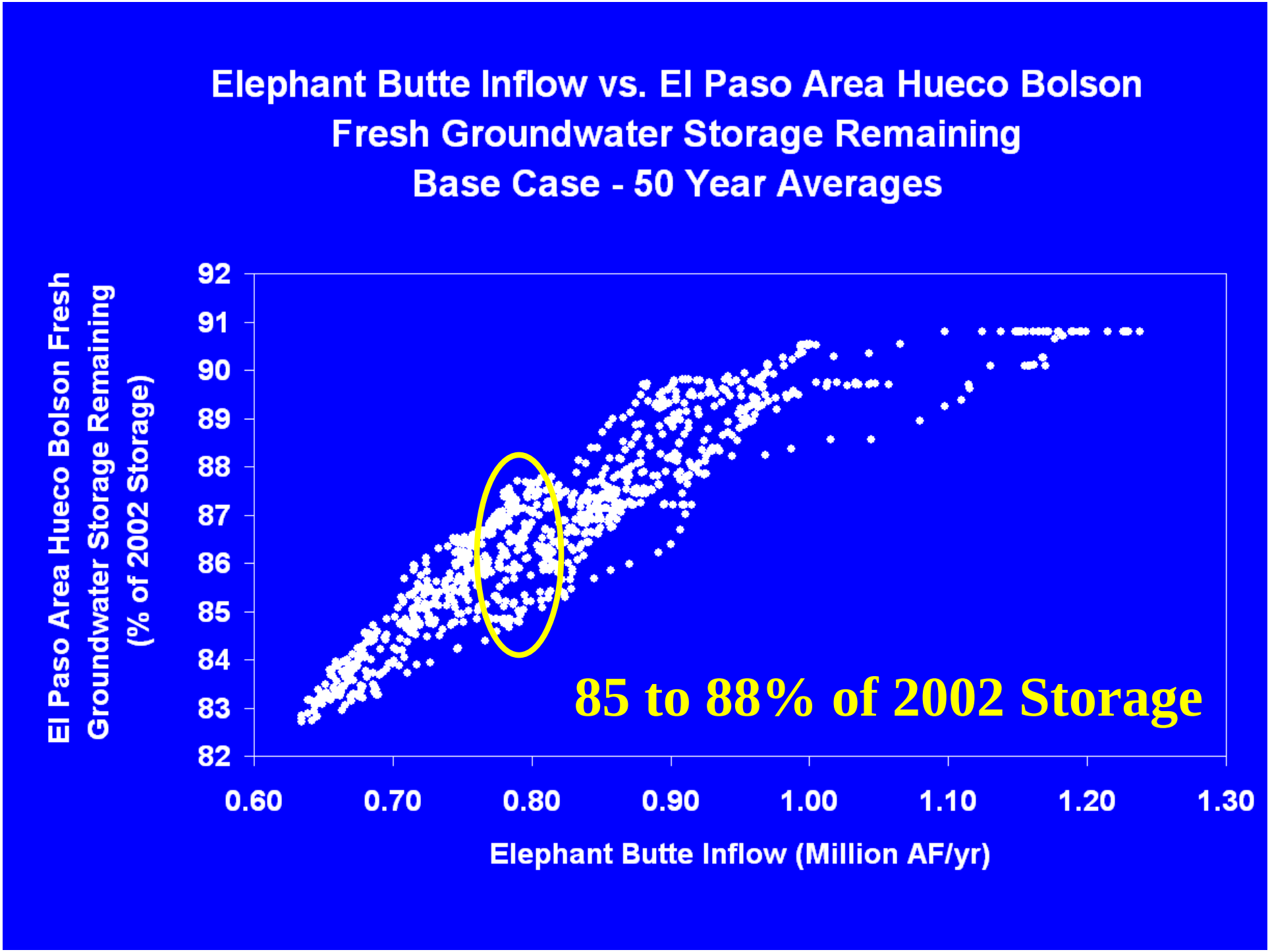

Elephant Butte Inflow vs. El Paso County
Hueco Bolson Pumping
Base Case - 50 Year Averages
45,000 to 65,000 AF/yr
El Paso County Hueco Bolson Pumping (AF/yr)
70,000
65,000
60,000
55,000
50,000
45,000
40,000
0.60
0.70
0.80
0.90
1.00
1.10
1.20
1.30
Elephant Butte Inflow (Million AF/yr)

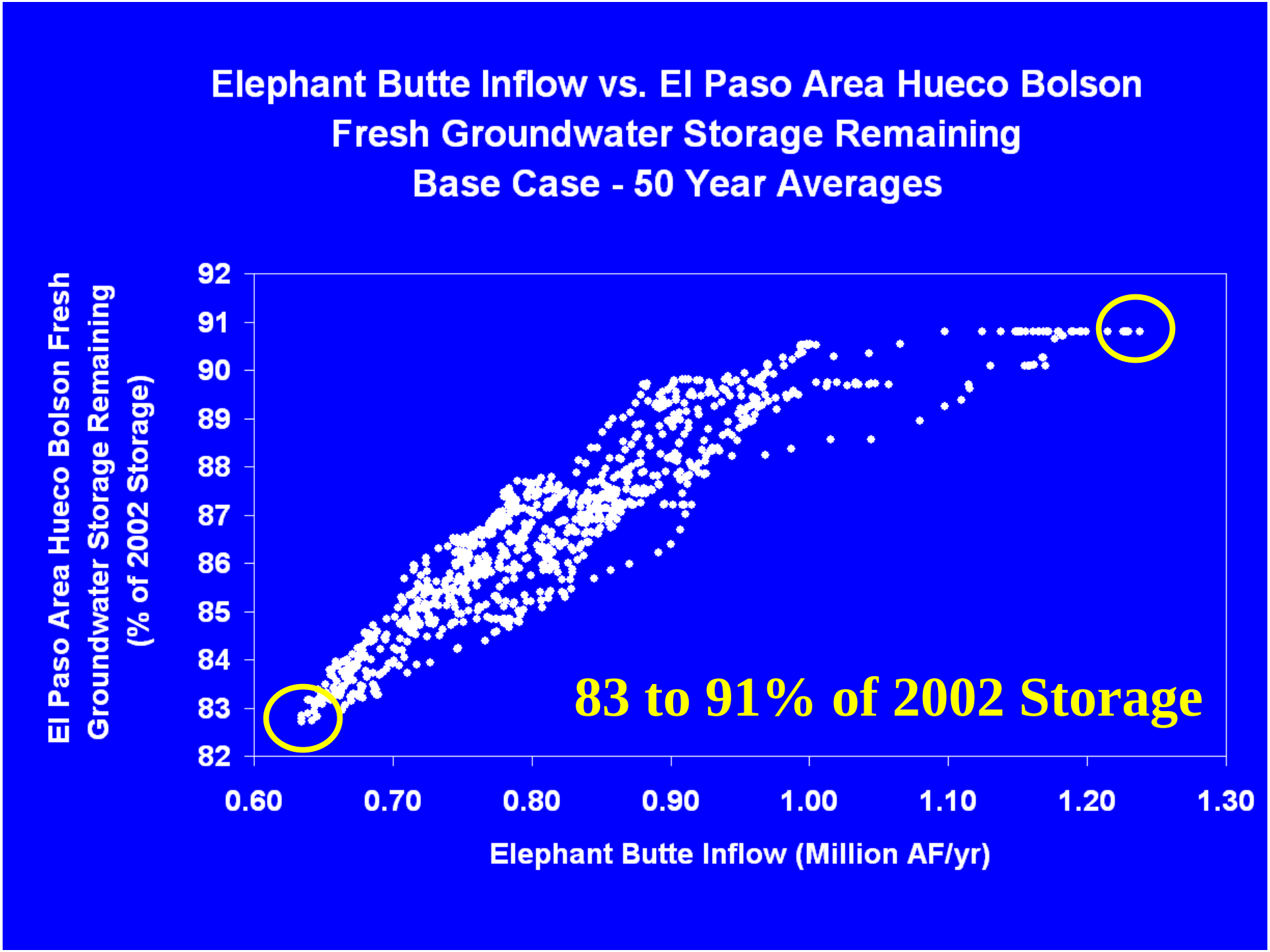

Elephant Butte Inflow vs. El Paso Area Hueco Bolson
Groundwater Storage Change
Base Case - 50 Year Averages
El Paso Area Hueco Bolson
Groundwater Storage Change
(AF/yr)
-15,000
-17,000
-19,000
-21,000
-23,000
-25,000
-27,000
-29,000
-31,000
-33,000
-35,000
0.60
0.70
0.80
0.90
1.00
1.10
1.20
1.30
Elephant Butte Inflow (Million AF/yr)
-28,000 to -23,000 AF/yr


Elephant Butte Inflow vs. El Paso Area Hueco Bolson
Groundwater Storage Change
Base Case - 50 Year Averages
El Paso Area Hueco Bolson
Groundwater Storage Change
(AF/yr)
-15,000
-17,000
-19,000
-21,000
-23,000
-25,000
-27,000
-29,000
-31,000
-33,000
-35,000
0.60
0.70
0.80
0.90
1.00
1.10
1.20
1.30
Elephant Butte Inflow (Million AF/yr)
-33,000 to -17,000 AF/yr

Storage Change Impact on Estimated 2002 Fresh Groundwater Storage

- 2002 Fresh Groundwater Storage in El Paso Area = 9.4 Million AF
- Attribute all storage change to fresh groundwater (conservative)
- Estimate percentage of fresh groundwater remaining after 50 years

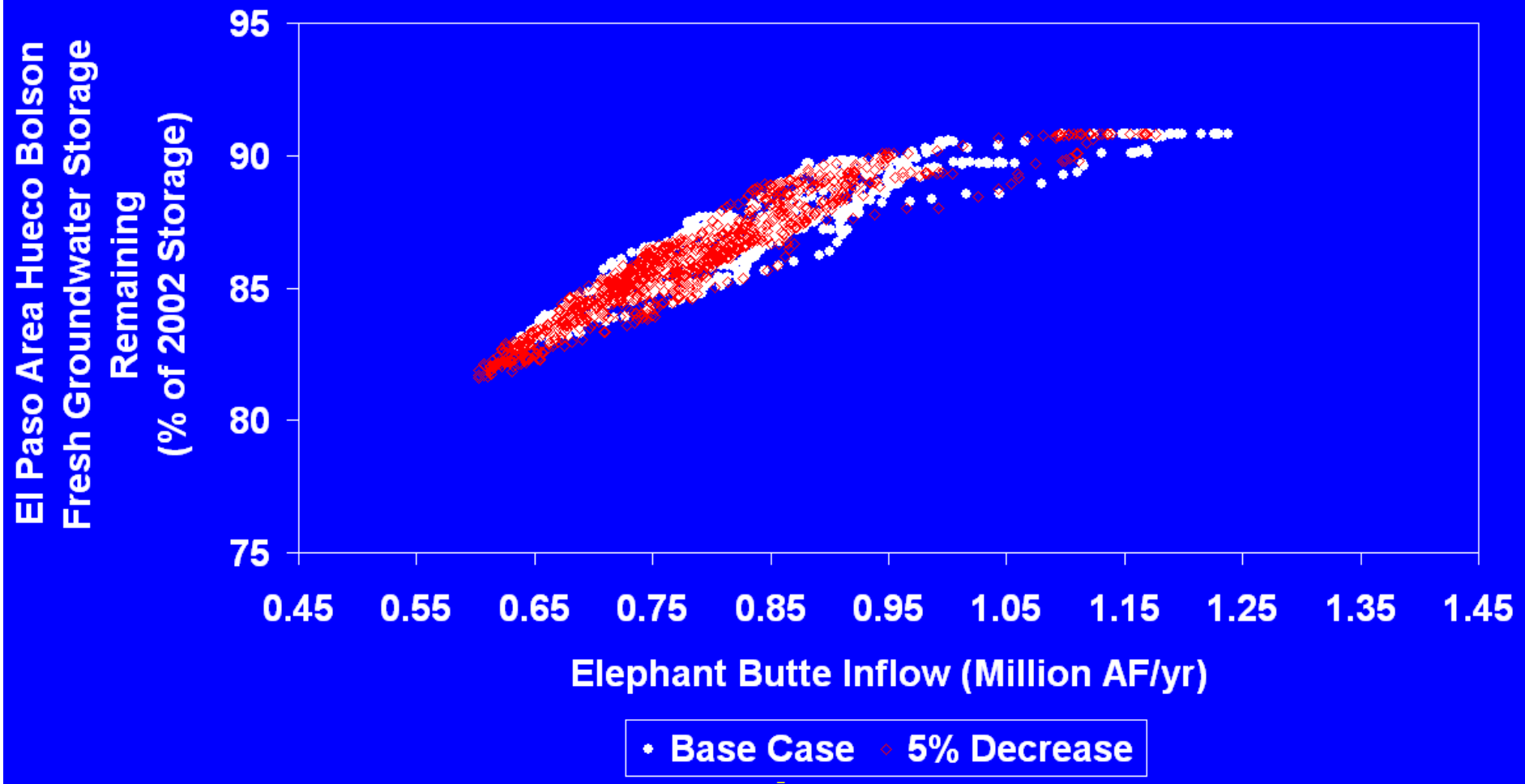

Elephant Butte Inflow vs. El Paso Area Hueco Bolson
Fresh Groundwater Storage Remaining
Base Case - 50 Year Averages
El Paso Area Hueco Bolson Fresh
Groundwater Storage Remaining
(% of 2002 Storage)
92
91
90
89
88
87
86
85
84
83
82
0.60
0.70
0.80
0.90
1.00
1.10
1.20
1.30
Elephant Butte Inflow (Million AF/yr)
85 to 88% of 2002 Storage


Elephant Butte Inflow vs. El Paso Area Hueco Bolson
Fresh Groundwater Storage Remaining
Base Case - 50 Year Averages
El Paso Area Hueco Bolson Fresh
Groundwater Storage Remaining
(% of 2002 Storage)
92
91
90
89
88
87
86
85
84
83
82
0.60
0.70
0.80
0.90
1.00
1.10
1.20
1.30
Elephant Butte Inflow (Million AF/yr)
83 to 91% of 2002 Storage

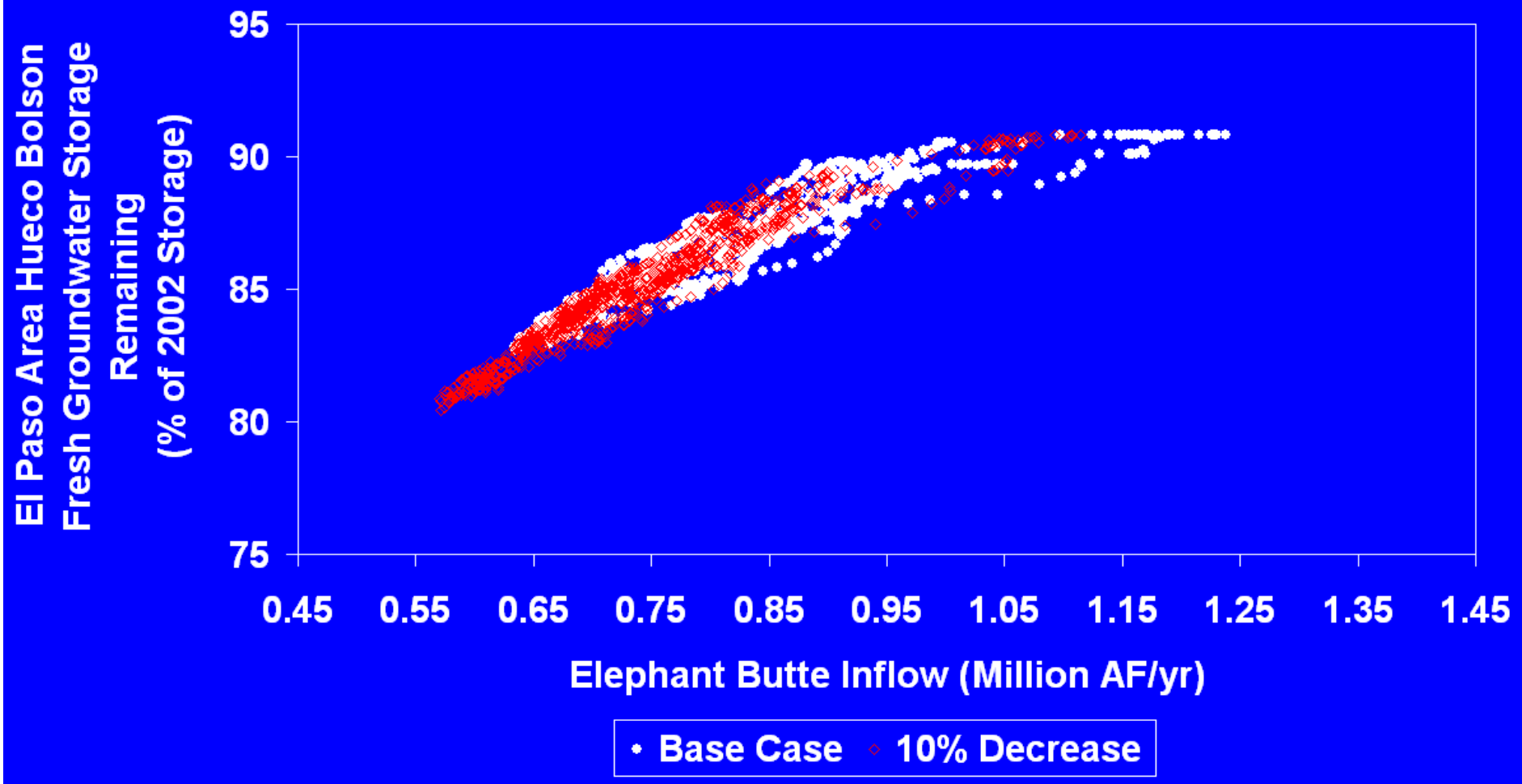
Changes in Precipitation/Inflow (IPCC Predictions)

- 5% Decrease (Avg of all 21 IPCC models)
- 10% Decrease (8 IPCC models)
- 20% Decrease (4 IPCC models)
- 25% Decrease (1 IPCC model)
- 5% Increase (4 IPCC models)
- 10% Increase (4 IPCC models)

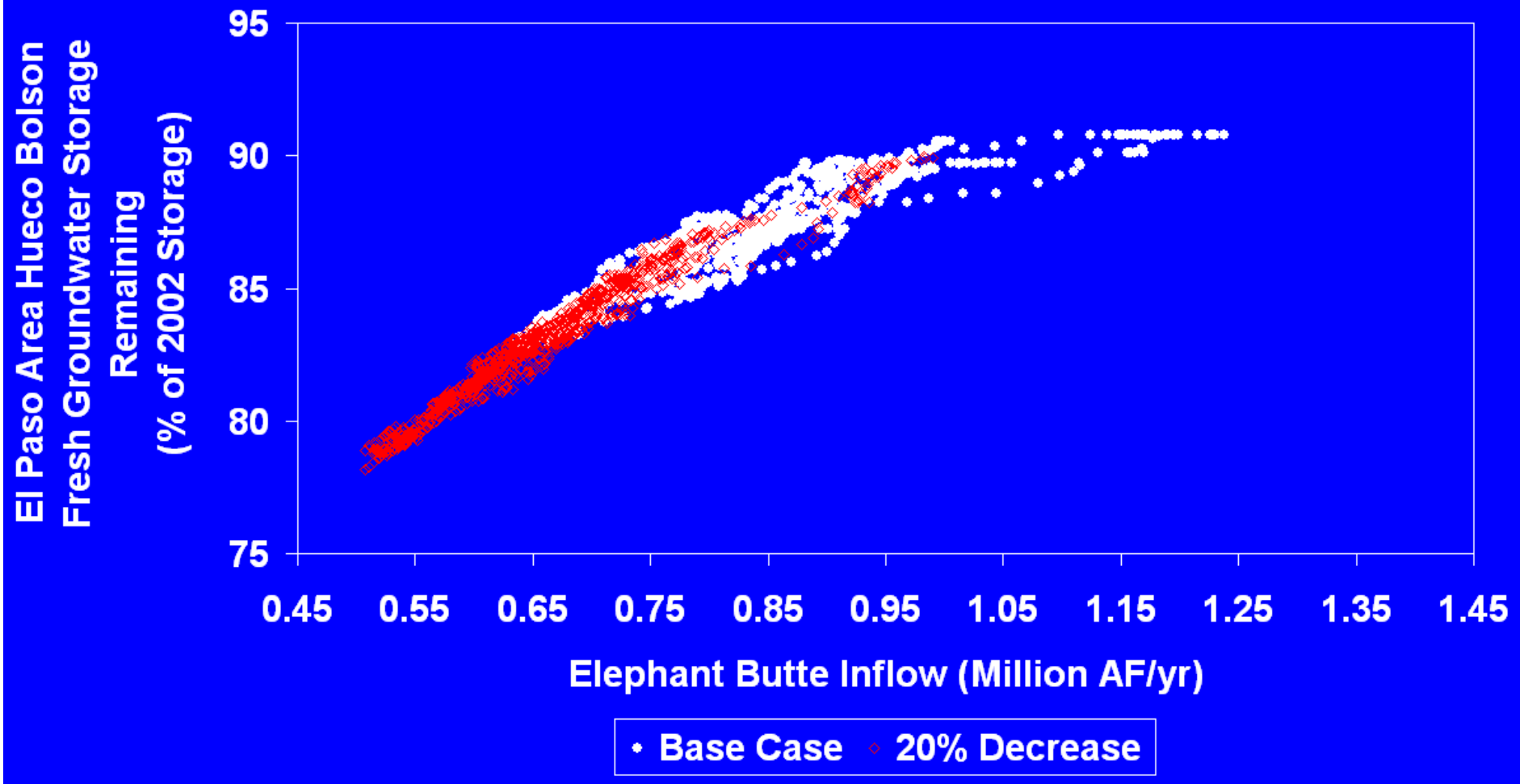
Elephant Butte Inflow vs. El Paso Area Hueco Bolson Fresh Groundwater Storage Remaining 5% Decrease (average of all IPCC models)



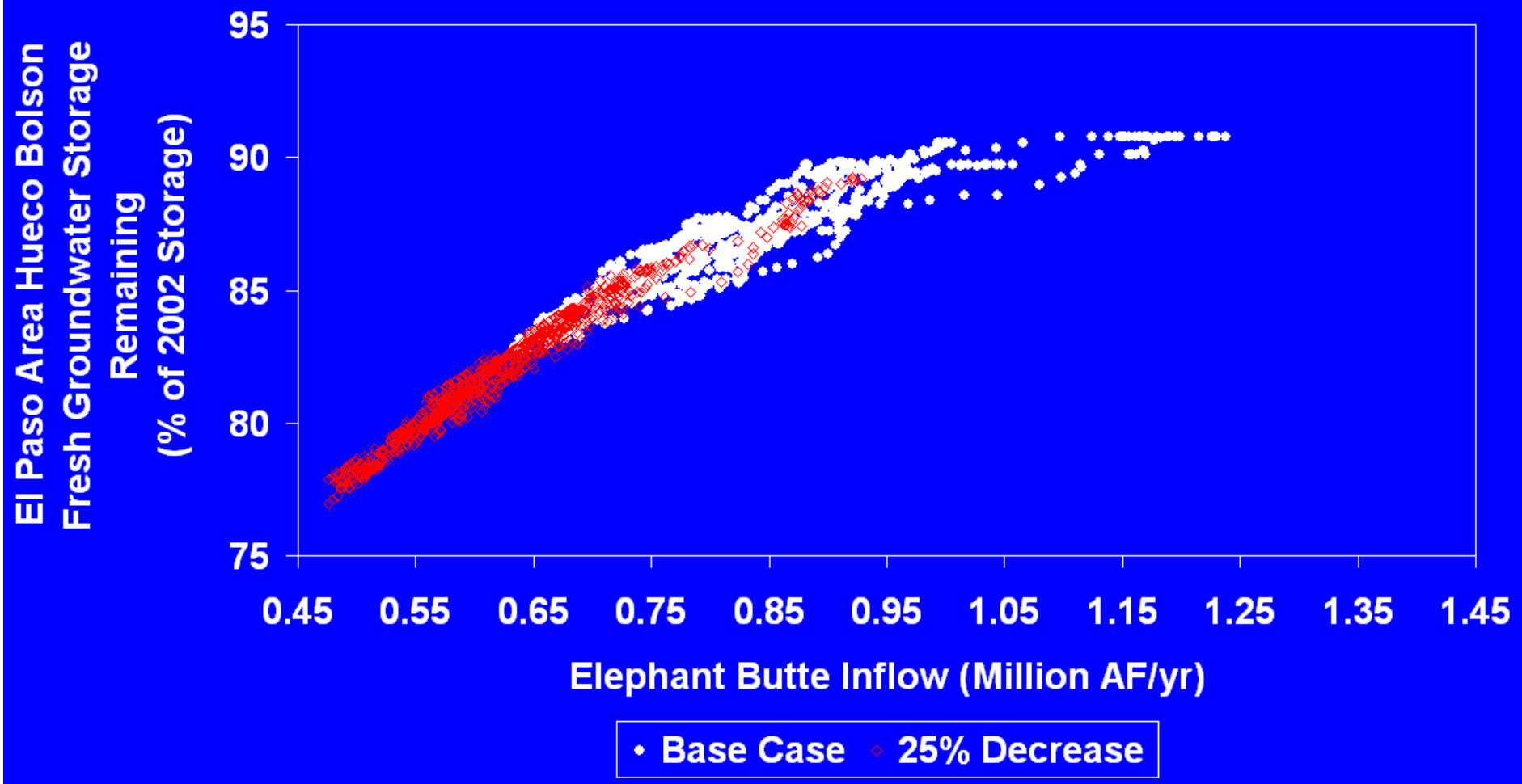
Elephant Butte Inflow vs. El Paso Area Hueco Bolson Fresh Groundwater Storage Remaining 10% Decrease (8 IPCC models)



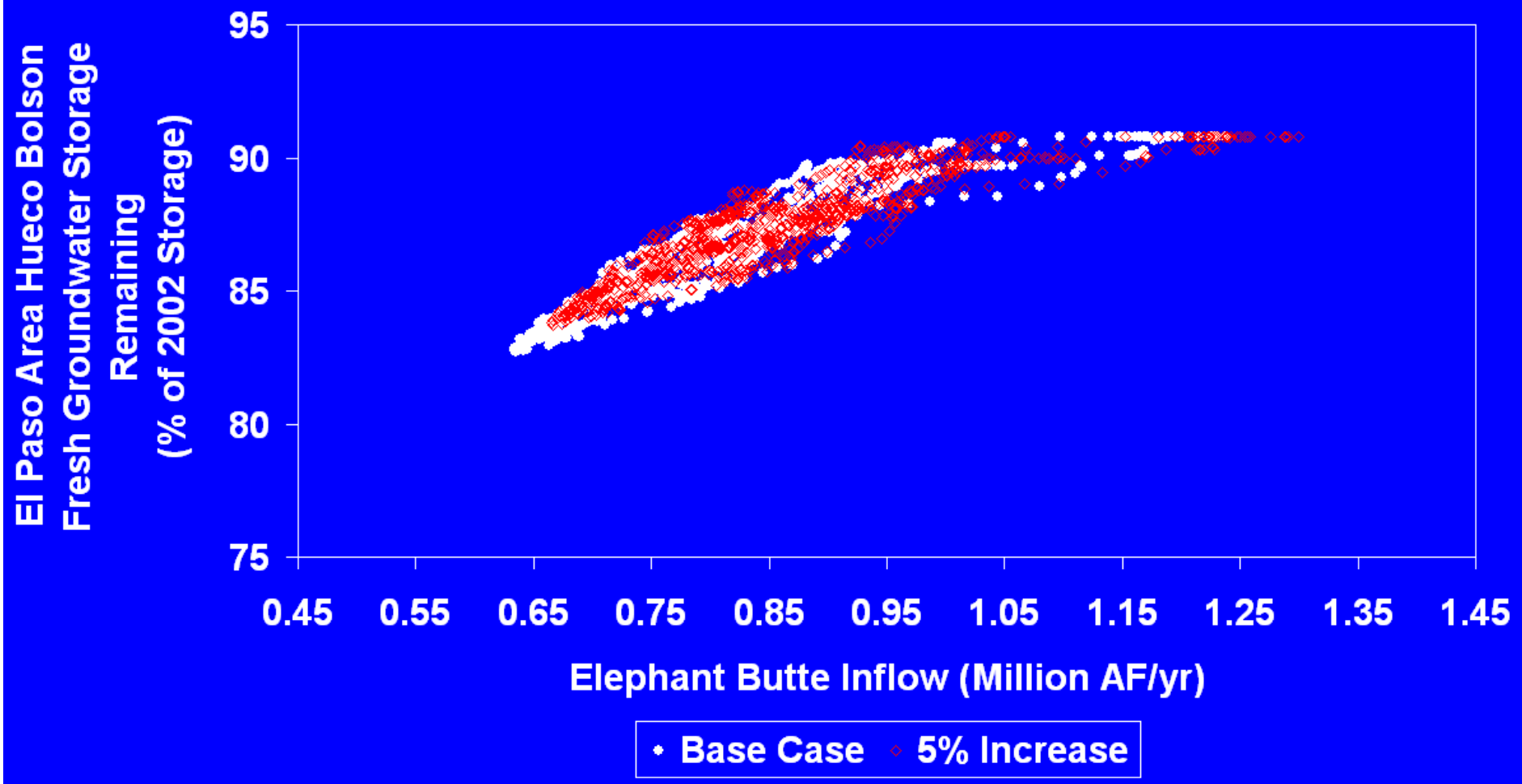
Elephant Butte Inflow vs. El Paso Area Hueco Bolson Fresh Groundwater Storage Remaining 20% Decrease (4 IPCC models)



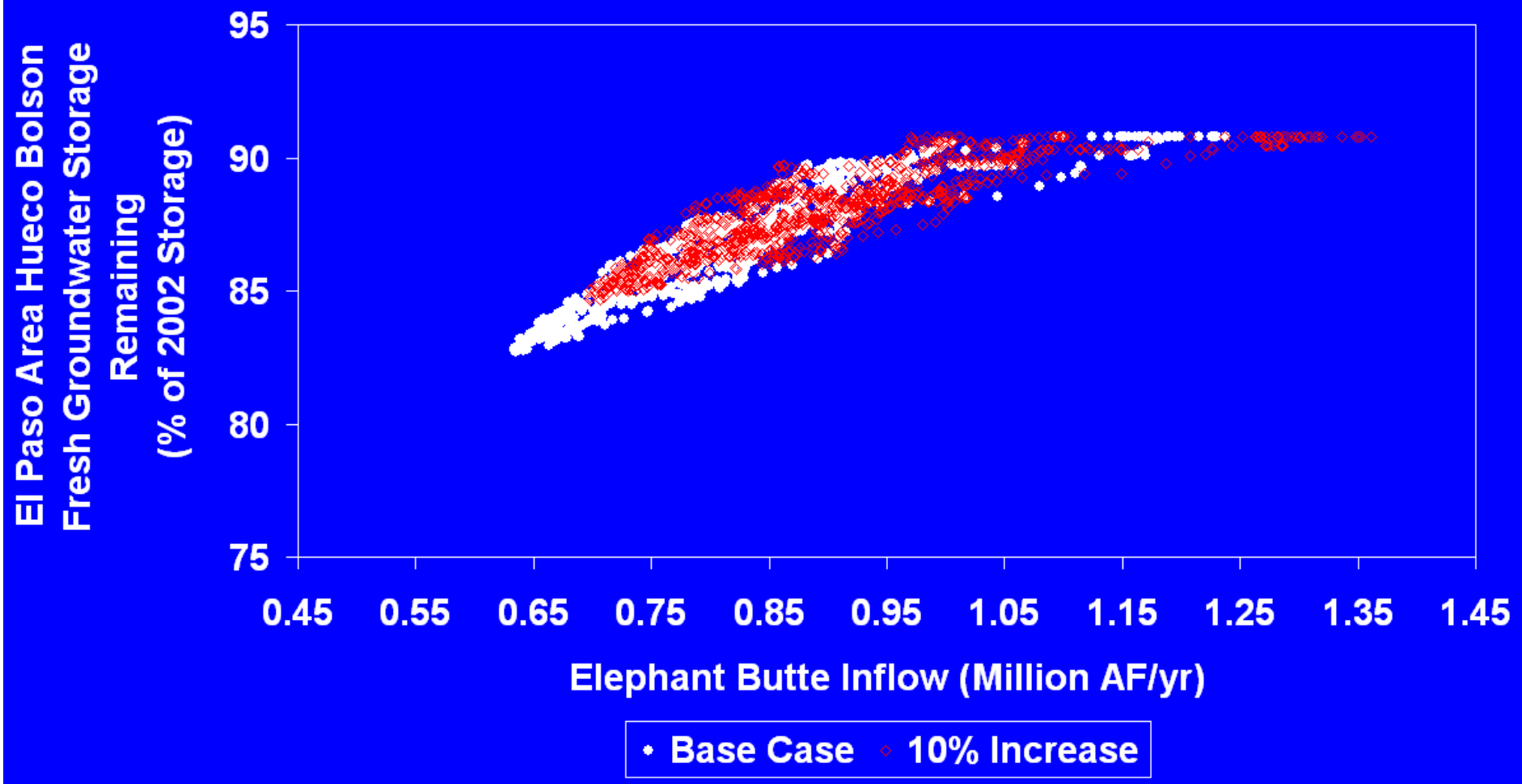
Elephant Butte Inflow vs. El Paso Area Hueco Bolson Fresh Groundwater Storage Remaining 25% Decrease (1 IPCC model)



Elephant Butte Inflow vs. El Paso Area Hueco Bolson Fresh Groundwater Storage Remaining 5% Increase (4 IPCC models)



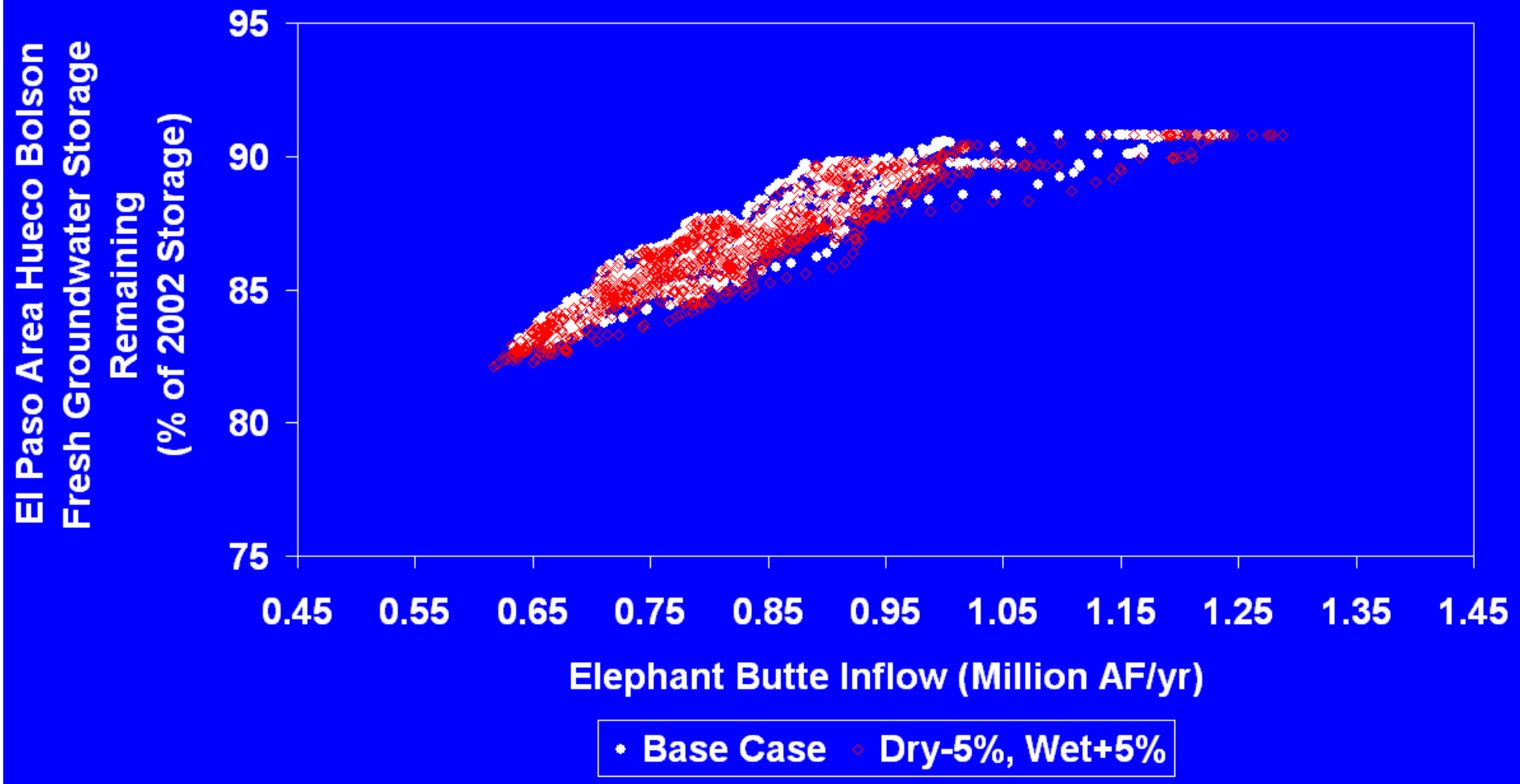
Elephant Butte Inflow vs. El Paso Area Hueco Bolson Fresh Groundwater Storage Remaining 10% Increase (4 IPCC models)



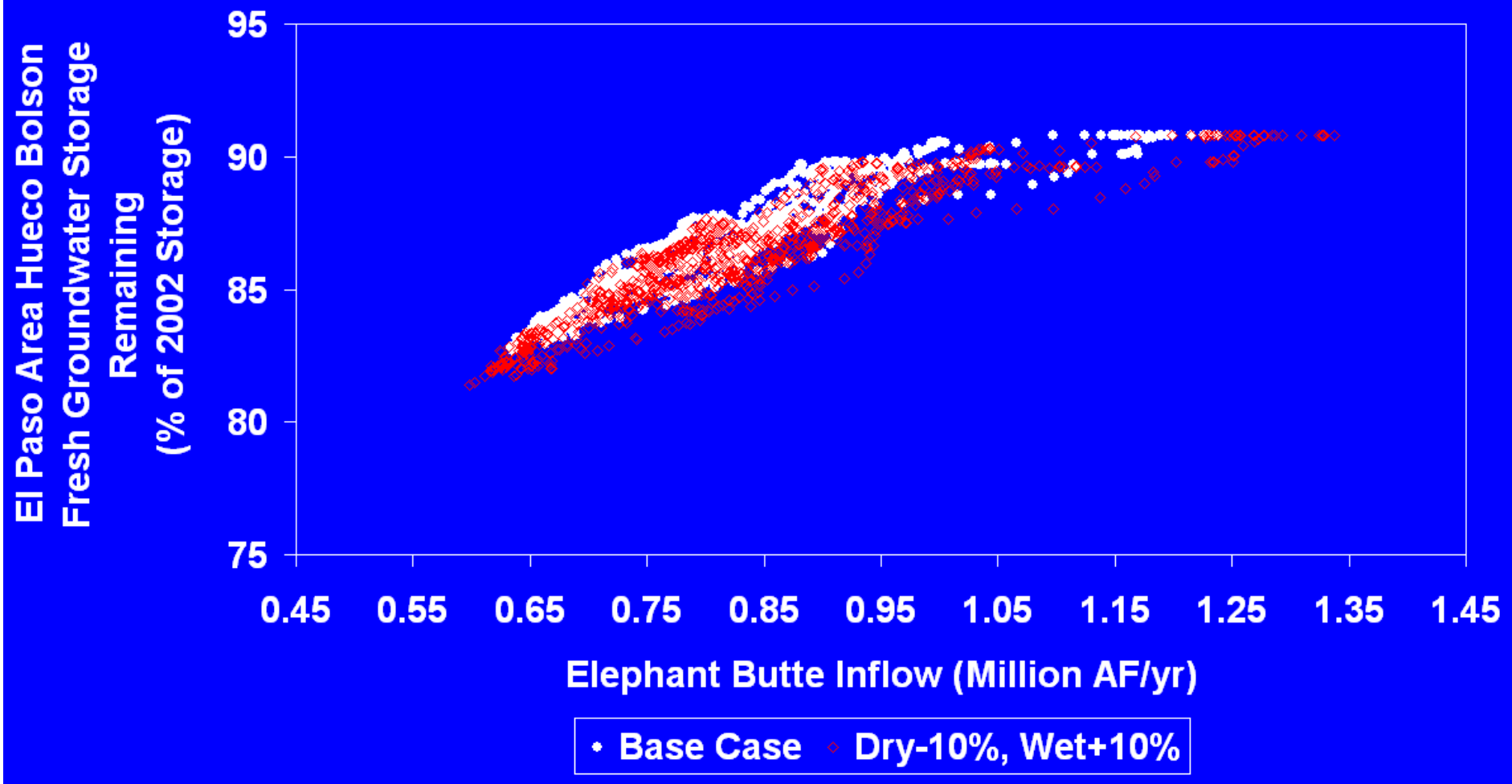
Increased Variability

- Dry -5%, Wet +5%
- Dry -10%, Wet +10%
- Dry -20%, Wet +20%

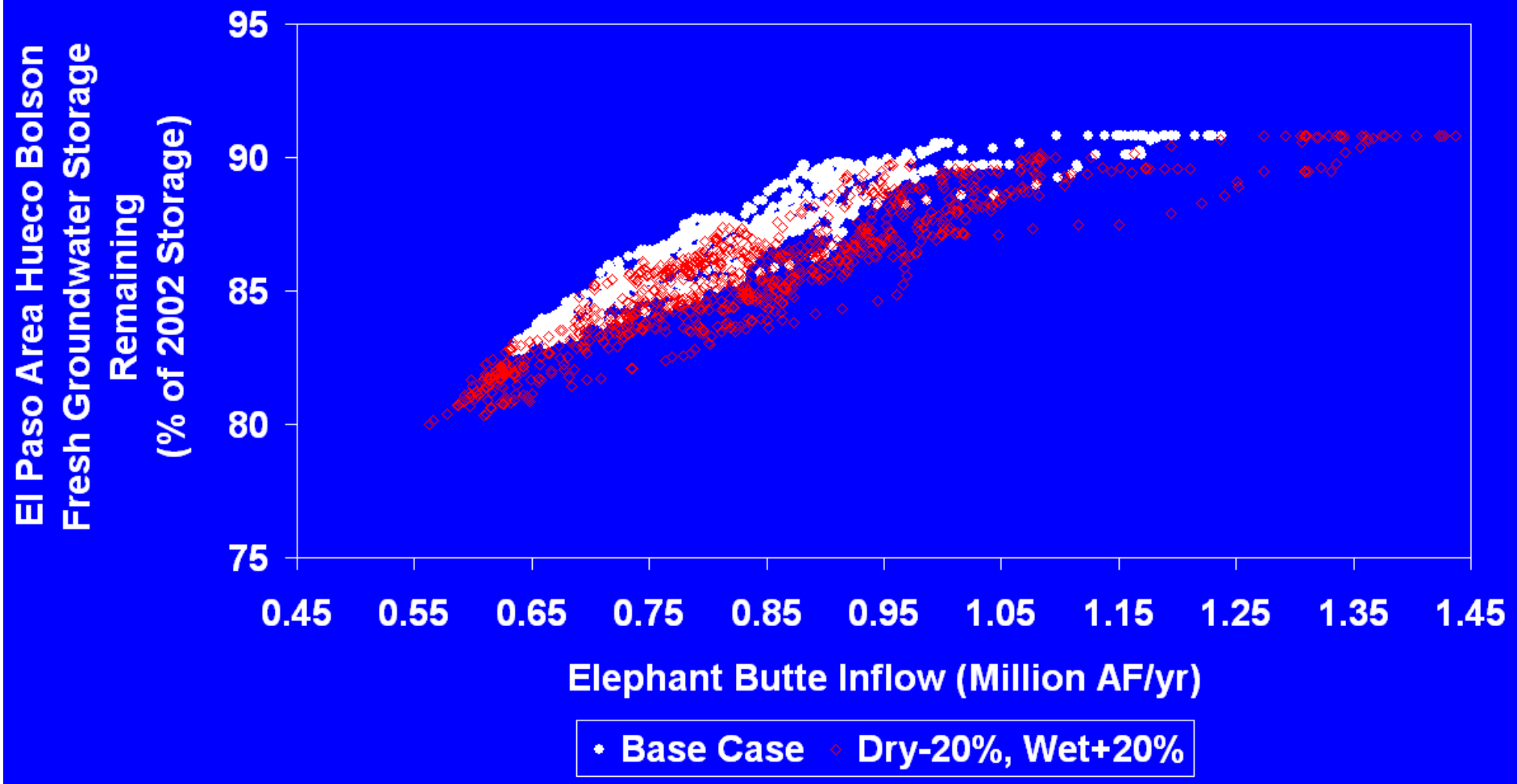
Elephant Butte Inflow vs. El Paso Area Hueco Bolson Fresh Groundwater Storage Remaining
Dry 5% Decrease, Wet 5% Increase



Elephant Butte Inflow vs. El Paso Area Hueco Bolson Fresh Groundwater Storage Remaining Dry 10% Decrease, Wet 10% Increase



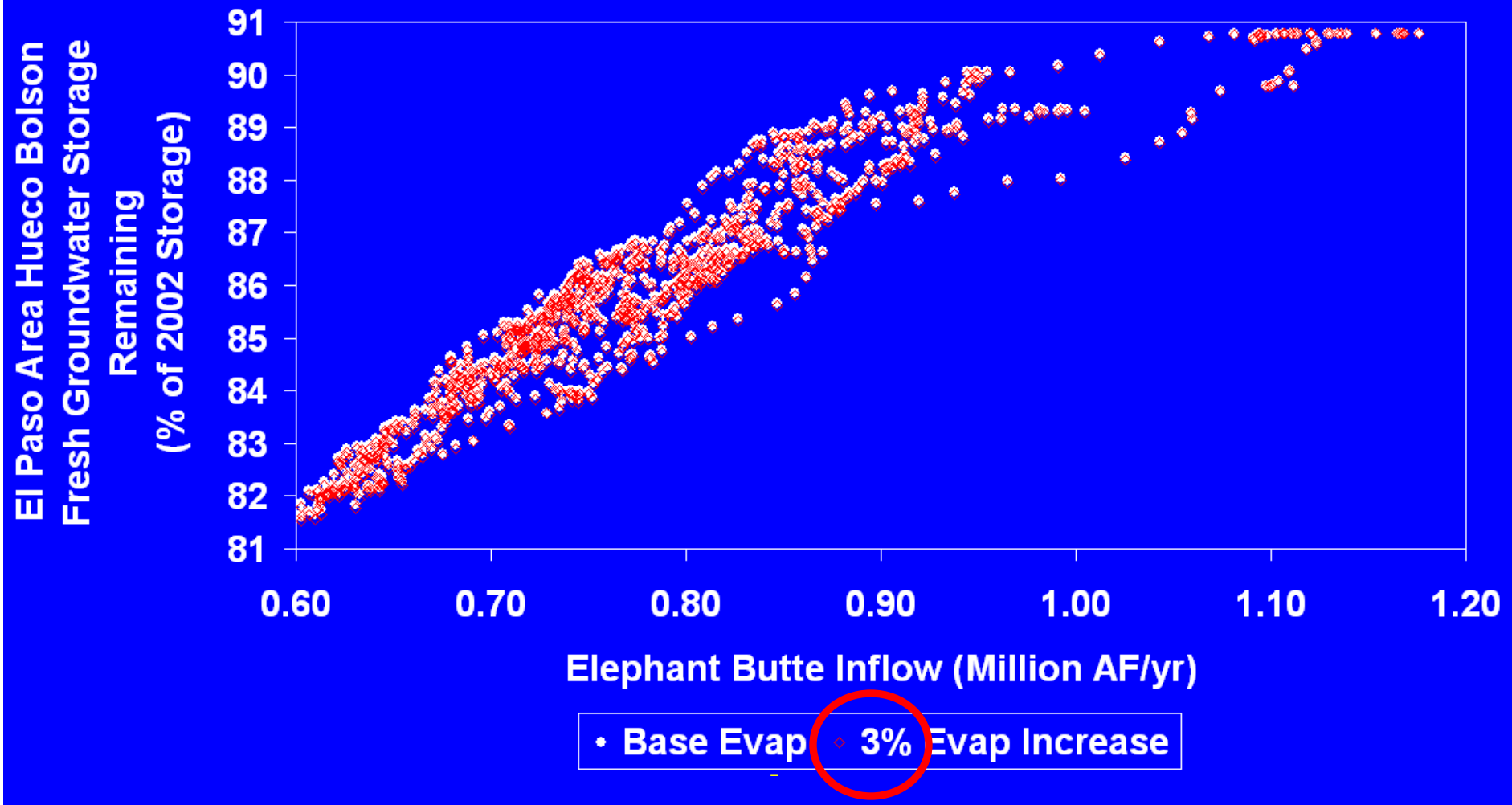
Elephant Butte Inflow vs. El Paso Area Hueco Bolson Fresh Groundwater Storage Remaining
Dry 20% Decrease, Wet 20% Increase



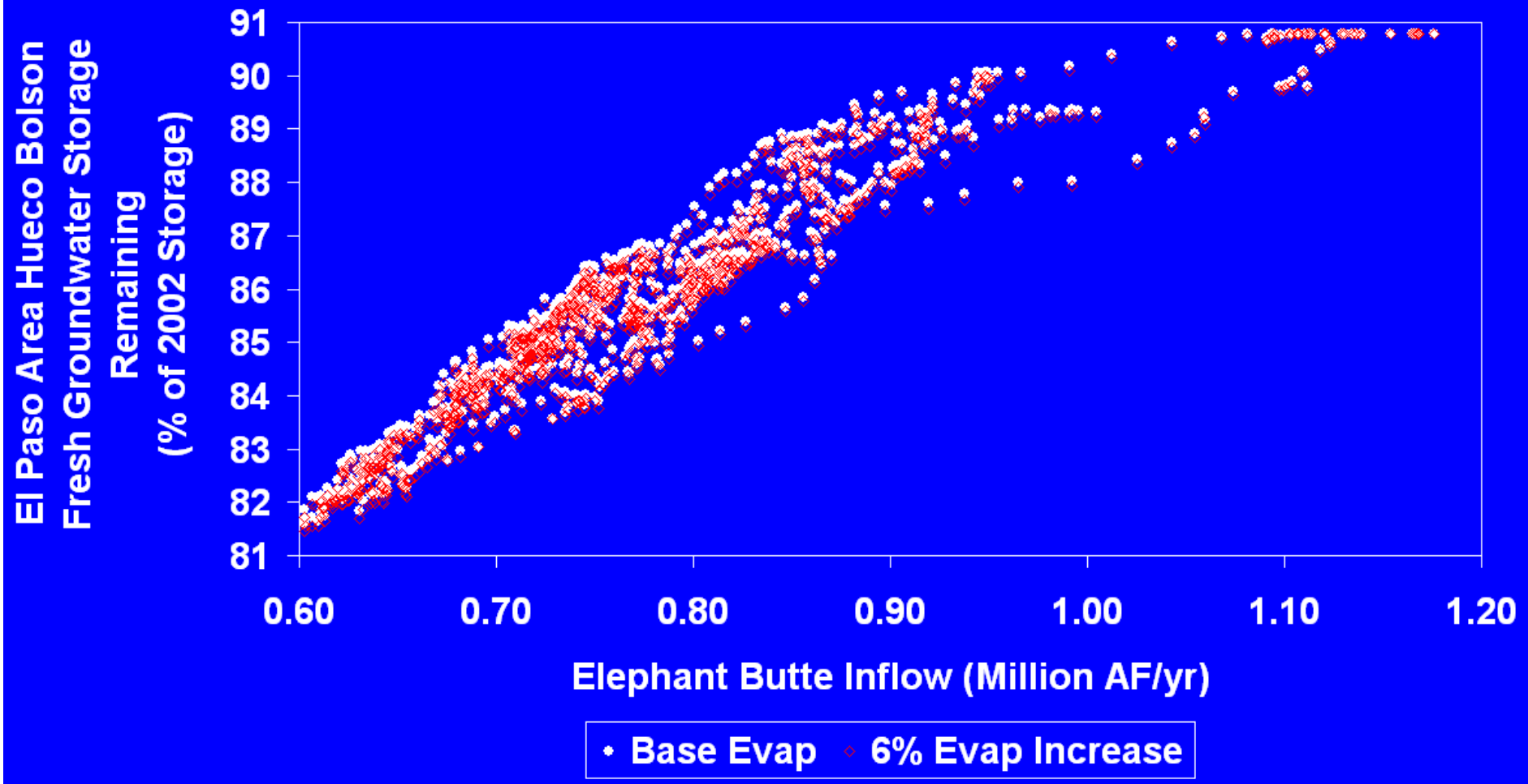
Impacts of Increased Evaporation

- 3 % (1°C)
- 6 % (2°C)
- 9 % (3°C)
- 12 % (4°C)
- 15 % (5°C)

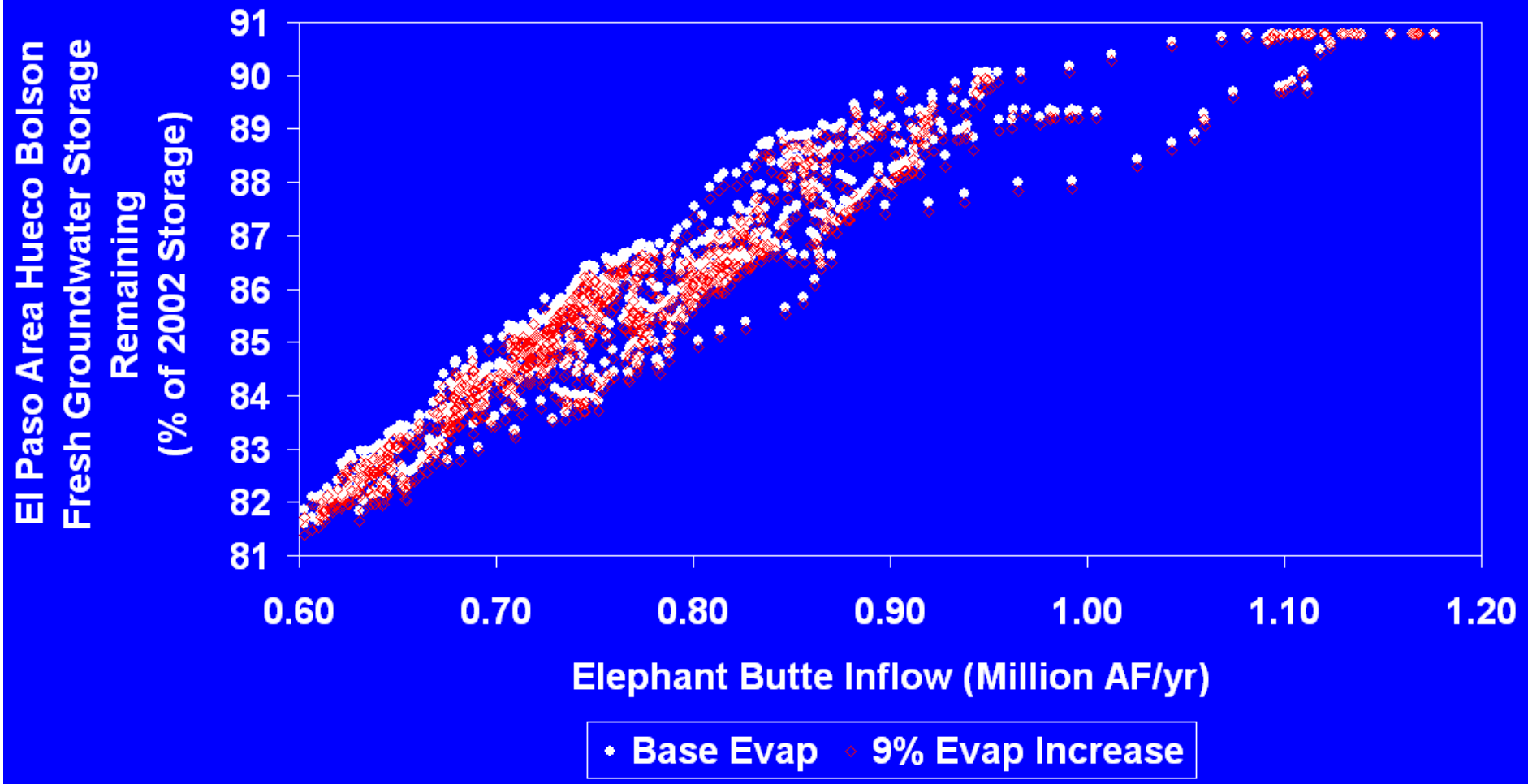
Elephant Butte Inflow vs. El Paso Area Hueco Bolson Fresh Groundwater Storage Remaining
5% Inflow Decrease, 0 to 3% Evaporation Increase



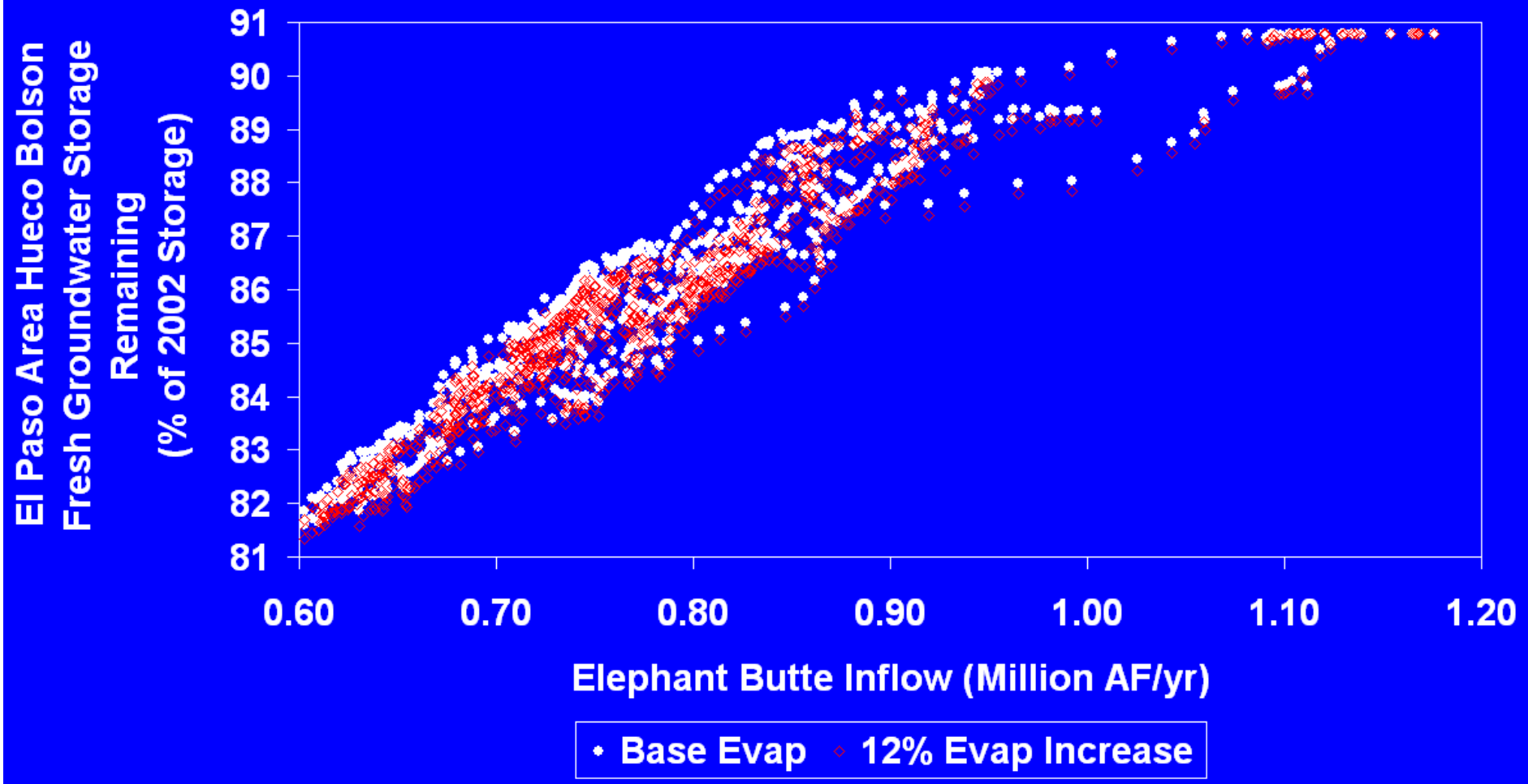
Elephant Butte Inflow vs. El Paso Area Hueco Bolson Fresh Groundwater Storage Remaining
5% Inflow Decrease, 0 to 6% Evaporation Increase



Elephant Butte Inflow vs. El Paso Area Hueco Bolson Fresh Groundwater Storage Remaining
5% Inflow Decrease, 0 to 9% Evaporation Increase



Elephant Butte Inflow vs. El Paso Area Hueco Bolson Fresh Groundwater Storage Remaining
5% Inflow Decrease, 0 to 12% Evaporation Increase



Findings (Surface Water)

- Increased Temperature (up to 5°C) will have no impact on El Paso Municipal Supplies
  - Did not consider impacts on demand
- IPCC predictions on precipitation are mixed
  - Past 1,000 years suggest that future changes in EB inflow are likely (natural variability)
  - IPCC predicts that even more change is possible (wetter? or drier?)

Findings (Surface Water)

- Elephant Butte Inflow Change:
  - Natural variability
  - Impacts from upstream land use changes
  - Changes in upstream diversion patterns
  - Increased CO_2 impacts (IPCC)

Findings (Groundwater Resources)

- Fresh groundwater storage will be > 75% of 2002 condition in 2060 under current management approach
  - Insignificant relative to meeting municipal demand
- Conservative Analysis:
  - RG Flow in El Paso varies only with “cool season” EB inflow
  - Recharge from summer monsoons ignored

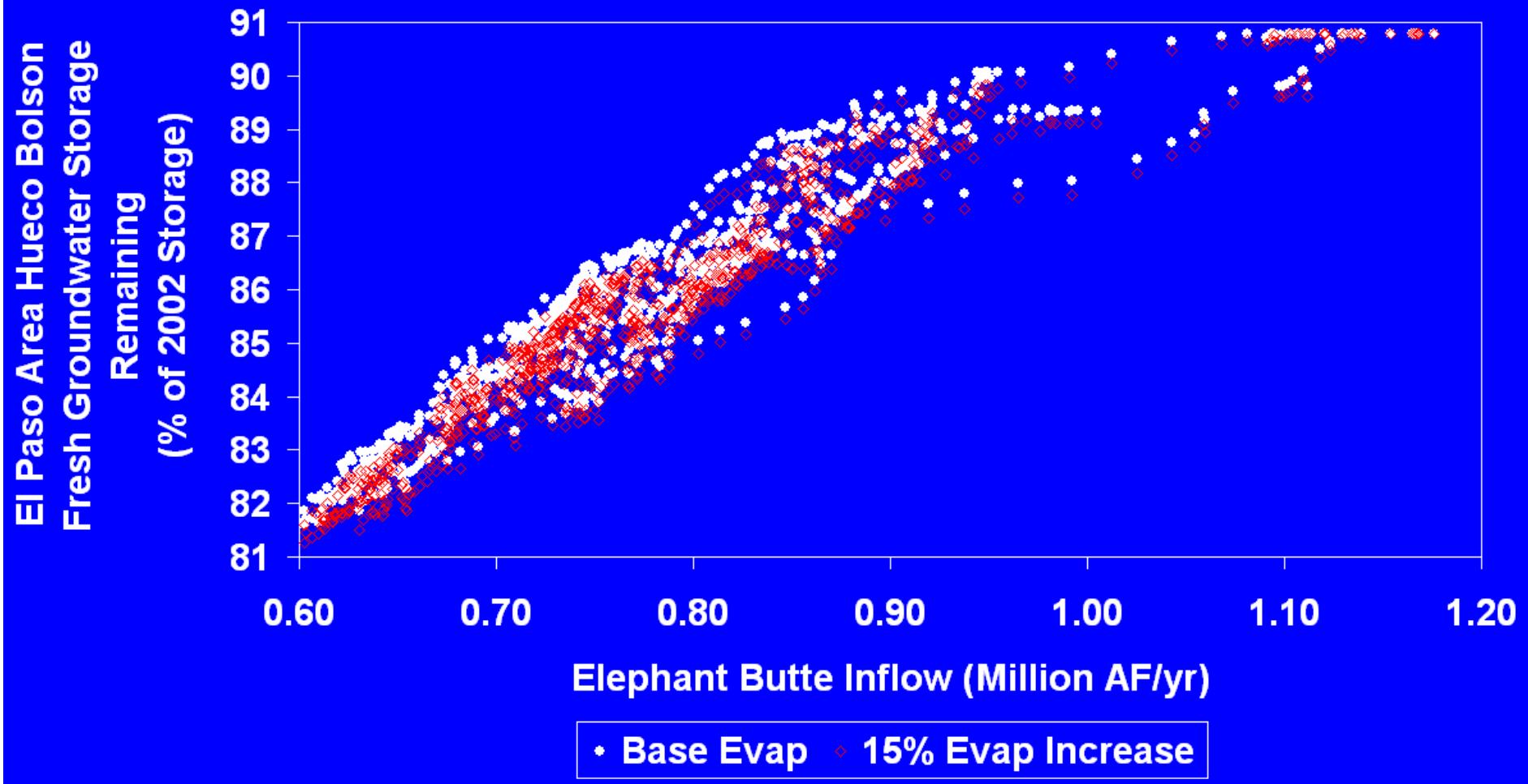
Findings
(Groundwater Infrastructure)

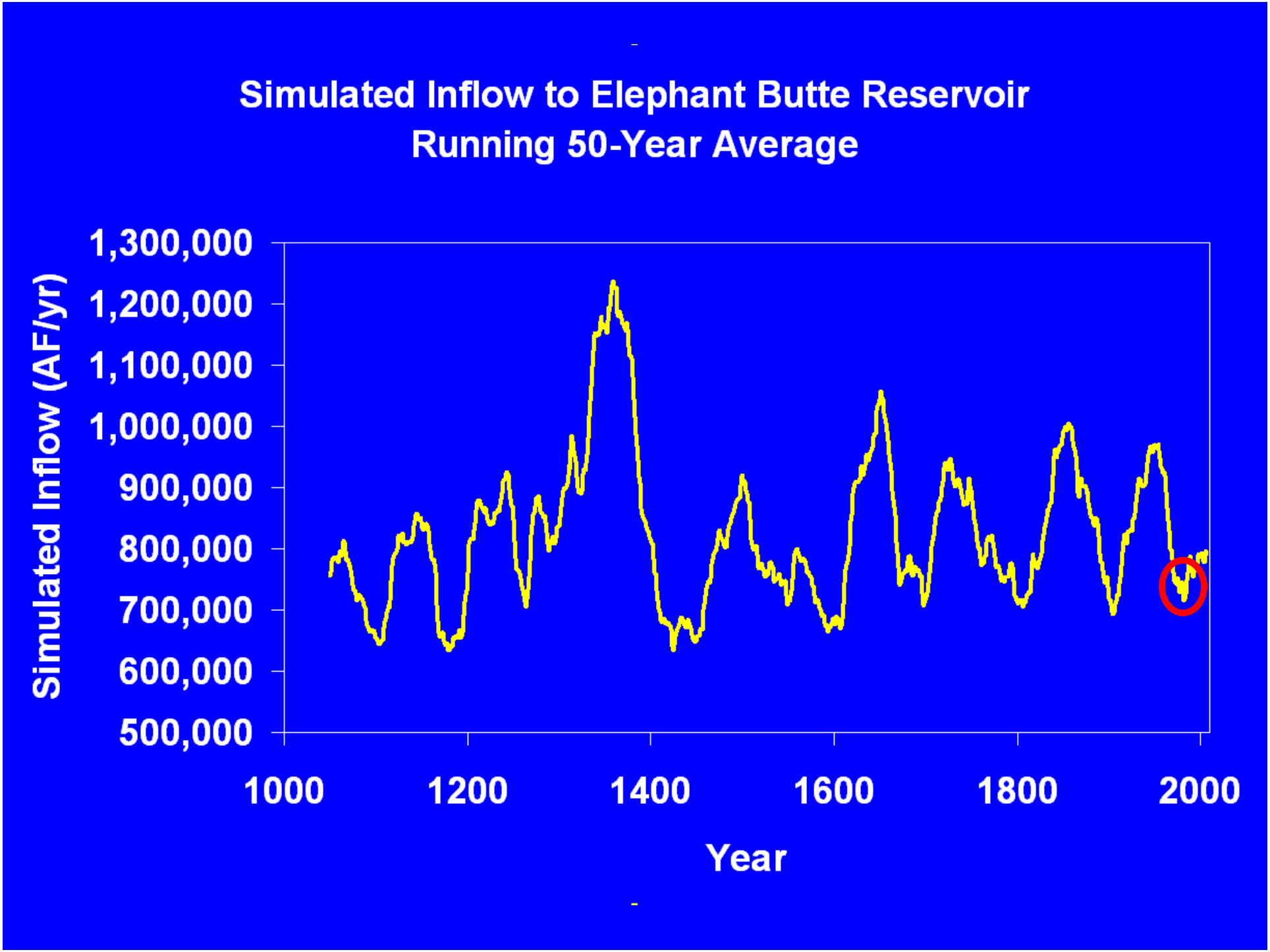
- Even under the most extreme surface flow reduction:
  - Groundwater infrastructure will be adequate for the next 50 years
  - Meeting conjunctive use objectives in 2006 Region E plan is feasible

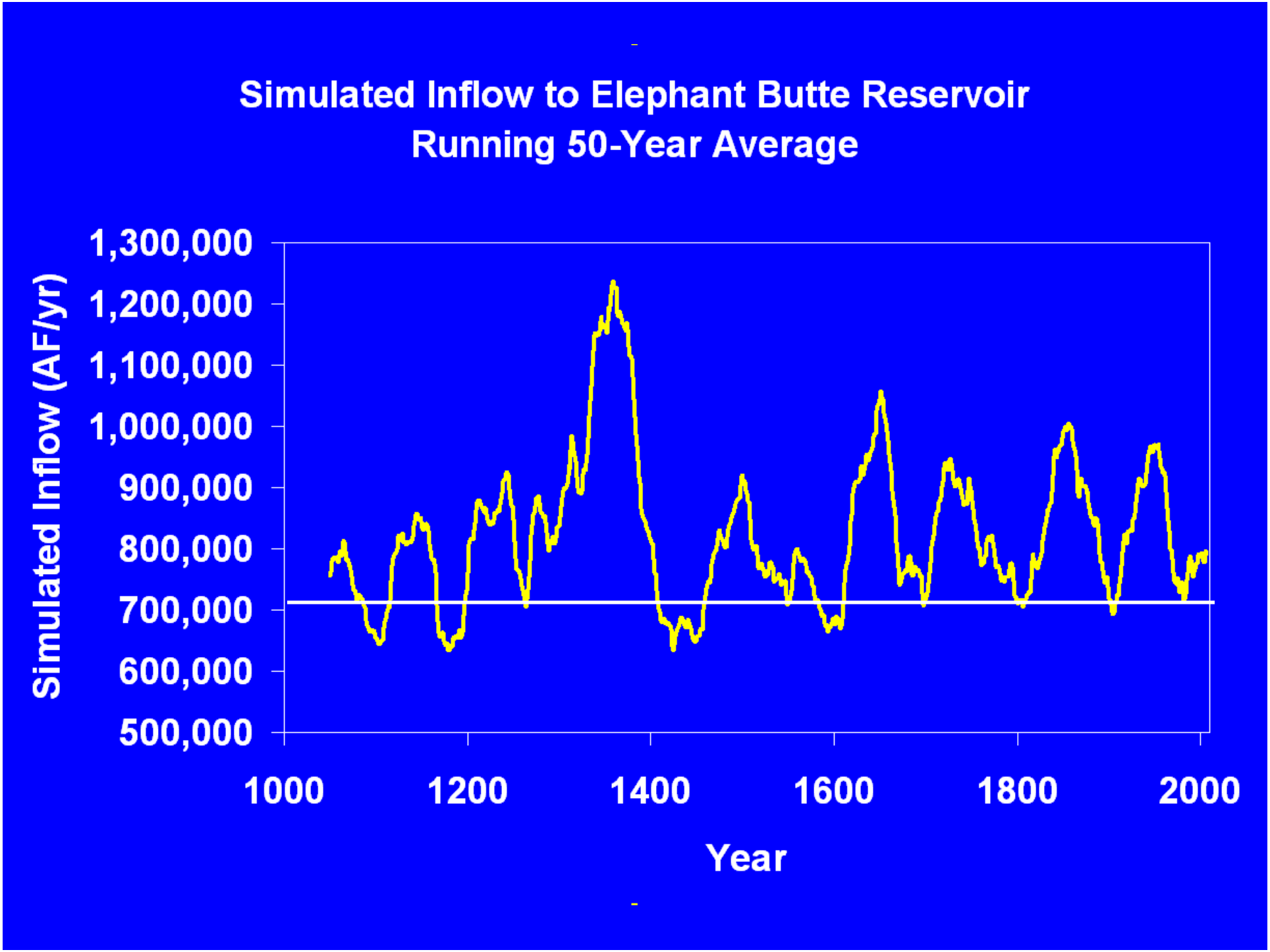
Regional Planning

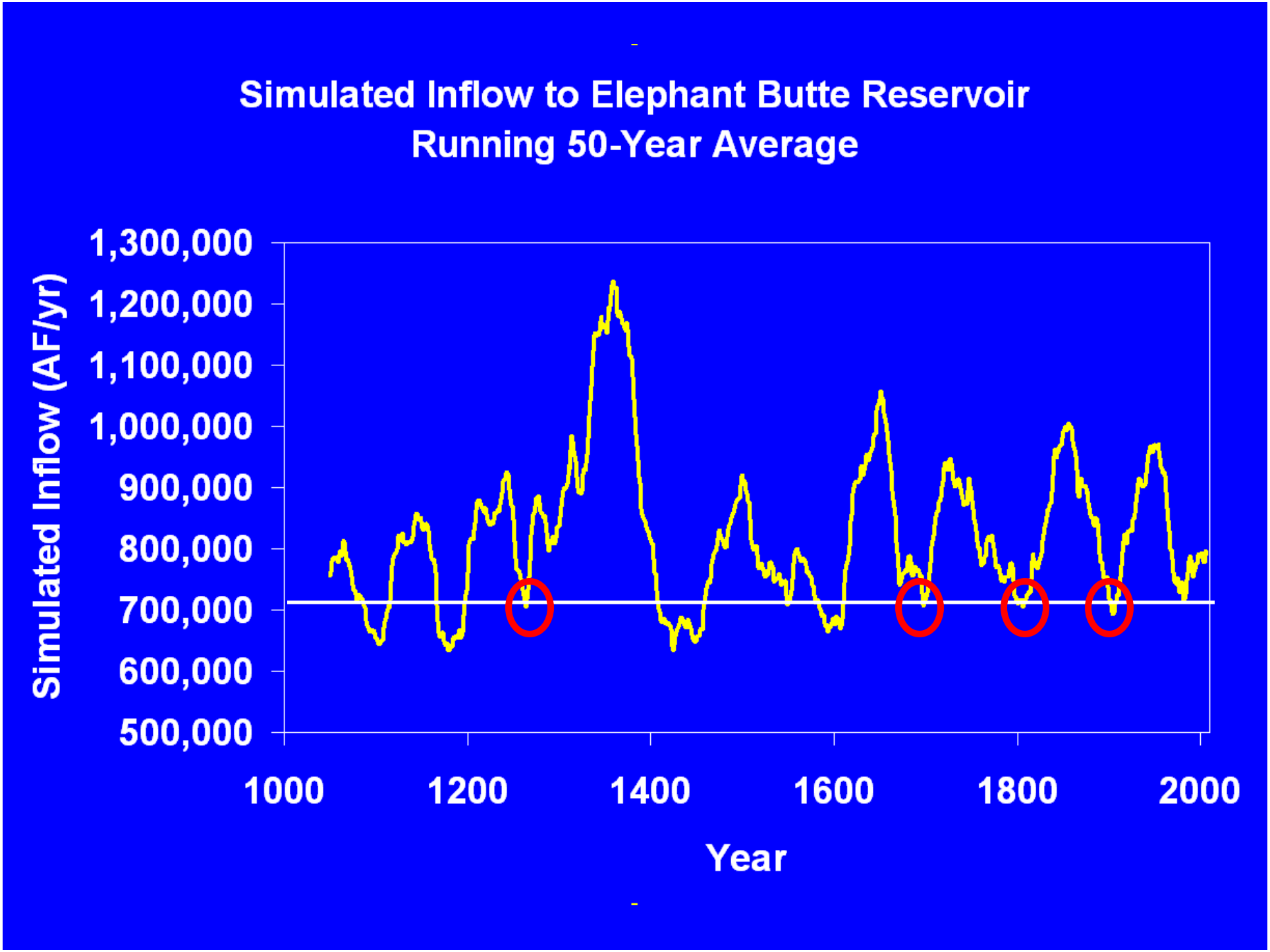
- "Drought of Record"
  - Current Requirement
- Management Strategies need to be viewed in context of more complete history

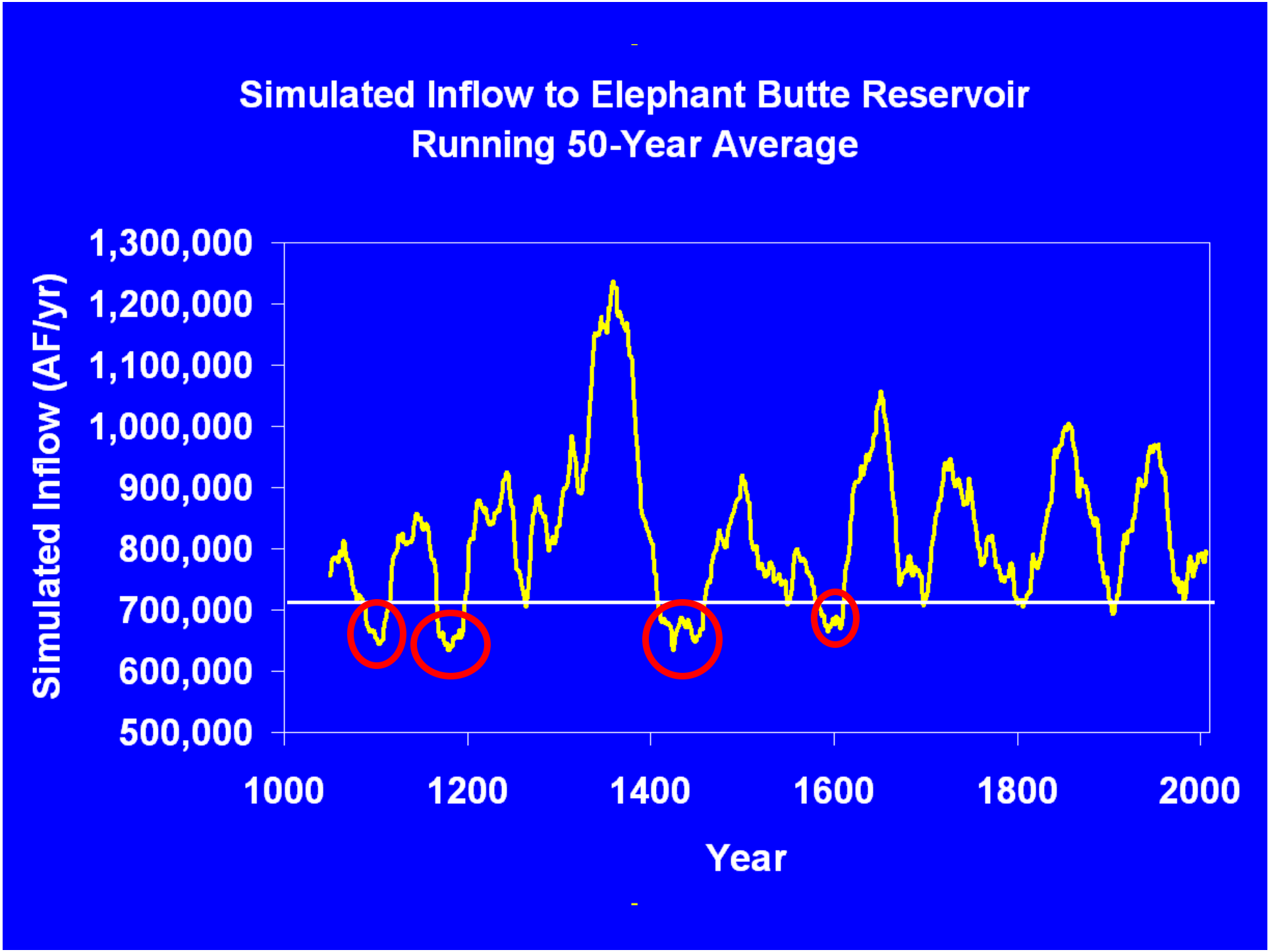
Elephant Butte Inflow vs. El Paso Area Hueco Bolson Fresh Groundwater Storage Remaining
5% Inflow Decrease, 0 to 15% Evaporation Increase




Simulated Inflow to Elephant Butte Reservoir
Running 50-Year Average
Simulated Inflow (AF/yr)
1,300,000
1,200,000
1,100,000
1,000,000
900,000
800,000
700,000
600,000
500,000
1000
1200
1400
1600
1800
2000
Year


Simulated Inflow to Elephant Butte Reservoir
Running 50-Year Average
Simulated Inflow (AF/yr)
1,300,000
1,200,000
1,100,000
1,000,000
900,000
800,000
700,000
600,000
500,000
1000
1200
1400
1600
1800
2000
Year


Simulated Inflow to Elephant Butte Reservoir
Running 50-Year Average
Simulated Inflow (AF/yr)
1,300,000
1,200,000
1,100,000
1,000,000
900,000
800,000
700,000
600,000
500,000
1000
1200
1400
1600
1800
2000
Year

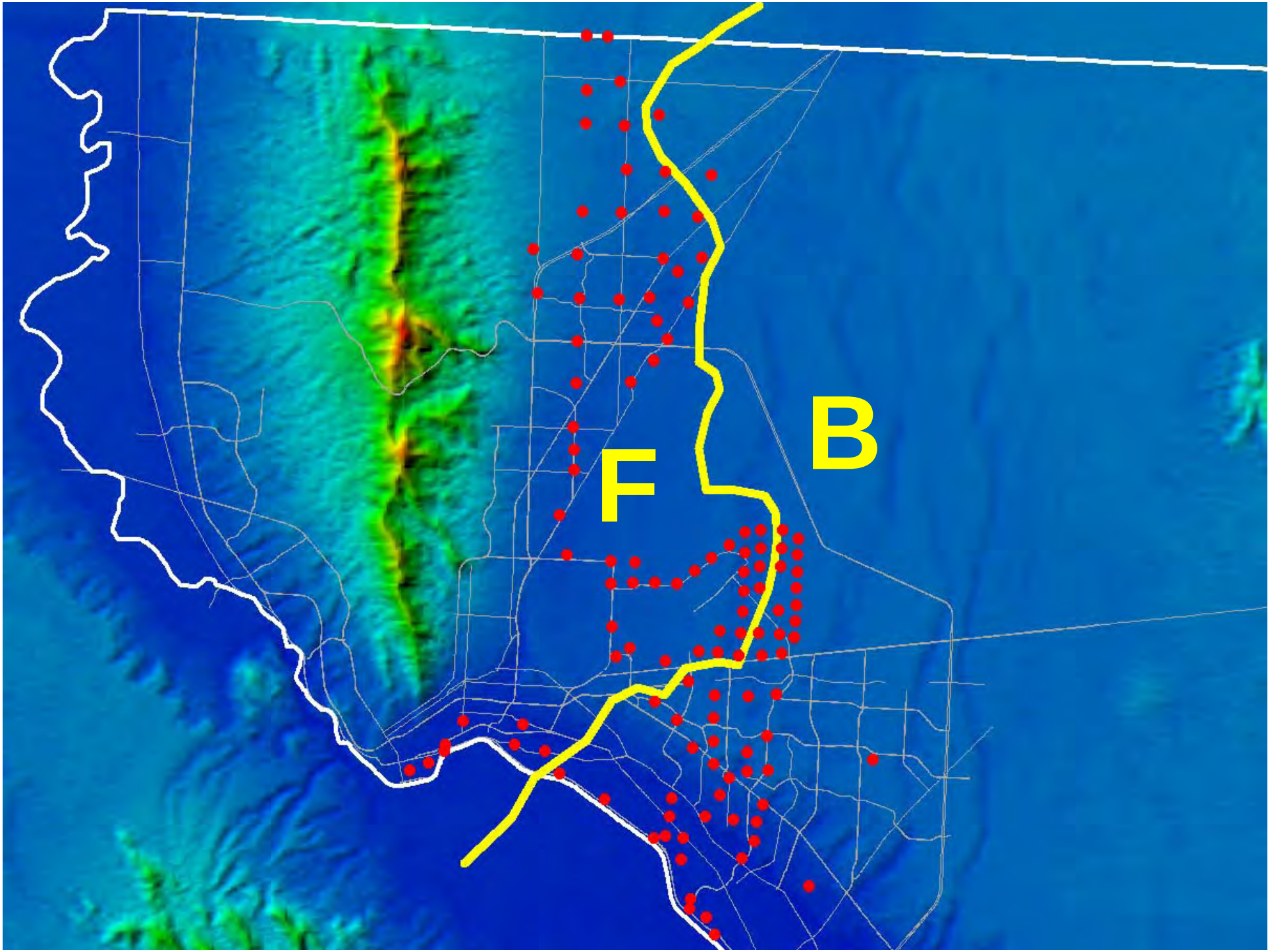

Simulated Inflow to Elephant Butte Reservoir
Running 50-Year Average
Simulated Inflow (AF/yr)
1,300,000
1,200,000
1,100,000
1,000,000
900,000
800,000
700,000
600,000
500,000
1000
1200
1400
1600
1800
2000
Year

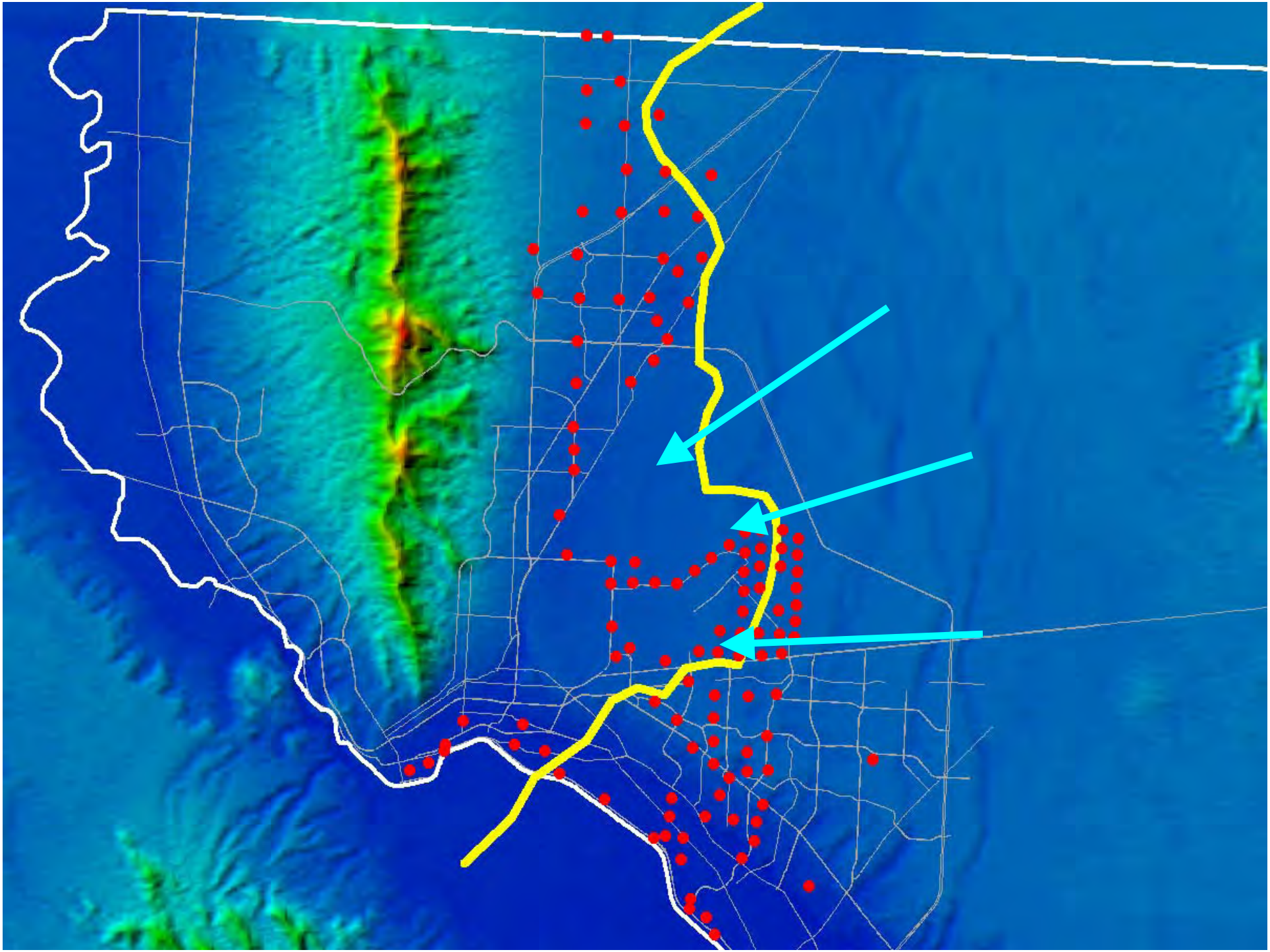
Is El Paso Vulnerable?

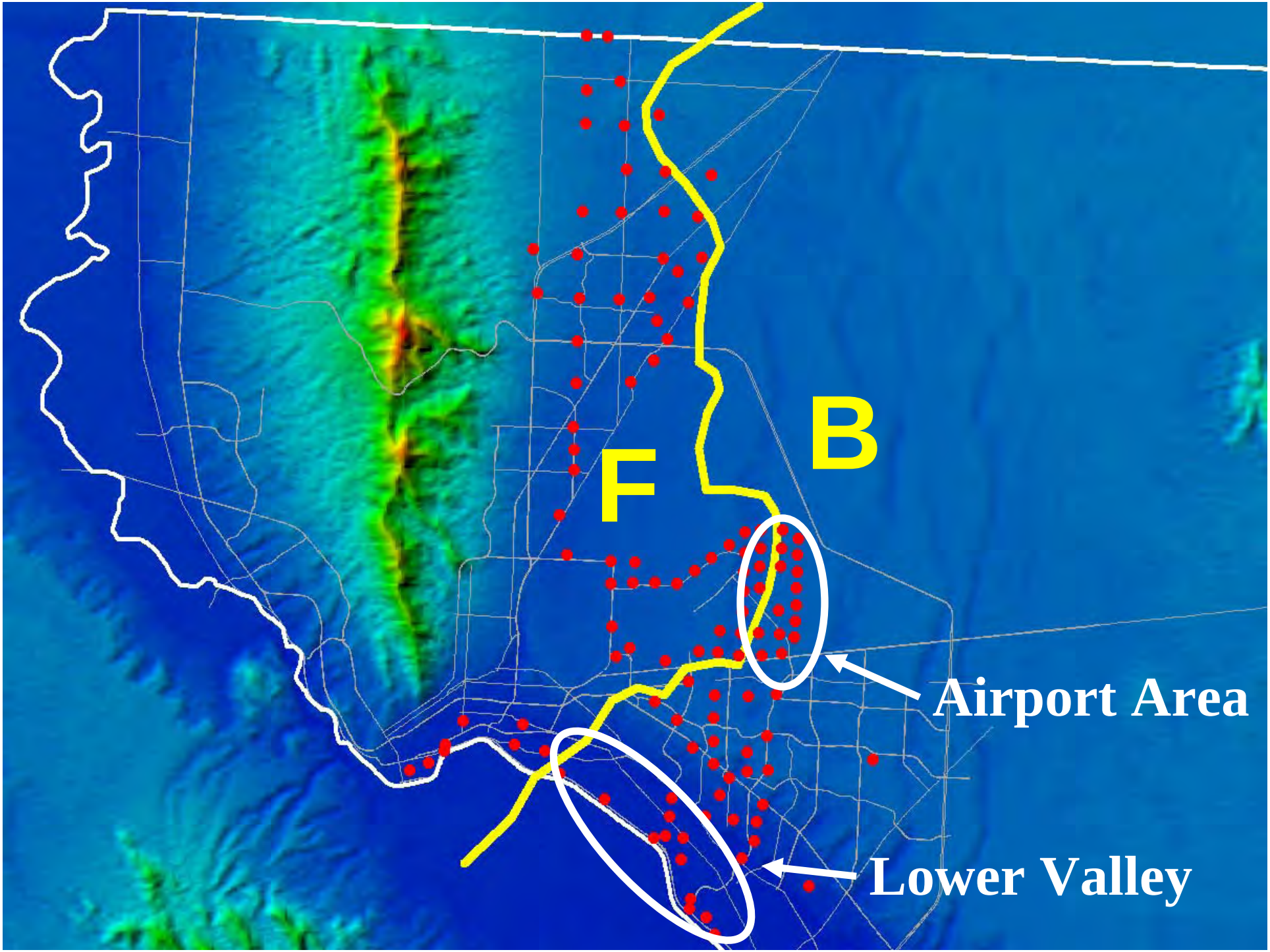
- Past EPWU/PSB investments were designed to deal with climatic variability
- Infrastructure and management approaches are adequate to meet goals of 2006 Region E Plan
  - Historic (1000 yr) variability
  - IPCC Predictions

Desalination Projects

- Component of Conjunctive Use Management
  - Utilize Local Brackish Groundwater
  - Manage Local Fresh Groundwater


F
B



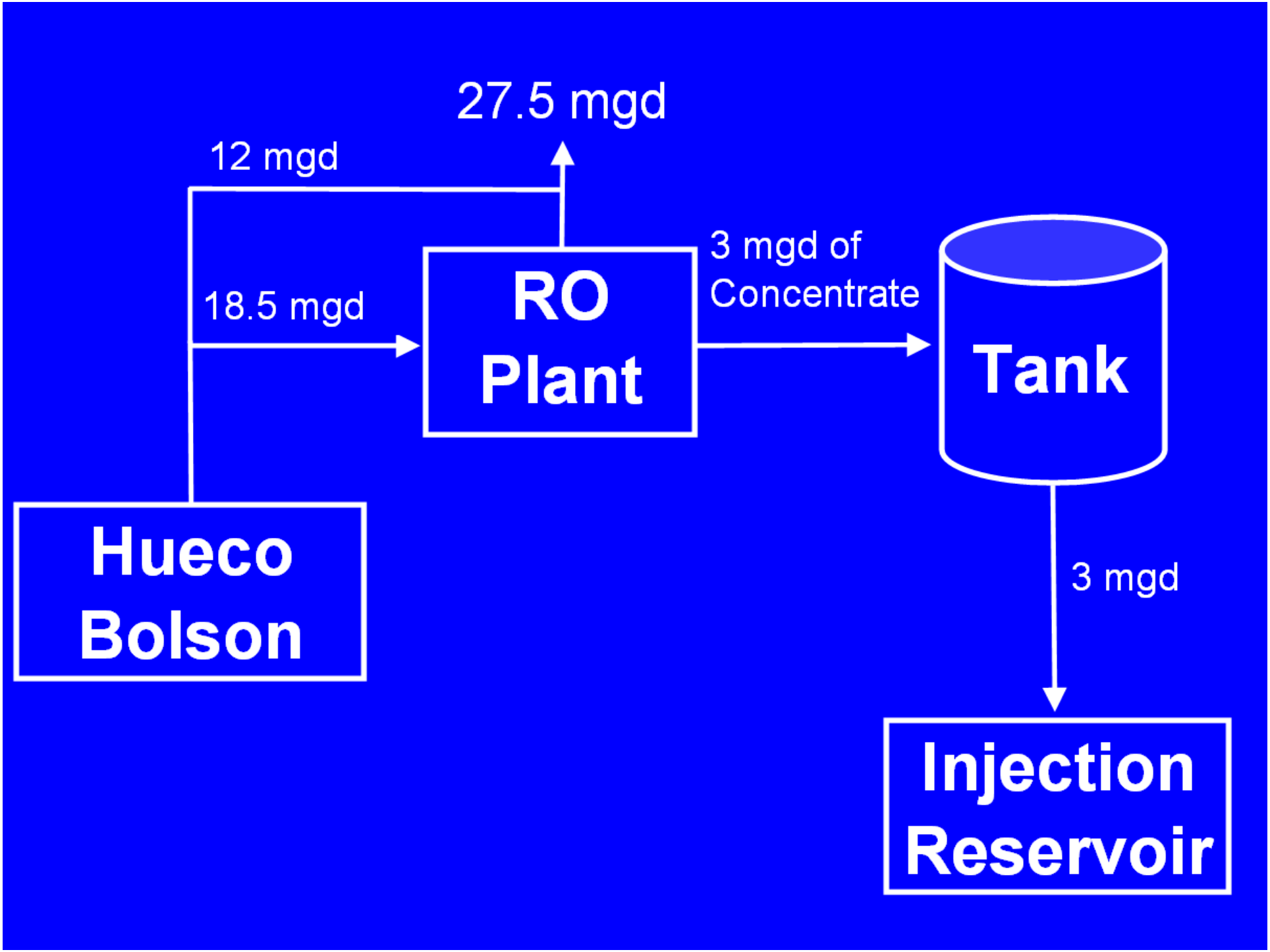

F
B
Airport Area
Lower Valley

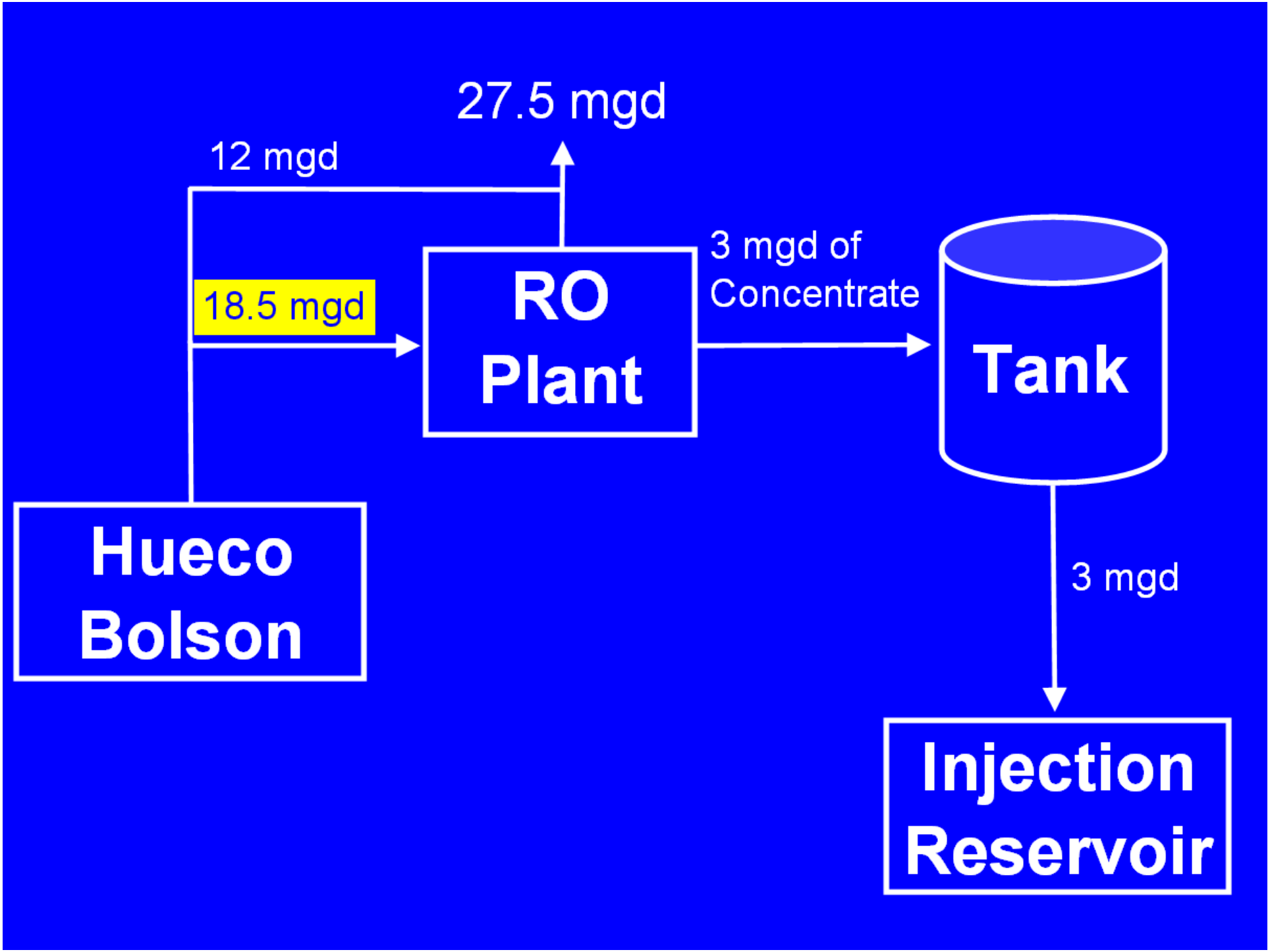
Desalination Projects

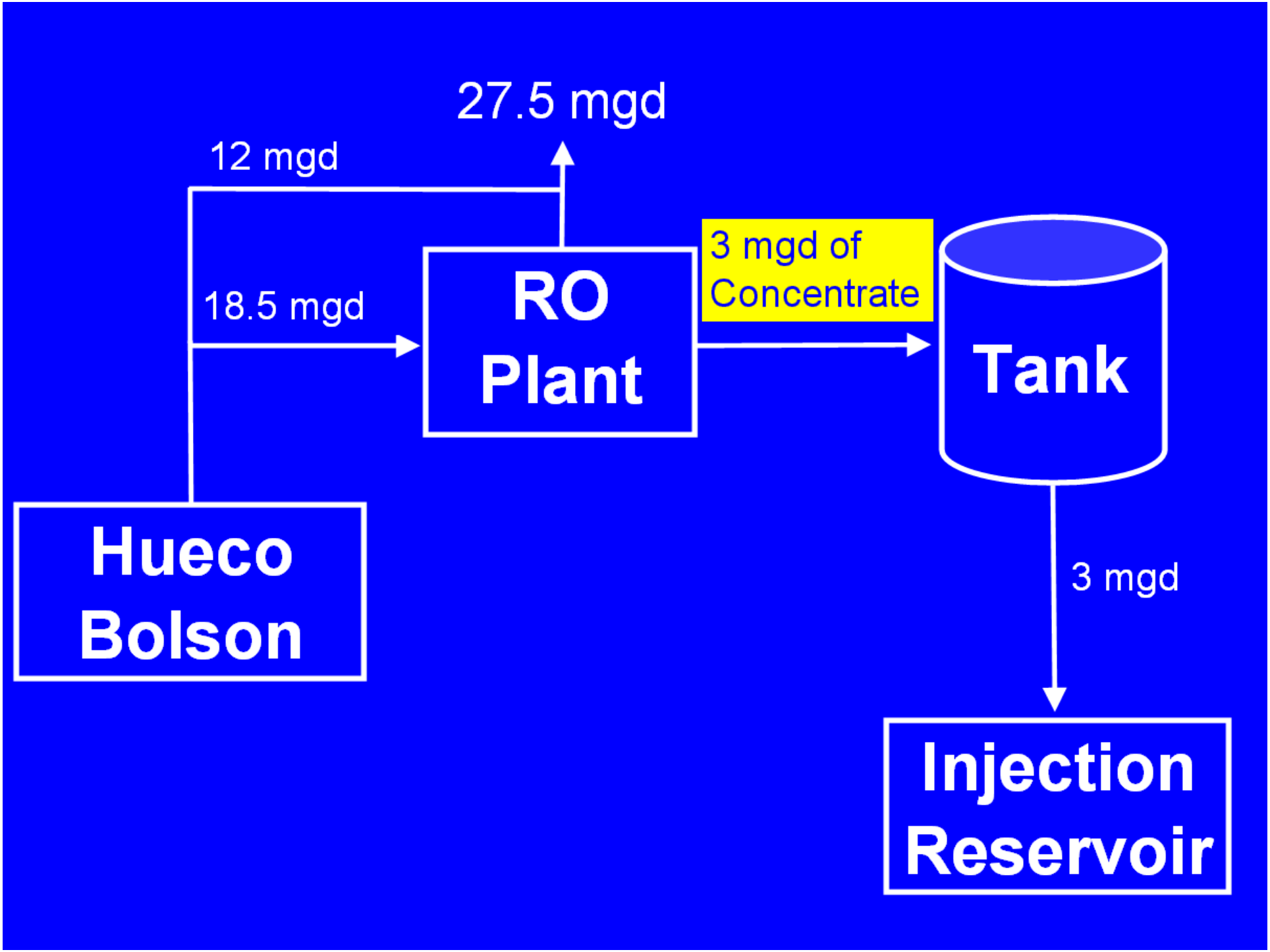
- 11 Wellhead Units (Lower Valley)
  - Completed in 2004
- 27.5 mgd Desalination Plant (Airport Area)
  - Completed in 2007

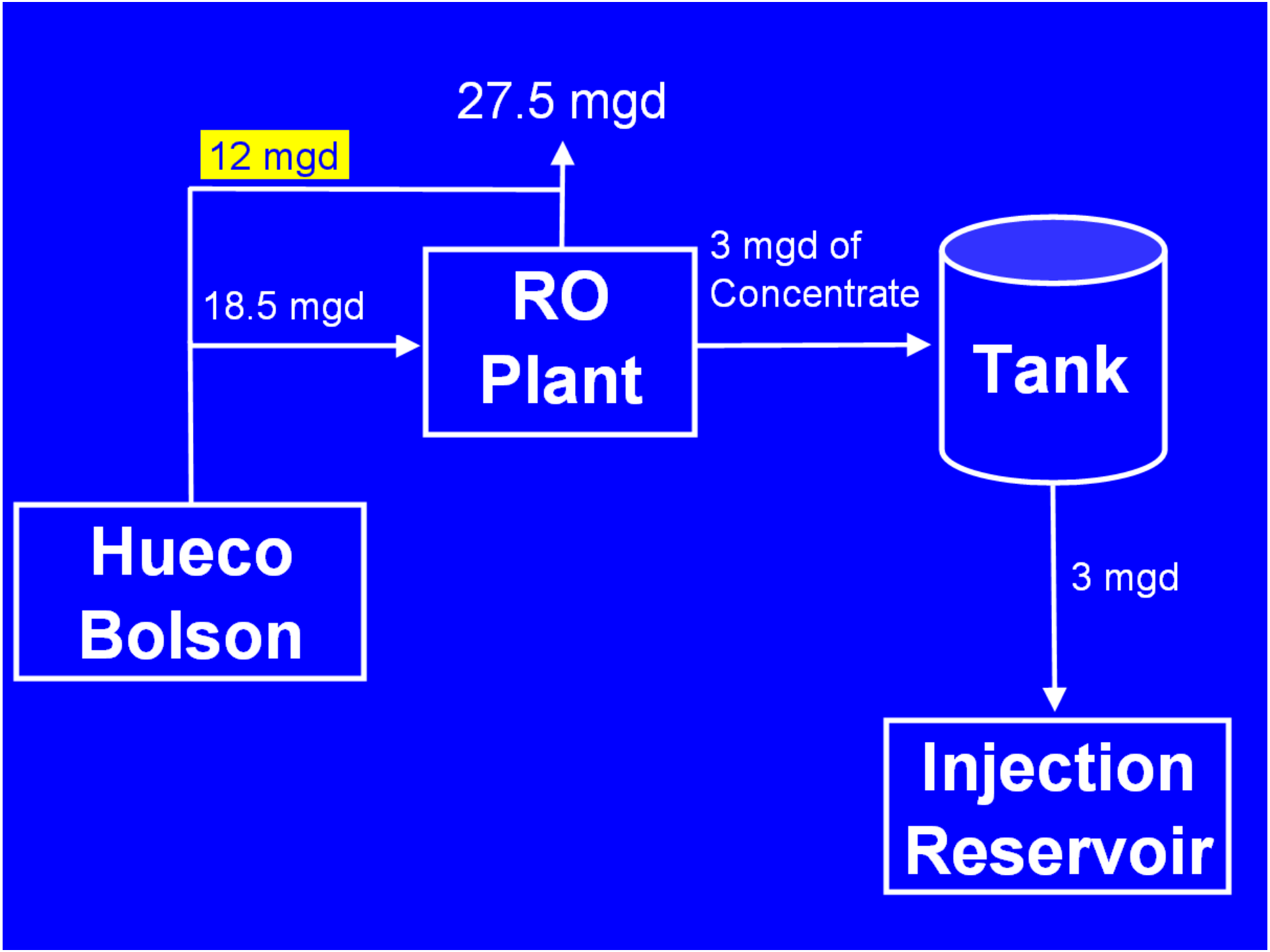
Kay Bailey Hutchison Desalination Plant

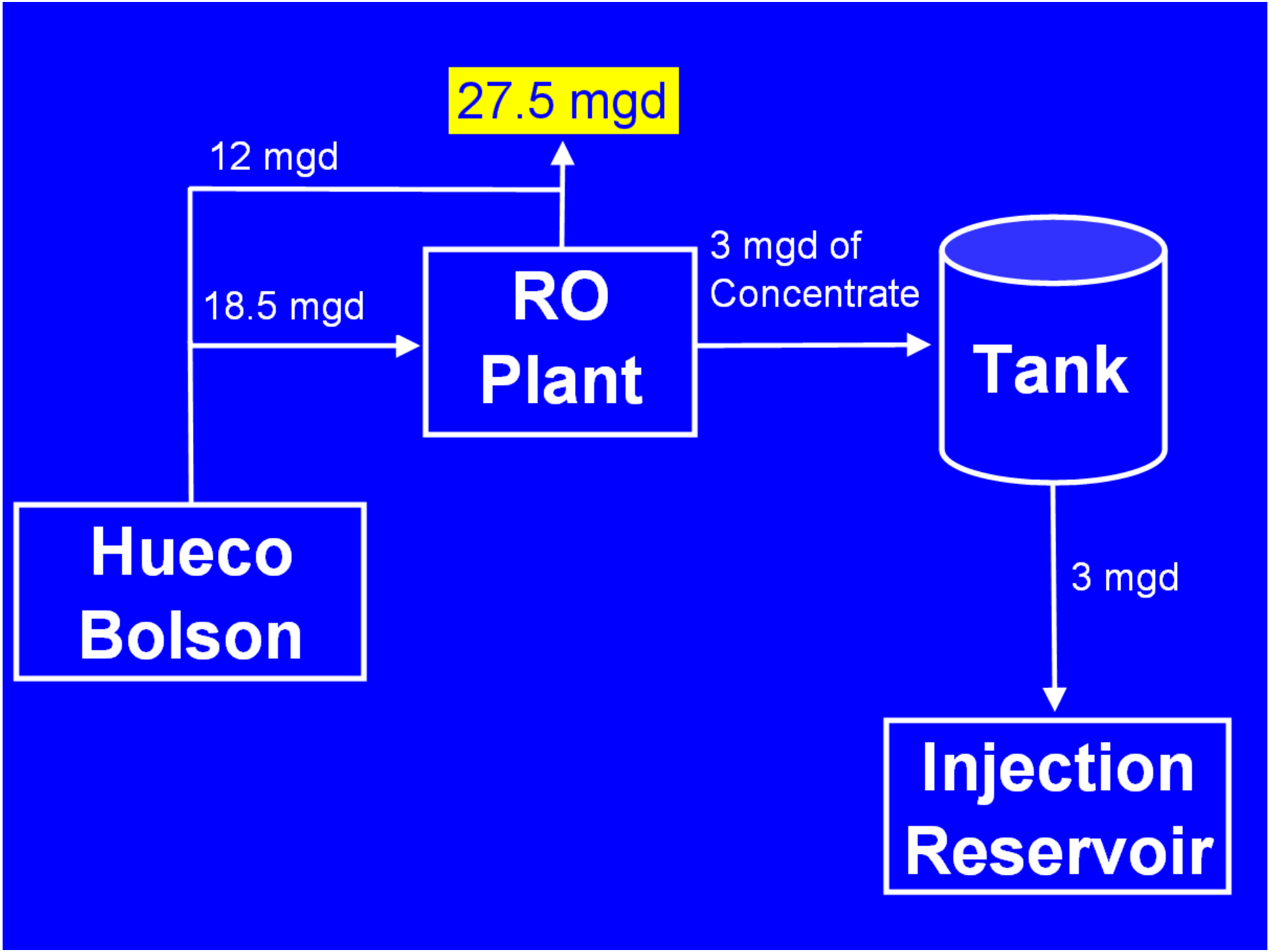
- Desalination Plant and some wells located on Ft Bliss
- Concentrate disposal by injection well


27.5 mgd
12 mgd
18.5 mgd
RO Plant
3 mgd of Concentrate
Tank
Hueco Bolson
3 mgd
Injection Reservoir


27.5 mgd
12 mgd
18.5 mgd
RO Plant
3 mgd of Concentrate
Tank
Hueco Bolson
3 mgd
Injection Reservoir

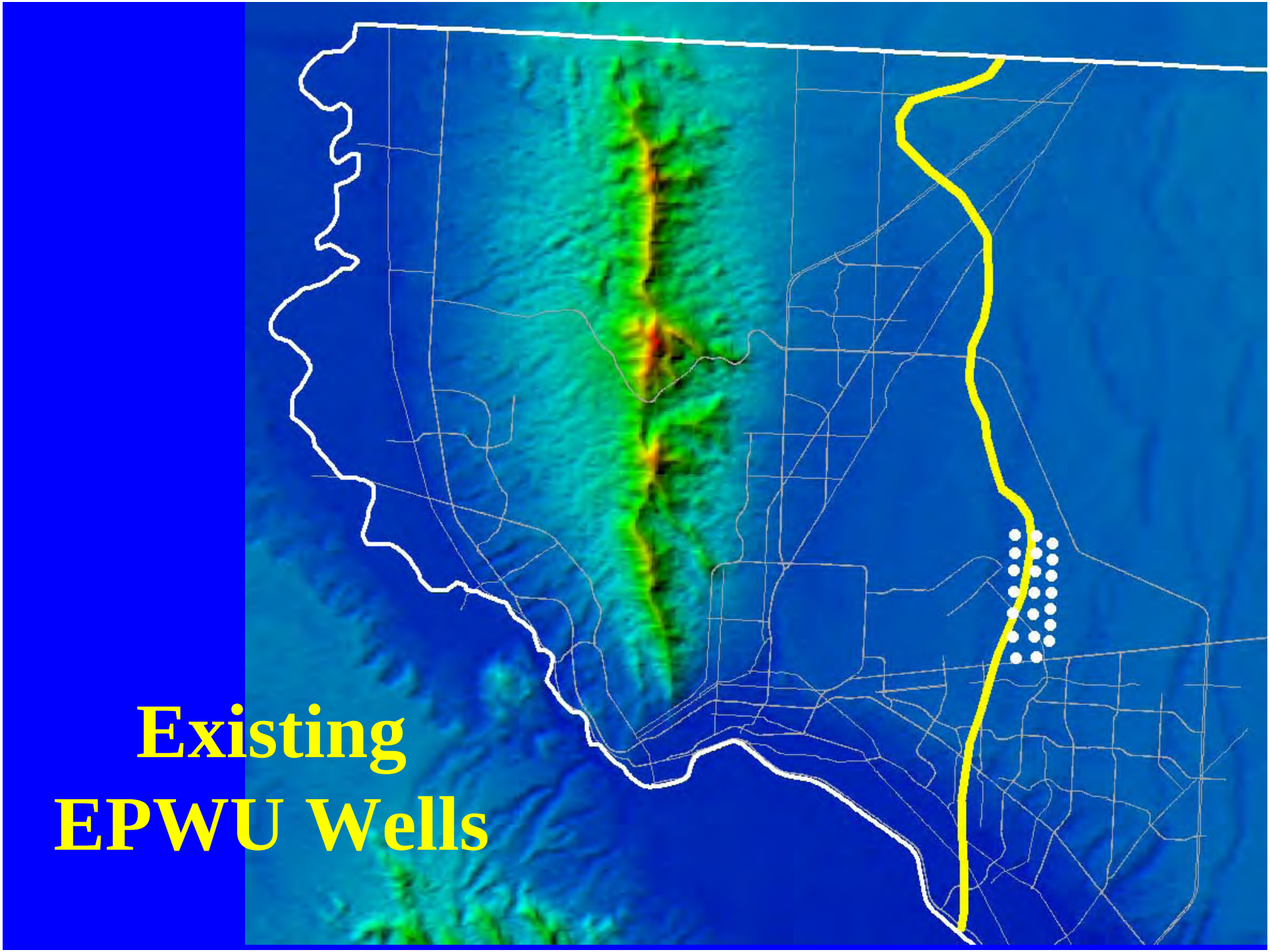

27.5 mgd
12 mgd
18.5 mgd
RO Plant
3 mgd of Concentrate
Tank
3 mgd
Hueco Bolson
Injection Reservoir

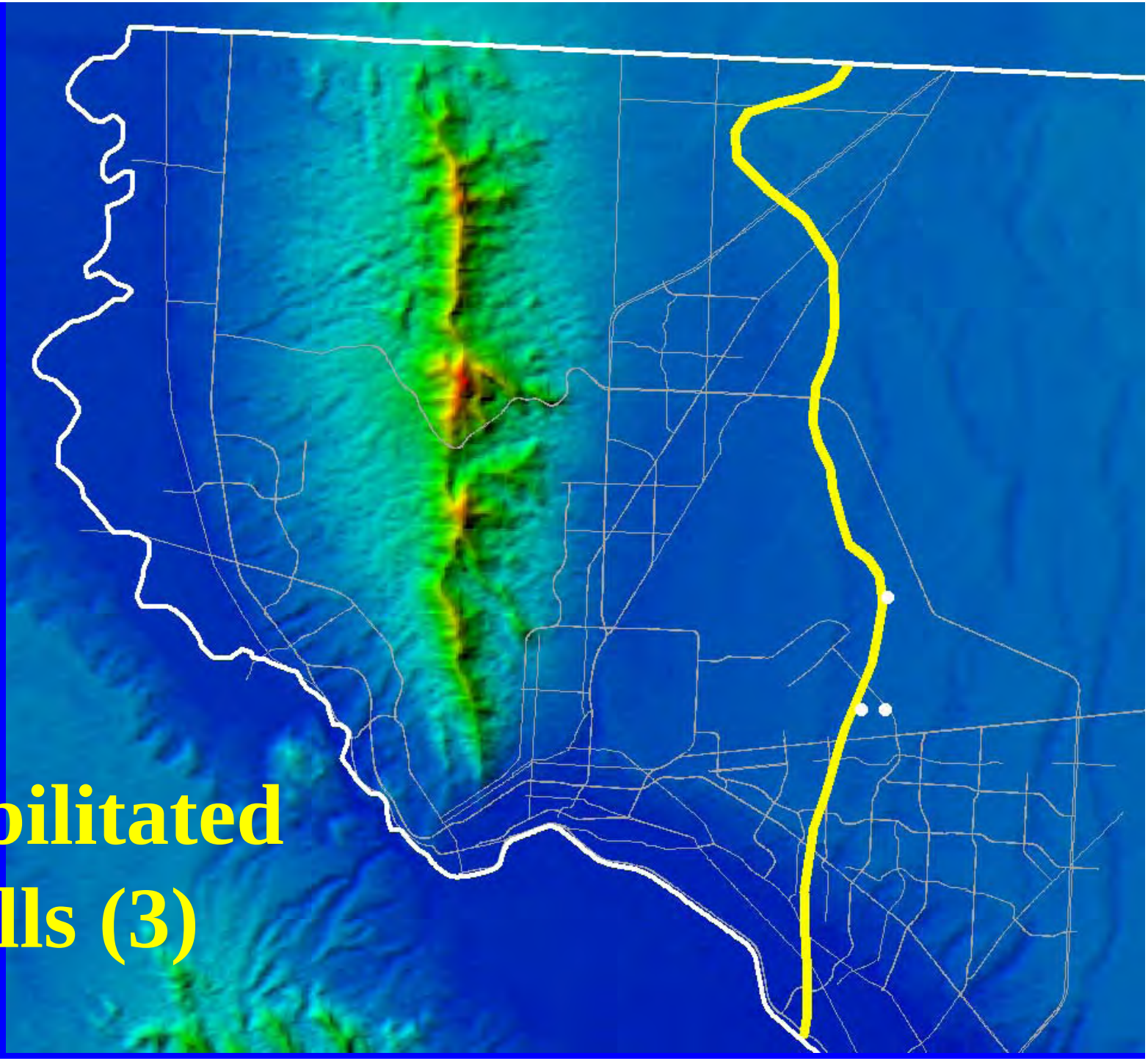

27.5 mgd
12 mgd
18.5 mgd
RO Plant
3 mgd of Concentrate
Tank
Hueco Bolson
3 mgd
Injection Reservoir


27.5 mgd
12 mgd
18.5 mgd
RO Plant
3 mgd of Concentrate
Tank
Hueco Bolson
3 mgd
Injection Reservoir

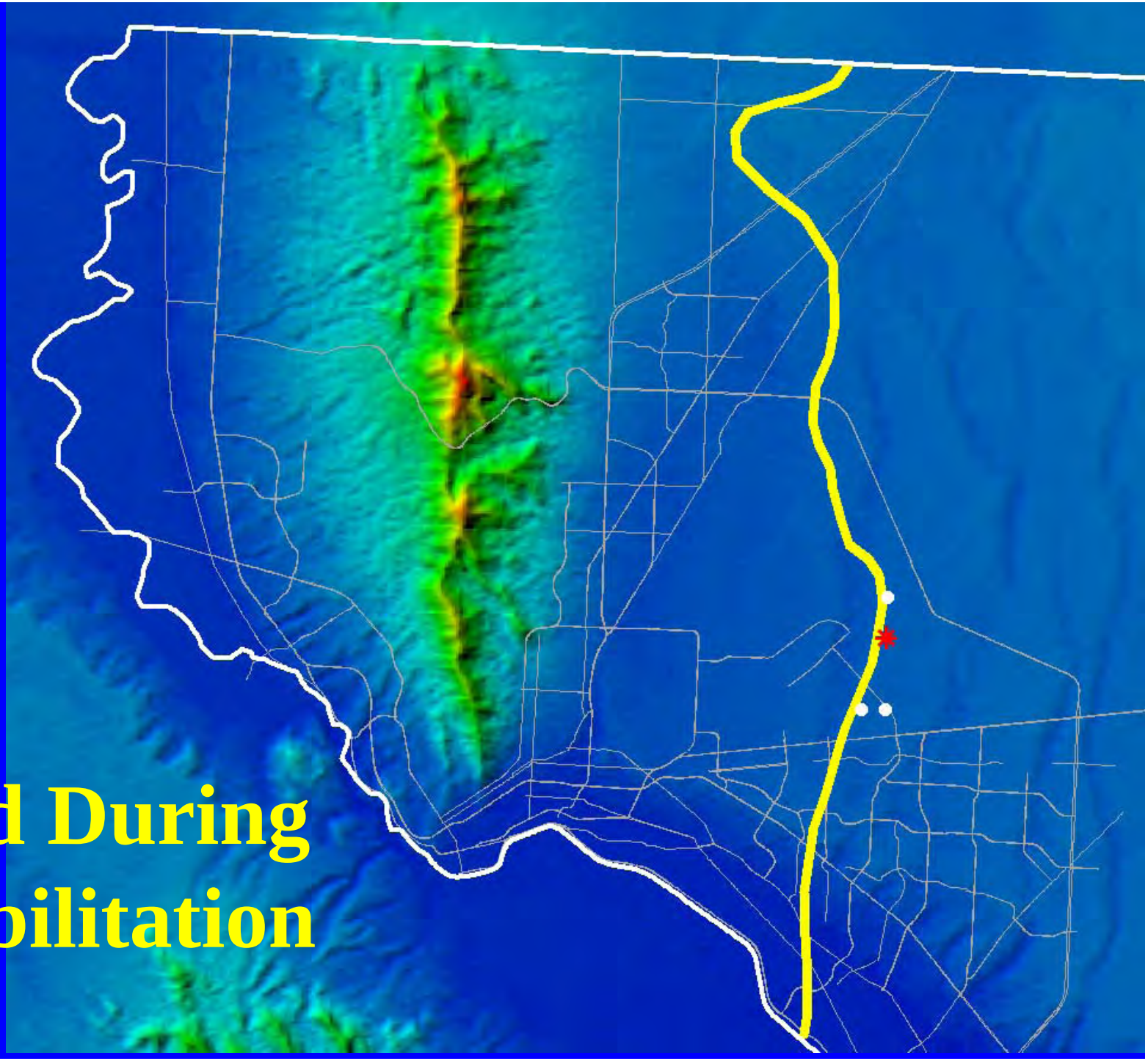
Major Components

- Production Wells and Collector Lines
- Plant and Near-Plant Piping
- Concentrate Disposal Wells and Pipelines

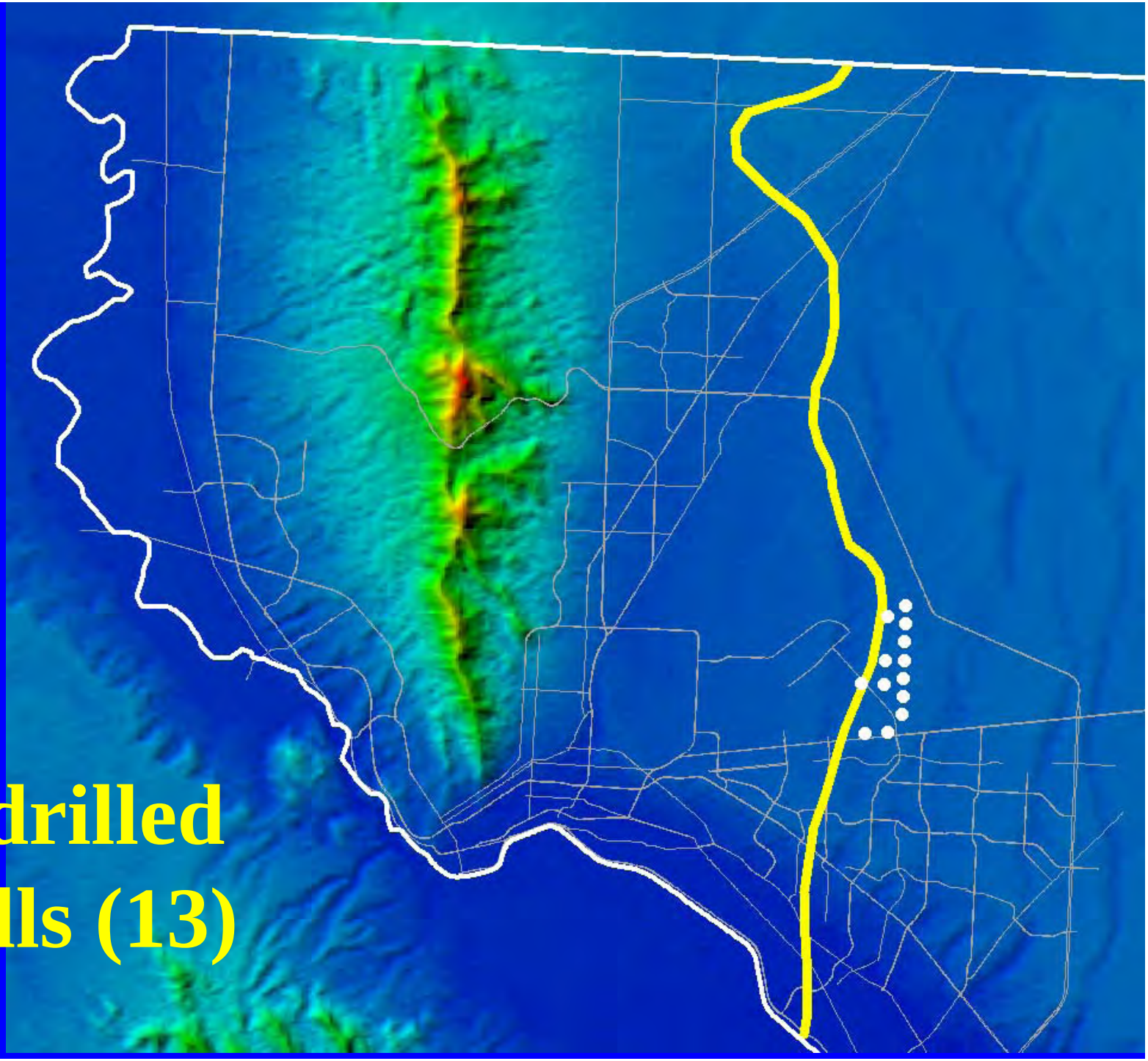

Existing
EPWU Wells



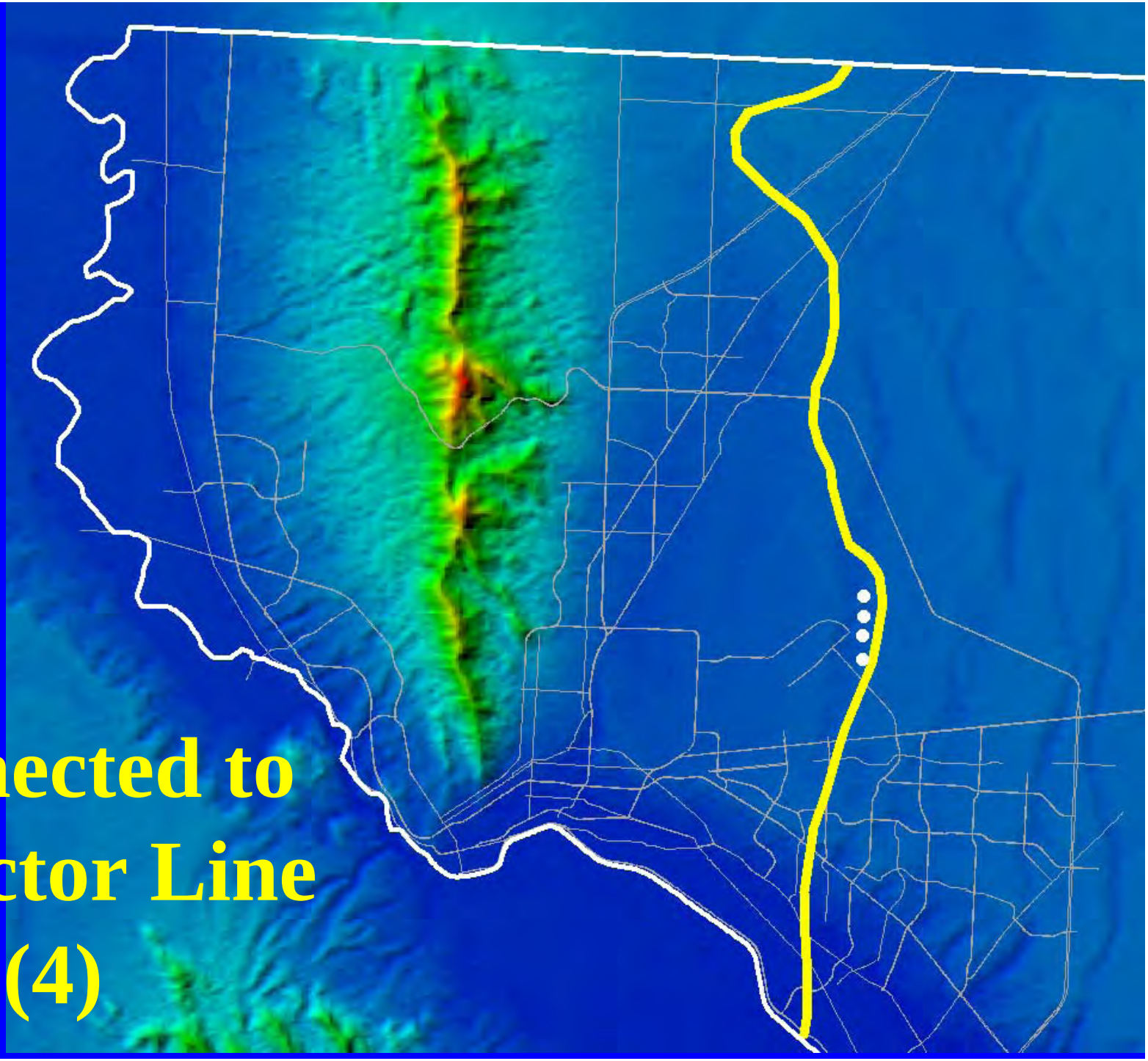
Rehabilitated Wells (3)



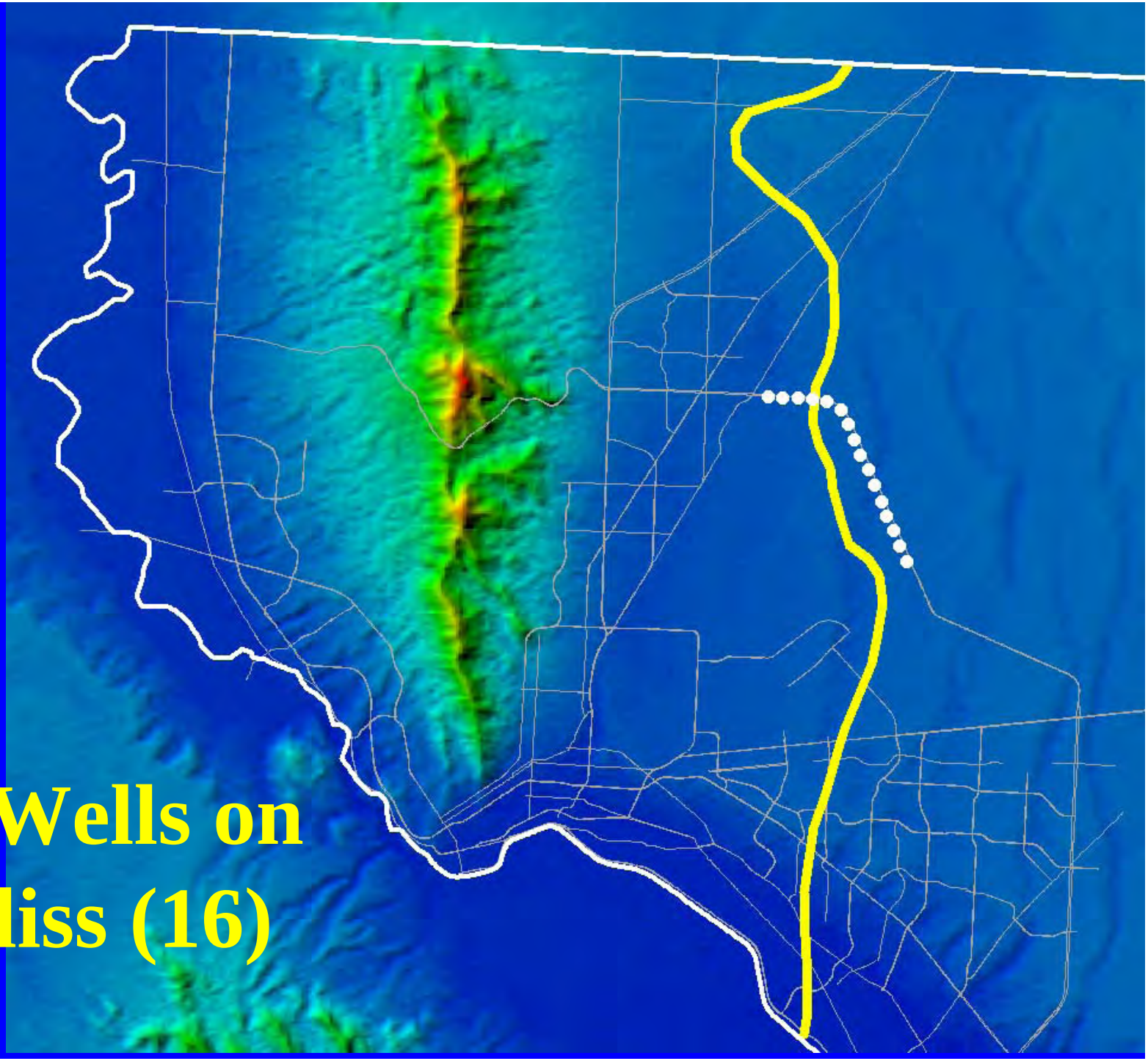
Failed During Rehabilitation



Redrilled Wells (13)

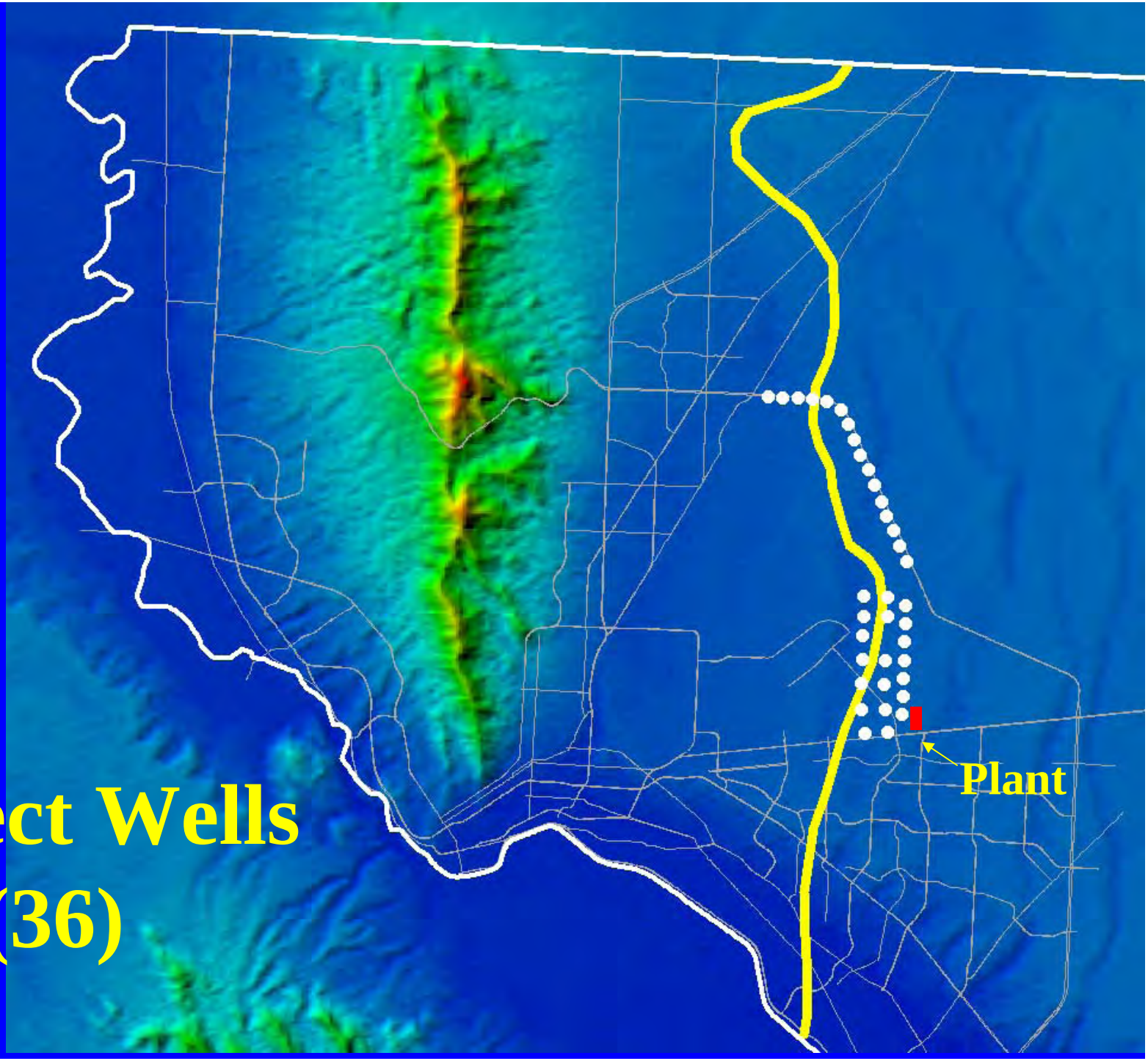


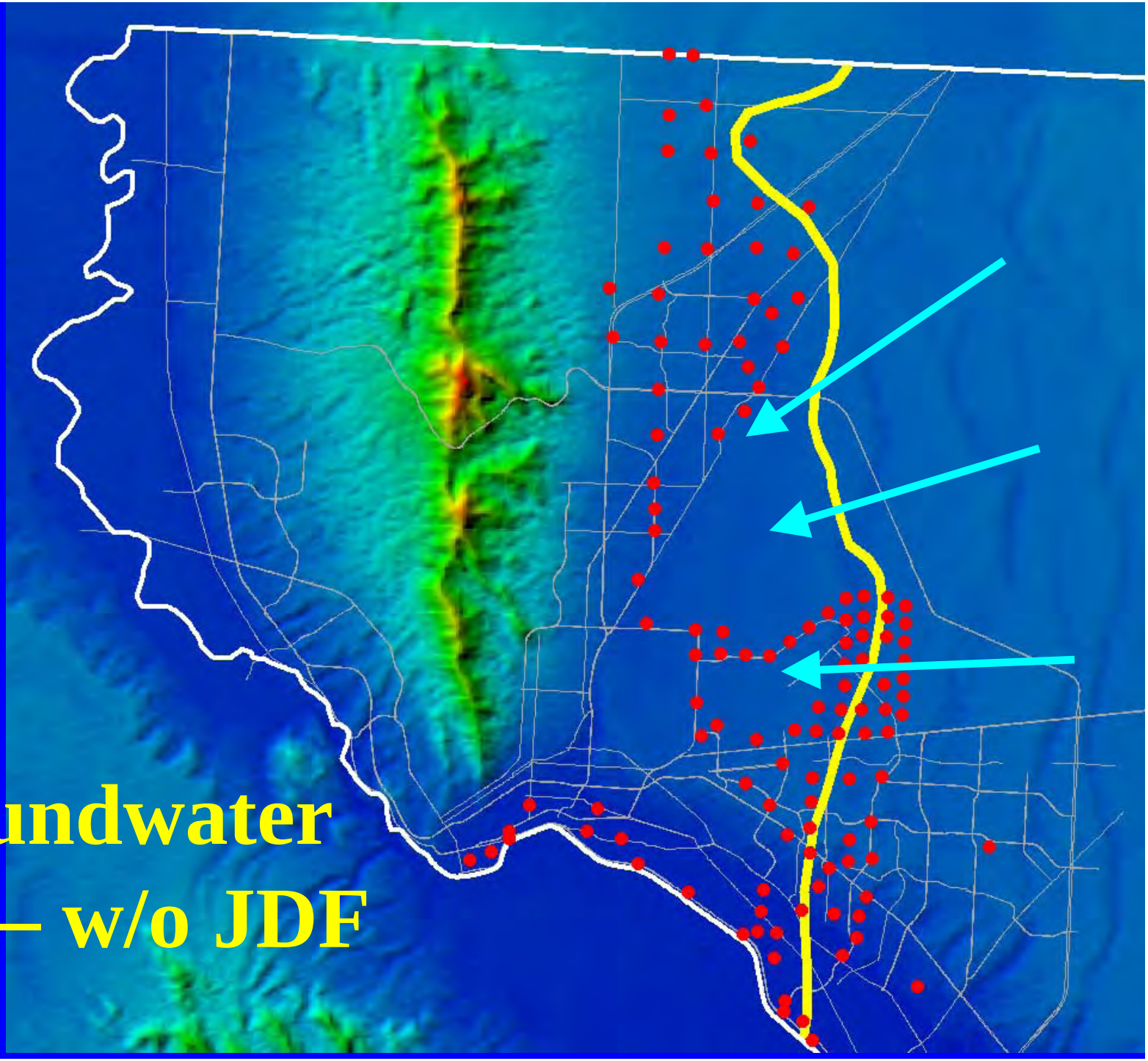
Connected to Collector Line (4)



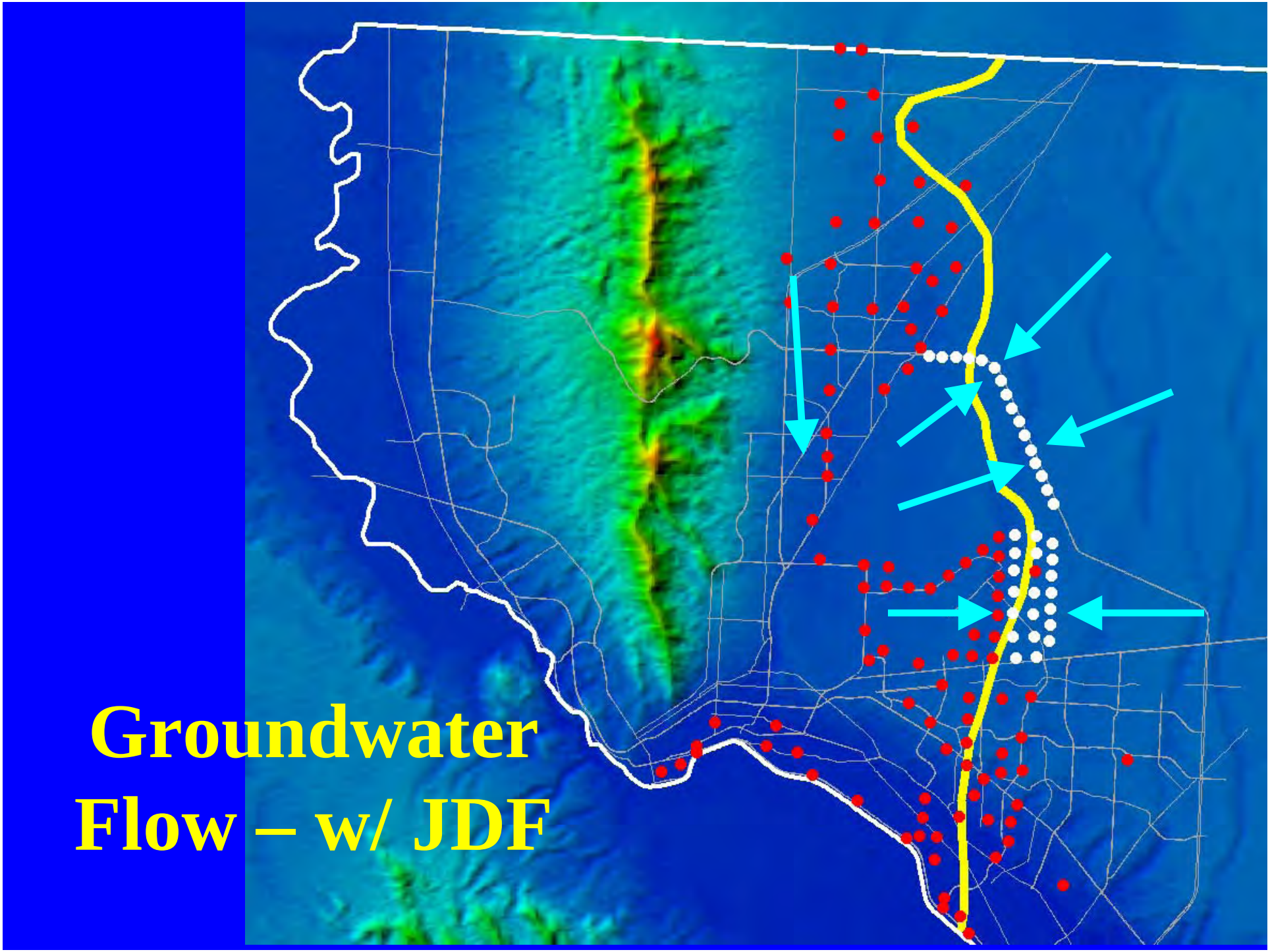
New Wells on Ft Bliss (16)

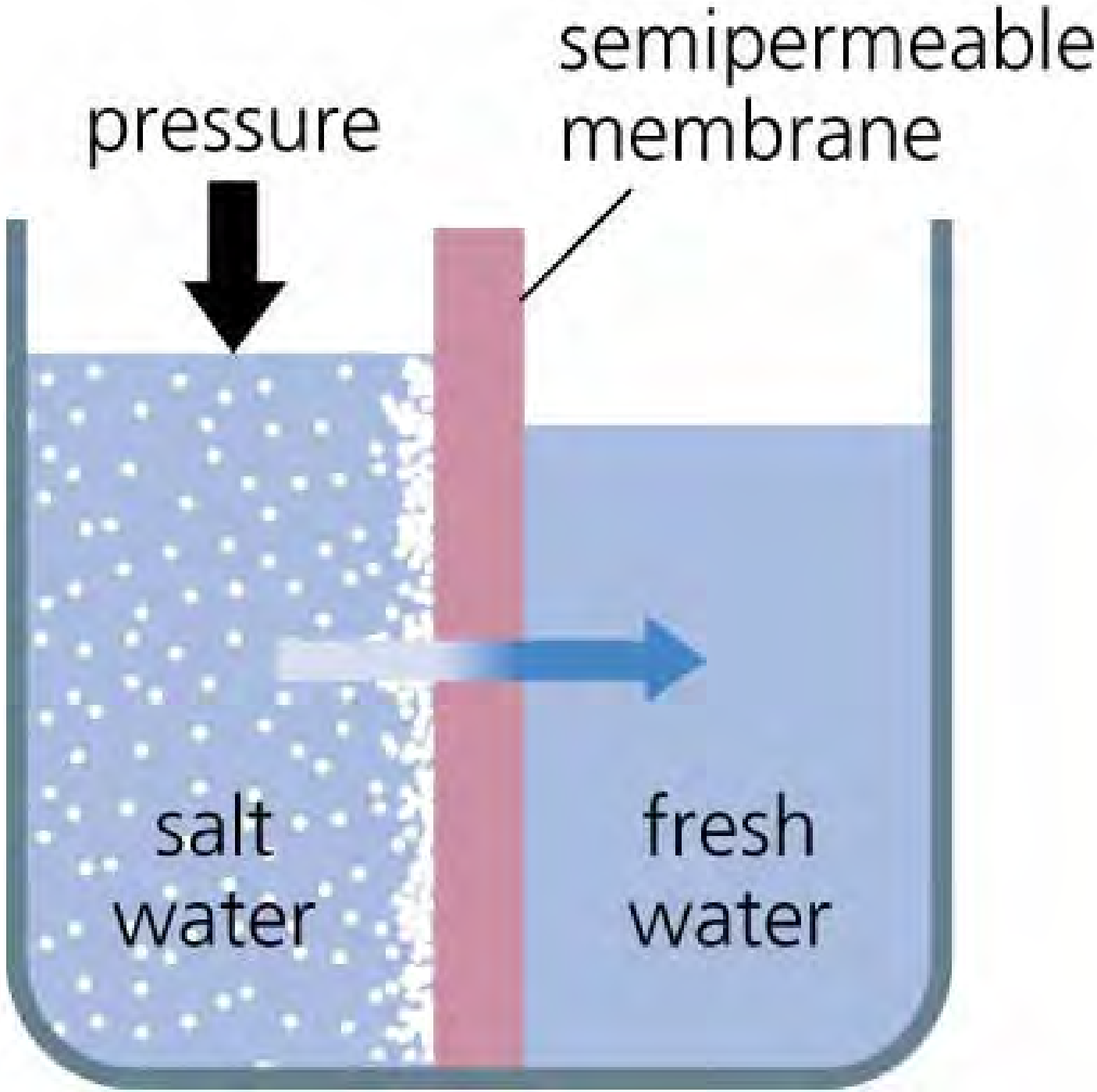
Project Wells (36)



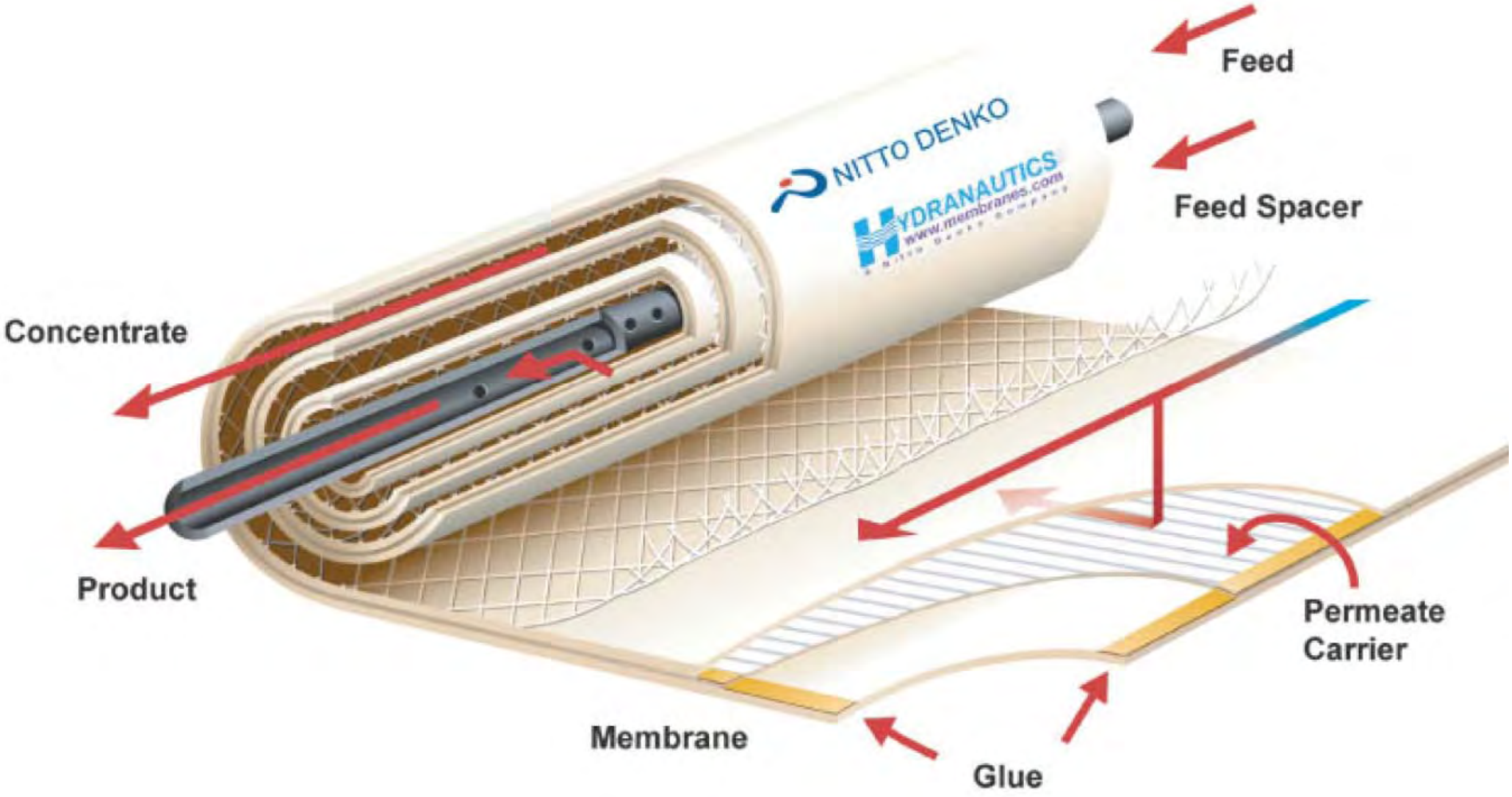


Groundwater Flow – w/o JDF


Groundwater
Flow – w/ JDF


semipermeable
membrane
pressure
salt
water
fresh
water

ESPA-1 Membranes

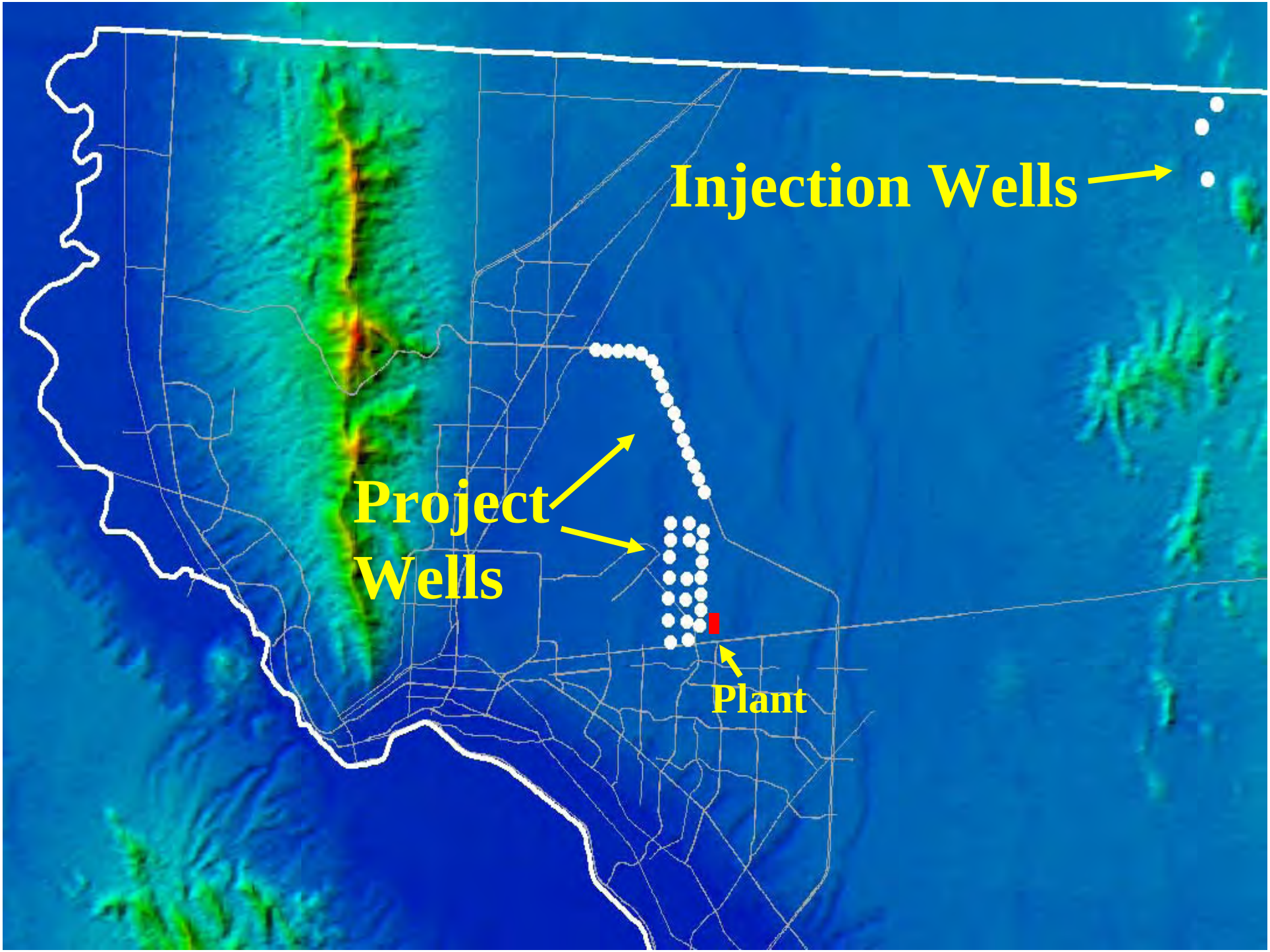


Plant Overview

- 5 Skids
- Recovery: 70% to 82.5%
- Salt Rejection: up to 93%

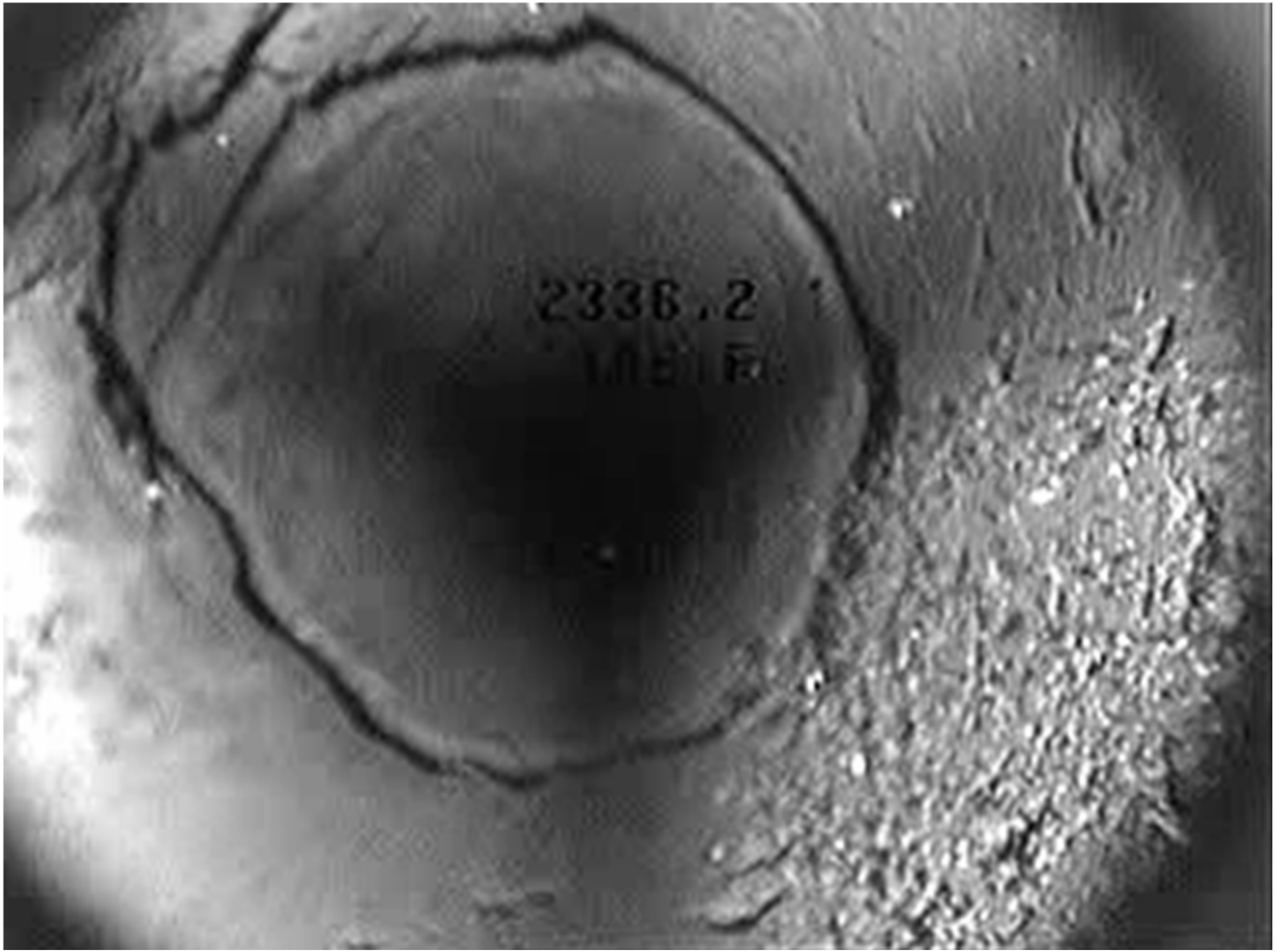
Concentrate Disposal

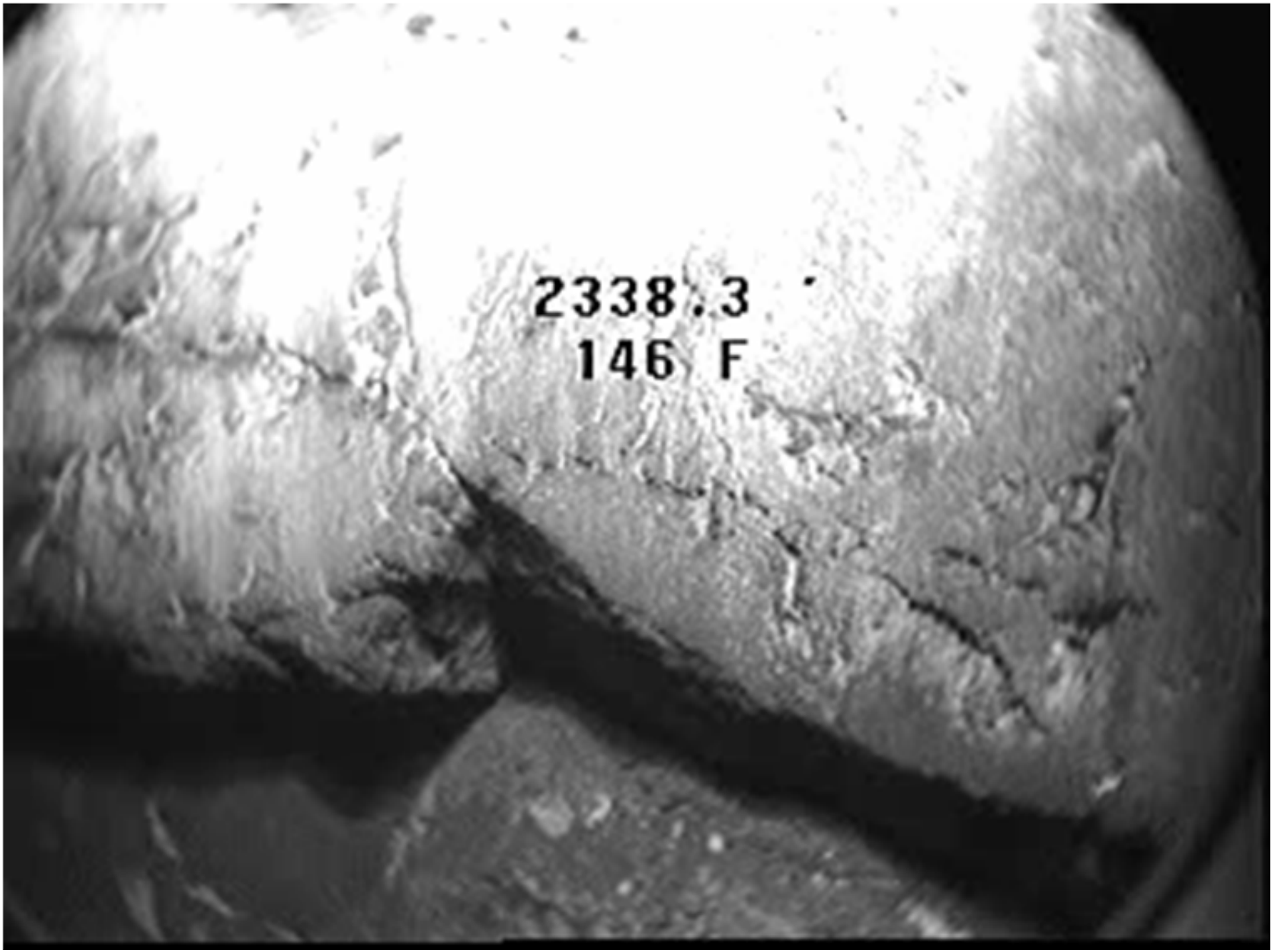
- 3 Injection Wells
- Surface Injection Facilities
- Concentrate Pipeline (22 mi)


Injection Wells
Project
Wells
Plant

Injection Well Construction

- Class I Standards
- Open Hole Injection Zone
- Well 1 (2004)
  - 3,777 ft deep
- Well 3 (2006)
  - 4,030 ft deep
- Well 2 (2007)
  - 3,720 ft deep




2338.3
146 F

Surface Injection Facilities

- Yard Piping
- Storage Tanks (~300,000 gal each site)
- Electrical System (solar w/ backup)
- Communications and Controls

Class V Authorization by Rule

- Studies and Pilot Well (2001 – 2004)
- Application Submitted March 2005
- Class V Authorization Received July 2005
- Additional Wells, Studies and Tests (2005 – 2007)

Application Summary

I. Class V Application for each well

II. Technical Report

Parts V to XII of Class I Injection Well Application

III. Appendices

Application Highlights

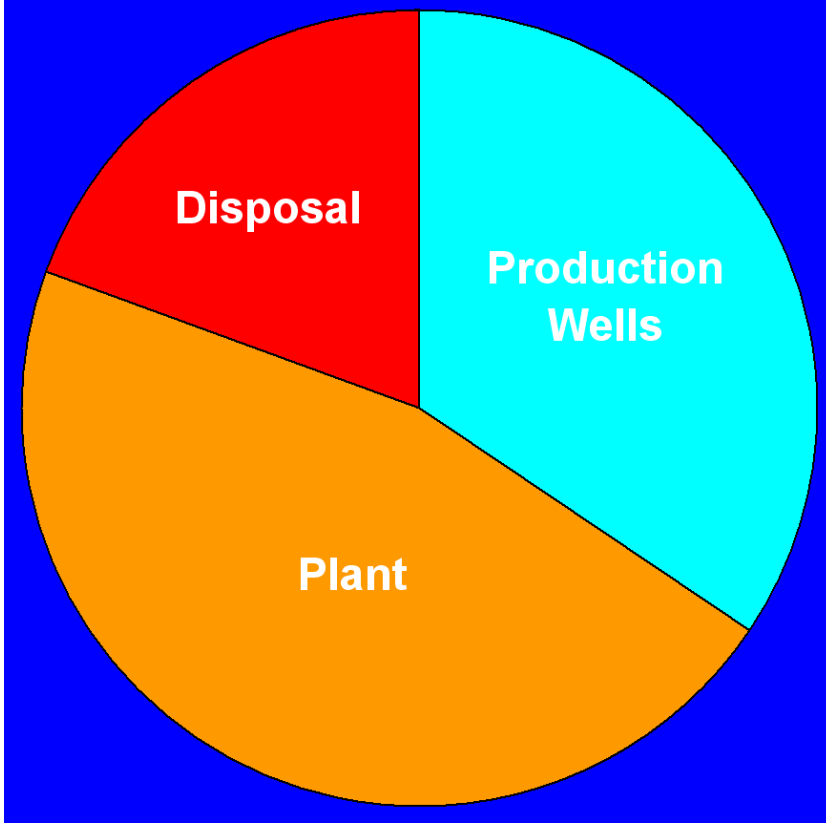
- Remote location
  - No deep wells in area
- Concentrate TDS lower than groundwater TDS
  - 6,000 mg/l vs. 9,000 mg/l
- Gravity “injection”
- Maximum buildup = 160 ft

Authorization

- Limited to Injecting Water that Meets Primary Drinking Water Standards
  - Formation Water Exceeds Primary Standards for Arsenic, Gross Alpha, Nitrite, and Radium

Capital Costs

- Production Wells and Collectors $ 32 Million
- Plant and Near-Plant Pipes $ 40 Million
- Concentrate Disposal $ 19 Million



Total Cost: $91 Million

(21 Contracts)

Sources of Funding

• Congressional Appropriations	$26.0 Million
• TWDB Interest Free Loan	$ 1.0 Million
• EPWU Bonds and Cash	$60.7 Million
• Army Contribution	$ 3.3 Million
• **Total**	**$91.0 Million**

Annual Operating Costs

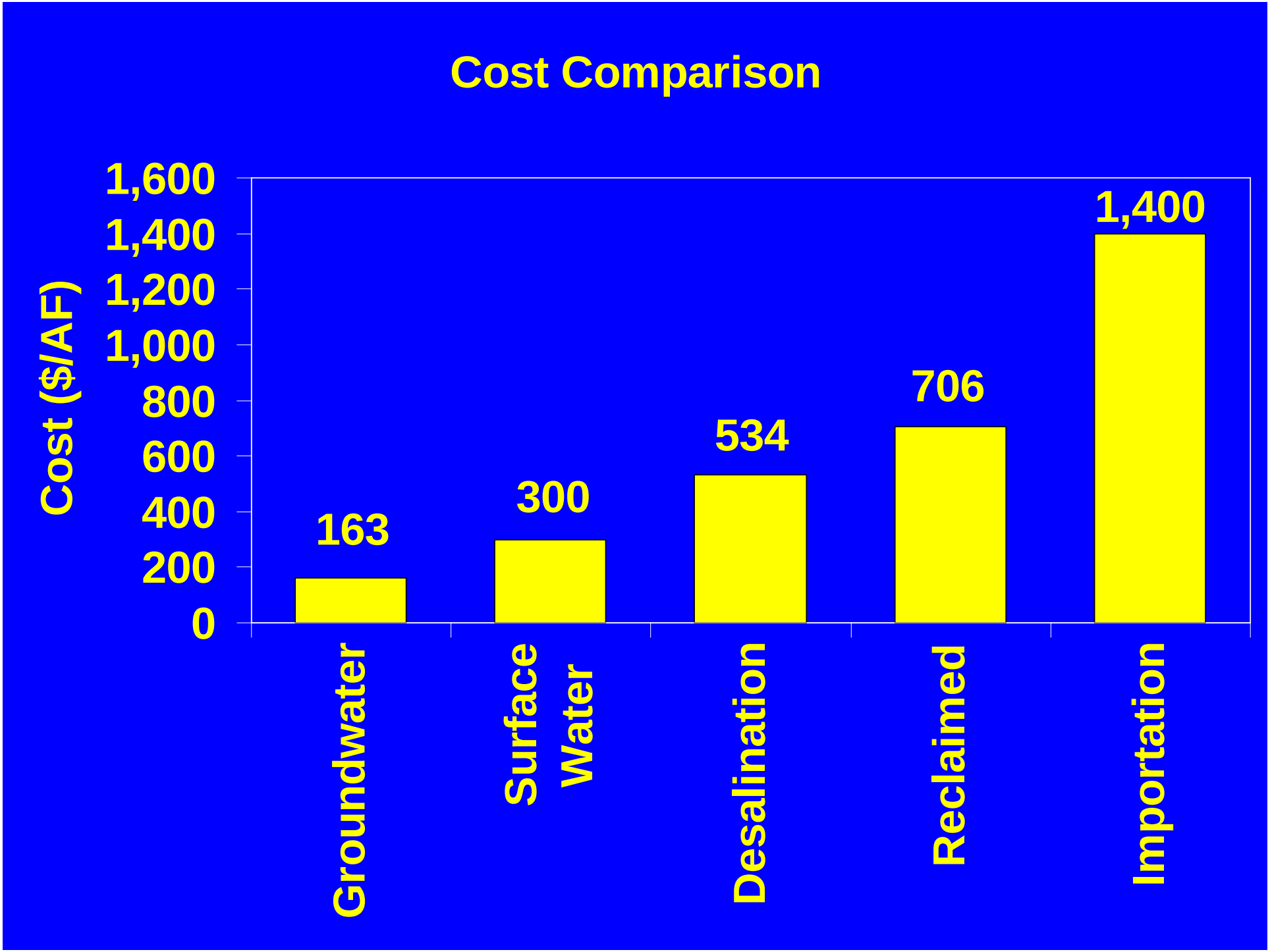
Assumes $0.07/kwh and 80% Operation

• Wells, Collectors	$ 700,000
• Ft Bliss (water and land)	$ 1,300,000
• Desalination Plant	$ 2,600,000
• Disposal	$ 200,000
• Finished Water Pipeline	$ 26,000
• **Total**	**$ 4,826,000**

Amortized Capital and O&M ($/AF)

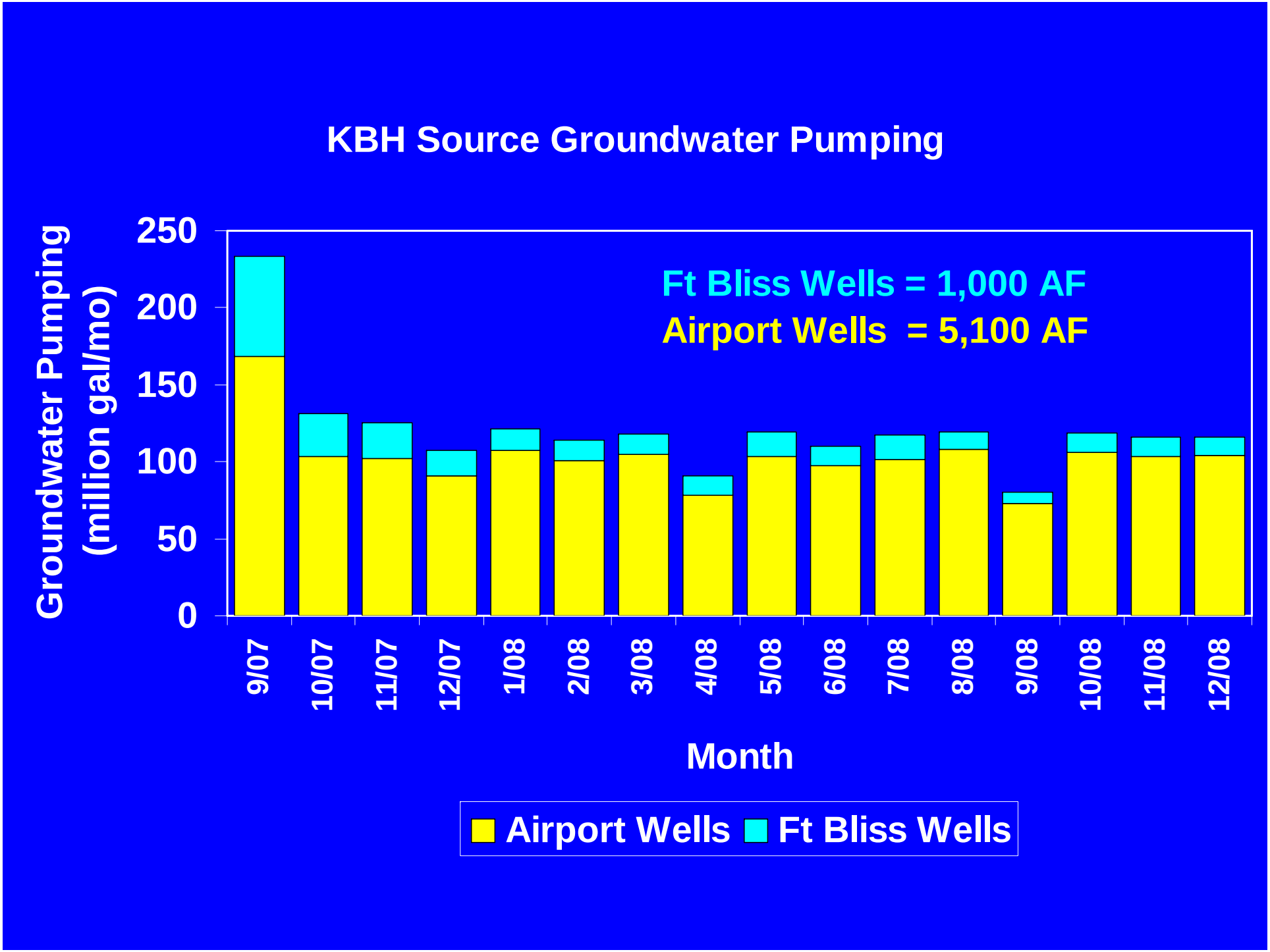
Assumes 5% Discount Rate

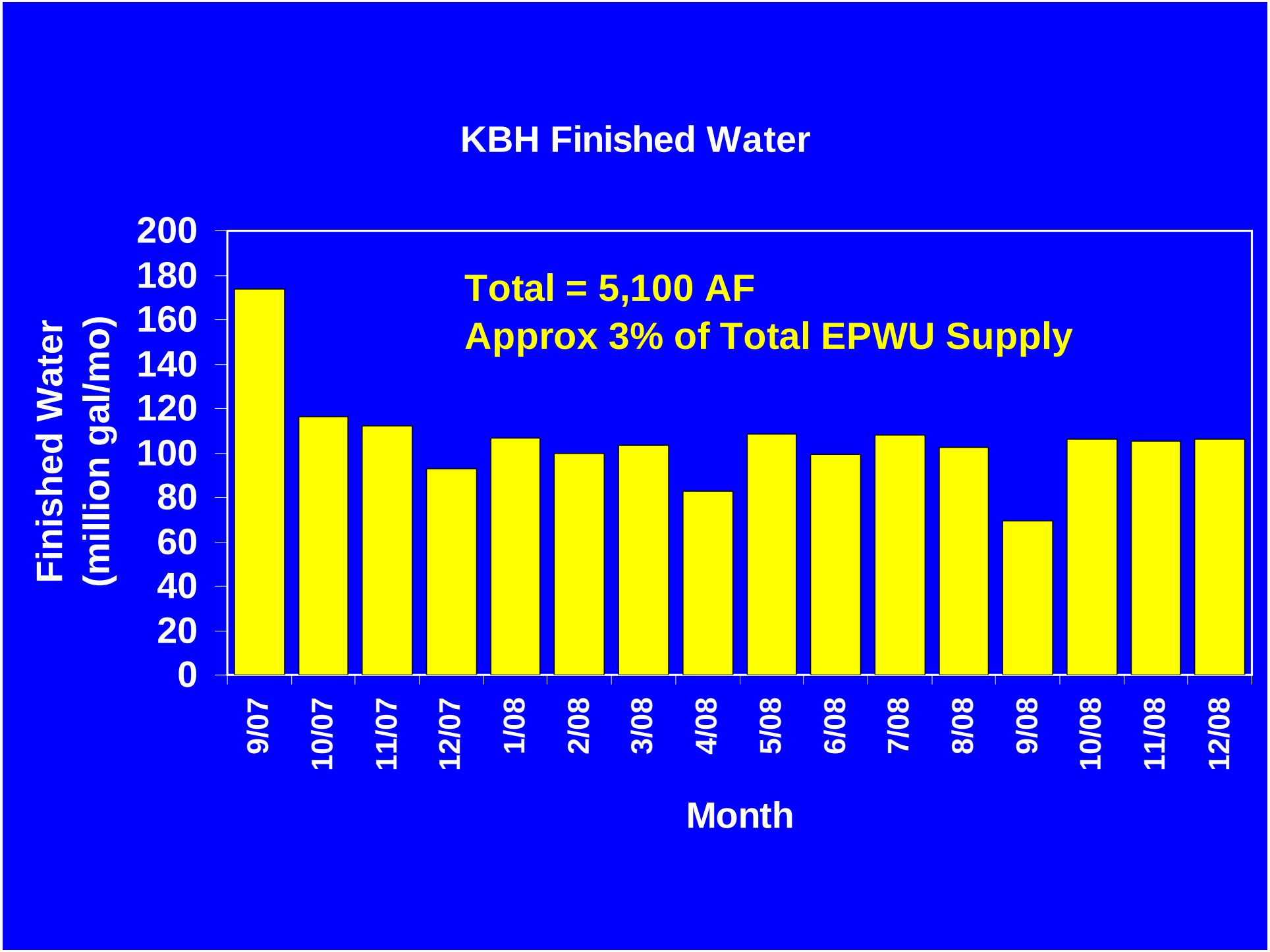
• Wells, Collectors	$ 189
• Ft Bliss (water and land)	$ 42
• Desalination Plant	$ 232
• Disposal	$ 49
• Finished Water Pipeline	$ 22
• **Total**	**$ 534**

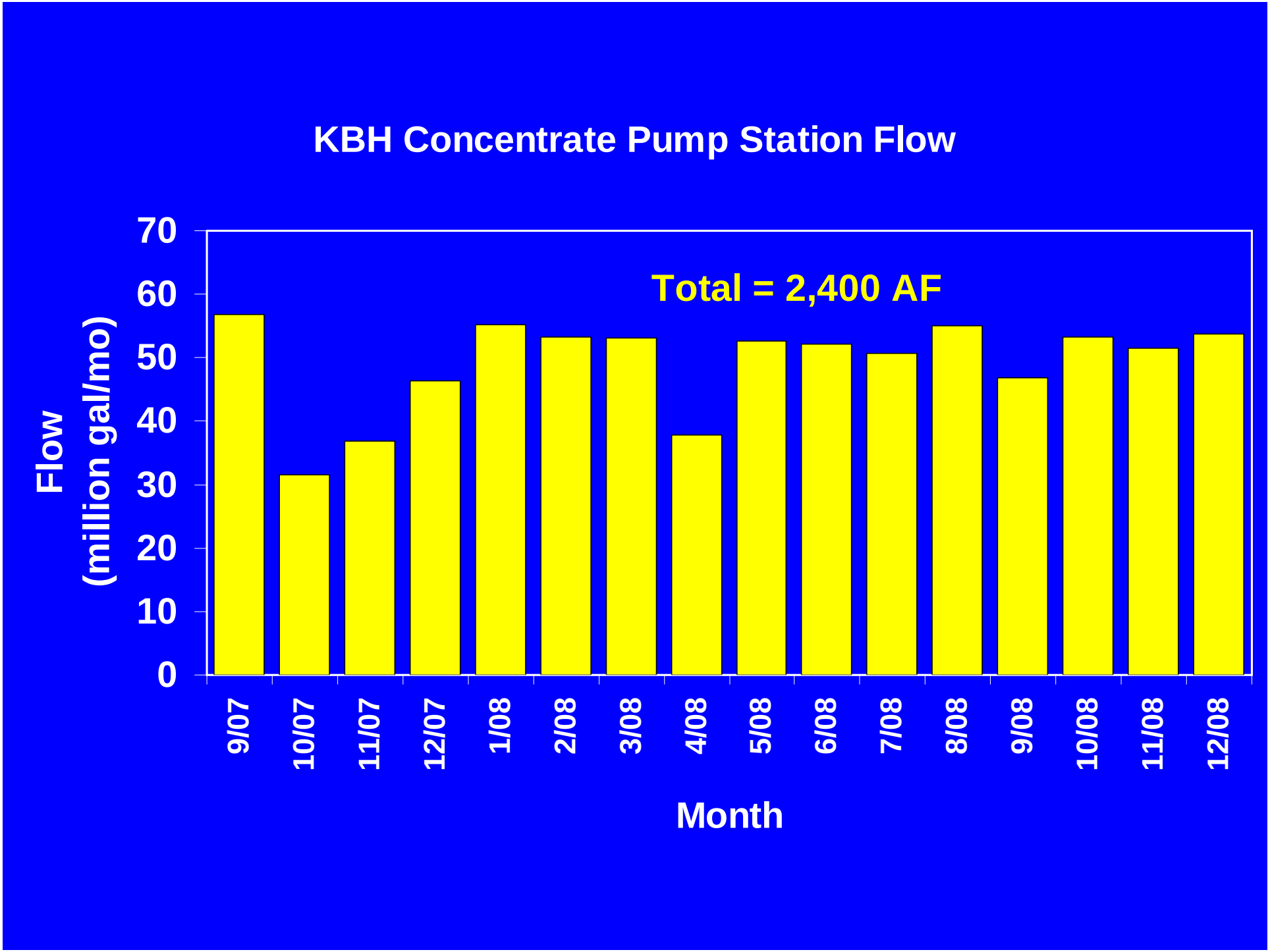

Cost Comparison
Cost ($/AF)
1,600
1,400
1,200
1,000
800
600
400
200
0
163
300
534
706
1,400
Groundwater
Surface Water
Desalination
Reclaimed
Importation

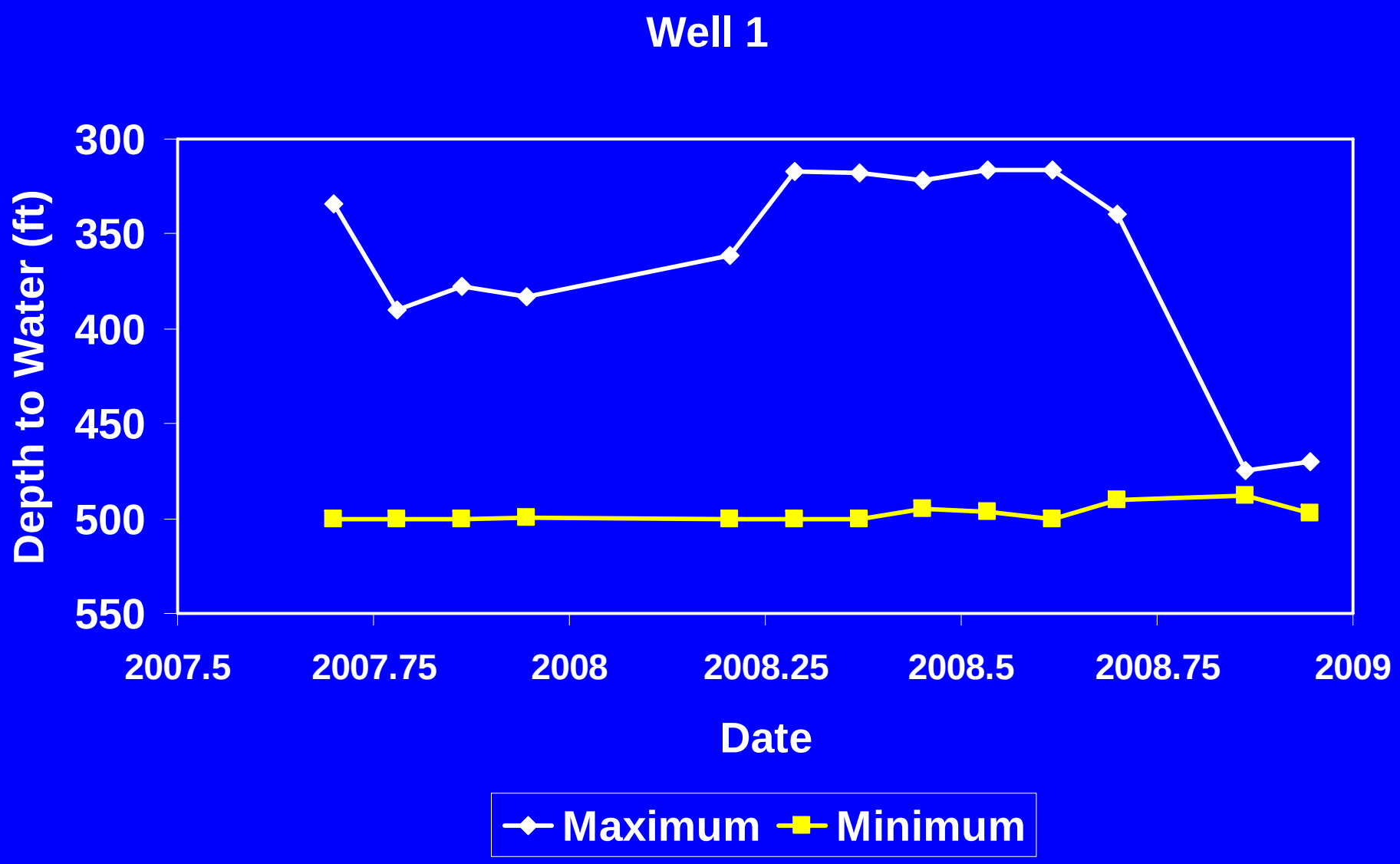
Summary of Initial Operations

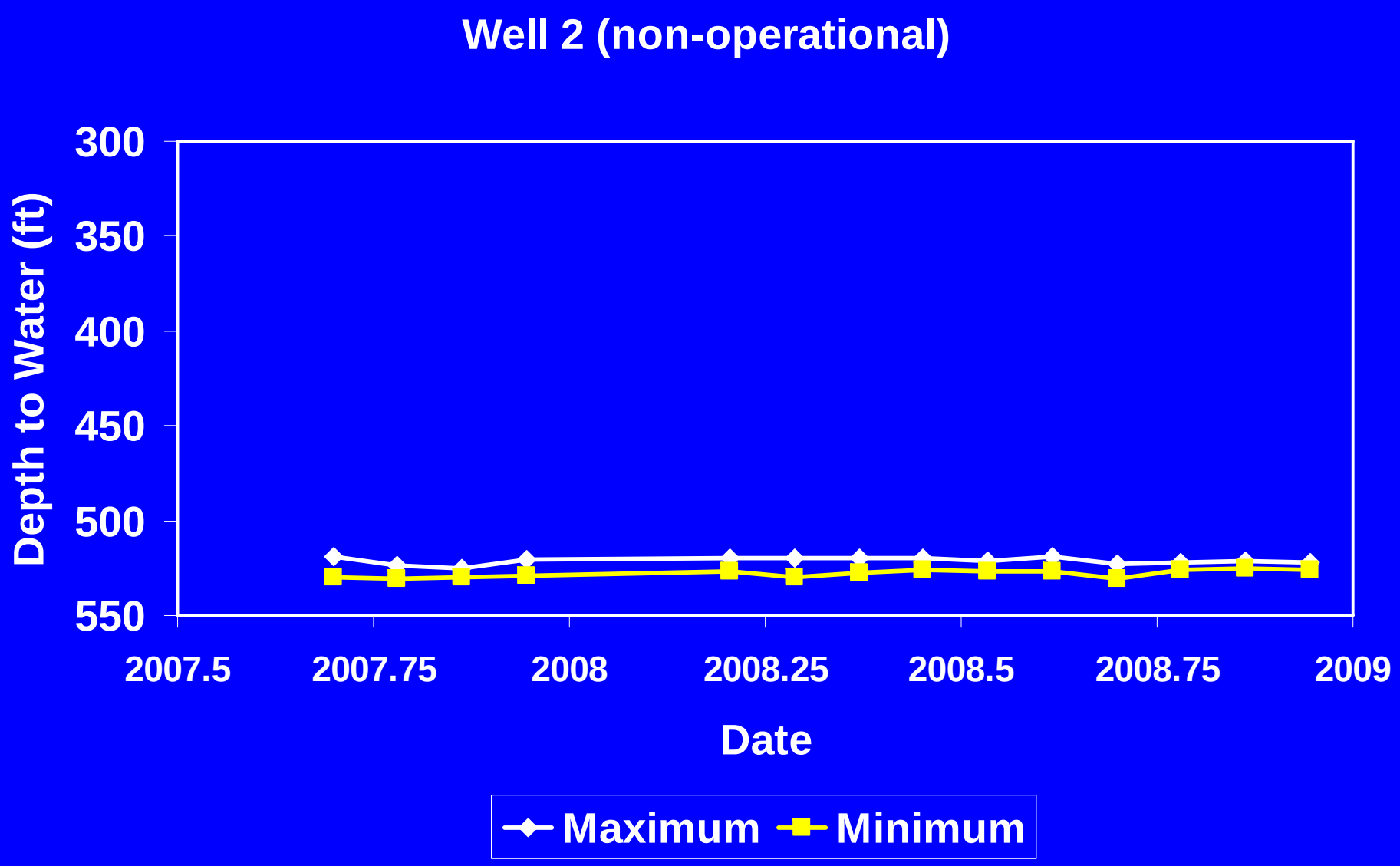
- September 2007 to December 2008
  - Plant Operations
  - Injection Well Performance
  - Compliance with Authorization

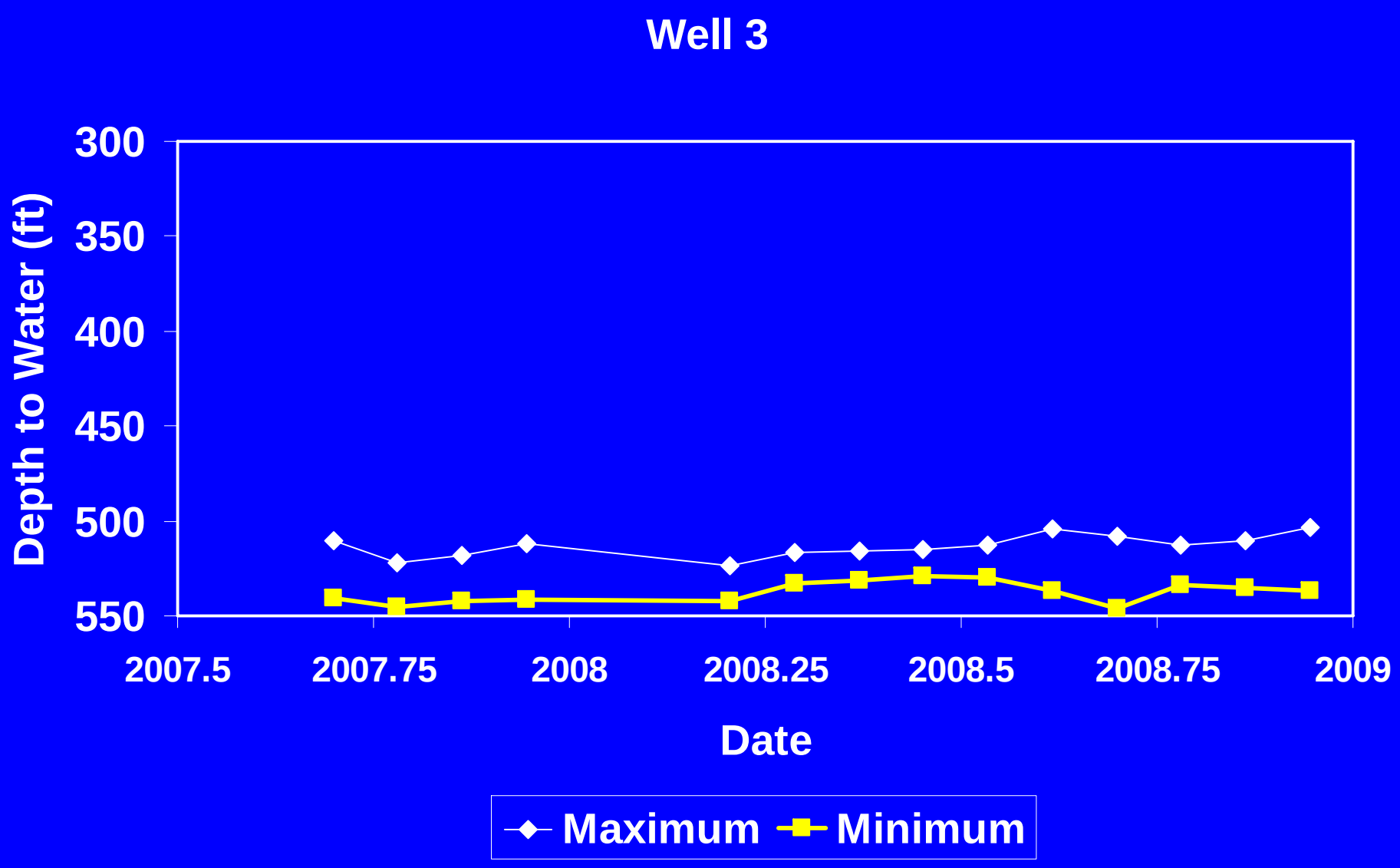

KBH Source Groundwater Pumping
Ft Bliss Wells = 1,000 AF
Airport Wells = 5,100 AF
Groundwater Pumping (million gal/mo)
250
200
150
100
50
0
9/07
10/07
11/07
12/07
1/08
2/08
3/08
4/08
5/08
6/08
7/08
8/08
9/08
10/08
11/08
12/08
Month
Airport Wells
Ft Bliss Wells

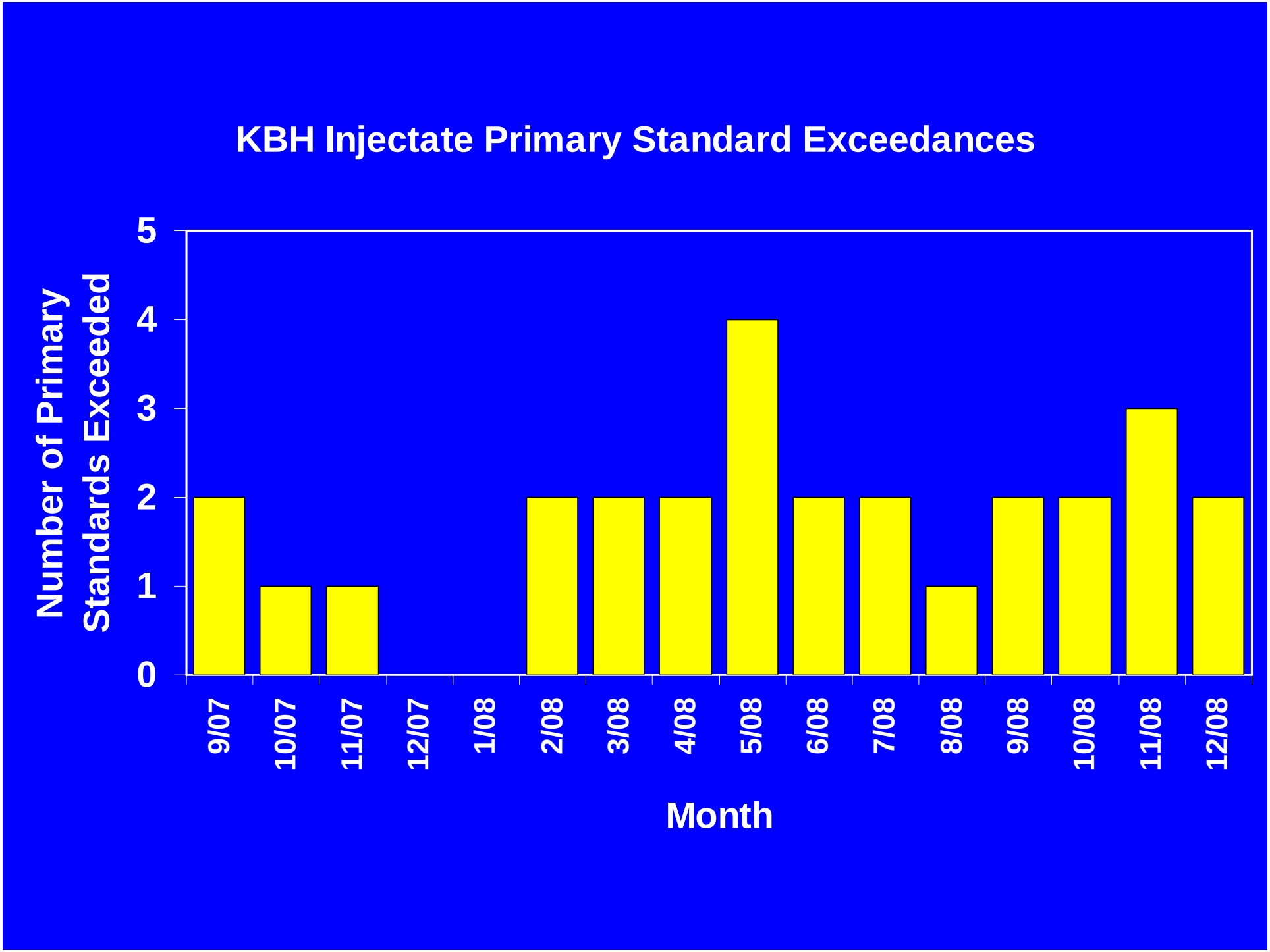

KBH Finished Water
Total = 5,100 AF
Approx 3% of Total EPWU Supply
Finished Water
(million gal/mo)
200
180
160
140
120
100
80
60
40
20
0
9/07
10/07
11/07
12/07
1/08
2/08
3/08
4/08
5/08
6/08
7/08
8/08
9/08
10/08
11/08
12/08
Month

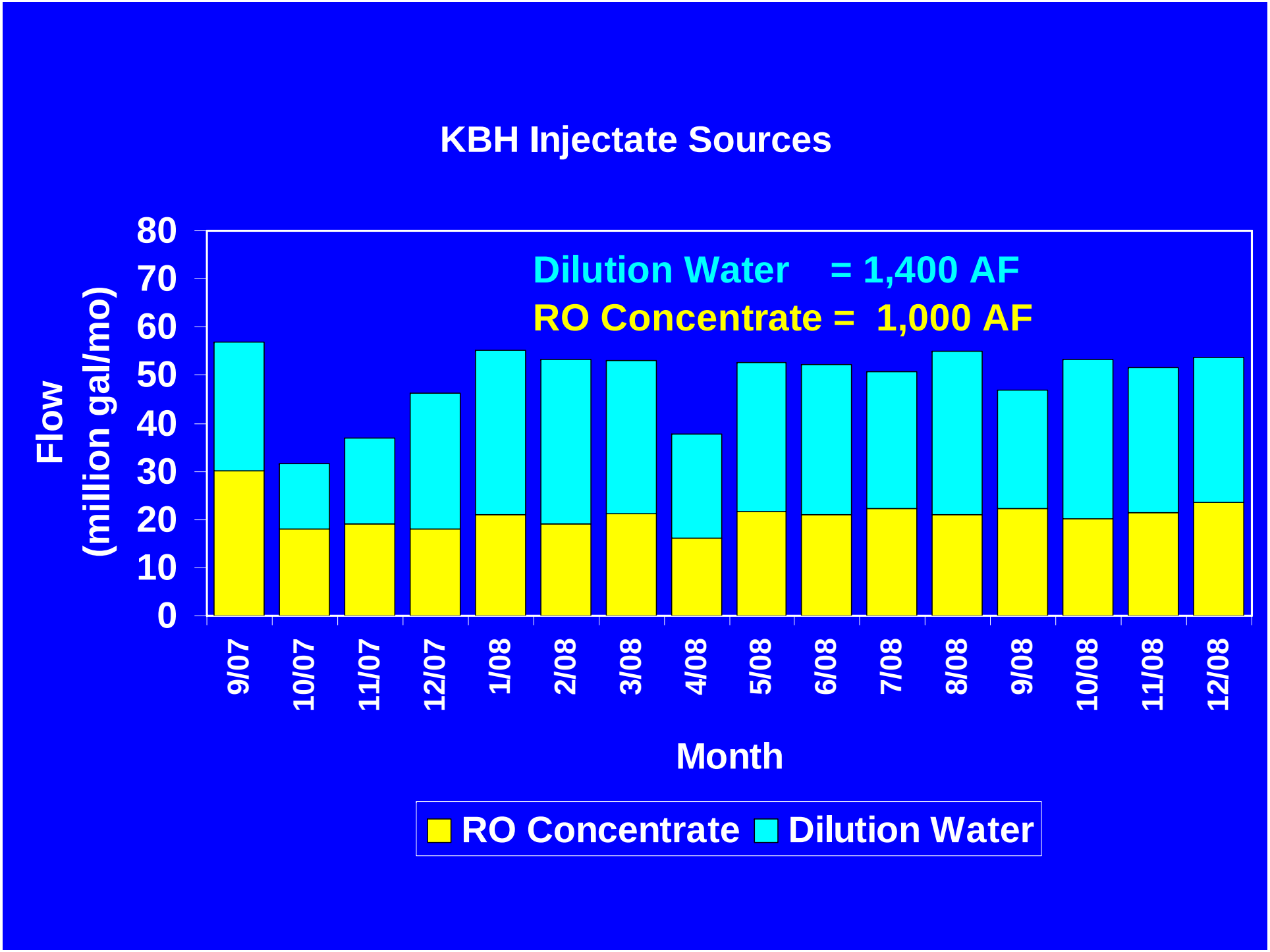

KBH Concentrate Pump Station Flow
Total = 2,400 AF
Flow
(million gal/mo)
70
60
50
40
30
20
10
0
9/07
10/07
11/07
12/07
1/08
2/08
3/08
4/08
5/08
6/08
7/08
8/08
9/08
10/08
11/08
12/08
Month

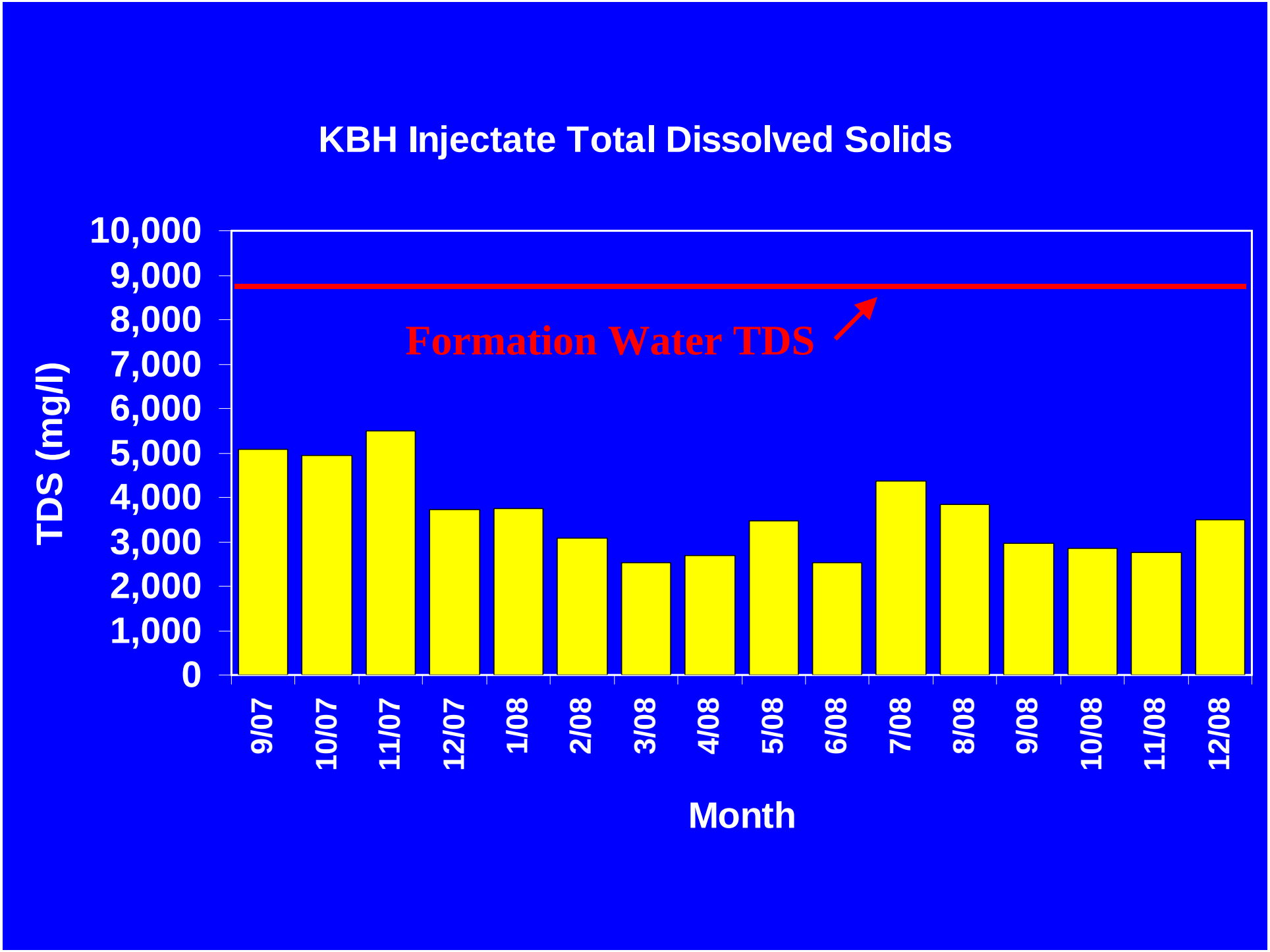

Well 1
Depth to Water (ft)
300
350
400
450
500
550
2007.5
2007.75
2008
2008.25
2008.5
2008.75
2009
Date
Maximum
Minimum


Well 2 (non-operational)
Depth to Water (ft)
300
350
400
450
500
550
2007.5
2007.75
2008
2008.25
2008.5
2008.75
2009
Date
Maximum
Minimum


Well 3
Depth to Water (ft)
300
350
400
450
500
550
2007.5
2007.75
2008
2008.25
2008.5
2008.75
2009
Date
Maximum
Minimum


KBH Injectate Primary Standard Exceedances
Number of Primary Standards Exceeded
0
1
2
3
4
5
9/07
10/07
11/07
12/07
1/08
2/08
3/08
4/08
5/08
6/08
7/08
8/08
9/08
10/08
11/08
12/08
Month


KBH Injectate Sources
Dilution Water = 1,400 AF
RO Concentrate = 1,000 AF
Flow
(million gal/mo)
80
70
60
50
40
30
20
10
0
9/07
10/07
11/07
12/07
1/08
2/08
3/08
4/08
5/08
6/08
7/08
8/08
9/08
10/08
11/08
12/08
Month
RO Concentrate
Dilution Water


KBH Injectate Total Dissolved Solids
TDS (mg/l)
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Formation Water TDS
9/07
10/07
11/07
12/07
1/08
2/08
3/08
4/08
5/08
6/08
7/08
8/08
9/08
10/08
11/08
12/08
Month

What is Non-Degradation?

- Overall water quality?
- Individual constituents?
  - What sample/analysis to use?
- Treatment of a USDW?
  - TDS/Chloride based?

Aquifer Exemption

- Discussions with TCEQ began in December 2007
- Regulatory Authority
  - 40 CFR Parts 144 – 146
  - 30 TAC Chapter 331
- Application submitted in August 2008
  - TCEQ, NMED
  - EPA Concurrence after TCEQ and NMED

USDW Can be Exempted if:

- Aquifer does not currently serve as a source of drinking water
- Aquifer cannot now and will not in the future serve as a source of drinking water based on certain criteria
- The TDS of the ground water is more than 3,000 and less than 10,000 mg/L and it is not reasonably expected to supply a public water system

Application Highlights

- Remote Area
- Formation Water Meets TDS Guidelines
- Formation Water Does Not Meet Primary Standards
- Treatment to Meet Primary Standards and TDS
- Introduction of Injectate Would Not Necessitate Further or More Expensive Treatment

Concentrate

- Disposal
- Management
- Storage

Hueco Bolson Management

- Wastewater Effluent Project (1985 – pres)
- Conservation Programs (1991 – pres)
- Conjunctive Use Management (1992 – pres)
  - Jonathan Rogers Plant (1992, expanded in 2002)
  - Desalination Project (2007)

Desalination Project

- Key Component of Conjunctive Use Management
- No Increase in Pumping
  - Redistributed Pumping (Interception)
  - Drought Protection (Fresh Groundwater)

Climate Change

- Conjunctive Use Approach is Adequate to Meet Demands
  - Natural Variability
  - Greenhouse Gas Impacts

Key Upcoming Issues

- Design of Excess Surface Water Storage Project (up to ~ 5,000 AF/yr recharge)
- Aquifer Exemption
  - TCEQ/NMED Approval
  - EPA Concurrence

Questions?