# Appendix F

## Presentations for the Consideration of Factors

# F.1 Aquifer Uses and Conditions

# GMA 15
# Discussion of Nine Factors in TWC 36.108(d): Aquifer Use & Conditions

Groundwater Management Area 15

April 10, 2025




Presented by:
Steven Young Ph.D, PE, PG
Nick Lamkey PG

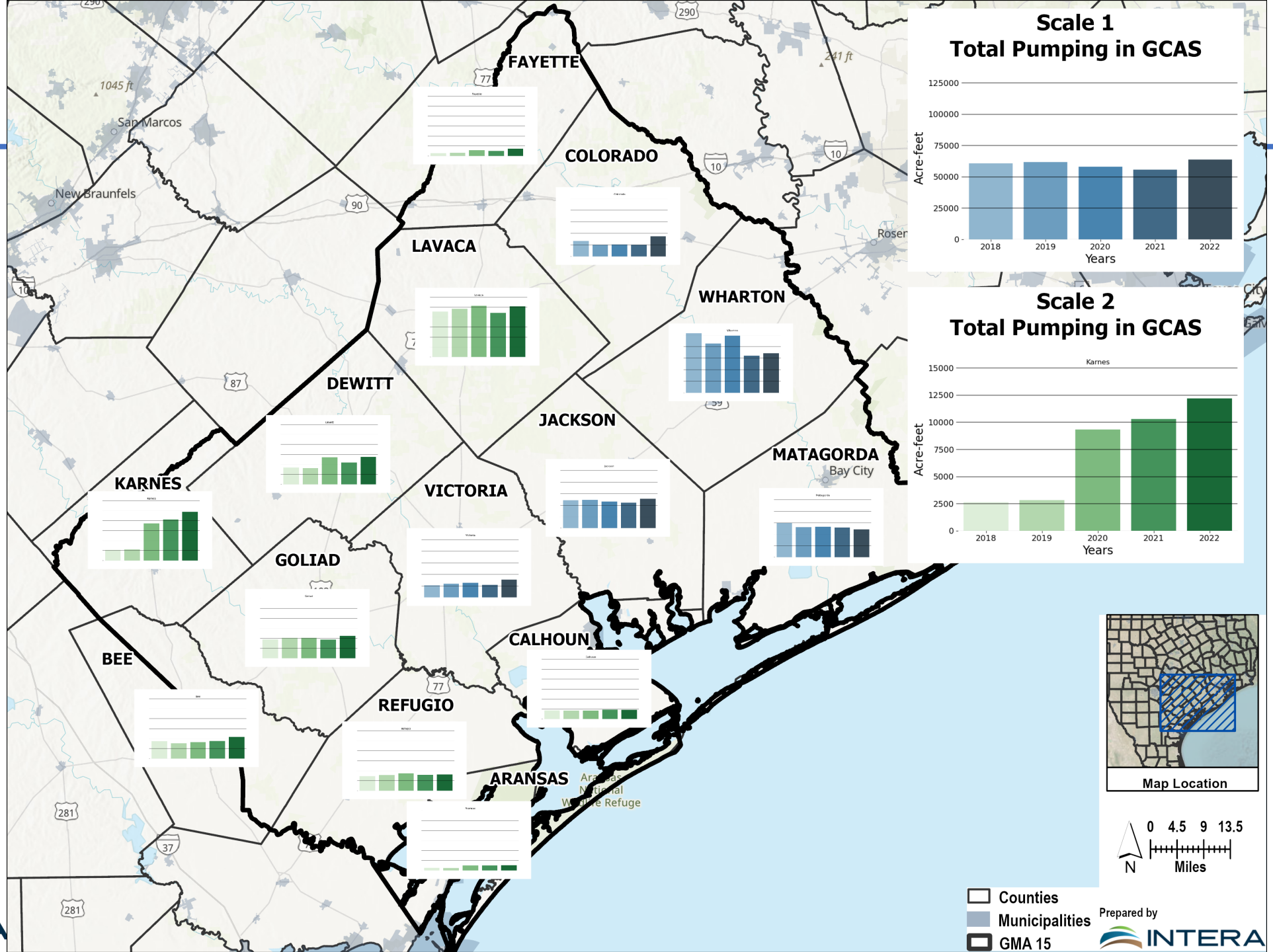
# Agenda

- Water Use
  - Amount
  - Type
- Wells
  - Numbers
  - Water Use
  - Aquifer

# Aquifer Uses in GMA 15

- Aquifer uses and capacity differ substantially across GMA 15
- Generally, aquifer capacity increases to the northeast and decrease to the southwest
  - Capacity also increases down dip relative to up dip portion of the aquifer
- Northeastern portions of GMA 15
  - Groundwater production is generally higher
  - Colorado, Wharton, Matagorda, and Jackson counties
  - Predominate use is for irrigation
- Central portion of GMA 15
  - Victoria County
  - Predominate use is irrigation, municipal, and industrial
- Northcentral portion of GMA 15
  - DeWitt and Karnes counties
  - Predominate use is domestic, livestock and oil and gas production in the Eagle Ford Shale
- Southwestern portion of GMA 15
  - Predominate use is domestic, livestock, and agricultural

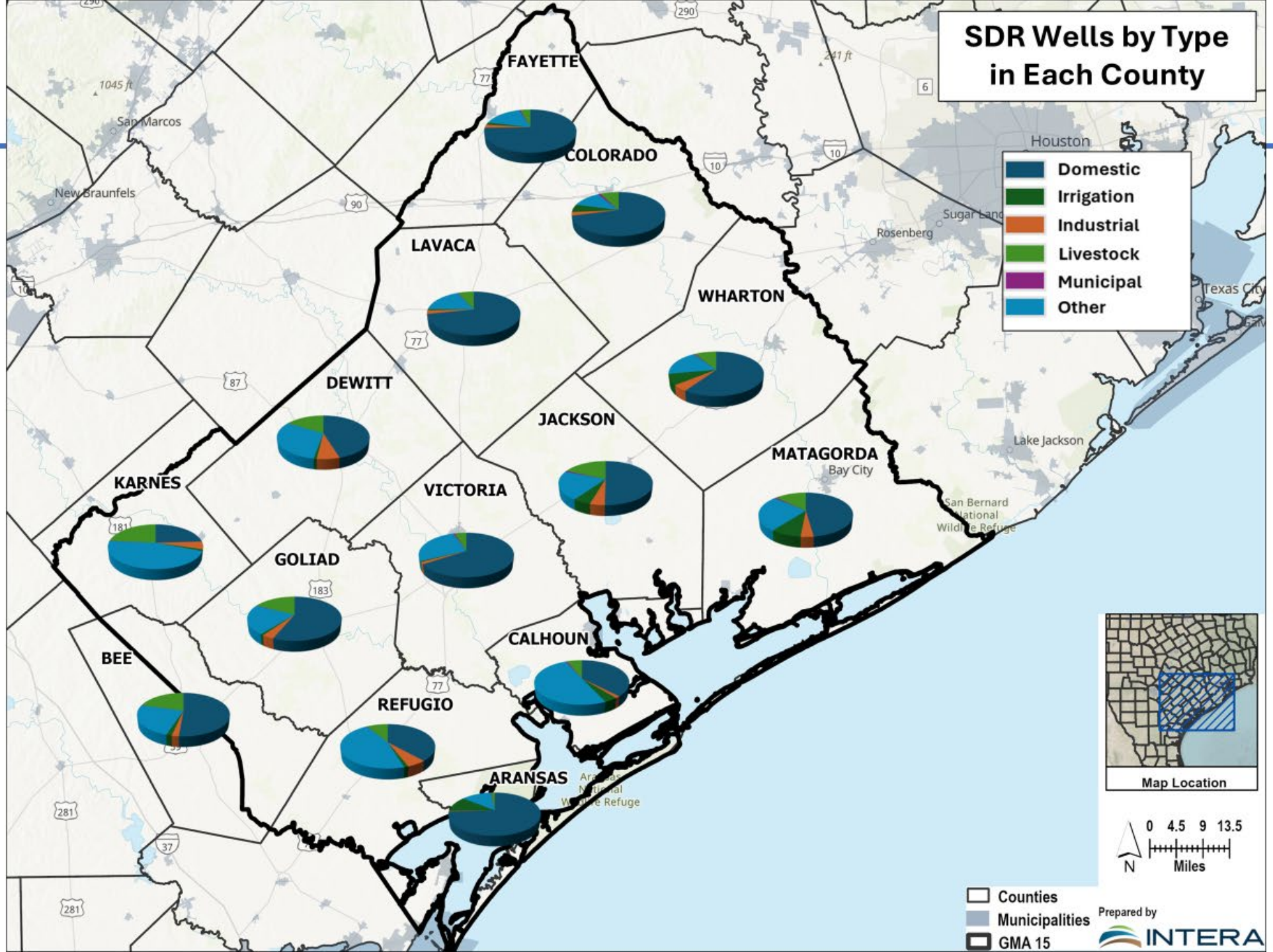
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FAYETTE
COLORADO
LAVACA
WHARTON
DEWITT
JACKSON
MATAGORDA
Bay City
KARNES
VICTORIA
GOLIAD
CALHOUN
BEE
REFUGIO
ARANSAS
San Marcos
New Braunfels
Scale 1
Total Pumping in GCAS
Acre-feet
125000
100000
75000
50000
25000
0
2018
2019
2020
2021
2022
Years
Scale 2
Total Pumping in GCAS
Karnes
15000
12500
10000
7500
5000
2500
0
Map Location
0 4.5 9 13.5
N
Miles
Counties
Municipalities
GMA 15
Prepared by
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# Summary of GMA 15 Average Groundwater Use in Acre-feet for years 2018 through 2022

| GCD/County | Irrigation | Municipal | Livestock | Man/Pwr | Mining | Domestic | Total County | Total 2022 |
|---|---|---|---|---|---|---|---|---|
| ND Aransas/ Aransas | 0 | 487 | 18 | 0 | 0 | -- | **504** | **640** |
| Bee GCD/ Bee | 2,177 | 1,762 | 434 | 0 | 27 | 1,664 | **6,064** | **5,361** |
| Calhoun County GCD/ Calhoun | 444 | 279 | 184 | 188 | 0 | 63 | **1,158** | **1,151** |
| Colorado County GCD/ Colorado | 24,115 | 2,654 | 530 | 2 | 3,329 | 663 | **31,293** | **43,388** |
| Pecan Valley GCD/ Dewitt | 494 | 2,616 | 904 | 0 | 1,444 | 720 | **6,178** | **6,845** |
| Fayette County GCD/ Fayette | 538 | 367 | 200 | 115 | 0 | 570 | **1,790** | **1,816** |
| Goliad County GCD/ Goliad | 3,764 | 509 | 590 | 175 | 1 | 1,070 | **6,109** | **5,607** |
| Texana GCD/ Jackson | 58,279 | 995 | 442 | 160 | 0 | 357 | **60,233** | **63,779** |
| Evergreen UWCD/ Karnes | 764 | 1,992 | 322 | 0 | 4,366 | 282 | **7,726** | **12,198** |
| ND Lavaca/ Lavaca | 8,041 | 2,491 | 1,399 | 81 | 0 | -- | **12,011** | **12,676** |
| Coastal Plains GCD/ Matagorda | 28,169 | 1,579 | 677 | 2,657 | 0 | 2,689 | **35,770** | **30,259** |
| Refugio GCD/ Refugio | 756 | 816 | 419 | 0 | 0 | 153 | **2,144** | **2,050** |
| Victoria County GCD/ Victoria | 9,970 | 2,979 | 542 | 1,785 | 26 | 1,290 | **16,593** | **19,284** |
| Coastal Bend GCD/ Wharton | 99,747 | 2,361 | 720 | 2,078 | 0 | 2,689 | **107,595** | **85,822** |
| **Total** | **237,257** | **21,888** | **7,379** | **7,241** | **9,193** | **12,210** | **295,168** | **290,876** |

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SDR Wells by Type in Each County
Domestic
Irrigation
Industrial
Livestock
Municipal
Other
FAYETTE
COLORADO
LAVACA
WHARTON
DEWITT
JACKSON
MATAGORDA
KARNES
VICTORIA
GOLIAD
CALHOUN
BEE
REFUGIO
ARANSAS
Houston
San Marcos
New Braunfels
Rosenberg
Sugar Land
Texas City
Lake Jackson
Bay City
Map Location
0 4.5 9 13.5
N
Miles
Counties
Municipalities
GMA 15
Prepared by
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# Total SDR Wells by County

| County | Domestic | Industrial | Irrigation | Other | Municipal | Livestock | Total Wells |
|---|---|---|---|---|---|---|---|
| Aransas | 1,350 | 9 | 204 | 248 | 5 | 25 | **1,841** |
| Bee | 350 | 14 | 11 | 178 | 1 | 141 | **695** |
| Calhoun | 676 | 28 | 67 | 889 | 10 | 106 | **1,776** |
| Colorado | 2,646 | 99 | 207 | 457 | 43 | 282 | **3,734** |
| DeWitt | 1,806 | 267 | 35 | 1,218 | 7 | 650 | **3,983** |
| Fayette | 2,005 | 68 | 47 | 452 | 14 | 114 | **2,700** |
| Goliad | 1,141 | 73 | 18 | 466 | 5 | 348 | **2,051** |
| Jackson | 884 | 74 | 91 | 383 | 13 | 322 | **1,767** |
| Karnes | 513 | 115 | 24 | 923 | 5 | 488 | **2,068** |
| Lavaca | 2,957 | 108 | 41 | 748 | 10 | 272 | **4,136** |
| Matagorda | 1,437 | 108 | 267 | 768 | 23 | 387 | **2,990** |
| Refugio | 469 | 69 | 16 | 536 | 1 | 106 | **1,197** |
| Victoria | 3,084 | 79 | 27 | 1,248 | 30 | 225 | **4,693** |
| Wharton | 2,128 | 168 | 292 | 671 | 18 | 319 | **3,596** |
| **Total** | **21,446** | **1,279** | **1,347** | **9,185** | **185** | **3,785** | **37,227** |

- **Categories Included in "Other":**
  - **Monitor**
  - **Environmental Soil Boring**
  - **Other**
  - **Rig Supply**
  - **Fracking Supply**
  - **Test Well**
  - **Closed-Loop Geothermal**
  - **Unknown**
  - **Injection**
  - **De-watering**

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# Total SDR Percentages Wells by County

| County | Domestic | Industrial | Irrigation | Other | Municipal | Livestock | Total Wells |
|---|---|---|---|---|---|---|---|
| **Aransas** | 73% | 0% | 11% | 13% | 0% | 1% | **5%** |
| **Bee** | 50% | 2% | 2% | 26% | 0% | 20% | **2%** |
| **Calhoun** | 38% | 2% | 4% | 50% | 1% | 6% | **5%** |
| **Colorado** | 71% | 3% | 6% | 12% | 1% | 8% | **10%** |
| **DeWitt** | 45% | 7% | 1% | 31% | 0% | 16% | **11%** |
| **Fayette** | 74% | 3% | 2% | 17% | 1% | 4% | **7%** |
| **Goliad** | 56% | 4% | 1% | 23% | 0% | 17% | **6%** |
| **Jackson** | 50% | 4% | 5% | 22% | 1% | 18% | **5%** |
| **Karnes** | 25% | 6% | 1% | 45% | 0% | 24% | **6%** |
| **Lavaca** | 71% | 3% | 1% | 18% | 0% | 7% | **11%** |
| **Matagorda** | 48% | 4% | 9% | 26% | 1% | 13% | **8%** |
| **Refugio** | 39% | 6% | 1% | 45% | 0% | 9% | **3%** |
| **Victoria** | 66% | 2% | 1% | 27% | 1% | 5% | **13%** |
| **Wharton** | 59% | 5% | 8% | 19% | 1% | 9% | **10%** |
| **Total** | **58%** | **3%** | **4%** | **25%** | **0%** | **10%** | **100%** |

INTERA

# Total SDR Wells by County in Gulf Coast Aquifer

| County | Domestic | Industrial | Irrigation | Other | Municipal | Livestock | Total Wells |
|---|---|---|---|---|---|---|---|
| **Aransas** | 1,350 | 9 | 204 | 243 | 5 | 25 | **1,836** |
| **Bee** | 349 | 14 | 11 | 152 | 1 | 141 | **668** |
| **Calhoun** | 675 | 28 | 67 | 869 | 10 | 106 | **1,755** |
| **Colorado** | 2,594 | 99 | 205 | 435 | 41 | 274 | **3,648** |
| **DeWitt** | 1,778 | 218 | 32 | 904 | 5 | 633 | **3,570** |
| **Fayette** | 1,094 | 7 | 13 | 110 | 2 | 65 | **1,291** |
| **Goliad** | 1,141 | 73 | 18 | 393 | 5 | 348 | **1,978** |
| **Jackson** | 884 | 74 | 91 | 370 | 13 | 322 | **1,754** |
| **Karnes** | 287 | 42 | 5 | 430 | 5 | 253 | **1,022** |
| **Lavaca** | 2,777 | 72 | 35 | 554 | 9 | 255 | **3,702** |
| **Matagorda** | 1,425 | 108 | 267 | 767 | 23 | 387 | **2,977** |
| **Refugio** | 469 | 68 | 16 | 534 | 1 | 105 | **1,193** |
| **Victoria** | 3,084 | 79 | 27 | 1,126 | 30 | 225 | **4,571** |
| **Wharton** | 2,128 | 168 | 292 | 666 | 18 | 319 | **3,591** |
| **Total** | **20,035** | **1,059** | **1,283** | **7,553** | **168** | **3,458** | **33,556** |

* Based on surfaces developed by the TWDB GAM for the central CZWX

INTERA

# Total SDR Percentages by County in Gulf Coast Aquifer

| County | Domestic | Industrial | Irrigation | Other | Municipal | Livestock | Total Wells |
|---|---|---|---|---|---|---|---|
| **Aransas** | 74% | 0% | 11% | 13% | 0% | 1% | **5%** |
| **Bee** | 52% | 2% | 2% | 23% | 0% | 21% | **2%** |
| **Calhoun** | 38% | 2% | 4% | 50% | 1% | 6% | **5%** |
| **Colorado** | 71% | 3% | 6% | 12% | 1% | 8% | **11%** |
| **DeWitt** | 50% | 6% | 1% | 25% | 0% | 18% | **11%** |
| **Fayette** | 85% | 1% | 1% | 9% | 0% | 5% | **4%** |
| **Goliad** | 58% | 4% | 1% | 20% | 0% | 18% | **6%** |
| **Jackson** | 50% | 4% | 5% | 21% | 1% | 18% | **5%** |
| **Karnes** | 28% | 4% | 0% | 42% | 0% | 25% | **3%** |
| **Lavaca** | 75% | 2% | 1% | 15% | 0% | 7% | **11%** |
| **Matagorda** | 48% | 4% | 9% | 26% | 1% | 13% | **9%** |
| **Refugio** | 39% | 6% | 1% | 45% | 0% | 9% | **4%** |
| **Victoria** | 67% | 2% | 1% | 25% | 1% | 5% | **14%** |
| **Wharton** | 59% | 5% | 8% | 19% | 1% | 9% | **11%** |
| **Total** | **60%** | **3%** | **4%** | **23%** | **1%** | **10%** | **100%** |

* Based on surfaces developed by the TWDB GAM for the central CZWX

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# Gulf Coast SDR Wells by Aquifer and County

| Aquifer | County | Domestic | Industrial | Irrigation | Other | Municipal | Livestock | Total Wells |
|---|---|---|---|---|---|---|---|---|
| **Chicot** | **Aransas** | 1,350 | 9 | 204 | 243 | 5 | 25 | **1,836** |
| **Chicot** | **Bee** | 36 | 4 | | 23 | | 8 | **71** |
| **Chicot** | **Calhoun** | 675 | 28 | 67 | 869 | 10 | 106 | **1,755** |
| **Chicot** | **Colorado** | 1,341 | 80 | 100 | 331 | 14 | 166 | **2,032** |
| **Chicot** | **DeWitt** | 39 | | | 3 | | 6 | **48** |
| **Chicot** | **Goliad** | 16 | 4 | | 4 | | 13 | **37** |
| **Chicot** | **Jackson** | 883 | 74 | 82 | 369 | 13 | 322 | **1,743** |
| **Chicot** | **Lavaca** | 292 | 29 | 4 | 80 | | 50 | **455** |
| **Chicot** | **Matagorda** | 1,425 | 107 | 264 | 767 | 23 | 387 | **2,973** |
| **Chicot** | **Refugio** | 446 | 64 | 12 | 531 | 1 | 103 | **1,157** |
| **Chicot** | **Victoria** | 1,912 | 48 | 18 | 1,040 | 18 | 155 | **3,191** |
| **Chicot** | **Wharton** | 2,128 | 158 | 260 | 664 | 18 | 319 | **3,547** |
| | **Total** | **10,543** | **605** | **1,011** | **4,924** | **102** | **1,660** | **18,845** |

| Aquifer | County | Domestic | Industrial | Irrigation | Other | Municipal | Livestock | Total Wells |
|---|---|---|---|---|---|---|---|---|
| **Evangeline** | **Bee** | 287 | 6 | 10 | 83 | 1 | 97 | **484** |
| **Evangeline** | **Colorado** | 1,151 | 17 | 84 | 99 | 21 | 98 | **1,470** |
| **Evangeline** | **DeWitt** | 883 | 32 | 11 | 406 | 1 | 191 | **1,524** |
| **Evangeline** | **Fayette** | 158 | | 2 | 1 | | 6 | **167** |
| **Evangeline** | **Goliad** | 1,118 | 67 | 14 | 380 | 5 | 318 | **1,902** |
| **Evangeline** | **Jackson** | 1 | | 9 | 1 | | | **11** |
| **Evangeline** | **Karnes** | 10 | | | | | 4 | **14** |
| **Evangeline** | **Lavaca** | 1,457 | 32 | 19 | 378 | 4 | 99 | **1,989** |
| **Evangeline** | **Matagorda** | | 1 | 3 | | | | **4** |
| **Evangeline** | **Refugio** | 23 | 4 | 4 | 3 | | 2 | **36** |
| **Evangeline** | **Victoria** | 1,172 | 31 | 9 | 86 | 12 | 70 | **1,380** |
| **Evangeline** | **Wharton** | | 10 | 32 | 2 | | | **44** |
| | **Total** | **6,260** | **200** | **197** | **1,439** | **44** | **885** | **9,025** |

* Based on surfaces developed by the TWDB GAM for the central CZWX

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# Gulf Coast SDR Wells by Aquifer and County

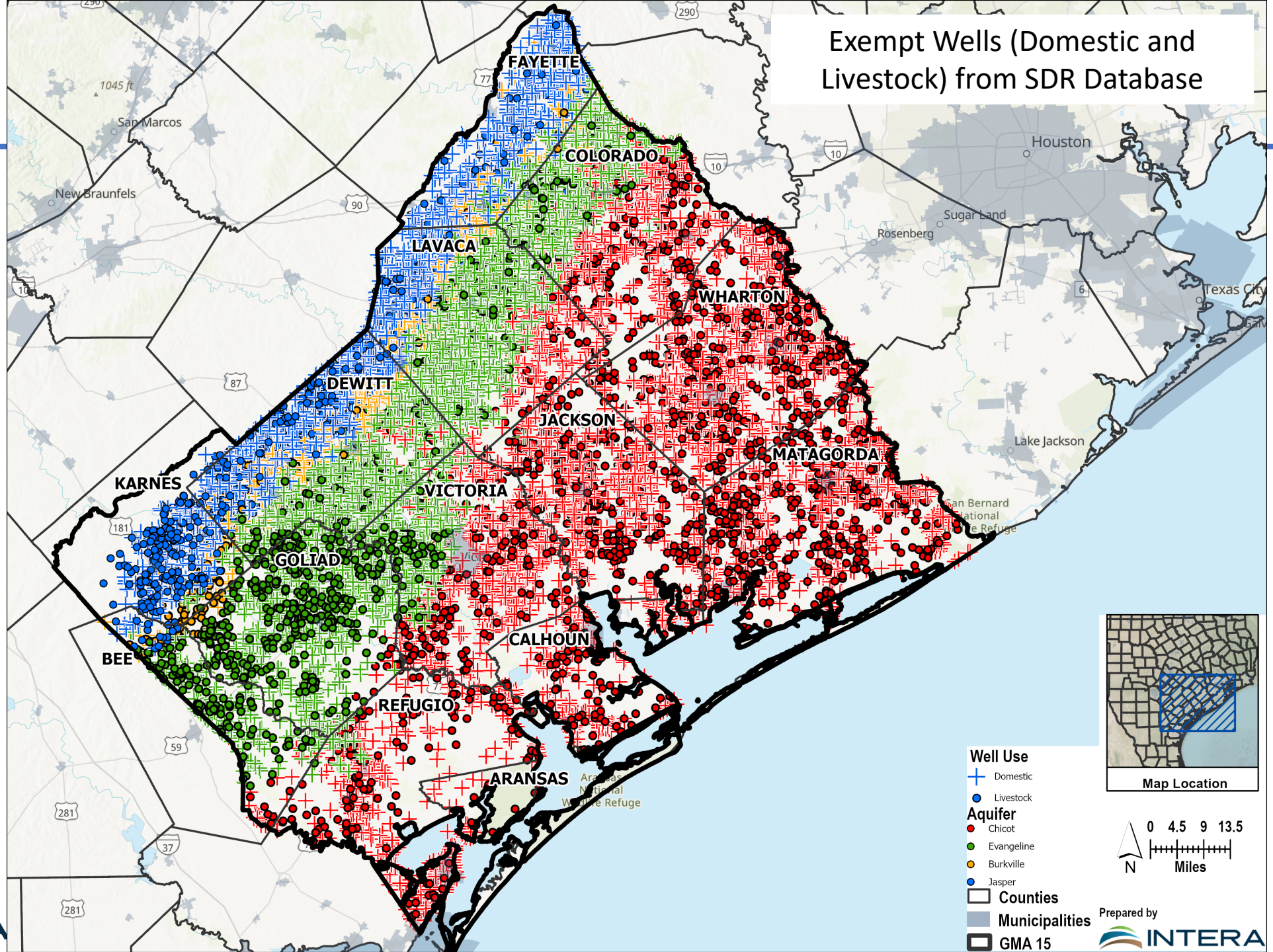
| Aquifer | County | Domestic | Industrial | Irrigation | Other | Municipal | Livestock | Total Wells |
|---|---|---|---|---|---|---|---|---|
| **Burkville** | **Bee** | 16 | 1 | | 17 | | 22 | **56** |
| **Burkville** | **Colorado** | 94 | 2 | 12 | 4 | 3 | 9 | **124** |
| **Burkville** | **DeWitt** | 251 | 10 | 2 | 80 | 1 | 81 | **425** |
| **Burkville** | **Fayette** | 251 | | 2 | 35 | | 20 | **308** |
| **Burkville** | **Goliad** | 7 | 2 | 3 | 9 | | 17 | **38** |
| **Burkville** | **Karnes** | 55 | 1 | | 108 | 1 | 58 | **223** |
| **Burkville** | **Lavaca** | 357 | 4 | 4 | 39 | 2 | 43 | **449** |
| | **Total** | **1,031** | **20** | **23** | **292** | **7** | **250** | 1,623 |

| Aquifer | County | Domestic | Industrial | Irrigation | Other | Municipal | Livestock | Total Wells |
|---|---|---|---|---|---|---|---|---|
| **Jasper** | **Bee** | 10 | 3 | 1 | 29 | | 14 | **57** |
| **Jasper** | **Colorado** | 8 | | 9 | 1 | 3 | 1 | **22** |
| **Jasper** | **DeWitt** | 605 | 176 | 19 | 415 | 3 | 355 | **1,573** |
| **Jasper** | **Fayette** | 685 | 7 | 9 | 74 | 2 | 39 | **816** |
| **Jasper** | **Goliad** | | | **1** | | | | **1** |
| **Jasper** | **Karnes** | 222 | 41 | 5 | 322 | 4 | 191 | **785** |
| **Jasper** | **Lavaca** | 671 | 7 | 8 | 57 | 3 | 63 | **809** |
| | **Total** | **2,201** | **234** | **52** | **898** | **15** | **663** | 4,063 |

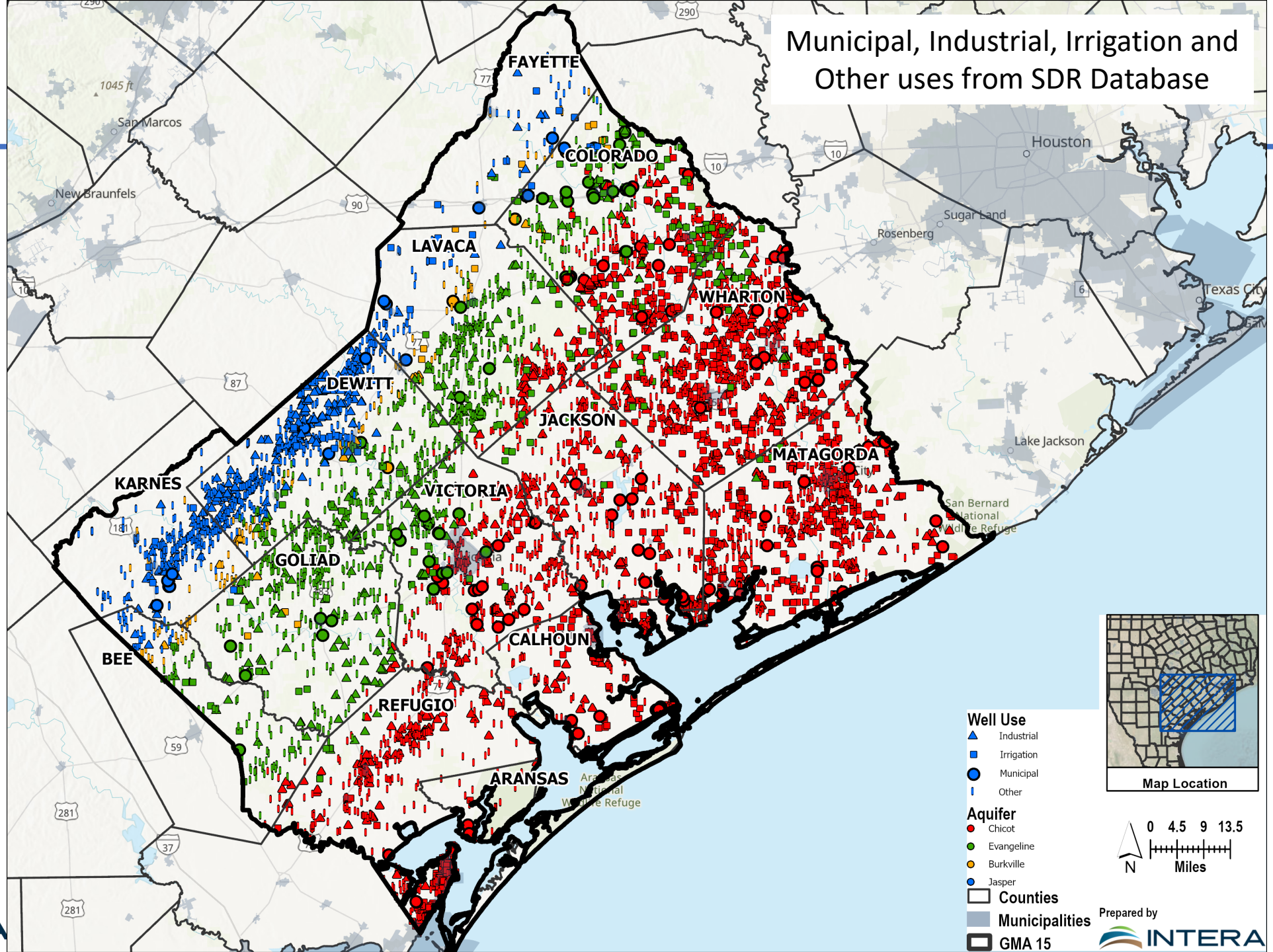
* Based on surfaces developed by the TWDB GAM for the central CZWX

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# Exempt Wells (Domestic and Livestock) from SDR Database

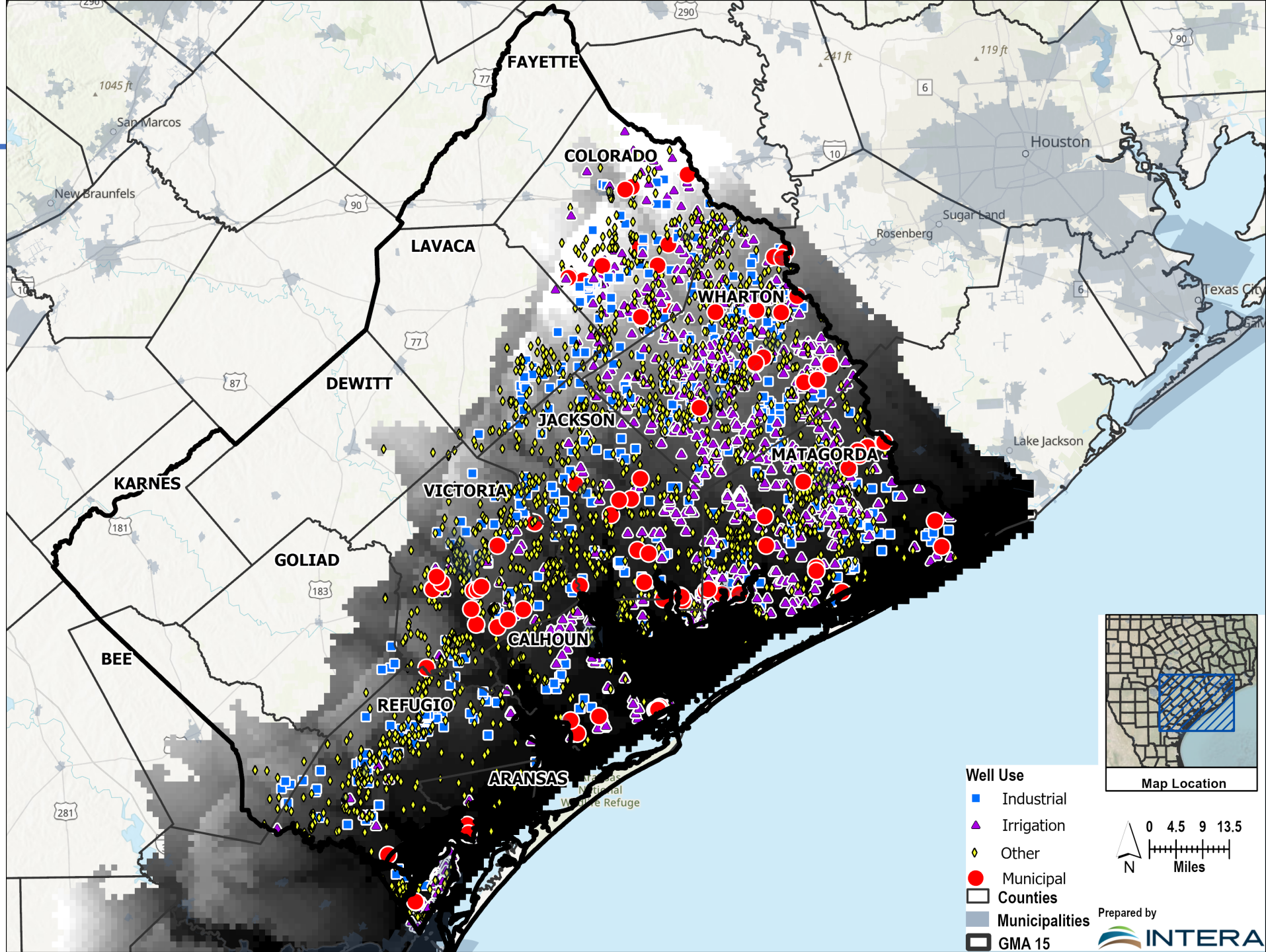


# Municipal, Industrial, Irrigation and Other uses from SDR Database



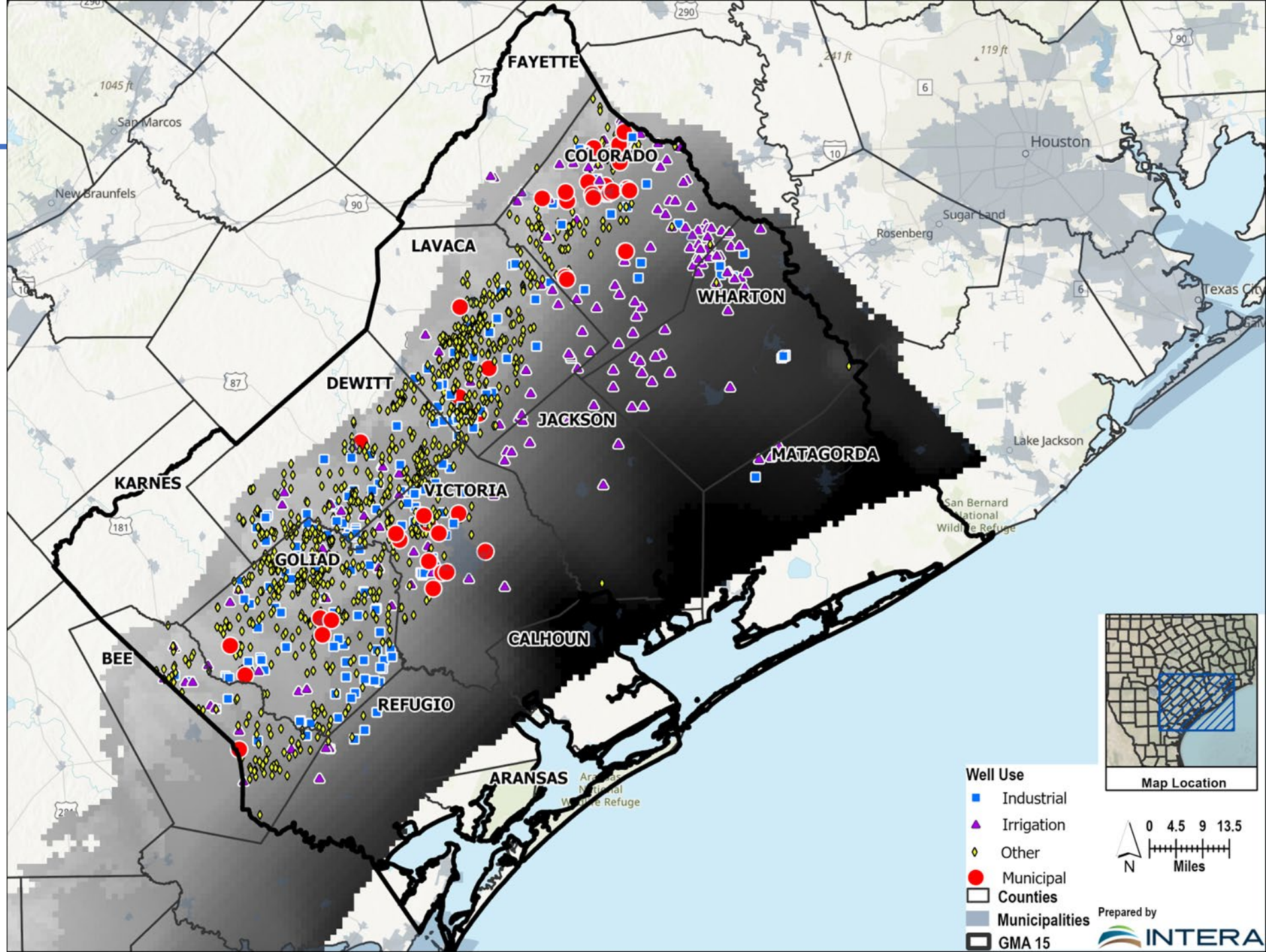
# Chicot

Chicot Aquifer Municipal, Industrial, Irrigation and Other uses from SDR Database



# Evangeline

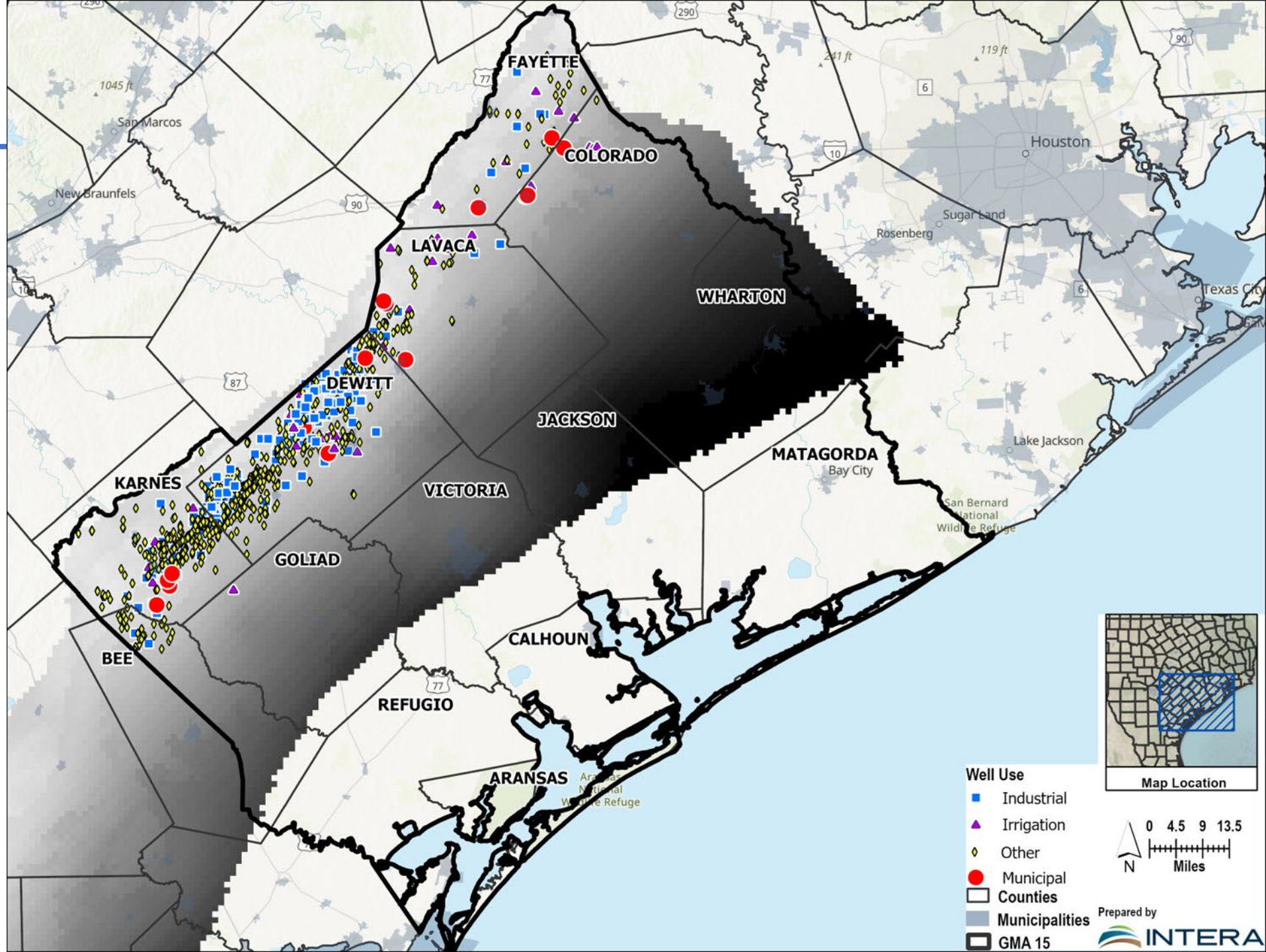
Evangeline Aquifer Municipal, Industrial, Irrigation and Other uses from SDR Database




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# Jasper

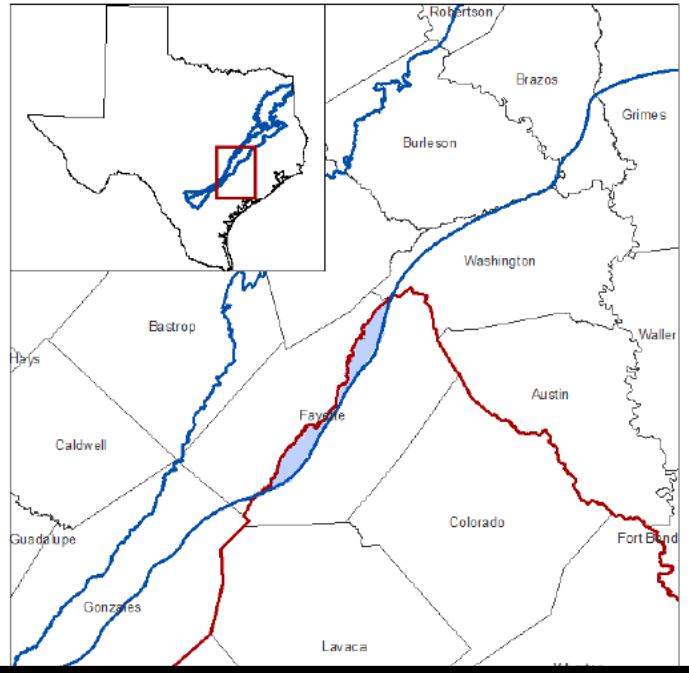
Jasper Aquifer
Municipal, Industrial, Irrigation and Other uses from SDR Database




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# Queen City & Sparta: Non-Relevant Status

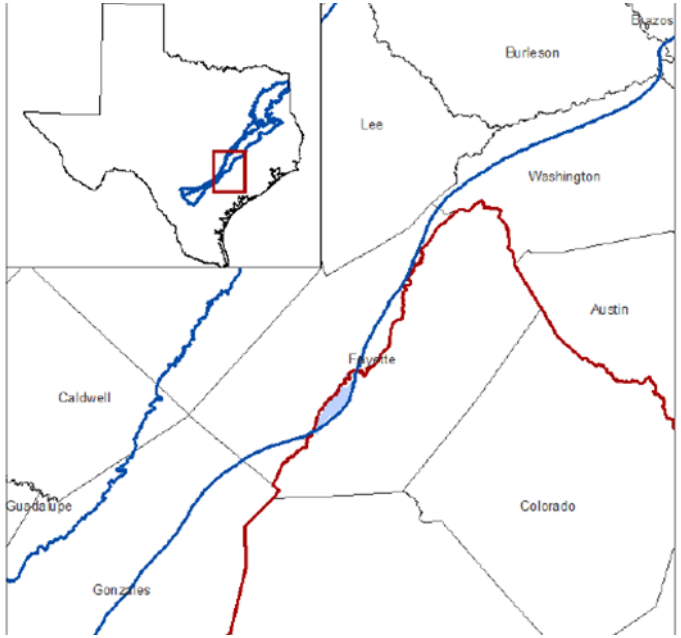
## Sparta




| County | Sq. Miles | Aquifer | Model |
|---|---|---|---|
| Fayette | 2 | Sparta | CZWX_S |
| Fayette | 72 | Sparta | CZWX_C |

| GCD | Sq. Miles | Aquifer | Model |
|---|---|---|---|
| Fayette County GCD | 2 | Sparta | CZWX_S |
| Fayette County GCD | 72 | Sparta | CZWX_C |

## Queen City

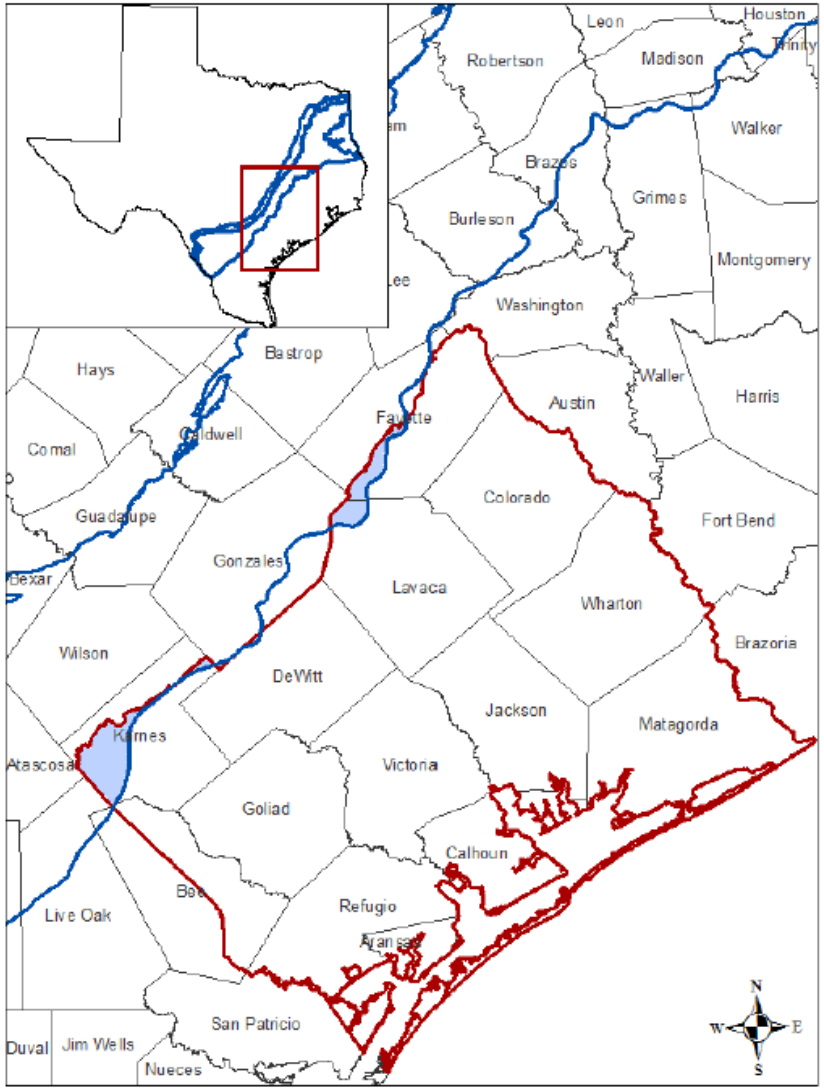



| County | Sq. Miles | Aquifer | Model |
|---|---|---|---|
| Fayette | 13 | Queen City | CZWX_C |

| GCD | Sq. Miles | Aquifer | Model |
|---|---|---|---|
| Fayette County GCD | 13 | Queen City | CZWX_C |

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# Carrizo-Wilcox: Non-Relevant Status

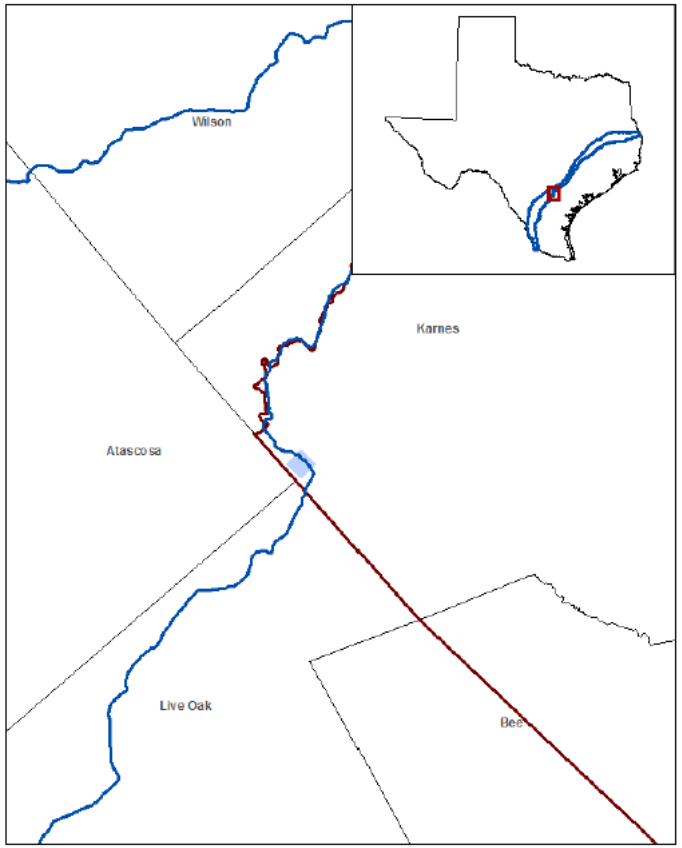


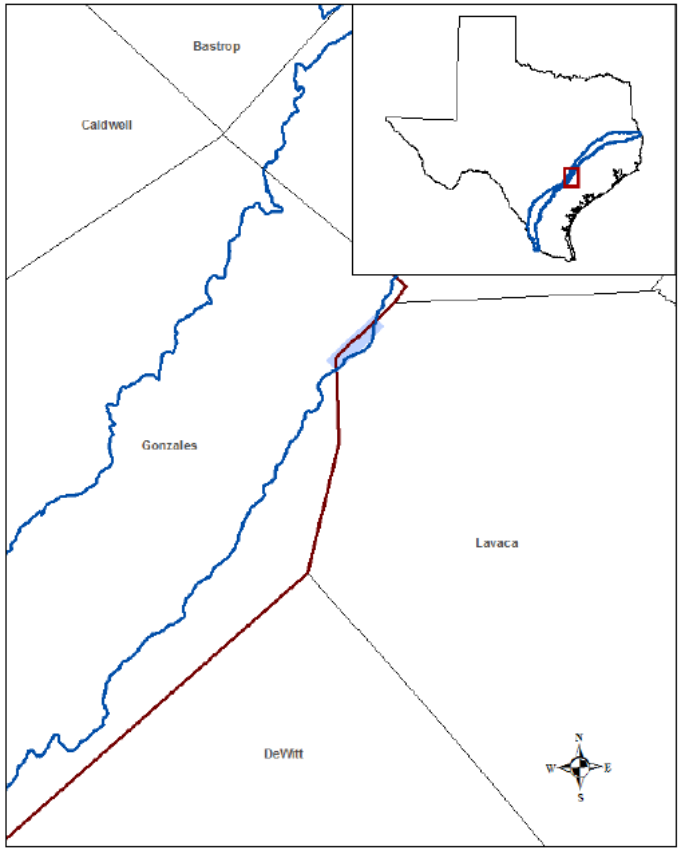

| County | Sq. Miles | Aquifer | Model |
|---|---|---|---|
| DeWitt | 4 | Carrizo-Wilcox | CZWX_S |
| Fayette | 24 | Carrizo-Wilcox | CZWX_S |
| Karnes | 160 | Carrizo-Wilcox | CZWX_S |
| Lavaca | 37 | Carrizo-Wilcox | CZWX_S |
| DeWitt | 3 | Carrizo-Wilcox | CZWX_C |
| Fayette | 56 | Carrizo-Wilcox | CZWX_C |
| Karnes | 23 | Carrizo-Wilcox | CZWX_C |
| Lavaca | 37 | Carrizo-Wilcox | CZWX_C |

| GCD | Sq. Miles | Aquifer | Model |
|---|---|---|---|
| Evergreen UWCD | 160 | Carrizo-Wilcox | CZWX_S |
| Fayette County GCD | 24 | Carrizo-Wilcox | CZWX_S |
| ND Lavaca | 37 | Carrizo-Wilcox | CZWX_S |
| Pecan Valley GCD | 4 | Carrizo-Wilcox | CZWX_S |
| Evergreen UWCD | 23 | Carrizo-Wilcox | CZWX_C |
| Fayette County GCD | 56 | Carrizo-Wilcox | CZWX_C |
| ND Lavaca | 37 | Carrizo-Wilcox | CZWX_C |
| Pecan Valley GCD | 3 | Carrizo-Wilcox | CZWX_C |

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# Yegua-Jackson:Non-Relevant Status



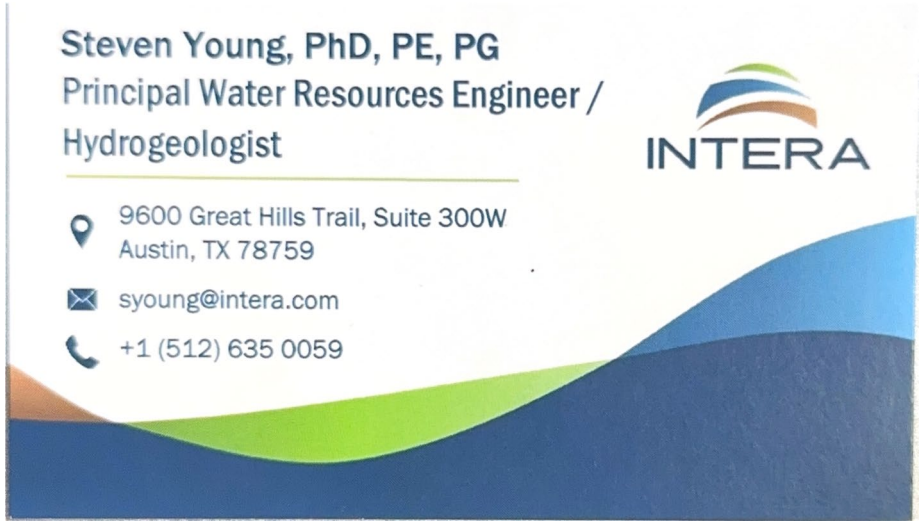



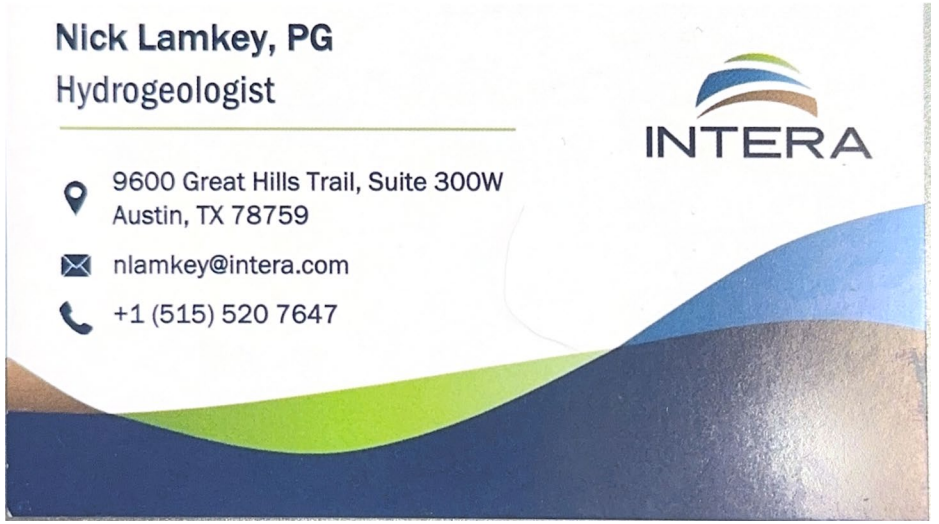

| County | Sq. Miles | Aquifer | Model |
|---|---|---|---|
| Fayette | 9 | Yegua-Jackson | YGJK |
| Karnes | 5 | Yegua-Jackson | YGJK |
| Lavaca | 4 | Yegua-Jackson | YGJK |

| GCD | Sq. Miles | Aquifer | Model |
|---|---|---|---|
| Evergreen UWCD | 5 | Yegua-Jackson | YGJK |
| Fayette County GCD | 9 | Yegua-Jackson | YGJK |
| ND Lavaca | 4 | Yegua-Jackson | YGJK |

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# Questions?


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# F.2 Water Supply Needs and Water Management Strategies

# GMA 15
# Consideration of Water Supply Needs and Management Strategies

Groundwater Management Area 15

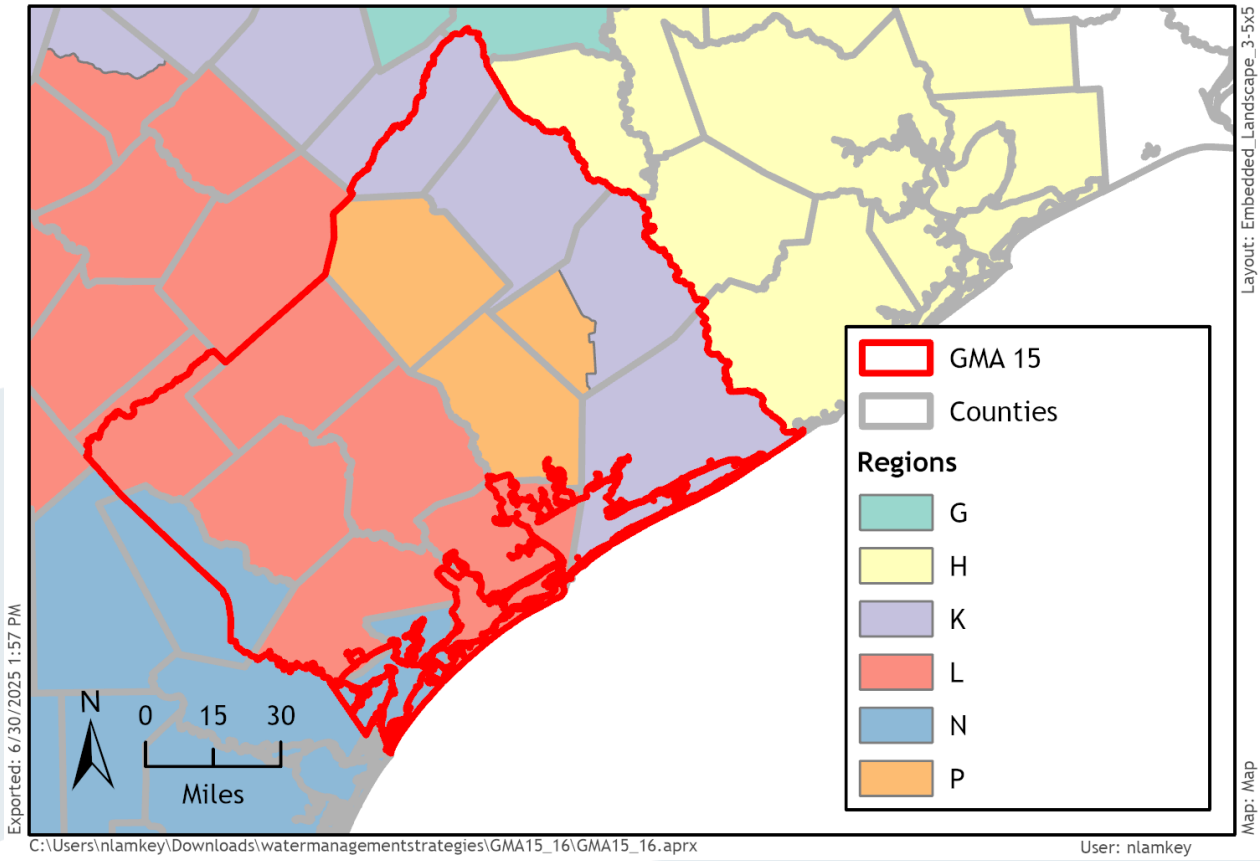
July 10, 2025




Presented by:
Steven Young Ph.D, PE, PG
Nick Lamkey PG

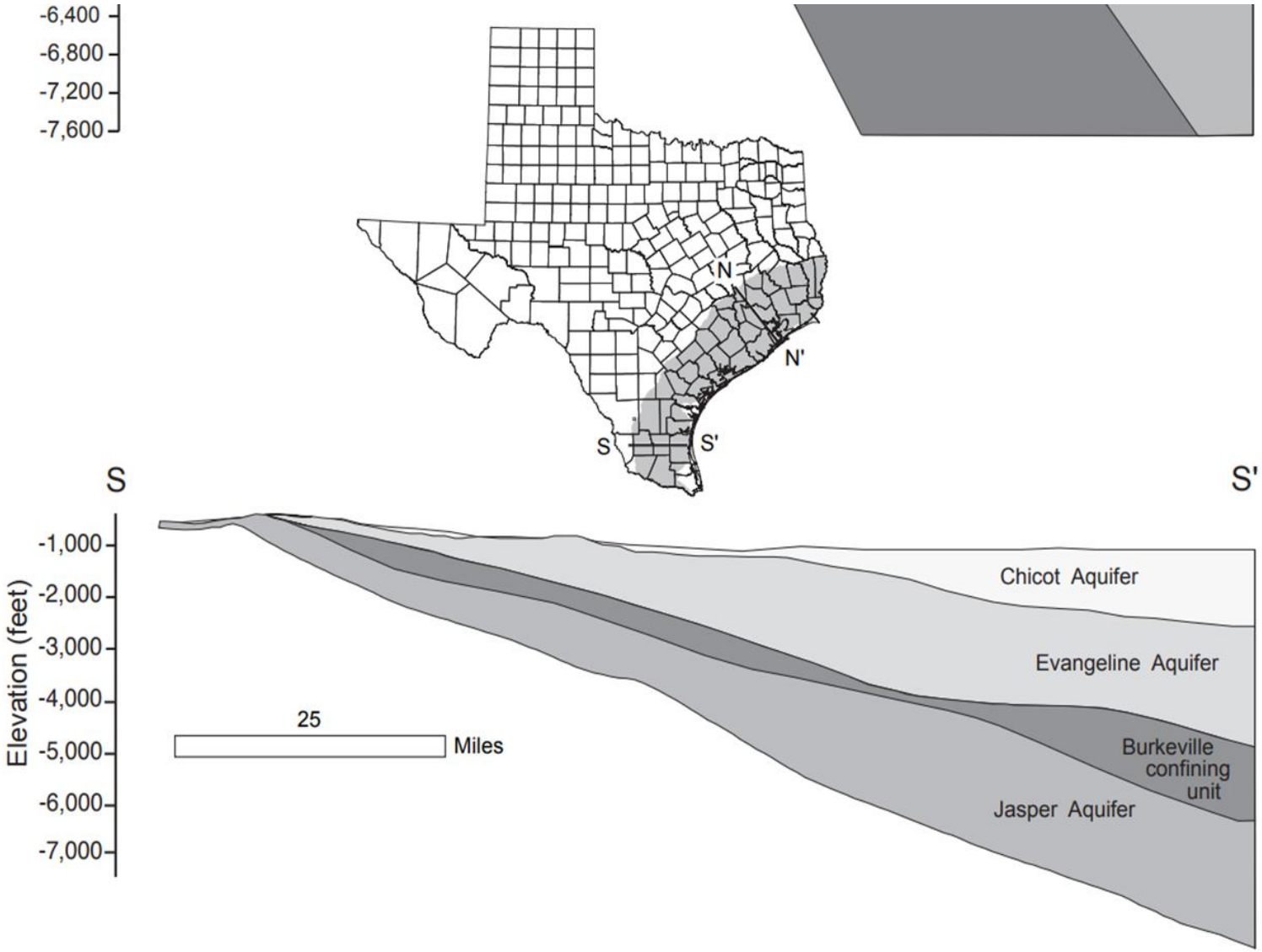
# Consideration of Water Supply Needs and Management Strategies

- Texas Water Code Section 36.108(d)(2)
- Describe the water supply needs and water management strategies included in the state water plan
- Texas State Water Plan is a compilation of Regional Water Plans
- GMA 15 contains parts of 4 Regional Water Planning Areas

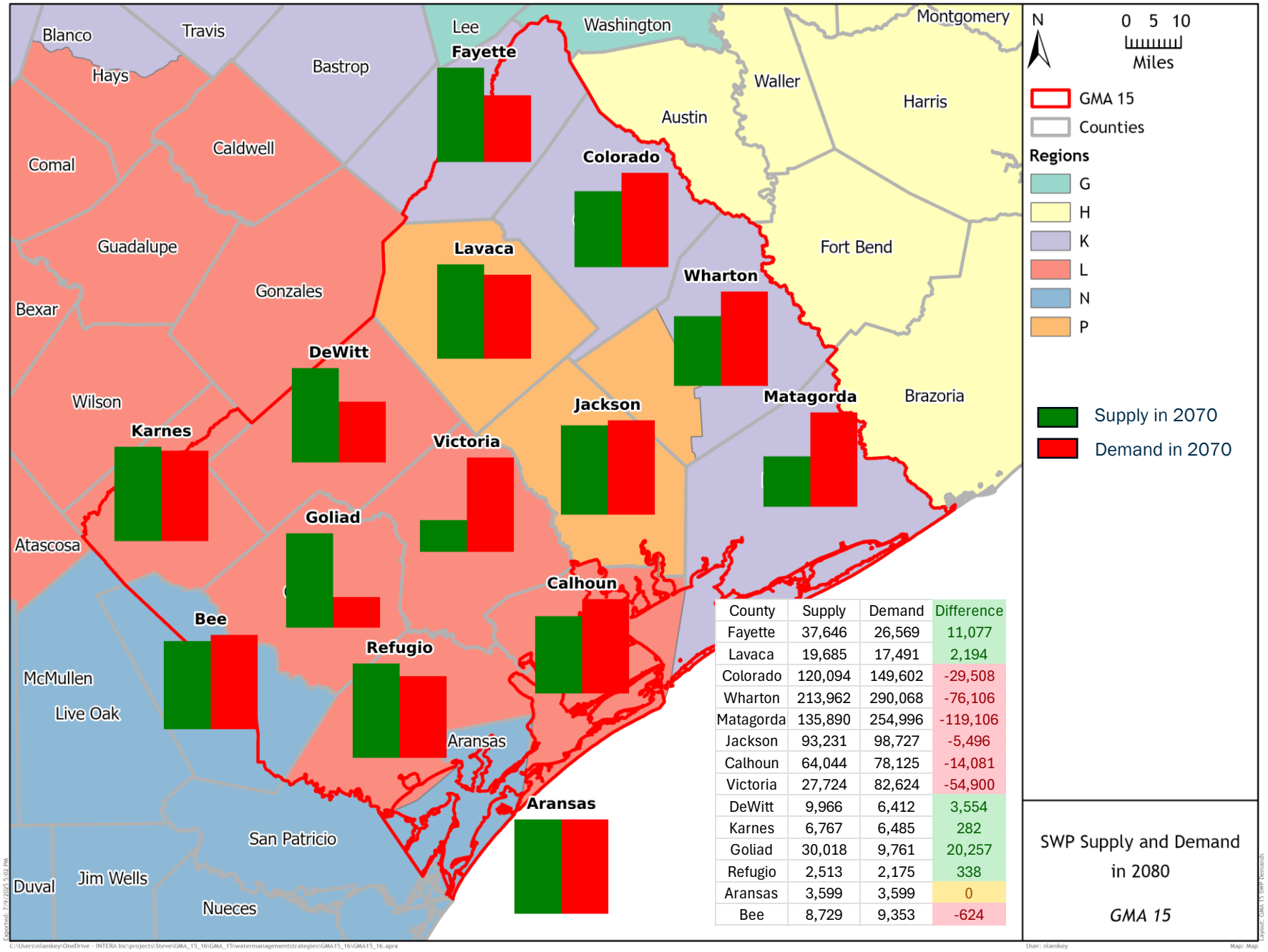


# Gulf Coast Aquifer System

- Gulf Coast Aquifer is the only groundwater source listed for all GMA 15 counties except Fayette and Karnes
- Regional Water Planning values only specify the major aquifer name (Gulf Coast Aquifer)
- Regional Planning values do not distinguish between the 4 aquifer layers



# Demands




| County | Supply | Demand | Difference |
|---|---|---|---|
| Fayette | 37,646 | 26,569 | 11,077 |
| Lavaca | 19,685 | 17,491 | 2,194 |
| Colorado | 120,094 | 149,602 | -29,508 |
| Wharton | 213,962 | 290,068 | -76,106 |
| Matagorda | 135,890 | 254,996 | -119,106 |
| Jackson | 93,231 | 98,727 | -5,496 |
| Calhoun | 64,044 | 78,125 | -14,081 |
| Victoria | 27,724 | 82,624 | -54,900 |
| DeWitt | 9,966 | 6,412 | 3,554 |
| Karnes | 6,767 | 6,485 | 282 |
| Goliad | 30,018 | 9,761 | 20,257 |
| Refugio | 2,513 | 2,175 | 338 |
| Aransas | 3,599 | 3,599 | 0 |
| Bee | 8,729 | 9,353 | -624 |

SWP Supply and Demand in 2080

*GMA 15*

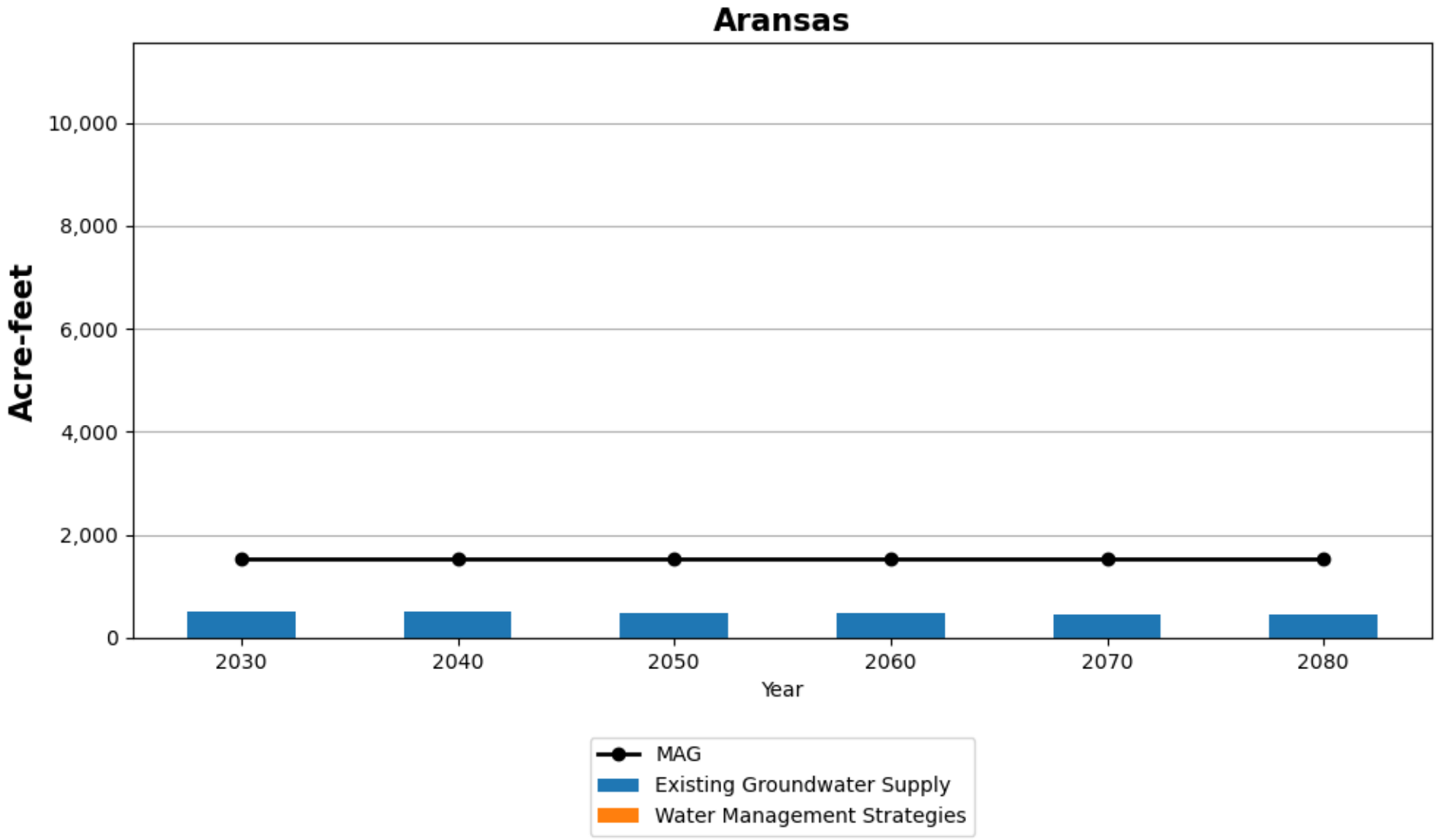
INTERA

*Bar plots not on same scal

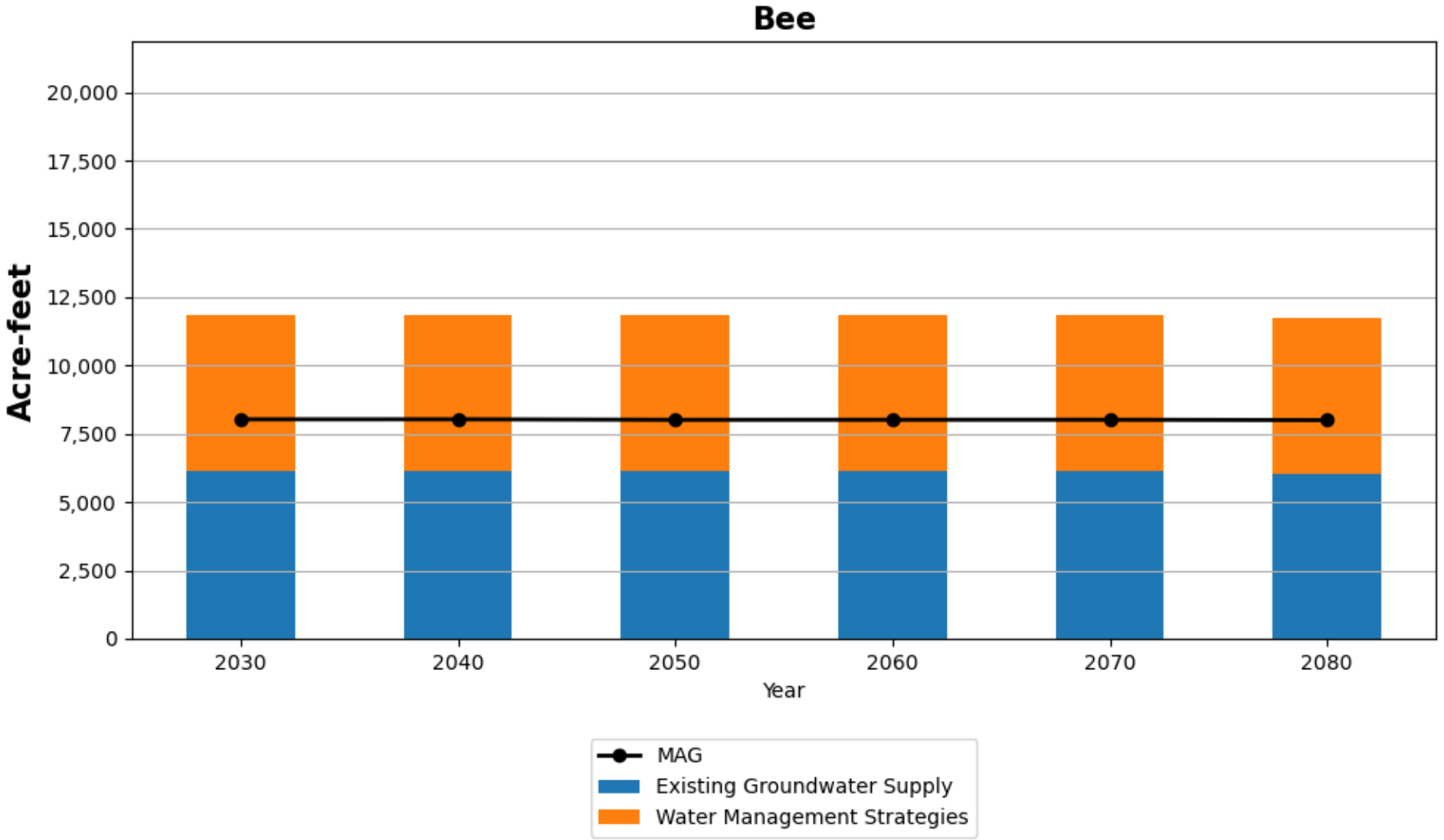
# GCAS Groundwater Supplies Plots

- Note axes are different scales for each county
- Showing groundwater values for Gulf Coast Aquifer System

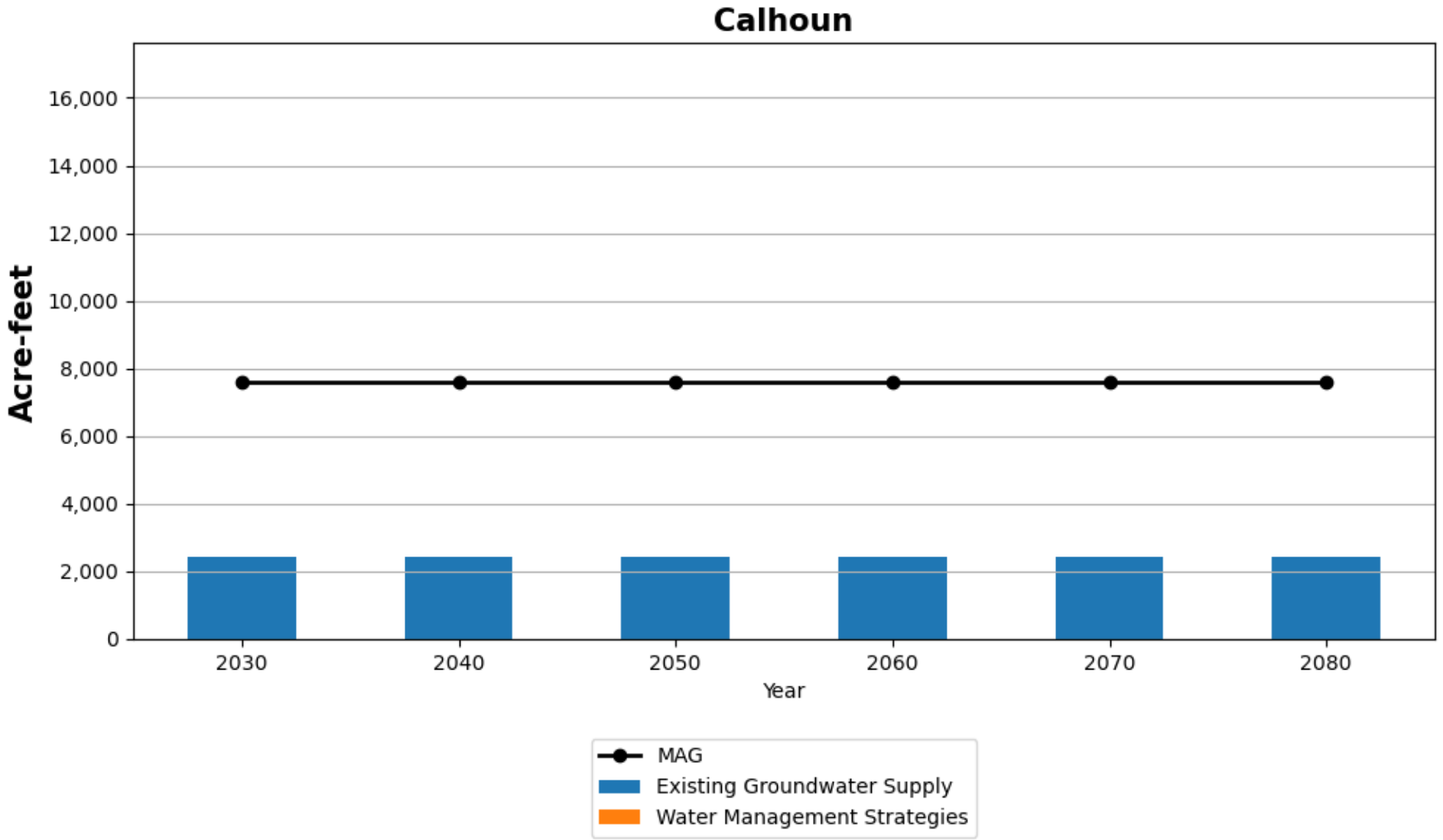
# Aransas


Aransas
Acre-feet
10,000
8,000
6,000
4,000
2,000
0
2030
2040
2050
2060
2070
2080
Year
MAG
Existing Groundwater Supply
Water Management Strategies

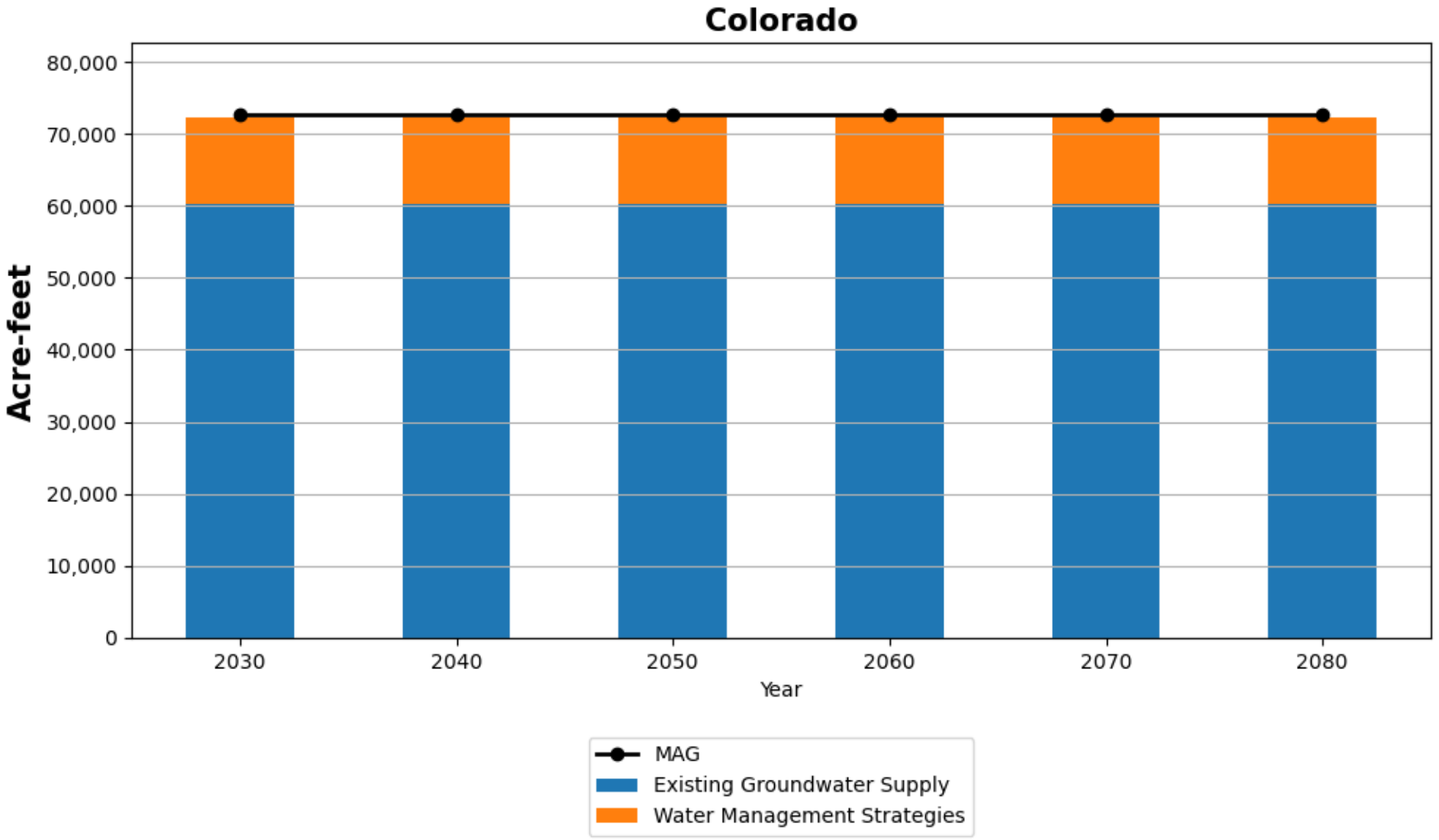
# Bee County


Bee
Acre-feet
20,000
17,500
15,000
12,500
10,000
7,500
5,000
2,500
0
2030
2040
2050
2060
2070
2080
Year
MAG
Existing Groundwater Supply
Water Management Strategies

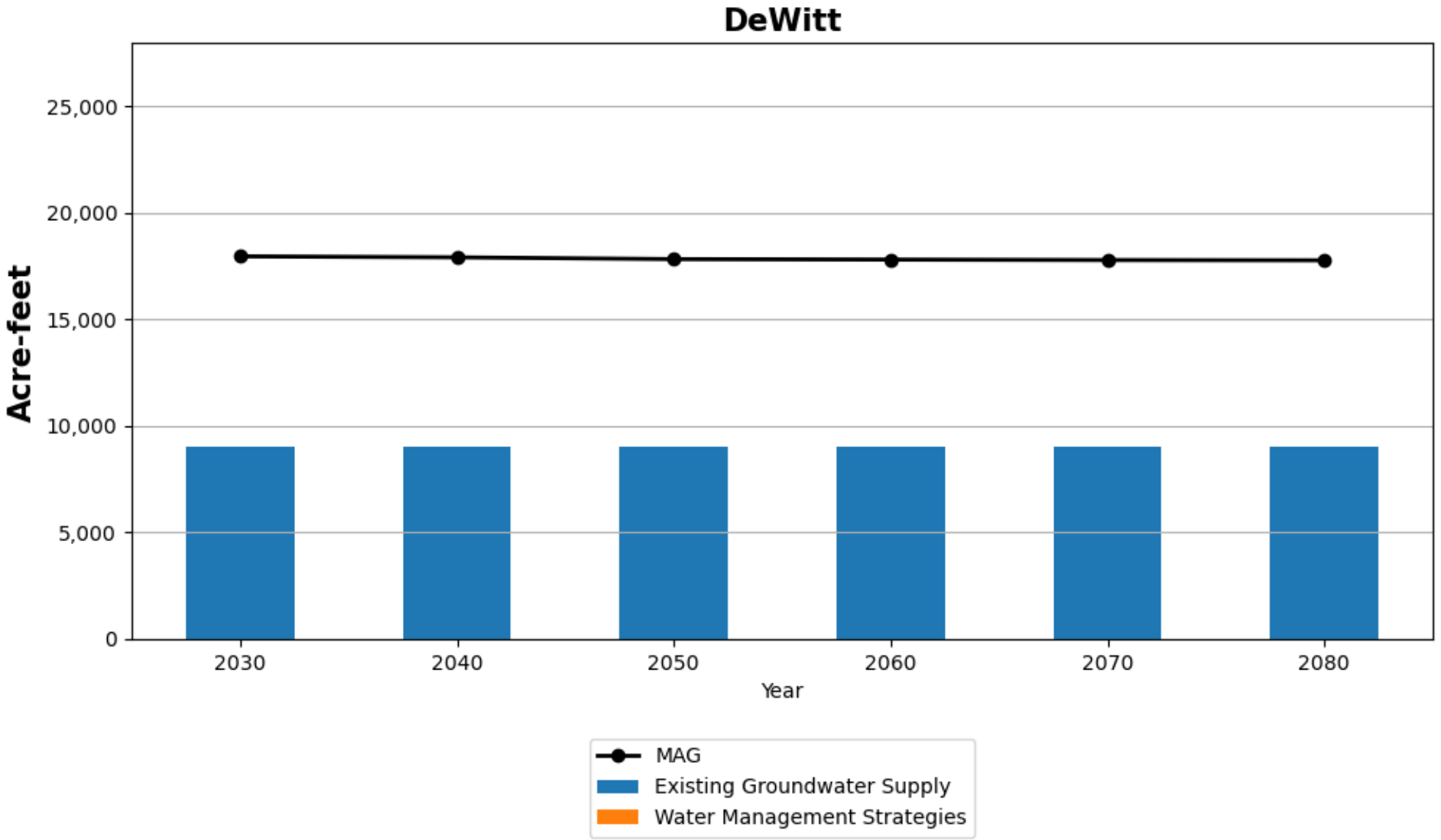
# Calhoun


Calhoun
Acre-feet
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
2030
2040
2050
2060
2070
2080
Year
MAG
Existing Groundwater Supply
Water Management Strategies

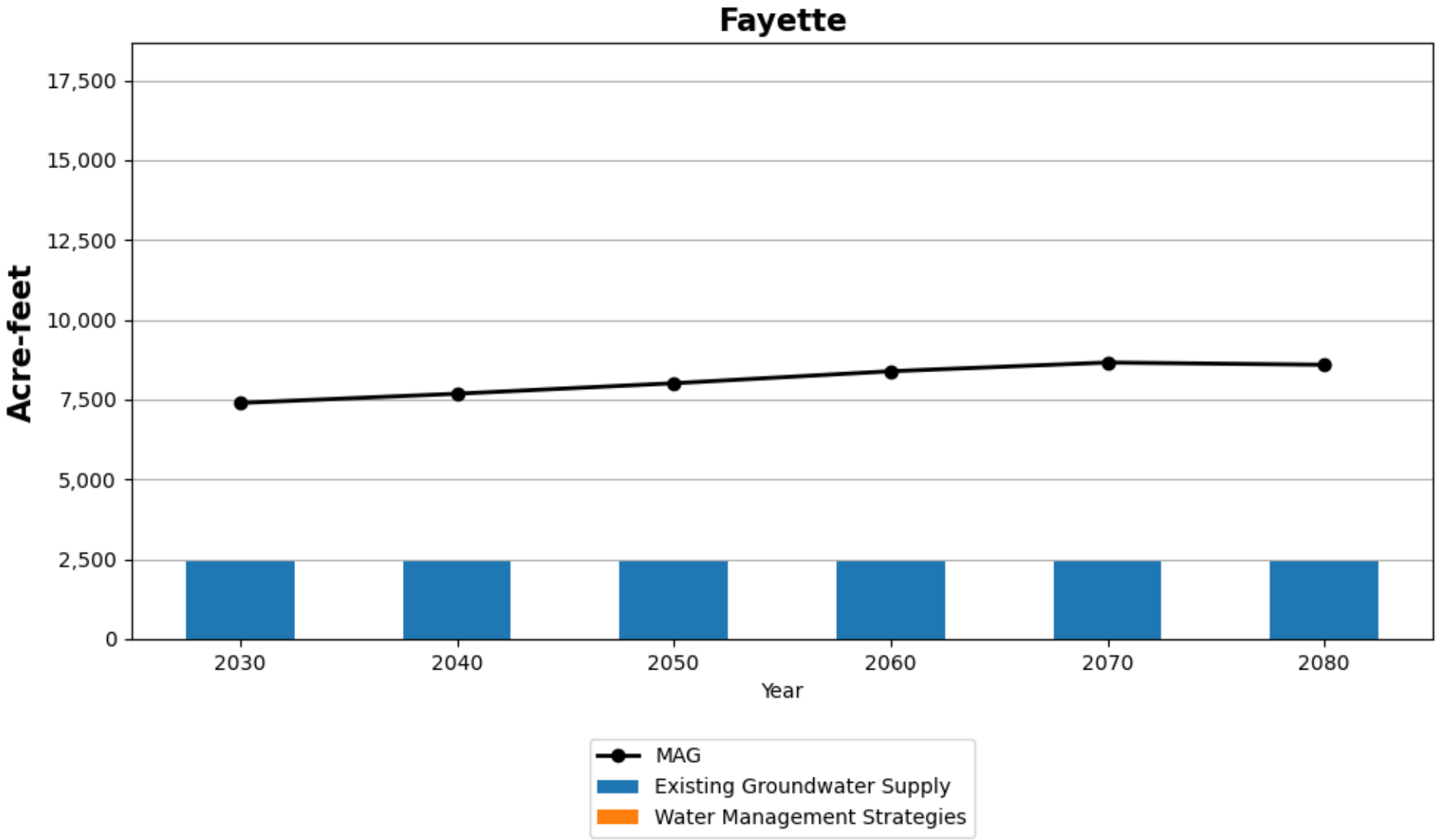
# Colorado


Colorado
Acre-feet
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
2030
2040
2050
2060
2070
2080
Year
MAG
Existing Groundwater Supply
Water Management Strategies

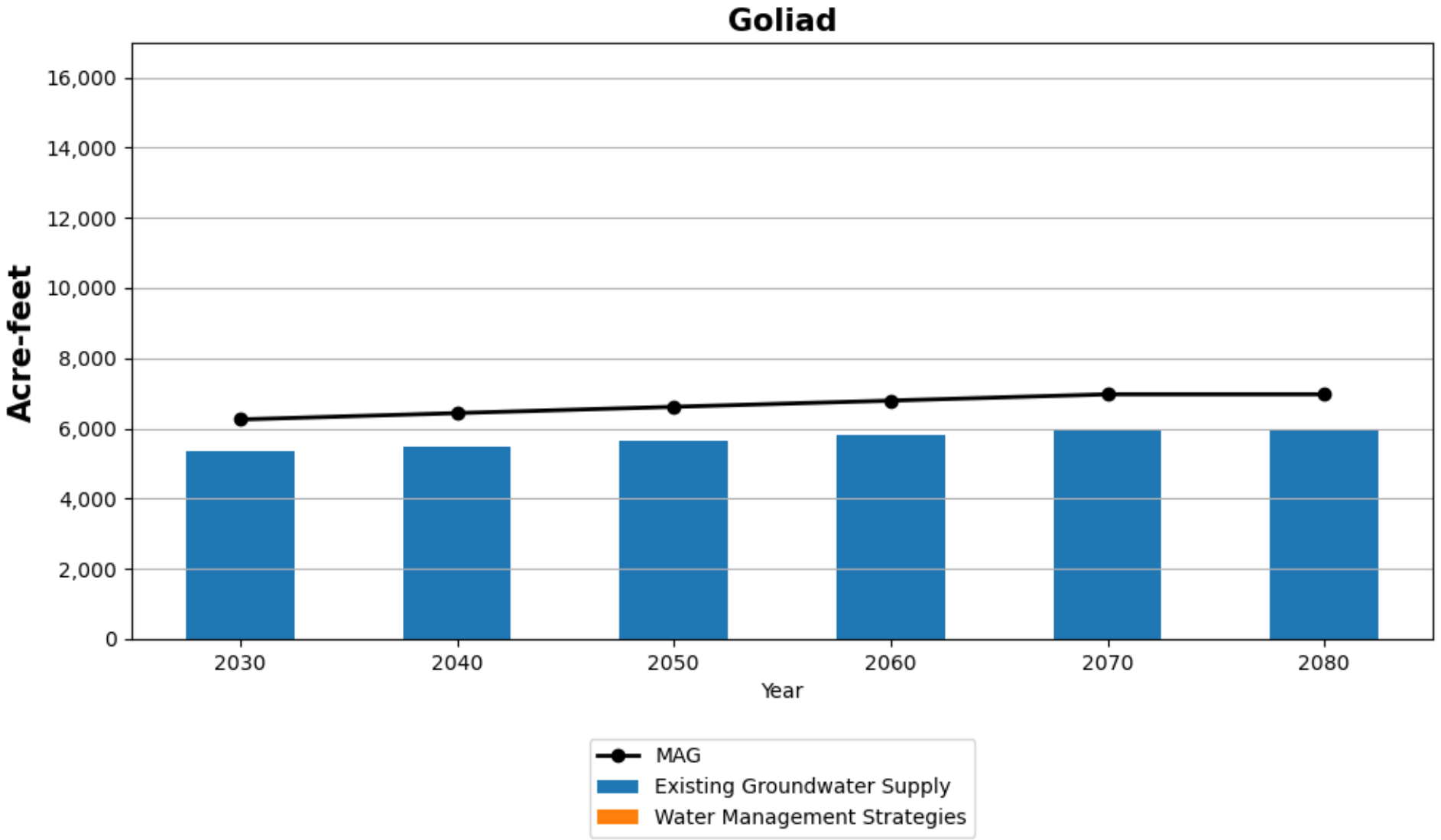
# De Witt


DeWitt
Acre-feet
25,000
20,000
15,000
10,000
5,000
0
2030
2040
2050
2060
2070
2080
Year
MAG
Existing Groundwater Supply
Water Management Strategies

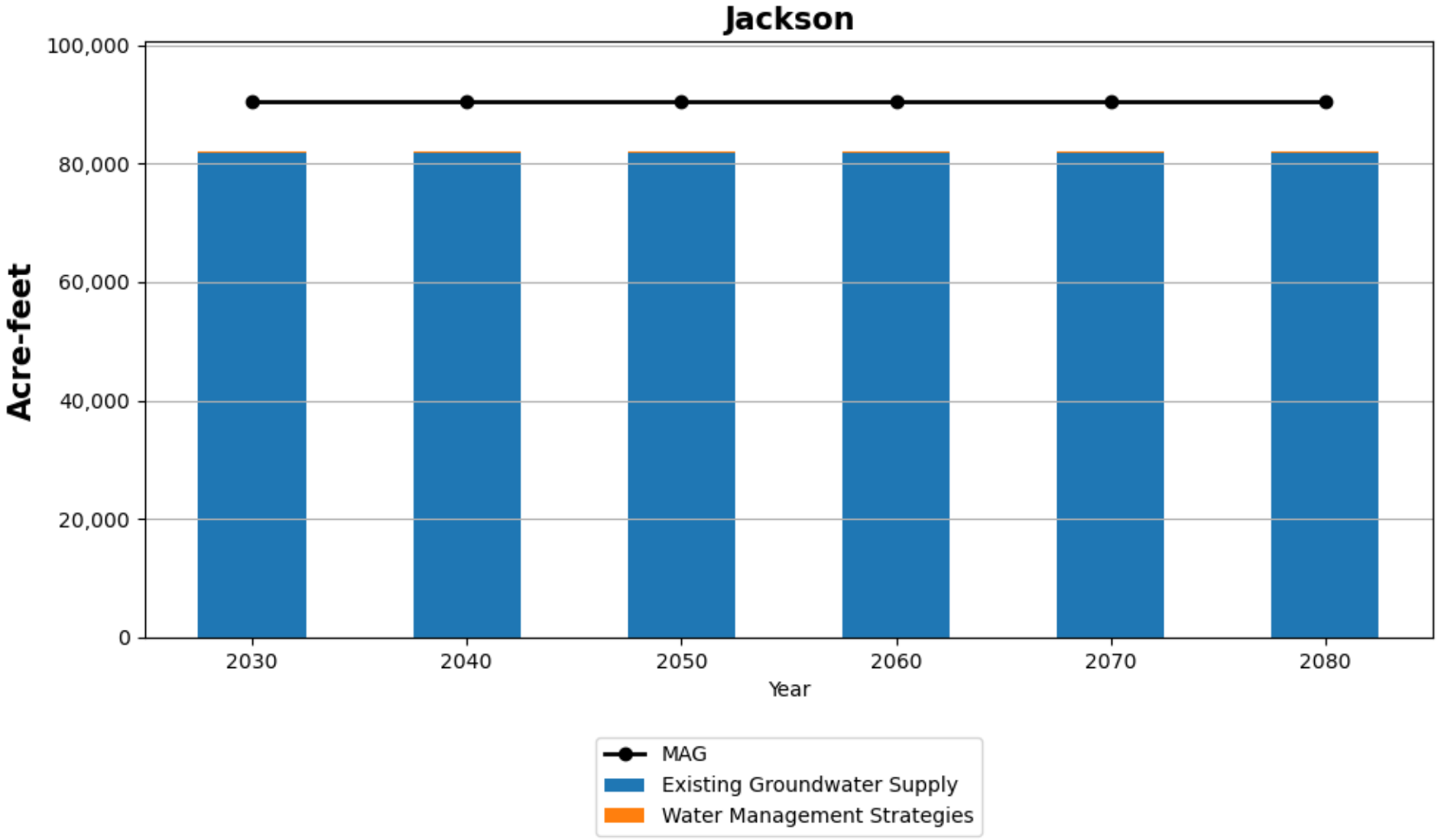
# Fayette


Fayette
17,500
15,000
12,500
10,000
7,500
5,000
2,500
0
Acre-feet
2030
2040
2050
2060
2070
2080
Year
MAG
Existing Groundwater Supply
Water Management Strategies

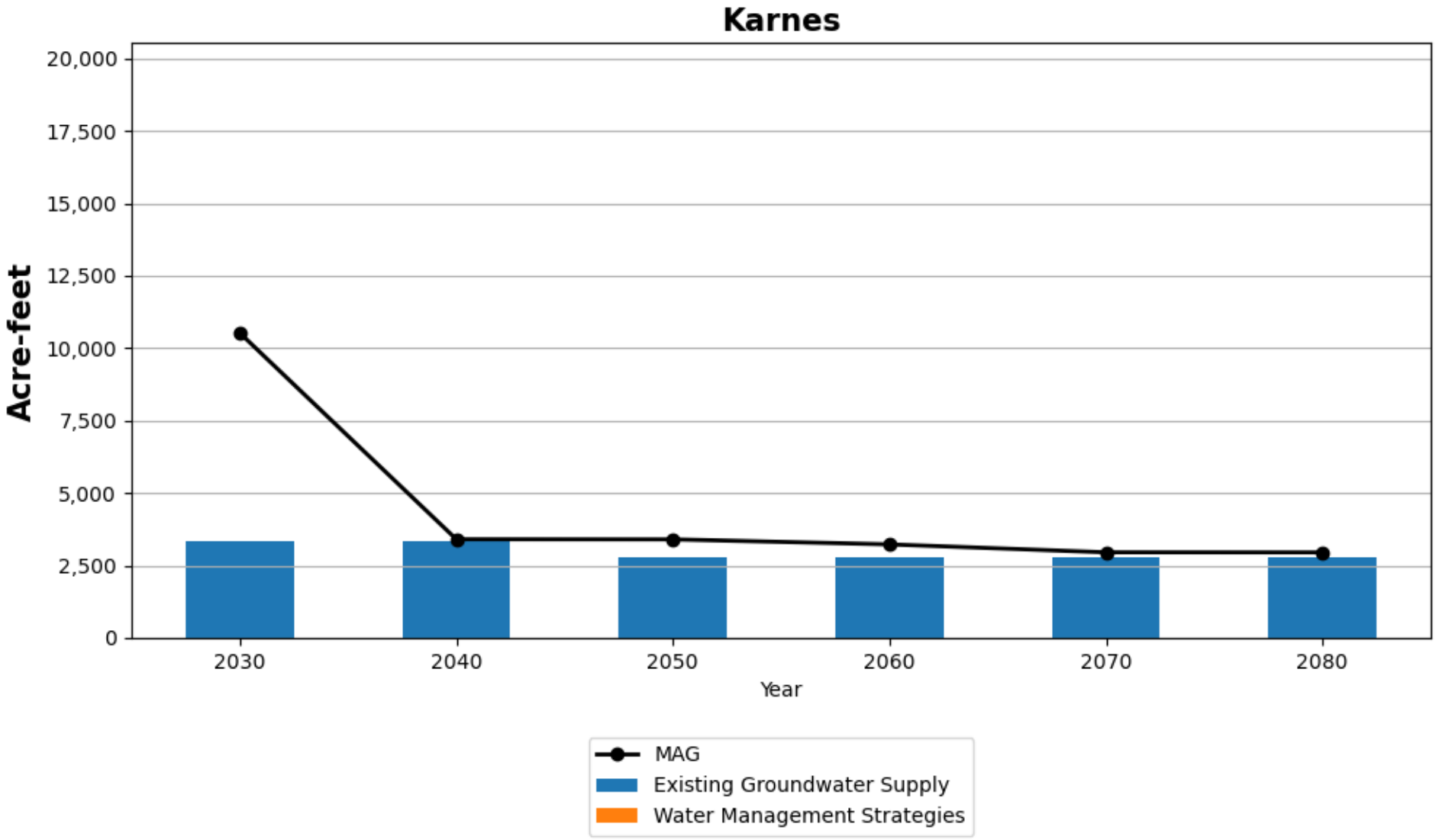
# Goliad


Goliad
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Acre-feet
2030
2040
2050
2060
2070
2080
Year
MAG
Existing Groundwater Supply
Water Management Strategies

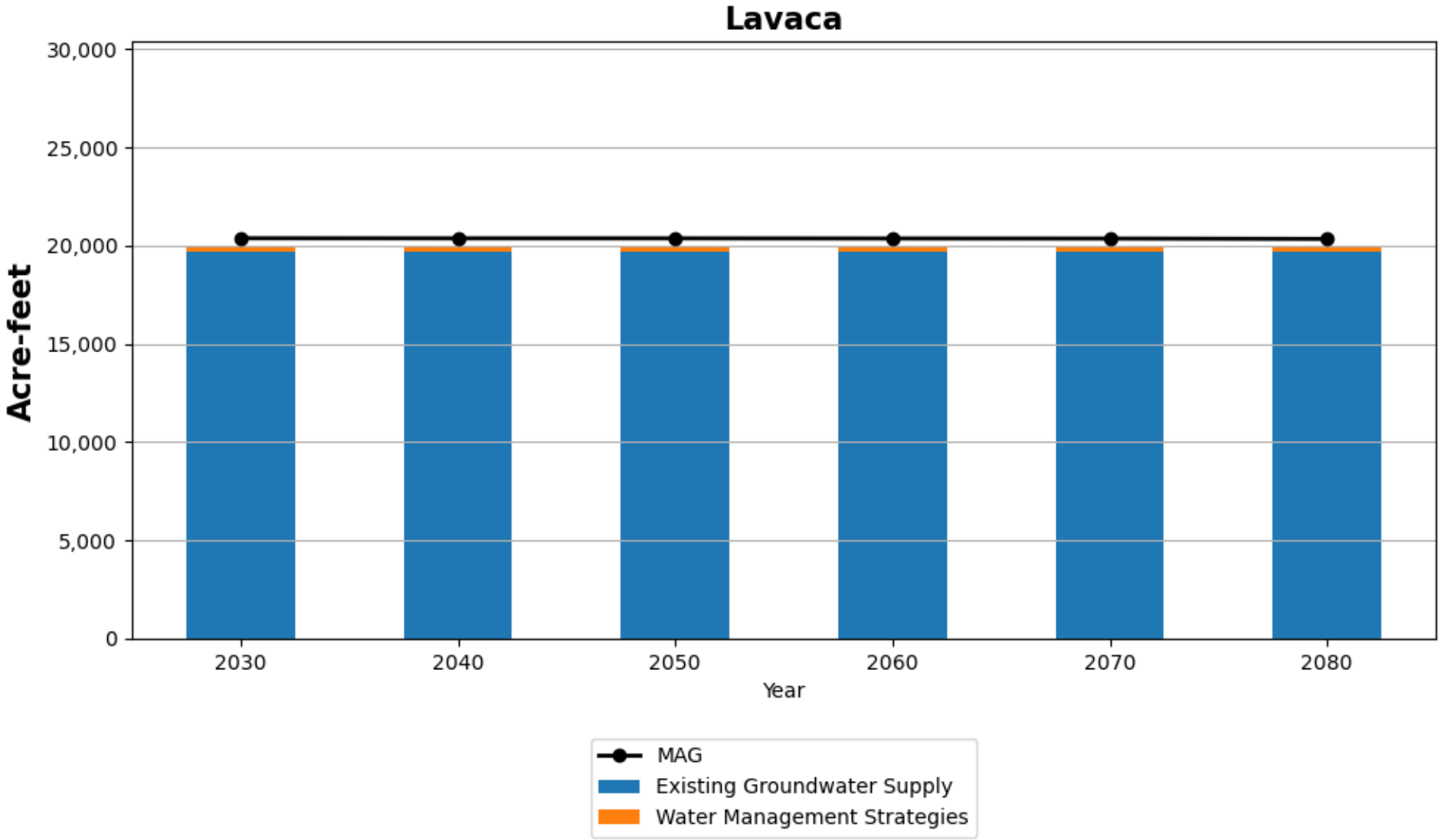
# Jackson


Jackson
100,000
80,000
60,000
40,000
20,000
0
Acre-feet
2030
2040
2050
2060
2070
2080
Year
MAG
Existing Groundwater Supply
Water Management Strategies

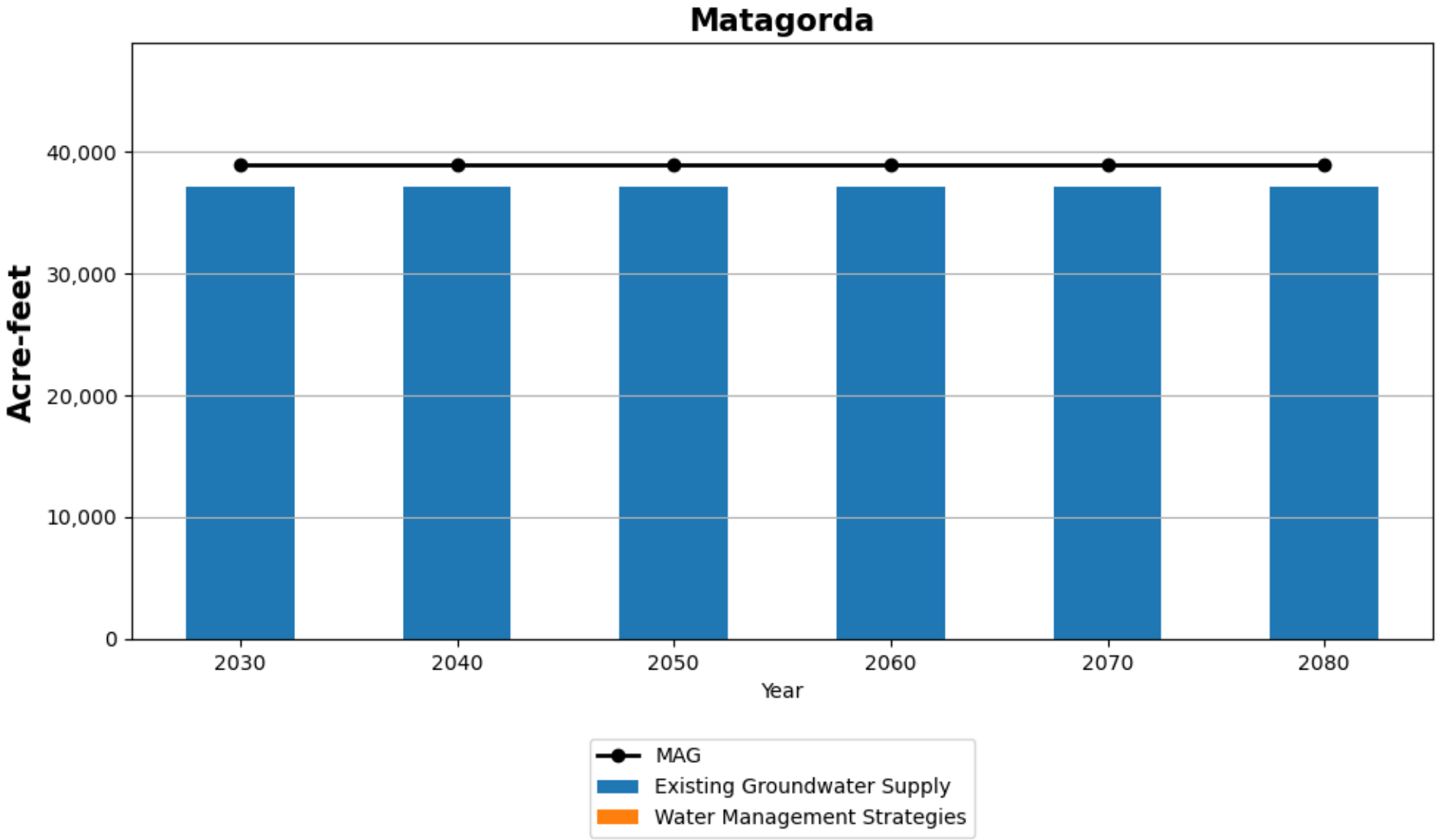
# Karnes


Karnes
Acre-feet
20,000
17,500
15,000
12,500
10,000
7,500
5,000
2,500
0
2030
2040
2050
2060
2070
2080
Year
MAG
Existing Groundwater Supply
Water Management Strategies

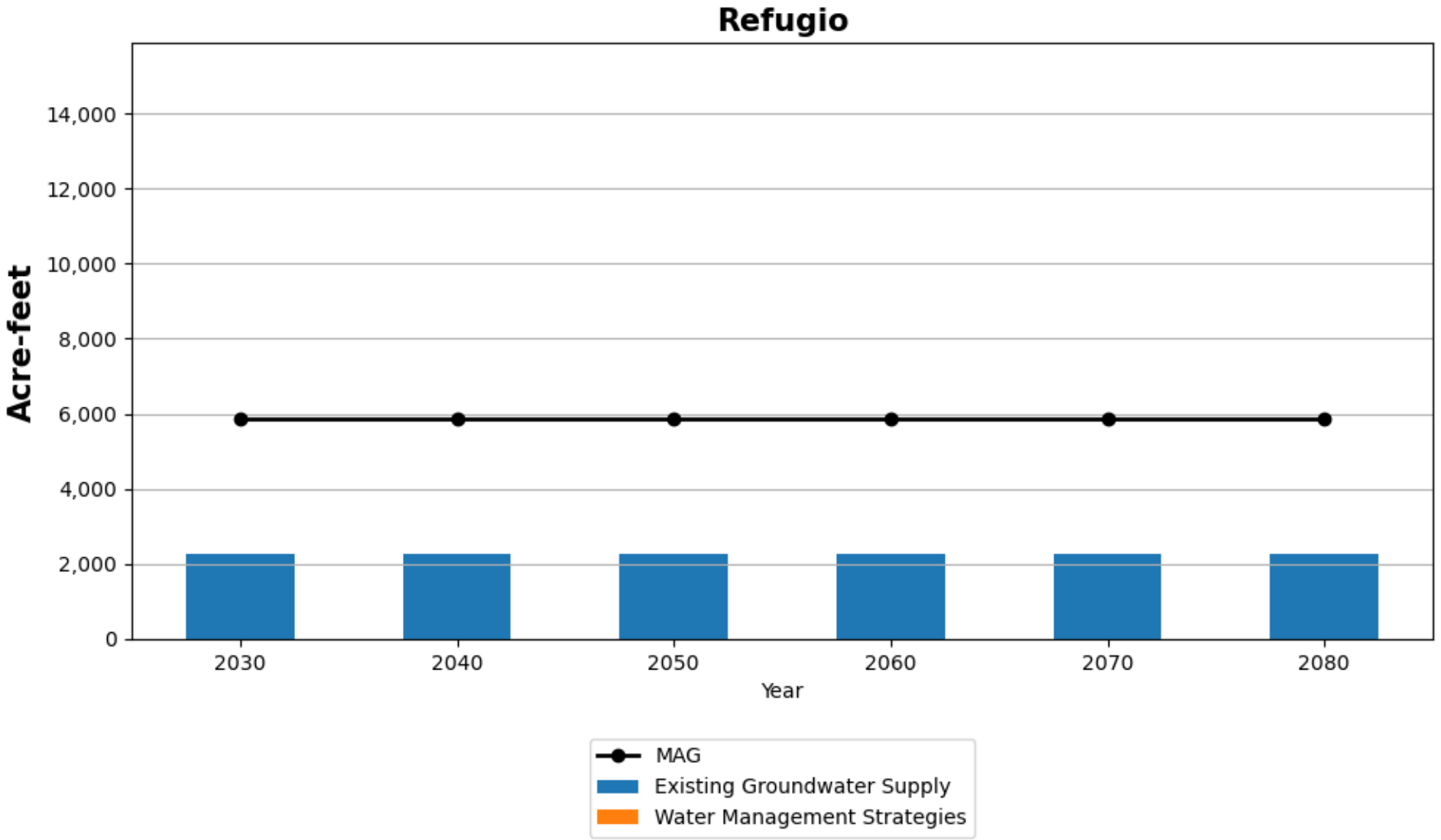
# Lavaca


Lavaca
30,000
25,000
20,000
15,000
10,000
5,000
0
Acre-feet
2030
2040
2050
2060
2070
2080
Year
MAG
Existing Groundwater Supply
Water Management Strategies

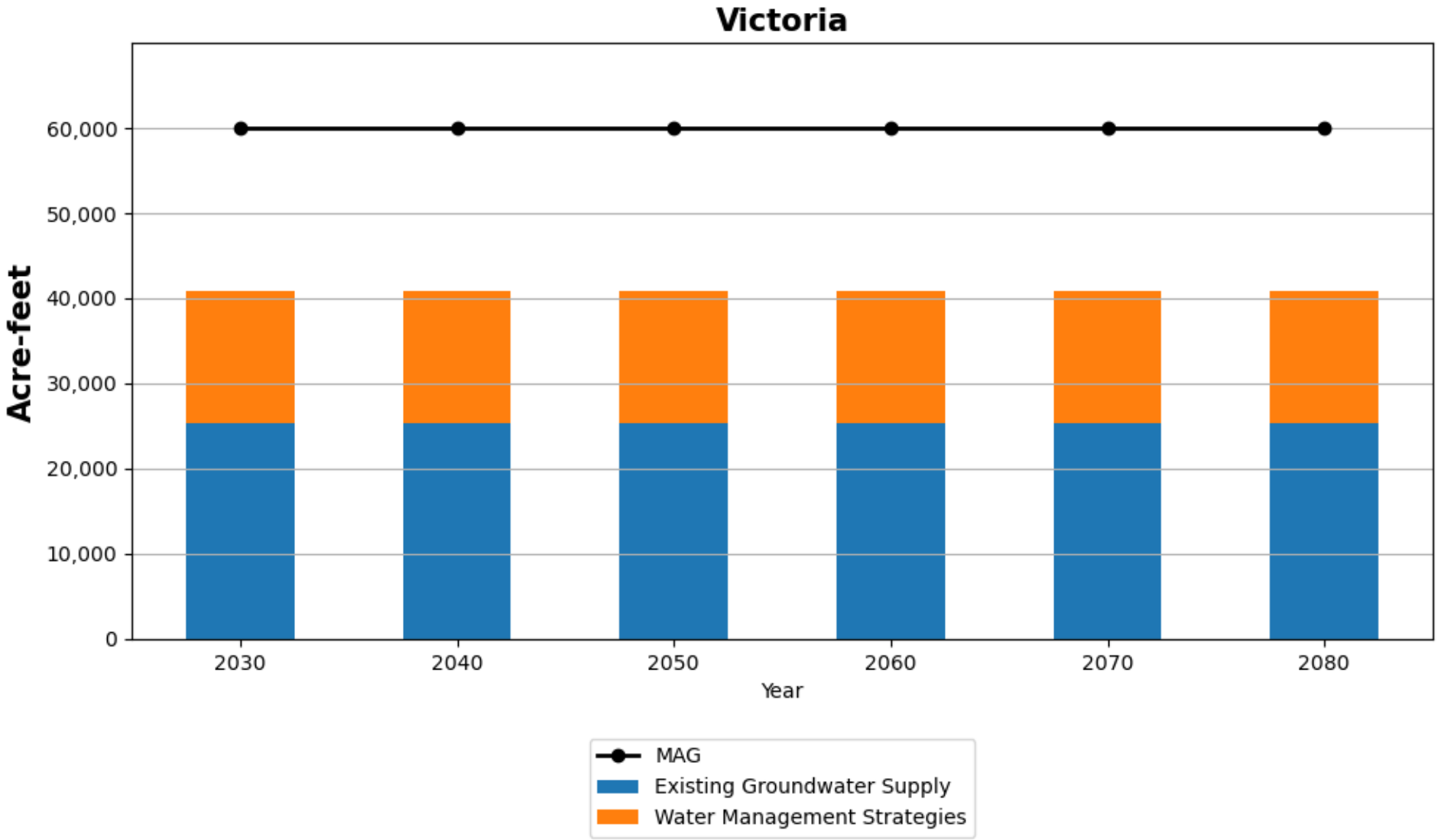
# Matagorda


Matagorda
Acre-feet
40,000
30,000
20,000
10,000
0
2030
2040
2050
2060
2070
2080
Year
MAG
Existing Groundwater Supply
Water Management Strategies

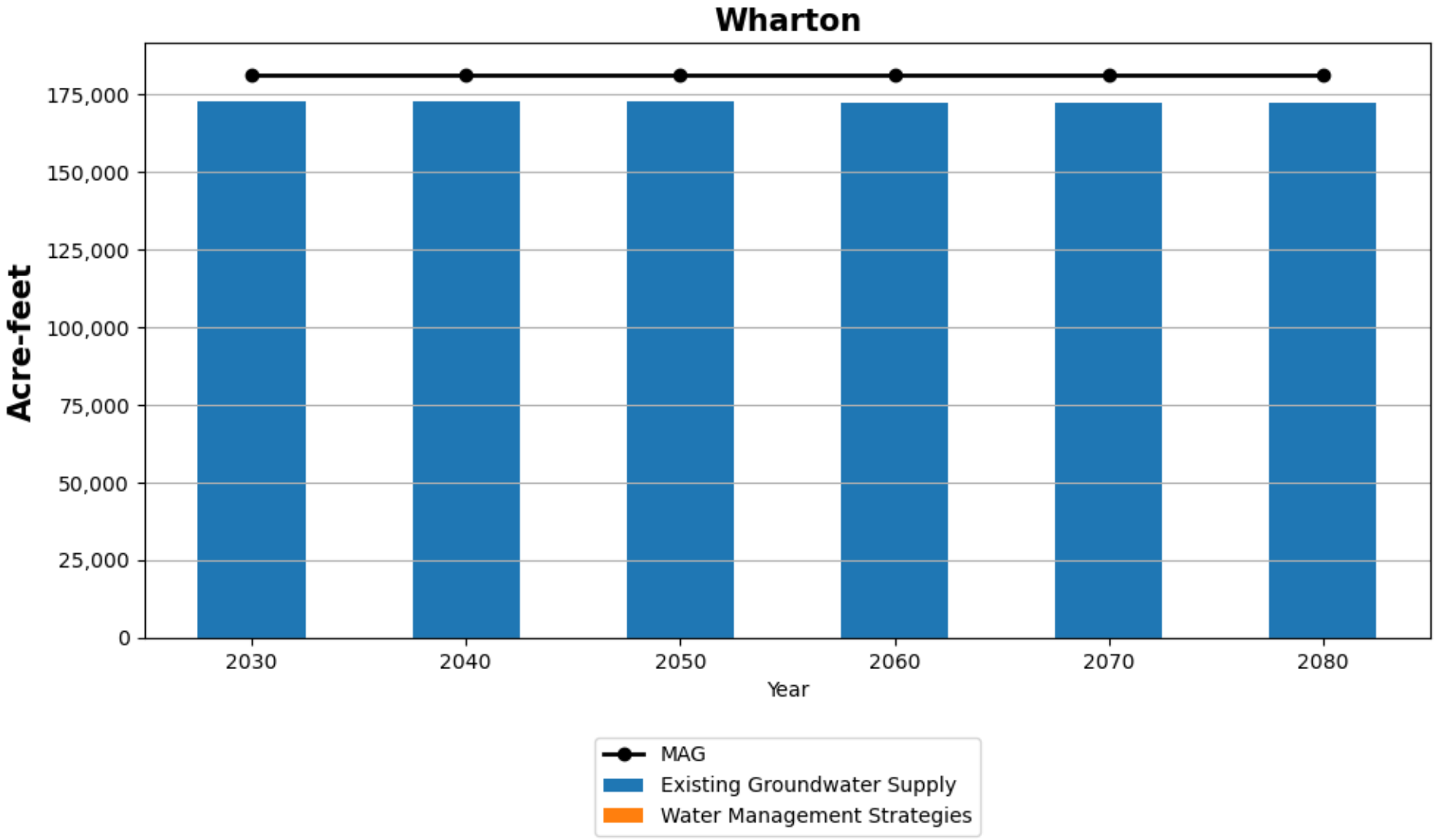
# Refugio


Refugio
Acre-feet
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
2030
2040
2050
2060
2070
2080
Year
MAG
Existing Groundwater Supply
Water Management Strategies

# Victoria


Victoria
Acre-feet
60,000
50,000
40,000
30,000
20,000
10,000
0
2030
2040
2050
2060
2070
2080
Year
MAG
Existing Groundwater Supply
Water Management Strategies

# Wharton


Wharton
Acre-feet
175,000
150,000
125,000
100,000
75,000
50,000
25,000
0
2030
2040
2050
2060
2070
2080
Year
MAG
Existing Groundwater Supply
Water Management Strategies

# Summary

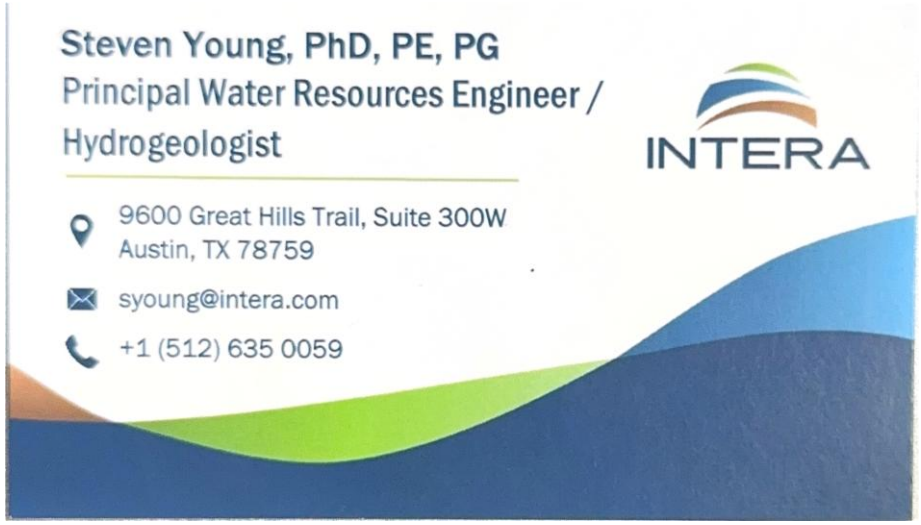
| | Surface Water Supply | Groundwater Supply | Total Demand | Strategies | MAG | Needs |
|---|---|---|---|---|---|---|
| Aransas | 2,949 | 453 | 3,599 | 0 | 1,547 | 0 |
| Bee | 2,418 | 6,012 | 9,353 | 5,704 | 7,989 | 624 |
| Calhoun | 61,412 | 2,448 | 78,125 | 0 | 7,611 | 17,914 |
| Colorado | 59,898 | 60,196 | 149,602 | 12,000 | 72,583 | 31,678 |
| DeWitt | 869 | 9,036 | 6,412 | 0 | 17,772 | 0 |
| Fayette | 30,495 | 2,458 | 26,569 | 0 | 8,590 | 201 |
| Goliad | 24,062 | 5,956 | 9,761 | 0 | 6,972 | 0 |
| Jackson | 11,432 | 81,799 | 98,727 | 217 | 90,571 | 5,516 |
| Karnes | 578 | 2,783 | 6,485 | 0 | 2,949 | 751 |
| Lavaca | 0 | 19,685 | 17,491 | 294 | 20,350 | 500 |
| Matagorda | 98,799 | 37,091 | 254,996 | 0 | 38,892 | 122,507 |
| Refugio | 231 | 2,282 | 2,175 | 0 | 5,858 | 0 |
| Victoria | 2,341 | 25,383 | 82,624 | 15,440 | 59,948 | 56,605 |
| Wharton | 41,538 | 172,424 | 290,068 | 0 | 181,446 | 86,362 |

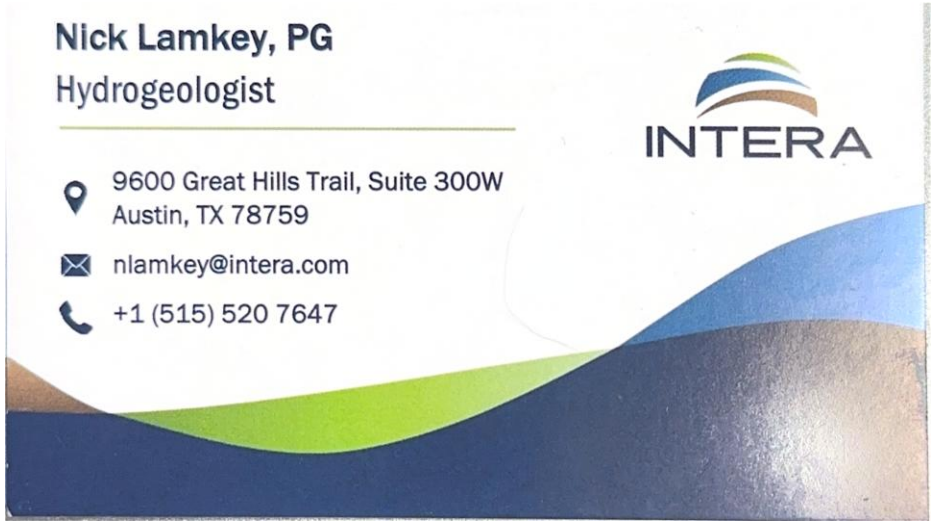
* Demand includes total demand (including all groundwater and surface water sources)
* Surface Water Includes all sources of Surface water
* MAG GCAS 2080
* Groundwater supply GCAS 2080
* Strategies GCAS 2080
* Needs includes all water needs 2080



INTERA

# Questions?


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# F.3 Hydrological Conditions

# GMA 15
# Discussion of Nine Factors in TWC 36.108(d): Hydrologic Conditions

Groundwater Management Area 15

April 10, 2025




Presented by:
Steven Young Ph.D, PE, PG
Nick Lamkey PG
Shou Yang Ph.D,

# Agenda

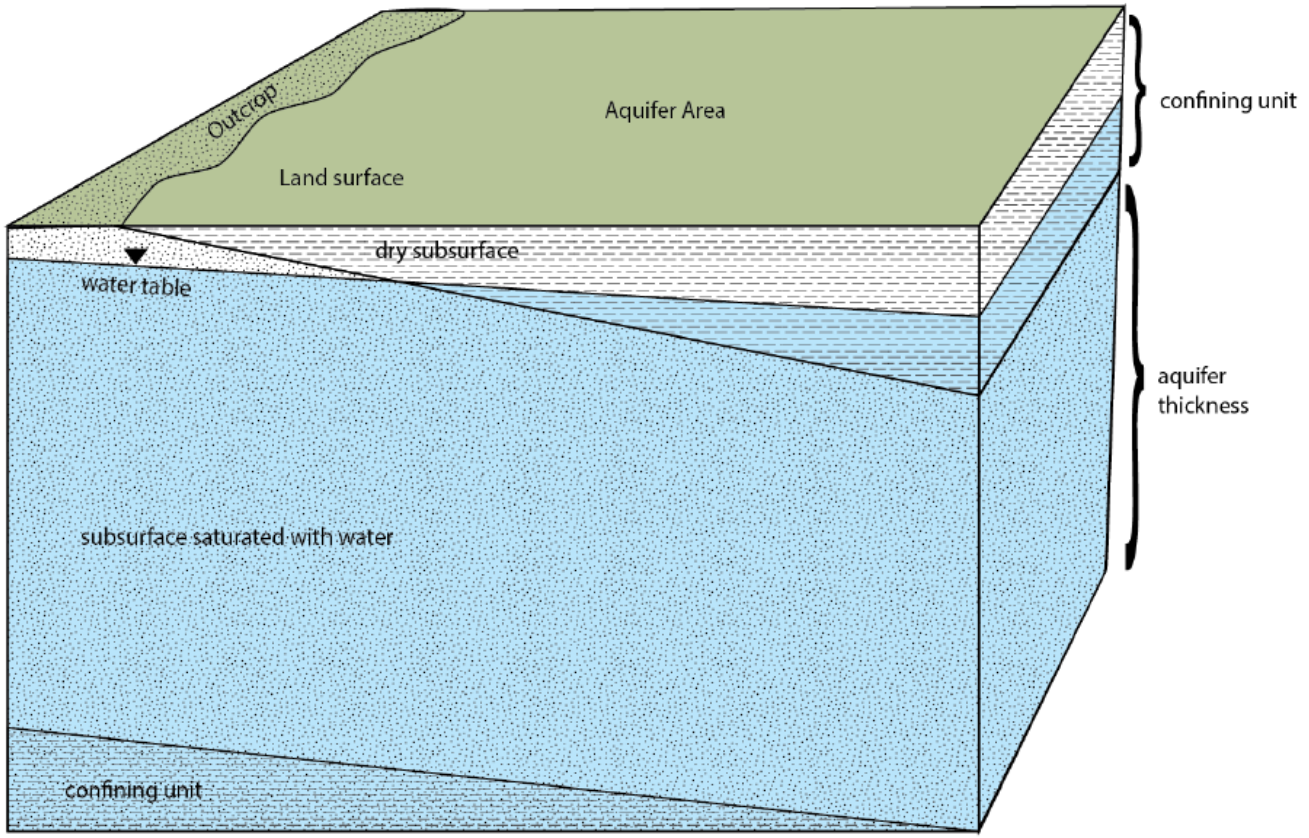
- Mechanics of Groundwater Storage
  - Unconfined Aquifer
  - Confined Aquifer
- Case Examples of Pumping Impacts
- Calculated TERS for GMA 15
- GAM Simulations with Updated TWDB Pumping
- Water Budgets

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# Total Estimated Recoverable Storage (TERS)

**Total Estimated Recoverable Storage**—The estimated amount of groundwater within an aquifer that accounts for recovery scenarios that range between 25% and 75% of the porosity-adjusted aquifer volume

Texas Administrative Code Sec. 356.10



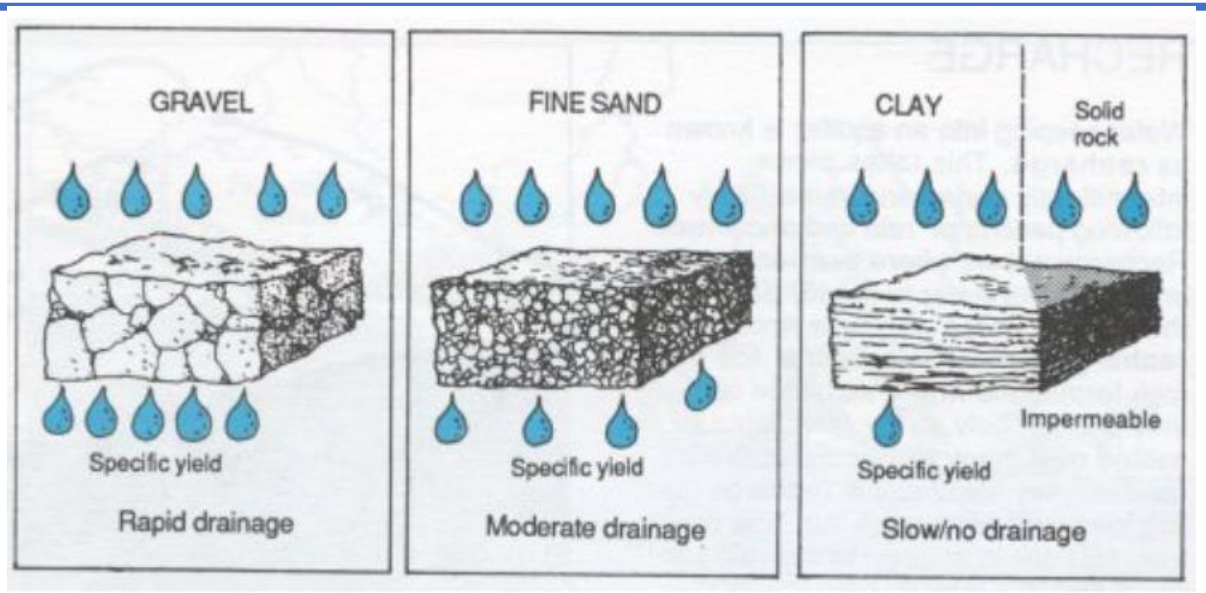

Storage volume = area x thickness x specific yield
(Plus some for the confined storage)

# Water From Storage: Drainage

**Specific Yield** —is the ratio of the volume of water that a saturated rock or soil will yield by gravity to the total volume of the rock or soil

**Factors affecting Specific yield**

a) soild texture
b) time
c) depth to water table



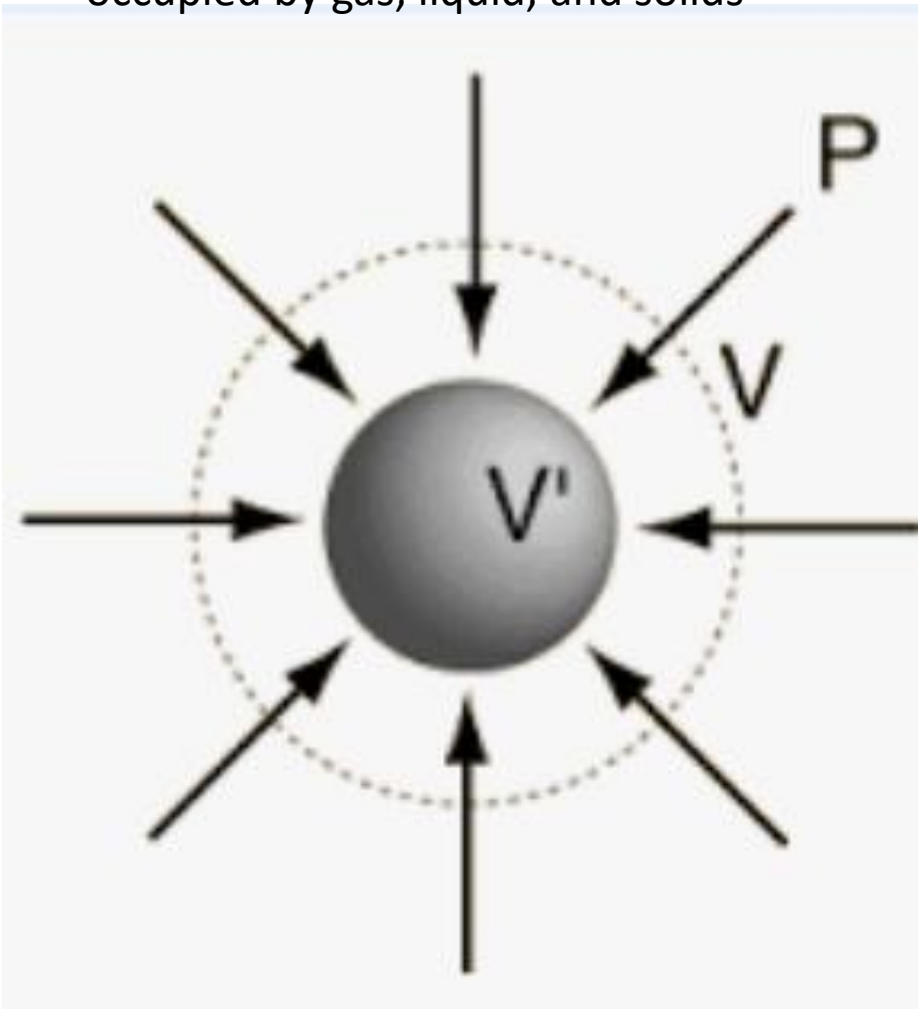

| Formation | $S_y$ (range) % |
|---|---|
| Clay | 0 - 5 |
| Sandy clay | 3 - 12 |
| Silt | 3 - 19 |
| Fine sand | 10 - 28 |
| Medium sand | 15 - 32 |
| Coarse sand | 20 - 35 |
| Gravelly sand | 20 - 35 |
| Fine gravel | 21 - 35 |
| Medium gravel | 13 - 26 |
| Coarse gravel | 12 - 26 |
| Limestone | |

# Water From Storage:  Compressibility of Water

**Specific Storage** —terms used to account for the change in volume of groundwater as pressure change.

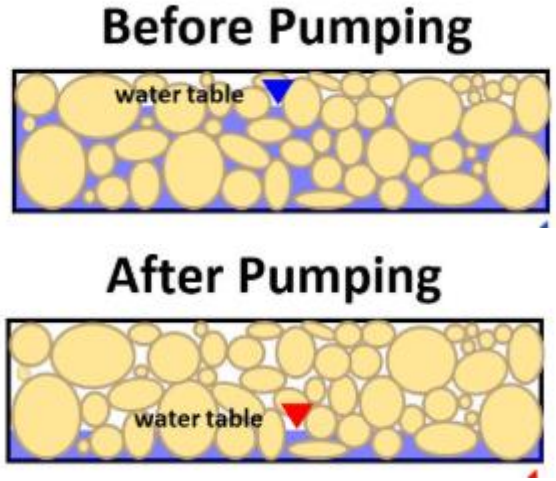
- Defined as change in volume per change in pressure.
- 1,000 to 100,000 times les that specific yield.  Express as a percentage

Water and soil is compressible. Change in pressure affects the  amount of space occupied by gas, liquid, and solids



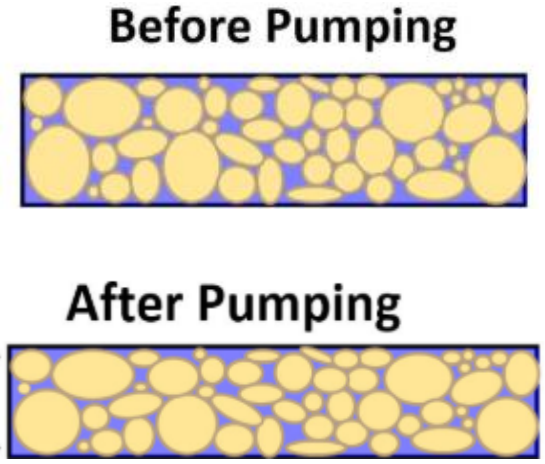
# Water From Storage:  Pumping Effects on Storage

## Unconfined Aquifer




Water has drained from pores and has been replaced by air

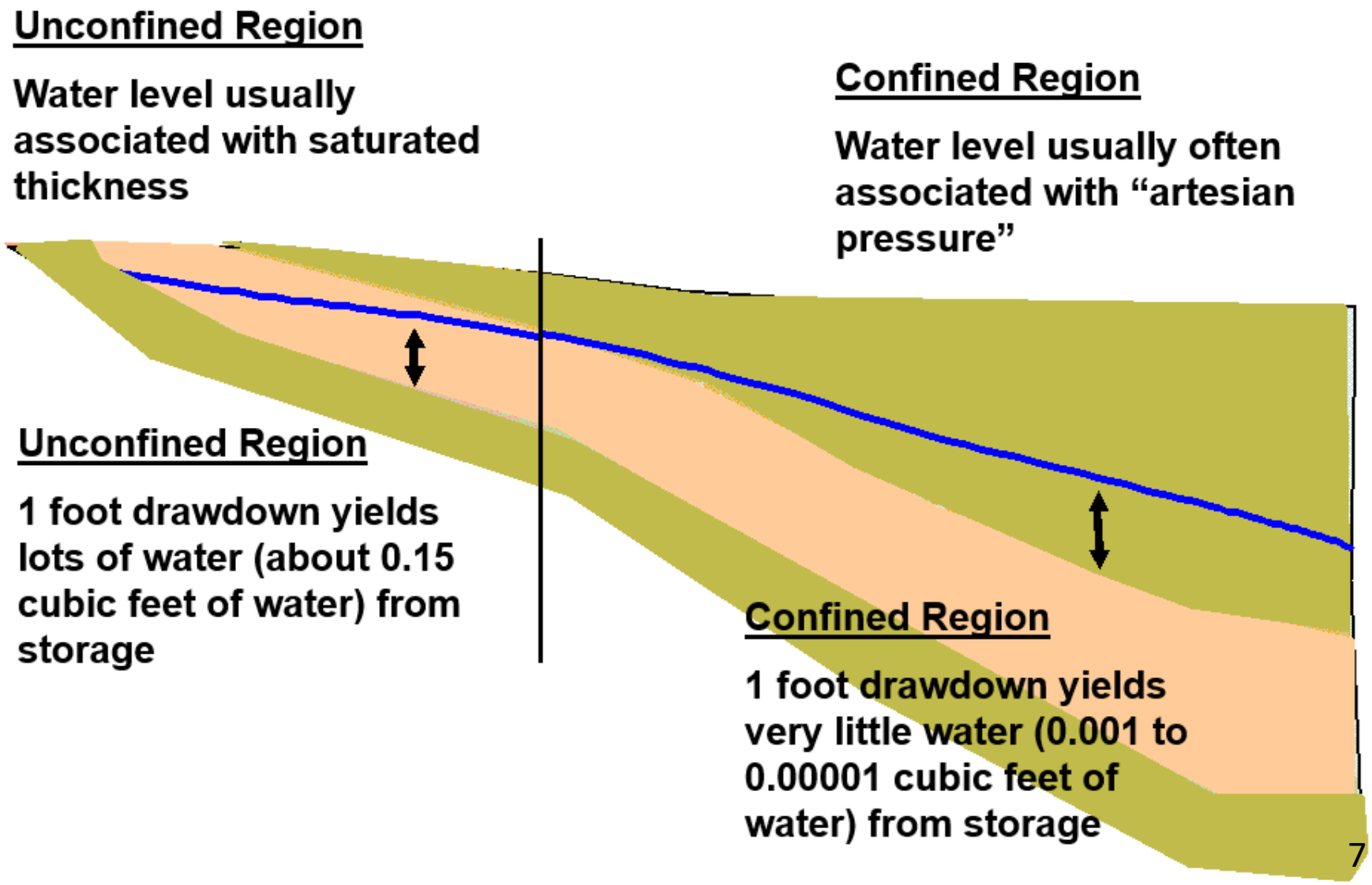
## Confined  Aquifer



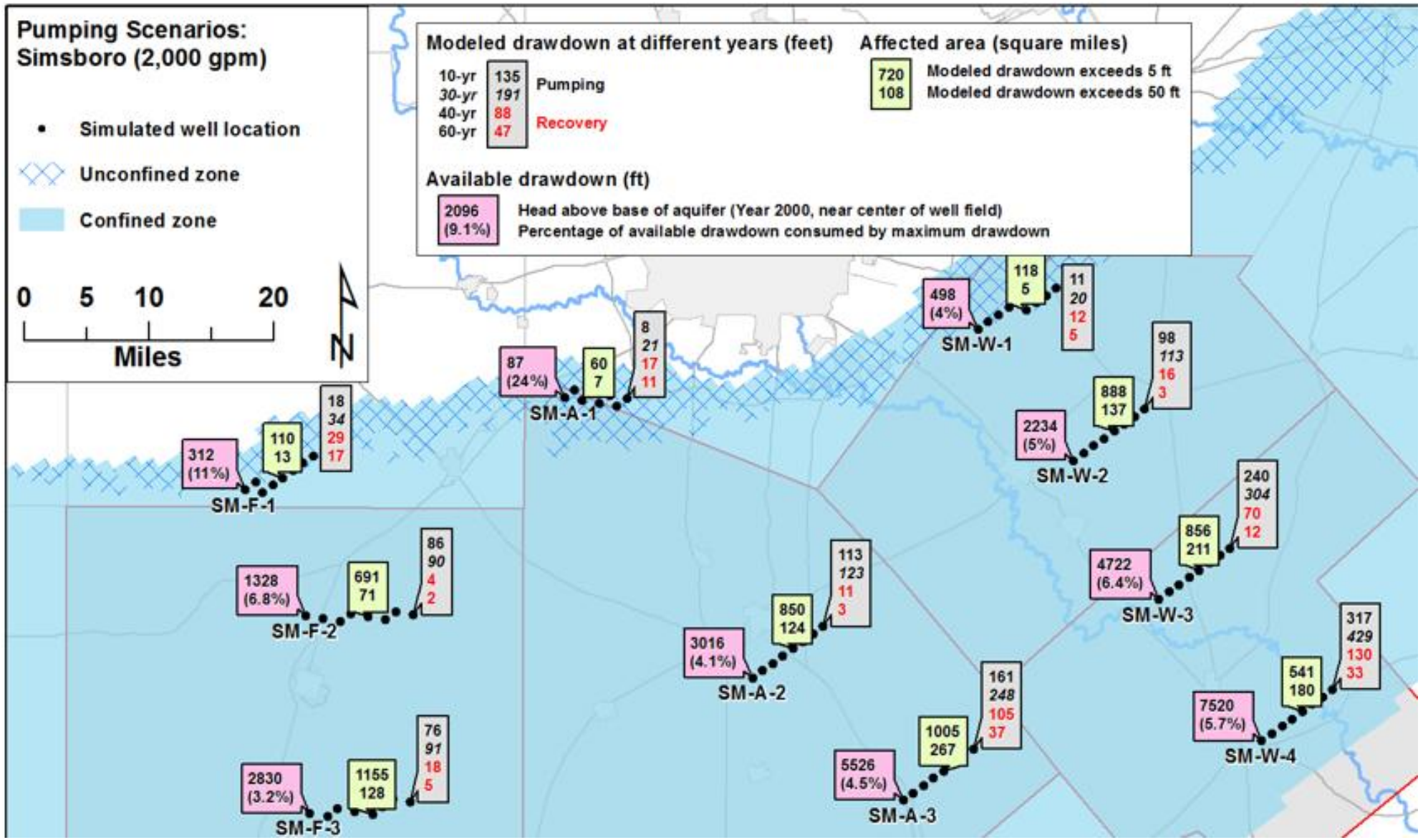

Water has expanded because of lowering of hydraulic presssure and soil has contracted  be because of increase pressure or load from weight of soil above.  Aquifer is a little smaller (subsidence)

# Impacts from Pumping:  Unconfined vs Confined

**Pumping impacts on drawdown is site specific**



# Impacts from Pumping: Unconfined vs Confined

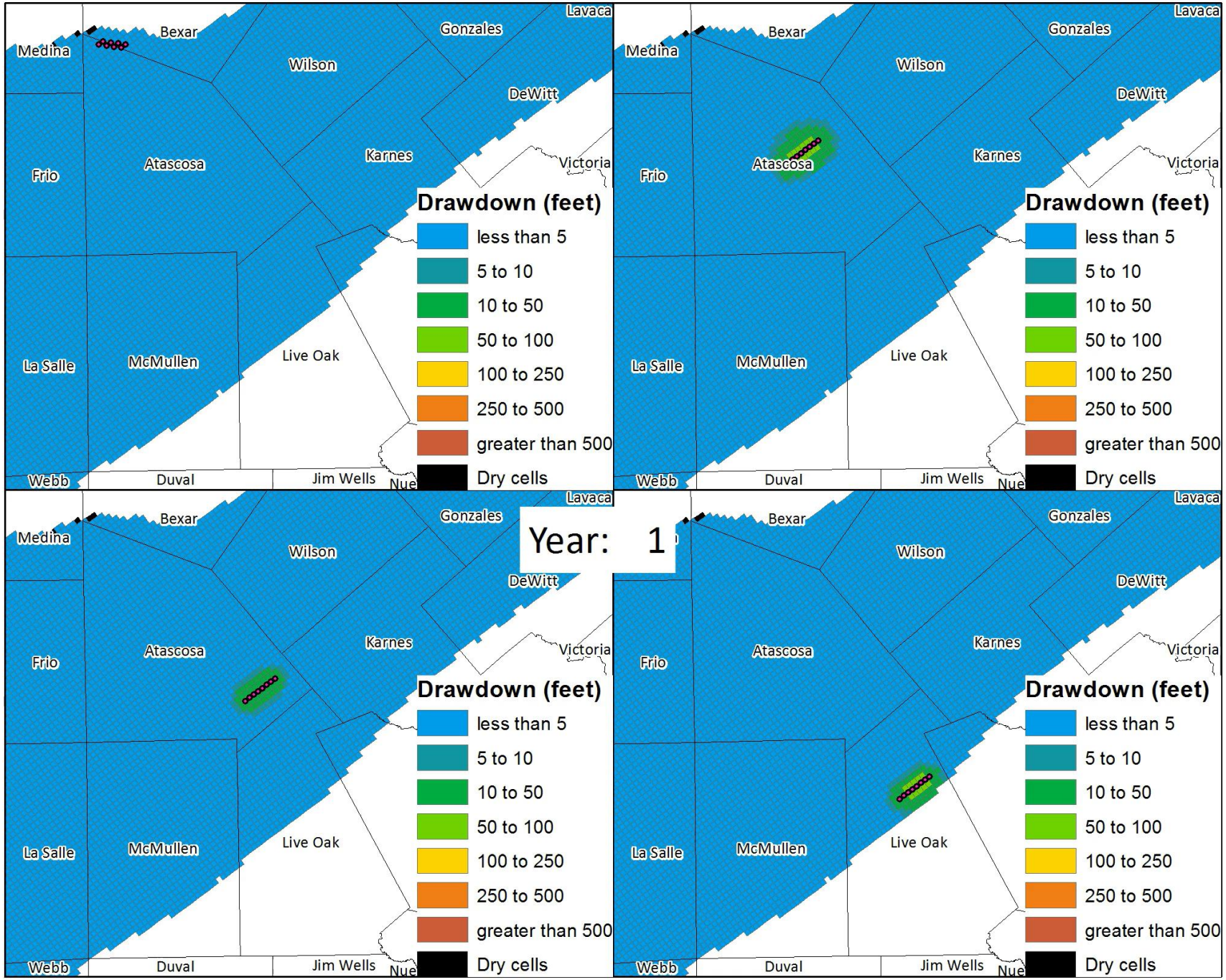


# Impacts from Location of Pumping: MAG

| GCD | Aquifer | MAG[1] (acre-feet per year) | Average Drawdown (feet) from 2011 to 2070 based on Pumping Distribution | |
|---|---|---|---|---|
| | | | Based on Run S-19 | Based on Distributing Pumping from Run S-19 Across the Entire Aquifer by County |
| LPGCD | Carrizo | 12,980 | 134 | 49 |
| | Simsboro | 79,945 | 238 | 61 |
| POSGCD | Carrizo | 18,206 | 146 | 56 |
| | Simsboro | 79,422 | 236 | 87 |

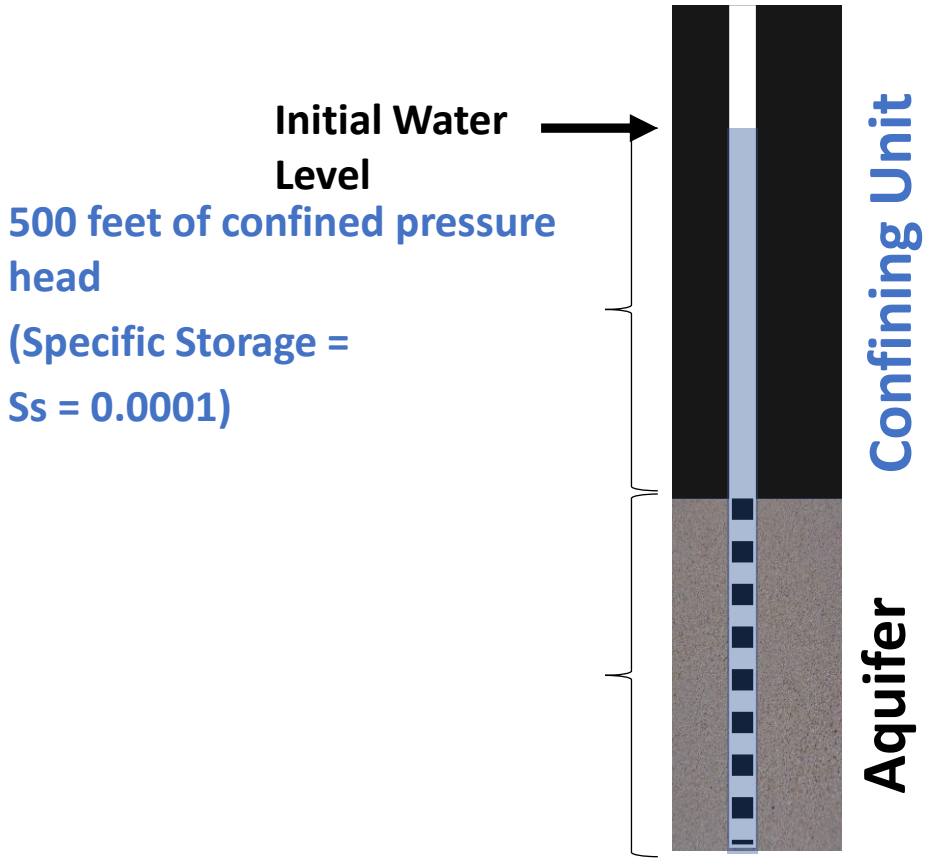
[1]modeled available groundwater

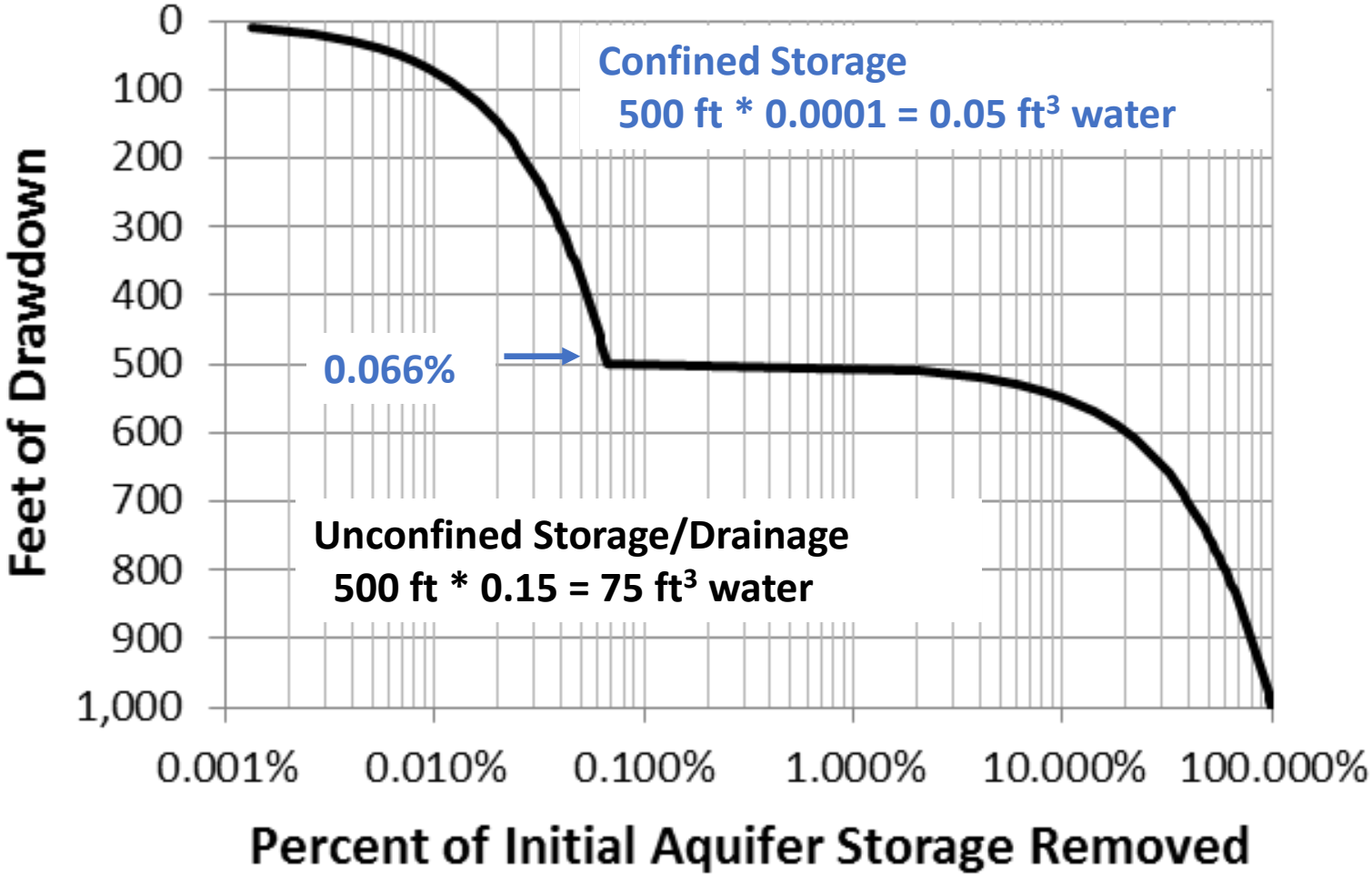
**Texas Water Journal**
Volume 15, Number 1, March 19, 2024
Pages 34-54


Year: 1
Drawdown (feet)
less than 5
5 to 10
10 to 50
50 to 100
100 to 250
250 to 500
greater than 500
Dry cells
Medina
Bexar
Wilson
Gonzales
Lavaca
DeWitt
Frio
Atascosa
Karnes
Victoria
La Salle
McMullen
Live Oak
Webb
Duval
Jim Wells

# TERS: Example of Depletion of a Confined Aquifer

**Example Aquifer**



# TERS: GMA 15 Aquifers

## Gulf Coast

| County | Total Storage (acre-feet) |
|---|---|
| Aransas | 5,500,000 |
| Bee | 12,000,000 |
| Calhoun | 17,000,000 |
| Colorado | 28,000,000 |
| De Witt | 21,000,000 |
| Fayette | 3,900,000 |
| Goliad | 26,000,000 |
| Jackson | 45,000,000 |
| Karnes | 6,400,000 |
| Lavaca | 22,000,000 |
| Matagorda | 48,000,000 |
| Refugio | 23,000,000 |
| Victoria | 39,000,000 |
| Wharton | 72,000,000 |
| Total | 368,800,000 |

## Aquifers Deemed Non Relevant

### Carrizo-WIlcox

| County | Total Storage (acre-feet) |
|---|---|
| De Witt | 1,200,000 |
| Fayette | 16,000,000 |
| Karnes | 43,000,000 |
| Lavaca | 9,700,000 |
| Total | 69,900,000 |

### Sparta

| County | Total Storage (acre-feet) |
|---|---|
| Fayette | 2,900,000 |
| Total | 2,900,000 |

### Queen City

| County | Total Storage (acre-feet) |
|---|---|
| Fayette | 640,000 |
| Total | 640,000 |

### Yegua Jackson

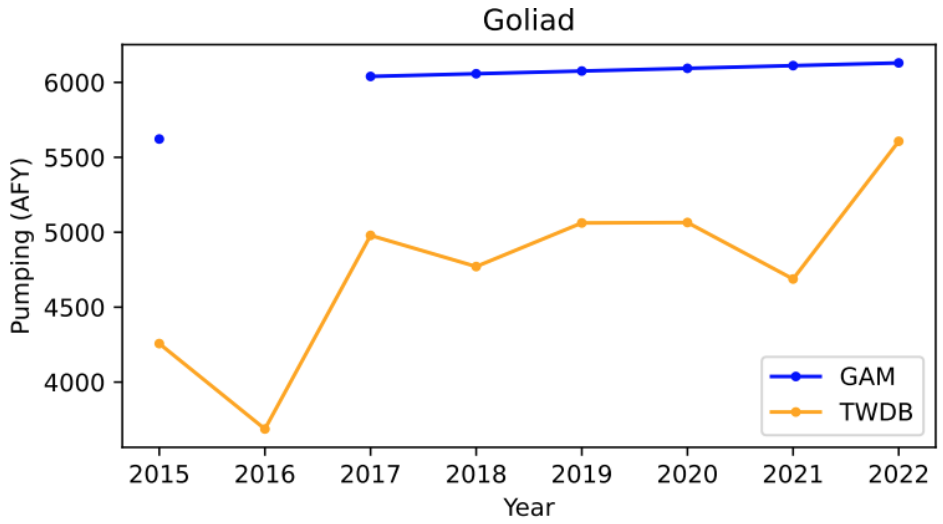
| County | Total Storage (acre-feet) |
|---|---|
| Lavaca | 620,000 |
| Karnes | 190,000 |
| Total | 810,000 |

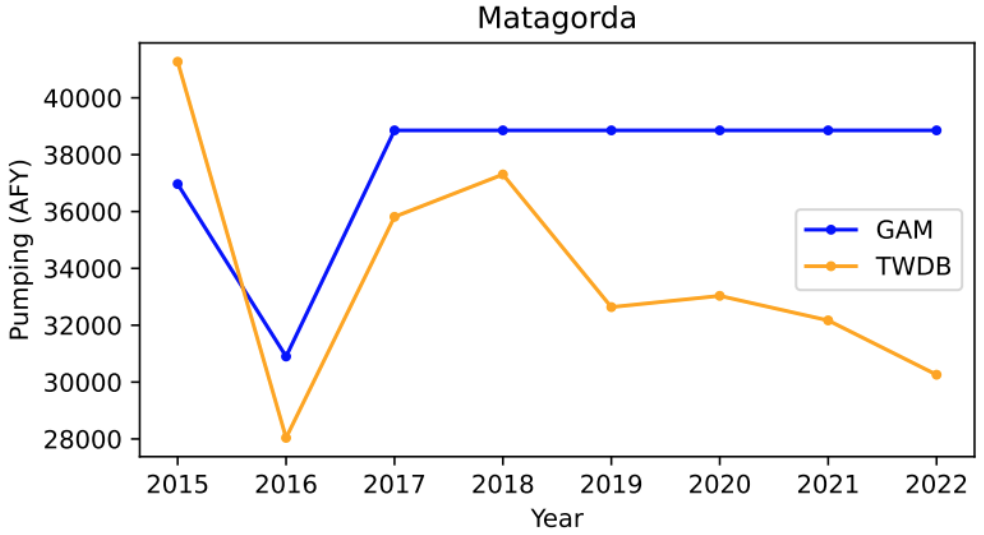
# TERS:  Considerations and Constraints

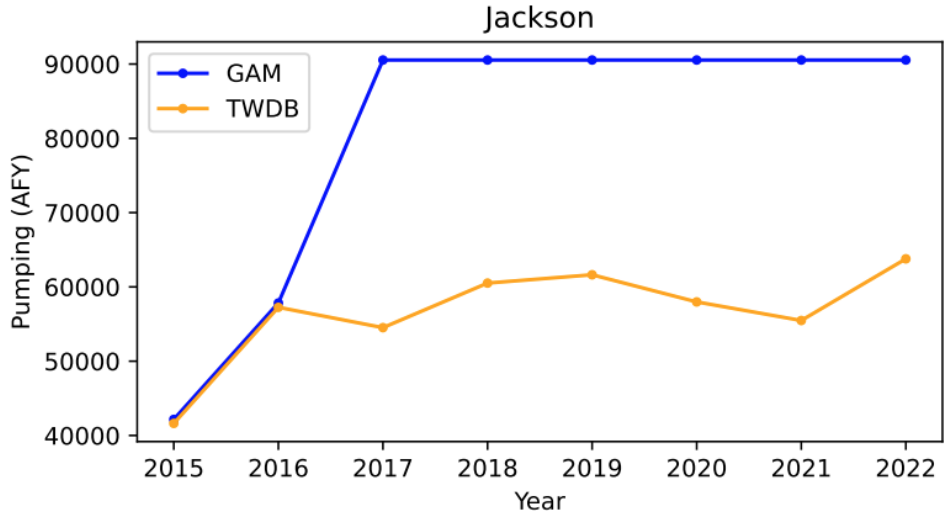
- TWDB Definition – between 25% and 75% of the porosity-adjusted aquifer volume

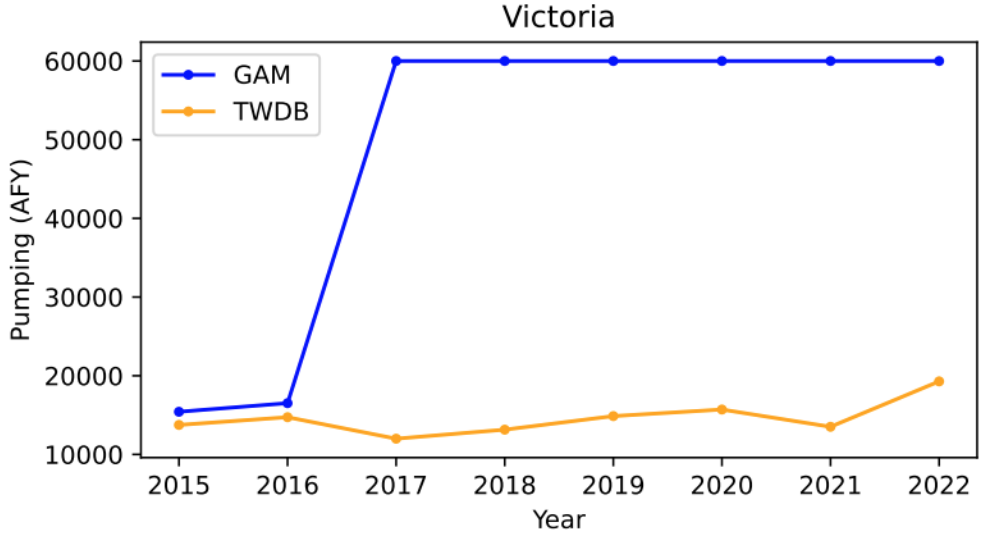
- No considerations
  - Unreasonable impacts
    - Groundwater & surface resources
    - Existing wells
  - Aquifer water quality
  - Water levels dropping below pumps
  - Land surface subsidence
  - Degradation of water quality
  - Changes to surface water-groundwater interaction
  - **Practicality/economics of development**
  - **Groundwater physics of removing of removing the**

# Current GAM Pumping and Modification using TWDB Pumping



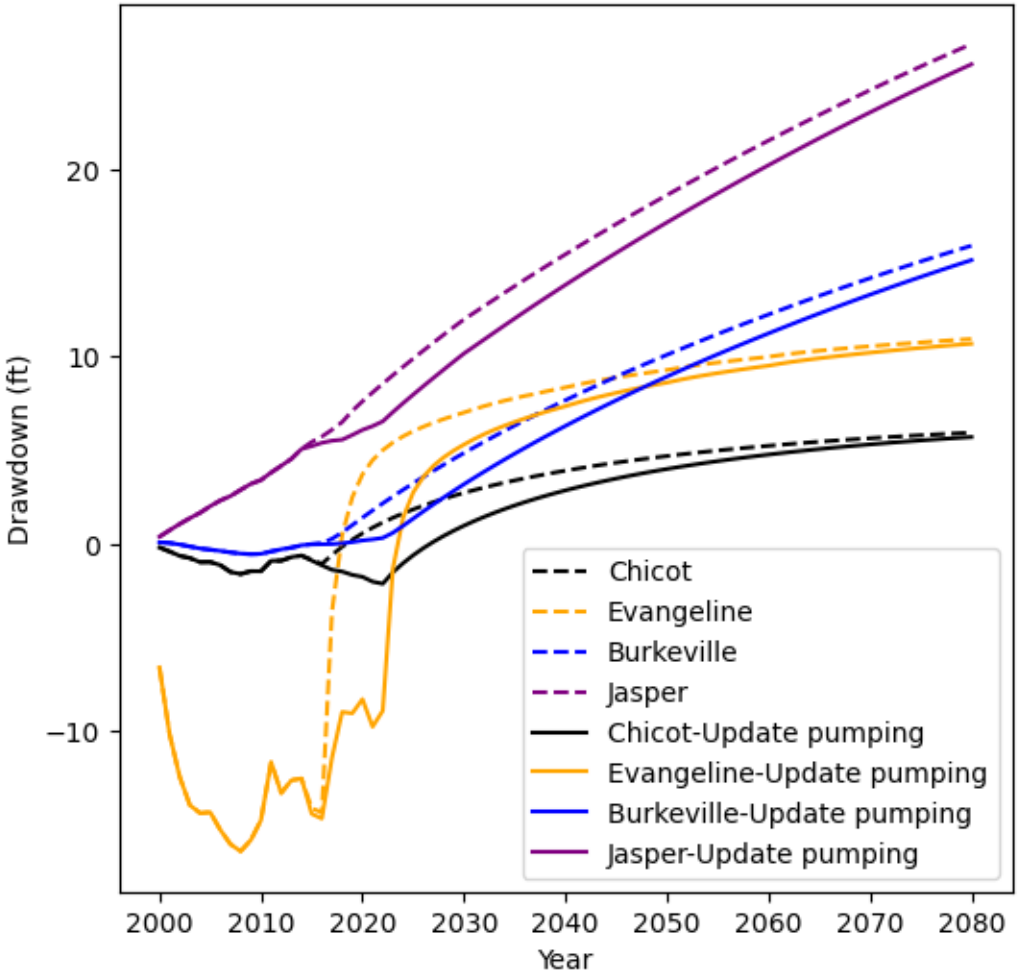



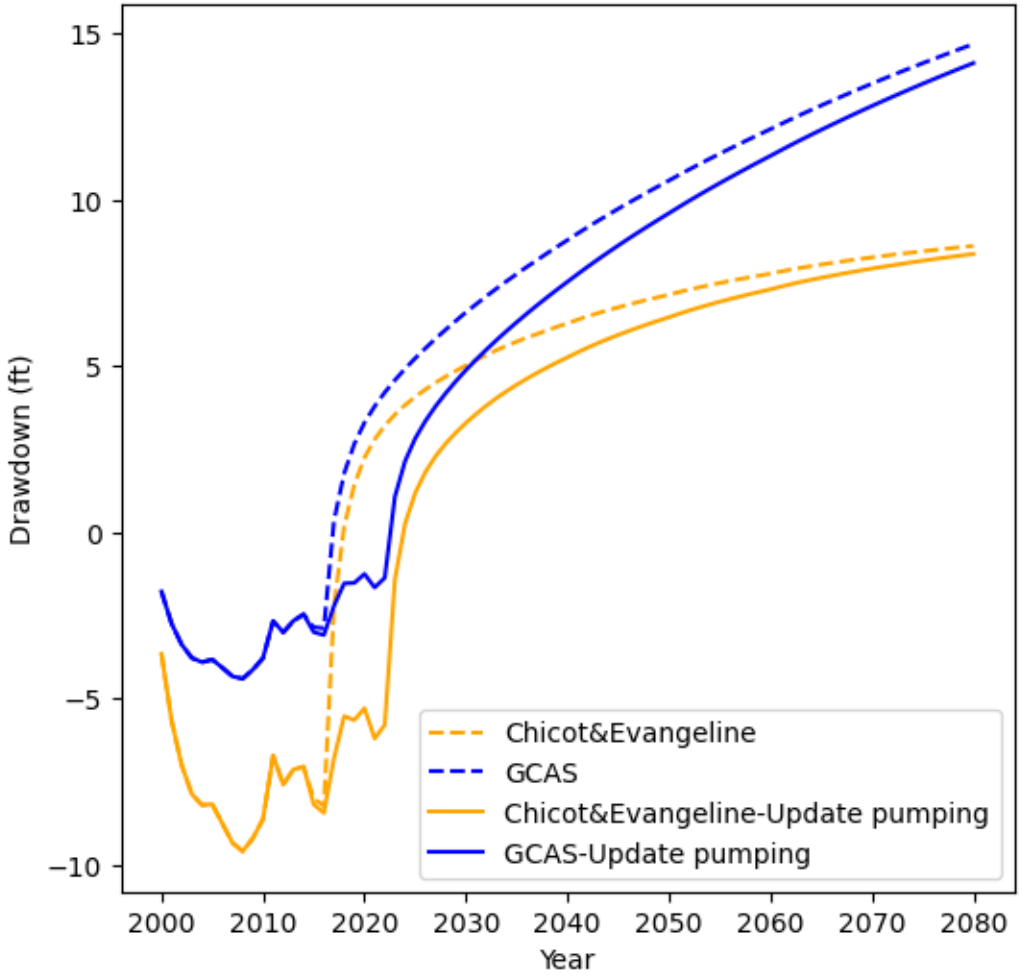

Note: Current GAM was calibrated to water levels in 1999

# TWDB Factors Applied to GAM Pumping

| County | Year | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
| Aransas | 0.36 | 0.36 | 0.24 | 0.19 | 0.18 | 0.35 | 0.35 | 0.36 |
| Bee | 0.79 | 0.81 | 0.19 | 0.19 | 0.17 | 0.18 | 0.19 | 0.24 |
| Calhoun | 0.57 | 0.53 | 0.11 | 0.14 | 0.13 | 0.13 | 0.15 | 0.14 |
| Colorado | 0.96 | 0.96 | 0.35 | 0.46 | 0.35 | 0.35 | 0.35 | 0.60 |
| De witt | 0.41 | 0.55 | 0.68 | 0.23 | 0.22 | 0.37 | 0.30 | 0.38 |
| Fayette | 0.22 | 0.23 | 0.23 | 0.20 | 0.11 | 0.20 | 0.17 | 0.25 |
| Goliad | 0.76 | | 0.83 | 0.79 | 0.83 | 0.83 | 0.77 | 0.92 |
| Jackson | 0.98 | 0.99 | 0.60 | 0.67 | 0.68 | 0.64 | 0.61 | 0.70 |
| Karnes | 0.65 | 0.56 | 0.24 | 0.23 | 0.25 | 0.82 | 0.91 | 1.08 |
| Lavaca | 0.86 | 0.86 | 0.48 | 0.55 | 0.59 | 0.62 | 0.54 | 0.62 |
| Matagorda | 1.12 | 0.91 | 0.92 | 0.96 | 0.84 | 0.85 | 0.83 | 0.78 |
| Refugio | 0.81 | 0.84 | 0.35 | 0.30 | 0.32 | 0.36 | 0.33 | 0.34 |
| Victoria | 0.89 | 0.89 | 0.20 | 0.22 | 0.25 | 0.26 | 0.23 | 0.32 |
| Wharton | 0.94 | 0.95 | 0.64 | 0.71 | 0.59 | 0.68 | 0.44 | 0.47 |

# Drawdown Predicted by Current GAM and GAM with Pumping Updated Using TWDB Pumping through 2022




Average drawdown relative to Jan. 2000 in GMA15 Predicted by the GAM.

# DFC for Current GAM and GAM with TWDB Pumping through 20ww

Average Drawdown (Jan. 2000 – Dec. 2080) for Counties in GMA15 Predicted by the GAM and updated GAM.

| County | Chicot | | Evangeline | | Chicot & Evangeline | | Burkeville | | Jasper | | Gulf Coast Aquifer System | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | GAM | GAM-update pumping | GAM | GAM-update pumping | GAM | GAM-update pumping | GAM | GAM-update pumping | GAM | GAM-update pumping | GAM | GAM-update pumping |
| Fayette | | | 11.3 | 11.3 | 11.3 | 11.3 | 42.6 | 42.5 | 53.7 | 53.6 | 44.4 | 44.3 |
| Jackson | 15.5 | 15 | 20.3 | 19.9 | 17.9 | 17.4 | 14 | 12.7 | 21.7 | 20.3 | 17.5 | 16.7 |
| Refugio | -0.5 | -0.5 | 6.9 | 6.9 | 3 | 3 | 2.5 | 2.3 | | | 2.9 | 2.9 |
| Goliad | -4.3 | -4.3 | -1.9 | -2 | -2.4 | -2.4 | 8.4 | 8.1 | 13.3 | 12.8 | 5.4 | 5.2 |
| Karnes | | | 0 | -0.2 | 0 | -0.2 | 22.3 | 21.8 | 27.1 | 25.6 | 23.4 | 22.3 |
| Matagorda | 4.7 | 4.6 | 17.2 | 16.9 | 9 | 8.9 | 15.8 | 15.1 | | | 9.7 | 9.5 |
| De Witt | 0.2 | 0.2 | 4.7 | 4.5 | 4 | 3.9 | 16.3 | 16.2 | 34.5 | 33.4 | 20.1 | 19.6 |
| Victoria | -4 | -4.1 | 5.6 | 5.5 | 1 | 0.9 | 4.8 | 4.2 | 8.2 | 7.2 | 3.2 | 2.9 |
| Wharton | 14.5 | 14 | 12.2 | 11.7 | 13.3 | 12.9 | 24.3 | 22.9 | 27.4 | 26.1 | 19.4 | 18.5 |
| Colorado | 12.2 | 11.7 | 25.8 | 25.4 | 19.7 | 19.3 | 23.7 | 22.5 | 28.2 | 26.9 | 23 | 22.1 |
| Calhoun | -1.2 | -1.2 | 9.8 | 9.7 | 2.6 | 2.6 | 2.9 | 2.7 | | | 2.7 | 2.6 |
| Bee | 0.9 | 0.8 | 7.9 | 7.8 | 5.6 | 5.4 | 7.5 | 6.9 | 5.9 | 5 | 6.2 | 5.8 |
| Lavaca | 7 | 6.5 | 6.8 | 6.5 | 6.9 | 6.5 | 16.5 | 15.7 | 32.2 | 31 | 18.1 | 17.3 |
| Aransas | -0.2 | -0.2 | 5.6 | 5.6 | 0.1 | 0.1 | | | | | 0.1 | 0.1 |
| GMA15 | 5.9 | 5.7 | 10.9 | 10.7 | 8.6 | 8.4 | 15.9 | 15.1 | 26.7 | 25.6 | 14.7 | 14.1 |

# Water Budget: Sources and Sinks

- Sources:
  - recharge from precipitation;
  - flow from rivers;
  - lateral inflow;
  - vertical flow from other aquifers
  - Storage in place
- Sinks
  - pumping;
  - evapotranspiration;
  - flow to rivers;
  - lateral outflow;
  - vertical flow to other aquifers
  - storage in place

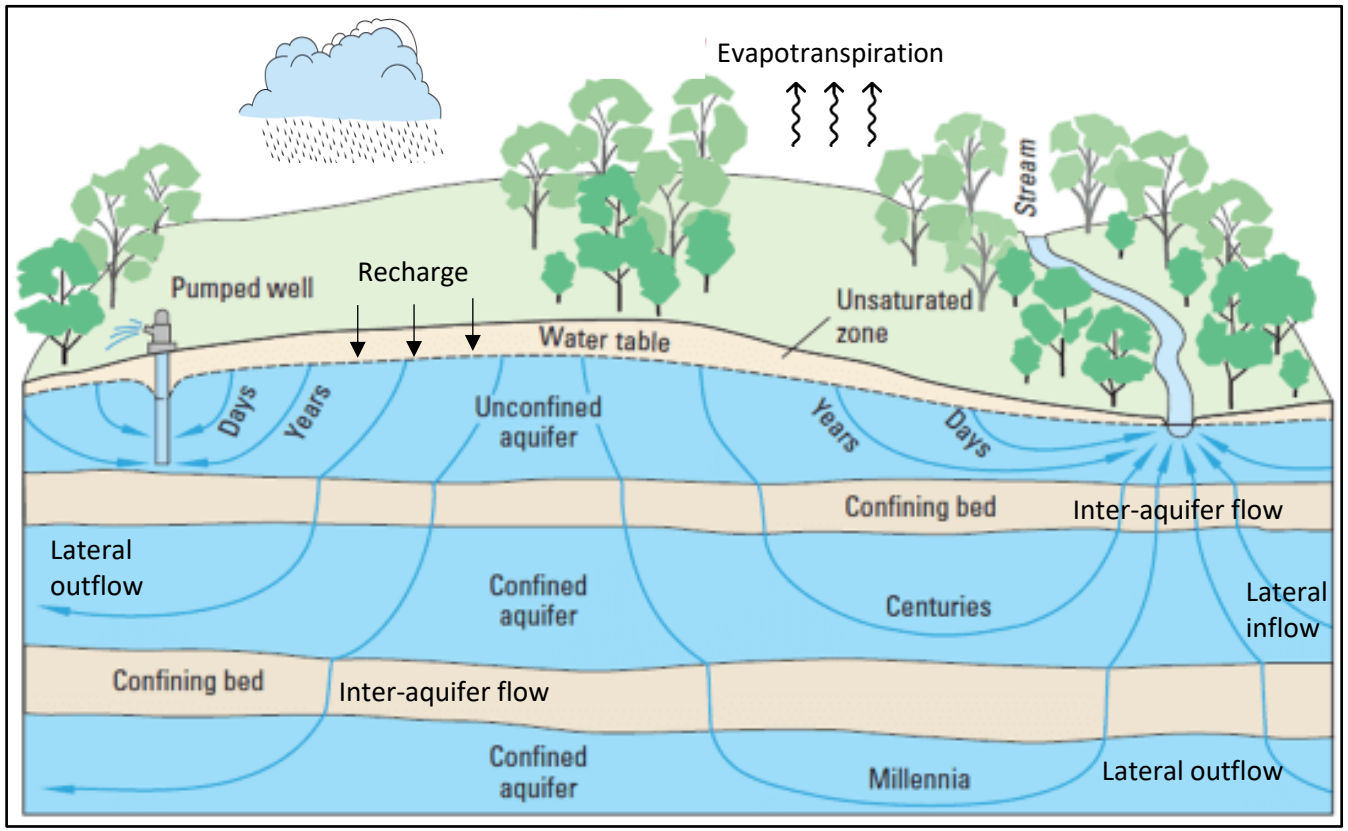
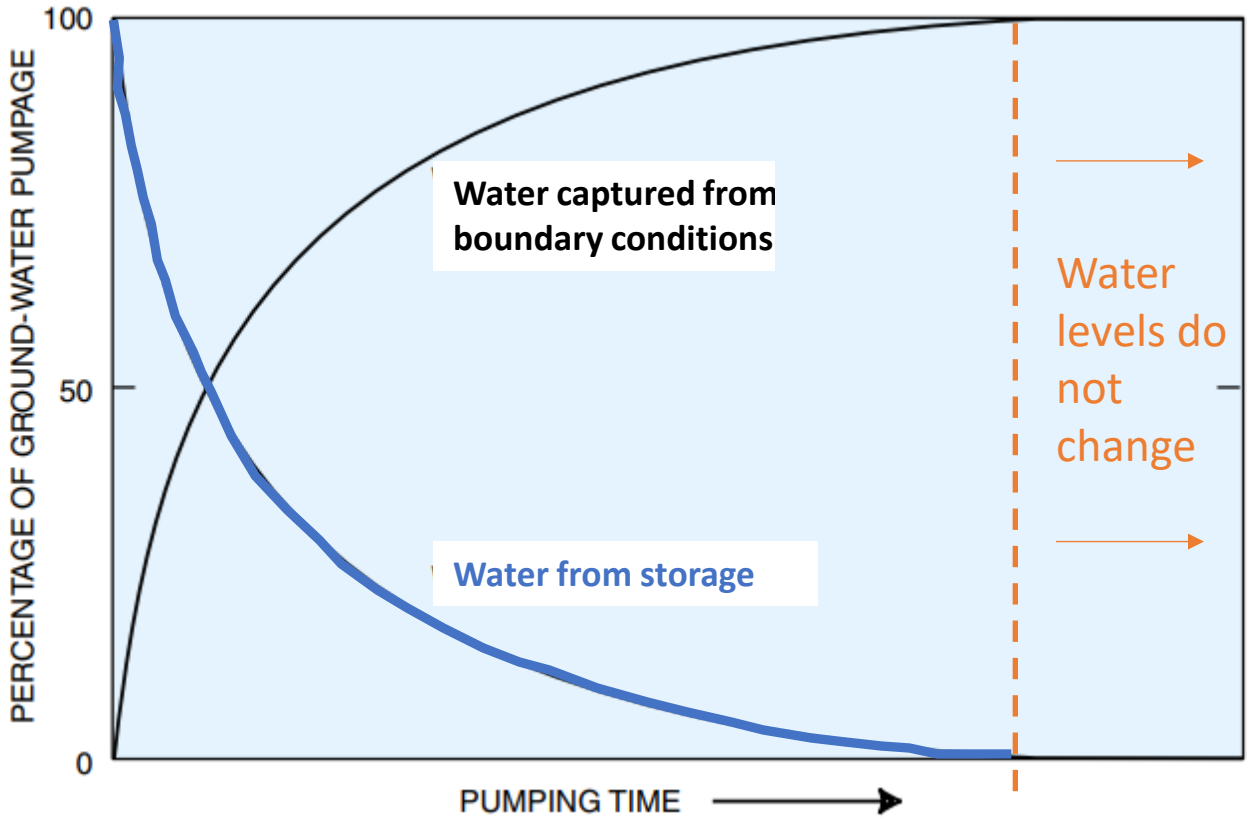



Illustration of water budget components in an aquifer system.

# Water Budget: Evolution over Time

- Sources for Pumped Water
  - Initial water is from aquifer itself (storage)
  - As cone-of-depression spreads outwards, additional sources of water besides storage
  - At very late times, cone-of-depression stops migration and water levels remains constant
  - At very late times, all water is from boundary conditions
- Hydraulic Boundary Conditions
  - Streams, lakes, creeks, springs
  - Recharge from precipitation
  - Adjacent aquifers



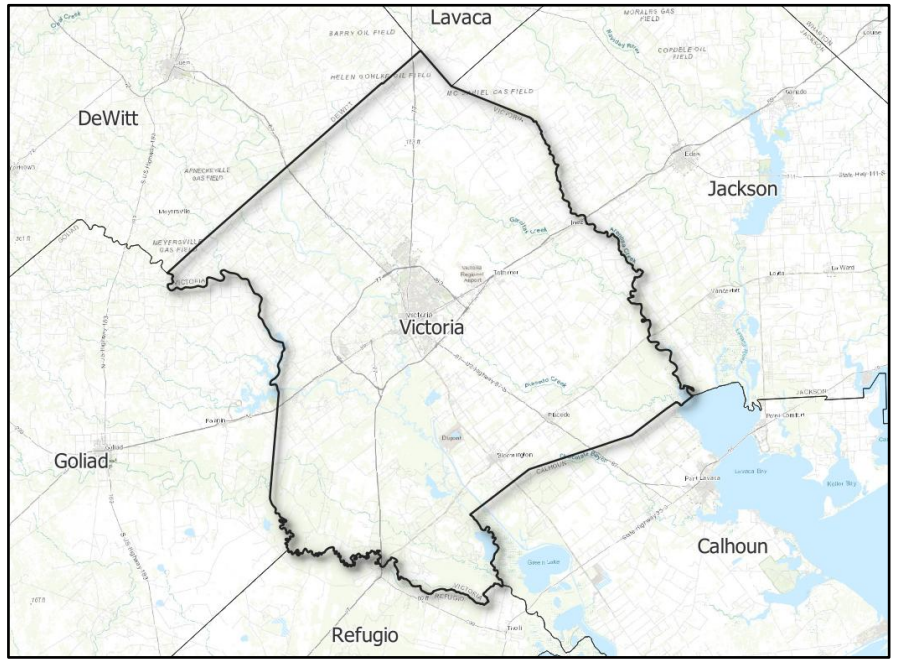
# Water Budget: Entire Gulf Coast

Water inflow to Gulf Coast Aquifer System in Victoria County.

| Boundary Conditions | Pre-Dev. | 1981 | 1990 | 1991 | 2000 | 2010 | 2020 | 2080 |
|---|---|---|---|---|---|---|---|---|
| Storage | 0.0 | 2272.57 | 14175.72 | 1128.26 | 696.14 | 585.8 | 963.57 | 724.38 |
| River Leakage | 0.0 | 1053.38 | 1055.79 | 1055.79 | 1055.79 | 1044.3 | 1048.75 | 1055.79 |
| Head Dep Bounds | 0.0 | 374.63 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Recharge | 8131.96 | 31188.51 | 20228.97 | 35419.19 | 25557.23 | 25557.23 | 25557.23 | 25557.23 |
| Stream Leakage | 41644.59 | 52727.85 | 7759.26 | 23695.09 | 62761.67 | 43306.52 | 41908.0 | 57578.28 |
| Lavaca County | 441.22 | 647.83 | 571.12 | 564.92 | 592.1 | 526.87 | 502.64 | 603.45 |
| Dewitt County | 5351.76 | 7626.66 | 6526.96 | 7033.51 | 6573.62 | 6029.87 | 5800.85 | 6955.75 |
| Jackson County | 1959.2 | 2412.3 | 1523.69 | 1535.75 | 3085.91 | 2067.14 | 1953.07 | 2095.42 |
| Goliad County | 4114.05 | 5445.17 | 5650.62 | 5413.37 | 5262.28 | 4677.24 | 4498.91 | 5692.62 |
| Calhoun County | 2880.97 | 2470.69 | 1168.79 | 1198.65 | 1233.65 | 2820.11 | 2956.9 | 3430.59 |
| Refugio County | 1554.92 | 2069.53 | 1928.3 | 1881.73 | 1950.28 | 1624.68 | 1883.81 | 3298.57 |

Water outflow of Gulf Coast Aquifer System in Victoria County.

| Boundary Conditions | Pre-Dev. | 1981 | 1990 | 1991 | 2000 | 2010 | 2020 | 2080 |
|---|---|---|---|---|---|---|---|---|
| Storage | 0.0 | 25767.37 | 1319.31 | 19278.19 | 46644.01 | 6014.94 | 1444.44 | 0.0 |
| Drains | 1634.95 | 250.61 | 97.66 | 116.57 | 973.36 | 1630.33 | 1646.44 | 1331.15 |
| Et | 0.0 | 1273.12 | 610.46 | 599.49 | 801.68 | 1011.97 | 1026.38 | 870.96 |
| Head Dep Bounds | 778.45 | 0.0 | 48.55 | 76.85 | 322.52 | 569.66 | 606.3 | 391.71 |
| Stream Leakage | 42249.3 | 21557.85 | 17580.93 | 20109.85 | 20706.5 | 41072.46 | 41464.03 | 22752.33 |
| Wells | 0.0 | 39938.26 | 26872.58 | 24052.69 | 24815.23 | 15384.21 | 15736.37 | 59995.01 |
| Lavaca County | 1205.92 | 1317.66 | 1054.85 | 1019.72 | 1323.98 | 1451.5 | 1491.16 | 1262.43 |
| Dewitt County | 44.33 | 37.91 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.65 |
| Jackson County | 7757.89 | 12883.83 | 7362.33 | 8027.89 | 5781.64 | 8304.62 | 11485.07 | 9482.05 |
| Goliad County | 1520.65 | 1403.09 | 1258.65 | 1164.21 | 1484.6 | 1709.64 | 1728.07 | 1469.32 |
| Calhoun County | 8691.53 | 1802.05 | 2630.4 | 2631.92 | 3950.18 | 8375.51 | 7889.1 | 7635.34 |
| Refugio County | 2195.66 | 2057.15 | 1753.35 | 1848.76 | 1942.34 | 2713.47 | 2556.38 | 1798.33 |



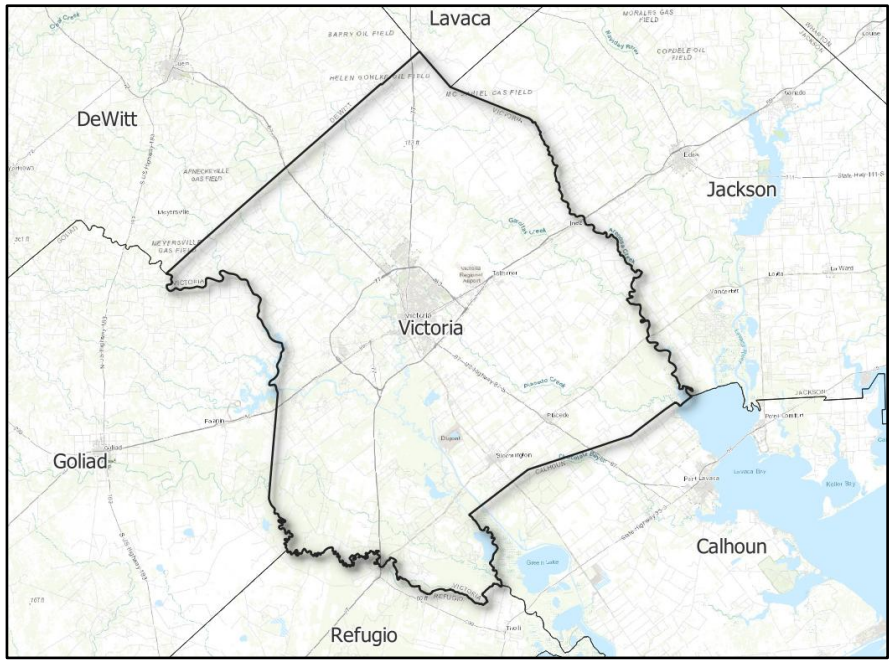

*Unit: AFY.

# Water Budget: Entire Gulf Coast

Net flow to Gulf Coast Aquifer System in Victoria County.

| Boundary Conditions | Pre-Dev. | 1981 | 1990 | 1991 | 2000 | 2010 | 2020 | 2080 |
|---|---|---|---|---|---|---|---|---|
| Storage | 0.0 | -23494.8 | 12856.42 | -18149.93 | -45947.87 | -5429.14 | -480.87 | 724.38 |
| Drains | -1634.95 | -250.61 | -97.66 | -116.57 | -973.36 | -1630.33 | -1646.44 | -1331.15 |
| River Leakage | 0.0 | 1053.38 | 1055.79 | 1055.79 | 1055.79 | 1044.3 | 1048.75 | 1055.79 |
| Et | 0.0 | -1273.12 | -610.46 | -599.49 | -801.68 | -1011.97 | -1026.38 | -870.96 |
| Head Dep Bounds | -778.45 | 374.63 | -48.55 | -76.85 | -322.52 | -569.66 | -606.3 | -391.71 |
| Recharge | 8131.96 | 31188.51 | 20228.97 | 35419.19 | 25557.23 | 25557.23 | 25557.23 | 25557.23 |
| Stream Leakage | -604.71 | 31170.0 | -9821.67 | 3585.24 | 42055.17 | 2234.07 | 443.97 | 34825.94 |
| Wells | 0.0 | -39938.26 | -26872.58 | -24052.69 | -24815.23 | -15384.21 | -15736.37 | -59995.01 |
| Lavaca County | -764.69 | -669.83 | -483.72 | -454.8 | -731.89 | -924.63 | -988.53 | -658.97 |
| Dewitt County | 5307.43 | 7588.75 | 6526.96 | 7033.51 | 6573.62 | 6029.87 | 5800.85 | 6952.09 |
| Jackson County | -5798.68 | -10471.52 | -5838.64 | -6492.14 | -2695.74 | -6237.48 | -9532.0 | -7386.63 |
| Goliad County | 2593.4 | 4042.08 | 4391.97 | 4249.16 | 3777.68 | 2967.6 | 2770.84 | 4223.31 |
| Calhoun County | -5810.57 | 668.63 | -1461.61 | -1433.27 | -2716.53 | -5555.4 | -4932.2 | -4204.75 |
| Refugio County | -640.74 | 12.38 | 174.94 | 32.96 | 7.94 | -1088.79 | -672.57 | 1500.24 |

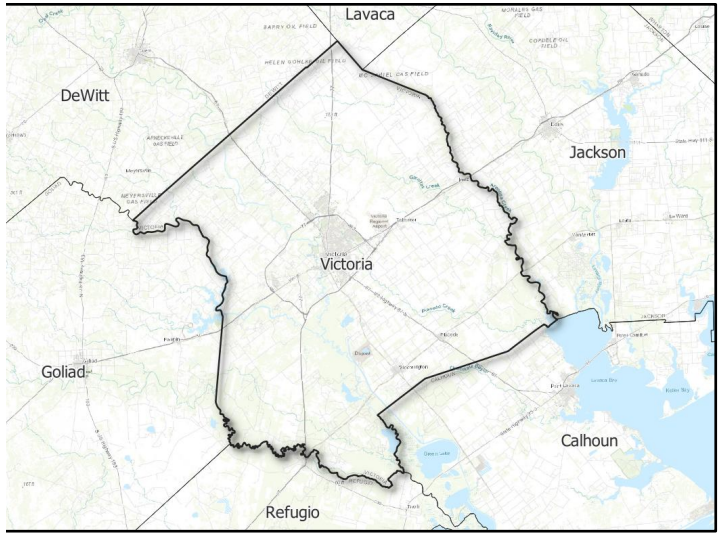
*Unit: AFY.



# Water Budget: Gulf Coast Aquifer – Chicot, Evangeline Inflows

Table 79: Victoria county Inflows (Units: Acre-Feet per Year)

| | Boundary Conditions | Pre-Dev. | 1981 | 1990 | 1991 | 2000 | 2010 | 2020 | 2080 |
|---|---|---|---|---|---|---|---|---|---|
| Chicot | Storage | 0.0 | 720.26 | 12802.22 | 311.34 | 66.97 | 153.99 | 698.09 | 172.27 |
| | River Leakage | 0.0 | 1053.38 | 1055.79 | 1055.79 | 1055.79 | 1044.3 | 1048.75 | 1055.79 |
| | Head Dep Bounds | 0.0 | 374.63 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Recharge | 7579.37 | 30511.28 | 19717.49 | 34363.59 | 24815.13 | 24815.13 | 24815.13 | 24815.13 |
| | Stream Leakage | 40393.27 | 50987.58 | 7235.9 | 22143.72 | 60252.12 | 41499.65 | 40293.7 | 54998.49 |
| | Lavaca County | 293.03 | 348.44 | 337.11 | 323.13 | 350.44 | 316.22 | 314.3 | 360.11 |
| | Dewitt County | 1132.26 | 1497.62 | 1457.65 | 1843.12 | 1469.88 | 1281.28 | 1238.47 | 1431.28 |
| | Jackson County | 1392.18 | 1661.22 | 943.8 | 932.27 | 2509.33 | 1547.94 | 1372.32 | 1448.58 |
| | Goliad County | 755.49 | 1058.68 | 1056.71 | 1087.6 | 1018.3 | 1065.83 | 1055.49 | 1032.59 |
| | Calhoun County | 2856.24 | 2016.3 | 923.6 | 963.46 | 888.06 | 2689.37 | 2771.54 | 2593.93 |
| | Refugio County | 1052.75 | 1086.27 | 1098.67 | 1058.82 | 1124.5 | 1031.64 | 1039.03 | 1317.59 |
| | Evangeline Aquifer | 4299.89 | 307.46 | 399.27 | 420.49 | 382.37 | 1348.94 | 1143.15 | 62.16 |
| Evangeline | Storage | 0.0 | 17.01 | 453.13 | 0.0 | 32.7 | 357.27 | 194.75 | 9.55 |
| | Recharge | 552.59 | 677.23 | 511.48 | 1055.6 | 742.1 | 742.1 | 742.1 | 742.1 |
| | Stream Leakage | 1251.31 | 1740.27 | 523.36 | 1551.37 | 2509.56 | 1806.87 | 1614.31 | 2579.79 |
| | Lavaca County | 137.6 | 284.82 | 219.84 | 227.71 | 227.79 | 197.1 | 176.45 | 233.31 |
| | Dewitt County | 3817.18 | 5728.28 | 4671.75 | 4795.13 | 4712.35 | 4370.07 | 4241.02 | 5230.66 |
| | Jackson County | 547.21 | 707.1 | 540.28 | 564.85 | 547.27 | 495.1 | 556.67 | 625.34 |
| | Goliad County | 3095.76 | 4099.69 | 4299.06 | 4029.84 | 3943.45 | 3309.6 | 3142.44 | 4347.62 |
| | Calhoun County | 24.51 | 454.07 | 244.86 | 234.85 | 345.24 | 130.38 | 185.0 | 836.21 |
| | Refugio County | 500.54 | 981.52 | 827.86 | 821.15 | 824.0 | 591.25 | 842.98 | 1978.72 |
| | Chicot Aquifer | 2130.52 | 14023.7 | 9871.74 | 9326.43 | 12660.51 | 6944.18 | 6380.22 | 16305.63 |
| | Burkeville Aquifer | 567.03 | 2177.66 | 1488.79 | 1297.39 | 1121.24 | 272.55 | 218.36 | 1037.69 |

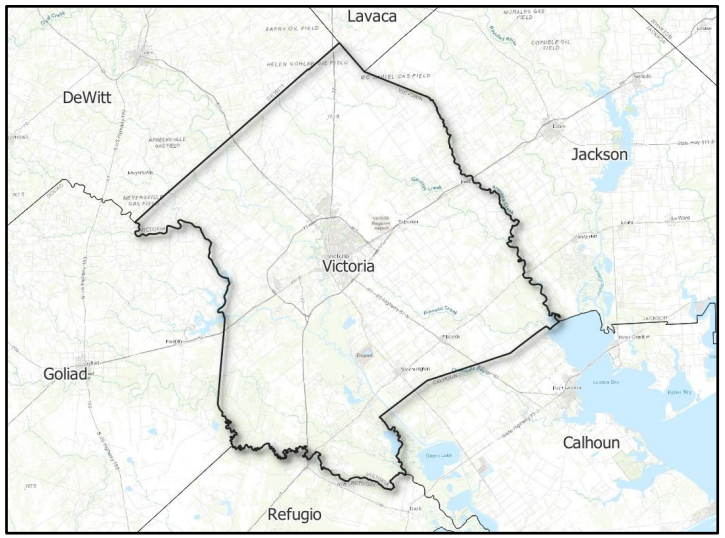



*Unit: AFY.

# Water Budget: Gulf Coast Aquifer – Chicot, Evangeline Outflows

Table 80: Victoria county Outflows (Units: Acre-Feet per Year)

| | Boundary Conditions | Pre-Dev. | 1981 | 1990 | 1991 | 2000 | 2010 | 2020 | 2080 |
|---|---|---|---|---|---|---|---|---|---|
| Chicot | Storage | 0.0 | 25355.34 | 1043.5 | 17758.31 | 45905.49 | 5500.09 | 875.39 | 0.0 |
| | Drains | 1634.95 | 250.61 | 97.66 | 116.57 | 973.36 | 1630.33 | 1646.44 | 1331.15 |
| | Et | 0.0 | 1251.82 | 592.29 | 580.58 | 775.75 | 985.19 | 999.33 | 845.16 |
| | Head Dep Bounds | 778.45 | 0.0 | 48.55 | 76.85 | 322.52 | 569.66 | 606.3 | 391.71 |
| | Stream Leakage | 37533.7 | 18884.76 | 15338.27 | 17367.62 | 17906.88 | 37406.31 | 37441.58 | 20878.0 |
| | Wells | 0.0 | 18599.17 | 11263.44 | 9520.58 | 4772.71 | 5977.59 | 8429.93 | 32146.81 |
| | Lavaca County | 755.75 | 694.73 | 458.1 | 453.26 | 696.77 | 789.91 | 852.15 | 704.22 |
| | Dewitt County | 44.33 | 37.91 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.84 |
| | Jackson County | 6837.83 | 9108.51 | 4455.47 | 5351.4 | 4362.7 | 6508.66 | 8487.72 | 7110.98 |
| | Goliad County | 673.07 | 677.3 | 468.27 | 495.33 | 554.81 | 771.31 | 773.2 | 608.81 |
| | Calhoun County | 7836.48 | 1359.23 | 2254.48 | 2231.01 | 3666.86 | 7714.91 | 7344.95 | 7628.7 |
| | Refugio County | 1529.42 | 1379.85 | 1136.32 | 1225.27 | 1313.66 | 1995.4 | 1950.71 | 1334.91 |
| | Evangeline Aquifer | 2130.52 | 14023.7 | 9871.74 | 9326.43 | 12660.51 | 6944.18 | 6380.22 | 16305.63 |
| Evangeline | Storage | 0.0 | 409.89 | 205.58 | 1362.56 | 595.12 | 0.04 | 0.0 | 0.0 |
| | Et | 0.0 | 21.3 | 18.17 | 18.91 | 25.93 | 26.78 | 27.05 | 25.8 |
| | Stream Leakage | 4715.6 | 2673.09 | 2242.66 | 2742.24 | 2799.62 | 3666.15 | 4022.44 | 1874.33 |
| | Wells | 0.0 | 21339.09 | 15609.14 | 14532.11 | 20042.52 | 9406.62 | 7306.44 | 27848.21 |
| | Lavaca County | 434.04 | 608.51 | 581.99 | 551.64 | 610.88 | 643.27 | 617.42 | 526.09 |
| | Jackson County | 882.33 | 3757.03 | 2887.11 | 2656.41 | 1394.42 | 1759.74 | 2947.41 | 2309.36 |
| | Goliad County | 773.15 | 653.47 | 717.74 | 596.44 | 857.47 | 864.72 | 885.14 | 788.98 |
| | Calhoun County | 854.17 | 442.2 | 375.35 | 400.34 | 282.78 | 660.05 | 543.61 | 6.39 |
| | Refugio County | 663.96 | 675.05 | 614.79 | 621.24 | 626.43 | 715.83 | 603.43 | 461.45 |
| | Chicot Aquifer | 4299.89 | 307.46 | 399.27 | 420.49 | 382.37 | 1348.94 | 1143.15 | 62.16 |
| | Burkeville Aquifer | 1.11 | 4.26 | 0.35 | 1.94 | 46.92 | 123.65 | 200.0 | 23.7 |

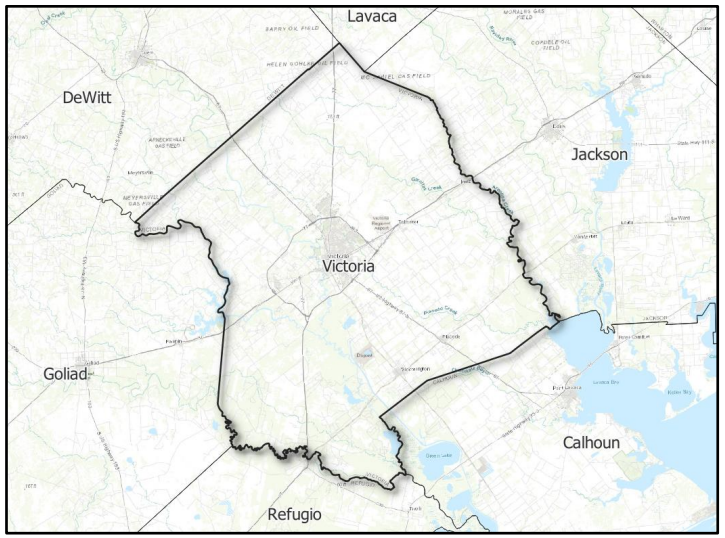



*Unit: AFY.

# Water Budget: Gulf Coast Aquifer – Chicot, Evangeline Net

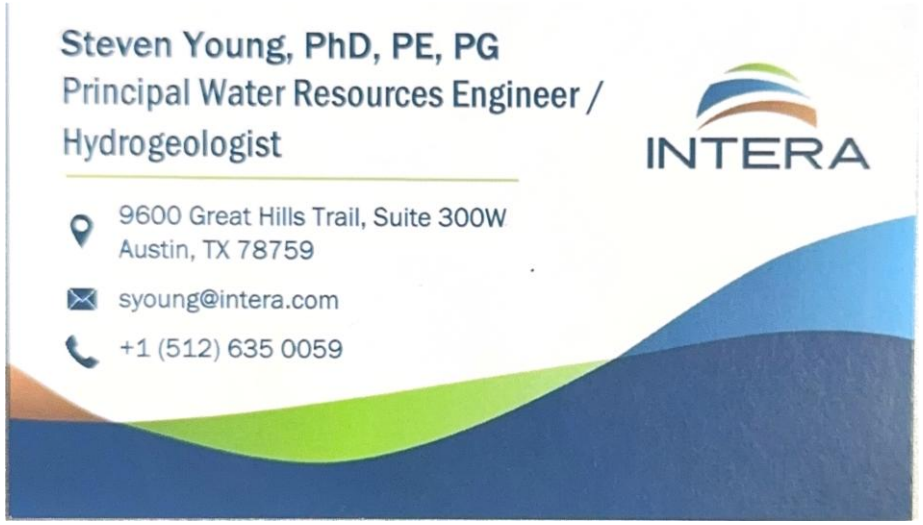
Table 81: Victoria county Nets (Units: Acre-Feet per Year)

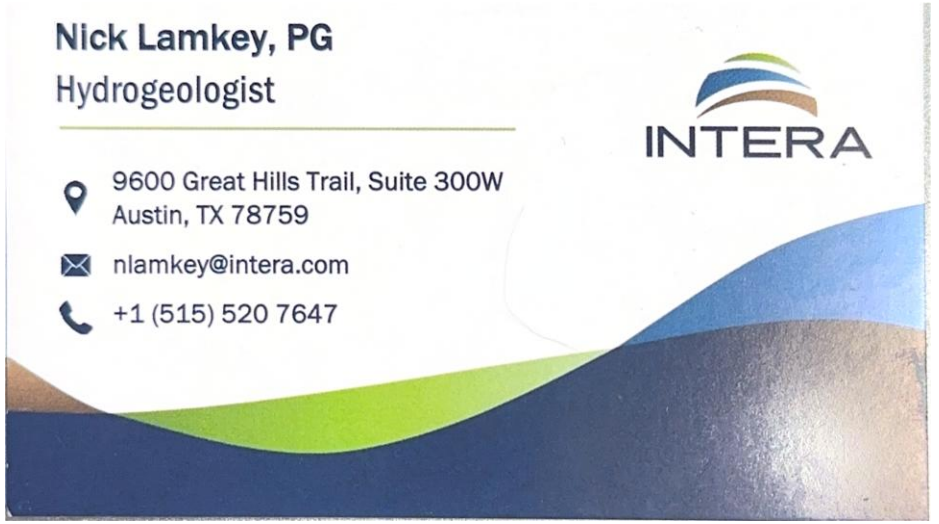
| | Boundary Conditions | Pre-Dev. | 1981 | 1990 | 1991 | 2000 | 2010 | 2020 | 2080 |
|---|---|---|---|---|---|---|---|---|---|
| Chicot | Storage | 0.0 | -24635.08 | 11758.73 | -17446.97 | -45838.51 | -5346.1 | -177.29 | 172.27 |
| | Drains | -1634.95 | -250.61 | -97.66 | -116.57 | -973.36 | -1630.33 | -1646.44 | -1331.15 |
| | River Leakage | 0.0 | 1053.38 | 1055.79 | 1055.79 | 1055.79 | 1044.3 | 1048.75 | 1055.79 |
| | Et | 0.0 | -1251.82 | -592.29 | -580.58 | -775.75 | -985.19 | -999.33 | -845.16 |
| | Head Dep Bounds | -778.45 | 374.63 | -48.55 | -76.85 | -322.52 | -569.66 | -606.3 | -391.71 |
| | Recharge | 7579.37 | 30511.28 | 19717.49 | 34363.59 | 24815.13 | 24815.13 | 24815.13 | 24815.13 |
| | Stream Leakage | 2859.58 | 32102.82 | -8102.37 | 4776.1 | 42345.24 | 4093.35 | 2852.11 | 34120.49 |
| | Wells | 0.0 | -18599.17 | -11263.44 | -9520.58 | -4772.71 | -5977.59 | -8429.93 | -32146.81 |
| | Lavaca County | -462.72 | -346.29 | -120.98 | -130.13 | -346.33 | -473.69 | -537.85 | -344.11 |
| | Dewitt County | 1087.93 | 1459.71 | 1457.65 | 1843.12 | 1469.88 | 1281.28 | 1238.47 | 1429.44 |
| | Jackson County | -5445.65 | -7447.29 | -3511.67 | -4419.14 | -1853.37 | -4960.73 | -7115.4 | -5662.4 |
| | Goliad County | 82.42 | 381.39 | 588.44 | 592.27 | 463.49 | 294.51 | 282.29 | 423.78 |
| | Calhoun County | -4980.24 | 657.07 | -1330.88 | -1267.55 | -2778.8 | -5025.54 | -4573.41 | -5034.78 |
| | Refugio County | -476.67 | -293.57 | -37.65 | -166.45 | -189.16 | -963.76 | -911.68 | -17.32 |
| | Evangeline Aquifer | 2169.37 | -13716.24 | -9472.47 | -8905.94 | -12278.15 | -5595.25 | -5237.07 | -16243.47 |
| Evangeline | Storage | 0.0 | -392.88 | 247.56 | -1362.56 | -562.42 | 357.24 | 194.75 | 9.55 |
| | Et | 0.0 | -21.3 | -18.17 | -18.91 | -25.93 | -26.78 | -27.05 | -25.8 |
| | Recharge | 552.59 | 677.23 | 511.48 | 1055.6 | 742.1 | 742.1 | 742.1 | 742.1 |
| | Stream Leakage | -3464.29 | -932.82 | -1719.3 | -1190.86 | -290.06 | -1859.28 | -2408.14 | 705.46 |
| | Wells | 0.0 | -21339.09 | -15609.14 | -14532.11 | -20042.52 | -9406.62 | -7306.44 | -27848.21 |
| | Lavaca County | -296.44 | -323.68 | -362.15 | -323.92 | -383.09 | -446.18 | -440.97 | -292.78 |
| | Dewitt County | 3817.18 | 5728.28 | 4671.75 | 4795.13 | 4712.35 | 4370.07 | 4241.02 | 5230.66 |
| | Jackson County | -335.12 | -3049.93 | -2346.83 | -2091.55 | -847.14 | -1264.64 | -2390.74 | -1684.02 |
| | Goliad County | 2322.61 | 3446.22 | 3581.32 | 3433.4 | 3085.98 | 2444.88 | 2257.3 | 3558.64 |
| | Calhoun County | -829.66 | 11.87 | -130.49 | -165.48 | 62.47 | -529.67 | -358.61 | 829.81 |
| | Refugio County | -163.42 | 306.47 | 213.08 | 199.9 | 197.56 | -124.58 | 239.55 | 1517.27 |
| | Chicot Aquifer | -2169.37 | 13716.24 | 9472.47 | 8905.94 | 12278.15 | 5595.25 | 5237.07 | 16243.47 |
| | Burkeville Aquifer | 565.92 | 2173.4 | 1488.44 | 1295.45 | 1074.31 | 148.9 | 18.35 | 1013.98 |




*Unit: AFY.

# Questions?


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# F.4 Environmental Impacts

# GMA 15
# Environmental Impacts

Groundwater Management Area 15

October 9, 2025

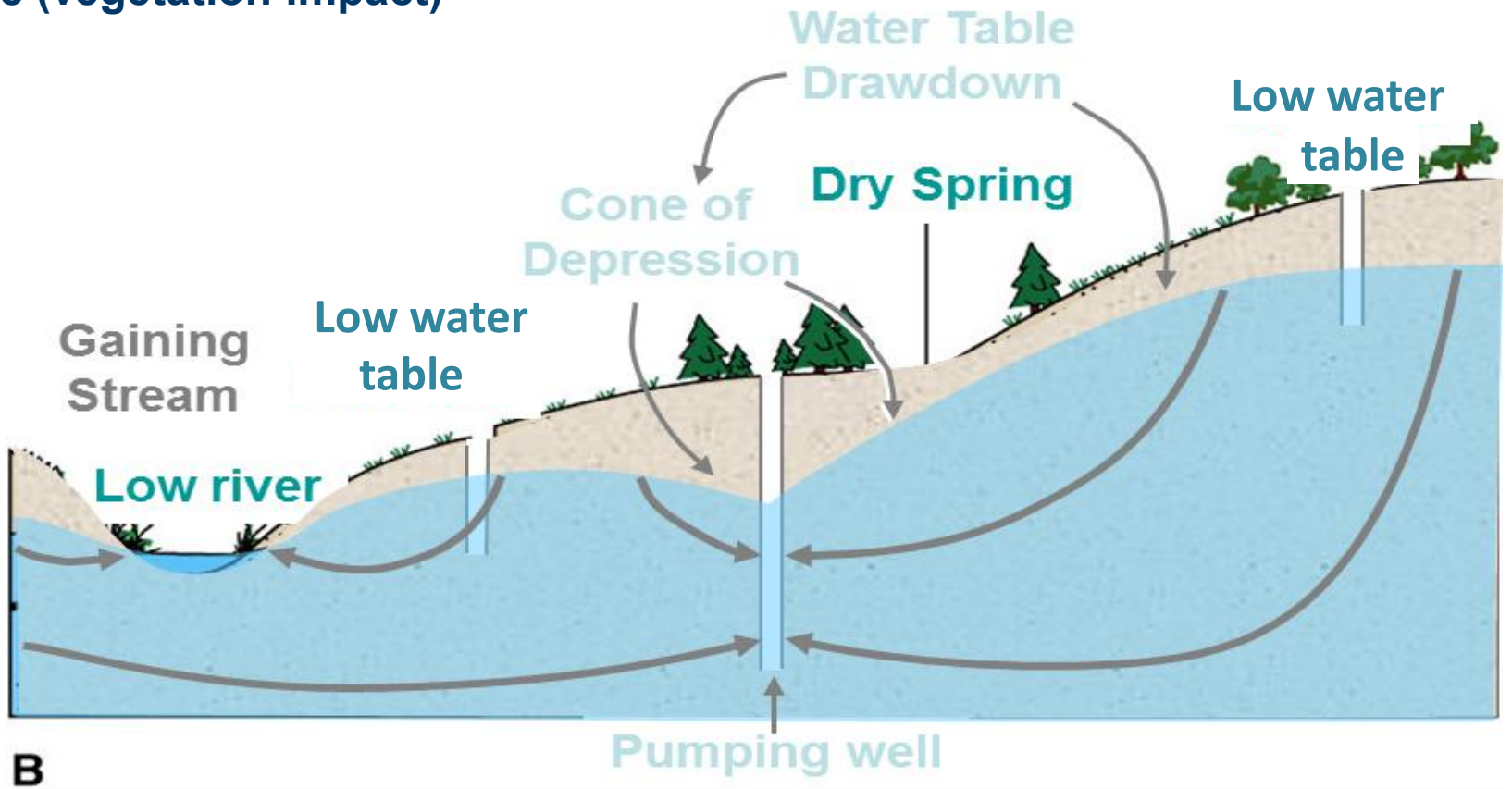



Presented by:
Nick Lamkey PG
Steven Young Ph.D, PE, PG

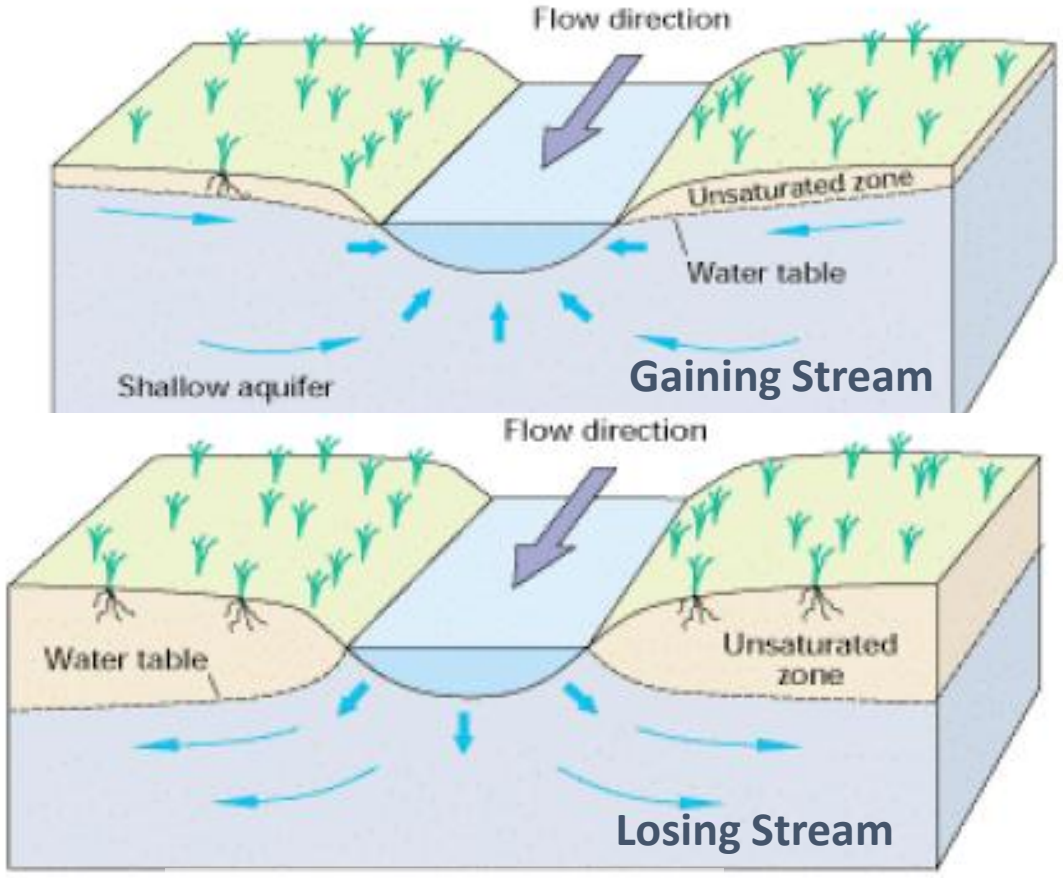
# Impacts Associated with Pumping

- **Reduced flows to rivers**
- **Withdrawal from rivers (losing streams)**
- **Reduced spring flows**
- **Dried springs**
- **Lowered water table (vegetation impact)**

Caused by lower of water levels



# Gaining and Losing Streams

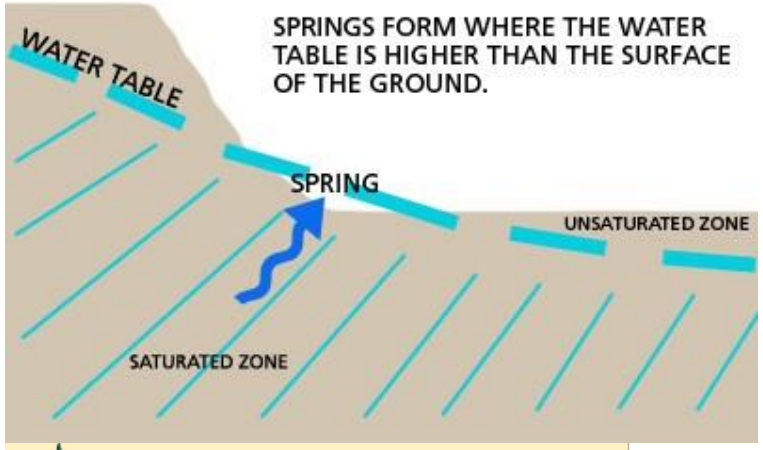


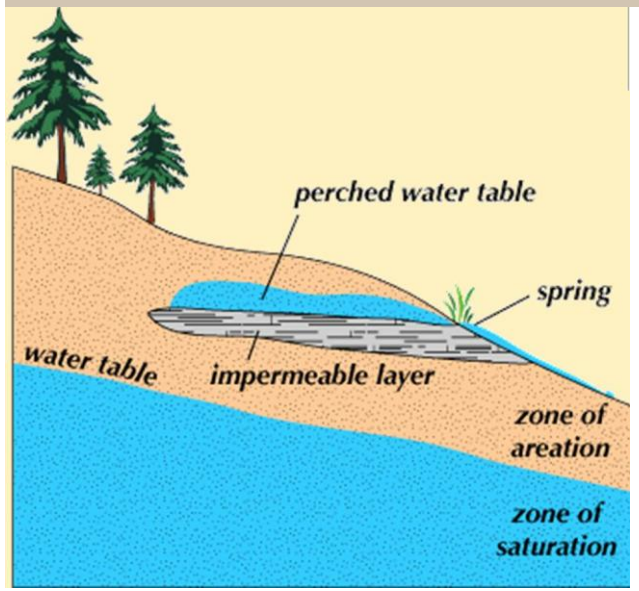

USGS Circular 1186, 1999

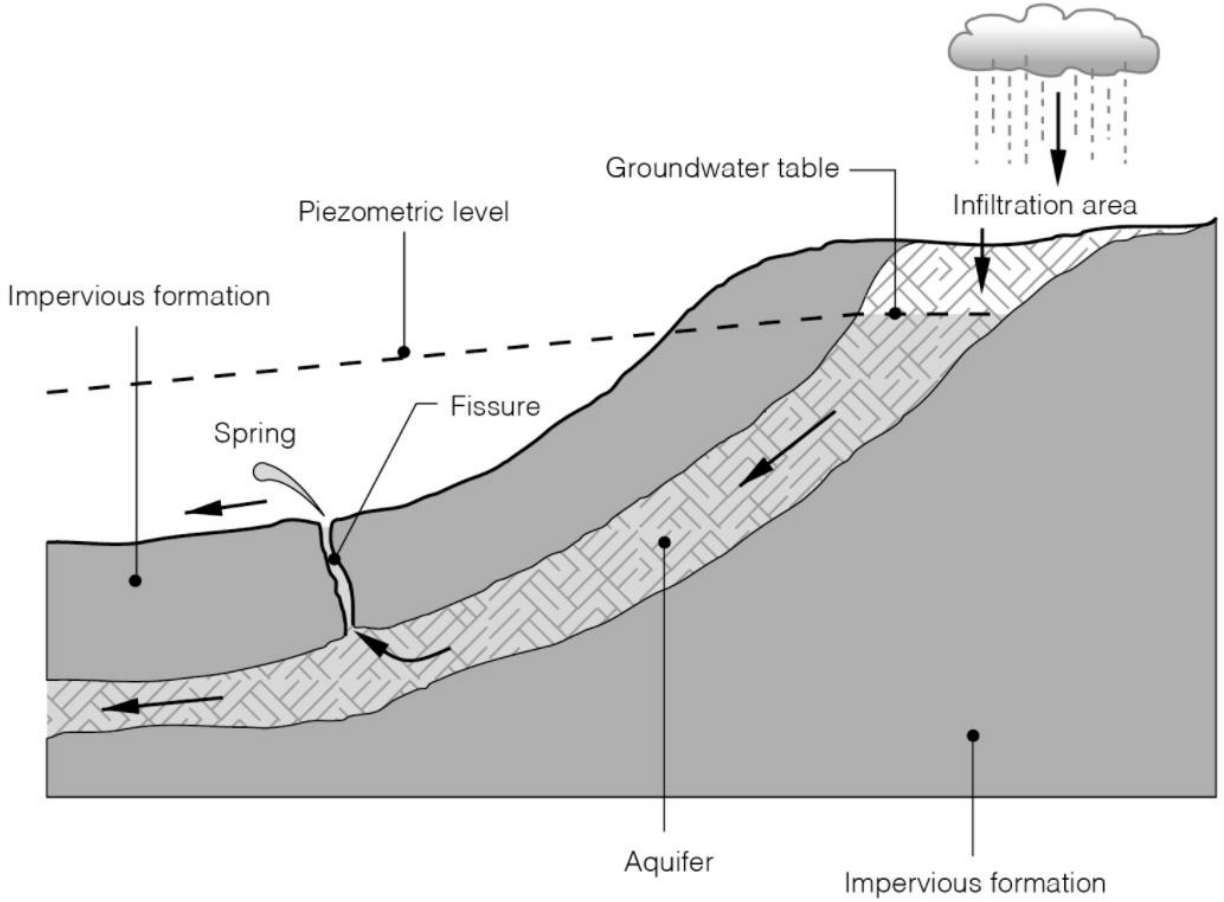
- Gaining:
  - Net discharge of groundwater to surface water "baseflow"
- Losing:
  - Net discharge of surface water to groundwater "recharge"

The TCEQ rules define baseflow as "*[t]he portion of streamflow uninfluenced by recent rainfall or flood runoff and is comprised of springflow, seepage, discharge from artesian wells or other groundwater sources, and the delayed drainage of large lakes and swamps.*

# Springs

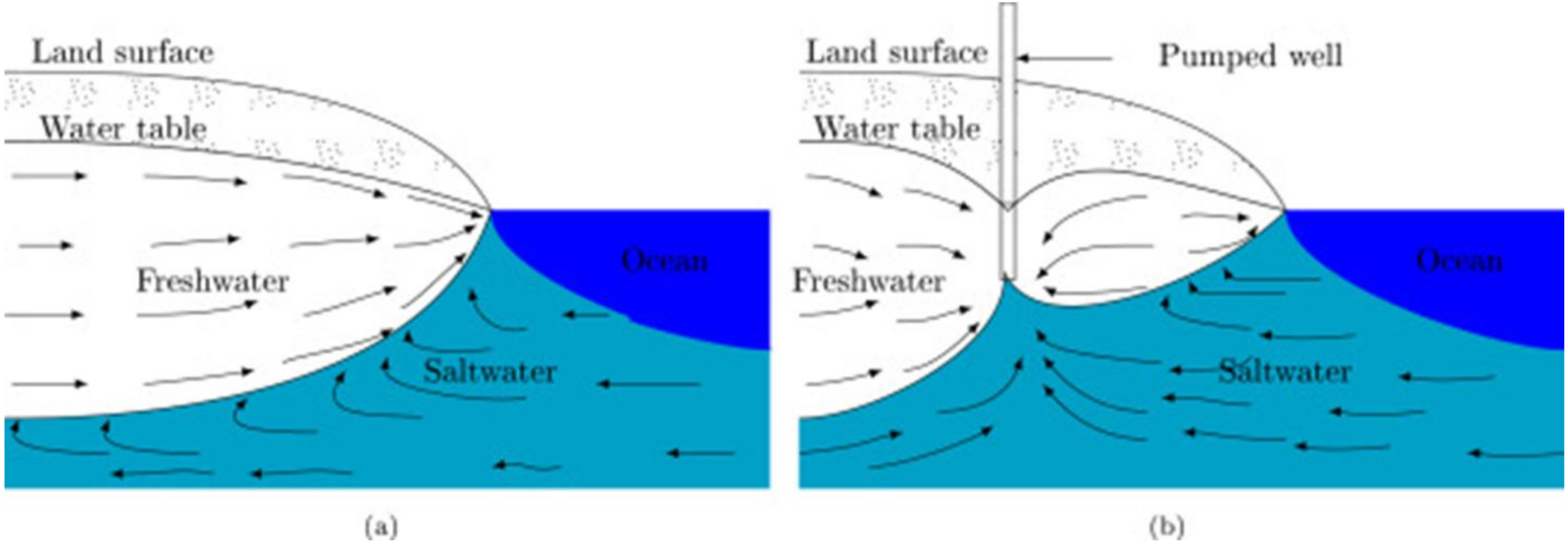



https://www.nps.gov/thro/learn/nature/springs.htm

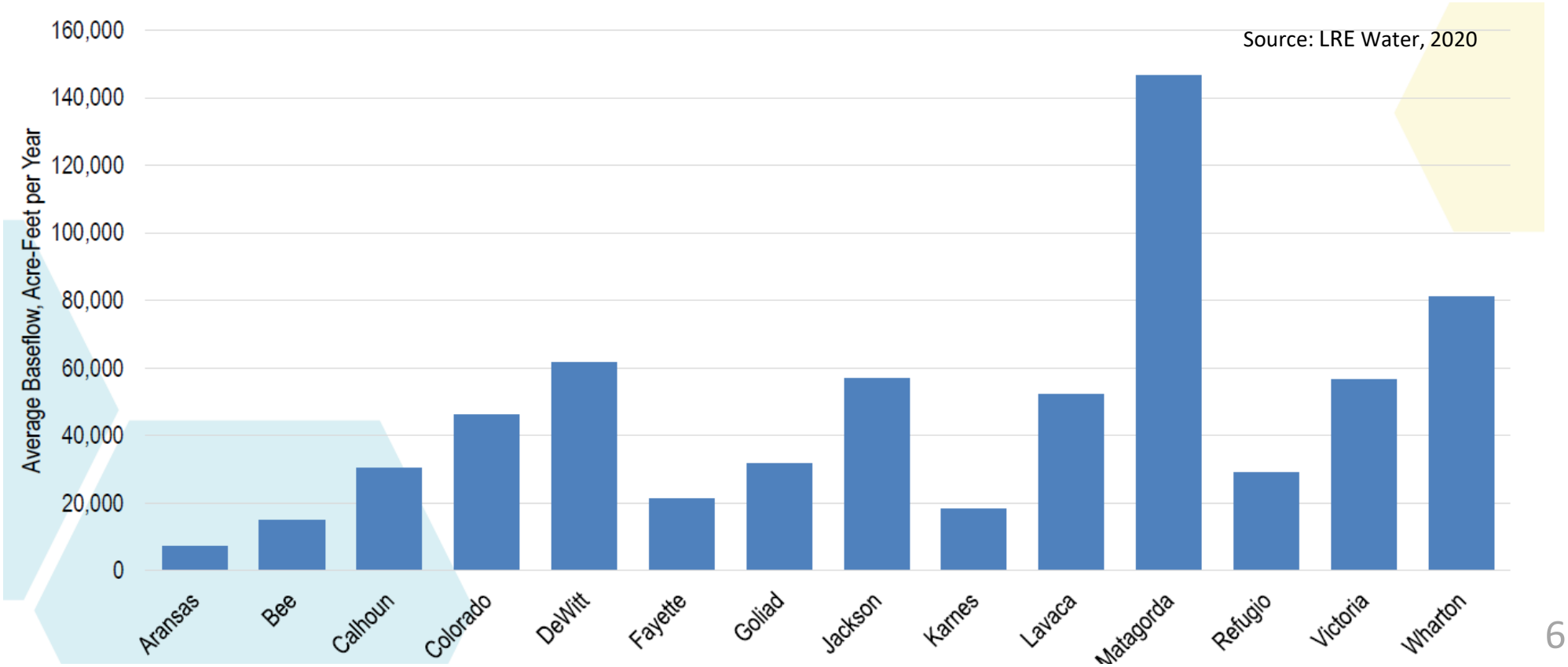
# Sea Water Intrusion



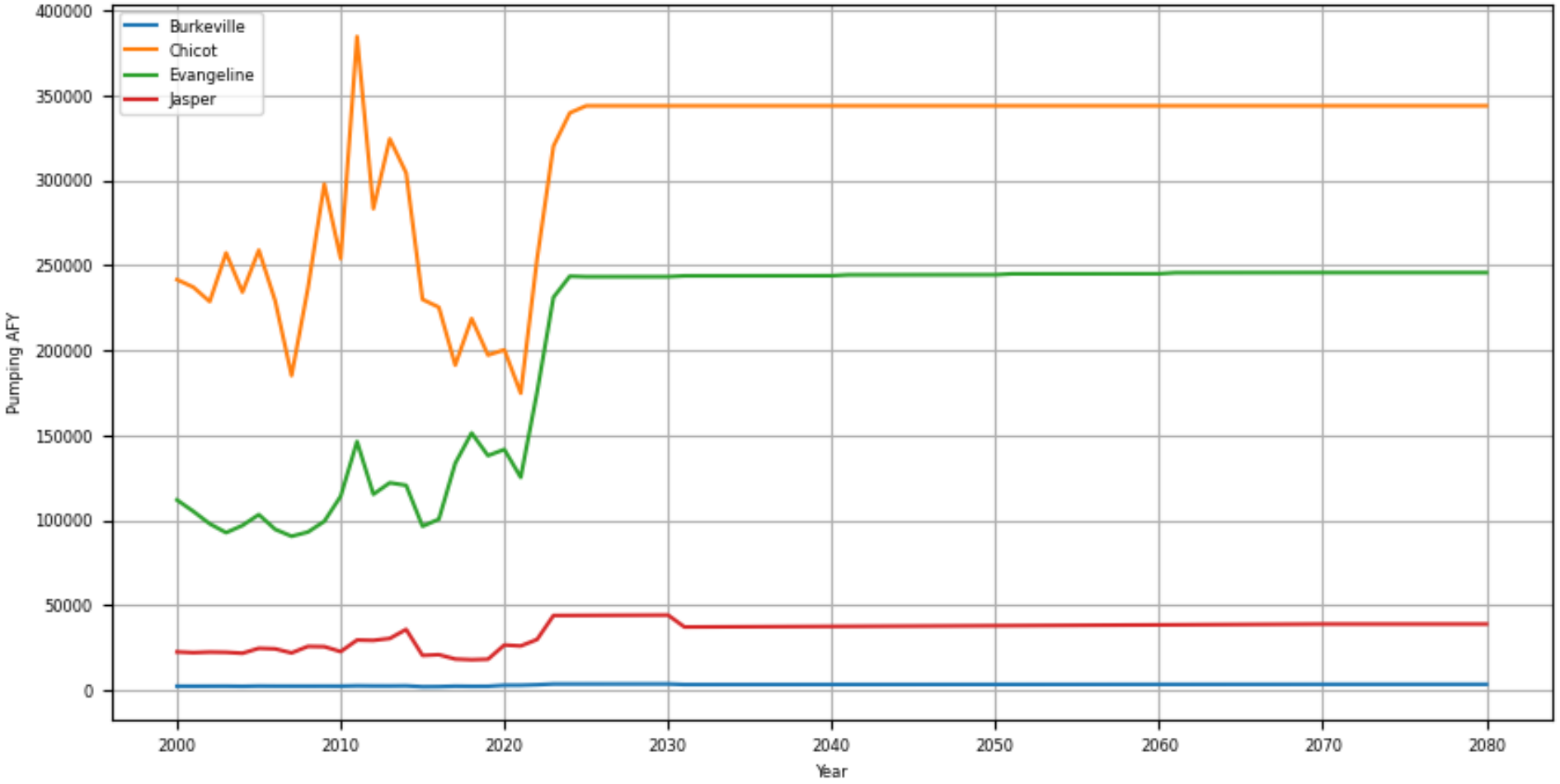

https://www.sciencedirect.com/science/article/abs/pii/S0378475418301538

# Surface Water – Groundwater Exchange

- Average Baseflow from TWDB 2016 Study used USGS Stream gage data to assess contribution of groundwater to stream baseflow



# Current Pumping



# Surface Water – Groundwater Exchange

- Table to interpret Water Budgets and tables

| Component | Sign convention in model output | Positive % change means… | Negative % change means… |
|---|---|---|---|
| **Recharge** | Positive = flow *into* the aquifer | More recharge in 2080 (gain) | Less recharge in 2080 (loss) |
| **Stream** | Positive = flow *from* streams *into* aquifer (gain) | More stream inflow or less stream leakage | Less inflow or more leakage to streams |
| **Lateral** | Sign can vary by boundary | Larger inflow or smaller outflow laterally | Smaller inflow or larger outflow laterally |
| **Vertical** | Positive = inflow from overlying or underlying aquifers | Increased vertical inflow from other aquifers | Decreased inflow or increased leakage to other aquifers |
| **Storage** | Negative = aquifer releasing water (depletion) | System losing less water to storage (less depletion) | System losing more water to storage (greater depletion) |
| **Wells** | Negative = pumping (outflow) | Pumping *decreased* (less extraction) | Pumping *increased* (more extraction) |
| **Ocean/Lake** | Positive = flow into aquifer | More inflow from boundaries | More discharge to boundaries |
| **Spring/Wetland** | Positive = discharge from aquifer | Greater spring discharge (larger outflow) | Reduced spring discharge |

# Surface Water – Groundwater Exchange

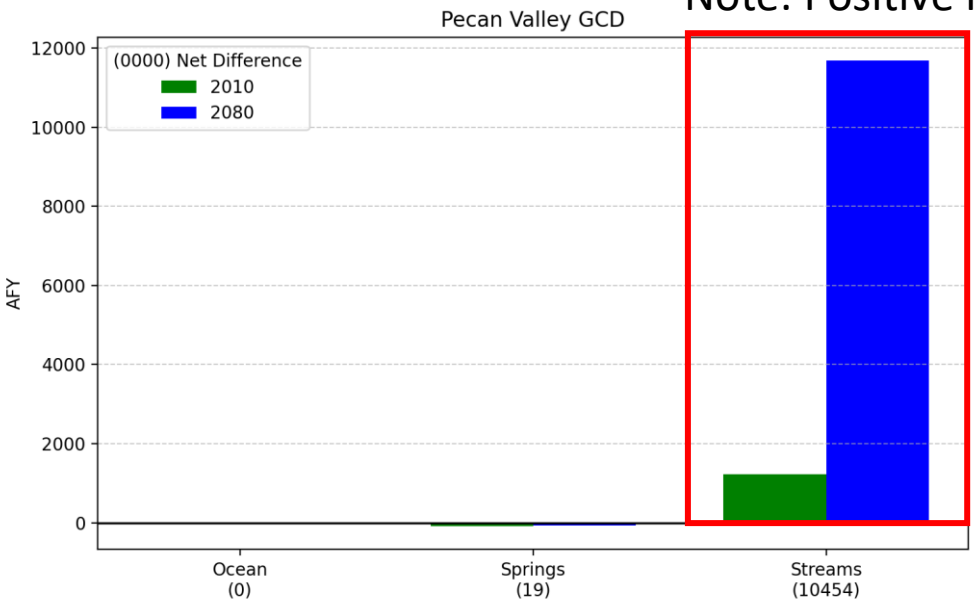
- Table of percent change in net flow from 2010 to 2080

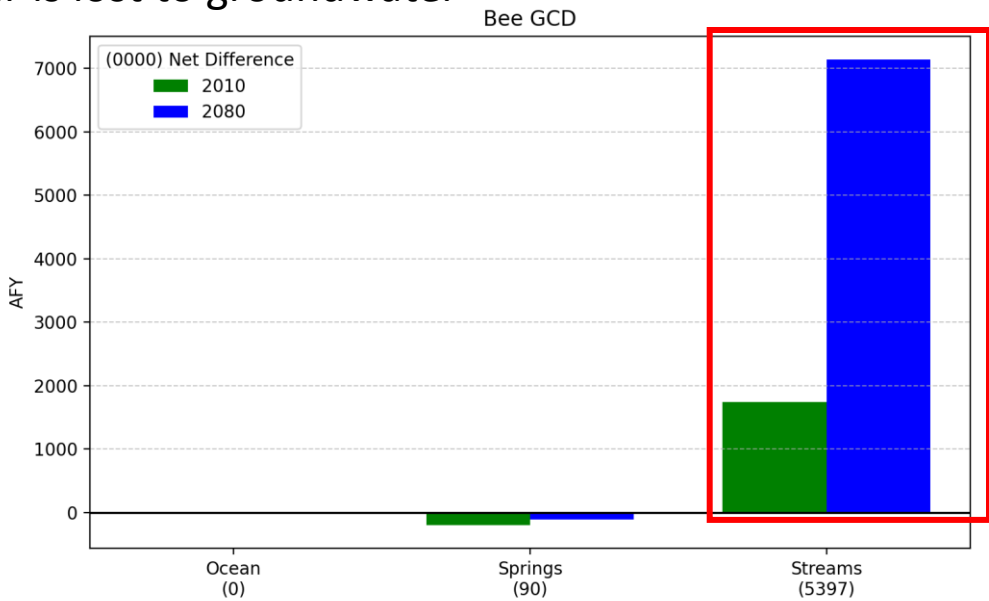
| | Percentage change in Net Flow from 2010 to 2080 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Other Budget Terms | | | | | GW-SW Interactions | | |
| County | Storage | Recharge | Lateral | Vertical | Wells | Ocean/Lake | Spring/Wetland | Stream |
| Aransas | 102 | 0 | -5 | 0 | -96 | 21 | 1 | 2 |
| Austin | -40 | 0 | -135 | -296 | 0 | 0 | 0 | 140 |
| Bee | 319 | 0 | 22 | 0 | -183 | 0 | 46 | 310 |
| Brazoria | 204 | 0 | -47 | -264 | 0 | 18 | 6 | 2 |
| Brooks | 69 | 0 | -2 | -50 | -1 | 0 | 0 | 0 |
| Calhoun | 101 | 0 | -21 | -124 | -334 | 51 | 7 | -4 |
| Colorado | -67 | 0 | -26 | 2 | -36 | 0 | 28 | 175 |
| DeWitt | 95 | 0 | 7 | 0 | -297 | 0 | 23 | 850 |
| Duval | -66 | 0 | 5 | 0 | 0 | 0 | 27 | 0 |
| Fayette | 80 | 0 | 58 | 0 | -222 | 0 | 45 | 619 |
| Fort Bend | 202 | 0 | -25 | -1,167 | -24 | 0 | 46 | 758 |
| Goliad | 236 | 0 | -19 | -100 | -30 | 0 | 10 | 57 |
| Gonzales | 3 | 0 | -36 | 0 | -13 | 0 | 47 | 0 |
| Jackson | 382 | 0 | -4 | 700 | -80 | 405 | 35 | 223 |
| Jim Hogg | 66 | 0 | -6 | 0 | 0 | 0 | 0 | 0 |
| Jim Wells | -37 | 0 | -6 | -100 | 0 | 0 | 1 | 0 |
| Karnes | -37 | 0 | -76 | 0 | 14 | 0 | 73 | 205 |
| Kenedy | 105 | 0 | -3 | 0 | 0 | -2 | 0 | 0 |
| Kleberg | -53 | 0 | 3 | 400 | 8 | 1 | 0 | 4 |
| Lavaca | 199 | 0 | -75 | 300 | -117 | 0 | 0 | 2,687 |
| Live Oak | -6 | 0 | -43 | -100 | 0 | 0 | 37 | -1 |
| Matagorda | 6 | 0 | -224 | -16,540 | -74 | 13 | 6 | 117 |
| McMullen | -40 | 0 | -24 | 0 | 0 | 0 | 26 | 21 |
| Nueces | -73 | 0 | -96 | -200 | 0 | 2 | 3 | 33 |
| Refugio | 131 | 0 | -52 | 115 | -175 | 5 | 3 | 0 |
| San Patricio | -75 | 0 | 2 | -200 | 2 | 18 | 20 | 10 |
| Victoria | 112 | 0 | 124 | -650 | -290 | 29 | 16 | 735 |
| Washington | 43 | 0 | -60 | 0 | 0 | 0 | 0 | 0 |
| Webb | 100 | 0 | -5 | 0 | 0 | 0 | 0 | 0 |
| Wharton | 279 | 0 | 239 | -900 | -38 | 0 | 22 | 16 |

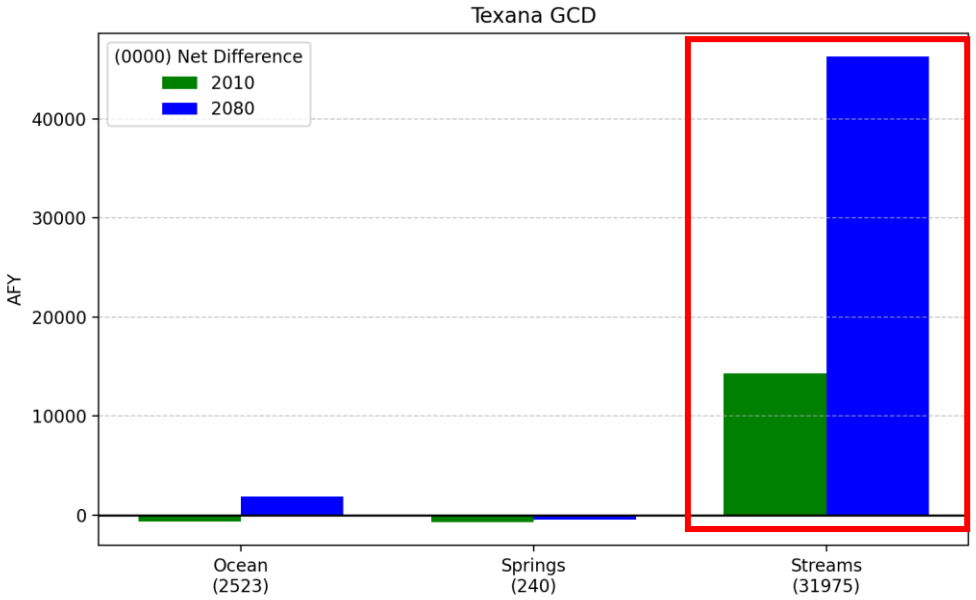
INTERA

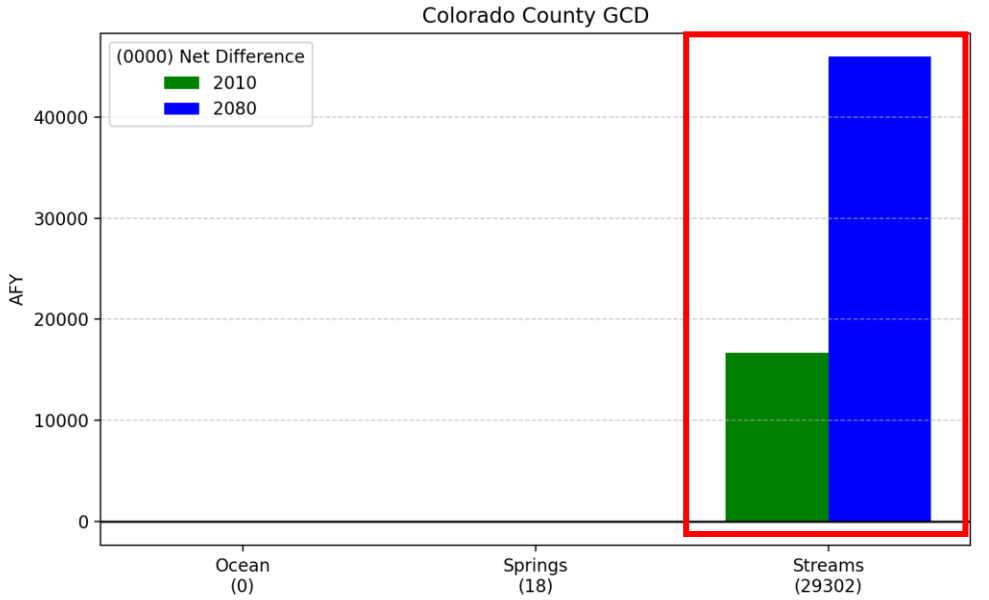
# Surface-Water Groundwater Exchange

Note: Positive numbers indicate surface water is lost to groundwater

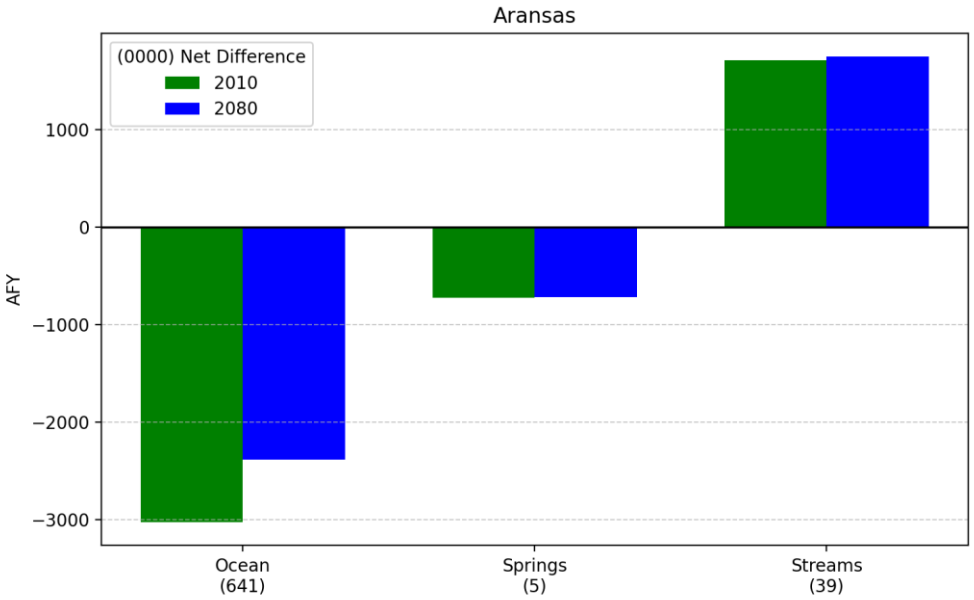


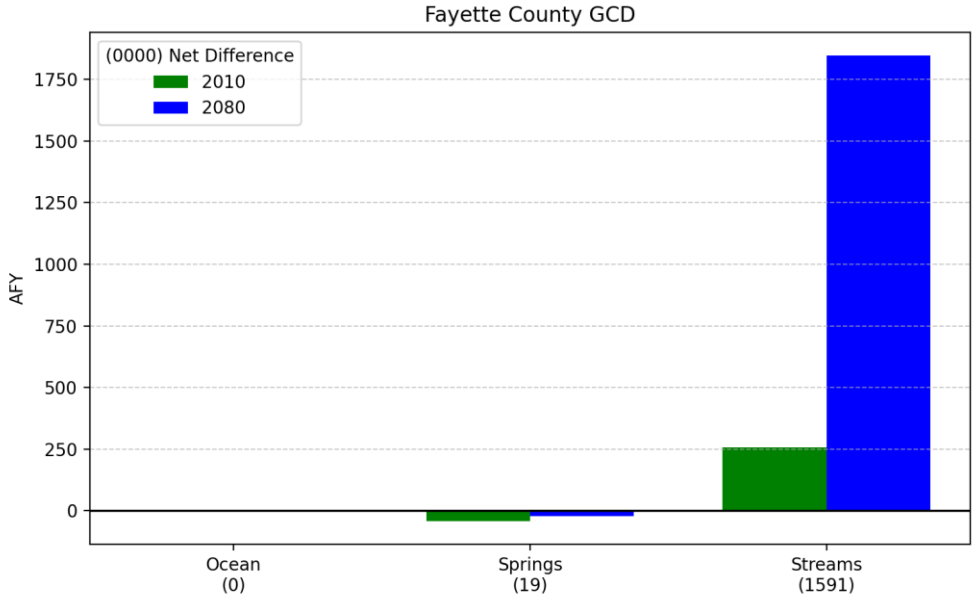



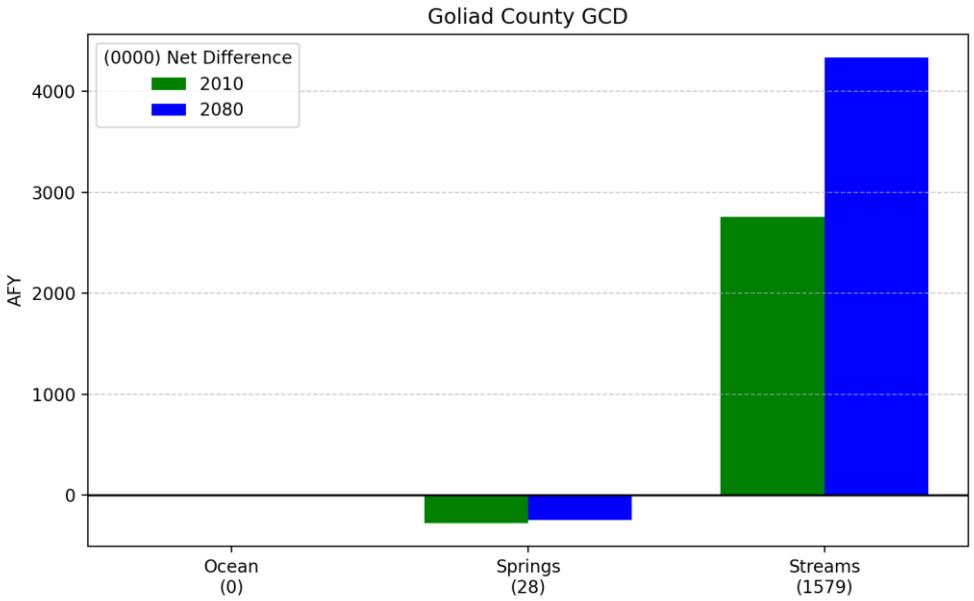



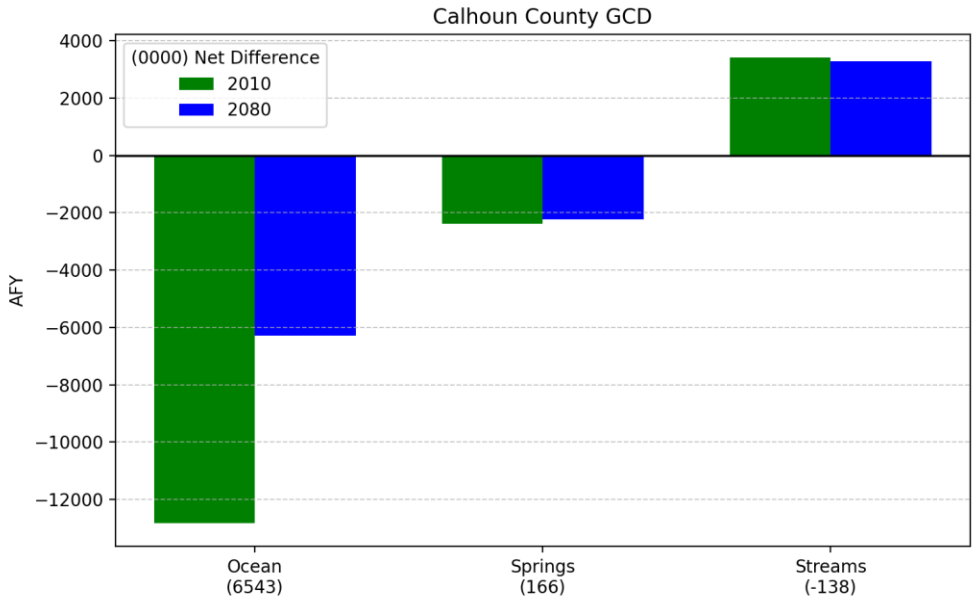



# Surface-Water Groundwater Exchange

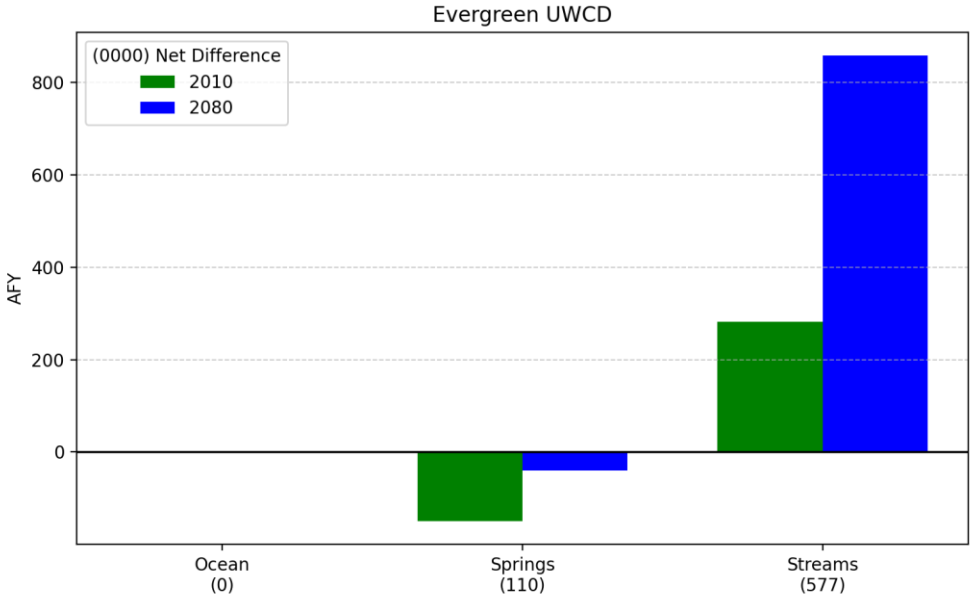


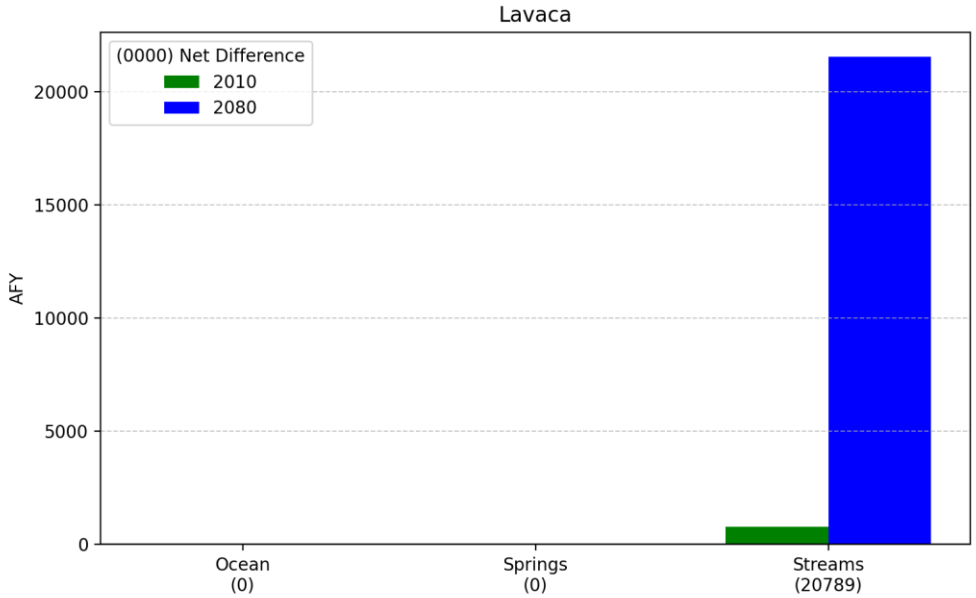



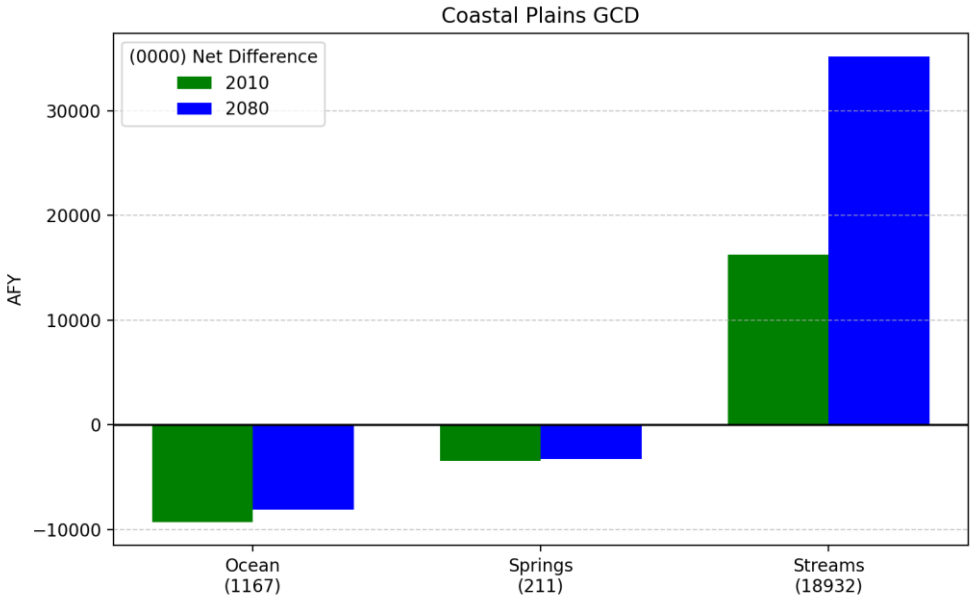



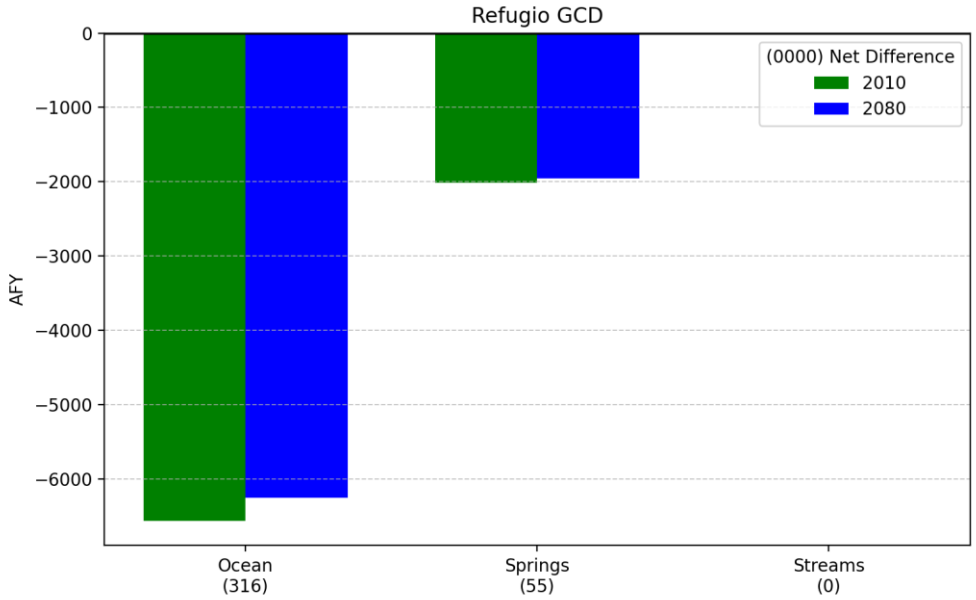



# Surface-Water Groundwater Exchange

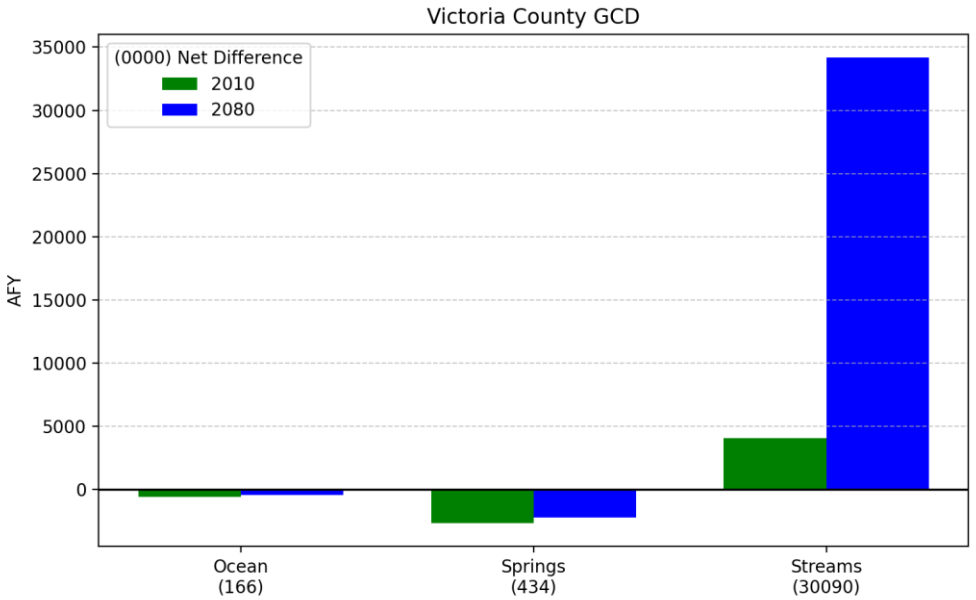


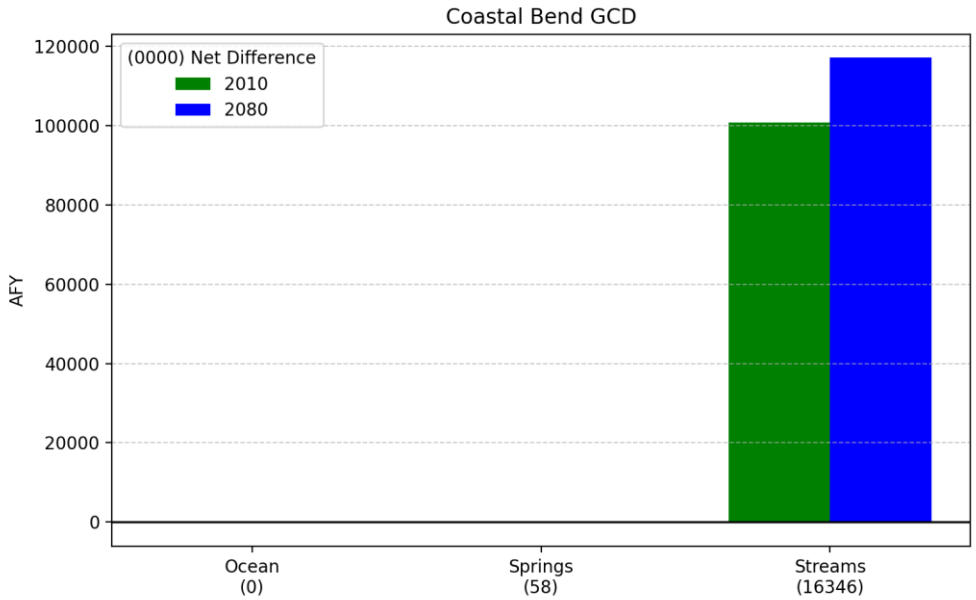



# Surface-Water Groundwater Exchange



# DeWitt County Budget

| Aquifer | Storage | Recharge | Surface Water – Groundwater Interaction | | | Groundwater Flow | | Wells |
|---|---|---|---|---|---|---|---|---|
| | | | Ocean/ Lake | Stream | Spring/ Wetlands | Lateral | Vertical | |
| **2000** | | | | | | | | |
| Chicot | -12.88 | 4566.67 | 0 | 1223.87 | -20.8 | -1668 | -3990.11 | -98.73 |
| Evangeline | -1349.87 | 5769.47 | 0 | 532.91 | -59.14 | -6072.58 | 2191.7 | -1011.61 |
| Burkeville | -22.23 | 15.1 | 0 | 287.7 | 0 | -37.4 | -74.55 | -168.57 |
| Jasper | 1386.45 | 242.44 | 0 | 161.32 | 0 | -532.35 | 1872.96 | -3130.77 |
| Total | 1.47 | 10593.68 | 0 | 2205.8 | -79.94 | -8310.33 | -2.27 | -4409.68 |
| **2010** | | | | | | | | |
| Chicot | 0.27 | 4566.67 | 0 | 905.41 | -24.17 | -1496.58 | -3842.51 | -109.06 |
| Evangeline | 18.42 | 5769.47 | 0 | 0 | -60.41 | -5782.63 | 1895.03 | -1120.55 |
| Burkeville | 161.79 | 15.08 | 0 | 324.25 | 0 | -38.55 | -284.02 | -178.56 |
| Jasper | 1412.63 | 242.46 | 0 | 0 | 0 | -803.22 | 2231.5 | -3072.76 |
| Total | 1593.11 | 10593.68 | 0 | 1229.66 | -84.59 | -8120.98 | 0 | -4480.93 |
| **2020** | | | | | | | | |
| Chicot | 2.34 | 4566.67 | 0 | 1049.99 | -22.65 | -1452.8 | -3831.83 | -311.64 |
| Evangeline | 399.21 | 5769.47 | 0 | 0 | -59.42 | -5677.9 | 1610.51 | -2024.38 |
| Burkeville | 150.21 | 15.05 | 0 | 357.27 | 0 | -36.27 | -382.65 | -103.59 |
| Jasper | 1423.8 | 242.49 | 0 | 590.71 | 0 | -586.77 | 2603.97 | -4273.38 |
| Total | 1975.56 | 10593.68 | 0 | 1997.97 | -82.07 | -7753.74 | 0 | -6712.99 |
| **2080** | | | | | | | | |
| Chicot | 0.63 | 4566.67 | 0 | 2291.59 | -9.55 | -1597.1 | -4416.74 | -835.5 |
| Evangeline | 57.99 | 5756.55 | 0 | 4849.82 | -55.83 | -6110.49 | 879.53 | -5377.54 |
| Burkeville | 109.44 | 26.28 | 0 | 604.82 | 0 | -34.26 | -575.25 | -131.06 |
| Jasper | 2941.1 | 244.18 | 0 | 3937.91 | 0 | 200.04 | 4112.46 | -11436.1 |
| Total | 3109.16 | 10593.68 | 0 | 11684.14 | -65.38 | -7541.81 | 0 | -17780.2 |

INTERA

# Jackson County Budget

| Aquifer | Storage | Recharge | Surface Water – Groundwater Interaction | | | Groundwater Flow | | Wells |
|---|---|---|---|---|---|---|---|---|
| | | | Ocean/ Lake | Stream | Spring/ Wetlands | Lateral | Vertical | |
| **2000** | | | | | | | | |
| Chicot | 7138.09 | 11752.2 | -1656.39 | 18457.42 | -743.21 | 3095.92 | -10020.7 | -32097.8 |
| Evangeline | -4759.61 | 0 | 0 | 0 | 0 | 9004.26 | 10598.37 | -14833.9 |
| Burkeville | -63.04 | 0 | 0 | 0 | 0 | 24.76 | 38.28 | 0 |
| Jasper | 448.36 | 0 | 0 | 0 | 0 | 167.55 | -615.91 | 0 |
| Total | 2763.80 | 11752.2 | -1656.39 | 18457.42 | -743.21 | 12292.49 | -7.96 | -46931.7 |
| **2010** | | | | | | | | |
| Chicot | 623.98 | 11752.2 | -622.65 | 14332.93 | -694.94 | 6867.70 | -3152.42 | -33194.3 |
| Evangeline | 88.15 | 0 | 0 | 0 | 0 | 9040.35 | 3197.46 | -12327.9 |
| Burkeville | -445.83 | 0 | 0 | 0 | 0 | 25.8 | 420.03 | 0 |
| Jasper | 281.18 | 0 | 0 | 0 | 0 | 183.86 | -465.07 | 0 |
| Total | 547.48 | 11752.2 | -622.65 | 14332.93 | -694.94 | 16117.71 | -5.68 | -45522.2 |
| **2020** | | | | | | | | |
| Chicot | -3679.61 | 11752.2 | -420.87 | 28172.85 | -634.5 | 10453.61 | -7483.29 | -42287.5 |
| Evangeline | 134.19 | 0 | 0 | 0 | 0 | 7567.86 | 7985.8 | -15691.5 |
| Burkeville | 79.74 | 0 | 0 | 0 | 0 | 25.93 | -105.68 | 0 |
| Jasper | 225.17 | 0 | 0 | 0 | 0 | 171.5 | -396.83 | 0 |
| Total | -3240.51 | 11752.2 | -420.87 | 28172.85 | -634.5 | 18218.9 | 2.27 | -57979 |
| **2080** | | | | | | | | |
| Chicot | 1688.92 | 11752.2 | 1900.4 | 46307.88 | -454.72 | 13210.58 | -12419.6 | -66168.2 |
| Evangeline | 43.38 | 0 | 0 | 0 | 0 | 2241.41 | 13424.19 | -15713.8 |
| Burkeville | 637.09 | 0 | 0 | 0 | 0 | 14.42 | -651.49 | 0 |
| Jasper | 267.12 | 0 | 0 | 0 | 0 | 85.7 | -353.11 | 0 |
| Total | 2636.51 | 11752.2 | 1900.4 | 46307.88 | -454.72 | 15552.11 | 3.41 | -81882 |

INTERA

# Bee County Budget

| Aquifer | Storage | Recharge | Surface Water – Groundwater Interaction | | | Groundwater Flow | | Wells |
|---|---|---|---|---|---|---|---|---|
| | | | Ocean/ Lake | Stream | Spring/ Wetlands | Lateral | Vertical | |
| **2000** | | | | | | | | |
| Chicot | -4179.31 | 18909.56 | 0 | 0 | -165.95 | -8387.49 | -4019.86 | -429.63 |
| Evangeline | -2385.62 | 5001.57 | 0 | 2658.42 | -0.8 | -4887.91 | 3297.57 | -3681.9 |
| Burkeville | 449.7 | 1.41 | 0 | 81.52 | 0 | -61.05 | -137.71 | -333.88 |
| Jasper | 602.31 | 23.47 | 0 | 0 | 0 | -113.99 | 860 | -1248.55 |
| Total | -5512.92 | 23936.01 | 0 | 2739.94 | -166.75 | -13450.4 | 0 | -5693.96 |
| **2010** | | | | | | | | |
| Chicot | 177.25 | 18909.56 | 0 | 0 | -195.96 | -8875.89 | -5297.19 | -475.54 |
| Evangeline | -9.99 | 5001.57 | 0 | 1660.29 | -0.94 | -4894.16 | 4160.81 | -5917.09 |
| Burkeville | 96.71 | 1.41 | 0 | 80.62 | 0 | -61.26 | 99.94 | -217.44 |
| Jasper | 127.49 | 23.47 | 0 | 0 | 0 | 22.81 | 1036.44 | -1095.99 |
| Total | 391.46 | 23936.01 | 0 | 1740.91 | -196.9 | -13808.5 | 0 | -7706.06 |
| **2020** | | | | | | | | |
| Chicot | 133.77 | 18909.56 | 0 | 0 | -197.03 | -9009.12 | -4009.49 | -1779.16 |
| Evangeline | -603.29 | 5001.57 | 0 | 653.99 | -2.62 | -5536.58 | 2736.16 | -2249.42 |
| Burkeville | -292.43 | 1.41 | 0 | 84.36 | 0 | -66.87 | 288.2 | -14.65 |
| Jasper | -641.02 | 23.47 | 0 | 0 | 0 | -171.12 | 985.13 | -87.77 |
| Total | -1402.97 | 23936.01 | 0 | 738.35 | -199.66 | -14783.7 | 0 | -4131 |
| **2080** | | | | | | | | |
| Chicot | 738.18 | 18813.78 | 0 | 2143.38 | -107.19 | -7093.15 | -5550.3 | -8944.85 |
| Evangeline | 259.64 | 5073.21 | 0 | 4819.87 | -0.09 | -3287.77 | 5449.74 | -12314.5 |
| Burkeville | 310.44 | 25.55 | 0 | 96.77 | 0 | -69.14 | -283.07 | -80.53 |
| Jasper | 332.15 | 23.47 | 0 | 78.26 | 0 | -329.47 | 383.63 | -488.48 |
| Total | 1640.41 | 23936.01 | 0 | 7138.28 | -107.28 | -10779.5 | 0 | -21828.4 |

INTERA

# Aransas County Budget

| Aquifer | Storage | Recharge | Surface Water – Groundwater Interaction | | | Groundwater Flow | | Wells |
|---|---|---|---|---|---|---|---|---|
| | | | Ocean/ Lake | Stream | Spring/ Wetlands | Lateral | Vertical | |
| **2000** | | | | | | | | |
| Chicot | -798.22 | 104.42 | -2676.82 | 2009.22 | -718.01 | 2661.47 | 61.83 | -764.61 |
| Evangeline | -2.85 | 0 | 0 | 0 | 0 | 64.77 | -61.83 | -0.09 |
| Burkeville | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Jasper | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | -801.07 | 104.42 | -2676.82 | 2009.22 | -718.01 | 2726.24 | 0 | -764.7 |
| **2010** | | | | | | | | |
| Chicot | -14.52 | 104.42 | -3027.24 | 1708.93 | -727.25 | 2685.54 | 64.09 | -865.03 |
| Evangeline | -0.75 | 0 | 0 | 0 | 0 | 66.68 | -64.09 | -1.83 |
| Burkeville | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Jasper | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | -15.27 | 104.42 | -3027.24 | 1708.93 | -727.25 | 2752.22 | 0 | -866.86 |
| **2020** | | | | | | | | |
| Chicot | 89.72 | 104.42 | -3338.35 | 1690.92 | -729.85 | 2675.85 | 59.03 | -599.97 |
| Evangeline | 1.43 | 0 | 0 | 0 | 0 | 57.64 | -59.03 | 0 |
| Burkeville | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Jasper | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 91.15 | 104.42 | 0 | 1690.92 | 0 | 2733.49 | 0 | -599.97 |
| **2080** | | | | | | | | |
| Chicot | 0.23 | 104.42 | -2386.39 | 1748.22 | -721.95 | 2593.01 | 33.8 | -1695.72 |
| Evangeline | 0.02 | 0 | 0 | 0 | 0 | 33.79 | -33.8 | 0 |
| Burkeville | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Jasper | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 0.25 | 104.42 | -2386.39 | 1748.22 | -721.95 | 2626.8 | 0 | -1695.72 |

INTERA

# Calhoun County Budget

| Aquifer | Storage | Recharge | Surface Water – Groundwater Interaction | | | Groundwater Flow | | Wells |
|---|---|---|---|---|---|---|---|---|
| | | | Ocean/ Lake | Stream | Spring/ Wetlands | Lateral | Vertical | |
| **2000** | | | | | | | | |
| Chicot | -1244.4 | 3083.37 | -11915.63 | 3598.13 | -2025.96 | 8023.06 | -21.05 | -1094.07 |
| Evangeline | -115.92 | 0 | 0 | 0 | 0 | 98.53 | 25.11 | -5.72 |
| Burkeville | 3.86 | 0 | 0 | 0 | 0 | 0.19 | -4.06 | 0 |
| Jasper | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | -1356.46 | 3083.37 | -11915.63 | 3598.13 | -2025.96 | 8121.78 | -8.88 | -1099.79 |
| **2010** | | | | | | | | |
| Chicot | -1991.92 | 3083.37 | 0 | 3415.18 | 0 | 8611.27 | 865.78 | -1842.39 |
| Evangeline | -1.6 | 0 | 0 | 0 | 0 | 871.62 | -864.49 | -5.72 |
| Burkeville | 1.1 | 0 | 0 | 0 | 0 | 0.19 | -1.29 | 0 |
| Jasper | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | -1992.42 | 3083.37 | 0 | 3415.18 | 0 | 9483.08 | -3.64 | -1848.11 |
| **2020** | | | | | | | | |
| Chicot | -635.91 | 3083.37 | -14421.82 | 3447.12 | -2446.11 | 8960.71 | 59.43 | -1020.32 |
| Evangeline | 124.93 | 0 | 0 | 0 | 0 | -55.02 | -57.72 | -8.67 |
| Burkeville | 1.53 | 0 | 0 | 0 | 0 | 0.18 | -1.71 | 0 |
| Jasper | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | -509.45 | 3083.37 | -14421.82 | 3447.12 | -2446.11 | 8905.87 | 8.88 | -1028.99 |
| **2080** | | | | | | | | |
| Chicot | 16.42 | 3083.37 | -6283.25 | 3277.05 | -2228.98 | 9180.01 | -1703.67 | -7949.93 |
| Evangeline | 3.86 | 0 | 0 | 0 | 0 | -1645 | 1708.51 | -67.59 |
| Burkeville | 5.04 | 0 | 0 | 0 | 0 | -0.21 | -4.84 | 0 |
| Jasper | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 25.32 | 3083.37 | -6283.25 | 3277.05 | -2228.98 | 7534.8 | -8.17 | -8017.52 |

INTERA

# Colorado County Budget

| Aquifer | Storage | Recharge | Surface Water – Groundwater Interaction | | | Groundwater Flow | | Wells |
|---|---|---|---|---|---|---|---|---|
| | | | Ocean/ Lake | Stream | Spring/ Wetlands | Lateral | Vertical | |
| **2000** | | | | | | | | |
| Chicot | -10232 | 35101.88 | 0 | 16982.66 | -63.68 | -10769.3 | -21184.1 | -11247.6 |
| Evangeline | -1604.09 | 2499.22 | 0 | 262.68 | -0.78 | -6287.74 | 21466.58 | -16339.6 |
| Burkeville | 416.86 | 0 | 0 | 0 | 0 | -12.7 | -354.61 | -49.55 |
| Jasper | 102.99 | 0 | 0 | 0 | 0 | 256.92 | 72.13 | -432.04 |
| Total | -11316.3 | 37601.1 | 0 | 17245.34 | -64.46 | -16812.8 | 0 | -28068.8 |
| **2010** | | | | | | | | |
| Chicot | 8318.74 | 35101.88 | 0 | 15517.47 | -65.09 | -10041.9 | -25096.2 | -25142.6 |
| Evangeline | 1253.45 | 2499.22 | 0 | 1195.23 | -0.51 | -2794.72 | 25326.60 | -27478.3 |
| Burkeville | 415.52 | 0 | 0 | 0 | 0 | -12.68 | -357.8 | -45.05 |
| Jasper | 298.15 | 0 | 0 | 0 | 0 | 313.59 | 127.4 | -739.16 |
| Total | 10285.86 | 37601.1 | 0 | 16712.7 | -65.6 | -12535.7 | 1.45 | -53405.1 |
| **2020** | | | | | | | | |
| Chicot | -2350.68 | 35101.88 | 0 | 10631.96 | -64.96 | -12136.3 | -21390.1 | -11196.8 |
| Evangeline | -246.43 | 2499.22 | 0 | 9.47 | -0.66 | -9351.49 | 21285.72 | -14195.7 |
| Burkeville | 82.89 | 0 | 0 | 0 | 0 | -17.17 | -65.72 | 0 |
| Jasper | 66.01 | 0 | 0 | 0 | 0 | 89.34 | 170.09 | -325.52 |
| Total | -2448.21 | 37601.1 | 0 | 10641.43 | -65.62 | -21415.6 | 1.02 | -25718 |
| **2080** | | | | | | | | |
| Chicot | 1788.35 | 35101.88 | 0 | 42507.1 | -47.26 | -11091.5 | -38064.9 | -31601.3 |
| Evangeline | 88.68 | 2499.22 | 0 | 3507.36 | 0 | -4378.64 | 38349.03 | -40065.4 |
| Burkeville | 928.46 | 0 | 0 | 0 | 0 | -20.78 | -907.64 | 0 |
| Jasper | 539.45 | 0 | 0 | 0 | 0 | -244.44 | 623.49 | -918.73 |
| Total | 3344.94 | 37601.1 | 0 | 46014.46 | -47.26 | -15735.4 | 1.48 | -72585.4 |

INTERA

# Fayette County Budget

| Aquifer | Storage | Recharge | Surface Water – Groundwater Interaction | | | Groundwater Flow | | Wells |
|---|---|---|---|---|---|---|---|---|
| | | | Ocean/ Lake | Stream | Spring/ Wetlands | Lateral | Vertical | |
| **2000** | | | | | | | | |
| Chicot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Evangeline | -122.96 | 1736.12 | 0 | 0 | 0 | -390.5 | -305.61 | -272.58 |
| Burkeville | 45.52 | 3.28 | 0 | 153.61 | -20.96 | -17.9 | 202.82 | -173.49 |
| Jasper | 4202.06 | 356.94 | 0 | 93.42 | -29.08 | -385.53 | 102.79 | -1661.91 |
| Total | 4124.62 | 2096.34 | 0 | 247.03 | -50.04 | -793.93 | -1.42 | -2107.98 |
| **2010** | | | | | | | | |
| Chicot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Evangeline | -0.15 | 1736.12 | 0 | 0 | 0 | -381.94 | -309.4 | -286.52 |
| Burkeville | 100.09 | 3.28 | 0 | 159.04 | -18.9 | -19.69 | 75.3 | -182.36 |
| Jasper | 2561.74 | 356.94 | 0 | 97.87 | -23.45 | -503.95 | 234.1 | -2261.45 |
| Total | 2661.68 | 2096.34 | 0 | 256.91 | -42.35 | -905.58 | 0 | -2730.33 |
| **2020** | | | | | | | | |
| Chicot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Evangeline | -122.64 | 1736.12 | 0 | 0 | 0 | -421.71 | -274.77 | -59.91 |
| Burkeville | -25.74 | 3.28 | 0 | 163.33 | -18.86 | -17.29 | 63.9 | -38.13 |
| Jasper | 1447.11 | 356.94 | 0 | 103.33 | -18.86 | -343.02 | 210.87 | -1355.35 |
| Total | 1298.73 | 2096.34 | 0 | 266.66 | -37.72 | -782.02 | 0 | -1453.39 |
| **2080** | | | | | | | | |
| Chicot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Evangeline | 51.12 | 1736.12 | 0 | 515.25 | 0 | -614.59 | -1301.69 | -386.22 |
| Burkeville | 153.91 | 2.59 | 0 | 391.68 | -18.68 | -5.72 | -633.01 | -169.03 |
| Jasper | 4576.13 | 353.65 | 0 | 940.71 | -4.82 | 239.5 | 1934.7 | -8245.74 |
| Total | 4781.16 | 2092.36 | 0 | 1847.64 | -23.5 | -380.81 | 0 | -8800.99 |

INTERA

# Goliad County Budget

| Aquifer | Storage | Recharge | Surface Water – Groundwater Interaction | | | Groundwater Flow | | Wells |
|---|---|---|---|---|---|---|---|---|
| | | | Ocean/ Lake | Stream | Spring/ Wetlands | Lateral | Vertical | |
| **2000** | | | | | | | | |
| Chicot | -2848.5 | 10504.01 | 0 | 1511.87 | -189.33 | -3556.4 | -802.92 | -212.78 |
| Evangeline | -6177.44 | 7975.45 | 0 | 4955.43 | -37.59 | -5380.07 | 994.76 | -2330.86 |
| Burkeville | 166.31 | 0 | 0 | 0 | 0 | -12.2 | -75.18 | -78.93 |
| Jasper | 698.74 | 0 | 0 | 0 | 0 | -66.91 | -116.66 | -515.17 |
| Total | -8160.89 | 18479.46 | 0 | 6467.3 | -226.92 | -9015.58 | 2.84 | -3137.74 |
| **2010** | | | | | | | | |
| Chicot | -319.16 | 10504.01 | 0 | 1463.51 | -233.53 | -3656.95 | -718.09 | -163.5 |
| Evangeline | -33.37 | 7975.45 | 0 | 1294.37 | -42.28 | -5173.28 | 625.94 | -4646.96 |
| Burkeville | 73.08 | 0 | 0 | 0 | 0 | -9.29 | 17.65 | -81.44 |
| Jasper | 450.66 | 0 | 0 | 0 | 0 | -60.64 | 74.5 | -464.62 |
| Total | 171.21 | 18479.46 | 0 | 2757.88 | -275.82 | -8900.16 | 2.84 | -5356.52 |
| **2020** | | | | | | | | |
| Chicot | 154.29 | 10504.01 | 0 | 1467.87 | -232.65 | -3733.06 | -1069.09 | -348.96 |
| Evangeline | -175.06 | 7975.45 | 0 | 489.91 | -43.11 | -5002.9 | 909.53 | -4153.37 |
| Burkeville | 353.39 | 0 | 0 | 0 | 0 | -19.24 | 19.80 | -353.96 |
| Jasper | 113.09 | 0 | 0 | 0 | 0 | -44.25 | 139.76 | -208.72 |
| Total | 445.71 | 18479.46 | 0 | 1957.78 | -275.77 | -8799.45 | 5.68 | -5065.01 |
| **2080** | | | | | | | | |
| Chicot | 2.63 | 10504.01 | 0 | 1501.47 | -208.77 | -3781.74 | -1990.96 | -435.7 |
| Evangeline | 25.34 | 7975.45 | 0 | 2835.38 | -38.84 | -6957.51 | 1446.7 | -5286.6 |
| Burkeville | 263.3 | 0 | 0 | 0 | 0 | -16.61 | 312.94 | -559.62 |
| Jasper | 284.27 | 0 | 0 | 0 | 0 | 174.12 | 231.32 | -690.19 |
| Total | 575.54 | 18479.46 | 0 | 4336.85 | -247.62 | -10581.7 | 0 | -6972.11 |

INTERA

# Karnes County Budget

| Aquifer | Storage | Recharge | Surface Water – Groundwater Interaction | | | Groundwater Flow | | Wells |
|---|---|---|---|---|---|---|---|---|
| | | | Ocean/ Lake | Stream | Spring/ Wetlands | Lateral | Vertical | |
| **2000** | | | | | | | | |
| Chicot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Evangeline | -94.86 | 883.4 | 0 | 0 | -1.62 | -460.51 | -117.14 | -11.03 |
| Burkeville | 20.29 | 2.78 | 0 | 102.47 | -1.81 | -5.27 | -103.43 | -15.59 |
| Jasper | 2935.4 | 417.95 | 0 | 102.6 | -159.06 | -108.91 | 220.57 | -3408.56 |
| Total | 2860.83 | 1304.13 | 0 | 205.07 | -162.48 | -574.69 | 0 | -3435.18 |
| **2010** | | | | | | | | |
| Chicot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Evangeline | 6.44 | 883.4 | 0 | 0 | -1.42 | -361.85 | -157.39 | -24.73 |
| Burkeville | 269.82 | 2.78 | 0 | 181.58 | -0.81 | -8.59 | -369.63 | -75.11 |
| Jasper | 2640 | 417.95 | 0 | 99.84 | -147.16 | -202.35 | 527.02 | -3335.49 |
| Total | 2916.26 | 1304.13 | 0 | 281.42 | -149.4 | -572.79 | 0 | -3435.33 |
| **2020** | | | | | | | | |
| Chicot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Evangeline | -4.02 | 883.4 | 0 | 0 | -0.51 | -330.53 | -201.74 | -86.26 |
| Burkeville | 458.54 | 2.61 | 0 | 332.25 | -0.68 | 1.71 | -310.19 | -484.31 |
| Jasper | 6643.79 | 418.11 | 0 | 912.2 | -113.26 | -100.98 | 511.93 | -8272.12 |
| Total | 7098.31 | 1304.12 | 0 | 1244.45 | -114.45 | -429.8 | 0 | -8842.69 |
| **2080** | | | | | | | | |
| Chicot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Evangeline | 3.24 | 883.4 | 0 | 7.27 | -0.1 | -448.32 | -340.44 | -105.06 |
| Burkeville | 56.61 | 1.69 | 0 | 276.76 | -0.68 | 7.07 | -139.12 | -202.31 |
| Jasper | 1779.4 | 415.13 | 0 | 574.32 | -39.13 | -564.16 | 479.56 | -2645.46 |
| Total | 1839.25 | 1300.22 | 0 | 858.35 | -39.9 | -1005.41 | 0 | -2952.83 |

INTERA

# Lavaca County Budget

| Aquifer | Storage | Recharge | Surface Water – Groundwater Interaction | | | Groundwater Flow | | Wells |
|---|---|---|---|---|---|---|---|---|
| | | | Ocean/ Lake | Stream | Spring/ Wetlands | Lateral | Vertical | |
| **2000** | | | | | | | | |
| Chicot | -2158.69 | 18264.55 | 0 | 3629.07 | 0 | -12661.8 | -6796.24 | -273.96 |
| Evangeline | -1589.44 | 6103.45 | 0 | 1453.16 | 0 | -7508.27 | 6624.87 | -5080.02 |
| Burkeville | 34.98 | 2.04 | 0 | 131.49 | 0 | -25.78 | -137.79 | -4.73 |
| Jasper | 2429.25 | 171.07 | 0 | 343.26 | 0 | -60.62 | 309.16 | -3162.87 |
| Total | -1283.9 | 24541.11 | 0 | 5556.98 | 0 | -20256.5 | 1.14 | -8521.58 |
| **2010** | | | | | | | | |
| Chicot | -687.61 | 18264.55 | 0 | 0 | 0 | -10405.1 | -5939.94 | -765.33 |
| Evangeline | 374.22 | 6103.45 | 0 | 153.55 | 0 | -6186.64 | 5381.53 | -5820.67 |
| Burkeville | 368.97 | 2.04 | 0 | 148.51 | 0 | -18.8 | -433.96 | -65.86 |
| Jasper | 1002.02 | 171.07 | 0 | 471.71 | 0 | 131.45 | 992.37 | -2740.84 |
| Total | 1057.6 | 24541.11 | 0 | 773.77 | 0 | -16479.1 | 1.14 | -9392.7 |
| **2020** | | | | | | | | |
| Chicot | -123.19 | 18264.55 | 0 | 0 | 0 | -10774.3 | -5150.33 | -1932.91 |
| Evangeline | 145.22 | 6103.45 | 0 | 3449.98 | 0 | -6226.82 | 4431.55 | -7899.2 |
| Burkeville | 118.24 | 2.04 | 0 | 192.01 | 0 | -17.45 | -200.3 | -94.29 |
| Jasper | 1109.7 | 171.07 | 0 | 525.05 | 0 | 103.61 | 919.08 | -2808.45 |
| Total | 1249.97 | 24541.11 | 0 | 4167.04 | 0 | -16915 | 2.27 | -12734.9 |
| **2080** | | | | | | | | |
| Chicot | 690.81 | 18264.55 | 0 | 9865.21 | 0 | -17730.9 | -7992.17 | -3094.67 |
| Evangeline | 35.42 | 6103.45 | 0 | 10619.62 | 0 | -10942.6 | 6834.77 | -12647 |
| Burkeville | 444.99 | 1.78 | 0 | 289.63 | 0 | -23.68 | -593.93 | -118.79 |
| Jasper | 1987.82 | 171.32 | 0 | 788.29 | 0 | -202.16 | 1751.33 | -4496.45 |
| Total | 3159.04 | 24541.1 | 0 | 21562.75 | 0 | -28899.3 | 4.55 | -20356.9 |

INTERA

# Matagorda County Budget

| Aquifer | Storage | Recharge | Surface Water – Groundwater Interaction | | | Groundwater Flow | | Wells |
|---|---|---|---|---|---|---|---|---|
| | | | Ocean/ Lake | Stream | Spring/ Wetlands | Lateral | Vertical | |
| **2000** | | | | | | | | |
| Chicot | 15774.97 | 22869.53 | -11771.55 | 7076.68 | -3591.25 | 3312.9 | -4992.44 | -28833.4 |
| Evangeline | -4963.28 | 0 | 0 | 0 | 0 | -164.79 | 5161.48 | 0 |
| Burkeville | 169.44 | 0 | 0 | 0 | 0 | -0.4 | -169.04 | 0 |
| Jasper | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 10981.13 | 22869.53 | -11771.55 | 7076.68 | -3591.25 | 3147.71 | -2.84 | -28833.4 |
| **2010** | | | | | | | | |
| Chicot | 556.15 | 22869.53 | -9282.16 | 16237.23 | -3465.1 | -54.16 | -200.53 | -26765.2 |
| Evangeline | 1.06 | 0 | 0 | 0 | 0 | -77.34 | 198.66 | -122.14 |
| Burkeville | -2.37 | 0 | 0 | 0 | 0 | 0.51 | 1.87 | 0 |
| Jasper | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 554.84 | 22869.53 | -9282.16 | 16237.23 | -3465.1 | -130.99 | -4.44 | -26887.4 |
| **2020** | | | | | | | | |
| Chicot | -2049.91 | 22869.53 | -10546.05 | 19609.11 | -3444.86 | 1267.56 | -4704.93 | -22995 |
| Evangeline | 744.2 | 0 | 0 | 0 | 0 | -790.11 | 4890.59 | -4847.83 |
| Burkeville | 184.67 | 0 | 0 | 0 | 0 | 0.99 | -185.66 | 0 |
| Jasper | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | -1121.04 | 22869.53 | -10546.05 | 19609.11 | -3444.86 | 478.44 | -1.42 | -27842.8 |
| **2080** | | | | | | | | |
| Chicot | 235.83 | 22869.53 | -8114.87 | 35169.57 | -3253.74 | -1865.74 | -11304.4 | -33777.6 |
| Evangeline | 28.14 | 0 | 0 | 0 | 0 | 1444.67 | 11624.72 | -13102.7 |
| Burkeville | 323.09 | 0 | 0 | 0 | 0 | -2.78 | -320.3 | 0 |
| Jasper | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 587.06 | 22869.53 | -8114.87 | 35169.57 | -3253.74 | -423.85 | -7.34 | -46880.2 |

INTERA

# Refugio County Budget

| Aquifer | Storage | Recharge | Surface Water – Groundwater Interaction | | | Groundwater Flow | | Wells |
|---|---|---|---|---|---|---|---|---|
| | | | Ocean/ Lake | Stream | Spring/ Wetlands | Lateral | Vertical | |
| **2000** | | | | | | | | |
| Chicot | -5909.31 | 14658.3 | -6304.31 | 0 | -1944.2 | 1395.5 | 3710.45 | -2043.86 |
| Evangeline | -48.84 | 0 | 0 | 0 | 0 | 3992.9 | -3669.09 | -274.36 |
| Burkeville | 14.41 | 0 | 0 | 0 | 0 | 26.96 | -41.36 | 0 |
| Jasper | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | -5943.74 | 14658.3 | -6304.31 | 0 | -1944.2 | 5415.36 | 1.28 | -2318.22 |
| **2010** | | | | | | | | |
| Chicot | -273.36 | 14658.3 | -6568.41 | 0 | -2012.48 | 2242.37 | 4029.26 | -1774.37 |
| Evangeline | -23.37 | 0 | 0 | 0 | 0 | 4437.32 | -3997.41 | -416.5 |
| Burkeville | 5.23 | 0 | 0 | 0 | 0 | 26.62 | -31.85 | 0 |
| Jasper | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | -291.5 | 14658.3 | -6568.41 | 0 | -2012.48 | 6706.31 | -9.24 | -2190.87 |
| **2020** | | | | | | | | |
| Chicot | 107.64 | 14658.3 | -6751.19 | 0 | -2014.88 | 2228.52 | 3464.12 | -1214.09 |
| Evangeline | 85.22 | 0 | 0 | 0 | 0 | 4293.89 | -3427.17 | -948.91 |
| Burkeville | 10.83 | 0 | 0 | 0 | 0 | 26.12 | -36.95 | 0 |
| Jasper | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 203.69 | 14658.3 | -6751.19 | 0 | -2014.88 | 6548.53 | -1.85 | -2163 |
| **2080** | | | | | | | | |
| Chicot | 27.86 | 14658.3 | -6252.42 | 0 | -1957.91 | 181.61 | 440.02 | -3382.61 |
| Evangeline | 2.63 | 0 | 0 | 0 | 0 | 2997.74 | -356.41 | -2643.78 |
| Burkeville | 59.86 | 0 | 0 | 0 | 0 | 23.75 | -83.61 | 0 |
| Jasper | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 90.35 | 14658.3 | -6252.42 | 0 | -1957.91 | 3203.10 | 1.42 | -6026.39 |

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# Victoria County Budget

| Aquifer | Storage | Recharge | Surface Water – Groundwater Interaction | | | Groundwater Flow | | Wells |
|---|---|---|---|---|---|---|---|---|
| | | | Ocean/ Lake | Stream | Spring/ Wetlands | Lateral | Vertical | |
| **2000** | | | | | | | | |
| Chicot | -45838.5 | 24815.13 | -322.52 | 42345.24 | -1749.11 | -3234.29 | -12278.2 | -4772.71 |
| Evangeline | -562.42 | 742.1 | 0 | 0 | -25.93 | 6828.13 | 13352.46 | -20042.5 |
| Burkeville | 176.06 | 0 | 0 | 0 | 0 | 30.83 | -206.88 | 0 |
| Jasper | 277 | 0 | 0 | 0 | 0 | 590.43 | -867.43 | 0 |
| Total | -45947.9 | 25557.23 | -322.52 | 42345.24 | -1775.04 | 4215.1 | -4.55 | -24815.2 |
| **2010** | | | | | | | | |
| Chicot | -5347.1 | 24815.13 | -569.7 | 4092.71 | -2615.52 | -9847.68 | -5593.8 | -5977.59 |
| Evangeline | 357.06 | 742.1 | 0 | 0 | 0 | 4451.62 | 5742.56 | -9406.62 |
| Burkeville | -306.58 | 0 | 0 | 0 | 0 | 27.4 | 279.18 | 0 |
| Jasper | -133.84 | 0 | 0 | 0 | 0 | 561.8 | -427.94 | 0 |
| Total | -5430.46 | 25557.23 | -569.7 | 4092.71 | -2642.3 | -4806.86 | 2.27 | -15384.2 |
| **2020** | | | | | | | | |
| Chicot | -176.08 | 24815.13 | -610.32 | 2824.43 | -2646.02 | -11613.2 | -5228.04 | -8414.59 |
| Evangeline | 185.92 | 742.1 | 0 | 0 | -27.05 | 3552.87 | 5245.79 | -7289.41 |
| Burkeville | -334.05 | 0 | 0 | 0 | 0 | 25.53 | 308.53 | 0 |
| Jasper | -164.39 | 0 | 0 | 0 | 0 | 490.86 | -326.28 | 0 |
| Total | -488.6 | 25557.23 | -610.32 | 2824.43 | -2673.07 | -7543.98 | 0 | -15704 |
| **2080** | | | | | | | | |
| Chicot | 154.49 | 24815.13 | -403.44 | 33514.36 | -2182.44 | -9328.37 | -15478.7 | -32146.8 |
| Evangeline | 8.54 | 742.1 | 0 | 668.57 | -25.81 | 10004.59 | 16450.35 | -27848.2 |
| Burkeville | 301.83 | 0 | 0 | 0 | 0 | 31.46 | -333.29 | 0 |
| Jasper | 196.17 | 0 | 0 | 0 | 0 | 441.84 | -638.32 | 0 |
| Total | 661.03 | 25557.23 | -403.44 | 34182.93 | -2208.25 | 1149.52 | -1.25 | -59995 |

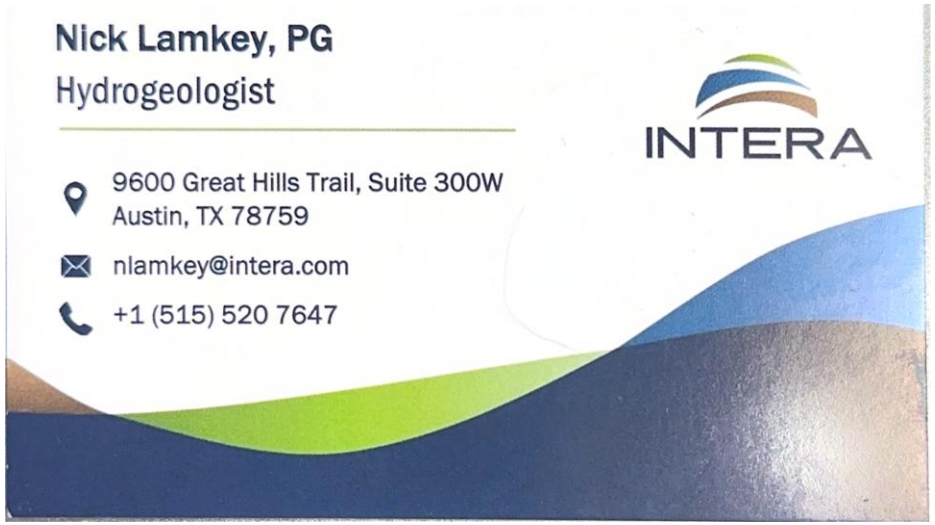
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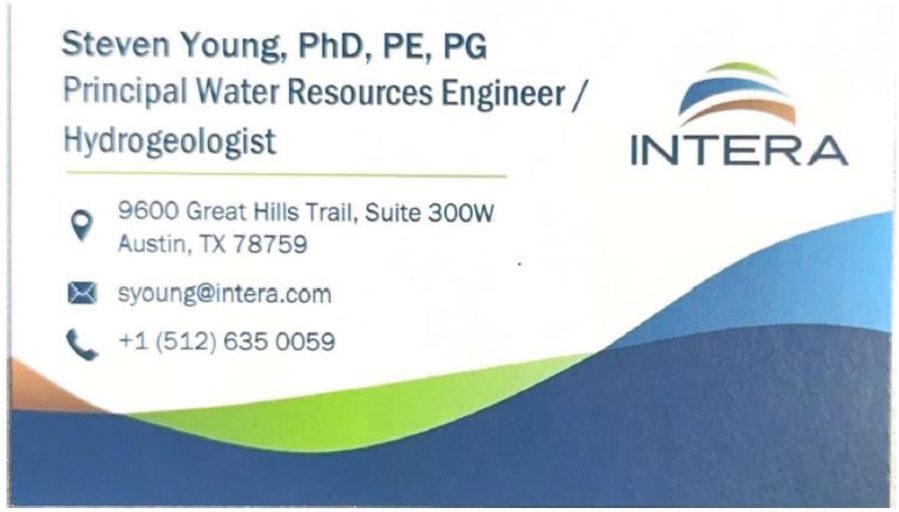
# Wharton County Budget

| Aquifer | Storage | Recharge | Surface Water – Groundwater Interaction | | | Groundwater Flow | | Wells |
|---|---|---|---|---|---|---|---|---|
| | | | Ocean/ Lake | Stream | Spring/ Wetlands | Lateral | Vertical | |
| **2000** | | | | | | | | |
| Chicot | 20760.99 | 21659.1 | 0 | 96524.6 | -259.96 | 5683.97 | -18858.5 | -126040 |
| Evangeline | -16595 | 0 | 0 | 0 | 0 | 6250.31 | 19765.32 | -9422.96 |
| Burkeville | -252.73 | 0 | 0 | 0 | 0 | 27.98 | 224.76 | 0 |
| Jasper | 1095.64 | 0 | 0 | 0 | 0 | 35.92 | -1131.57 | 0 |
| Total | 5008.92 | 21659.1 | 0 | 96524.6 | -259.96 | 11998.18 | 1.36 | -135463 |
| **2010** | | | | | | | | |
| Chicot | -2668.8 | 21659.1 | 0 | 100889.9 | -259.5 | 8830.12 | -5794.67 | -123202 |
| Evangeline | 232.88 | 0 | 0 | 0 | 0 | 2043.35 | 5607.56 | -7888.92 |
| Burkeville | -881.92 | 0 | 0 | 0 | 0 | 27.86 | 854.05 | 0 |
| Jasper | 579.62 | 0 | 0 | 0 | 0 | 87.19 | -666.94 | 0 |
| Total | -2738.22 | 21659.1 | 0 | 100889.9 | -259.5 | 10988.52 | 3.41 | -131091 |
| **2020** | | | | | | | | |
| Chicot | -21131.1 | 21659.1 | 0 | 92599.66 | -266.41 | 6073.67 | -24926.8 | -74551.9 |
| Evangeline | 400.56 | 0 | 0 | 0 | 0 | 16025.37 | 26770.54 | -43205.1 |
| Burkeville | 1130.22 | 0 | 0 | 0 | 0 | 27.06 | -1157.32 | 0 |
| Jasper | 599.9 | 0 | 0 | 0 | 0 | 85.89 | -686.41 | 0 |
| Total | -19000.4 | 21659.1 | 0 | 92599.66 | -266.41 | 22211.99 | -5.68 | -117757 |
| **2080** | | | | | | | | |
| Chicot | 2242.37 | 21659.1 | 0 | 117235.8 | -201.4 | 15837.09 | -42439.8 | -114875 |
| Evangeline | 71.9 | 0 | 0 | 0 | 0 | 21347.1 | 45145.53 | -66573.3 |
| Burkeville | 1609.66 | 0 | 0 | 0 | 0 | 37.17 | -1646.76 | 0 |
| Jasper | 988 | 0 | 0 | 0 | 0 | 69.72 | -1058.94 | 0 |
| Total | 4911.93 | 21659.1 | 0 | 117235.8 | -201.4 | 37291.08 | -2.73 | -181448 |

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# Questions?


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# F.5 Socioeconomic Impacts

# GMA 15
# Socioeconomic Impacts

Groundwater Management Area 15

October 9, 2025




Presented by:
Nick Lamkey PG
Steven Young Ph.D, PE, PG

# Socioeconomic Impacts

- For quantitative estimate of Socioeconomic Impacts we reviewed materials from Dr. John Ellis for the 2026 regional water plans for Regions K, L, N and P
- Reports contain estimated impacts for not meeting projected water needs for each county calculated in terms of income losses and job losses
- To estimate the socioeconomic impact associated with the potential DFC's we calculated drawdown from 2000 to 2080 for wells received in the data request and the SDR wells to look at impacts on wells in the GCAS

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# Summary of Income Losses

- Income losses in millions of $ for counties in GMA 15 if water needs are not met
- Estimates include whole county including areas outside GMA 15
- DeWitt, Aransas and Refugio were had no estimates in the State Water Plan
  - Only counties with projected economic impacts for at least one decade had values calculated
- For counties or water use categories not shown there is no estimated impacts in the 2026 regional water plans
- Values in 2023 $
- Highest income losses would be from not meeting manufacturing needs
- Example: For year 2030 if projected water needs are not met during a drought of record year the total economic activity tied to manufacturing could drop by 7.9 billion dollars

| County | Region | Water Use | 2030 | 2040 | 2050 | 2060 | 2070 | 2080 |
|---|---|---|---|---|---|---|---|---|
| Bee | N | Mining | $0.35 | $0.35 | $0.35 | $0.35 | $0.35 | - |
| | | Municipal | $8.02 | $7.53 | $6.66 | $5.57 | $4.37 | $3.01 |
| Calhoun | L | Irrigation | $5.83 | $5.83 | $5.83 | $5.83 | $5.83 | $5.83 |
| | | Manufacturing | - | - | - | $28.72 | $125.10 | $277.09 |
| Colorado | K | Irrigation | $10.74 | $9.17 | $7.72 | $6.40 | $5.21 | $4.13 |
| | | Municipal | $0.03 | $0.02 | $0.02 | $0.01 | $0.00 | - |
| Fayette | K | Municipal | - | 0.02 | $0.01 | $0.08 | $0.21 | $0.24 |
| Goliad | L | Irrigation | $0.00 | - | - | - | - | - |
| Jackson | P | Manufacturing | $2,150.64 | $2,816.35 | $2,839.34 | $2,862.16 | $2,886.07 | $2,912.77 |
| Karnes | L | Irrigation | $0.08 | $0.08 | $0.70 | $0.70 | $0.70 | $0.70 |
| | | Mining | $1,138.29 | $1,138.29 | $1,138.29 | $1,138.29 | $1,138.29 | - |
| Lavaca | P | Irrigation | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| Matagorda | K | Irrigation | $25.98 | $25.15 | $24.35 | $23.57 | $22.81 | $22.07 |
| | | Manufacturing | - | - | - | $45.45 | $105.78 | $181.62 |
| | | Municipal | $0.00 | $0.00 | - | - | - | - |
| Victoria | L | Manufacturing | $5,720.25 | $5,934.47 | $6,156.61 | $6,386.98 | $6,625.86 | $6,873.55 |
| | | Mining | $47.86 | $50.56 | $52.96 | $54.80 | $56.50 | $57.78 |
| | | Municipal | $74.25 | $76.12 | $76.62 | $75.94 | $75.17 | $74.28 |
| | | Steam Electric Power | $29.67 | $29.67 | $29.67 | $29.67 | $29.67 | $29.67 |
| Wharton | K | Irrigation | $24.51 | $22.43 | $20.46 | $18.60 | $16.85 | $15.20 |
| | P | Irrigation | $1.81 | $1.75 | $1.69 | $1.62 | $1.56 | $1.49 |
| GMA 15 | | Mining | $1,186.50 | $1,189.20 | $1,191.60 | $1,193.44 | $1,195.14 | $57.78 |
| | | Municipal | $82.30 | $83.69 | $83.31 | $81.60 | $79.75 | $77.53 |
| | | Irrigation | $68.95 | $64.41 | $60.75 | $56.72 | $52.96 | $49.42 |
| | | Manufacturing | $7,870.89 | $8,750.82 | $8,995.95 | $9,323.31 | $9,742.81 | $10,245.03 |
| | | Power | $29.67 | $29.67 | $29.67 | $29.67 | $29.67 | $29.67 |
| | | Livestock | NI | NI | NI | NI | NI | NI |

- Ellis, R. John, 2026 Region L, P, K, N Socioeconomic Impacts Projected Water Shortages Reports

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# Summary of Job Losses

- Job losses for counties in GMA 15 if water needs are not met
- Estimates include whole county including areas outside GMA 15
- DeWitt, Aransas and Refugio were had no estimates in the State Water Plan
  - Only counties with projected economic impacts for at least one decade had values calculated
- For counties or water use categories not shown there is no estimated impacts in the 2026 regional water plans
- Highest job losses would be from not meeting manufacturing needs

| County | Region | Water Use | 2030 | 2040 | 2050 | 2060 | 2070 | 2080 |
|---|---|---|---|---|---|---|---|---|
| Bee | N | Mining | 2 | 2 | 2 | 2 | 2 | - |
| | | Municipal | 113 | 106 | 94 | 79 | 62 | 42 |
| Calhoun | L | Irrigation | 314 | 314 | 314 | 314 | 314 | 314 |
| | | Manufacturing | - | - | - | 130 | 565 | 1,251 |
| Colorado | K | Irrigation | 266 | 227 | 191 | 158 | 129 | 102 |
| | | Municipal | 0 | 0 | 0 | 0 | 0 | - |
| Fayette | K | Municipal | - | 0 | 0 | 1 | 2 | 3 |
| Goliad | L | Irrigation | 0 | - | - | - | - | - |
| Jackson | P | Manufacturing | 13,502 | 17,681 | 17,826 | 17,969 | 18,119 | 18,287 |
| Karnes | L | Irrigation | 2 | 2 | 15 | 15 | 15 | 15 |
| | | Mining | 3,755 | 3,755 | 3,755 | 3,755 | 3,755 | - |
| Lavaca | P | Irrigation | 0 | 0 | 0 | 0 | 0 | 0 |
| Matagorda | K | Irrigation | 1,330 | 1,288 | 1,246 | 1,206 | 1,167 | 1,130 |
| | | Manufacturing | - | - | - | 149 | 347 | 595 |
| | | Municipal | 0 | 0 | - | - | - | - |
| Victoria | L | Manufacturing | 32,912 | 34,145 | 35,423 | 36,748 | 38,123 | 39,548 |
| | | Mining | 250 | 264 | 277 | 286 | 295 | 302 |
| | | Municipal | 958 | 982 | 989 | 980 | 970 | 959 |
| | | Steam Electric Power | - | - | - | - | - | - |
| Wharton | K | Irrigation | 812 | 743 | 678 | 616 | 558 | 504 |
| | P | Irrigation | 60 | 58 | 56 | 54 | 52 | 49 |
| GMA 15 | | Mining | 4,007 | 4,021 | 4,034 | 4,043 | 4,052 | 302 |
| | | Municipal | 1,071 | 1,088 | 1,083 | 1,060 | 1,034 | 1,004 |
| | | Irrigation | 2,784 | 2,632 | 2,500 | 2,363 | 2,235 | 2,114 |
| | | Manufacturing | 46,414 | 51,826 | 53,249 | 54,996 | 57,154 | 59,681 |
| | | Power | NI | NI | NI | NI | NI | NI |
| | | Livestock | NI | NI | NI | NI | NI | NI |

- Ellis, R. John, 2026 Region L, P, K, N Socioeconomic Impacts Projected Water Shortages Reports

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# Summary of Drawdown Impacts on Wells by County

| | GCD Wells | Drawdown Category | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| County | Aquifer | <-20 | -20 to -10 | -10 to 0 | 0 to 10 | 10 to 20 | 20 to 40 | >40 | Total Wells |
| Aransas | Chicot | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 3 |
| Calhoun | Chicot | 0 | 1 | 209 | 152 | 0 | 0 | 0 | 362 |
| Goliad | Evangeline | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 2 |
| Jackson | Chicot | 0 | 0 | 40 | 589 | 260 | 416 | 0 | 1,305 |
| Jackson | Evangeline | 0 | 0 | 4 | 18 | 9 | 11 | 1 | 42 |
| Matagorda | Chicot | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Refugio | Chicot | 0 | 0 | 578 | 287 | 0 | 0 | 0 | 865 |
| Refugio | Evangeline | 0 | 0 | 0 | 242 | 13 | 1 | 0 | 256 |
| San Patricio | Chicot | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| Victoria | Chicot | 5 | 213 | 1,568 | 406 | 110 | 75 | 32 | 2,377 |
| Victoria | Evangeline | 23 | 7 | 94 | 557 | 30 | 0 | 0 | 711 |
| Victoria | Jasper | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| | Total | 28 | 221 | 2,496 | 2,254 | 424 | 503 | 33 | 5,926 |

| | SDR Wells | Drawdown Category | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| County | Aquifer | <-20 | -20 to -10 | -10 to 0 | 0 to 10 | 10 to 20 | 20 to 40 | >40 | Total Wells |
| Aransas | Chicot | 0 | 0 | 170 | 1666 | 0 | 0 | 0 | 1836 |
| Bee | Burkville | 1 | 0 | 0 | 0 | 27 | 28 | 0 | 56 |
| Bee | Chicot | 0 | 0 | 1 | 58 | 11 | 0 | 0 | 70 |
| Bee | Evangeline | 0 | 0 | 4 | 355 | 102 | 20 | 3 | 484 |
| Bee | Jasper | 0 | 0 | 1 | 3 | 26 | 27 | 0 | 57 |
| Calhoun | Chicot | 0 | 3 | 896 | 848 | 8 | 0 | 0 | 1755 |
| Colorado | Burkville | 0 | 0 | 2 | 0 | 20 | 63 | 39 | 124 |
| Colorado | Chicot | 0 | 0 | 186 | 896 | 539 | 391 | 0 | 2012 |
| Colorado | Evangeline | 0 | 0 | 34 | 596 | 717 | 93 | 30 | 1470 |
| Colorado | Jasper | 0 | 0 | 0 | 0 | 0 | 14 | 8 | 22 |
| DeWitt | Burkville | 0 | 0 | 1 | 31 | 103 | 181 | 29 | 345 |
| DeWitt | Chicot | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 40 |
| DeWitt | Evangeline | 0 | 0 | 55 | 1271 | 170 | 27 | 0 | 1523 |
| DeWitt | Jasper | 0 | 0 | 0 | 145 | 125 | 651 | 652 | 1573 |
| Fayette | Burkville | 0 | 0 | 0 | 6 | 37 | 61 | 136 | 240 |
| Fayette | Evangeline | 0 | 0 | 0 | 81 | 60 | 23 | 0 | 164 |
| Fayette | Jasper | 0 | 0 | 2 | 22 | 32 | 111 | 621 | 788 |
| Goliad | Burkville | 0 | 0 | 0 | 4 | 21 | 12 | 1 | 38 |
| Goliad | Chicot | 0 | 0 | 35 | 2 | 0 | 0 | 0 | 37 |
| Goliad | Evangeline | 0 | 13 | 1366 | 461 | 62 | 0 | 0 | 1902 |
| Goliad | Jasper | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Jackson | Chicot | 0 | 0 | 61 | 674 | 417 | 591 | 0 | 1743 |
| Jackson | Evangeline | 0 | 0 | 1 | 6 | 1 | 3 | 0 | 11 |
| Karnes | Burkville | 0 | 1 | 2 | 4 | 15 | 83 | 4 | 109 |
| Karnes | Evangeline | 0 | 0 | 0 | 12 | 1 | 0 | 0 | 13 |
| Karnes | Jasper | 0 | 2 | 9 | 96 | 93 | 433 | 128 | 761 |
| Lavaca | Burkville | 0 | 0 | 0 | 33 | 310 | 59 | 2 | 404 |
| Lavaca | Chicot | 0 | 0 | 4 | 301 | 82 | 60 | 0 | 447 |
| Lavaca | Evangeline | 0 | 0 | 48 | 1868 | 67 | 2 | 0 | 1985 |
| Lavaca | Jasper | 0 | 0 | 0 | 28 | 153 | 392 | 232 | 805 |
| Matagorda | Chicot | 0 | 0 | 409 | 2168 | 349 | 47 | 0 | 2973 |
| Matagorda | Evangeline | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 4 |
| Refugio | Chicot | 0 | 0 | 866 | 291 | 0 | 0 | 0 | 1157 |
| Refugio | Evangeline | 0 | 0 | 0 | 36 | 0 | 0 | 0 | 36 |
| Victoria | Chicot | 17 | 461 | 2218 | 362 | 83 | 27 | 20 | 3188 |
| Victoria | Evangeline | 8 | 50 | 178 | 949 | 195 | 0 | 0 | 1380 |
| Wharton | Chicot | 0 | 0 | 99 | 1882 | 1020 | 546 | 0 | 3547 |
| Wharton | Evangeline | 0 | 0 | 0 | 0 | 0 | 7 | 37 | 44 |
| | Total | 26 | 530 | 6648 | 15195 | 4846 | 3952 | 1947 | 33144 |

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# Summary of Drawdown Impacts on Wells by County Percentages

| | GCD | Drawdown Category | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| County | Aquifer | <-20 | -20 to -10 | -10 to 0 | 0 to 10 | 10 to 20 | 20 to 40 | >40 | Total Wells |
| Aransas | Chicot | 0% | 0% | 100% | 0% | 0% | 0% | 0% | 100% |
| Calhoun | Chicot | 0% | 0% | 58% | 42% | 0% | 0% | 0% | 100% |
| Goliad | Evangeline | 0% | 0% | 0% | 50% | 50% | 0% | 0% | 100% |
| Jackson | Chicot | 0% | 0% | 3% | 45% | 20% | 32% | 0% | 100% |
| Jackson | Evangeline | 0% | 0% | 10% | 43% | 21% | 26% | 2% | 100% |
| Matagorda | Chicot | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 100% |
| Refugio | Chicot | 0% | 0% | 67% | 33% | 0% | 0% | 0% | 100% |
| Refugio | Evangeline | 0% | 0% | 0% | 95% | 5% | 0% | 0% | 100% |
| San Patricio | Chicot | 0% | 0% | 0% | 100% | 0% | 0% | 0% | 100% |
| Victoria | Chicot | 0% | 9% | 66% | 17% | 5% | 3% | 1% | 100% |
| Victoria | Evangeline | 3% | 1% | 13% | 78% | 4% | 0% | 0% | 100% |
| Victoria | Jasper | 0% | 0% | 0% | 100% | 0% | 0% | 0% | 100% |
| | Total | 0% | 4% | 42% | 38% | 7% | 8% | 1% | 100% |

| | | Drawdown Category | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| County | Aquifer | <-20 | -20 to -10 | -10 to 0 | 0 to 10 | 10 to 20 | 20 to 40 | >40 | Total Wells |
| Aransas | Chicot | 0% | 0% | 9% | 91% | 0% | 0% | 0% | 100% |
| Bee | Burkville | 2% | 0% | 0% | 0% | 48% | 50% | 0% | 100% |
| Bee | Chicot | 0% | 0% | 1% | 83% | 16% | 0% | 0% | 100% |
| Bee | Evangeline | 0% | 0% | 1% | 73% | 21% | 4% | 1% | 100% |
| Bee | Jasper | 0% | 0% | 2% | 5% | 46% | 47% | 0% | 100% |
| Calhoun | Chicot | 0% | 0% | 51% | 48% | 0% | 0% | 0% | 100% |
| Colorado | Burkville | 0% | 0% | 2% | 0% | 16% | 51% | 31% | 100% |
| Colorado | Chicot | 0% | 0% | 9% | 45% | 27% | 19% | 0% | 100% |
| Colorado | Evangeline | 0% | 0% | 2% | 41% | 49% | 6% | 2% | 100% |
| Colorado | Jasper | 0% | 0% | 0% | 0% | 0% | 64% | 36% | 100% |
| DeWitt | Burkville | 0% | 0% | 0% | 9% | 30% | 52% | 8% | 100% |
| DeWitt | Chicot | 0% | 0% | 0% | 100% | 0% | 0% | 0% | 100% |
| DeWitt | Evangeline | 0% | 0% | 4% | 83% | 11% | 2% | 0% | 100% |
| DeWitt | Jasper | 0% | 0% | 0% | 9% | 8% | 41% | 41% | 100% |
| Fayette | Burkville | 0% | 0% | 0% | 3% | 15% | 25% | 57% | 100% |
| Fayette | Evangeline | 0% | 0% | 0% | 49% | 37% | 14% | 0% | 100% |
| Fayette | Jasper | 0% | 0% | 0% | 3% | 4% | 14% | 79% | 100% |
| Goliad | Burkville | 0% | 0% | 0% | 11% | 55% | 32% | 3% | 100% |
| Goliad | Chicot | 0% | 0% | 95% | 5% | 0% | 0% | 0% | 100% |
| Goliad | Evangeline | 0% | 1% | 72% | 24% | 3% | 0% | 0% | 100% |
| Goliad | Jasper | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 100% |
| Jackson | Chicot | 0% | 0% | 3% | 39% | 24% | 34% | 0% | 100% |
| Jackson | Evangeline | 0% | 0% | 9% | 55% | 9% | 27% | 0% | 100% |
| Karnes | Burkville | 0% | 1% | 2% | 4% | 14% | 76% | 4% | 100% |
| Karnes | Evangeline | 0% | 0% | 0% | 92% | 8% | 0% | 0% | 100% |
| Karnes | Jasper | 0% | 0% | 1% | 13% | 12% | 57% | 17% | 100% |
| Lavaca | Burkville | 0% | 0% | 0% | 8% | 77% | 15% | 0% | 100% |
| Lavaca | Chicot | 0% | 0% | 1% | 67% | 18% | 13% | 0% | 100% |
| Lavaca | Evangeline | 0% | 0% | 2% | 94% | 3% | 0% | 0% | 100% |
| Lavaca | Jasper | 0% | 0% | 0% | 3% | 19% | 49% | 29% | 100% |
| Matagorda | Chicot | 0% | 0% | 14% | 73% | 12% | 2% | 0% | 100% |
| Matagorda | Evangeline | 0% | 0% | 0% | 0% | 0% | 0% | 100% | 100% |
| Refugio | Chicot | 0% | 0% | 75% | 25% | 0% | 0% | 0% | 100% |
| Refugio | Evangeline | 0% | 0% | 0% | 100% | 0% | 0% | 0% | 100% |
| Victoria | Chicot | 1% | 14% | 70% | 11% | 3% | 1% | 1% | 100% |
| Victoria | Evangeline | 1% | 4% | 13% | 69% | 14% | 0% | 0% | 100% |
| Wharton | Chicot | 0% | 0% | 3% | 53% | 29% | 15% | 0% | 100% |
| Wharton | Evangeline | 0% | 0% | 0% | 0% | 0% | 16% | 84% | 100% |
| | Total | 0% | 2% | 20% | 46% | 15% | 12% | 6% | 100% |

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# Summary of Drawdown Impacts on Wells

- Drawdown Analysis for submitted GCD Wells and SDR (submitted drillers reports from TWDB)
- Includes all wells that had either total depth information and/or screen depth information
  - If data only had total depth, screen was estimated to be the last 50 ft interval of the total depth
- Drawdown categories are feet of drawdown from 2000 to 2080
  - Positive values indicate a fall in water levels from 2000 to 2080
  - Negative values indicate a rise in water levels from 2000 to 2080

GCD Wells

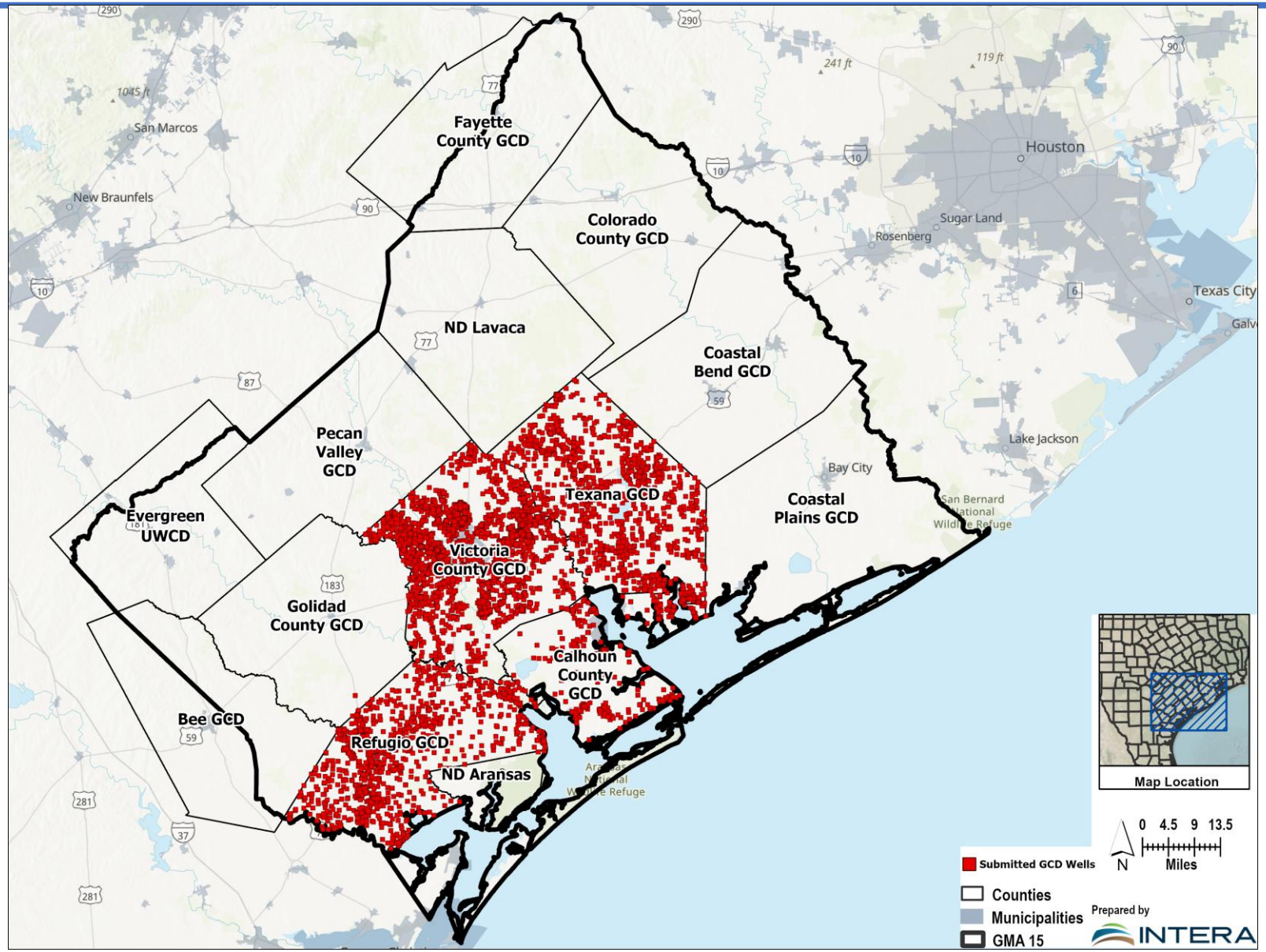
| | Drawdown Category | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Aquifer** | **< -20** | **-20 to -10** | **-10 to 0** | **0 to 10** | **10 to 20** | **20 to 40** | **> 40** | **Total Wells** |
| **Chicot** | **5** | **214** | **2,398** | **1,435** | **371** | **491** | **32** | **4,946** |
| **Evangeline** | **23** | **7** | **98** | **818** | **53** | **12** | **1** | **1,012** |
| **Jasper** | **0** | **0** | **0** | **1** | **0** | **0** | **0** | **1** |
| **Total** | **28** | **221** | **2,496** | **2,254** | **424** | **503** | **33** | **5,959** |

SDR Wells

| | Drawdown Category | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Aquifer** | **<-20** | **-20 to -10** | **-10 to 0** | **0 to 10** | **10 to 20** | **20 to 40** | **>40** | **Total Wells** |
| **Chicot** | **17** | **464** | **4,945** | **9,188** | **2,509** | **1,662** | **20** | **18,805** |
| **Evangeline** | **8** | **63** | **1,686** | **5,635** | **1,375** | **175** | **74** | **9,016** |
| **Jasper** | **0** | **2** | **12** | **294** | **429** | **1,628** | **1,642** | **4,007** |
| **Total** | **25** | **529** | **6,643** | **15,117** | **4,313** | **3,465** | **1,736** | **31,828** |

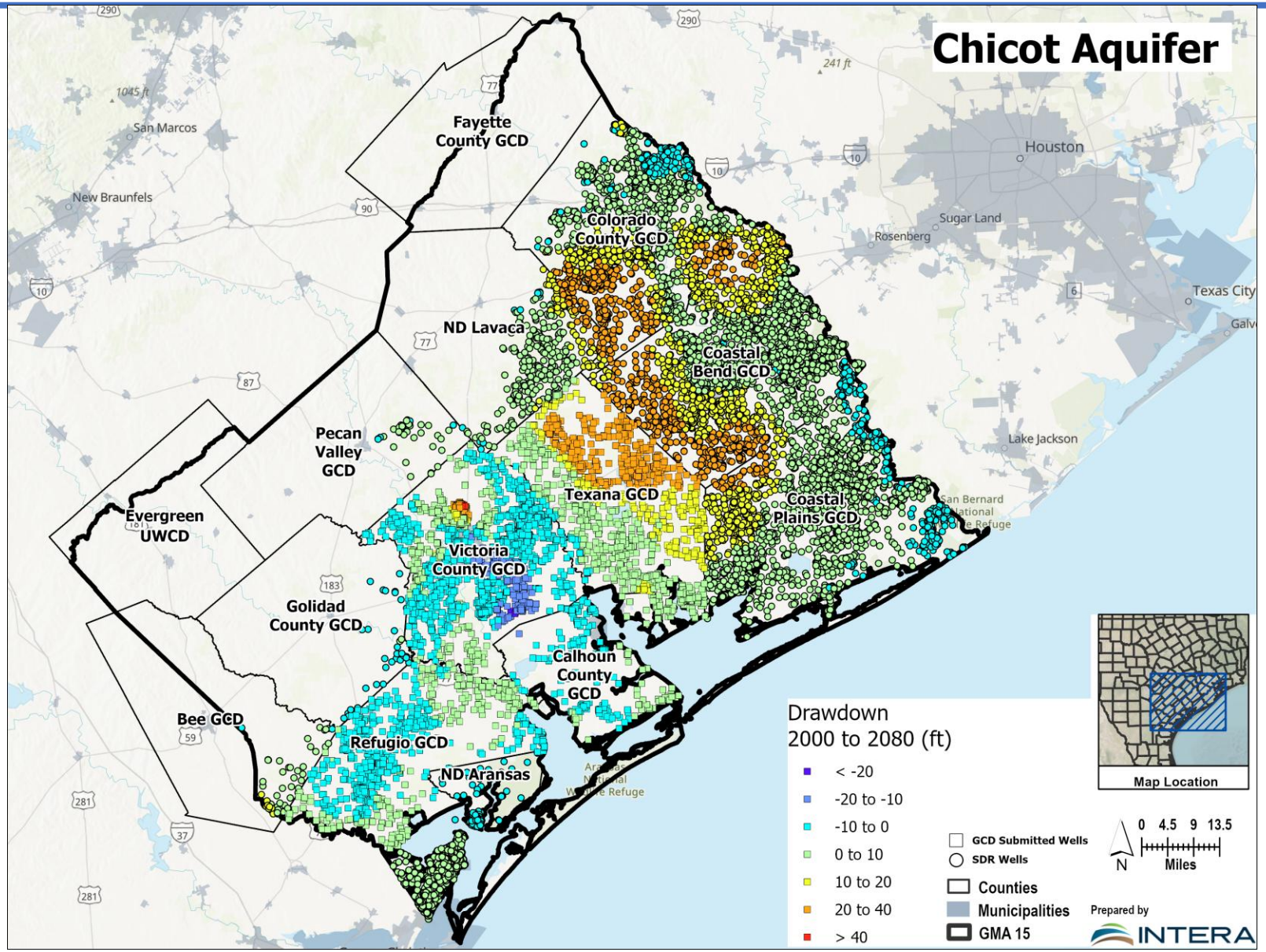
INTERA

# Wells Received from Data Request



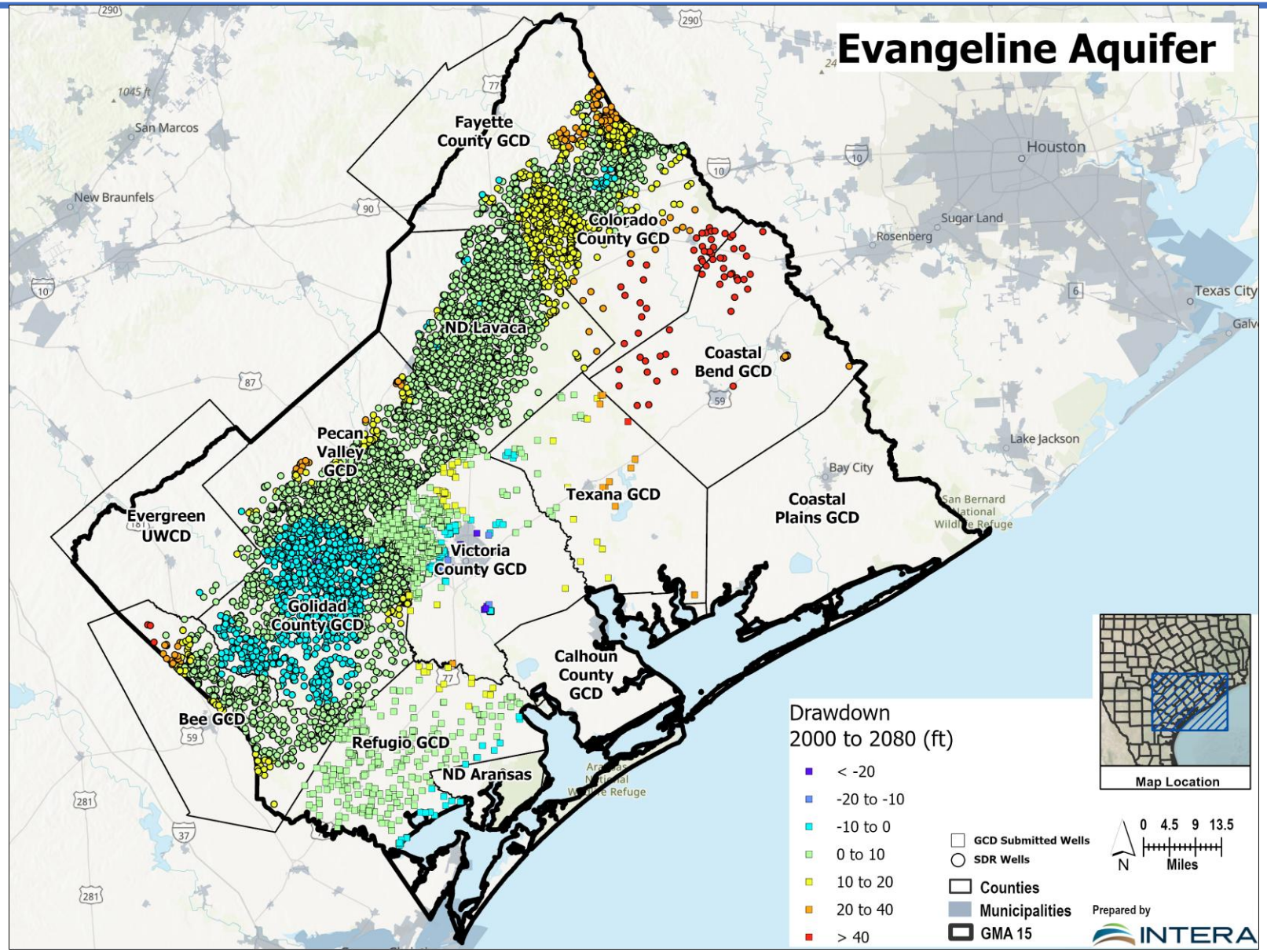
# Chicot Aquifer Impacts

- Water levels decreasing towards northeast and increasing through southwest



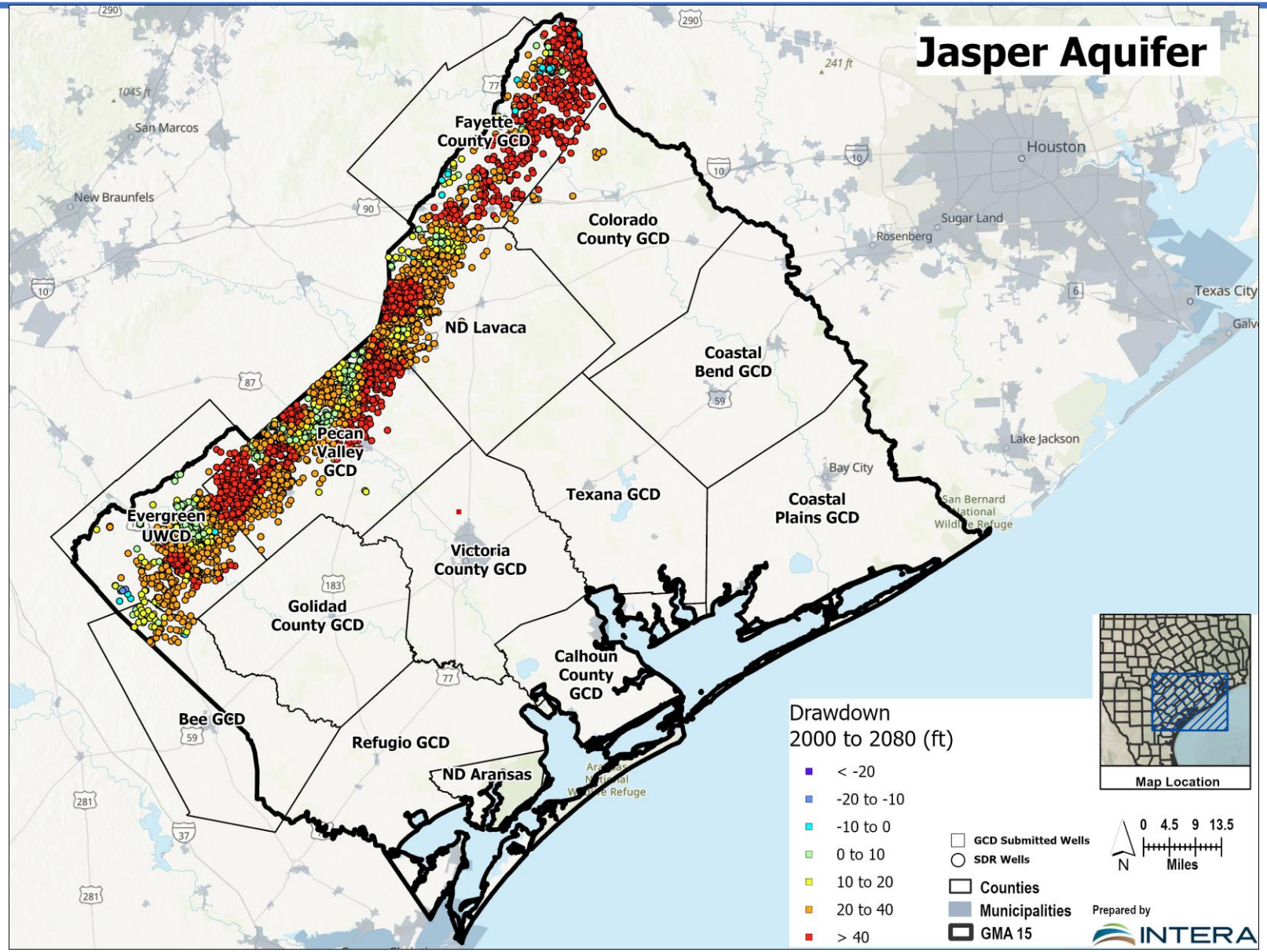
# Evangeline Aquifer Impacts

- Water levels decreasing towards northeast and increasing through southwest

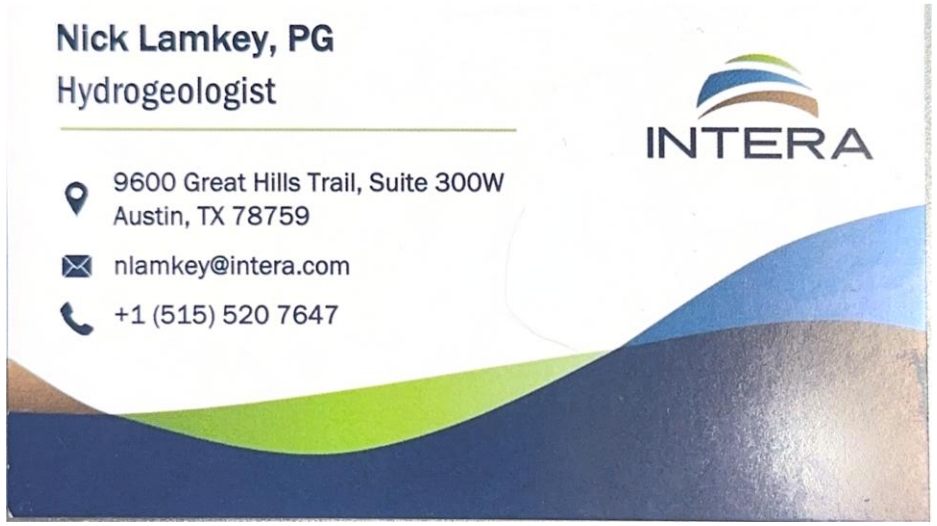


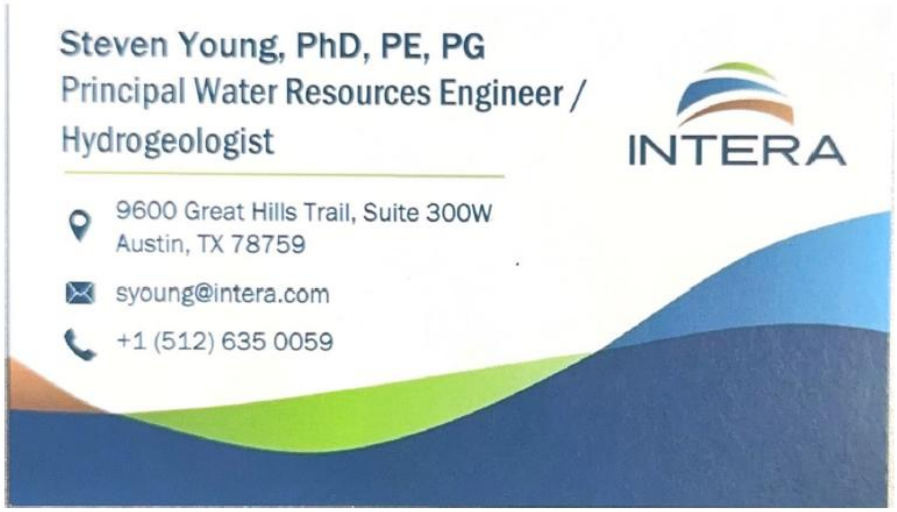
# Jasper Aquifer Impacts

- Water levels decreasing 20+ feet in most areas



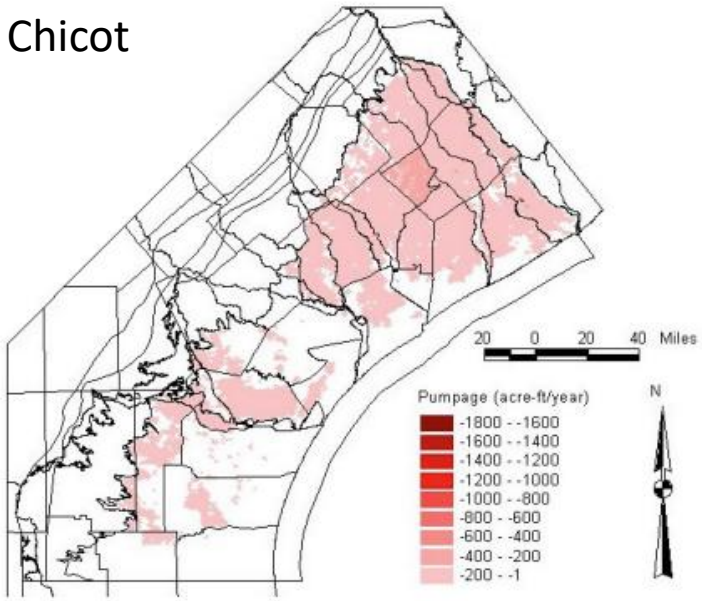
# Questions?


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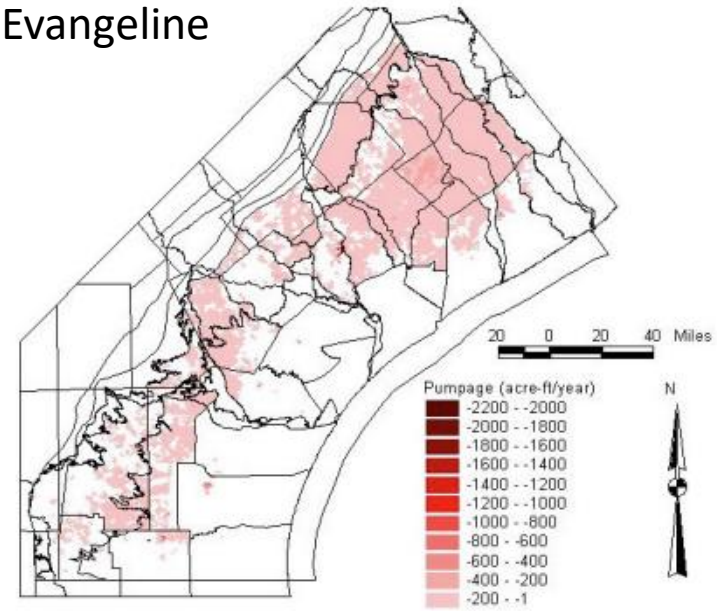

Steven Young, PhD, PE, PG
Principal Water Resources Engineer /
Hydrogeologist
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Austin, TX 78759
syoung@intera.com
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# Pumping Distributions

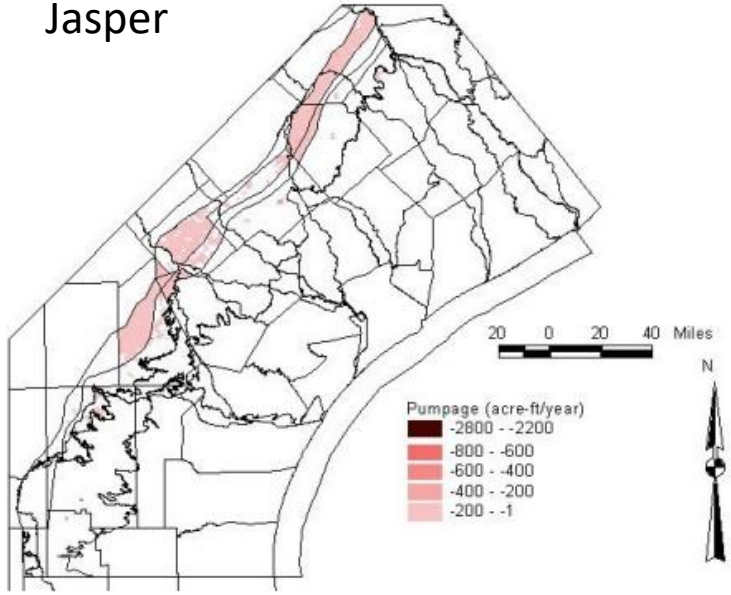
Chicot




Evangeline

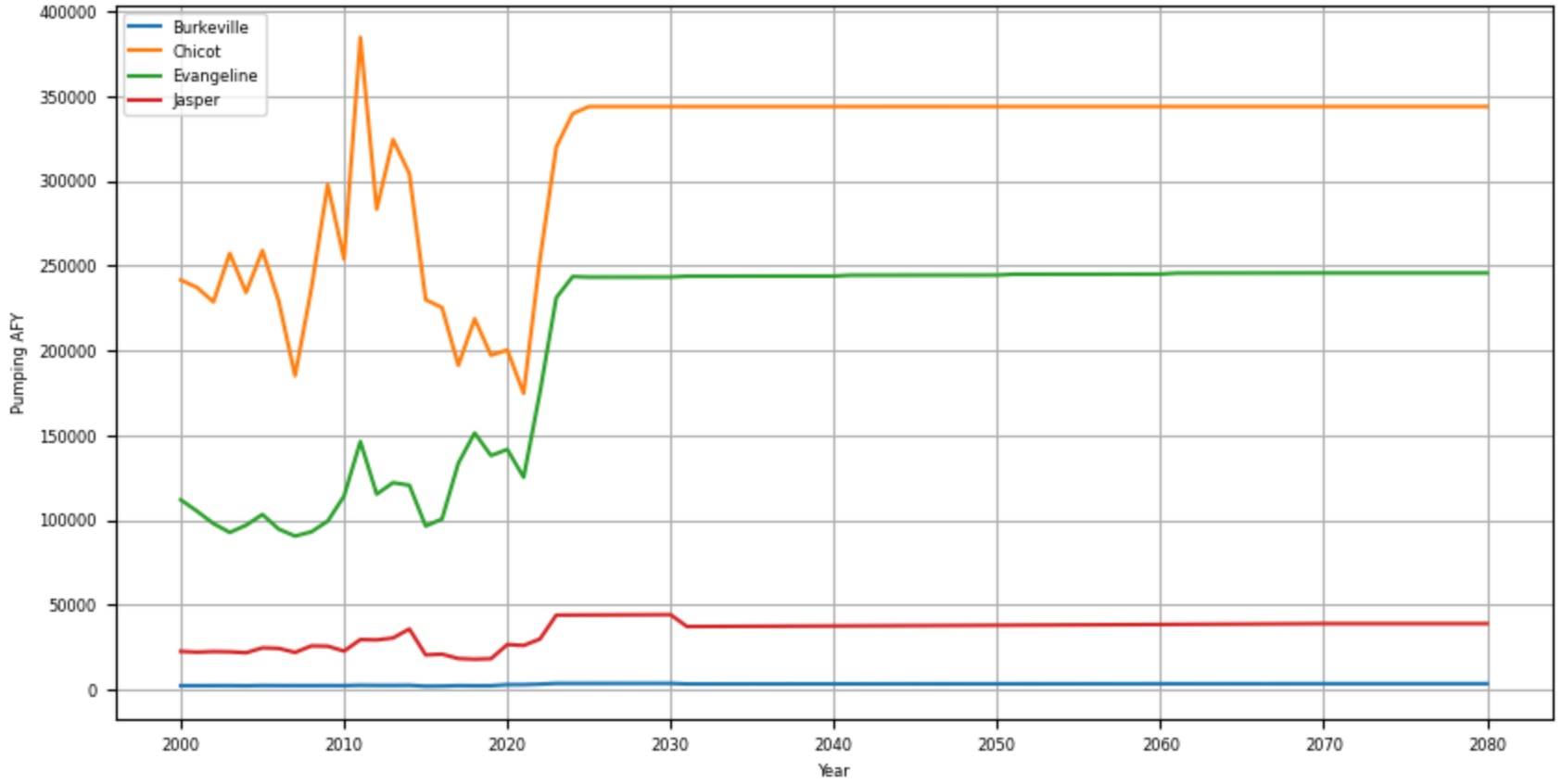



Jasper




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# Current Pumping



# F.6 Impacts of Desired Future Conditions on the Interests and Rights in Private Property

# GMA 15
# Discussion of Nine Factors in TWC 36.108(d): Impacts on the Interests and Rights in Private Property

Groundwater Management Area 15

July 10, 2025




Presented by:
Steven Young Ph.D, PE, PG
Nick Lamkey PG

# Consideration of Potential DFC Impacts

- "Considerations" analyze how property rights could be impacted.
- Impacts ≠ takings in this process
- A GMA must consider the rights of all owners of private property, including all owners of groundwater within the GMA. All interests, whether they favor highest practicable use or conservation, have property rights under the law.
- Impacts may be viewed as both restricting and enhancing property rights.
- Rules adopted by a District to achieve a DFC may have a potential impact on property rights

# Effects on the Balancing Requirement for DFC

**Highest Practicable Use**



**Conservation**

- Interests and rights that are benefitted or enhanced by the present use of groundwater.
- Interests and rights that are benefitted or enhanced by the use of groundwater in the near future.
- Interests and rights that are benefitted or enhanced by the ability to use groundwater over the long-term.
- Interests and rights that are benefitted or enhanced by leaving a significant amount of groundwater in place.

# How DFCs Could Impact Property Rights

- A DFC that allows for lower aquifer levels could favorably impact property interests identified on the “highest practicable use” in the balance; while negatively impacting interests identified as “conservation”



- A DFC that aims for a higher aquifer levels could favorably impact property interests identified as “conservation” in the balance; while negatively impacting interests identified as “highest practicable use”

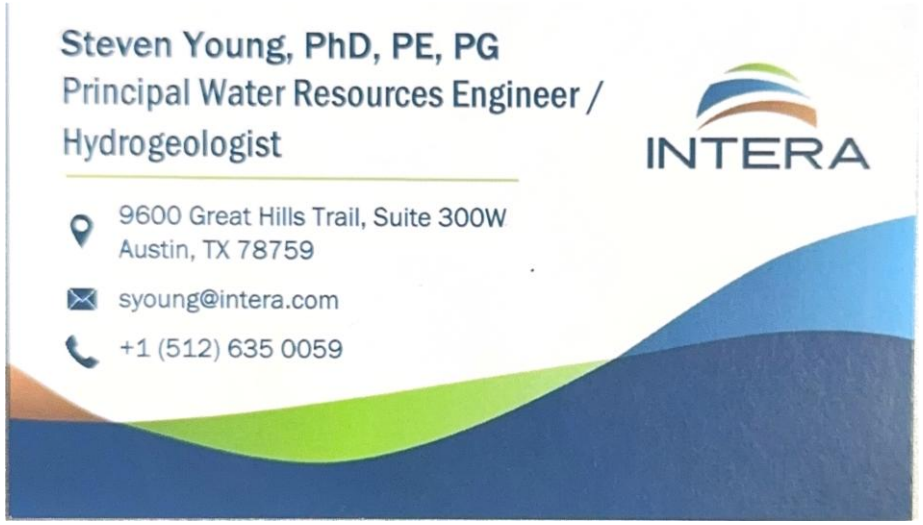
# Potential Impacts on Property Rights of DFCs Favoring "highest practical production"

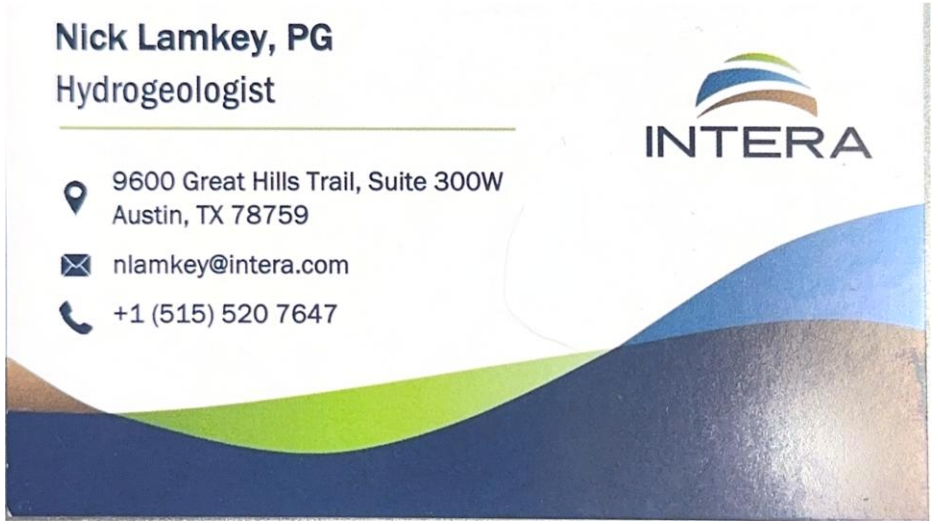
- lenient production restrictions that allow existing users to produce more groundwater with less acreage.
- may endanger long-term water supply and sustainability of groundwater resource
- may endanger springs and promote losing-segments along stream reaches
- may increase interference between groundwater right owners.

# Potential Impacts on Property Rights of DFCs Favoring conservation, preservation, protection, and recharging

- may help abate low spring flows
- may lead to larger acreages for permitted productions
- may extend groundwater supply and levels to reduce costs for well operations
- may extend the productive life of the aquifer.
- may help reduce  interference between groundwater right owners.
- Reduced potential for land subsidence

# Questions?


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# F.7 Subsidence

# GMA 15
# Discussion of Nine Factors in TWC 36.108(d): Subsidence Impacts

Groundwater Management Area 15

April 10, 2025




Presented by:
Steven Young Ph.D, PE, PG
Nick Lamkey PG

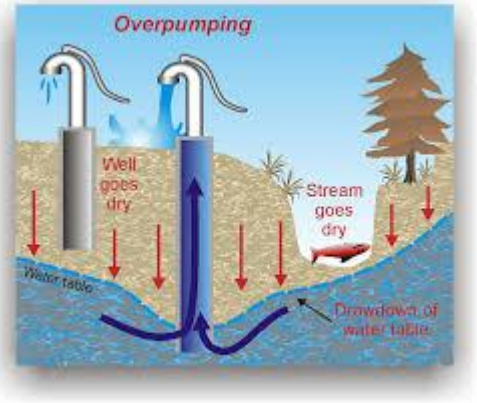
# Agenda

- Causes
- Approach for Estimating Subsidence
- Case Study
- TWDB Vulnerability Matrix
- Options for Modeling Subsidence
- Subsidence Prediction

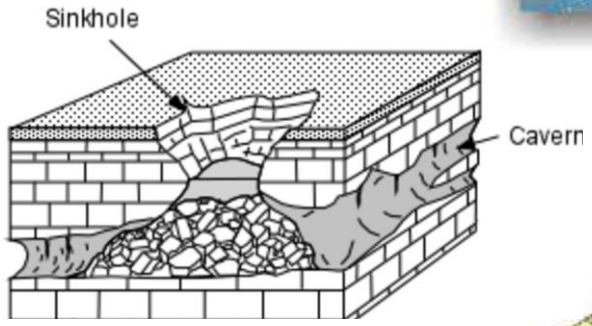
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# Causes of Land Subsidence

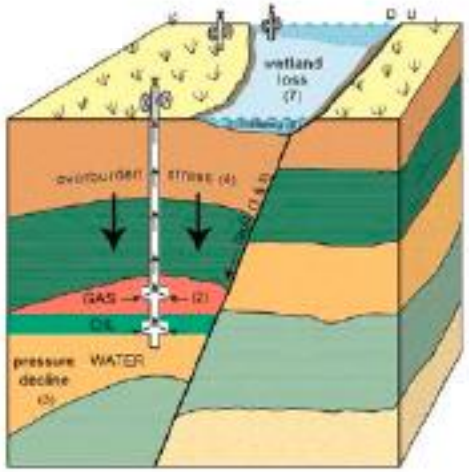
- Compaction-related subsidence can occur because of :
  - Accumulating soft sediments that sink under their own weight over time
  - Dissolution of calcium-rich rocks
  - Over-pumping  of groundwater
  - Removal of high pressurized fluids/gases in oil and gas producing areas
  - Tectonic subsidence occurs from movement along faults




**Collapse**




**Faulting and Geostatic Pressure**

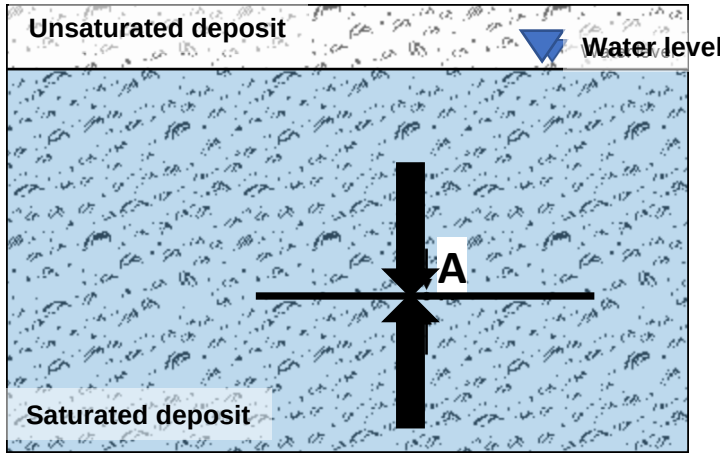


# Land Subsidence Caused by Consolidation of Sediments

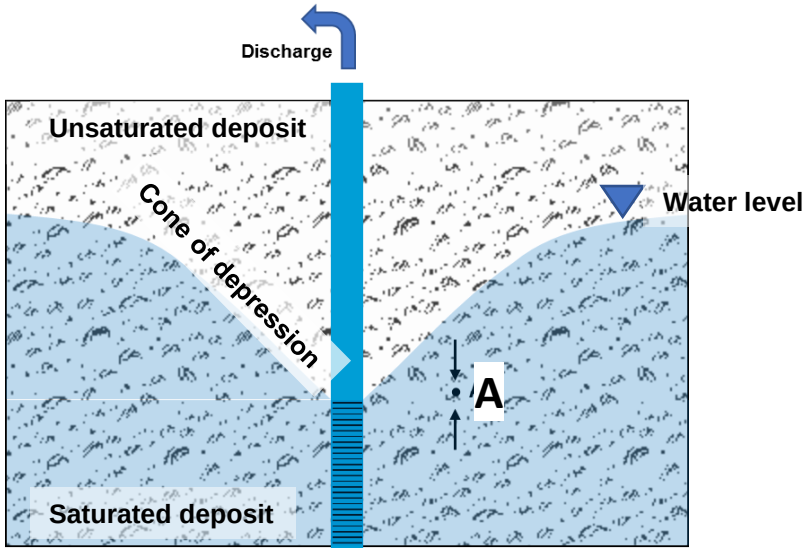
Compressibility of Sediments Occurs As Result of Increased Pressure on Aquifer Matrix:

- Downward force at Point A: weight of soils above Point A minus buoyancy provided by groundwater
- Upward force at Point A: Structural support provided by aquifer-system skeleton and hydraulic pressure of groundwater

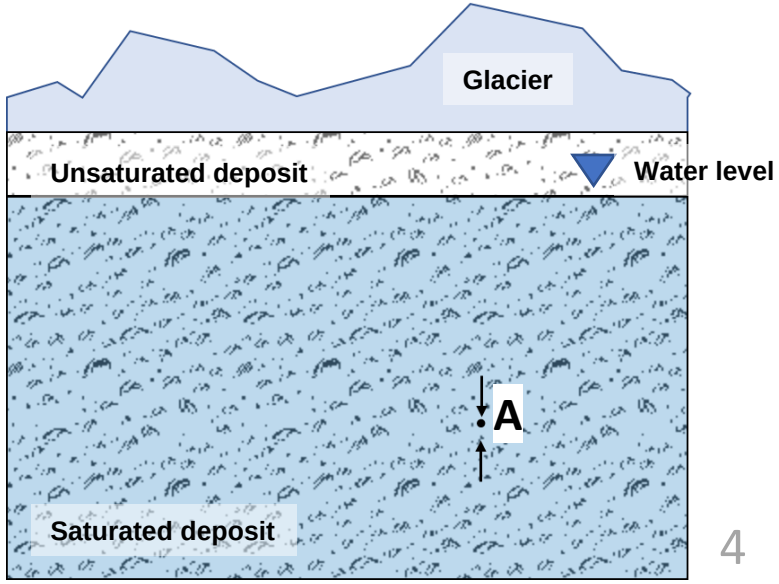
**No Land Subsidence Occurring**




**Land Subsidence Caused by Over Pumping**

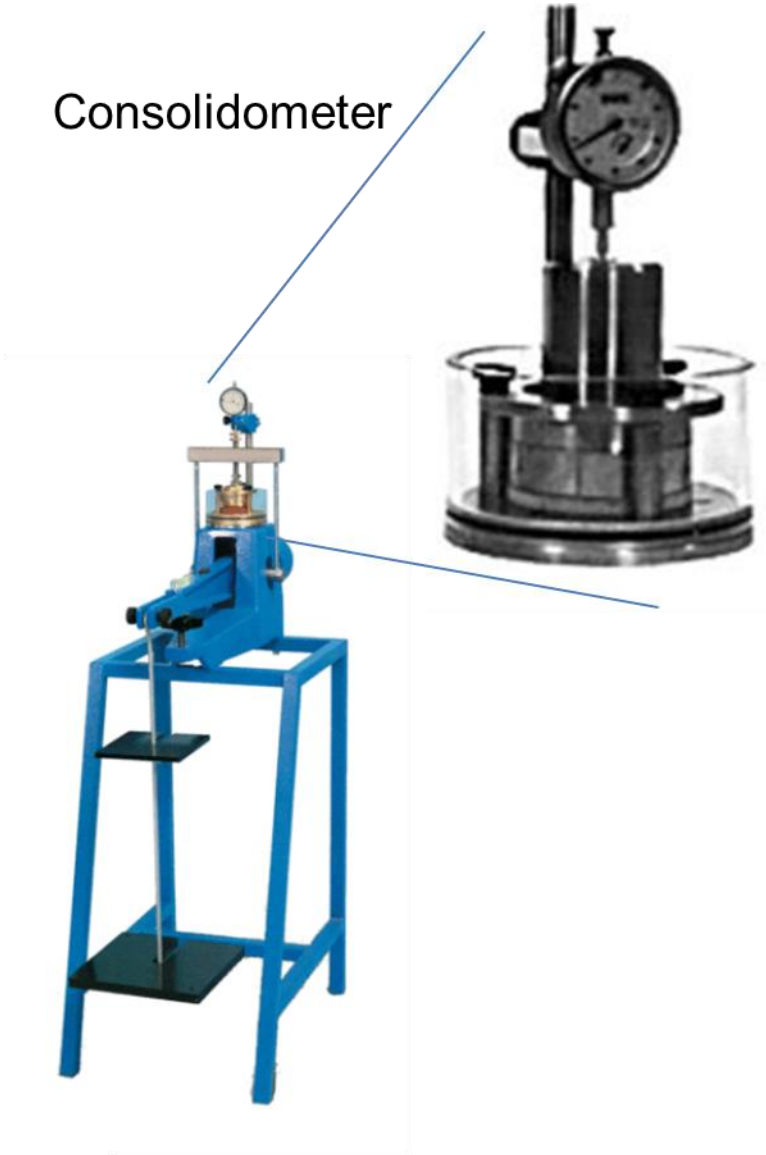



**Land Subsidence Caused by Increased Load**

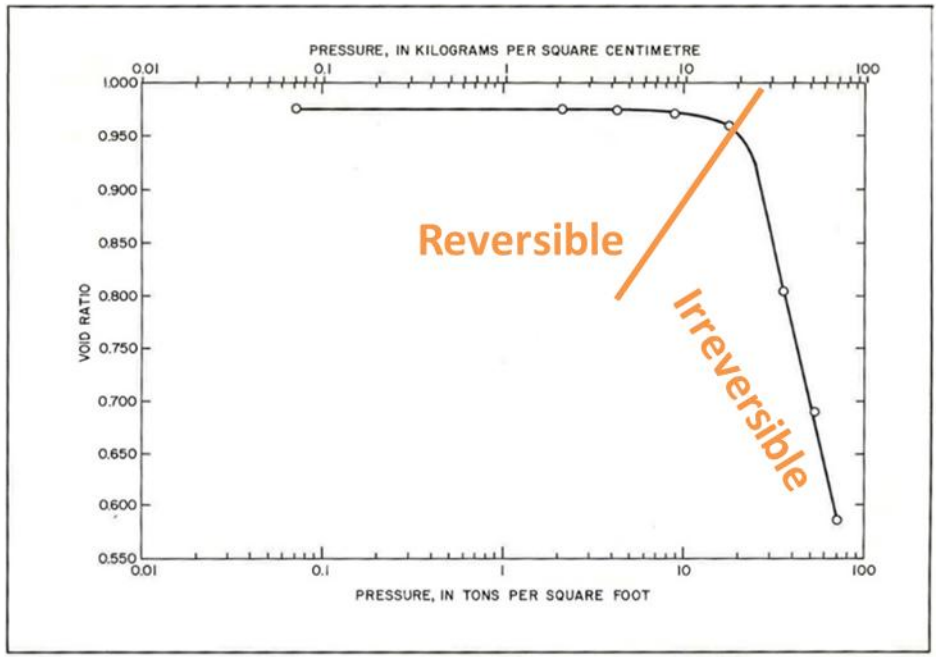



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# Measurement of Compressibility

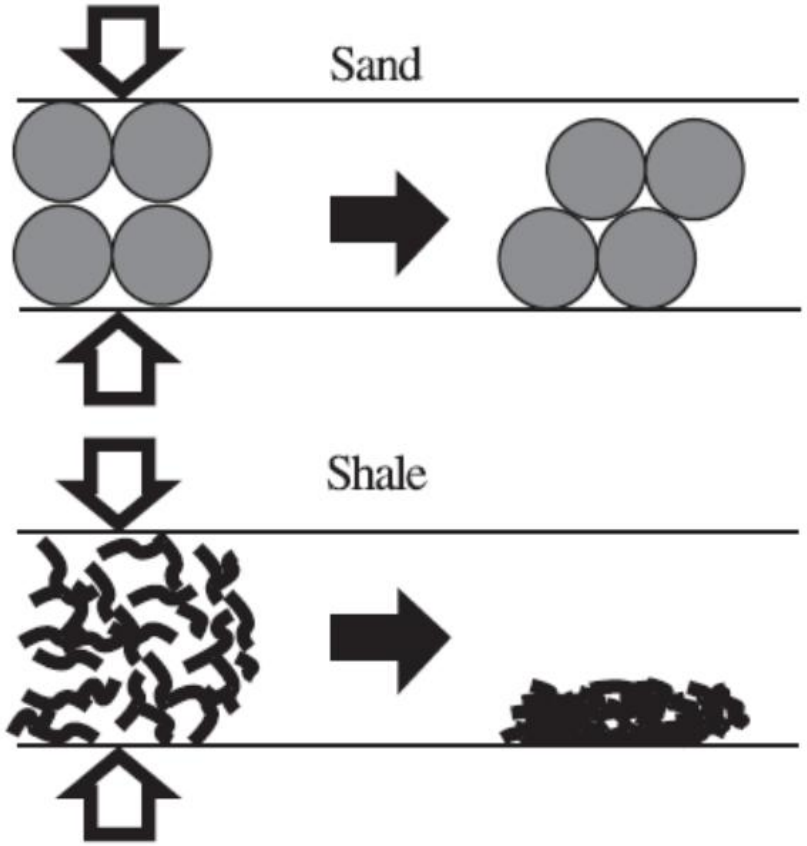



Consolidometer Test Results



# Factors Controlling Land Subsidence

- Three key factors to assess potential for land subsidence:
  - Amount of drawdown
  - Total thickness of clay
  - Compressibility of clay
- Factors affecting Compressibility of Clay:
  - Type of clay
  - Depth of burial
  - Age of clay
  - History of compaction
- Other potentially important factors:
  - Permeability of clay (affects timing)
  - Thickness of individual clay layers




**Schematic showing the reorientation and shifting of sand grains and clay particles associated with compaction caused by increased effective stress**

# Simplified Equation for Estimating Subsidence

$$\Delta b = \Delta d * \alpha_{eff} * C_t$$

Where:

$\Delta b$ = the thickness that the aquifer has compacted (L)

$\Delta d$ = Amount of drawdown in the aquifer since predevelopment (L)

$\alpha_{eff}$ = Effective compressibility coefficient for clays in the aquifer ($L^{-1}$)

$C_t$ = Total thickness of the clay units in the aquifer (L)

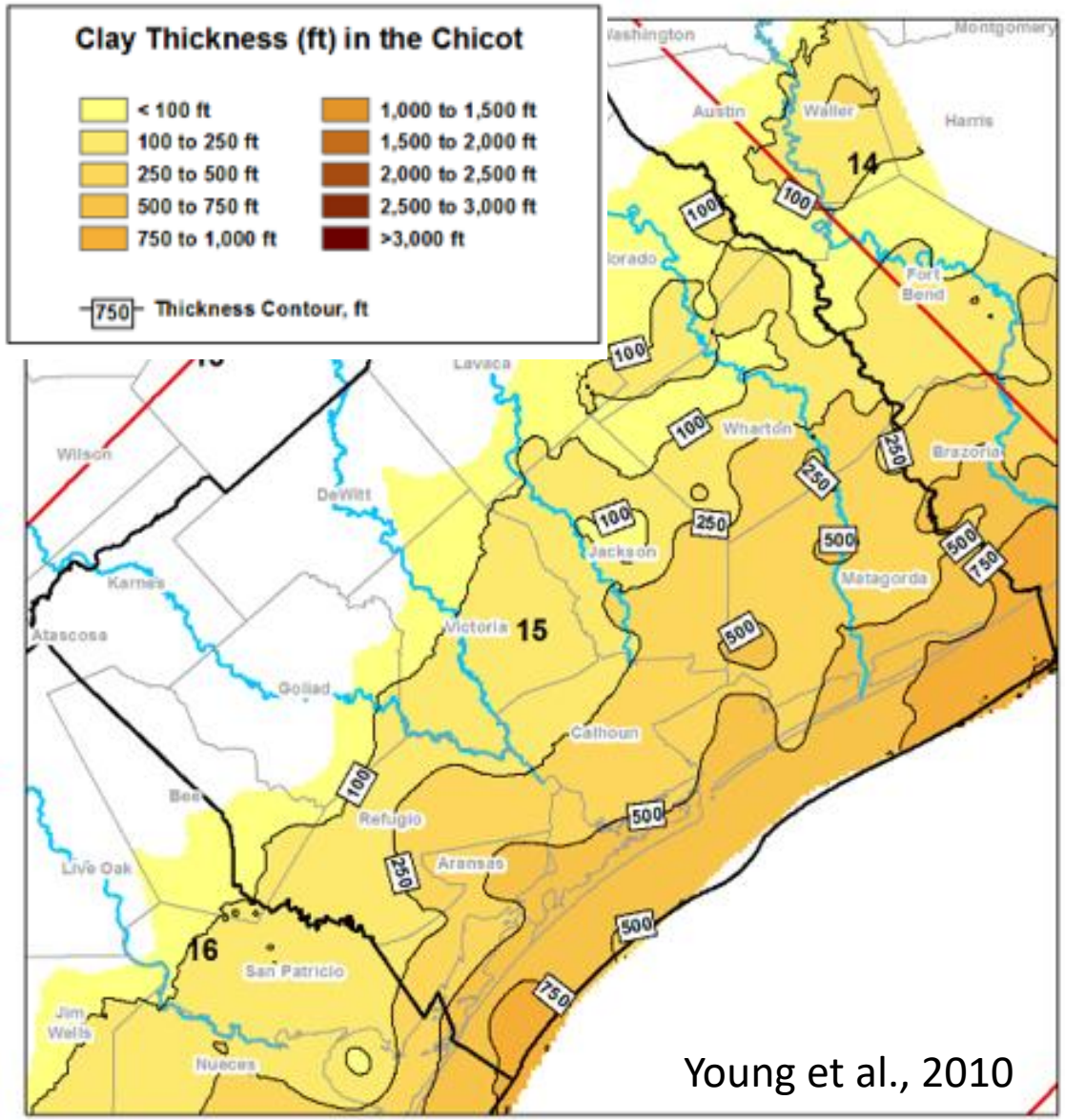
**Gabrysch studies (USGS reports 1975 to 1990)**

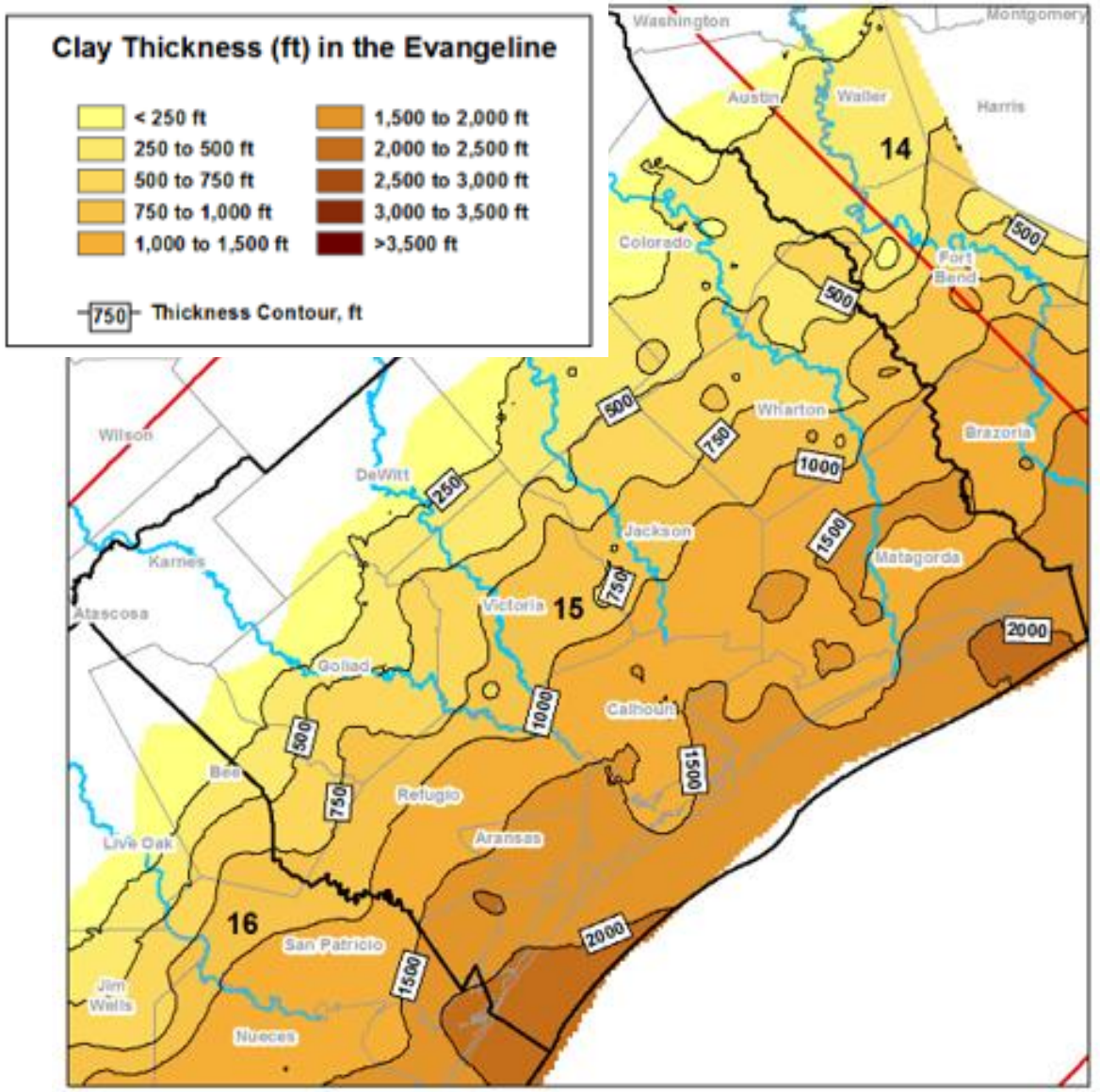
**-- Ct: values range between $7.2 \times 10^{-6}$ $ft^{-1}$ and $4.0 \times 10^{-5}$ $ft^{-1}$**

**average and geometric average of the values are $2.1 \times 10^{-5}$ $ft^{-1}$ and $1.8 \times 10^{-5}$ $ft^{-1}$**

INTERA

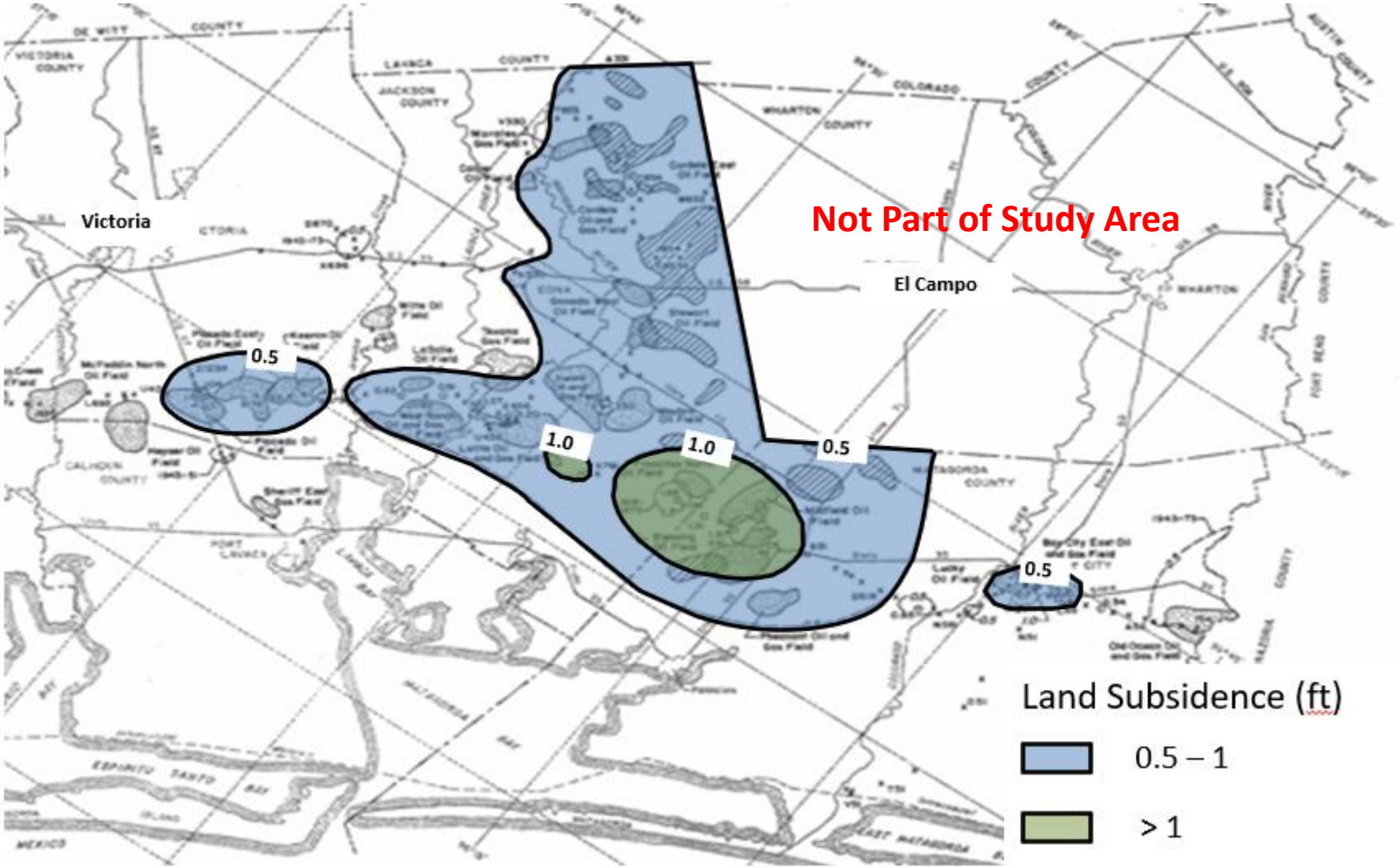
# Clay Thicknesses:



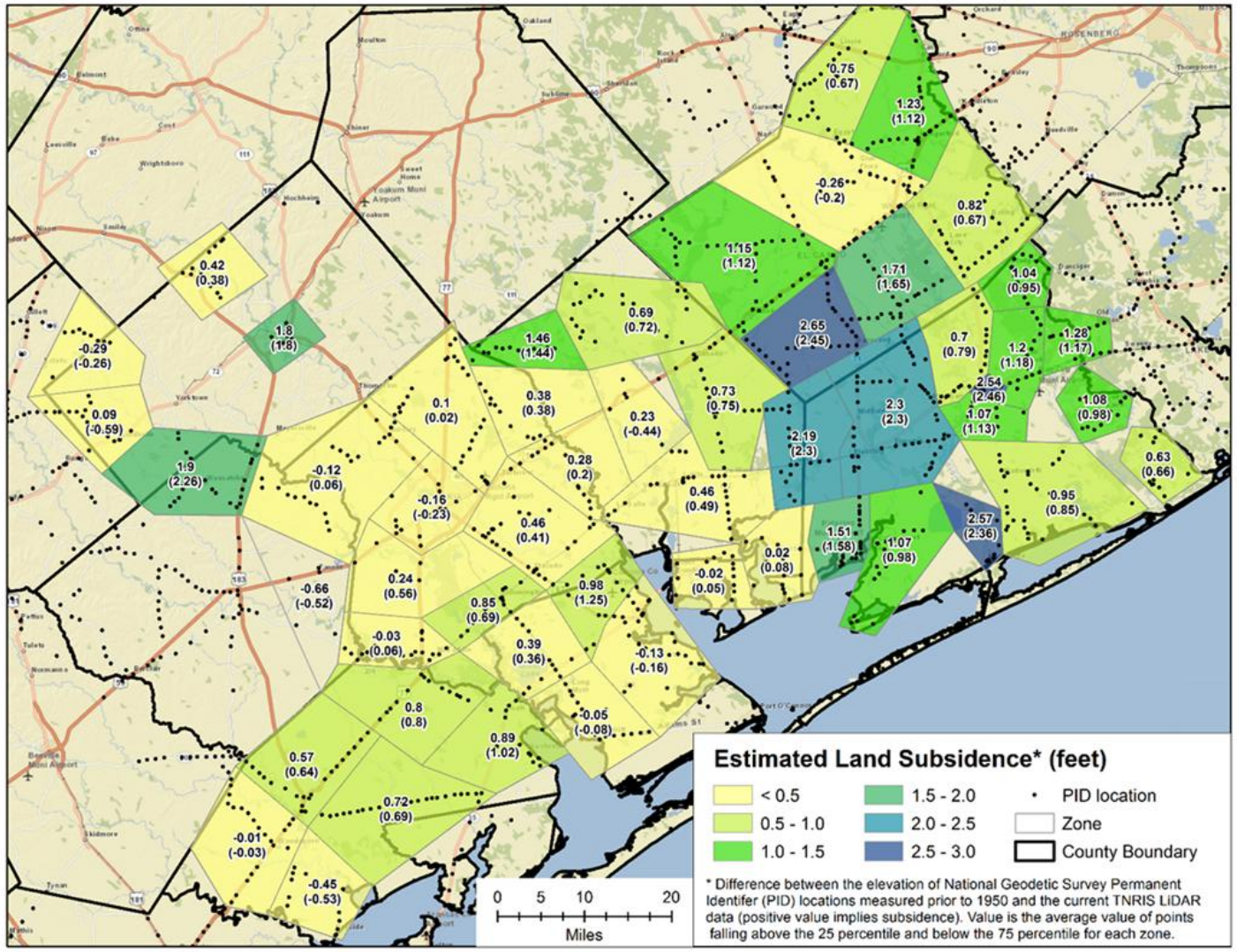



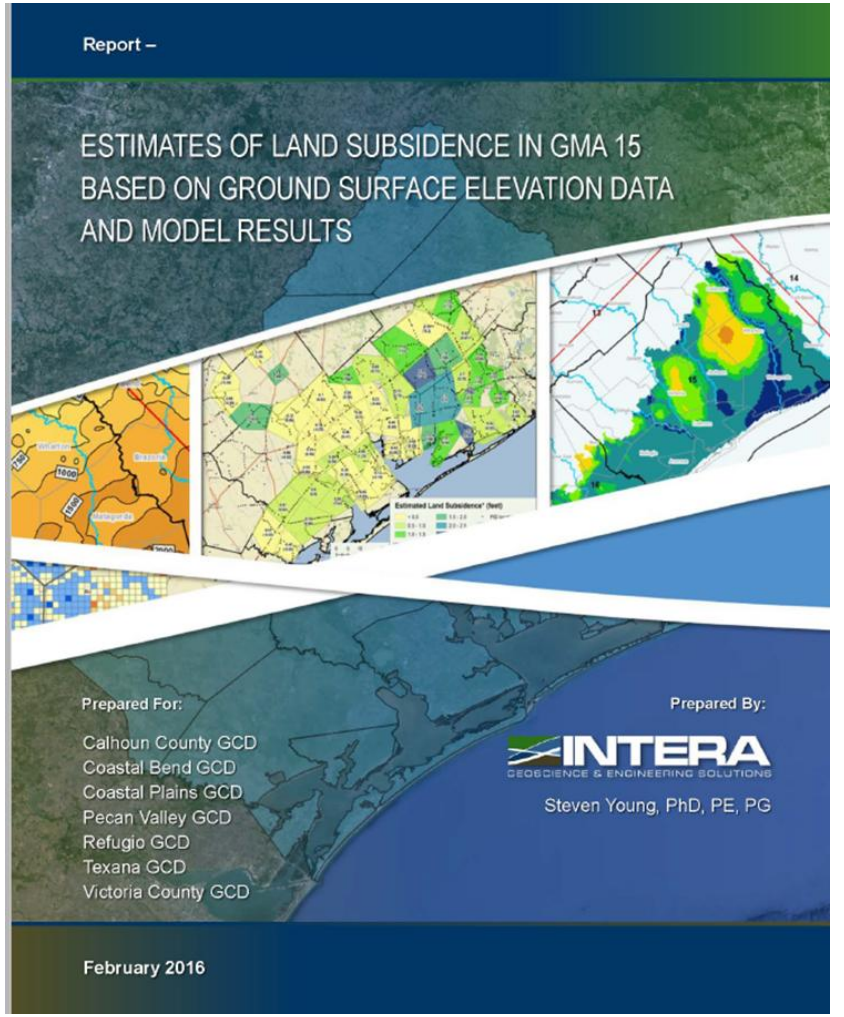

Young et al., 2010

# Documented Cases: 1918 to 1973 (Ratzlaff, 1982)

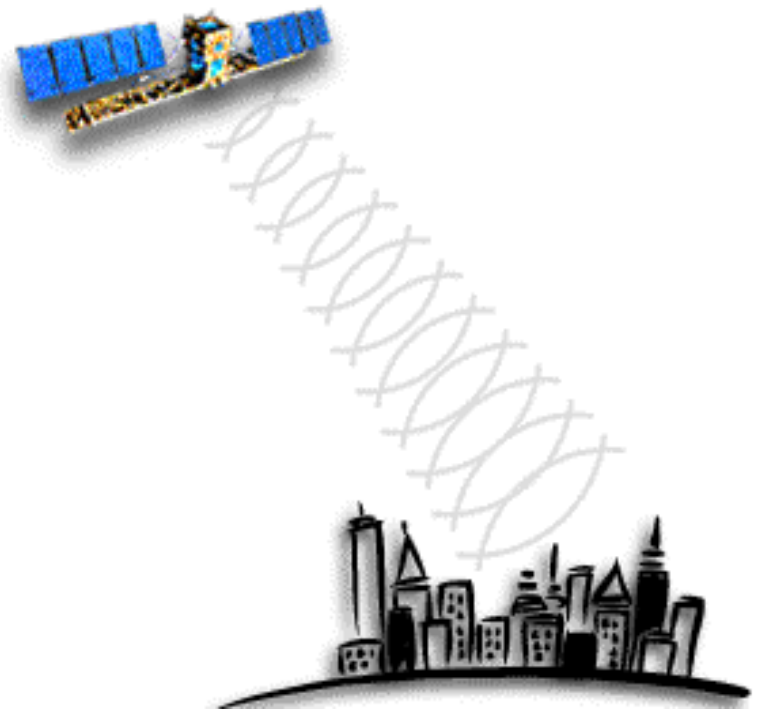


# Documented Cases: ~1950 to 2013 (INTERA, 2016)



# Radar and Remote Sensing



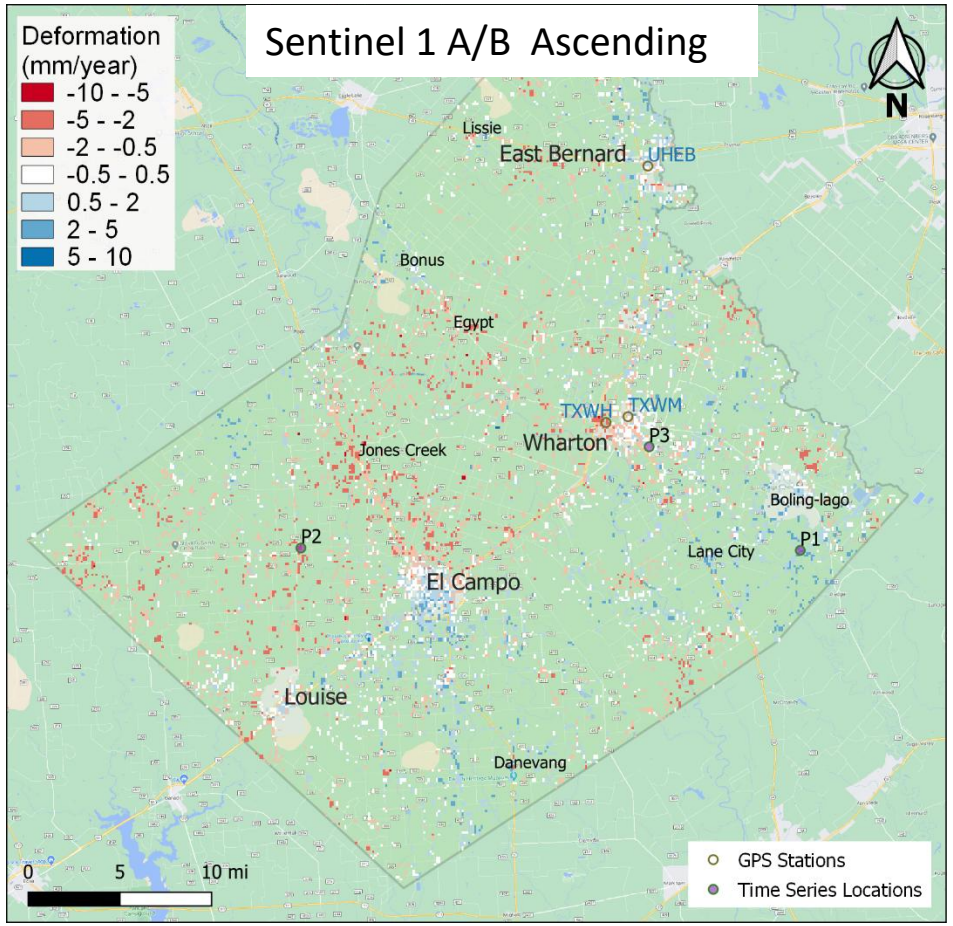
In its simplest form, a radar operates by:

- Sending a signal into space - when the signal encounters an object then some of the signal redirected back to the radar antenna
- Receiving the “echoed” signal back from the encountered objects

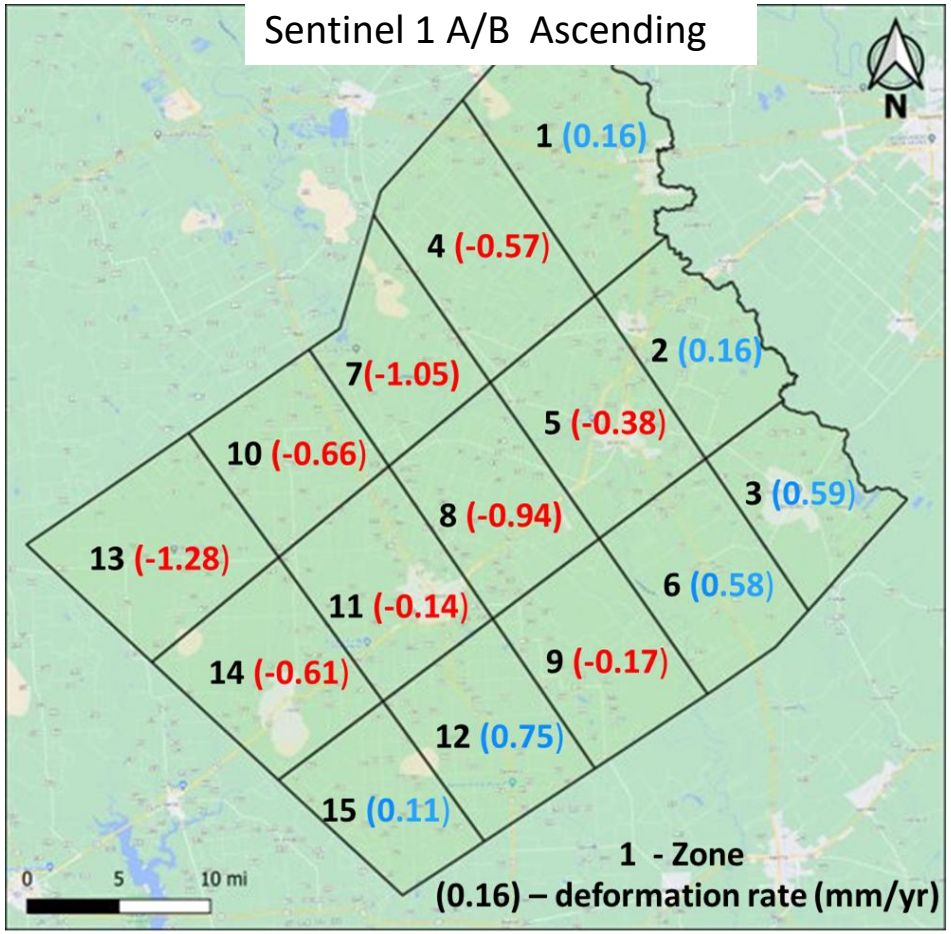
Precise timing of the echo delays allows determining of the distance and or “range”

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# Application of INSAR: Wharton County (Young, 2020)



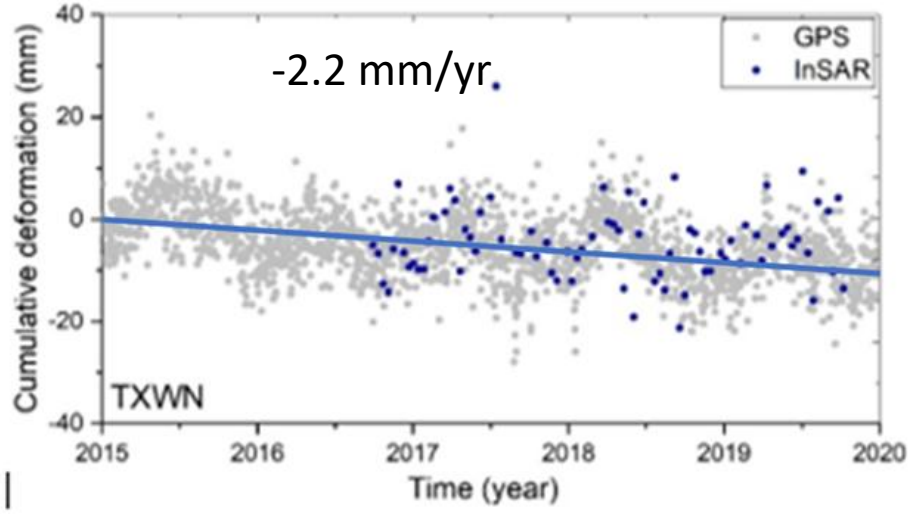

Deformation is average over 2016 to 2019




IN (Young et al., 2020)

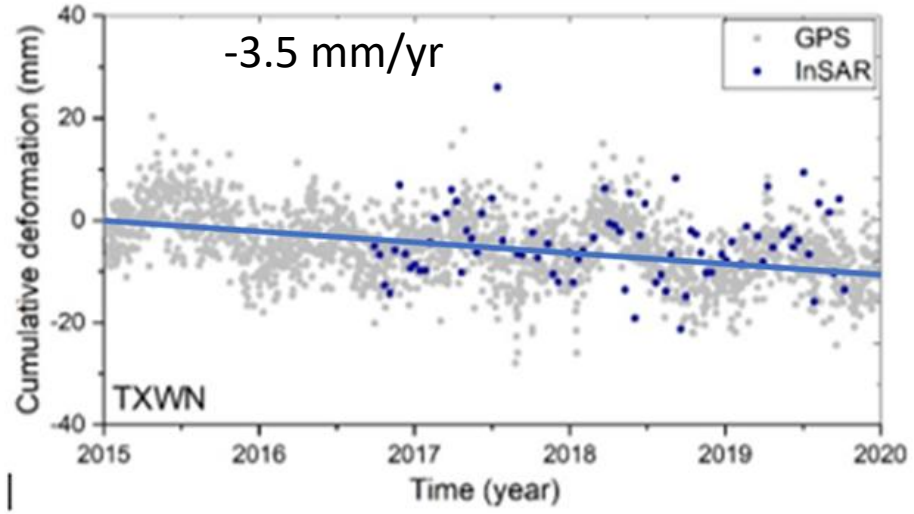
# Comparison Between CORS and InSAR Deformation Rates

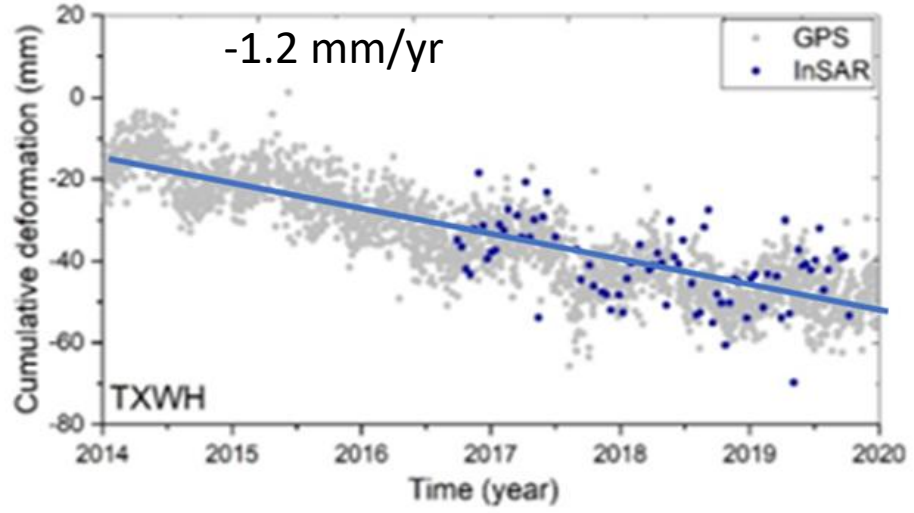
- Wharton County (Young et al. 2020)




- Ascending data has 75 to 80 data points from 2016 to 2019

- Slope of blue line provides deformation rate



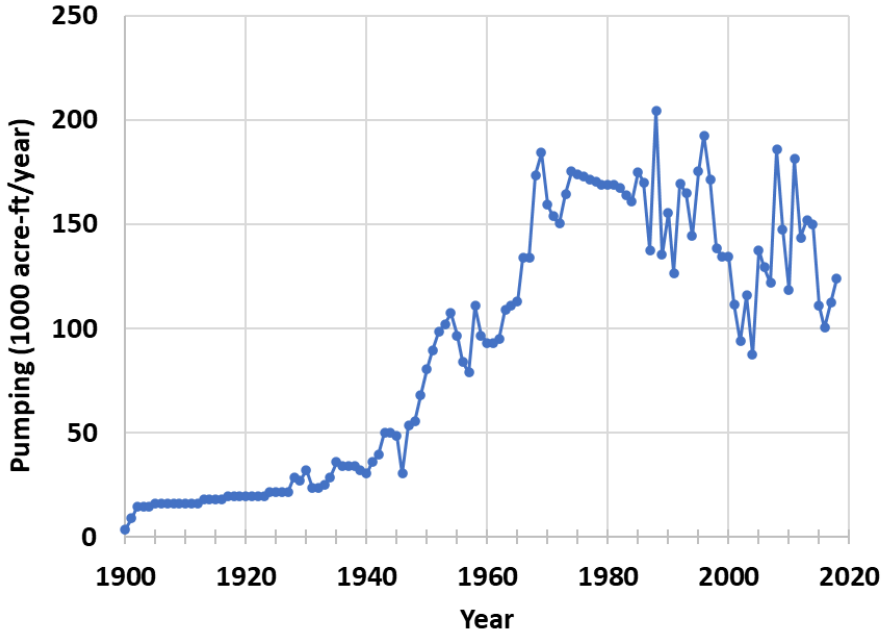

**(Young et al., 2020)**

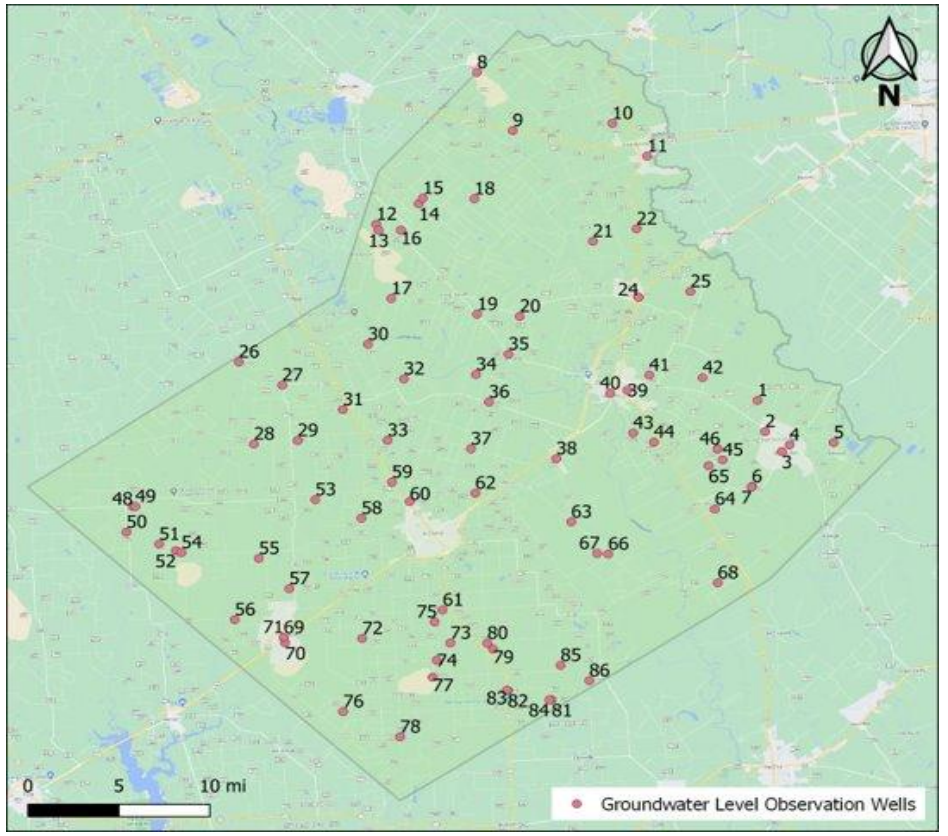
# Rationale for Low Subsidence Rates: Water Levels

- Wharton County (Young et al. 2020)

1.) Water levels have been relatively stable the last twenty years at 86 well locations

2) Average for recent annual productions lower than 1965-1965 averages



# TWDB Risk Vulnerability Matrix*:

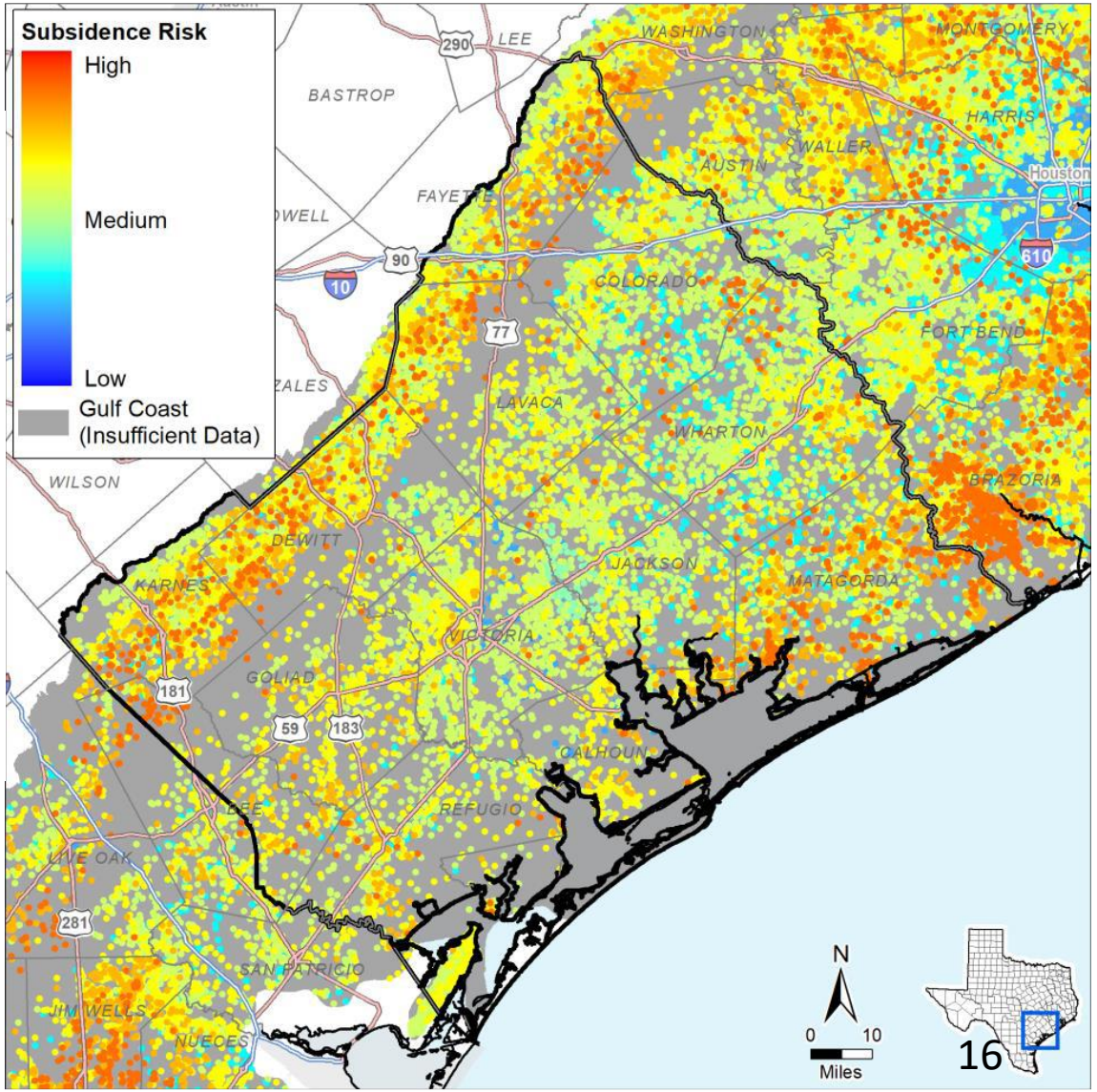
| Subsidence Risk Factor (Weight) | Subsidence Risk Factor Class | Subsidence Risk Value | Max Score |
|---|---|---|---|
| Clay Layer Saturated Thickness and Extent (6) | Regional Extent – Greater than 300 feet | 5 | 30 |
| | Regional Extent – 200 to 300 feet | 4 | |
| | Regional Extent – 100 to 200 feet | 3 | |
| | Regional Extent – Greater than 0 to 100 feet | 2 | |
| | Local Extent or No Clay | 1 | |
| Clay Compressibility (5) | Plastic Clay | 3 | 15 |
| | Stiff Clay | 2 | |
| | Hard or No Clay | 1 | |
| Aquifer Lithology (4) | Unconsolidated Clastic | 4 | 16 |
| | Consolidated Clastic | 3 | |
| | Carbonate/Evaporite | 2 | |
| | Igneous | 1 | |
| Preconsolidation Characterization (3) | Current Static Water Level Less than Historic Low Water Level Plus 25 Feet | 3 | 9 |
| | Current Static Water Level Greater than Historic Low Water Level Plus 25 Feet and Less than Historic Low Water Level Plus 50 Feet | 2 | |
| | Current Static Water Level Greater than Historic Low Water Level Plus 50 Feet | 1 | |
| Predicted 50-Year Water Level Decline based on Trend (2) | Greater than 200 feet | 5 | 10 |
| | Between 100 and 200 feet | 4 | |
| | Between 50 and 100 feet | 3 | |
| | Between 0 and 50 feet | 2 | |
| | Less than 0 feet | 1 | |
| Predicted DFC* Water Level Decline (1) | Greater than 200 feet | 5 | 5 |
| | Between 100 and 200 feet | 4 | |
| | Between 50 and 100 feet | 3 | |
| | Between 0 and 50 feet | 2 | |
| | Less than 0 feet | 1 | |
| *DFC = Desired Future Condition | | | 85 |

*Furnans and others, 2017

# Potential Concerns with Land-Subsidence Study

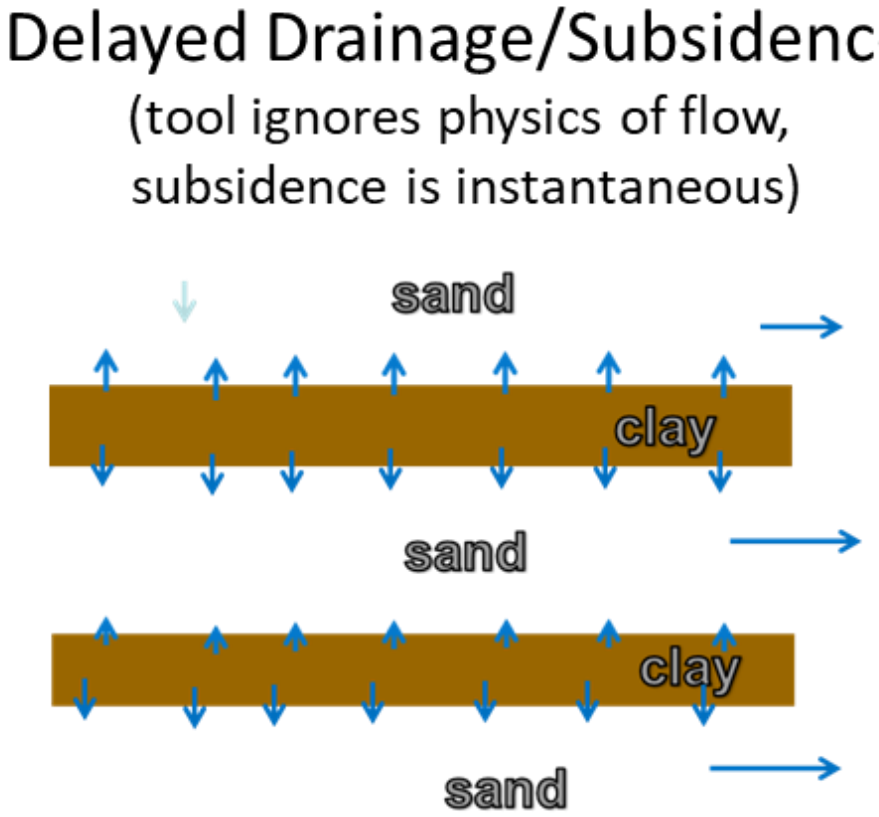
**Table 1.2. High total weighted risk by aquifer (ranked by third quartile cutoff).**

| Aquifer | Aquifer Type | Predominant Aquifer Lithology | Number of Wells Analyzed | Average Aquifer Thickness (ft) | Average Clay Thickness within Aquifer (ft) | Estimated Water Level Trend (negative for decline) (ft/year) | Third Quartile Cutoff on Total Weighted Risk for All Wells Analyzed in Aquifer | Weighted Subsidence Risk Category |
|---|---|---|---|---|---|---|---|---|
| Gulf Coast | Major | Unconsolidated Clastic | 105,292 | 650 | 66 | -0.000167 | 5.9 | High: Subsidence Risk is high with high subsidence risk in large areas of the aquifer |
| Yegua-Jackson | Minor | Unconsolidated Clastic | 3,373 | 828 | 110 | 0.0000372 | 5.9 | |
| Pecos Valley | Major | Unconsolidated Clastic | 1,952 | 549 | 36 | -0.266 | 5.5 | |
| Hueco-Mesilla Bolson | Major | Unconsolidated Clastic | 2,360 | 810 | 23 | -0.00276 | 5.4 | |
| Brazos River Alluvium | Minor | Unconsolidated Clastic | 985 | 54 | 1 | -0.000237 | 5.3 | |
| Ogallala | Major | Unconsolidated Clastic | 63,522 | 223 | 17 | -0.864 | 5.2 | |
| Carrizo-Wilcox | Major | Unconsolidated Clastic | 23,519 | 401 | 66 | -0.332 | 4.7 | |



# Concerns with Subsidence Risk Vulnerability Matrix

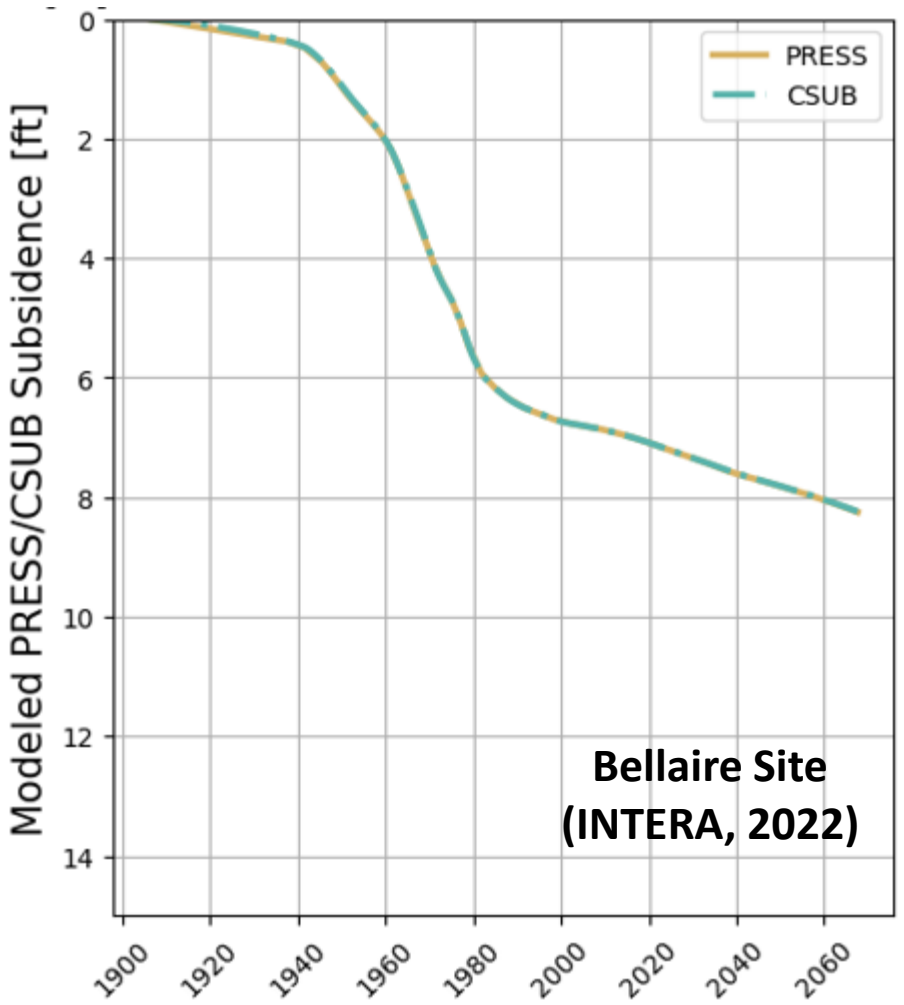
- Unclear what the risk factor for subsidence vulnerability represents
  - important factors are missing such as age of clay, permeability of clay, type of clay, and depth or burial
  - no data to show a correlation of risk factor and actual land subsidence
- No maps of measured land subsidence in report
- No validation or checking of tool for predicting subsidence with measured subsidence



# Options for Predicting Subsidence

- PRESS Model
  - 1-Dimensional
  - Needs to drawdown inputs
  - Helm, 1975
  - Used >15 years in Harris County
  - 26 sites

- CSUB Model
  - 1-Dimensional
  - Modflow-based (Hughes et al, 2022)
  - Two Solution Schemes
    - Water Pressure Solution
    - Effective Stress Solution



# Predictions Using Simplified Assumptions (No Physics)

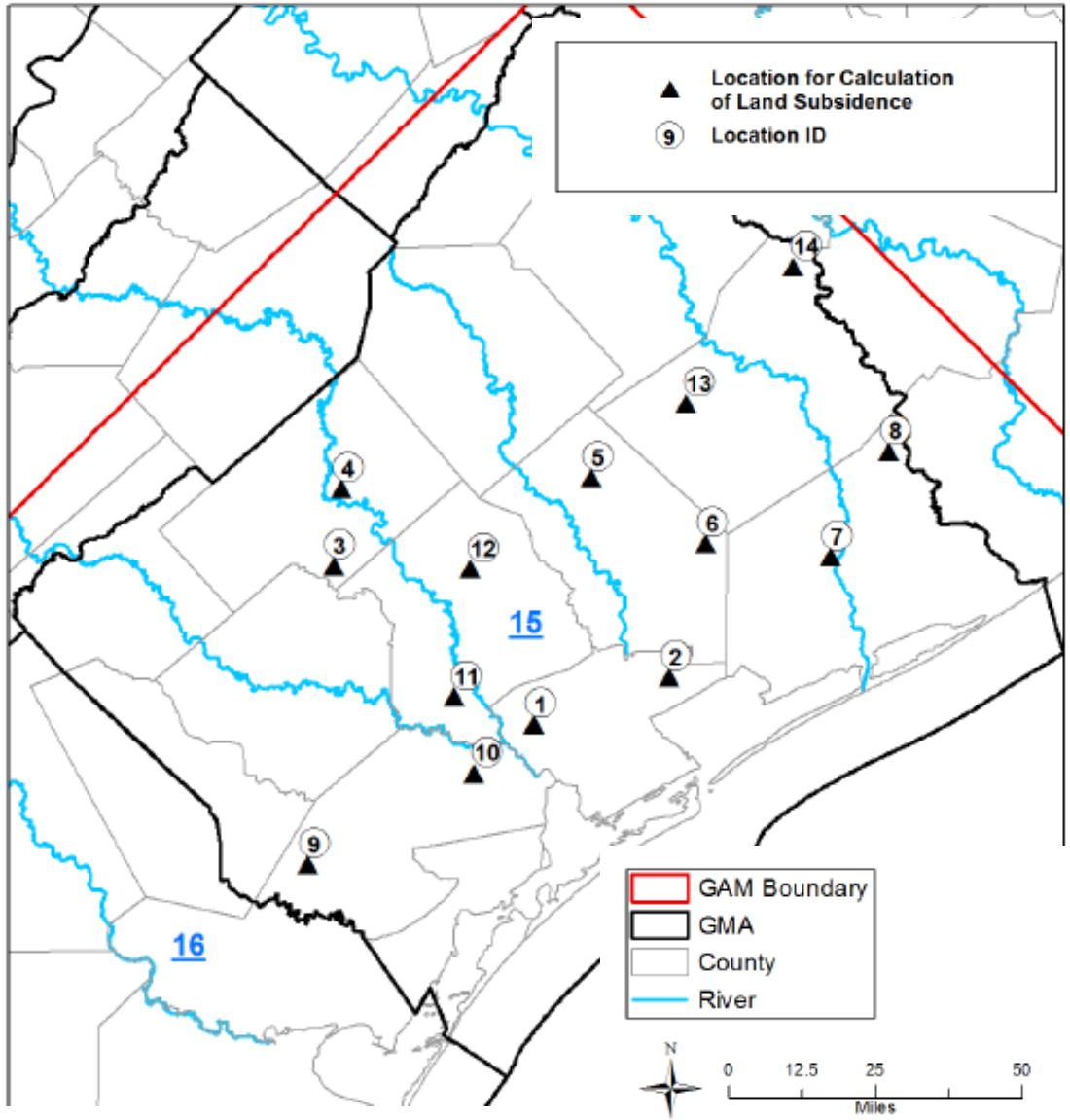
$$\Delta b = \Delta d * \alpha_{eff} * C_t$$

$\Delta b$ = subsidence

$\Delta d$ = drawdown

$\alpha_{eff}$ = compressibility coefficient

$C_t$ = clay thickness



# Predictions Using Simplified Assumptions (No Physics)

$$\Delta b = \Delta d * \alpha_{eff} * C_t$$

$\Delta b$ = subsidence

$\Delta d$ = drawdown

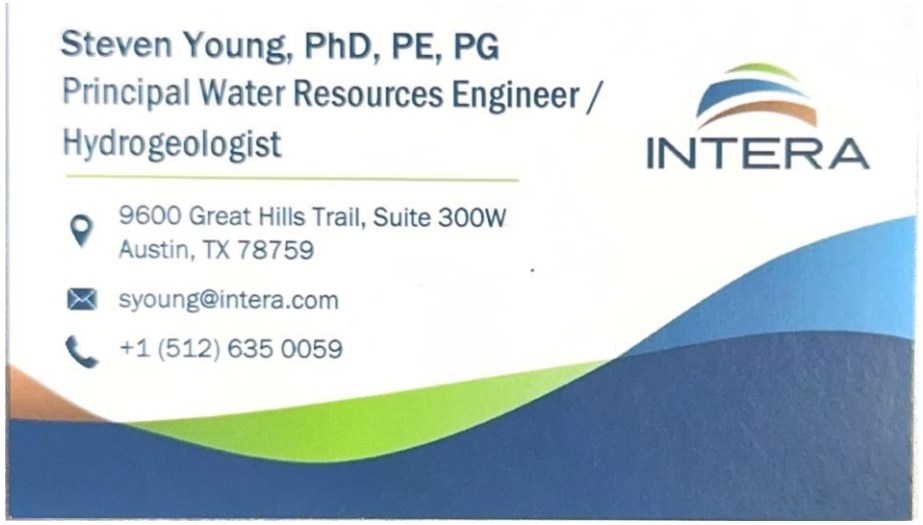
$\alpha_{eff}$ = compressibility coefficient

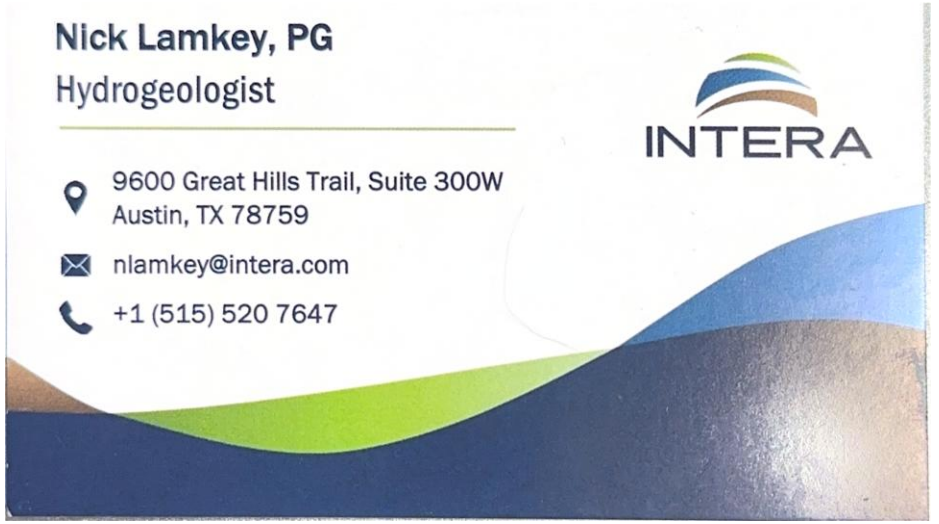
$C_t$ = clay thickness

Table 6-1 Land subsidence predicted at fourteen sites in GMA 15 using Equation 6-1 with a αeff of 2.0x10-5 ft-1, drawdown simulated by the Central Gulf Coast GAM (Chowdhury and others, 1999), and clay thickness data from Young and others (2010; 2012)

| ID | County | Drawdown (ft) | | | | | | | | Clay Thickness (ft) | | | | Land Subsidence (ft) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Chicot | | Evangeline | | Burkeville | | Jasper | | | | | | | |
| | | 1940-2000 | 1940-2070 | 1940-2000 | 1940-2070 | 1940-2000 | 1940-2070 | 1940-2000 | 1940-2070 | Chicot | Evangeline | Burkeville | Jasper | 1940-2000 | 1940-2070 |
| 1 | Calhoun | 7.4 | 3.4 | 12.4 | 18.9 | - | - | - | - | 226 | 1299 | 418 | 925 | 0.4 | 0.5 |
| 2 | Calhoun | -0.8 | 2.2 | 22.9 | 40.6 | - | - | - | - | 369 | 1442 | 407 | 1377 | 0.7 | 1.2 |
| 3 | Dewitt | - | - | 0.8 | 1.0 | 3.4 | 9.8 | 7.9 | 24.1 | - | 349 | 318 | 516 | 0.1 | 0.3 |
| 4 | Dewitt | - | - | 9.5 | 15.6 | 51.7 | 73.0 | 142.3 | 185.2 | - | 116 | 331 | 537 | 1.9 | 2.5 |
| 5 | Jackson | 18.7 | 55.7 | 64.7 | 88.1 | 39.2 | 56.3 | 22.0 | 45.4 | 139 | 683 | 224 | 618 | 1.4 | 2.2 |
| 6 | Jackson | 12.1 | 32.4 | 55.9 | 78.4 | 33.0 | 52.6 | - | - | 360 | 1096 | 339 | 966 | 1.5 | 2.3 |
| 7 | Matagorda | -1.7 | 1.2 | 39.4 | 57.4 | - | - | - | - | 482 | 1569 | 652 | 1220 | 1.2 | 1.8 |
| 8 | Matagorda | 2.1 | 0.8 | 37.9 | 49.0 | 13.1 | 27.0 | - | - | 203 | 1264 | 415 | 1400 | 1.1 | 1.5 |
| 9 | Refugio | 5.2 | 1.8 | 3.4 | 10.1 | -0.1 | 3.9 | - | - | 128 | 835 | 270 | 722 | 0.1 | 0.2 |
| 10 | Refugio | 0.3 | 1.2 | 4.1 | 15.5 | - | - | - | - | 264 | 1141 | 264 | 726 | 0.1 | 0.4 |
| 11 | Victoria | 5.0 | 8.0 | 13.2 | 40.1 | 1.7 | 6.4 | - | - | 207 | 757 | 225 | 550 | 0.2 | 0.7 |
| 12 | Victoria | 27.0 | 34.9 | 45.3 | 52.5 | 38.0 | 43.9 | 26.2 | 33.0 | 108 | 605 | 190 | 785 | 1.2 | 1.4 |
| 13 | Wharton | 75.4 | 94.1 | 156.7 | 149.8 | 61.9 | 90.2 | 27.9 | 59.9 | 84 | 780 | 266 | 610 | 3.2 | 3.7 |
| 14 | Wharton | 8.7 | 27.5 | 57.4 | 91.0 | 44.5 | 80.9 | 38.2 | 72.2 | 78 | 599 | 287 | 842 | 1.6 | 2.8 |

# Questions?


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# F.8 Feasibility of Achieving DFCs

# GMA 15
# Feasibility of DFCs

Groundwater Management Area 15

January 8, 2025




Presented by:
Nick Lamkey PG

# Overview: Trend Analysis of Water Levels

- Combined Water Levels from GCD's and TWDB GWDB
- Similar analysis as the last round of joint planning
- The goal is to look at the model and measured water levels to assess whether the model is representing system behavior
- There are some limitations using this type of analysis but it provides useful information and some insight into how the model is performing

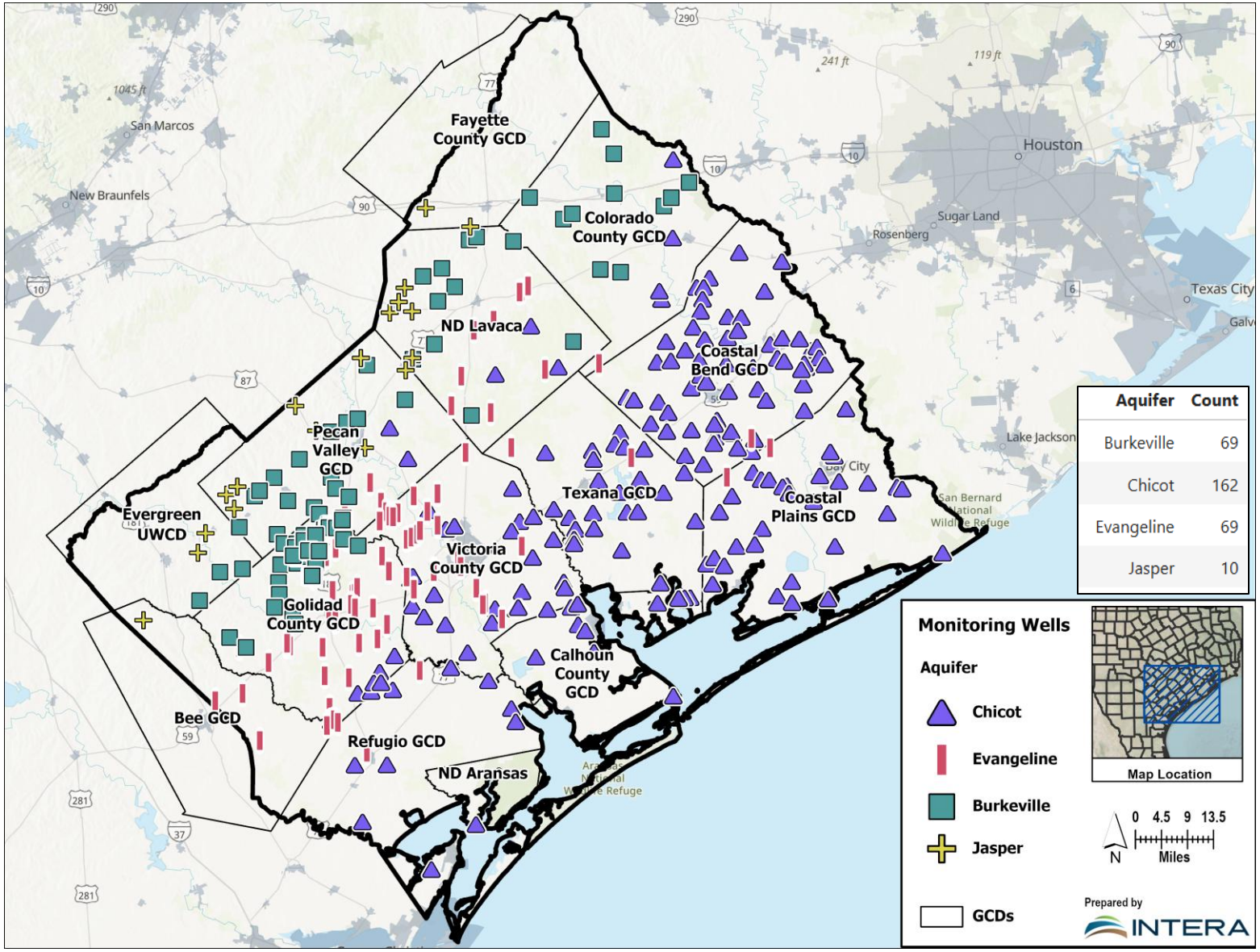
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# Analysis Overview

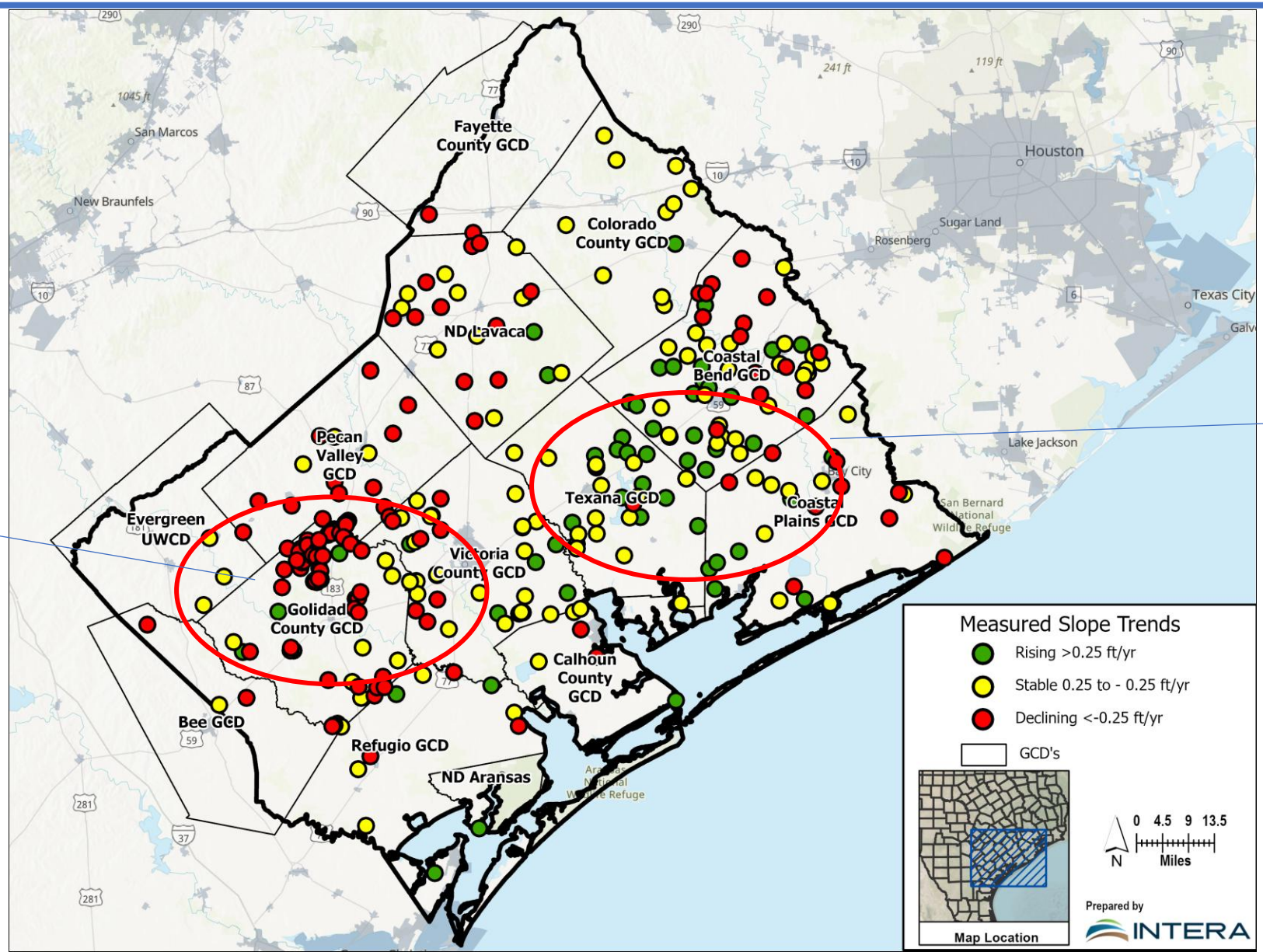
- We evaluated long-term groundwater level trends using the Theil–Sen (Sen's slope) method, which estimates the median slope from all pairwise combinations of measurements. This nonparametric approach is resistant to pumping-related fluctuations, irregular monitoring intervals, and non-normal data distributions (Theil, 1950; Sen, 1968)
- Similar methods to Keester and others 2021

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# Location of Wells



# Trend of Measured Water Levels 2000 to 2025



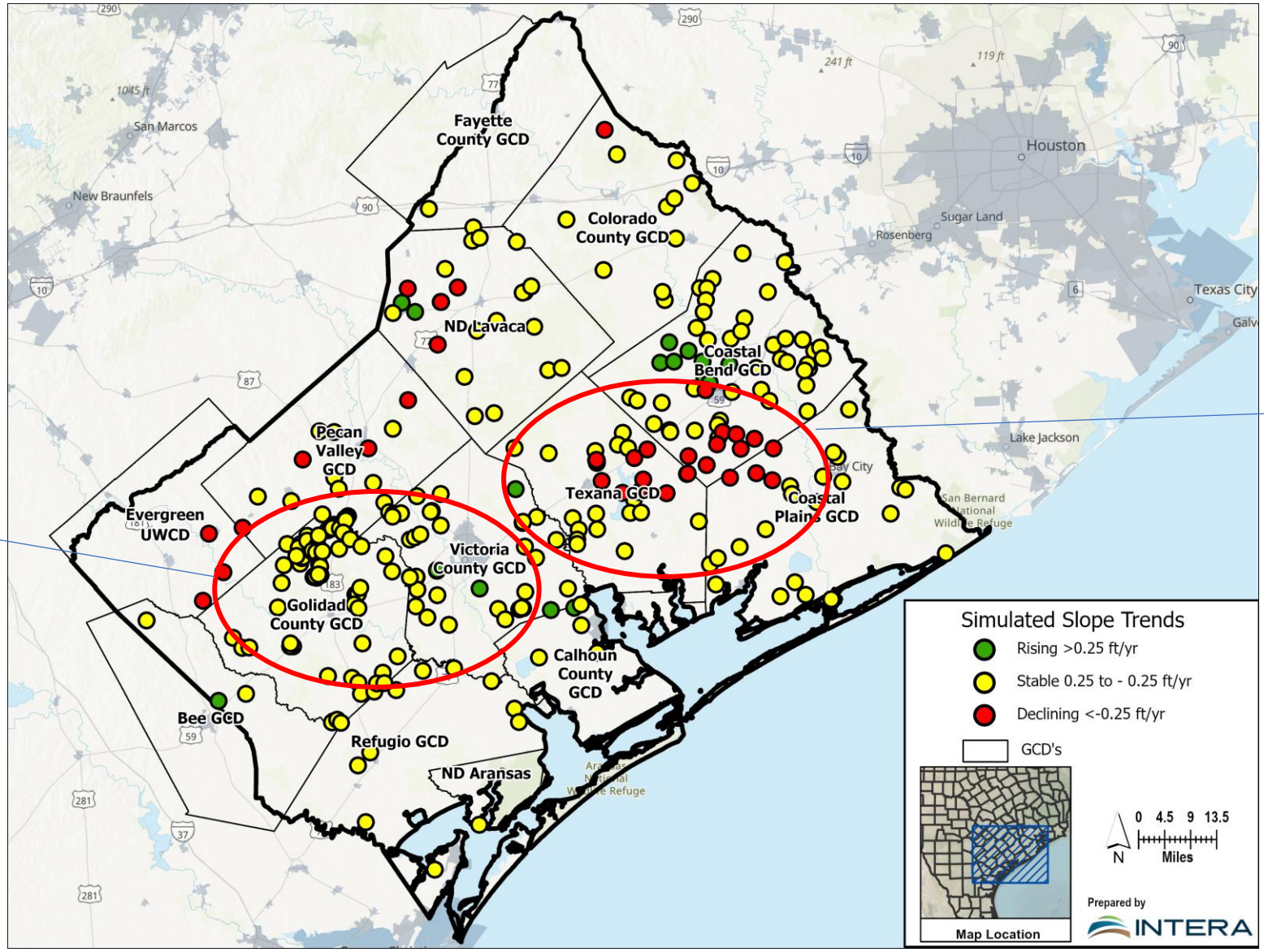

Generally Declining

Generally Rising

>0 means increasing water levels

2000 to 2025

# Trend of Simulated Water Levels 2000 to 2025



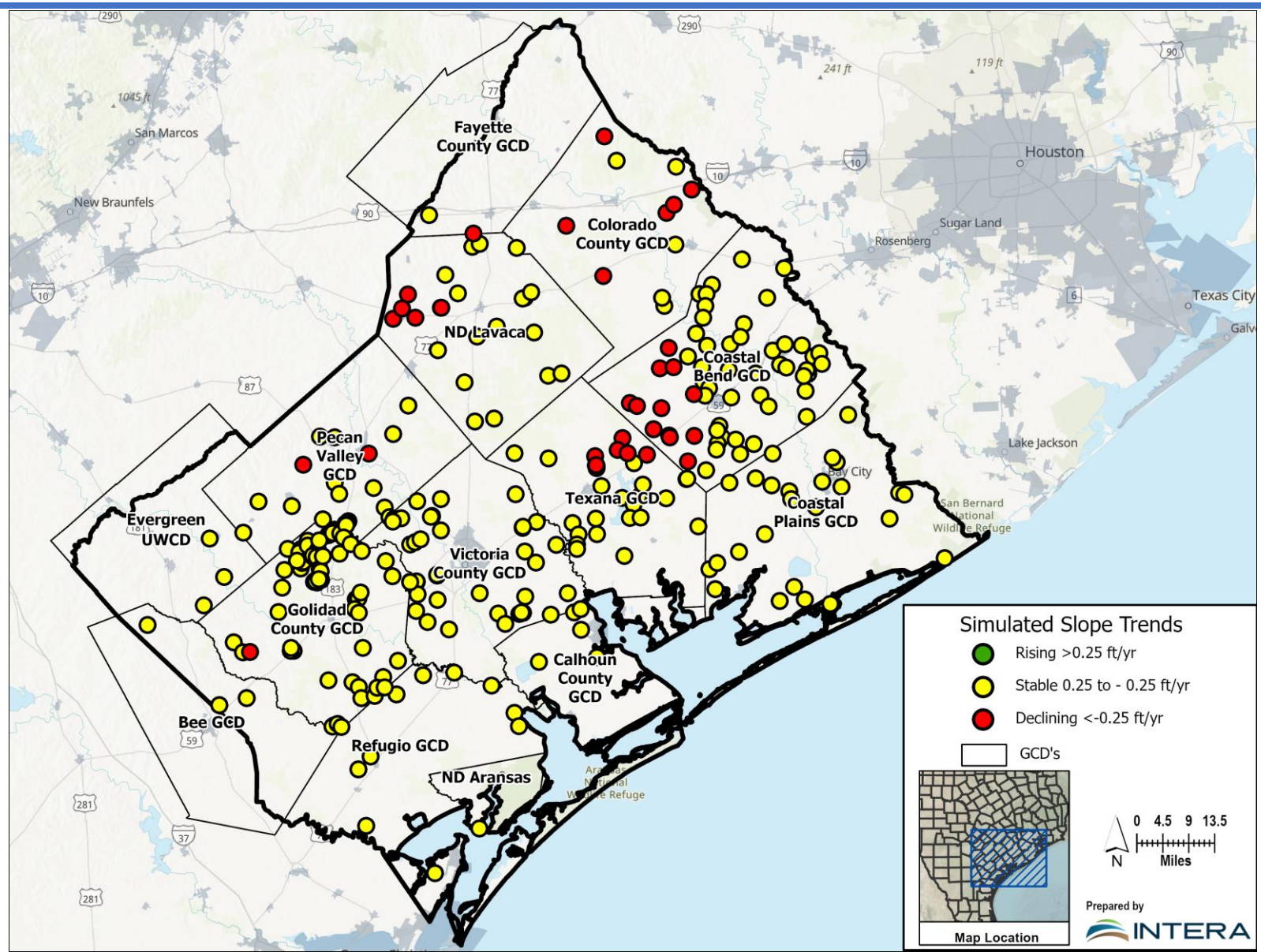

>0 means increasing water levels

2000 to 2025

Generally Stable

Generally Stable and Declining

# Trend of Simulated Water Levels 2025 to 2080




>0 means increasing water levels

2025 to 2080

# Difference between measured water Level trends and simulated water level trends

- Example Calculation of RMSE




Data from 2000 to 2005

- 3 Slopes
- Calculate the differences
  - 0.2−0.2=0.0
  - 0.0−0.2=−0.2
  - 1.1 – 0 = 1.1
- Square the differences
  - 0
  - .04
  - 1.21
- Compete the Mean of Squared differences

$$\text{MSE} = \frac{0.00 + 0.04 + 1.21}{3} = \frac{1.25}{3} = 0.417$$

- Take the Square Root (RMSE)

$$\text{RMSE} = \sqrt{0.417} \approx 0.65 \text{ ft/yr}$$




Difference in trend between two dataset is 0.65 ft/yr

# Difference between measured water Level trends and simulated water level trends

- Example Calculation of MAE




Data from 2000 to 2005

- 3 Slopes
- Calculate the differences
  - 0.2−0.2=0.0
  - 0.0−0.2=−0.2
  - 1.1 – 0 = 1.1
- Take ABS of Differences
  - 0
  - 0.2
  - 1.1
- Calculate the mean of absolute differences

$$\text{MAE} = \frac{0.00 + 0.20 + 1.10}{3} = \frac{1.30}{3} \approx 0.43 \text{ ft/yr}$$




MAE in trend between two datasets is 0.43 ft/yr

# Difference between measured water Level trends and simulated water level trends

- Example Calculation of ME




- 3 Slopes
- Calculate the differences
  - 0.2−0.2=0.0
  - 0.0−0.2=−0.2
  - 1.1 – 0 = 1.1
- Calculate the Mean of the differences

$$\mathrm{ME} = \frac{0.0 + (-0.2) + 1.1}{3} = \frac{0.9}{3} = 0.30 \text{ ft/yr}$$




ME in trend between two datasets is 0.43 ft/yr

# Comparison between measured water Level trends and simulated water level trends

- Restricting the measured trend period to observed data improves interpretability and allows direct assessment of model performance relative to actual monitoring records.

2000 to 2025

| County | RMSE_Chicot | MAE_Chicot | ME_Chicot | N_Chicot | RMSE_Evangeline | MAE_Evangeline | ME_Evangeline | N_Evangeline |
|---|---|---|---|---|---|---|---|---|
| Aransas | 0.55 | 0.54 | -0.54 | 2.00 | | | | |
| Bee | | | | | 0.42 | 0.41 | 0.41 | 2.00 |
| Calhoun | 0.40 | 0.36 | 0.36 | 5.00 | | | | |
| Colorado | 0.60 | 0.41 | -0.17 | 4.00 | | | | |
| DeWitt | 0.28 | 0.28 | 0.28 | 1.00 | 0.36 | 0.36 | 0.36 | 3.00 |
| Fayette | | | | | | | | |
| Goliad | 0.38 | 0.38 | 0.38 | 8.00 | 0.74 | 0.59 | 0.42 | 29.00 |
| Jackson | 0.60 | 0.50 | -0.45 | 29.00 | 1.05 | 0.88 | -0.57 | 2.00 |
| Karnes | | | | | | | | |
| Lavaca | 0.23 | 0.22 | -0.06 | 2.00 | 0.21 | 0.17 | 0.12 | 8.00 |
| Matagorda | 0.58 | 0.46 | -0.07 | 23.00 | 0.55 | 0.50 | -0.50 | 2.00 |
| Refugio | 0.35 | 0.29 | -0.01 | 7.00 | 0.29 | 0.24 | 0.24 | 2.00 |
| Victoria | 0.44 | 0.31 | -0.03 | 22.00 | 0.44 | 0.31 | 0.24 | 19.00 |
| Wharton | 0.63 | 0.42 | -0.11 | 56.00 | 1.58 | 1.58 | -1.58 | 2.00 |
| GMA 15 | 0.56 | 0.41 | -0.12 | 159.00 | 0.65 | 0.47 | 0.21 | 69.00 |

Note: Negative numbers indicate decreasing water levels over time

# Comparison between measured water Level trends and simulated water level trends

2000 to 2025

| County | RMSE_Burkeville | MAE_Burkeville | ME_Burkeville | N_Burkeville | RMSE_Jasper | MAE_Jasper | ME_Jasper | N_Jasper |
|---|---|---|---|---|---|---|---|---|
| Aransas | | | | | | | | |
| Bee | | | | | 0.36 | 0.36 | 0.36 | 1.00 |
| Calhoun | | | | | | | | |
| Colorado | 0.21 | 0.19 | -0.04 | 8.00 | | | | |
| DeWitt | 0.54 | 0.44 | 0.41 | 11.00 | 0.79 | 0.65 | -0.44 | 2.00 |
| Fayette | | | | | 0.57 | 0.57 | 0.57 | 2.00 |
| Goliad | 1.01 | 0.90 | 0.86 | 37.00 | | | | |
| Jackson | | | | | | | | |
| Karnes | 0.43 | 0.43 | -0.43 | 2.00 | 0.58 | 0.58 | -0.58 | 1.00 |
| Lavaca | 0.32 | 0.29 | 0.00 | 8.00 | 0.55 | 0.51 | 0.39 | 4.00 |
| Matagorda | | | | | | | | |
| Refugio | | | | | | | | |
| Victoria | | | | | | | | |
| Wharton | | | | | | | | |
| GMA 15 | 0.80 | 0.65 | 0.53 | 66.00 | 0.60 | 0.55 | 0.16 | 10.00 |

Note: Negative numbers indicate decreasing water levels over time

# Comparison between measured water Level trends and simulated water level trends

2000 to 2025

| County | RMSE_GCAS | MAE_GCAS | ME_GCAS | N_GCAS |
|---|---|---|---|---|
| Aransas | 0.55 | 0.54 | -0.54 | 2.00 |
| Bee | 0.40 | 0.39 | 0.39 | 3.00 |
| Calhoun | 0.40 | 0.36 | 0.36 | 5.00 |
| Colorado | 0.39 | 0.26 | -0.09 | 12.00 |
| DeWitt | 0.54 | 0.44 | 0.29 | 17.00 |
| Fayette | 0.57 | 0.57 | 0.57 | 2.00 |
| Goliad | 0.86 | 0.72 | 0.64 | 74.00 |
| Jackson | 0.64 | 0.52 | -0.46 | 31.00 |
| Karnes | 0.49 | 0.48 | -0.48 | 3.00 |
| Lavaca | 0.33 | 0.28 | 0.11 | 22.00 |
| Matagorda | 0.57 | 0.46 | -0.11 | 25.00 |
| Refugio | 0.34 | 0.28 | 0.05 | 9.00 |
| Victoria | 0.44 | 0.31 | 0.10 | 41.00 |
| Wharton | 0.69 | 0.46 | -0.16 | 58.00 |
| GMA 15 | 0.64 | 0.48 | 0.11 | 304.00 |

Note: Negative numbers indicate decreasing water levels over time

# DFC Variance in year 2080

| GCD | County | Chicot | Evangeline | Burkeville | Jasper | GCAS |
|---|---|---|---|---|---|---|
| ND Aransas | Aransas | -0 (-44 to 44) | 6 (-38 to 49) | — | — | 0 (-44 to 44) |
| Bee GCD | Bee | 1 (-31 to 33) | 8 (-26 to 41) | 7 (-25 to 39) | 5 (-24 to 34) | 6 (-26 to 38) |
| Calhoun County GCD | Calhoun | -1 (-33 to 31) | 8 (-24 to 40) | 3 (-30 to 35) | — | 2 (-30 to 34) |
| Colorado County GCD | Colorado | 12 (-37 to 60) | 25 (-6 to 56) | 22 (6 to 39) | 27 (-4 to 58) | 22 (-9 to 53) |
| Pecan Valley GCD | DeWitt | 0 (-22 to 23) | 4 (-24 to 33) | 16 (-27 to 60) | 33 (-30 to 96) | 20 (-24 to 63) |
| Fayette County GCD | Fayette | — | 11 (-35 to 57) | 42 (-4 to 88) | 52 (6 to 98) | 44 (-2 to 89) |
| Goliad County GCD | Goliad | -4 (-35 to 26) | -2 (-61 to 57) | 8 (-73 to 89) | 13 (-56 to 82) | 5 (-64 to 74) |
| Texana GCD | Jackson | 14 (-34 to 62) | 13 (-71 to 97) | 9 (-42 to 61) | 18 (-33 to 70) | 13 (-38 to 64) |
| Evergreen UWCD | Karnes | — | -0 (-39 to 39) | 22 (-13 to 56) | 26 (-21 to 72) | 22 (-17 to 61) |
| ND Lavaca | Lavaca | 6 (-12 to 24) | 6 (-11 to 22) | 15 (-10 to 41) | 31 (-13 to 74) | 17 (-10 to 43) |
| Coastal Plains GCD | Matagorda | 5 (-41 to 51) | 24 (-19 to 68) | 17 (-28 to 63) | — | 12 (-34 to 58) |
| Refugio GCD | Refugio | -0 (-28 to 27) | 7 (-17 to 30) | 2 (-25 to 29) | — | 3 (-24 to 30) |
| Victoria County GCD | Victoria | -4 (-40 to 31) | 4 (-31 to 39) | 3 (-32 to 39) | 6 (-29 to 42) | 2 (-33 to 37) |
| Coastal Bend GCD | Wharton | 14 (-37 to 64) | 12 (-114 to 139) | 23 (-32 to 78) | 26 (-29 to 81) | 19 (-36 to 74) |
| GMA15 | | 5 (-39 to 50) | 10 (-41 to 62) | 15 (-50 to 79) | 25 (-23 to 73) | 14 (-37 to 65) |

Based on propagating differences in 2000 to 2025 trends for 80 years

| | | | | | |
|---|---|---|---|---|---|
| GMA 15 | 6 (-40 to 52) | 12 (-39 to 62) | 16 (-6 to 38) | 24 (-72 to 121) | 14 (-42 to 71) |

*Average drawdown is for all of Bee County, not just the portion in GMA 15

Results from Keester (2021)

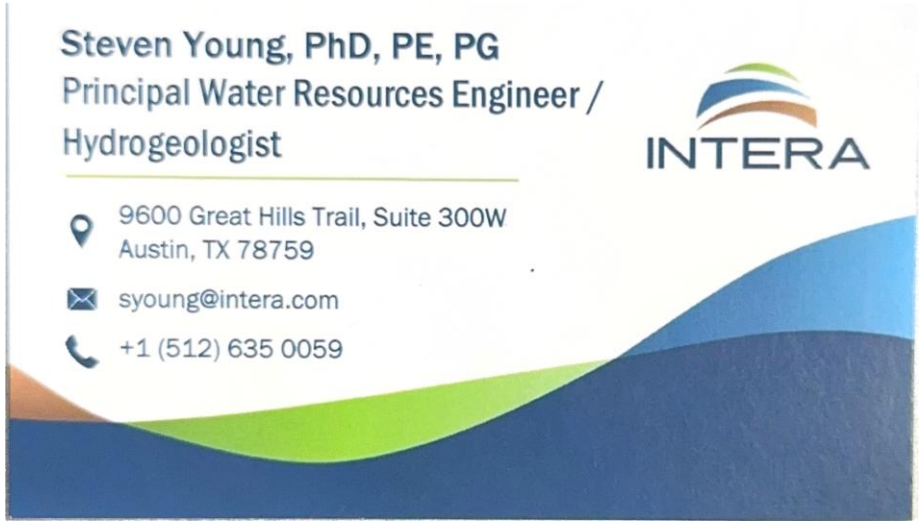
# Summary

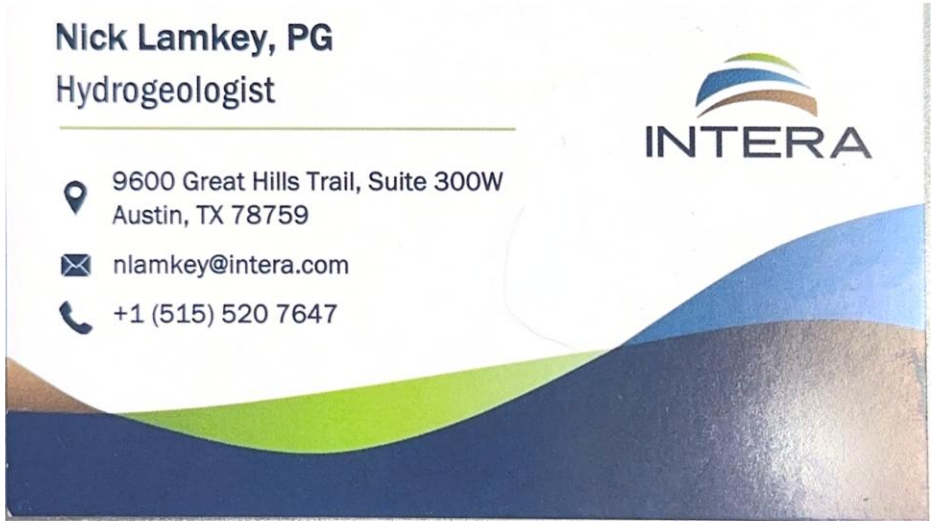
- Measured and simulated trends are generally consistent at the regional scale, but discrepancies vary by county and aquifer, reflecting differences in areas where the model is not replicating system behavior very well

- Uncertainty grows substantially during the predictive period emphasizing that long-term projections should be interpreted as ranges of plausible outcomes rather than exact predictions.

- DFC achievement is generally feasible, but feasibility is conditional on recognizing uncertainty

# Questions?


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# References


- Sen, P. K. (1968). Estimates of the regression coefficient based on Kendall's tau. *Journal of the American Statistical Association, 63*(324), 1379–1389. https://doi.org/10.1080/01621459.1968.10480934
- Theil, H. (1950). A rank-invariant method of linear and polynomial regression analysis. *Proceedings of the Section on Physical Sciences*, *53*, 386–392.
- Keester, M., Danielson, V., and Donnely, A, 2021, Desired Futrue Conditions Explanatory Report for Groundwater Management Area 15: Report prepared for Groundwater Management Area 15, 32 p.

# F.9 Other Factors

# GMA 15
# Other Factors

Groundwater Management Area 15

January 8, 2026




Presented by:
Steven Young Ph.D, PE, PG
Nick Lamkey PG

# TERS

**Total Estimated Recoverable Storage**—The estimated amount of groundwater within an aquifer that accounts for recovery scenarios that range between 25% and 75% of the porosity-adjusted aquifer volume

Texas Administrative Code Sec. 356.10

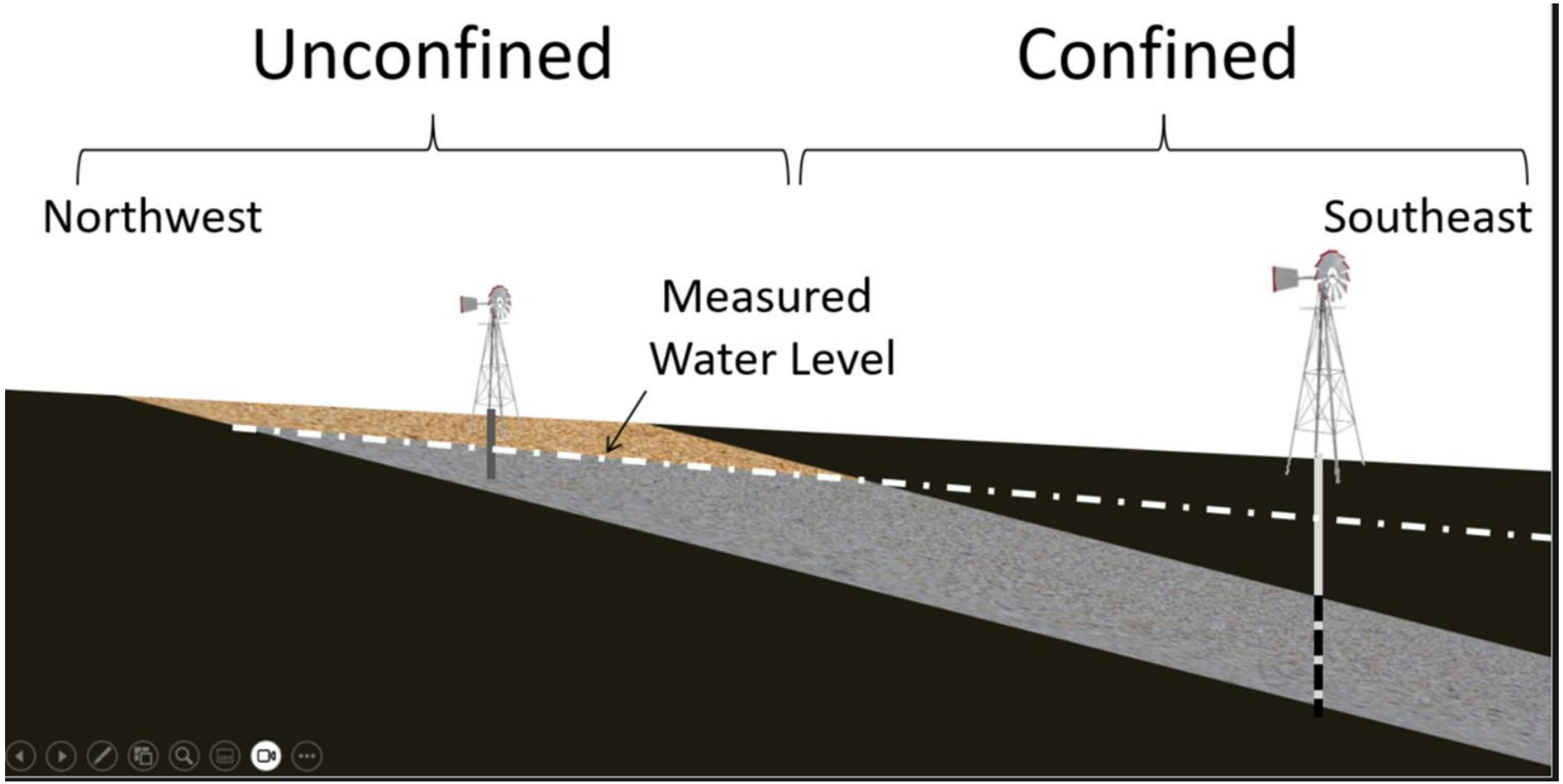
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# TERS Caveats

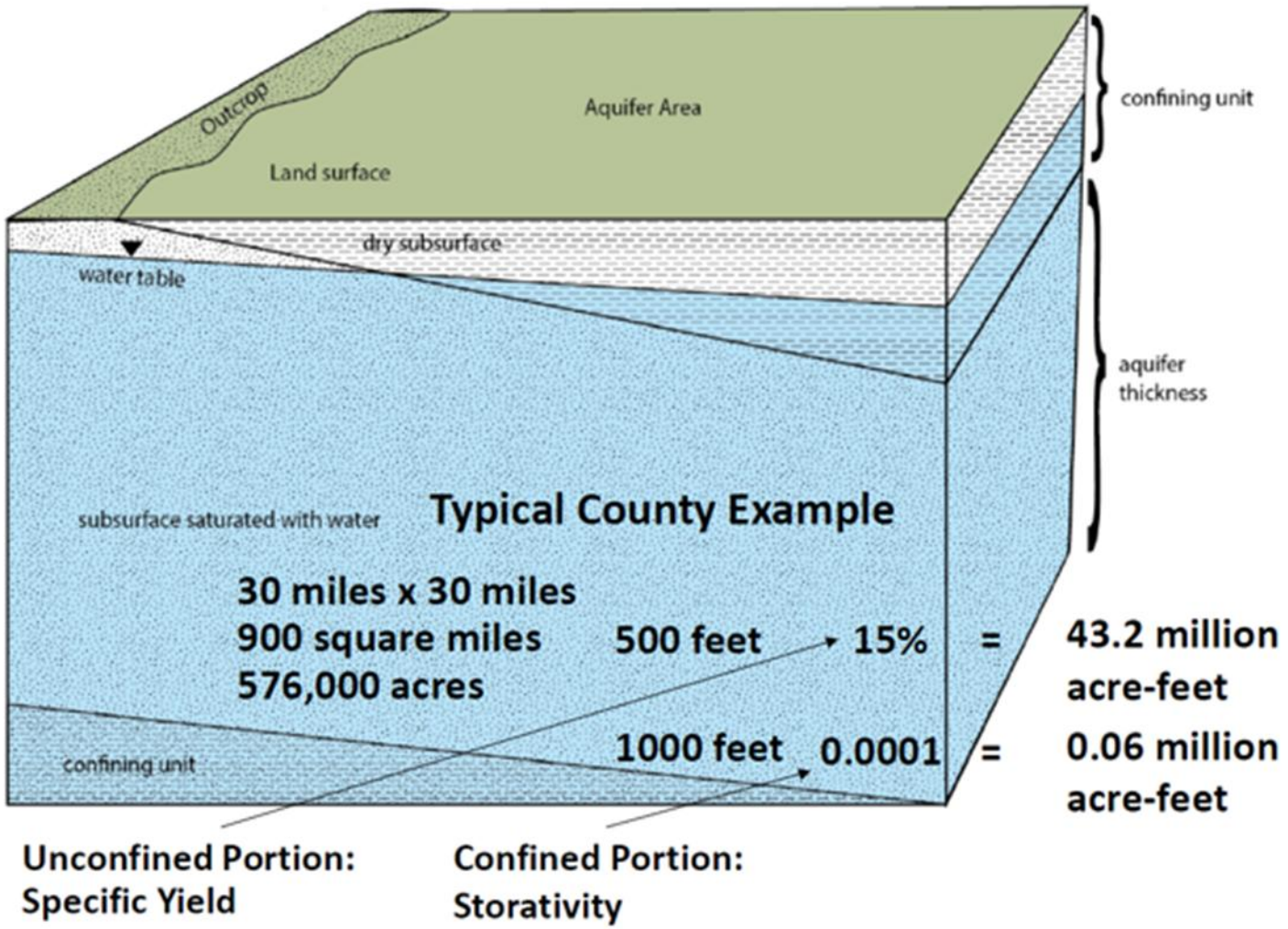
- No consideration given to:
  - Aquifer water quality
  - Water levels dropping below pumps
  - Land surface subsidence
  - Degradation of water quality
  - Changes to surface water-groundwater interaction
  - **Practicality/economics of development**

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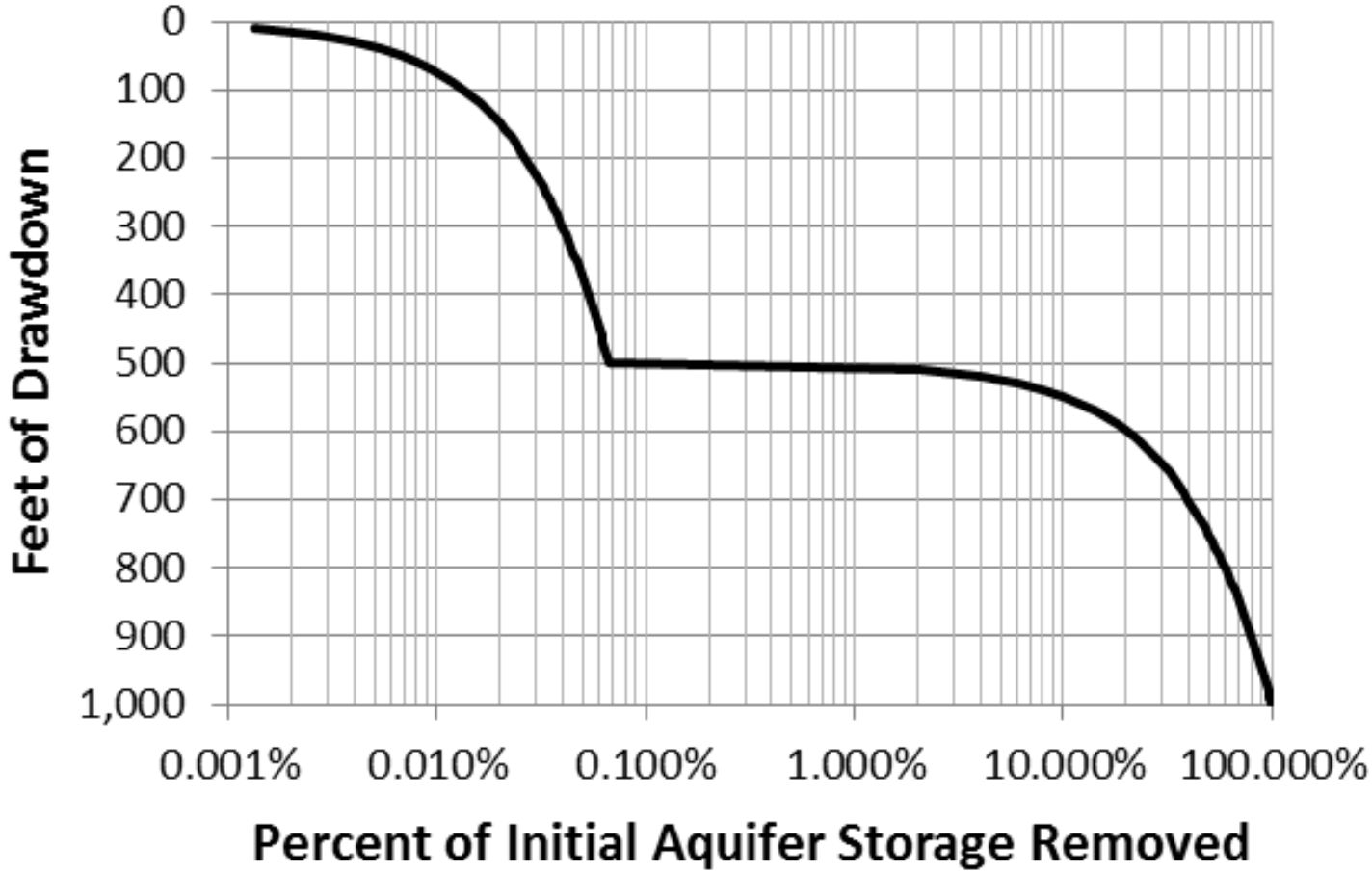
# TERS – Aquifer Conditions



# TERS


Outcrop
Aquifer Area
Land surface
confining unit
dry subsurface
water table
aquifer thickness
subsurface saturated with water
Typical County Example
30 miles x 30 miles
900 square miles
576,000 acres
500 feet
15%
=
43.2 million acre-feet
1000 feet
0.0001
=
0.06 million acre-feet
confining unit
Unconfined Portion:
Specific Yield
Confined Portion:
Storativity

# TERS – Drawdown vs. Storage Volume in an Example Confined Aquifer




Exact shape of curve is aquifer specific and depends on initial water levels, aquifer thickness, and storage properties (storativity and specific yield). Idealized curve developed using a 500 ft thick aquifer with 500 feet of confined head. Storativity set to 0.0001 and specific yield set to 0.15.

INTERA

# TERS – “Recoverable” is Aquifer Specific

- Could be 50% or more for highly productive, unconfined aquifers at the surface such as the Ogallala and Seymour.
- Likely less than 5% for most dipping, confined aquifers in Texas before impacts to water levels, quality, existing wells, well yields, surface water, and subsidence make additional production non-viable (Trinity, Carrizo-Wilcox, Gulf Coast, etc.)

INTERA

# TERS – Takeaways

- **What it does mean**
  - How much water is in the aquifer
- **What it doesn't mean**
  - That it is available for production
  - That using small fractions of the total volume cannot seriously harm the aquifer and its users
  - That it is, in any way, a useful tool in the planning and management of an aquifer

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# Brackish Groundwater

https://www.twdb.texas.gov/publications/reports/contracted_reports/doc/1600011947_InteraGulf_Coast_Brackish.pdf

- Brackish groundwater is water with a TDS between 1,000 and 10,000 mg/L subdivided into:
  - Slightly saline: 1,000 – 3,000 mg/L
  - Moderately saline: 3,000 – 10,000 mg/L
  - Very saline: 10,000 – 35,000

- HB 30 brackish production zones (BPZs) are generally focused on water >3,000 mg/L to avoid competition with freshwater

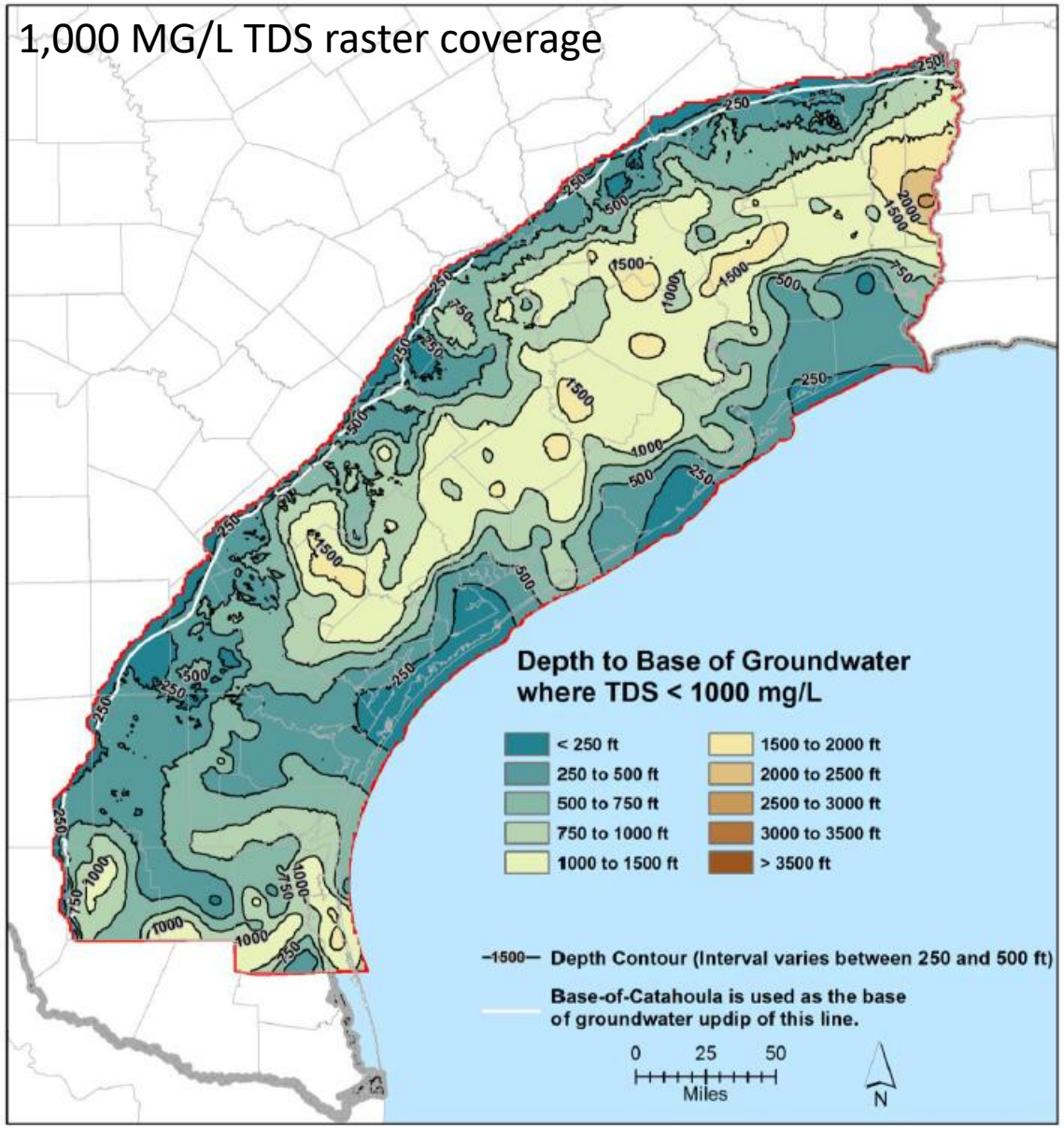
- Brackish Groundwater is abundant and laterally continuous
- Largely segregated from freshwater zones
- Development of these resources is one of the most effective tools available to support future water demands

INTERA

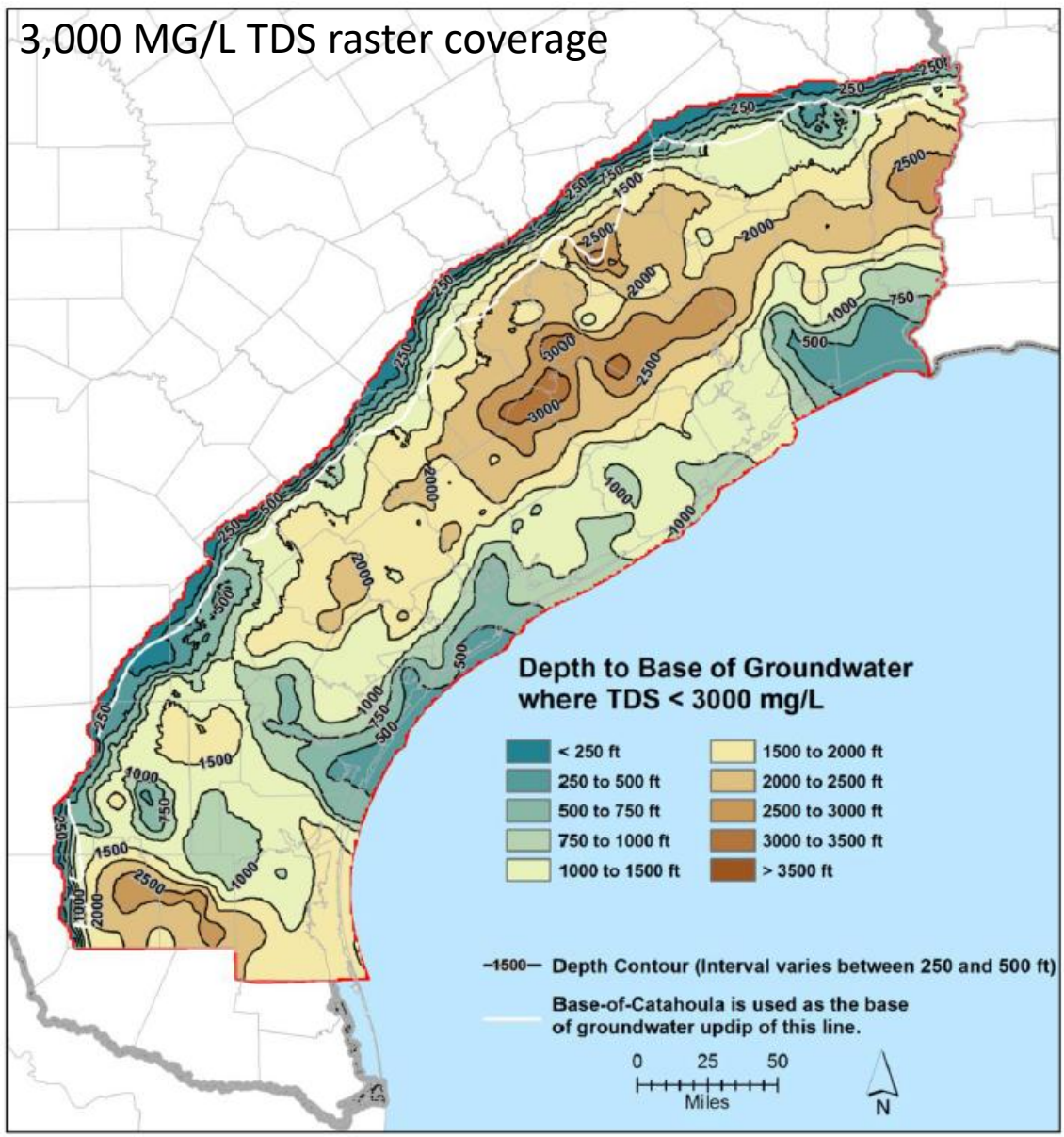
# Brackish Groundwater

https://www.twdb.texas.gov/publications/reports/contracted_reports/doc/1600011947_InteraGulf_Coast_Brackish.pdf

1,000 MG/L TDS raster coverage

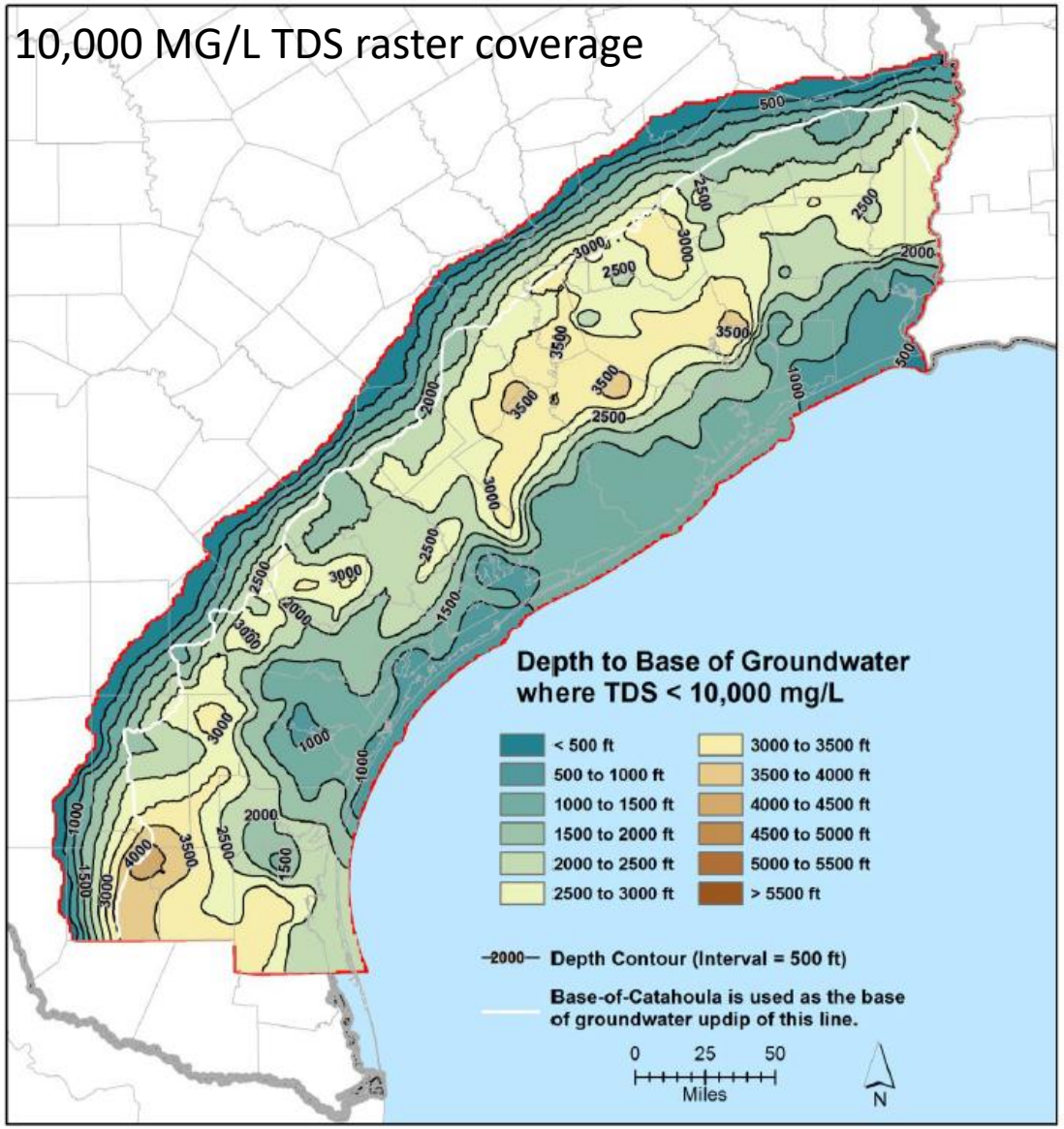



3,000 MG/L TDS raster coverage

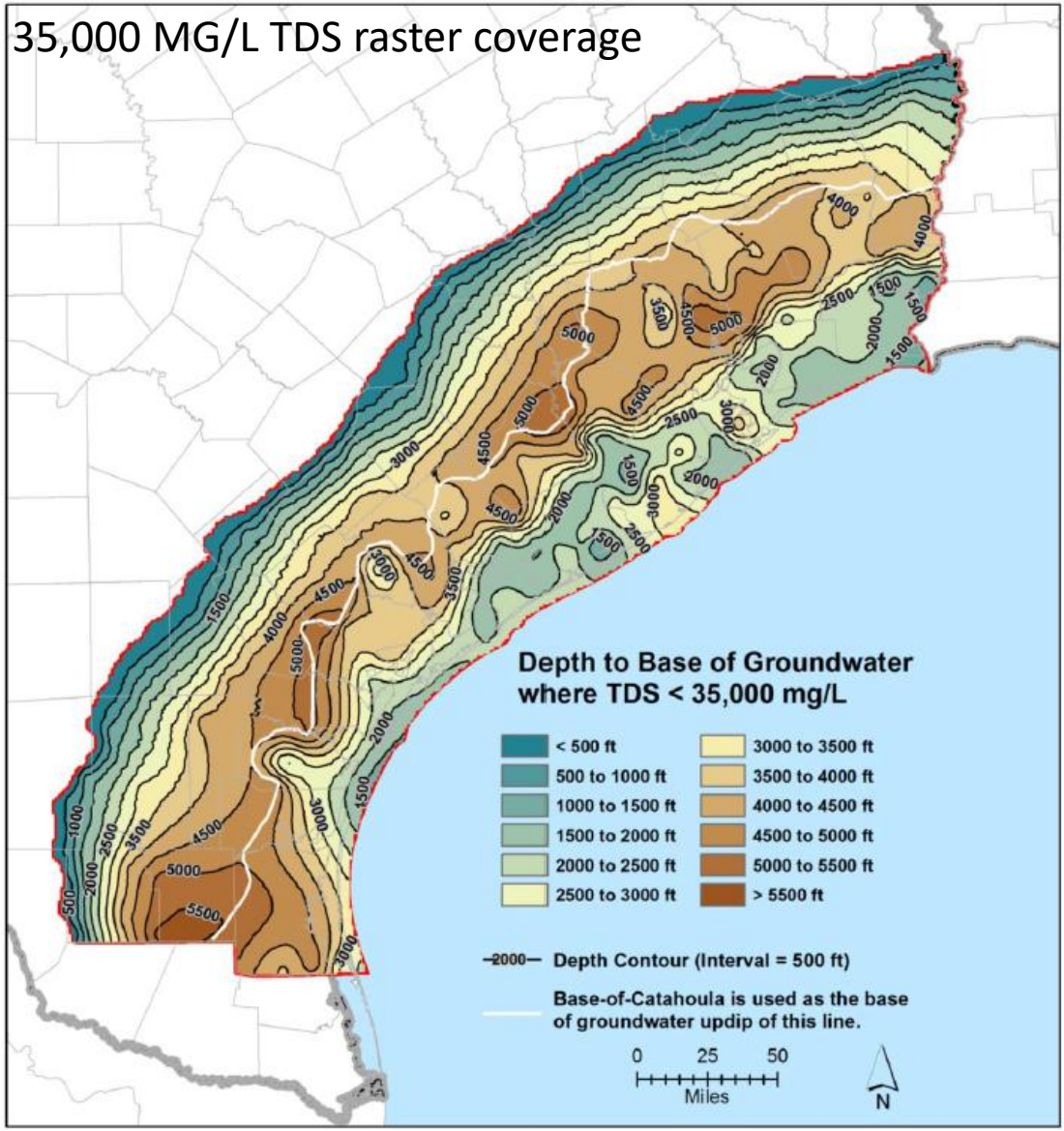


# Brackish Groundwater

10,000 MG/L TDS raster coverage




35,000 MG/L TDS raster coverage



# Brackish Groundwater

https://www.twdb.texas.gov/publications/reports/contracted_reports/doc/1600011947_InteraGulf_Coast_Brackish.pdf

| | | 1k TDS | | | | | 3k TDS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| County | Aquifer | AF 1k TDS | AF >1k TDS | Total | Percent 1k TDS | Percenet >1k TDS | AF 3k TDS | AF >3k TDS | Total | Percent 3k TDS | Percenet >3k TDS |
| Aransas | Burkeville | 0 | 0 | 0 | | | 0 | 0 | 0 | | |
| | Chicot | 3,424,830 | 6,872,495 | 10,297,325 | 33% | 67% | 8,197,733 | 2,099,592 | 10,297,325 | 80% | 20% |
| | Evangeline | 1,381 | 85,320 | 86,701 | 2% | 98% | 39,939 | 46,762 | 86,701 | 46% | 54% |
| | Jasper | 0 | 0 | 0 | | | 0 | 0 | 0 | | |
| | Total | 3,426,211 | 6,957,815 | 10,384,026 | 33% | 67% | 8,237,672 | 2,146,354 | 10,384,026 | 79% | 21% |
| Bee | Burkeville | 173,798 | 1,065,864 | 1,239,662 | 14% | 86% | 811,388 | 428,274 | 1,239,662 | 65% | 35% |
| | Chicot | 1,266,743 | 0 | 1,266,743 | 100% | 0% | 1,266,743 | 0 | 1,266,743 | 100% | 0% |
| | Evangeline | 2,514,493 | 915,251 | 3,429,744 | 73% | 27% | 3,224,997 | 204,747 | 3,429,744 | 94% | 6% |
| | Jasper | 898,313 | 13,955,595 | 14,853,908 | 6% | 94% | 6,795,298 | 8,058,609 | 14,853,907 | 46% | 54% |
| | Total | 4,853,347 | 15,936,710 | 20,790,057 | 23% | 77% | 12,098,426 | 8,691,630 | 20,790,056 | 58% | 42% |
| Calhoun | Burkeville | 0 | 62,931 | 62,931 | 0% | 100% | 635 | 62,297 | 62,932 | 1% | 99% |
| | Chicot | 8,573,372 | 17,352,251 | 25,925,623 | 33% | 67% | 19,281,942 | 6,643,682 | 25,925,624 | 74% | 26% |
| | Evangeline | 96,770 | 2,648,228 | 2,744,998 | 4% | 96% | 663,399 | 2,081,600 | 2,744,999 | 24% | 76% |
| | Jasper | 0 | 0 | 0 | | | 0 | 0 | 0 | | |
| | Total | 8,670,142 | 20,063,410 | 28,733,552 | 30% | 70% | 19,945,976 | 8,787,579 | 28,733,555 | 69% | 31% |
| Colorado | Burkeville | 117,886 | 1,436,534 | 1,554,420 | 8% | 92% | 1,553,135 | 1,285 | 1,554,420 | 100% | 0% |
| | Chicot | 7,055,903 | 0 | 7,055,903 | 100% | 0% | 7,055,903 | 0 | 7,055,903 | 100% | 0% |
| | Evangeline | 1,935,476 | 1,052,300 | 2,987,776 | 65% | 35% | 2,987,776 | 0 | 2,987,776 | 100% | 0% |
| | Jasper | 395,782 | 10,999,476 | 11,395,258 | 3% | 97% | 11,165,313 | 229,945 | 11,395,258 | 98% | 2% |
| | Total | 9,505,047 | 13,488,310 | 22,993,357 | 41% | 59% | 22,762,127 | 231,230 | 22,993,357 | 99% | 1% |
| DeWitt | Burkeville | 195,627 | 116,328 | 311,955 | 63% | 37% | 311,956 | 0 | 311,956 | 100% | 0% |
| | Chicot | 158,400 | 0 | 158,400 | 100% | 0% | 158,400 | 0 | 158,400 | 100% | 0% |
| | Evangeline | 1,261,878 | 202,698 | 1,464,576 | 86% | 14% | 1,464,576 | 0 | 1,464,576 | 100% | 0% |
| | Jasper | 10,438,247 | 7,574,698 | 18,012,945 | 58% | 42% | 17,632,603 | 380,342 | 18,012,945 | 98% | 2% |
| | Total | 12,054,152 | 7,893,724 | 19,947,876 | 60% | 40% | 19,567,535 | 380,342 | 19,947,877 | 98% | 2% |

INTERA

# Brackish Groundwater

https://www.twdb.texas.gov/publications/reports/contracted_reports/doc/1600011947_InteraGulf_Coast_Brackish.pdf

| | | 1k TDS | | | | | 3k TDS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| County | Aquifer | AF 1k TDS | AF >1k TDS | Total | Percent 1k TDS | Percenet >1k TDS | AF 3k TDS | AF >3k TDS | Total | Percent 3k TDS | Percenet >3k TDS |
| Fayette | Burkeville | 74,578 | 18,885 | 93,463 | 80% | 20% | 93,464 | 0 | 93,464 | 100% | 0% |
| | Chicot | 0 | 0 | 0 | | | 0 | 0 | 0 | | |
| | Evangeline | 33,878 | 5,496 | 39,374 | 86% | 14% | 39,373 | 0 | 39,373 | 100% | 0% |
| | Jasper | 2,254,976 | 1,404,650 | 3,659,626 | 62% | 38% | 3,518,013 | 141,612 | 3,659,625 | 96% | 4% |
| | Total | 2,363,432 | 1,429,031 | 3,792,463 | 62% | 38% | 3,650,850 | 141,612 | 3,792,462 | 96% | 4% |
| Goliad | Burkeville | 632,996 | 993,753 | 1,626,749 | 39% | 61% | 1,517,218 | 109,531 | 1,626,749 | 93% | 7% |
| | Chicot | 498,238 | 0 | 498,238 | 100% | 0% | 498,238 | 0 | 498,238 | 100% | 0% |
| | Evangeline | 4,251,763 | 230,442 | 4,482,205 | 95% | 5% | 4,482,206 | 0 | 4,482,206 | 100% | 0% |
| | Jasper | 2,429,337 | 10,756,934 | 13,186,271 | 18% | 82% | 10,155,098 | 3,031,172 | 13,186,270 | 77% | 23% |
| | Total | 7,812,334 | 11,981,129 | 19,793,463 | 39% | 61% | 16,652,760 | 3,140,703 | 19,793,463 | 84% | 16% |
| Jackson | Burkeville | 330 | 1,729,718 | 1,730,048 | 0% | 100% | 266,155 | 1,463,894 | 1,730,049 | 15% | 85% |
| | Chicot | 16,820,622 | 1,917,332 | 18,737,954 | 90% | 10% | 18,147,377 | 590,576 | 18,737,953 | 97% | 3% |
| | Evangeline | 2,117,633 | 4,762,510 | 6,880,143 | 31% | 69% | 4,120,424 | 2,759,719 | 6,880,143 | 60% | 40% |
| | Jasper | 0 | 7,796,658 | 7,796,658 | 0% | 100% | 480,767 | 7,315,891 | 7,796,658 | 6% | 94% |
| | Total | 18,938,585 | 16,206,218 | 35,144,803 | 54% | 46% | 23,014,723 | 12,130,080 | 35,144,803 | 65% | 35% |
| Karnes | Burkeville | 83,937 | 0 | 83,937 | 100% | 0% | 83,937 | 0 | 83,937 | 100% | 0% |
| | Chicot | 0 | 0 | 0 | | | 0 | 0 | 0 | | |
| | Evangeline | 36,126 | 0 | 36,126 | 100% | 0% | 36,126 | 0 | 36,126 | 100% | 0% |
| | Jasper | 3,883,764 | 2,166,552 | 6,050,316 | 64% | 36% | 5,992,795 | 57,520 | 6,050,315 | 99% | 1% |
| | Total | 4,003,827 | 2,166,552 | 6,170,379 | 65% | 35% | 6,112,858 | 57,520 | 6,170,378 | 99% | 1% |
| Lavaca | Burkeville | 314,495 | 751,765 | 1,066,260 | 29% | 71% | 1,064,330 | 1,930 | 1,066,260 | 100% | 0% |
| | Chicot | 2,168,558 | 0 | 2,168,558 | 100% | 0% | 2,168,558 | 0 | 2,168,558 | 100% | 0% |
| | Evangeline | 2,226,366 | 235,483 | 2,461,849 | 90% | 10% | 2,461,849 | 0 | 2,461,849 | 100% | 0% |
| | Jasper | 2,955,474 | 10,315,566 | 13,271,040 | 22% | 78% | 12,982,795 | 288,244 | 13,271,039 | 98% | 2% |
| | Total | 7,664,893 | 11,302,814 | 18,967,707 | 40% | 60% | 18,677,532 | 290,174 | 18,967,706 | 98% | 2% |

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# Brackish Groundwater

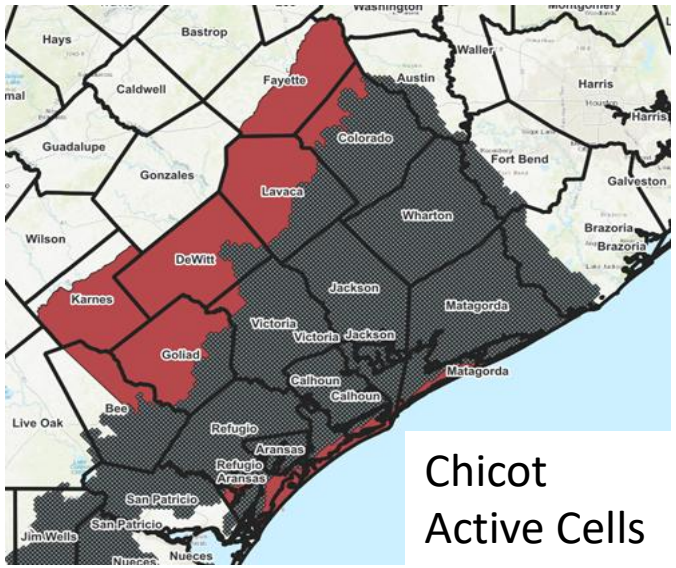
https://www.twdb.texas.gov/publications/reports/contracted_reports/doc/1600011947_InteraGulf_Coast_Brackish.pdf

| | | 1k TDS | | | | | 3k TDS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| County | Aquifer | AF 1k TDS | AF >1k TDS | Total | Percent 1k TDS | Percenet >1k TDS | AF 3k TDS | AF >3k TDS | Total | Percent 3k TDS | Percenet >3k TDS |
| Matagorda | Burkeville | 0 | 656,178 | 656,178 | 0% | 100% | 0 | 656,178 | 656,178 | 0% | 100% |
| | Chicot | 27,558,452 | 16,283,433 | 43,841,885 | 63% | 37% | 39,634,082 | 4,207,803 | 43,841,885 | 90% | 10% |
| | Evangeline | 287,880 | 6,235,143 | 6,523,023 | 4% | 96% | 628,507 | 5,894,516 | 6,523,023 | 10% | 90% |
| | Jasper | 0 | 0 | 0 | | | 0 | 0 | 0 | | |
| | Total | 27,846,332 | 23,174,754 | 51,021,086 | 55% | 45% | 40,262,589 | 10,758,497 | 51,021,086 | 79% | 21% |
| Refugio | Burkeville | 0 | 1,027,430 | 1,027,430 | 0% | 100% | 49,693 | 977,736 | 1,027,429 | 5% | 95% |
| | Chicot | 12,229,832 | 1,932,980 | 14,162,812 | 86% | 14% | 14,110,777 | 52,035 | 14,162,812 | 100% | 0% |
| | Evangeline | 1,939,720 | 3,482,347 | 5,422,067 | 36% | 64% | 3,767,011 | 1,655,056 | 5,422,067 | 69% | 31% |
| | Jasper | 0 | 0 | 0 | | | 0 | 0 | 0 | | |
| | Total | 14,169,552 | 6,442,757 | 20,612,309 | 69% | 31% | 17,927,481 | 2,684,827 | 20,612,308 | 87% | 13% |
| Victoria | Burkeville | 7,409 | 2,081,005 | 2,088,414 | 0% | 100% | 524,562 | 1,563,852 | 2,088,414 | 25% | 75% |
| | Chicot | 9,427,159 | 98,908 | 9,526,067 | 99% | 1% | 9,526,067 | 0 | 9,526,067 | 100% | 0% |
| | Evangeline | 3,530,159 | 2,508,033 | 6,038,192 | 58% | 42% | 5,850,384 | 187,807 | 6,038,191 | 97% | 3% |
| | Jasper | 0 | 11,786,139 | 11,786,139 | 0% | 100% | 3,684,264 | 8,101,875 | 11,786,139 | 31% | 69% |
| | Total | 12,964,727 | 16,474,085 | 29,438,812 | 44% | 56% | 19,585,277 | 9,853,534 | 29,438,811 | 67% | 33% |
| Wharton | Burkeville | 0 | 2,515,711 | 2,515,711 | 0% | 100% | 954,331 | 1,561,380 | 2,515,711 | 38% | 62% |
| | Chicot | 24,287,578 | 14,592 | 24,302,170 | 100% | 0% | 24,302,170 | 0 | 24,302,170 | 100% | 0% |
| | Evangeline | 3,493,528 | 5,495,510 | 8,989,038 | 39% | 61% | 7,693,710 | 1,295,328 | 8,989,038 | 86% | 14% |
| | Jasper | 0 | 18,318,538 | 18,318,538 | 0% | 100% | 2,851,426 | 15,467,112 | 18,318,538 | 16% | 84% |
| | Total | 27,781,106 | 26,344,351 | 54,125,457 | 51% | 49% | 35,801,637 | 18,323,820 | 54,125,457 | 66% | 34% |

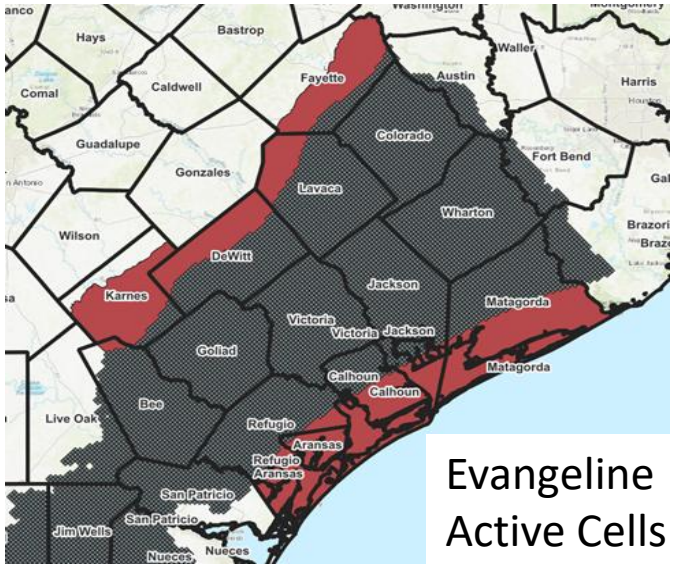
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# Model Limitations

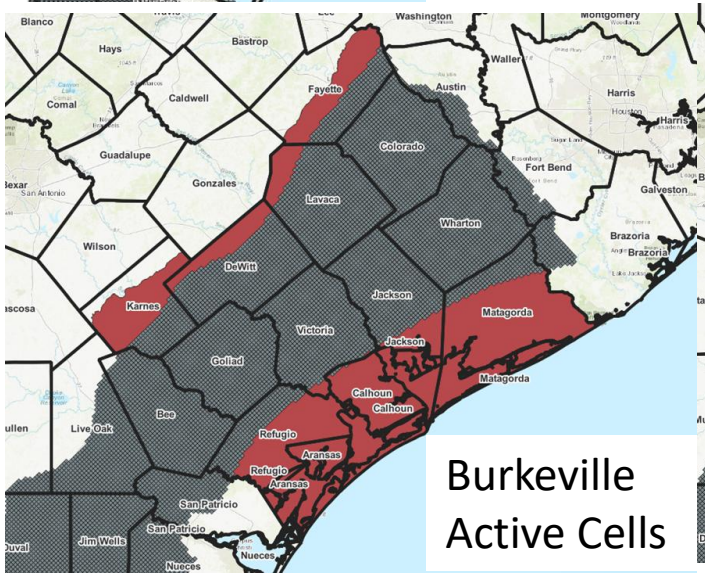
- Has not been calibrated in 25 years
- Model is not replicating system behavior in many locations where trends in water levels are opposite what is occurring in real life
- Model calibration wasn't properly weighted to capture baseflow and hydraulic properties
- Many lower counties are missing Evangeline, Burkeville and Jasper
- Jasper is totally absent in four counties
- Pumping Effects from GMA 14 are essentially ignored



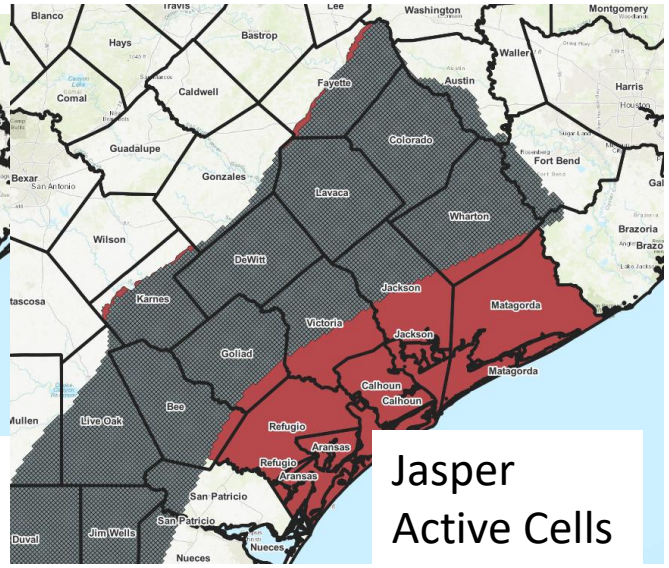

Chicot
Active Cells




Evangeline
Active Cells

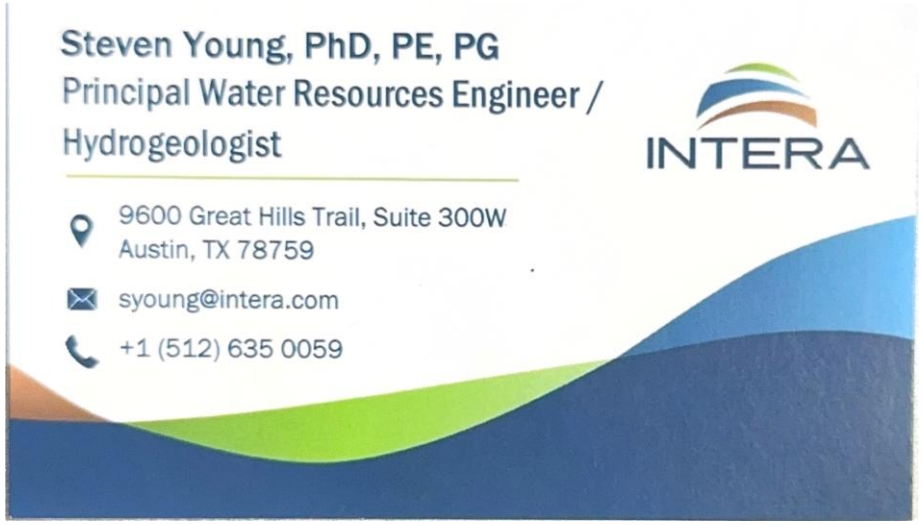


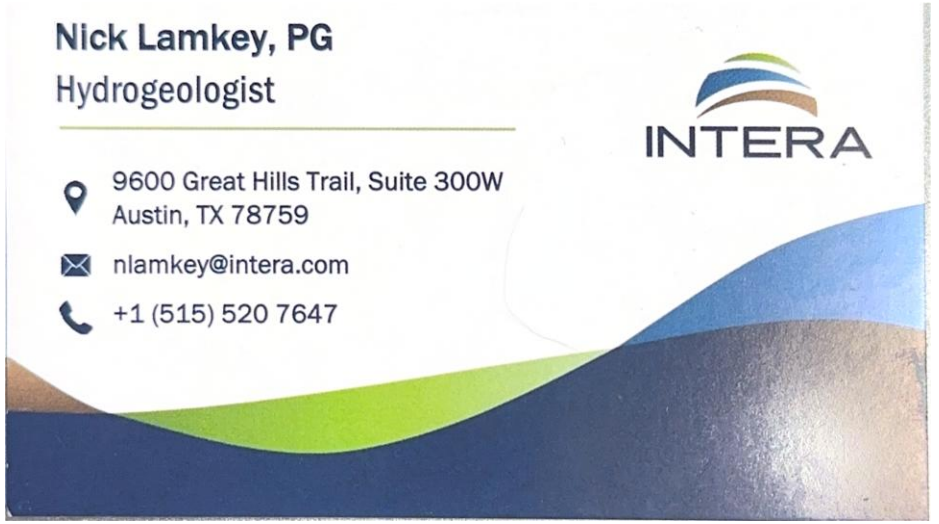

Burkeville
Active Cells




Jasper
Active Cells

# Questions?


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