# Role of Watershed-Scale Sediment Management in Enhancing Regional Water Supply and Ecological Function

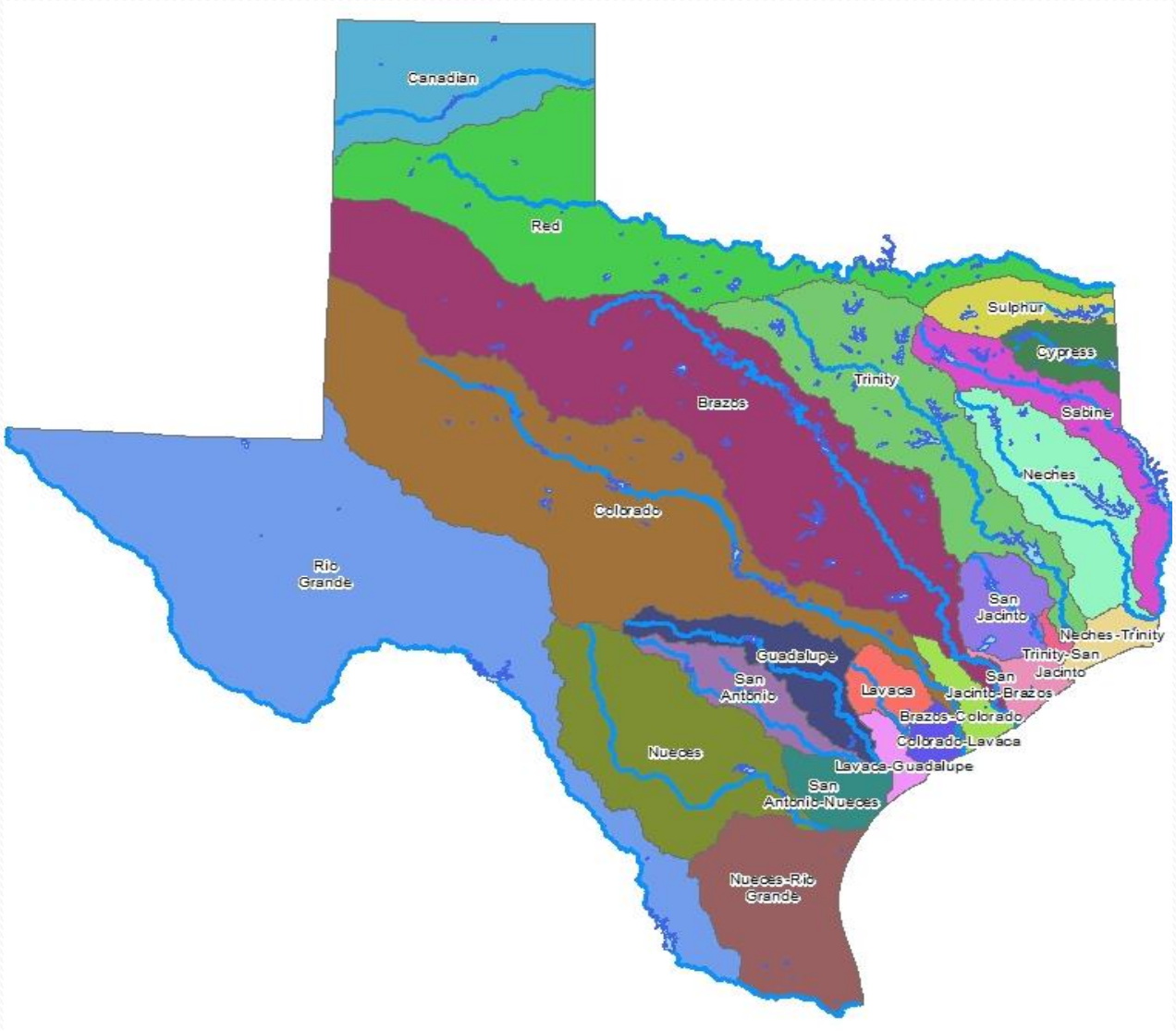
## NCER

David Coffman, M.S. & Becky Griffith, Ph.D.

July 31, 2013

FREESE AND NICHOLS

# Texas River Basins



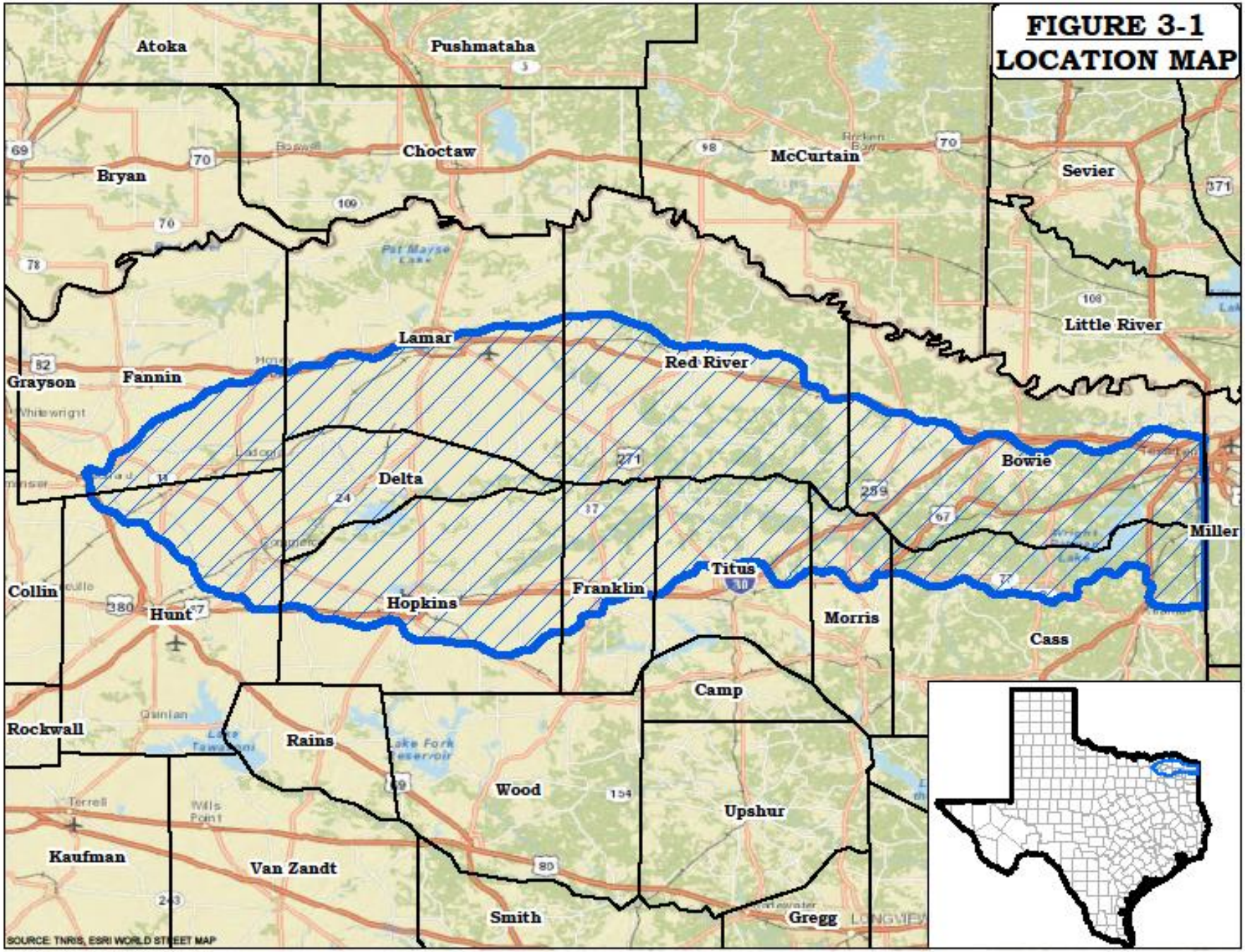


FIGURE 3-1
LOCATION MAP
Atoka
Pushmataha
Choctaw
McCurtain
Sevier
Bryan
Little River
Lamar
Red River
Grayson
Fannin
Delta
Bowie
Miller
Titus
Collin
Hunt
Hopkins
Franklin
Morris
Cass
Camp
Rockwall
Rains
Wood
Upshur
Kaufman
Van Zandt
Smith
Gregg
SOURCE: TNRIS, ESRI WORLD STREET MAP

# Sulphur River Watershed Sediment

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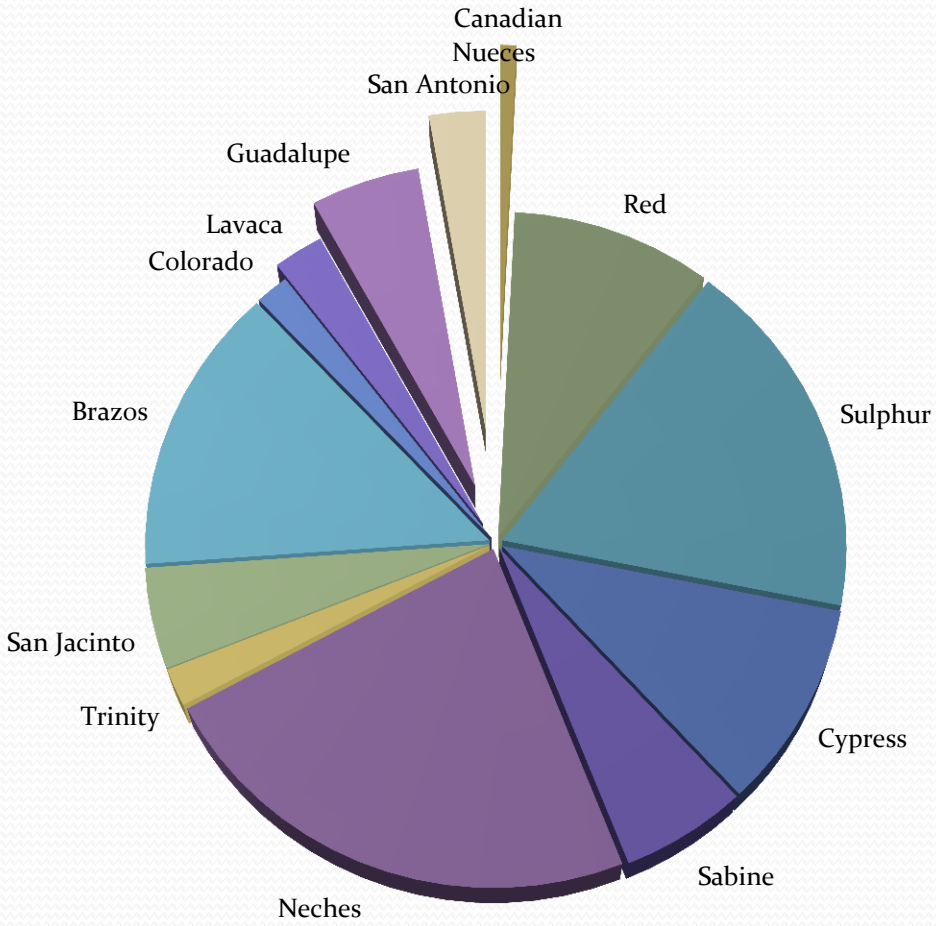
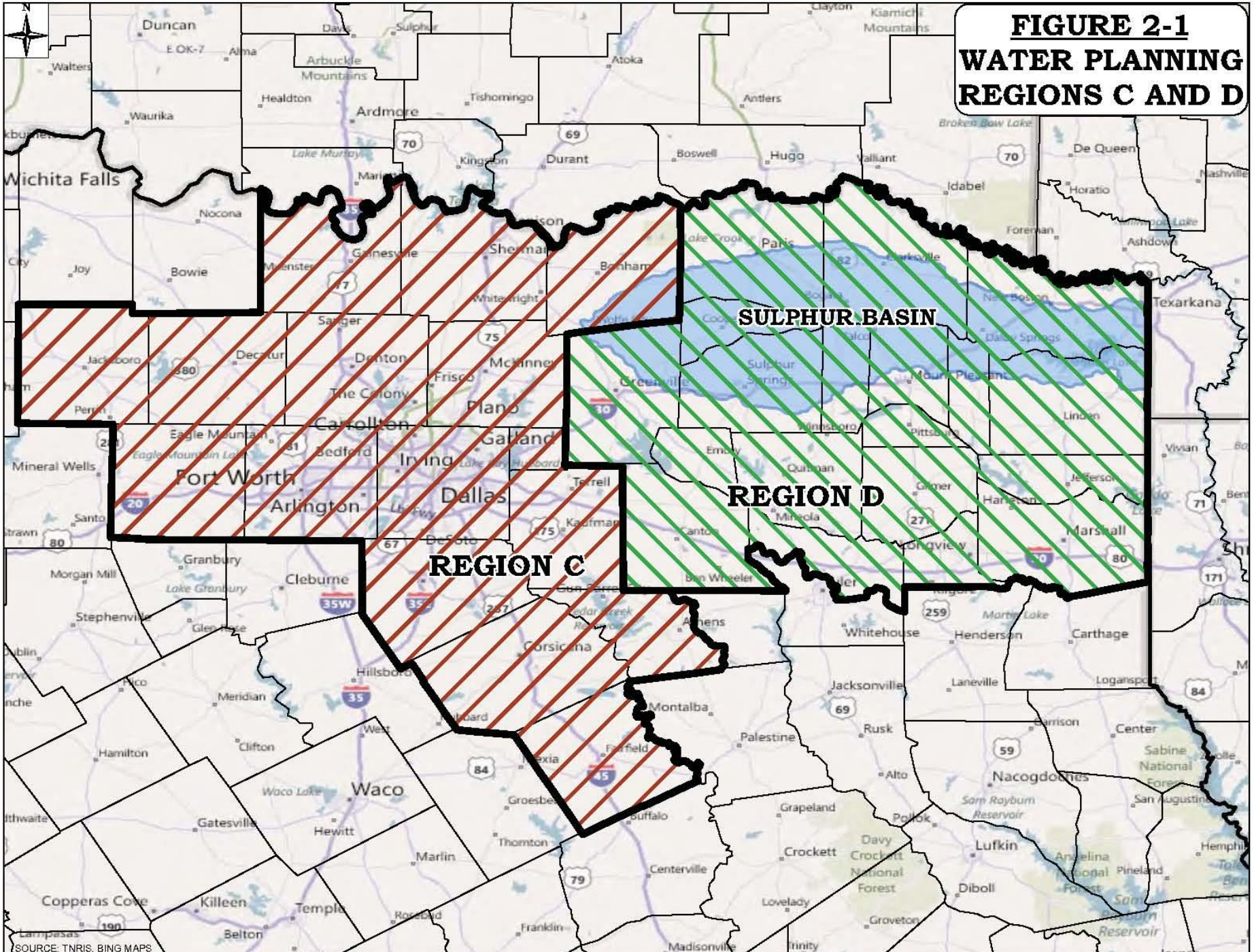
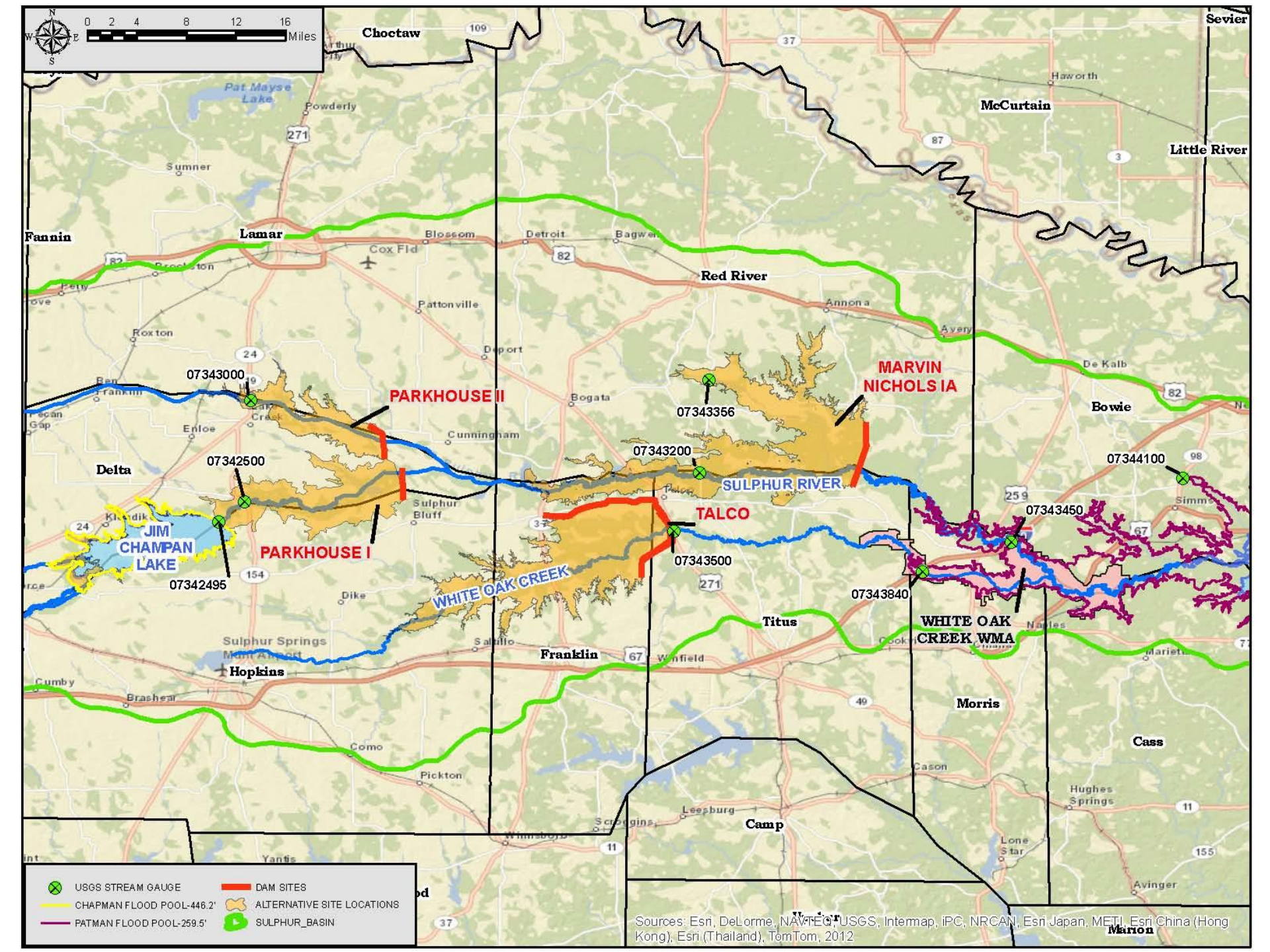
# Minimum 5 Year Average Availability (Acre-Feet)



# FIGURE 2-1
# WATER PLANNING REGIONS C AND D




0 2 4 8 12 16
Miles
Choctaw
Pat Mayse Lake
Powderly
Sumner
Fannin
Lamar
Cox Fld
Blossom
Detroit
Bagwell
Red River
McCurtain
Haworth
Sevier
Little River
Pattonville
Roxton
Deport
Annona
Avery
De Kalb
Bowie
Ben Franklin
Pecan Gap
Enloe
Cunningham
Bogata
Delta
Sulphur Bluff
Klondike
JIM CHAMPAN LAKE
Dike
Sulphur Springs
Hopkins
Cumby
Brashear
Como
Pickton
Yantis
Saltillo
Franklin
Winfield
Titus
Naples
Morris
Cass
Cason
Hughes Springs
Leesburg
Camp
Lone Star
Avinger
Marion
Simms
Scroggins
Winnsboro
07343000
07342500
07342495
07343356
07343200
07344100
07343450
07343500
07343840
PARKHOUSE II
PARKHOUSE I
MARVIN NICHOLS IA
TALCO
SULPHUR RIVER
WHITE OAK CREEK
WHITE OAK CREEK WMA
USGS STREAM GAUGE
CHAPMAN FLOOD POOL-446.2'
PATMAN FLOOD POOL-259.5'
DAM SITES
ALTERNATIVE SITE LOCATIONS
SULPHUR_BASIN
Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

# Initial Yield - Wright Patman

## Bottom of Conservation Pool at 220 ft

| Max Conservation Pool Elevation (feet) | Firm Yield (AFY) | Yield above Current Contract (AFY)* |
|---|---|---|
| Interim | 40,263 | 0 |
| Ultimate | 201,413 | 21,413 |
| 227.5 | 255,693 | 75,693 |
| 232.5 | 460,963 | 280,963 |
| 237.5 | 658,273 | 478,273 |
| 242.5 | 772,663 | 592,663 |
| 247.5 | 891,913 | 711,913 |
| 252.5 | 1,034,363 | 854,363 |
| 257.5 | 1,155,013 | 975,013 |
| 259.5 | 1,208,533 | 1,028,533 |

*** 180,000 af/yr**

# Initial Yield, Alternative Sites

## (acre-feet/yr)

| Reservoir | Initial Yield |
|---|---|
| George Parkhouse I | 124,300 |
| George Parkhouse II | 124,200 |
| Marvin Nichols IA | 590,000 |
| Jim Chapman Lake Reallocation ( increase) | 25,000 |

# Initial Yield, Talco Configurations

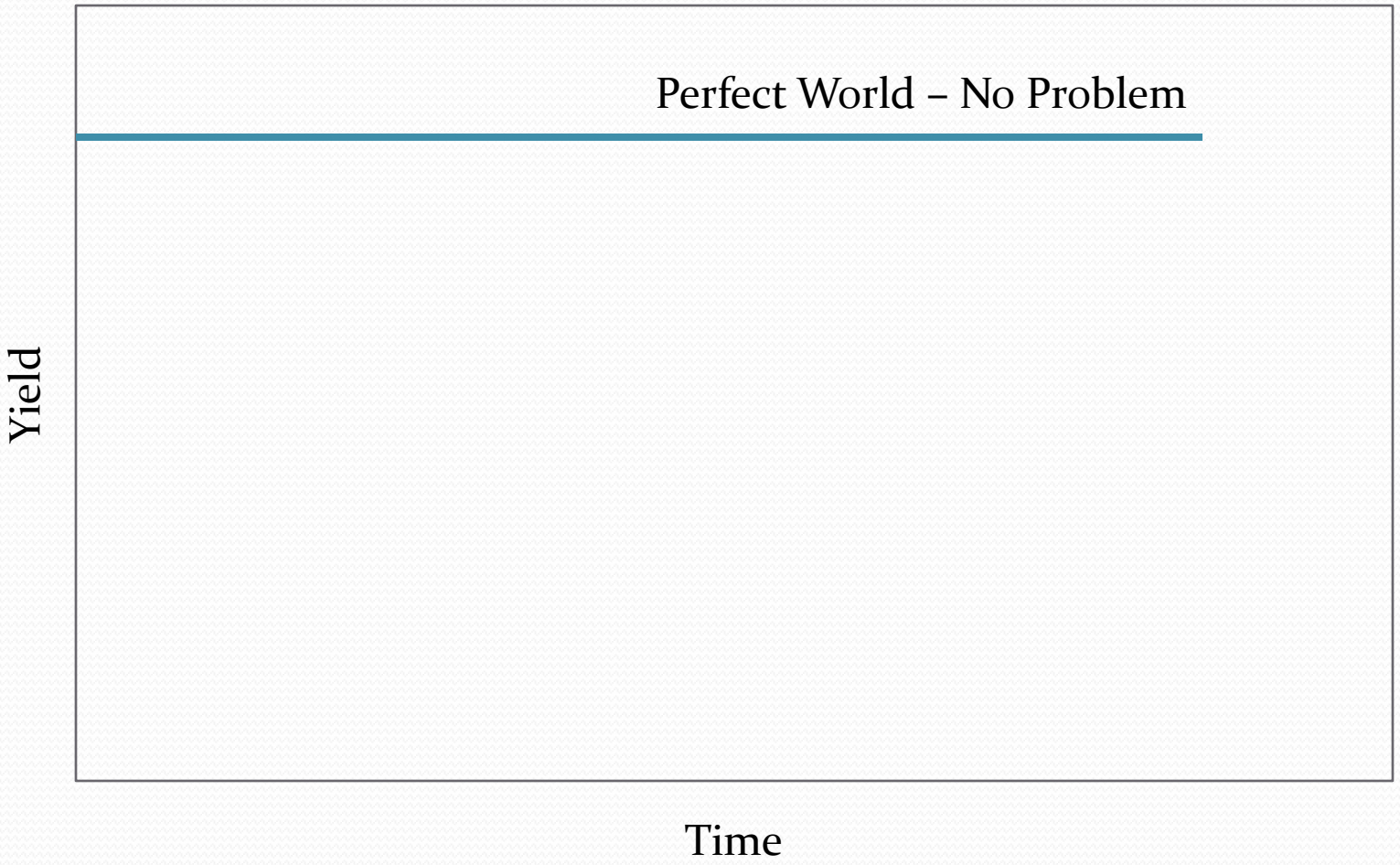
## (acre-feet/yr)

| Maximum Elevation | Configuration 1 | Configuration 2 | | Configuration 3 | |
|---|---|---|---|---|---|
| | | 500 cfs Pumping Rate | 2500 cfs Pumping Rate | 500 cfs Pumping Rate | 2500 cfs Pumping Rate |
| 328 | 66,200 | 81,700 | 96,100 | 104,900 | 121,400 |
| 350 | 169,600 | 204,200 | 231,000 | 204,400 | 240,900 |
| 360 | 226,400 | 273,800 | 314,900 | 273,200 | 315,900 |
| 370 | 265,100 | 320,800 | 392,000 | 329,700 | 397,400 |

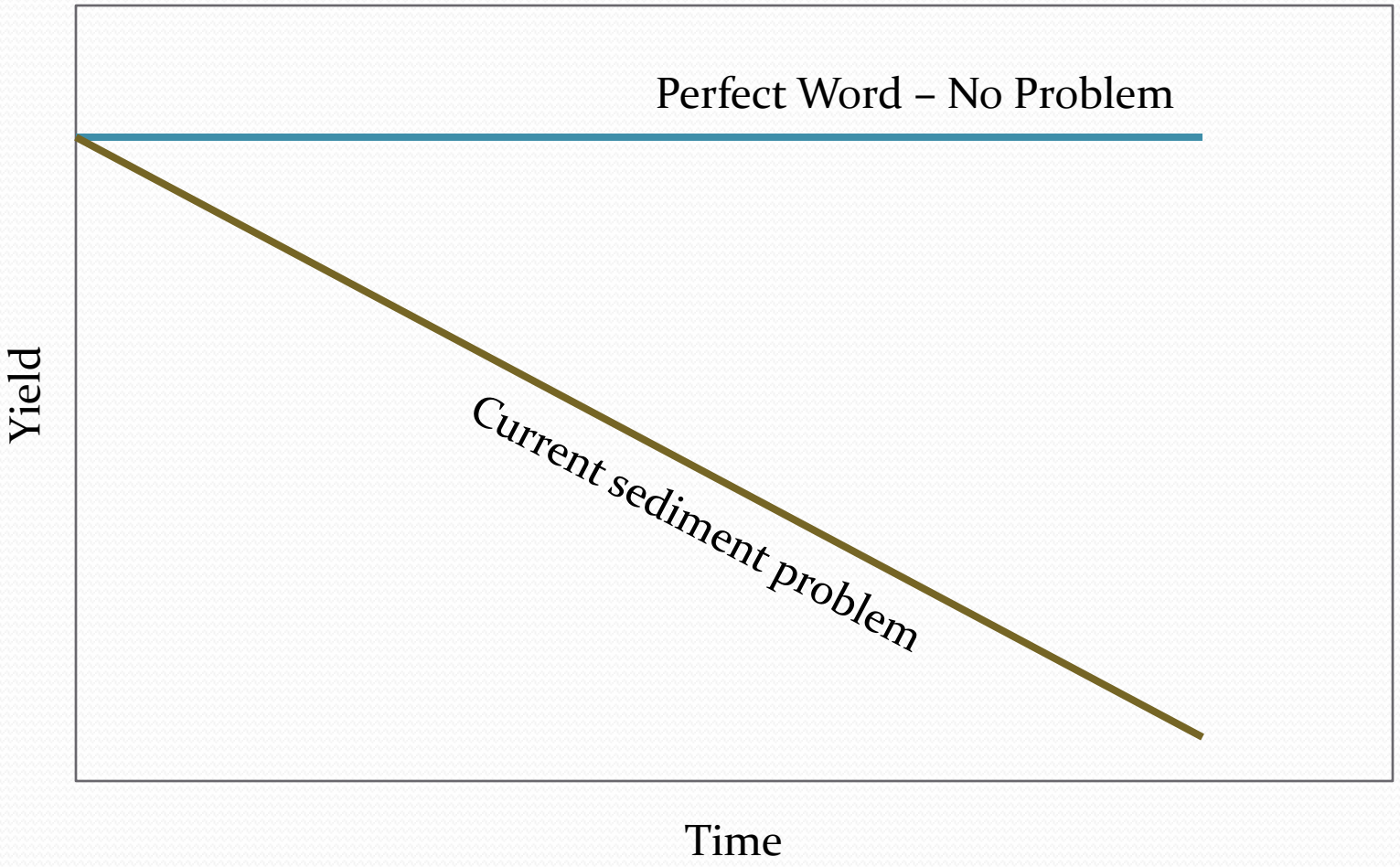
# Wright Patman Storage Losses

- Original (1956) storage capacity: 158,000 ac-feet
- 1997 Volumetric Survey: 115,715 ac-feet
- 2010 Volumentric Survey: 97,927 ac-feet
- Estimated Annual Storage Loss due to Sediment:
  - 730-1362 acre-feet (TWDB, 2012)

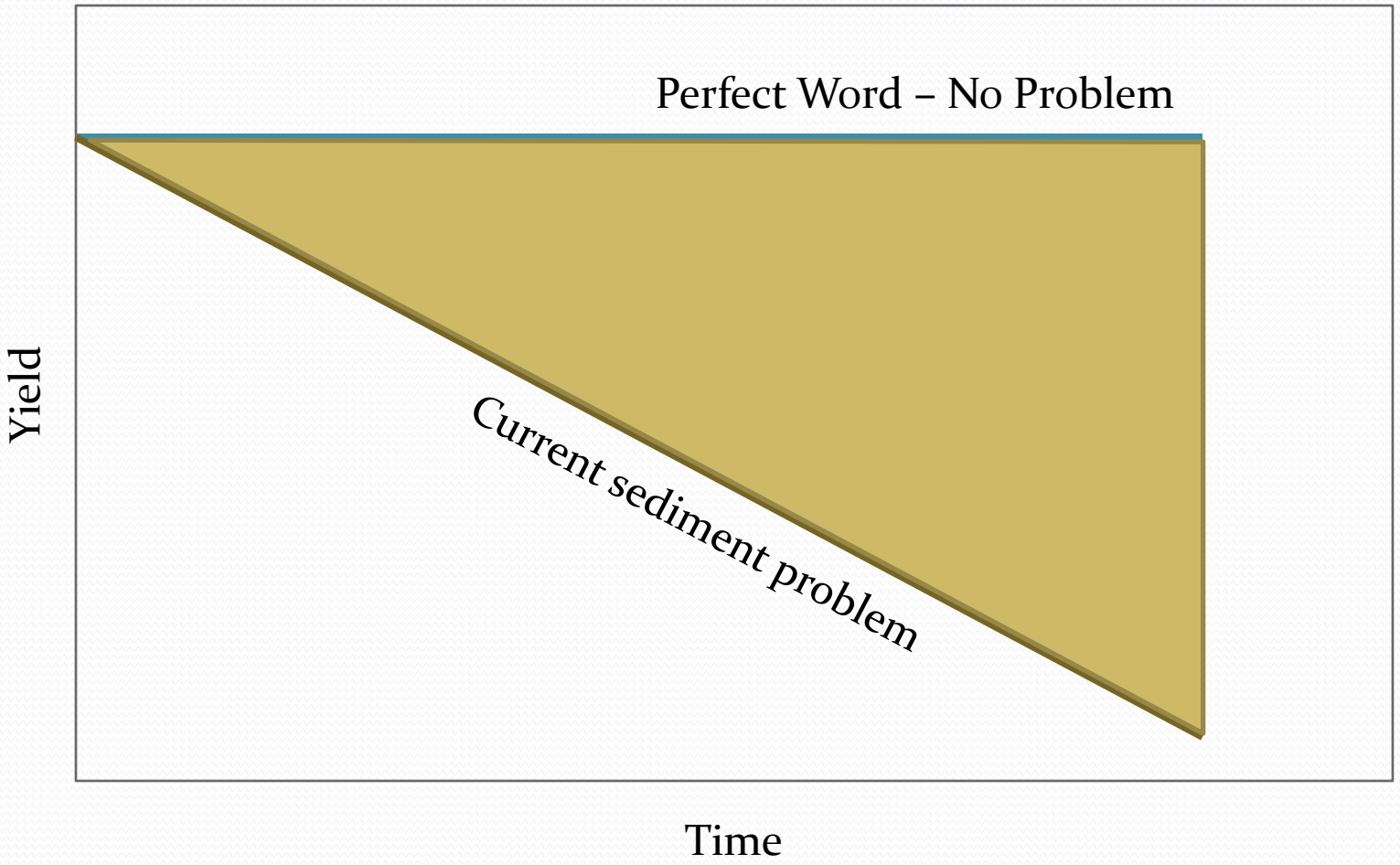
# Generic Yield Curve over Time



# Generic Yield Curve over Time

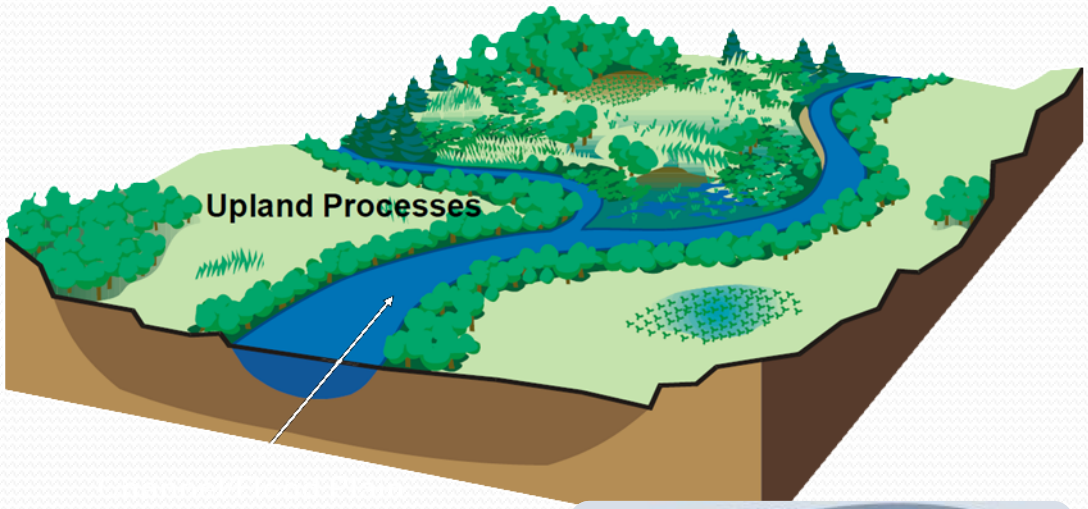


# Generic Yield Curve over Time



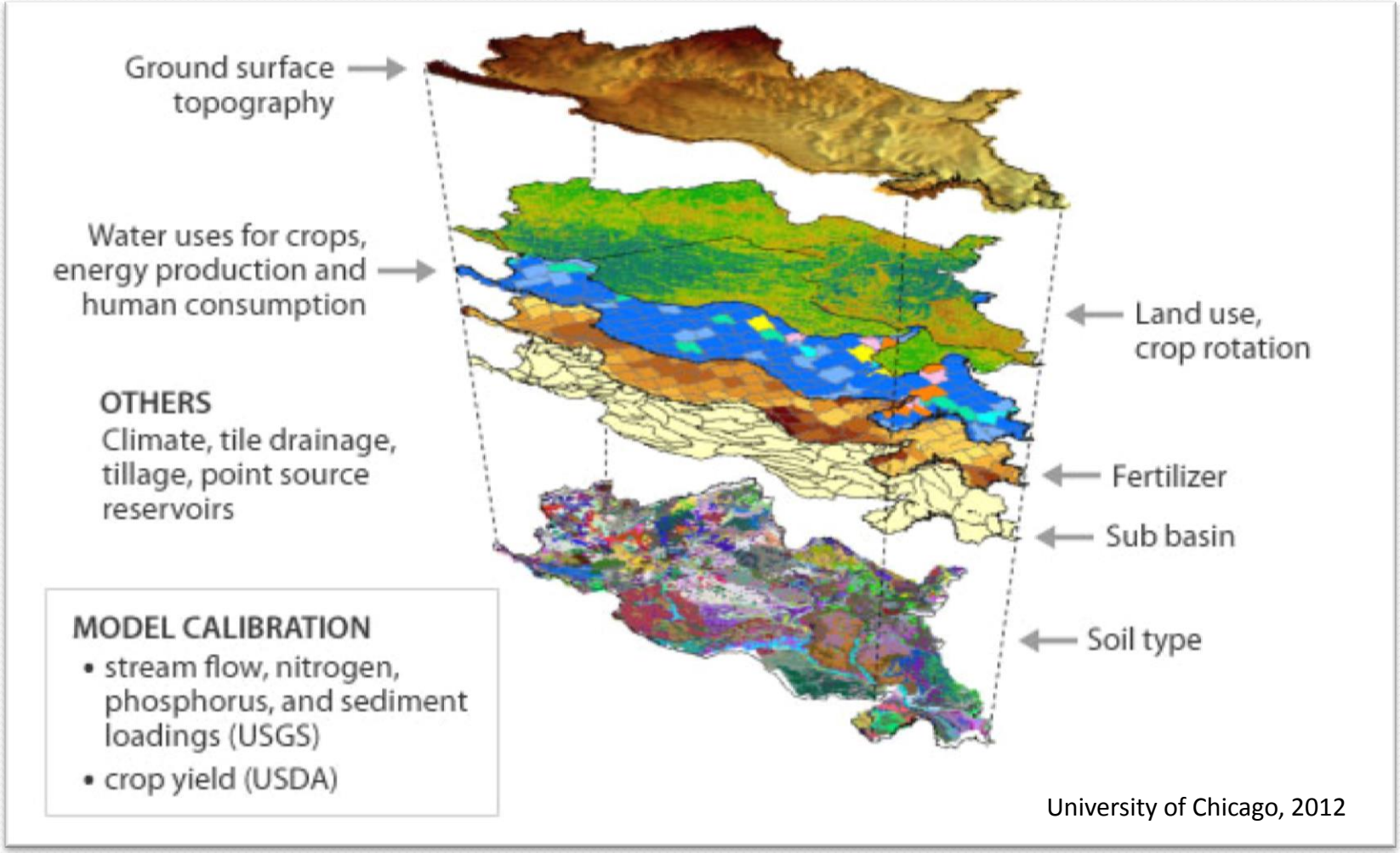
# Soil and Water Assessment Tool

- SWAT
- Predict effects of management on water, sediment, nutrient, and pesticide yields on large, un-gaged river basins
- Dr. Jeffery Arnold, USDA-ARS
- 30 years of continuous model development

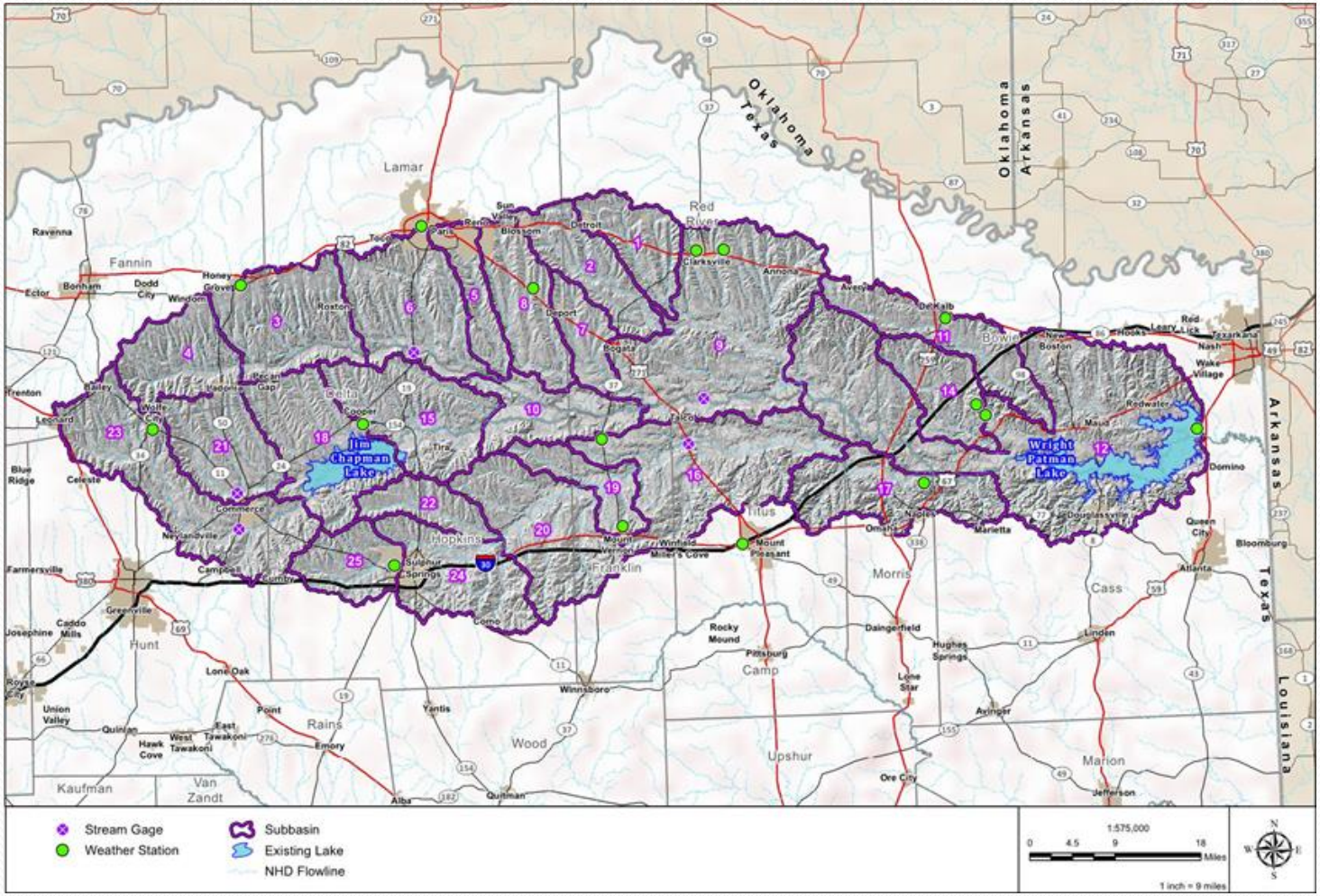



Soil & Water Assessment Tool | SWAT

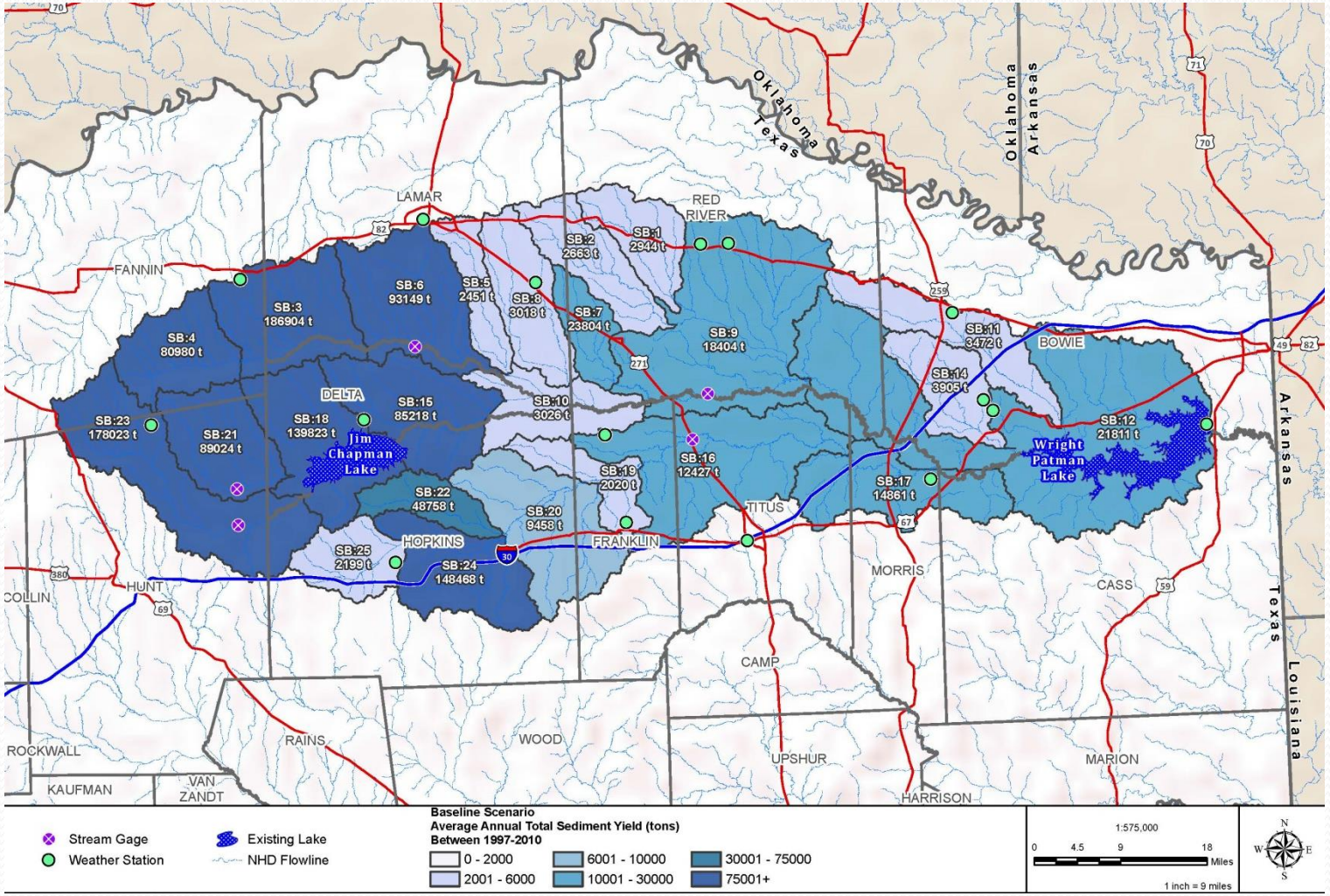
# Soil and Water Assessment Tool



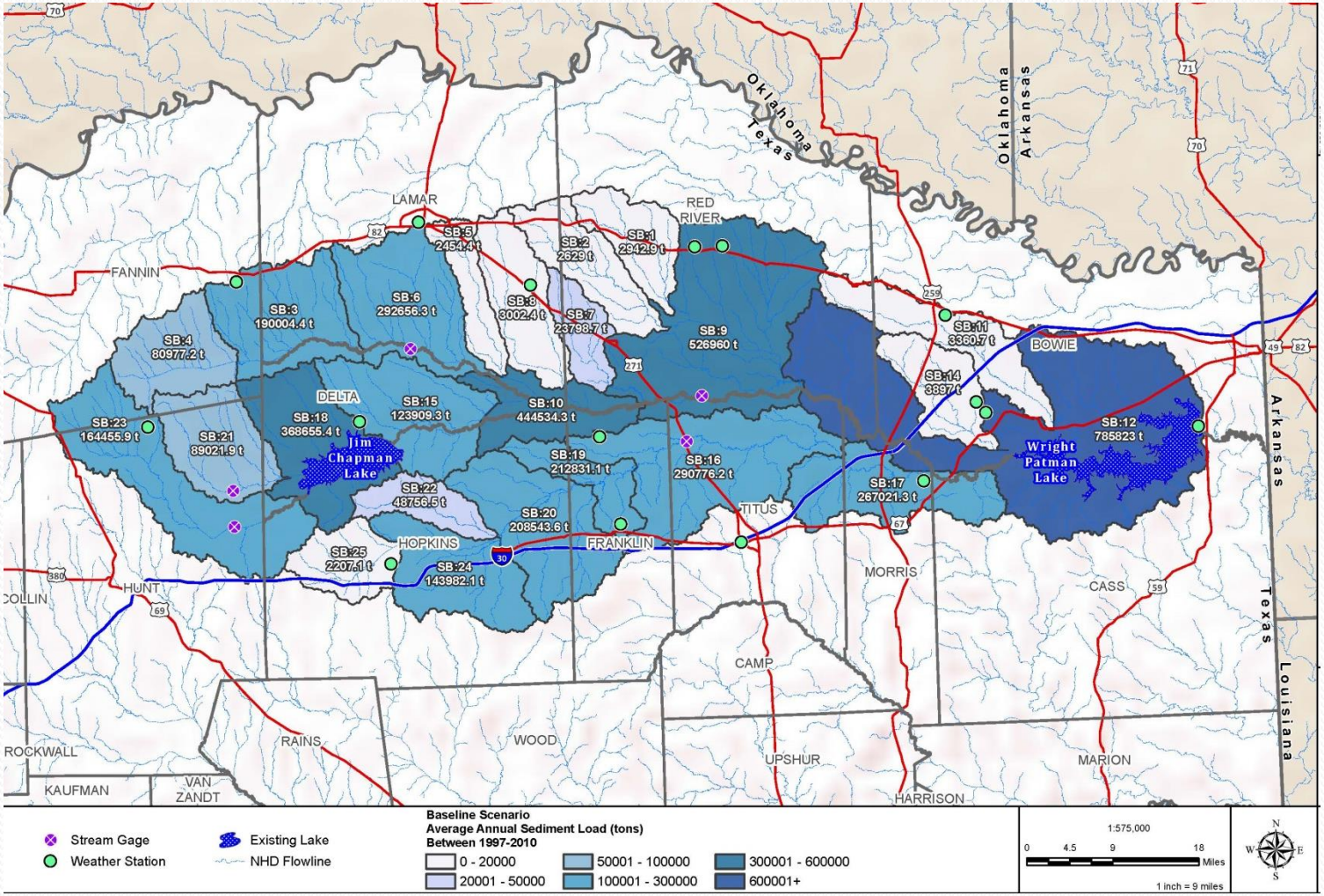
# SWAT Model


Oklahoma
Texas
Oklahoma
Arkansas
Arkansas
Texas
Louisiana
Lamar
Red River
Fannin
Hunt
Rains
Wood
Upshur
Morris
Cass
Marion
Camp
Titus
Franklin
Hopkins
Kaufman
Van Zandt
Jim Chapman Lake
Wright Patman Lake
Stream Gage
Weather Station
Subbasin
Existing Lake
NHD Flowline
1:575,000
0 4.5 9 18
Miles
1 inch = 9 miles
N
W
E
S

# Average Annual Total Yield



# Average Annual Sediment Load



# Wright Patman Yields over Time

## Minimum Elevation – 220 ft

| Max Elevation (feet) | Sediment Condition | Firm Yield (AFY) |
|---|---|---|
| Interim Curve | 2020 (without Ralph Hall) | 38,953 |
| Ultimate Curve | | 196,293 |
| 227.5 | | 251,313 |
| 237.5 | | 655,023 |
| 252.5 | | 1,031,993 |
| | | |
| Interim Curve | 2040 (with Ralph Hall) | 37,713 |
| Ultimate Curve | | 192,033 |
| 227.5 | | 240,633 |
| 237.5 | | 646,873 |
| 252.5 | | 1,025,243 |
| | | |
| Interim Curve | 2070 (with Ralph Hall) | 34,283 |
| Ultimate Curve | | 180,283 |
| 227.5 | | 220,153 |
| 237.5 | | 632,373 |
| 252.5 | | 1,014,063 |

# Alternative Project Yields over Time

## (acre-ft/yr)

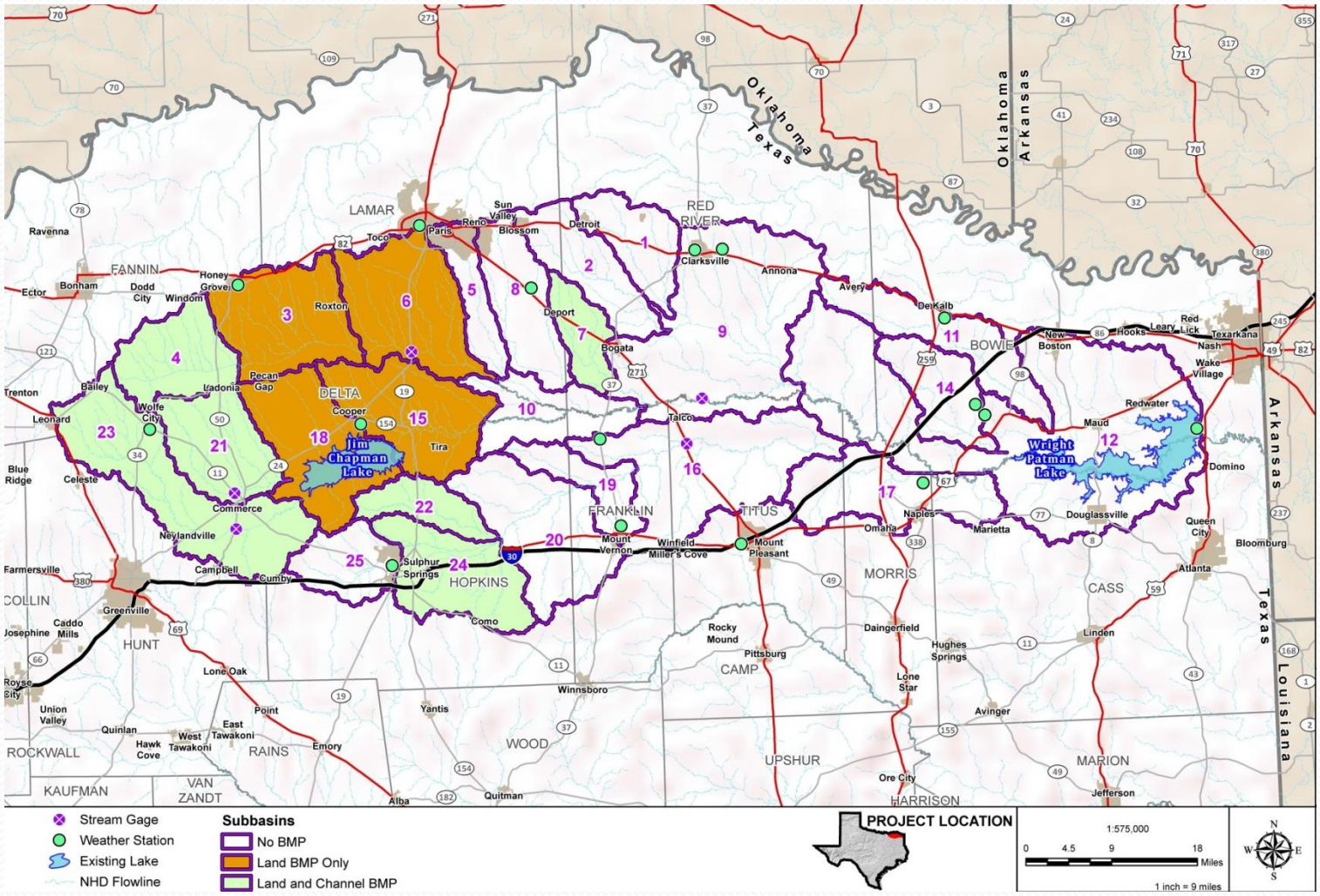
| Reservoir | Initial | 2070 |
|---|---|---|
| Parkhouse I | 124,300 | 123,500 |
| Parkhouse II | 124,200 | 121,000 |
| Marvin Nichols IA | 590,000 | 581,300 |
| Talco (350) | 204,200 | 200,000 |
| Talco (370) | 320,800 | 321,400 |

# Modified Sediment Condition

## ('Intensive' Scenario)

- Six Best Management Practices simulated in SWAT model
  - Filter Strips
  - Terracing
  - Cropland to Pasture Conversion
  - Critical Pasture Planting (perennial grasses)
  - In-channel Grade Control
  - Riparian Buffer Strips
- Ten of 28 sub basins targeted

# Land and Channel BMPs



# Number/Extent of BMP's Simulated ('Intensive' Scenario)

- 10 Sub basins
- Total Area = 1,539,883 acres
  - Filter Strips = 1,564 acres
  - Terrace = 118,891 acres
  - Cropland to Pasture = 154,619 acres
  - Critical Pasture Planting = 1,310,466 linear feet
  - Channel Grade Control
    - 352,788 linear feet
    - Approximately 22, 3-foot drops
  - Riparian Buffer Strip = 702,096 linear feet

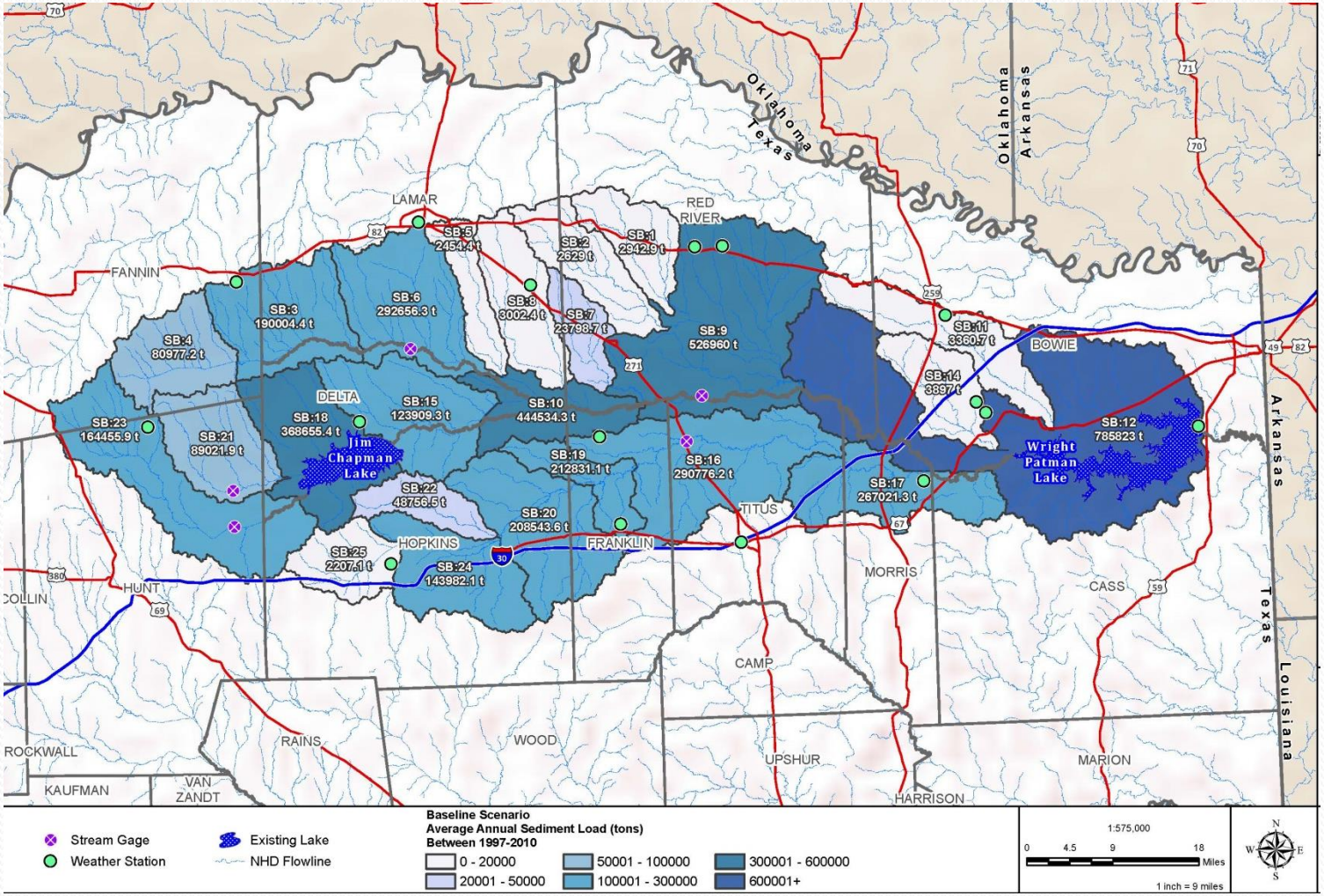
# ‘Feasible’ Scenario

- Based on initial results, number of BMP’s reduced to four:
  - Filter Strips
  - Cropland to Pasture Conversion
  - In-channel Grade control
  - Riparian Buffer Strips

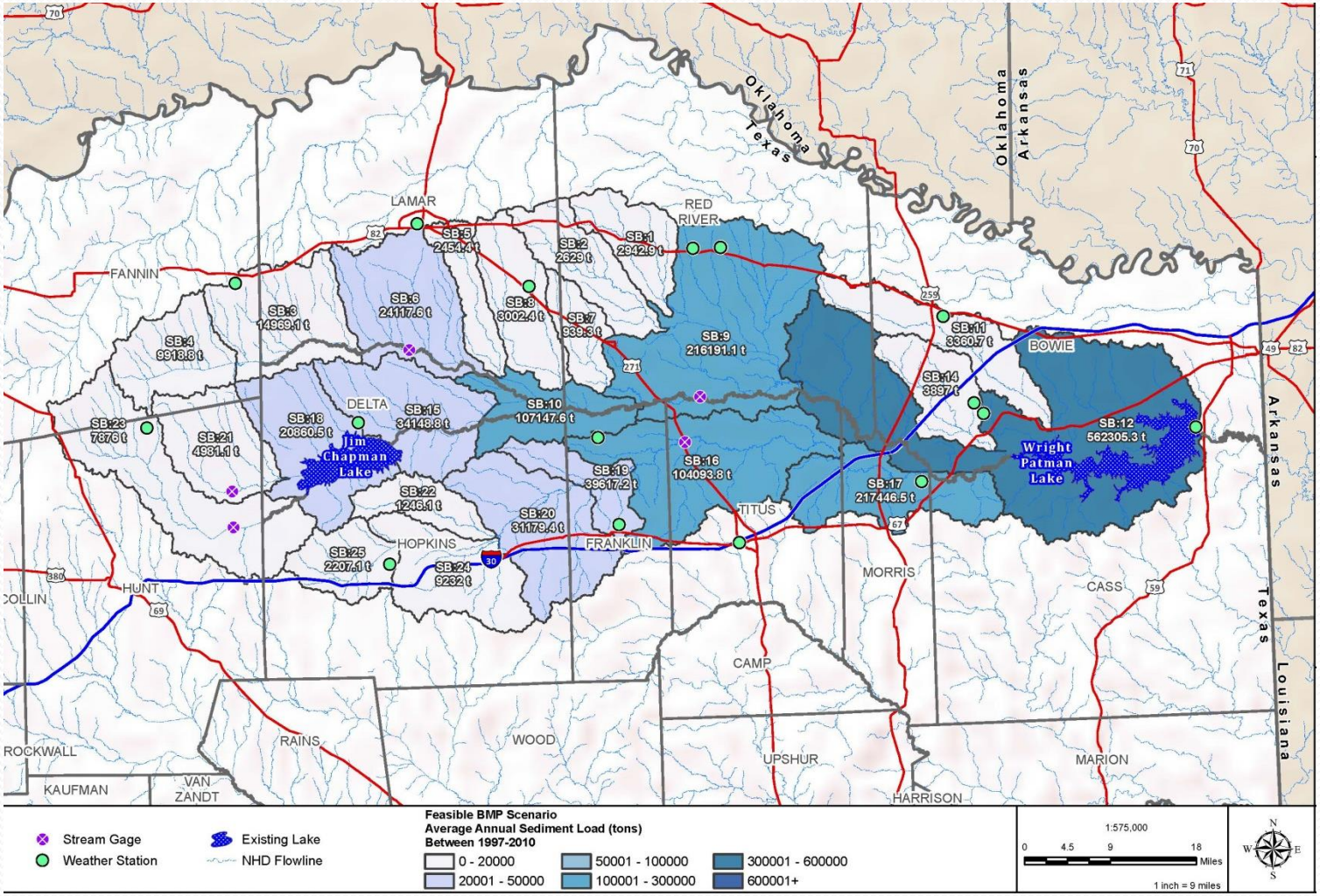
# Reduction in Sediment Yield for Targeted Sub basins

| Sub basin | Existing Conditions | Intensive BMP Scenario | Feasible BMP Scenario | Intensive BMP Scenario | Feasible BMP Scenario |
|---|---|---|---|---|---|
| | (Metric tons/hectare) | | | (% reduction) | |
| 3 | 4.932 | 0.161 | 0.280 | 97 | 94 |
| 4 | 3.110 | 0.280 | 0.381 | 91 | 88 |
| 6 | 2.256 | 0.091 | 0.161 | 96 | 93 |
| 7 | 1.743 | 0.042 | 0.069 | 98 | 96 |
| 15 | 2.263 | 0.077 | 0.138 | 97 | 94 |
| 18 | 3.449 | 0.074 | 0.125 | 98 | 96 |
| 21 | 3.138 | 0.110 | 0.176 | 96 | 94 |
| 22 | 3.413 | 0.020 | 0.087 | 99 | 97 |
| 23 | 3.194 | 0.072 | 0.155 | 98 | 95 |
| 24 | 4.531 | 0.065 | 0.187 | 99 | 96 |

# Average Annual Sediment Load



# Feasible BMP Scenario - Load



# Bottom Line

- Reduced sediment loads to Wright Patman Lake
  - Intensive BMP Scenario - 31% (240,767 metric tons per year)
  - Feasible BMP Scenario  - 28% (223,518 metric tons per year)
- Benefits to other reservoirs and riparian landowners would be additive to Wright Patman benefits
  - have not yet been estimated

# Modified Sediment Conditions

## Average Annual Sediment Load

(metric tons)

| Reservoir | Sediment Load | Reduction in Comparison with Baseline | Wright Patman Sediment Load | Reduction in Comparison with Baseline |
|---|---|---|---|---|
| Parkhouse I | 34,149 | 89,753 | 550,702 | 178,323 |
| Parkhouse II | 24,118 | 268,538 | 546,294 | 91,316 |
| Marvin Nichols IA | 216,191 | 310,769 | 447,696 | 338,127 |
| Talco | 39,617 | 173,214 | 566,742 | 193,941 |

# Water Availability Modeling Results – Modified Watershed Conditions

# Effect of Sediment Modification on Reservoir Yield

- Results of 'Feasible' scenario only
- Future yields based on storage reduction compared to existing condition
- WAM modified to reflect altered:
  - Storage volume/surface area relationship
  - Available storage at various elevations
    - Sediment loads converted to volume based on measured density from core samples at Wright Patman
    - Available storage modified based on reduced loss

# Wright Patman Yield under Mitigated Sediment Condition

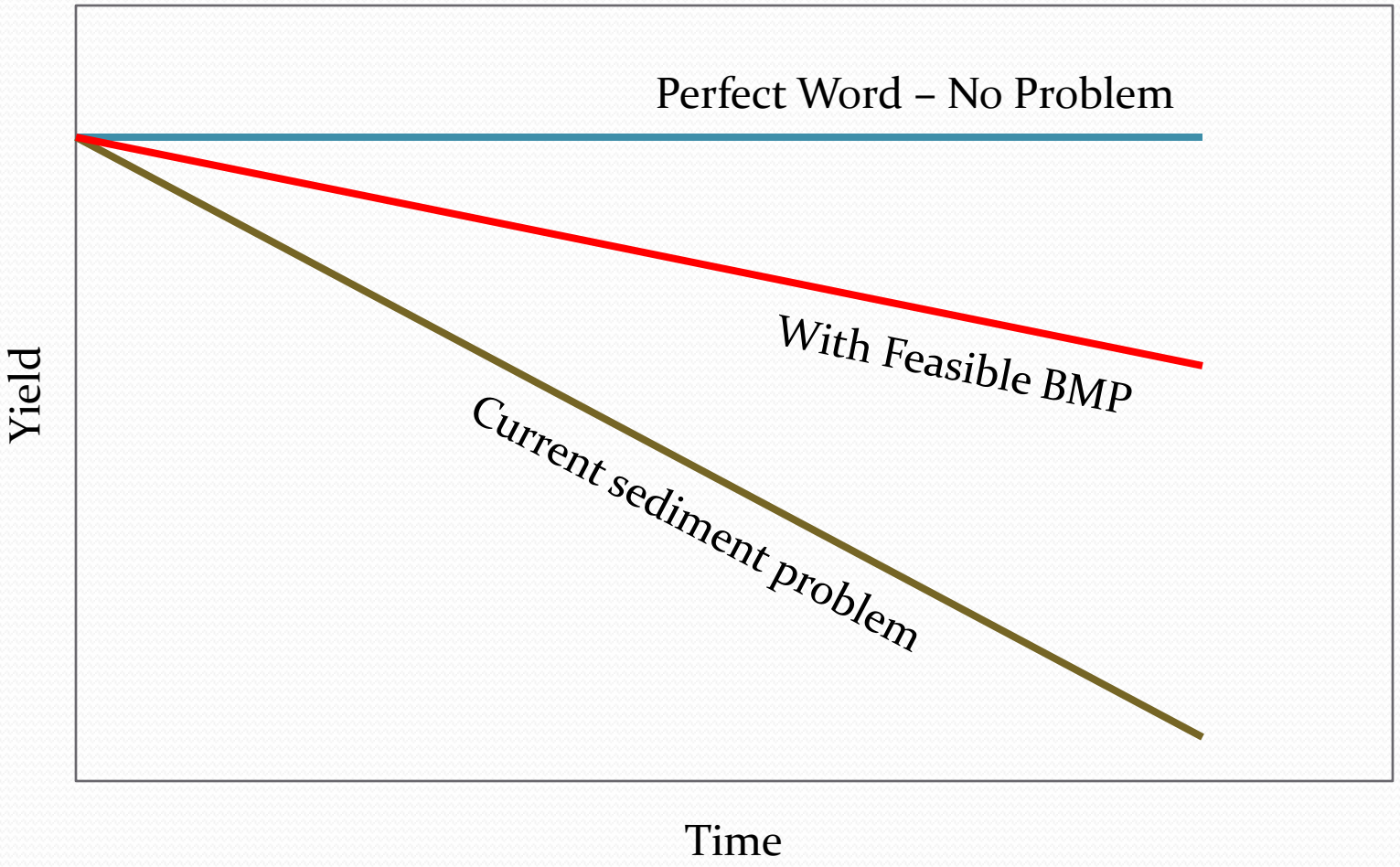
| Conservation Pool Max Elevation (feet) | Sediment Condition | Firm Yield (AFY) | Sediment Condition | Firm Yield (AFY) | Increase in Firm Yield due to BMPs (AFY) |
|---|---|---|---|---|---|
| Interim Curve | 2020 | 38,953 | 2020 | 38,953 | 0 |
| Ultimate Curve | | 196,293 | | 196,293 | 0 |
| 227.5 | | 251,313 | | 251,313 | 0 |
| 237.5 | | 655,023 | | 655,023 | 0 |
| 252.5 | | 1,031,993 | | 1,031,993 | 0 |
| | | | | | |
| Interim Curve | 2040 | 37,713 | 2040 (with Feasible BMPs) | 38,303 | 590 |
| Ultimate Curve | | 192,033 | | 194,013 | 1,980 |
| 227.5 | | 240,633 | | 244,113 | 3,480 |
| 237.5 | | 646,873 | | 649,323 | 2,450 |
| 252.5 | | 1,025,243 | | 1,027,243 | 2,000 |
| | | | | | |
| Interim Curve | 2070 | 34,283 | 2070 (with Feasible BMPs) | 35,983 | 1,700 |
| Ultimate Curve | | 180,283 | | 186,113 | 5,830 |
| 227.5 | | 220,153 | | 230,303 | 10,150 |
| 237.5 | | 632,373 | | 639,533 | 7,160 |
| 252.5 | | 1,014,063 | | 1,019,333 | 5,270 |

# Reservoir Yield under Mitigated Sediment Condition

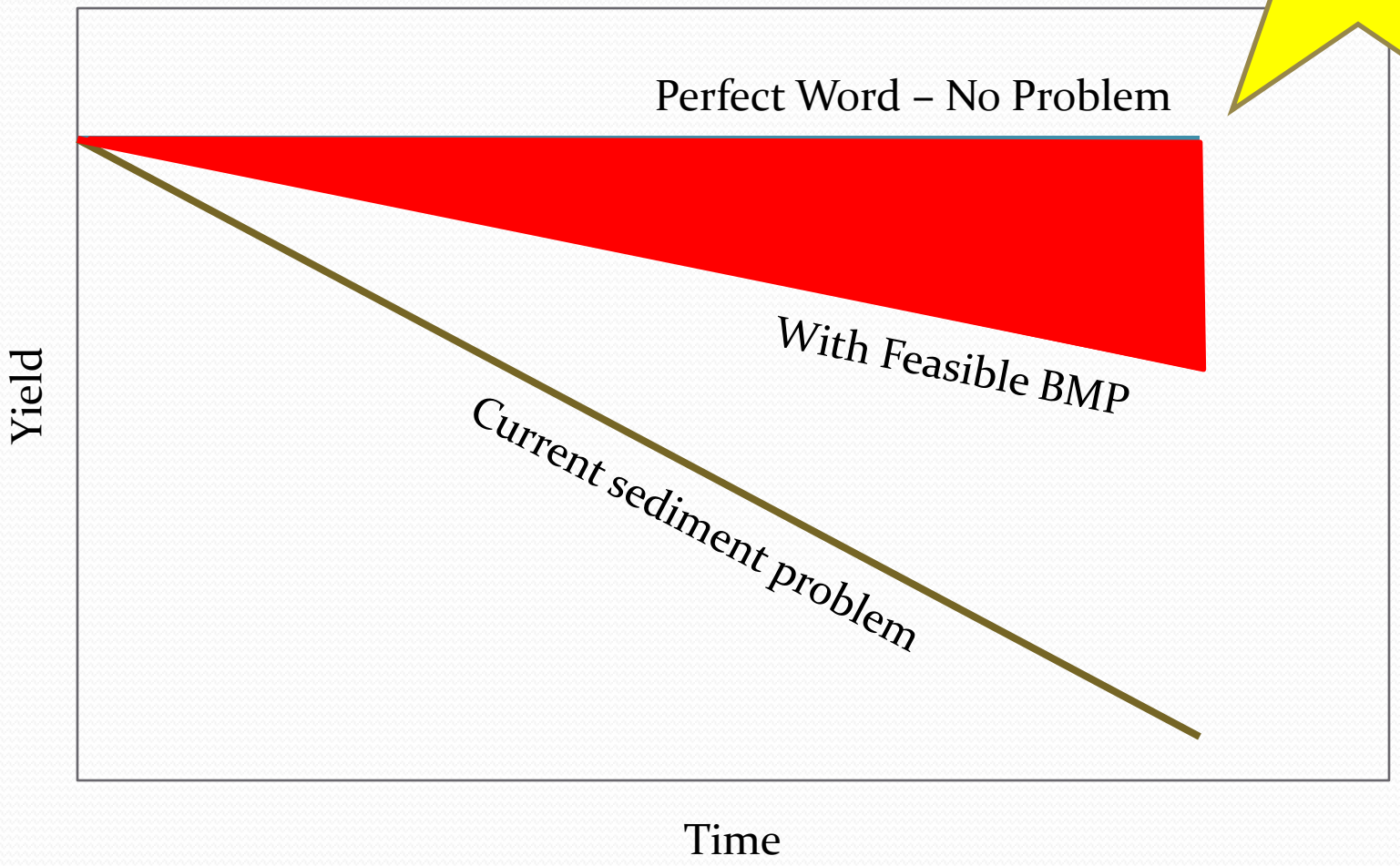
(acre-feet/yr)

| Reservoir | 2030 Yield | 2070 Yield | Improvement in 2070 Yield |
|---|---|---|---|
| Parkhouse I | 124,300 | 123,900 | 400 |
| Parkhouse II | 124,200 | 123,900 | 2,900 |
| Marvin Nichols IA | 589,900 | 586,400 | 5,100 |
| Talco (350) | 204,200 | 203,900 | 3900 |
| Talco (370) | 320,800 | 321,700 | 300 |

# Results


Perfect Word – No Problem
With Feasible BMP
Current sediment problem
Yield
Time

# Results


Perfect Word – No Problem
With Feasible BMP
Current sediment problem
Yield
Time

# Cumulative Savings Feasible BMP Scenario

(acre-ft)

| Reservoir | Priority |
|---|---|
| Wright Patman (227.5 ft msl) | 240,000 |
| Wright Patman (237.5 ft msl) | 170,000 |
| Wright Patman (252.5 ft msl) | 130,000 |
| Parkhouse I | 8,000 |
| Parkhouse II | 59,000 |
| Marvin Nichols IA | 104,000 |
| Talco (350) | 76,000 |
| Talco (370) | 6,000 |

# Additional Benefits

- Landowners
- Transportation
- Environmental

# Additional Needs

- Assess additional benefits
- Quantify cost
- Estimate participation
- Study Effect of reservoir shoreline erosion

# Thank you!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