

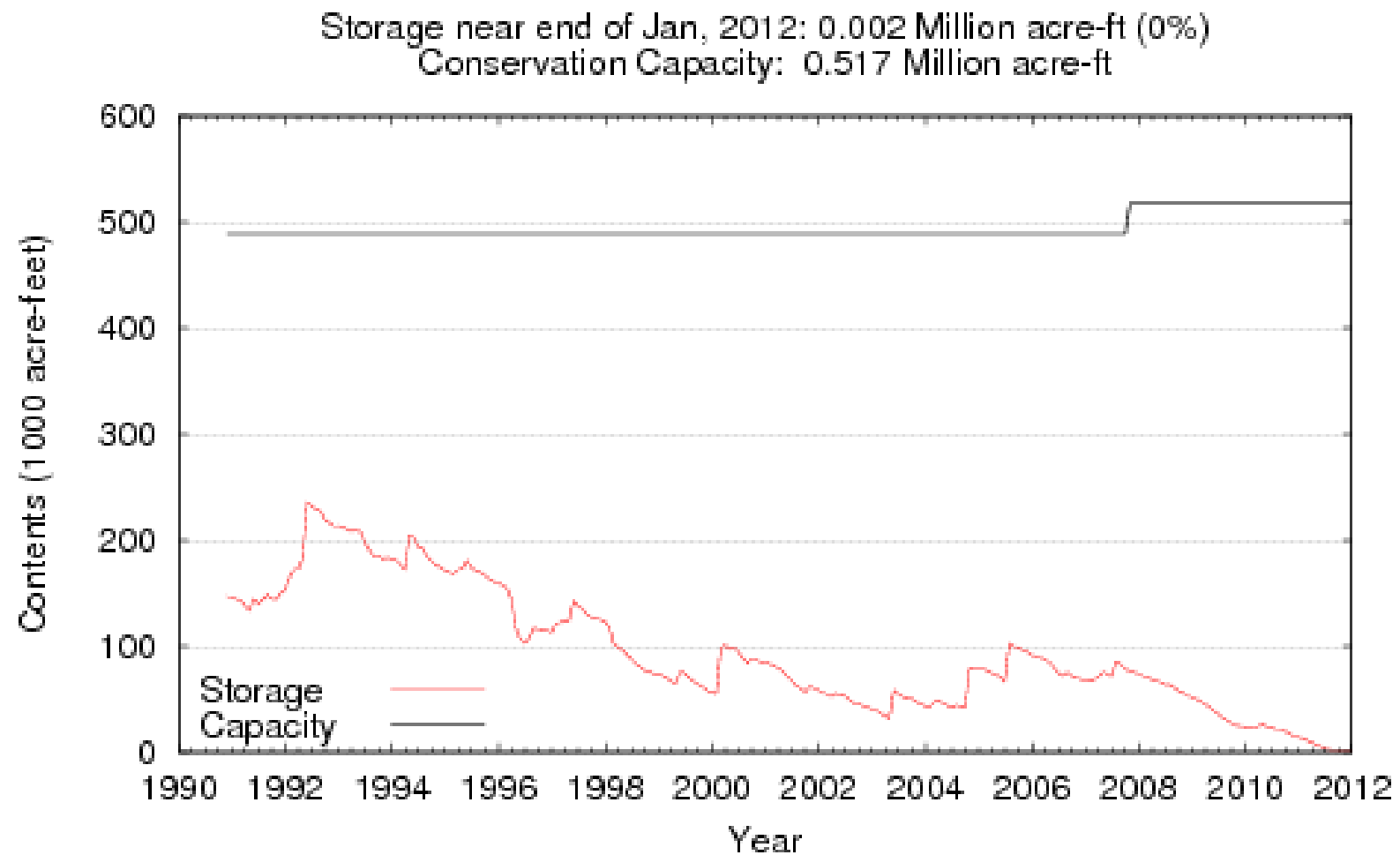


Hydraulic fracturing and water resources: a Texas study

Jean-Philippe 'JP' Nicot

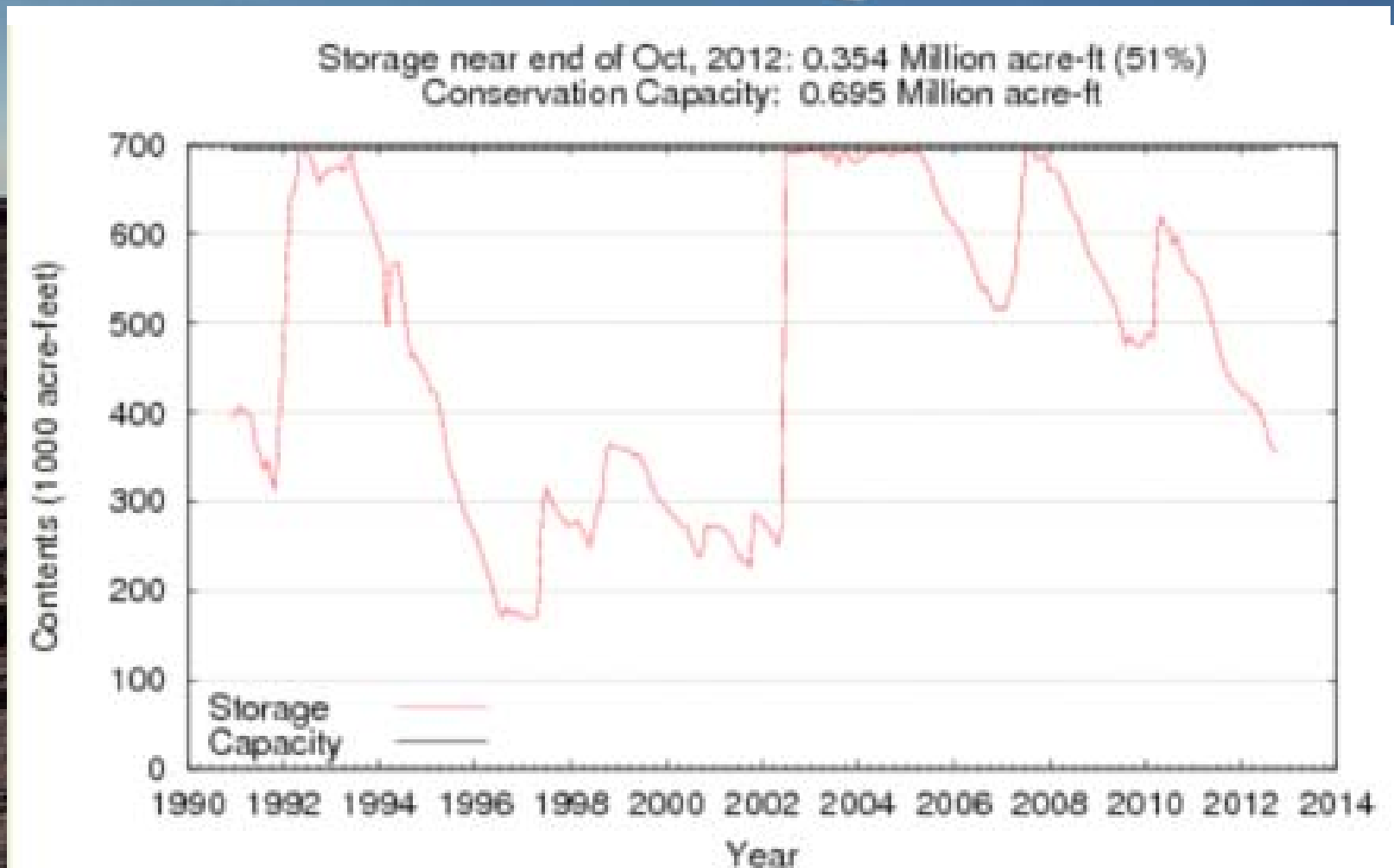
**Bureau of Economic Geology
Jackson School of Geosciences
The University of Texas at Austin**

**2012 GSA Annual Meeting
Charlotte, NC – November 6, 2012**



Dried bed of Lake E.V. Spence, Texas, Aug. 7, 2011

Tony Gutierrez/AP Photo



Dried bed of Lake E.V. Spence, Texas, Aug. 7, 2011

Tony Gutierrez/AP Photo

Development – Population Growth:

Barnett: DFW Metroplex
Eagle Ford: I-35 Corridor

x2 in the next 50 years: increase in
municipal water use



Semi-conductor plant – Austin, TX

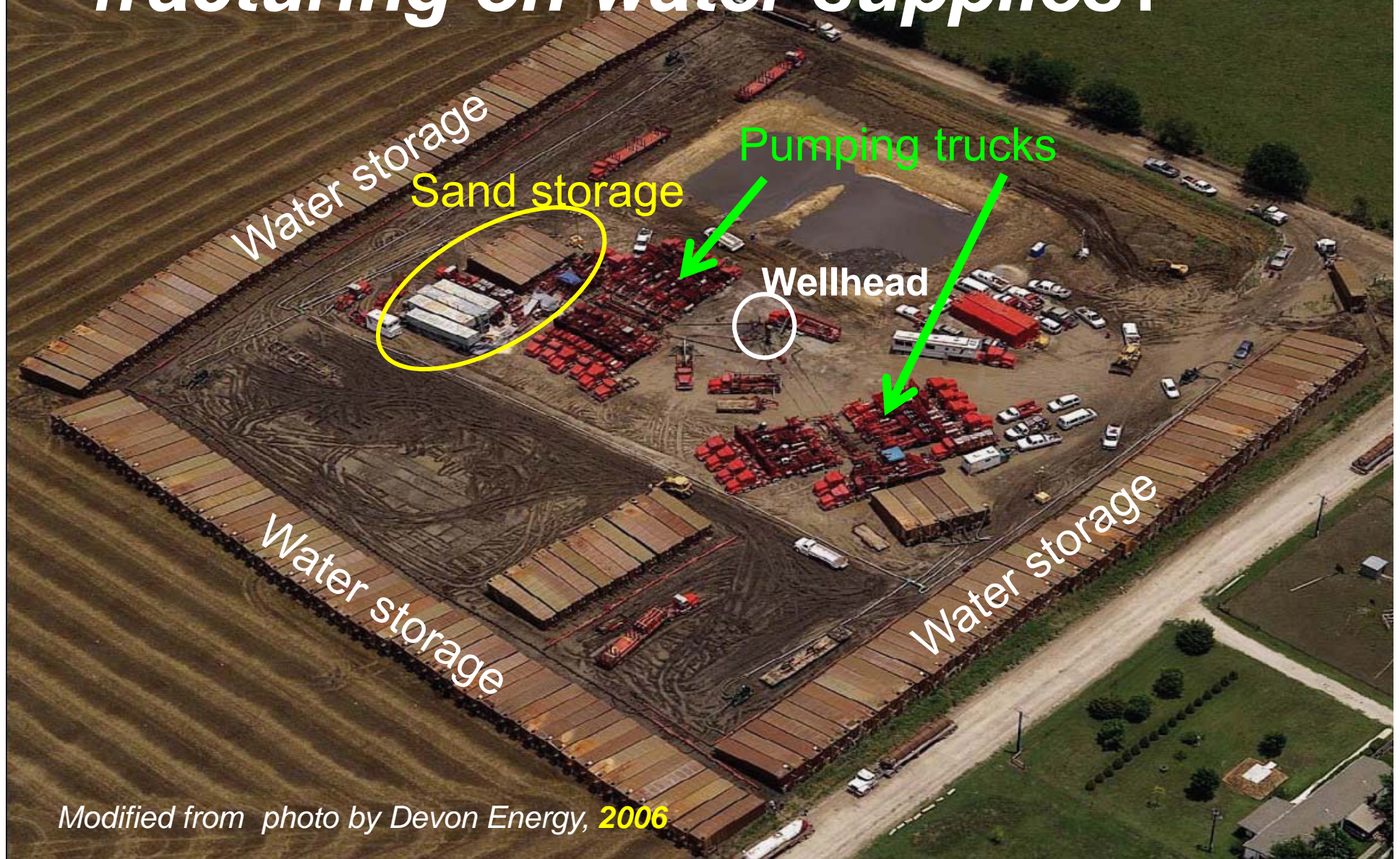


W.A. Parish, Houston area, TX – NRG Energy

Increase in manufacturing and electric water use



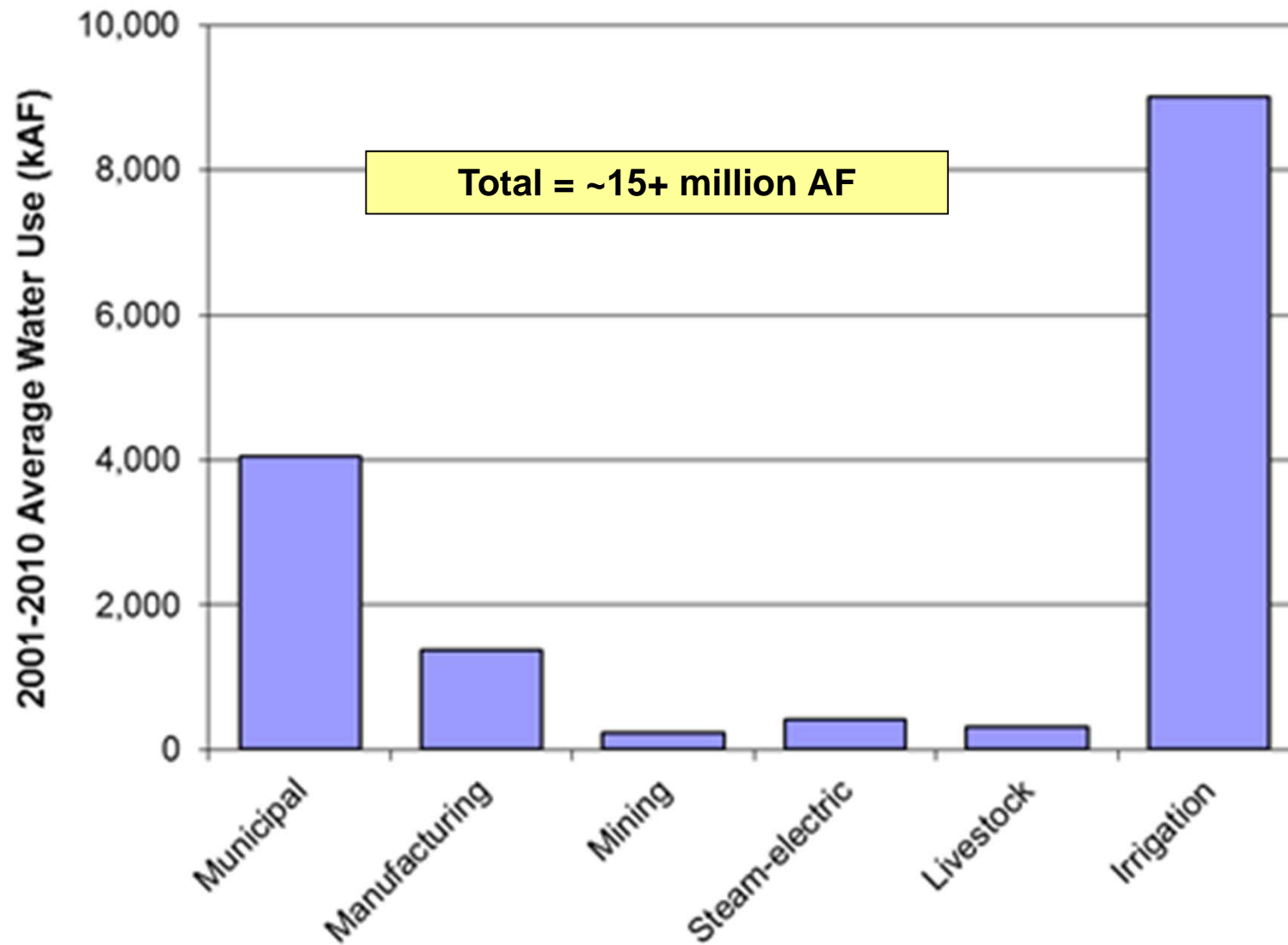
What is the impact of hydraulic fracturing on water supplies?



Modified from photo by Devon Energy, 2006

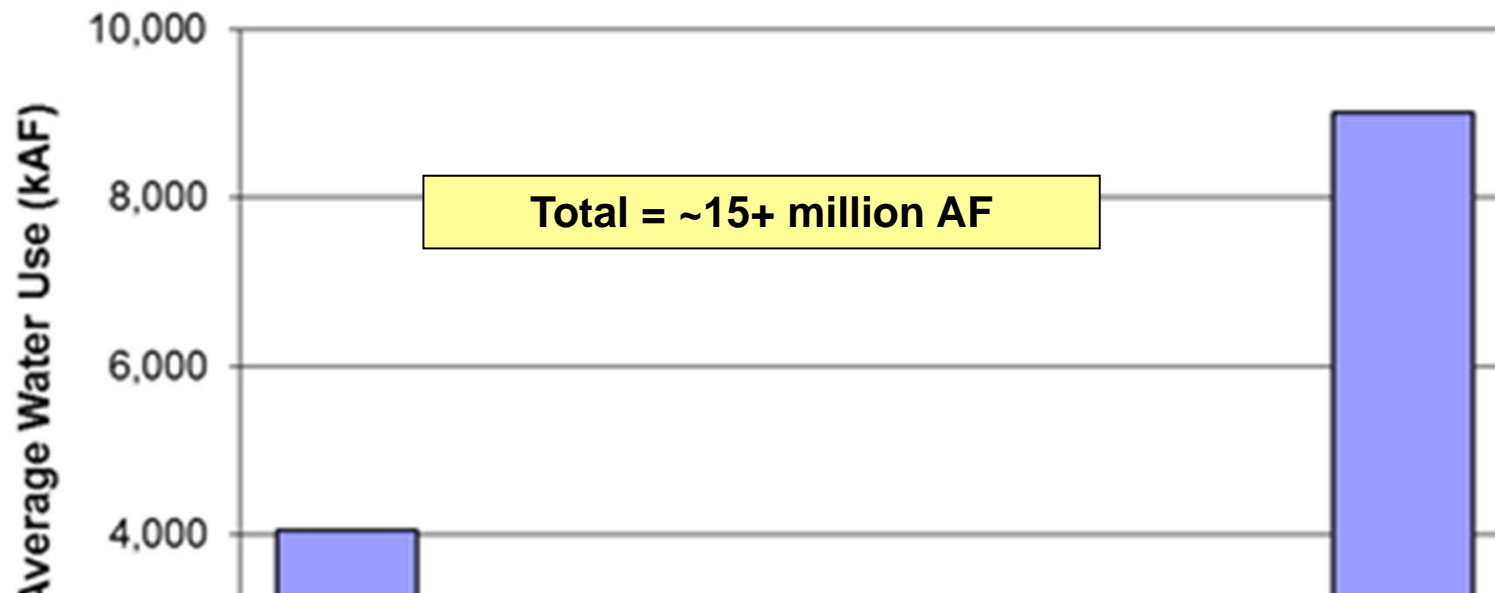
A few numbers....

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A few numbers....

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2008 Mining consumption:

Oil and Gas = ~60,000 AF (~36 kAF HF)

Coal/Lignite = ~20,000 AF

Aggregates = ~70,000 AF

Others = ~10,000 AF

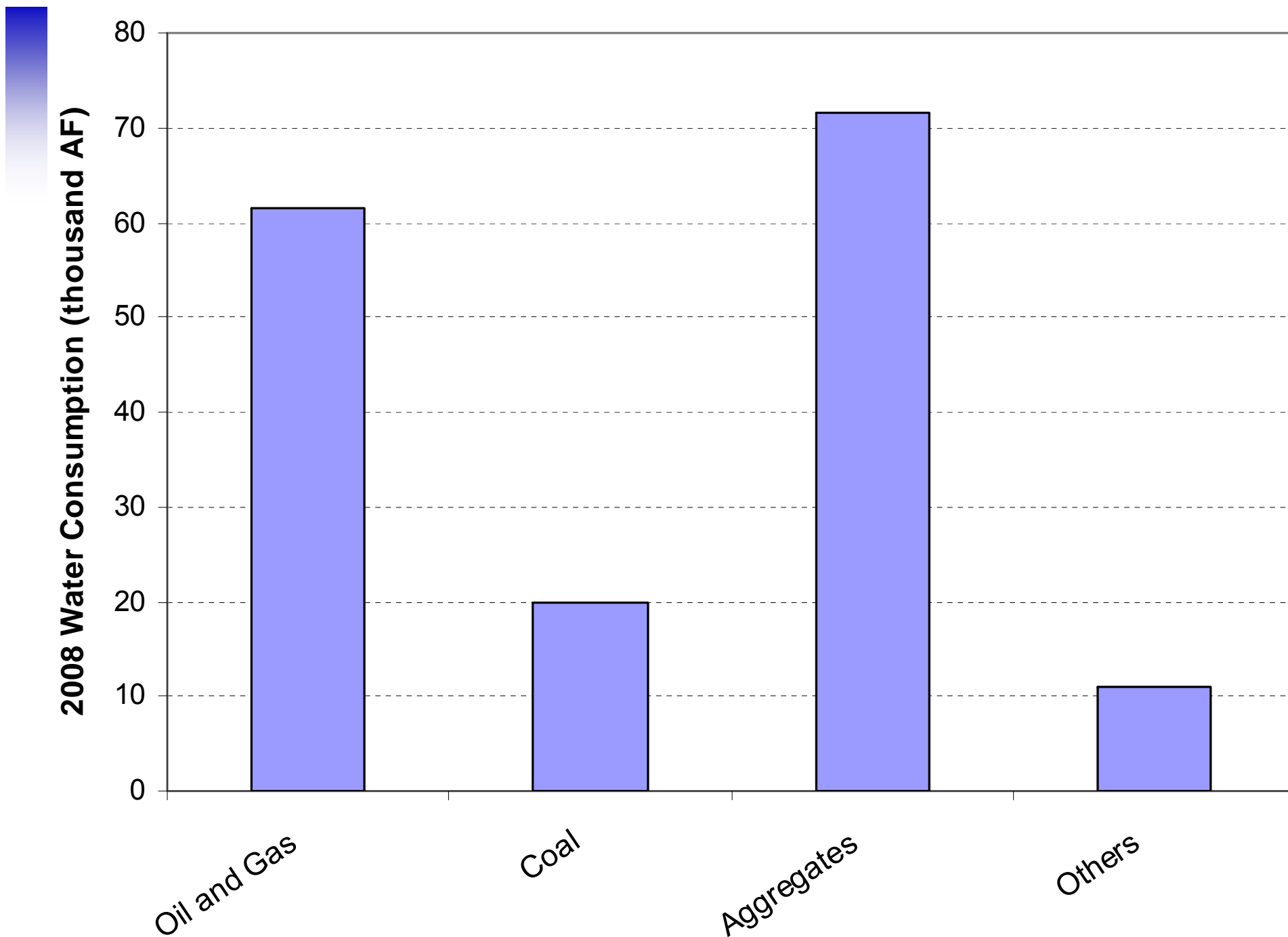
Total = ~160,000 AF

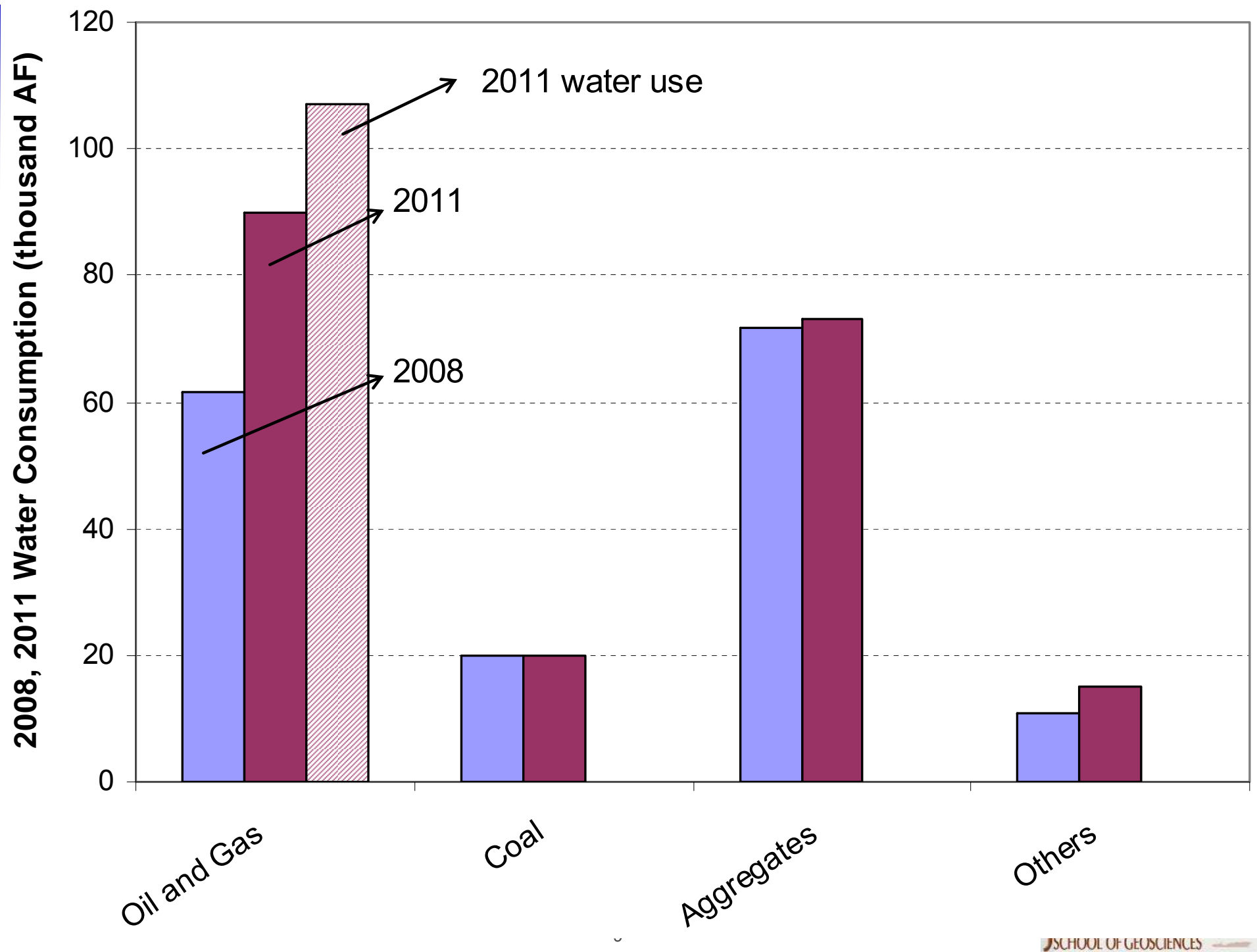
2011 Mining:

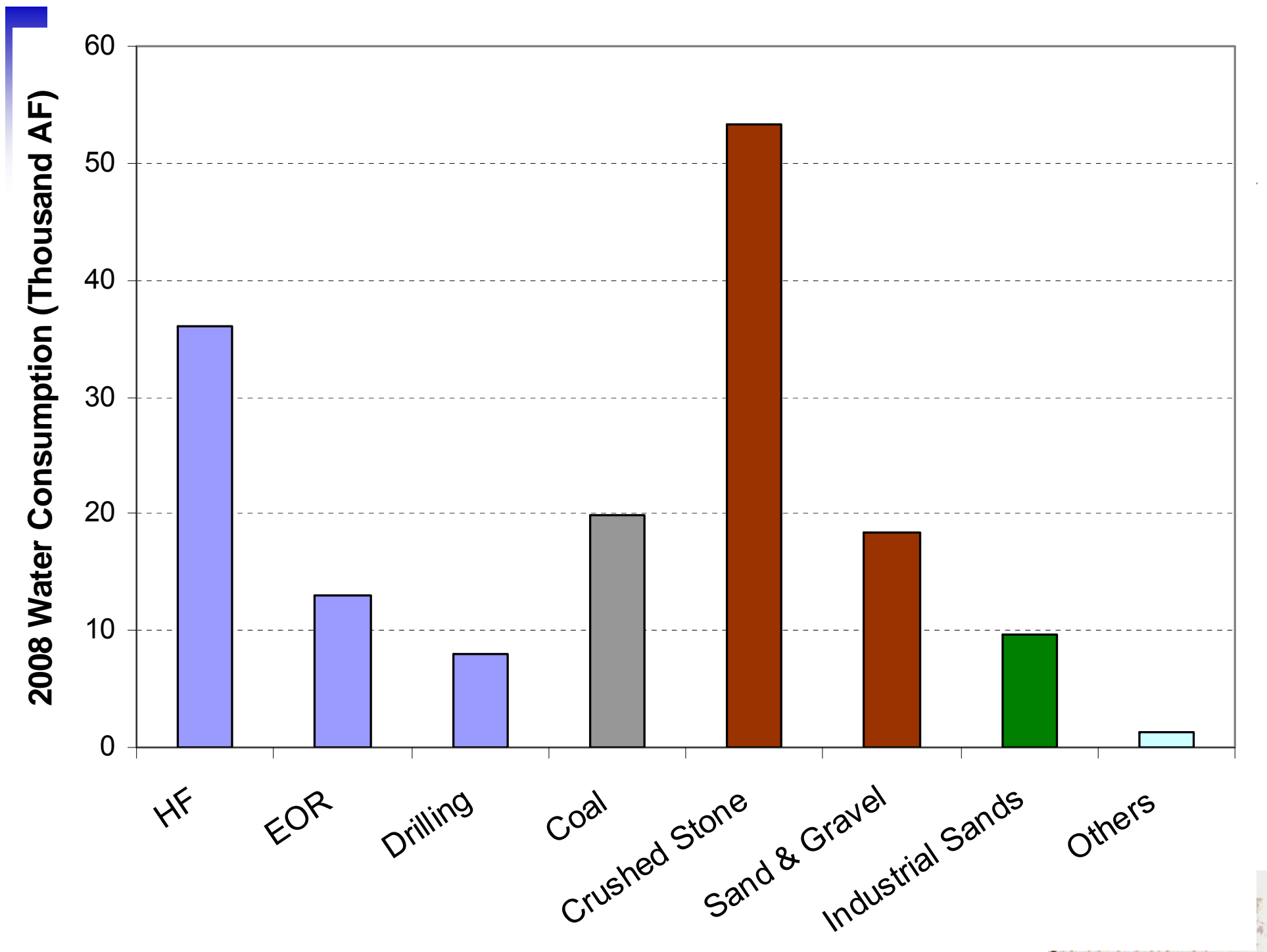
Oil and Gas = ~120,000 AF water use

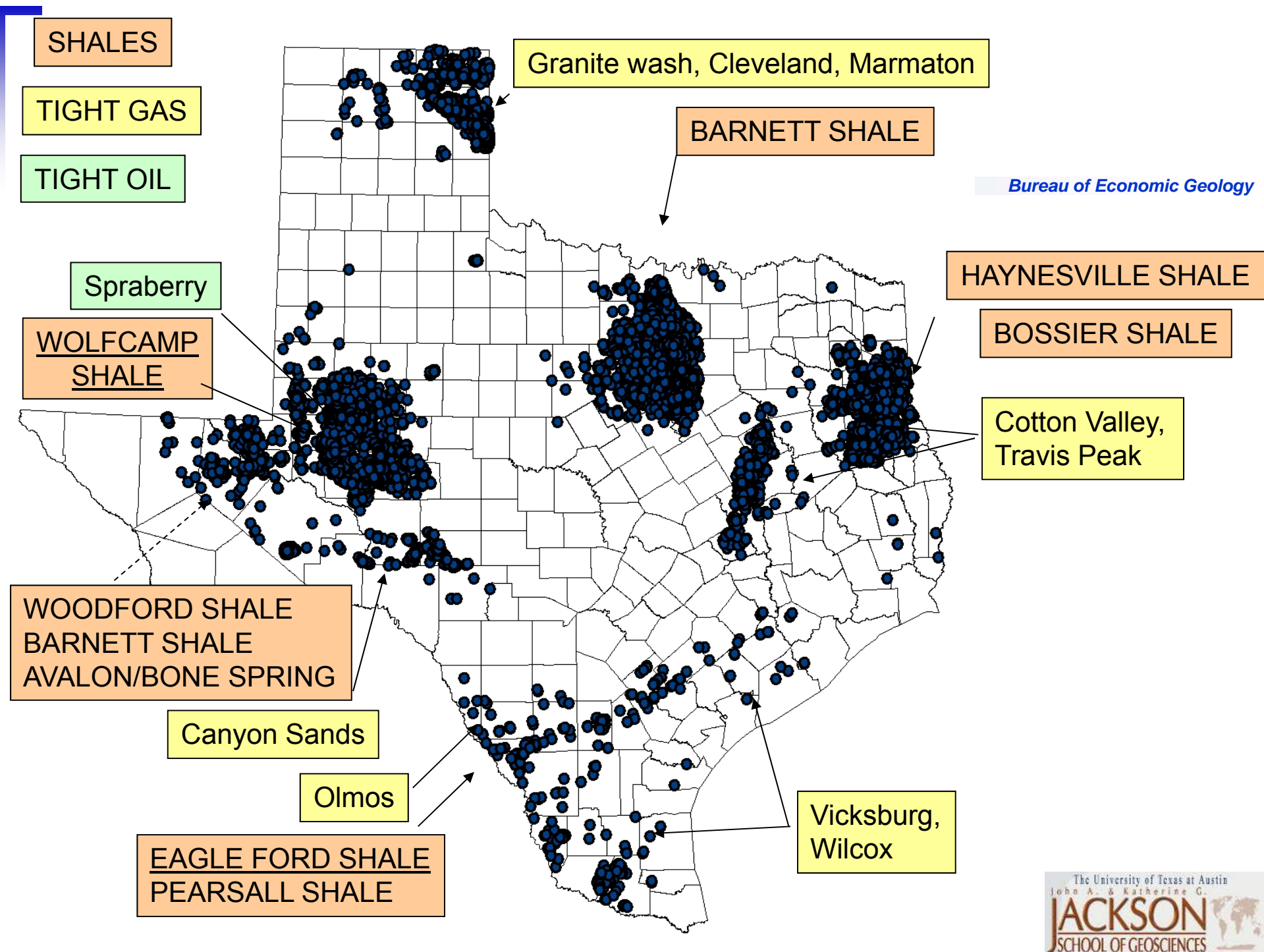
HF = ~81,500 AF water use

HF = ~65,000 AF water consumption

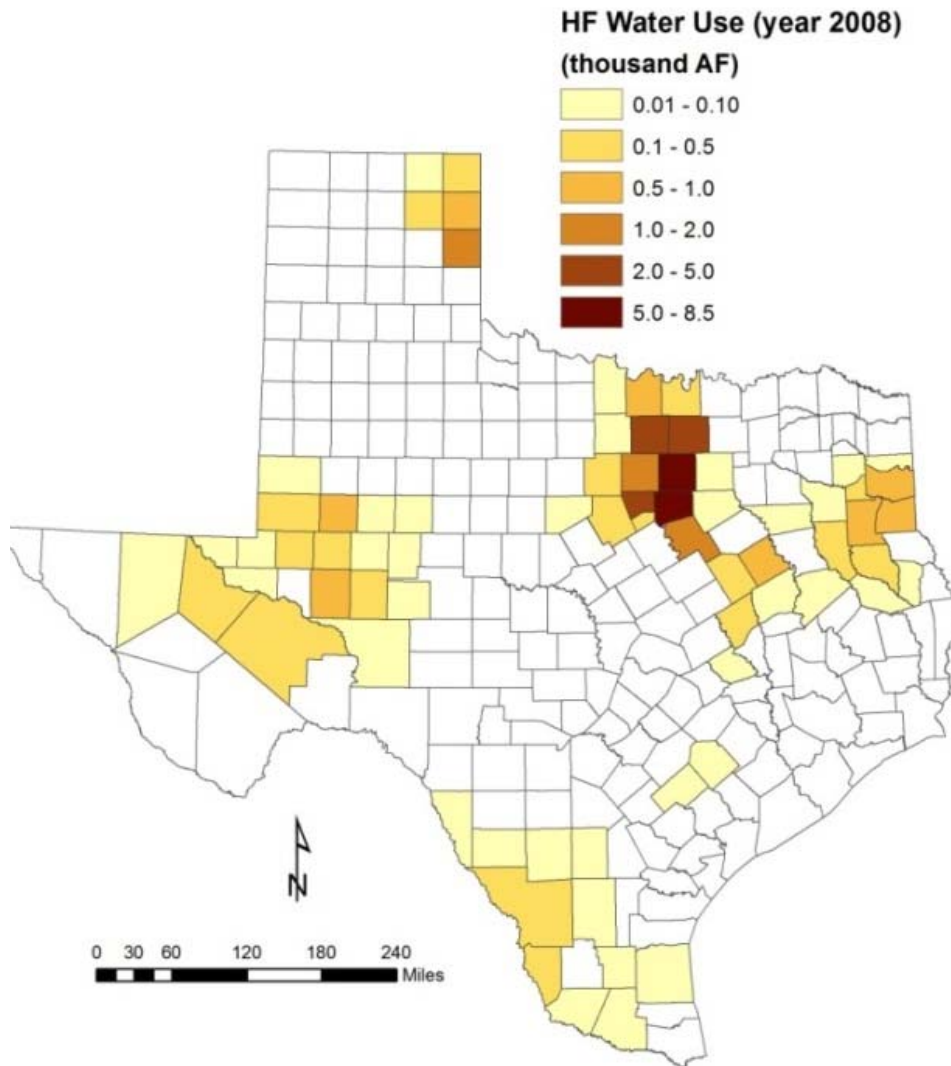




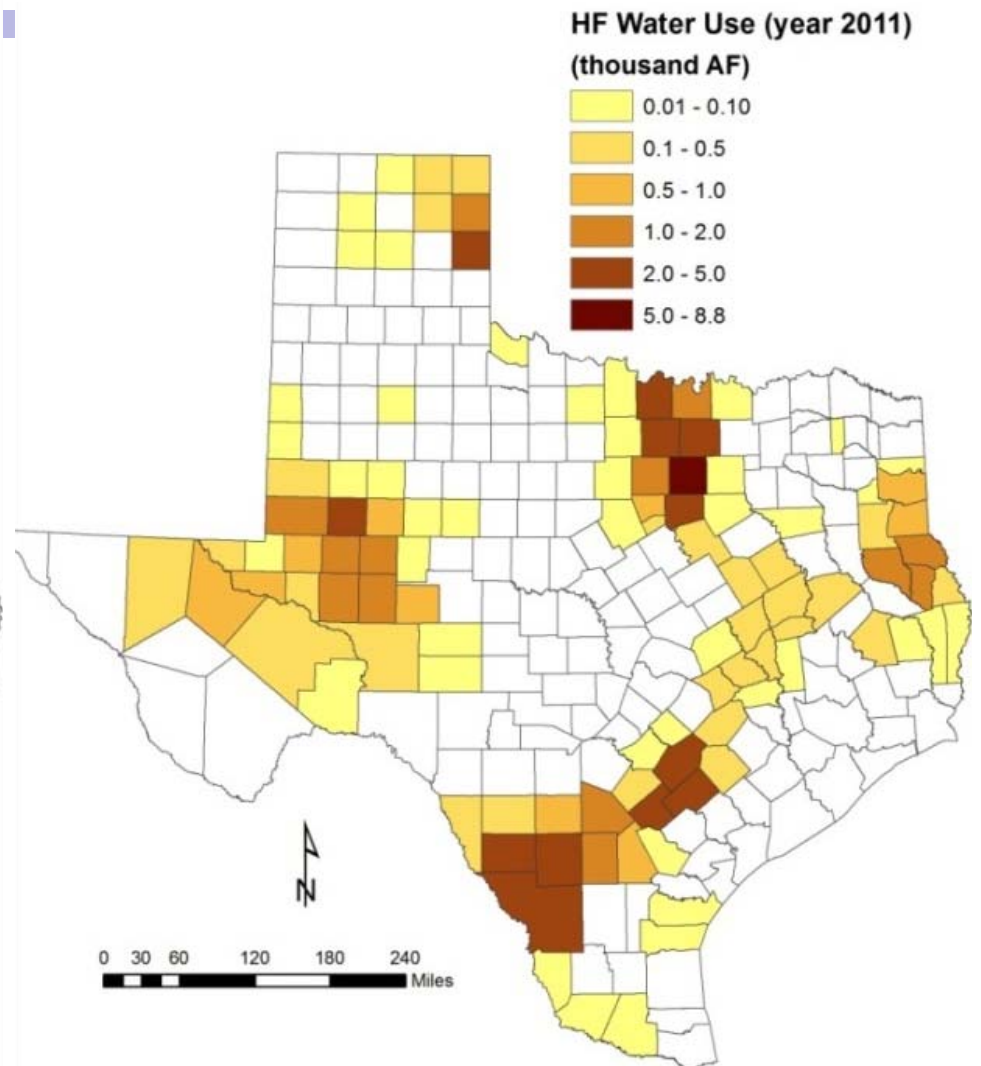




HF water use



2008: 36 kAF



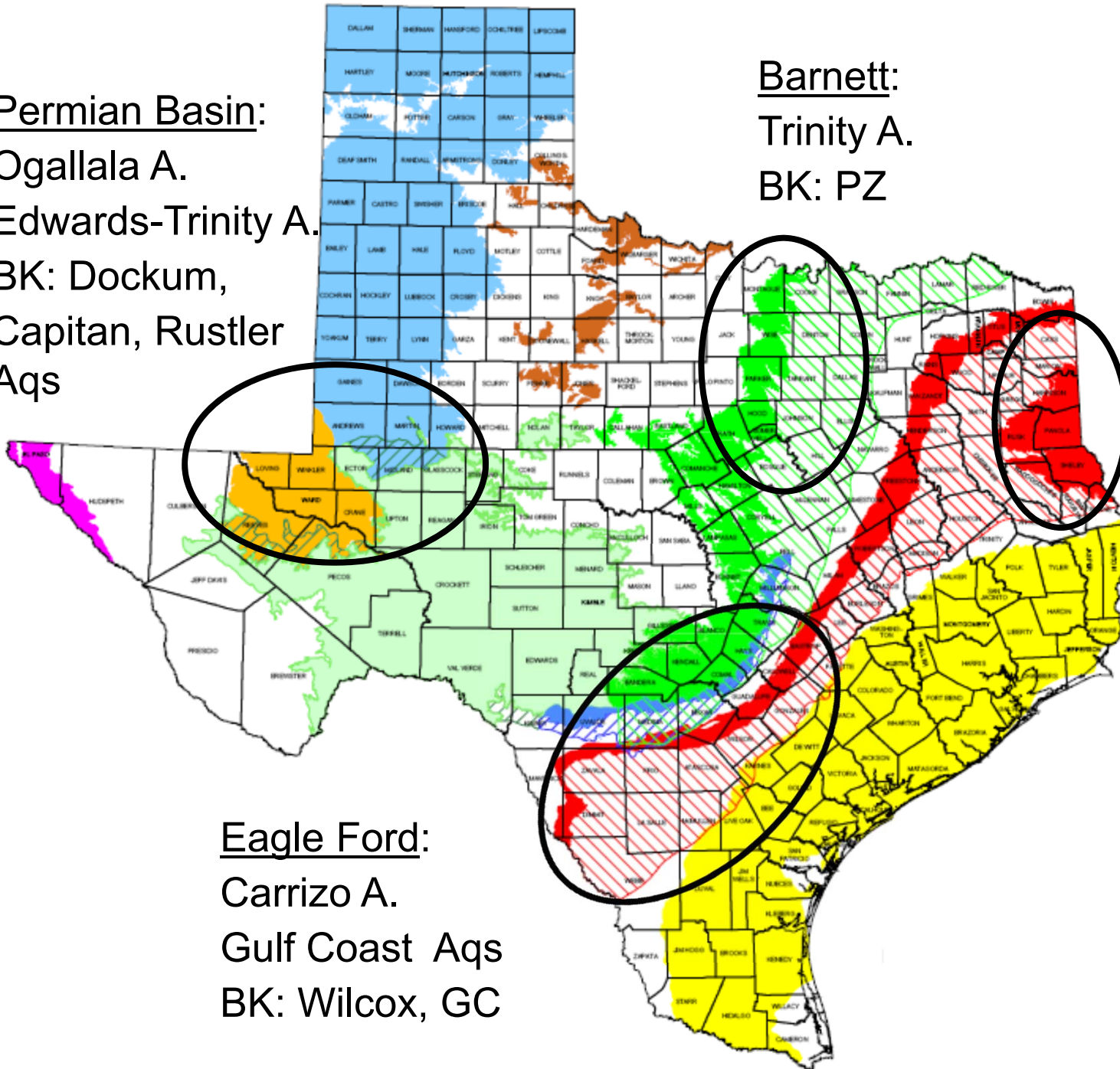
2011: 81.5 kAF

Permian Basin:
Ogallala A.
Edwards-Trinity A.
BK: Dockum,
Capitan, Rustler
Aqs

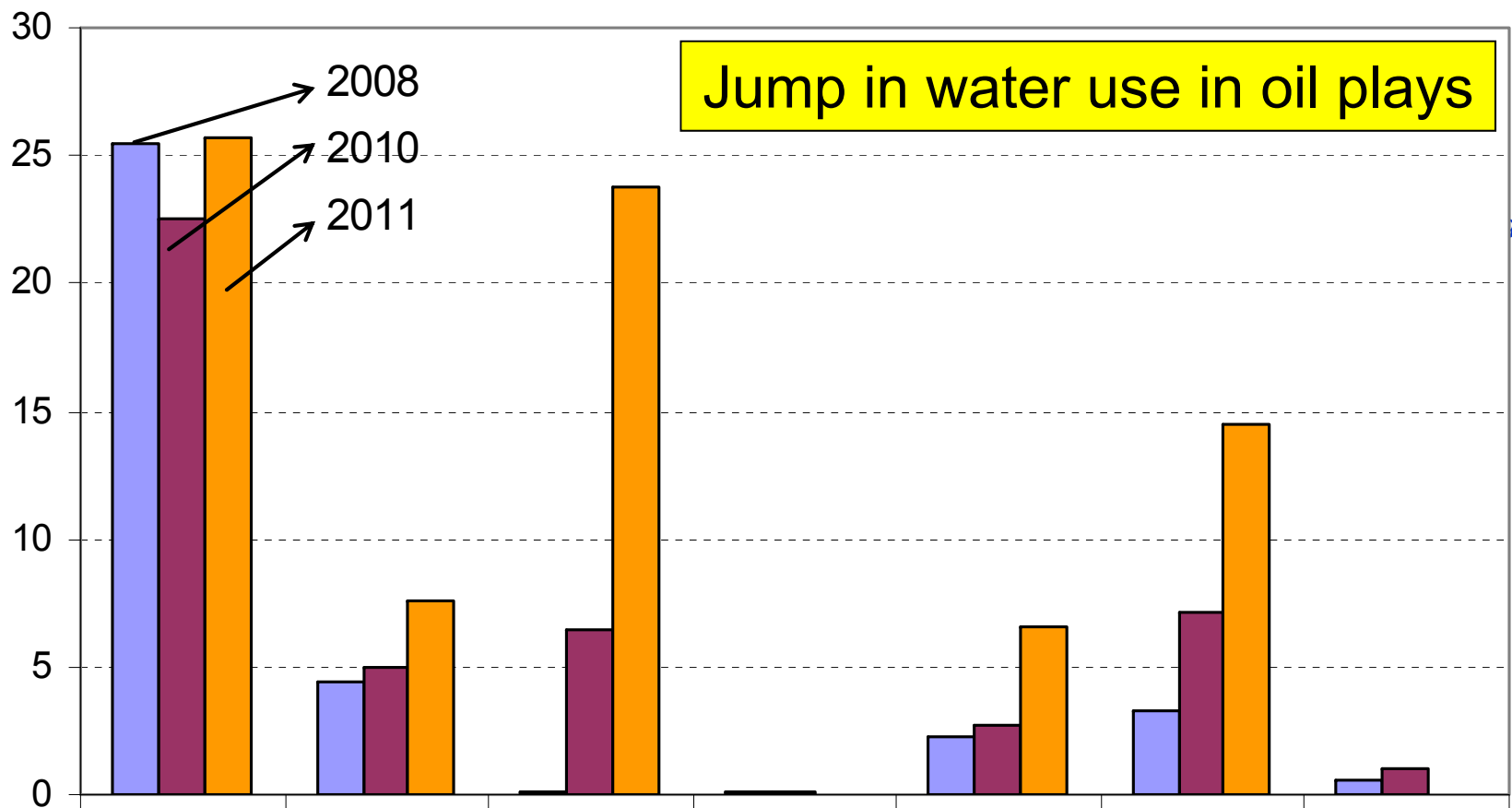
Barnett:
Trinity A.
BK: PZ

Haynesville:
Carrizo-
Wilcox A.

Eagle Ford:
Carrizo A.
Gulf Coast Aqs
BK: Wilcox, GC



2008, '10, '11 Water Use (thousand AF)



Barnett Sh.

Haynesville Sh. / East Texas TG

Eagle Ford Sh.

Woodford / Barnett PB / Pearsall Sh.

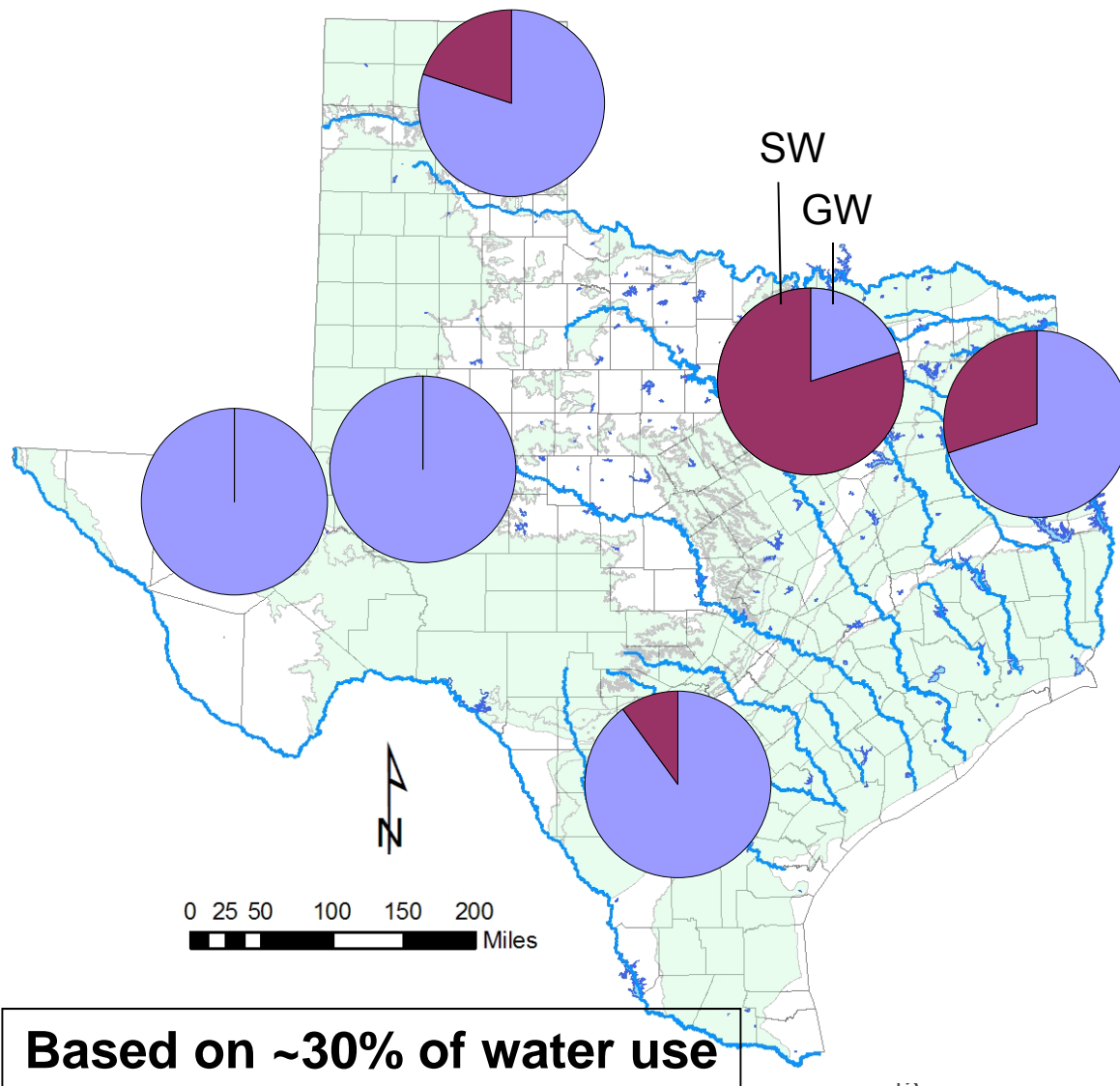
Anadarko TG

Permian Basin TO

South Texas / Gulf Coast TG

GW/SW split: little known

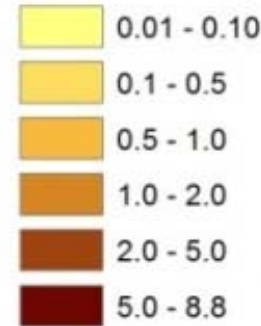
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- 2006 survey in Barnett:
~60% groundwater
- 2012 Barnett:
~20% groundwater
- 2012 Haynesville-ETx:
~70% groundwater
- 2012 Eagle Ford:
~90% groundwater
- 2012 Permian B.:
~100% groundwater

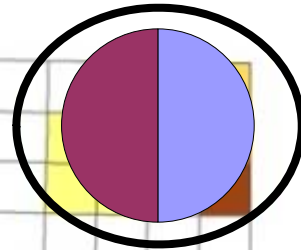
Based on ~30% of water use

HF Water Use (year 2011)
(thousand AF)



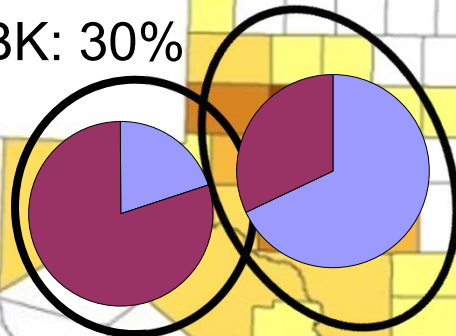
**Fraction
from
recycling /
reuse**

Anadarko:
R/R: 20%
BK: 30%



Barnett:
R/R: 5%
BK: 3%

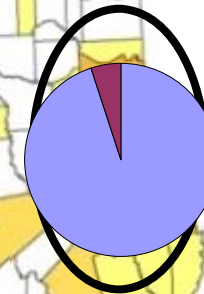
Midland:
R/R: 2%
BK: 30%



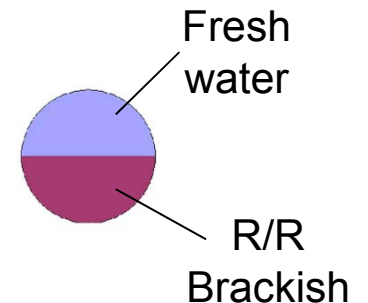
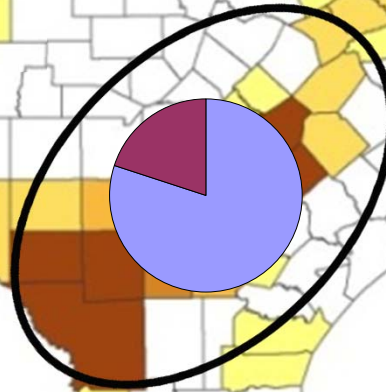
Delaware:
R/R: 0%
BK: 80%



East Texas:
R/R: 5%
BK: ~0%



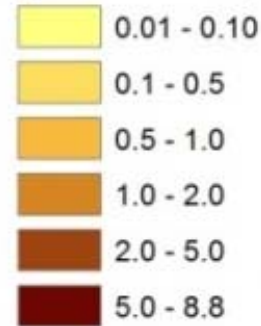
Eagle Ford:
R/R: ~0%
BK: 20%



0 30 60 120 180 240 Miles

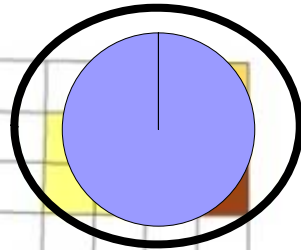
Based on ~30% of water use

HF Water Use (year 2011)
(thousand AF)

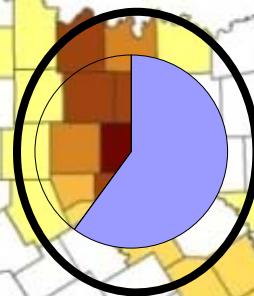


Flowback at end of Year1

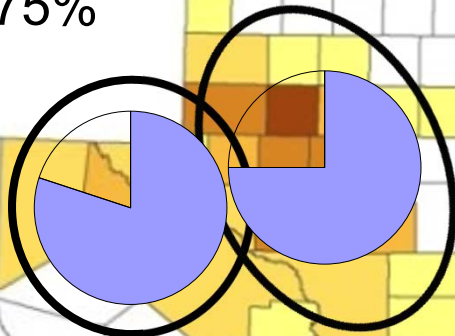
Anadarko:
~100%



Barnett:
~60%



Midland:
~75%

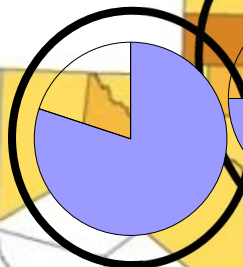


Haynesville:
~15%

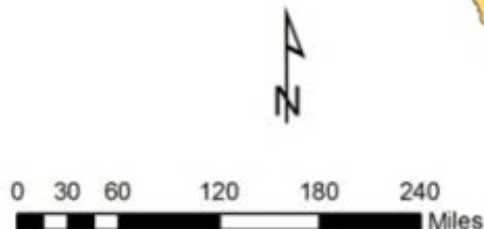
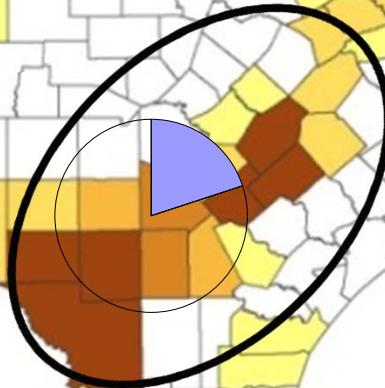


Cotton Valley:
~60%

Delaware:
~80%



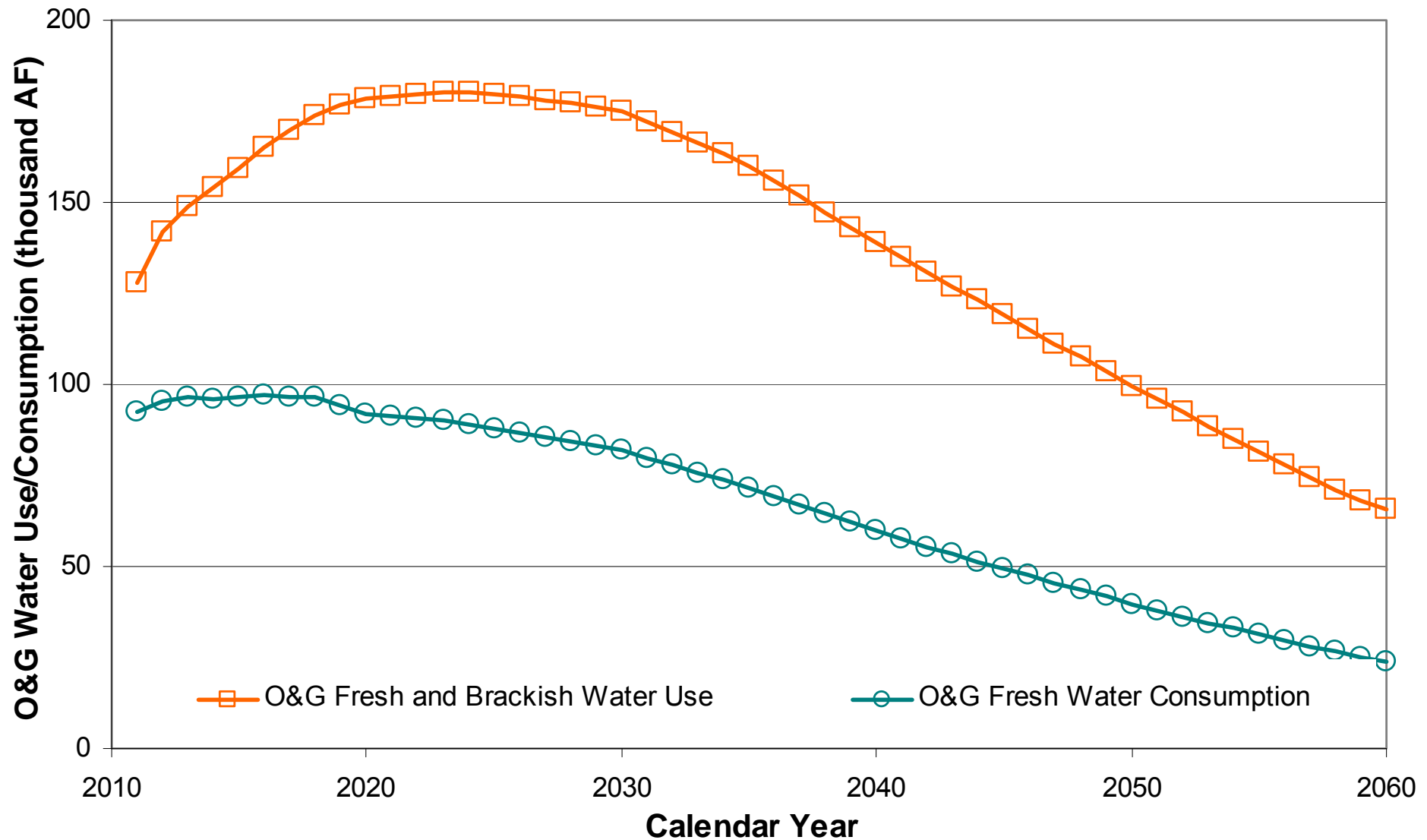
Eagle Ford:
~20%



O&G water use and consumption projections

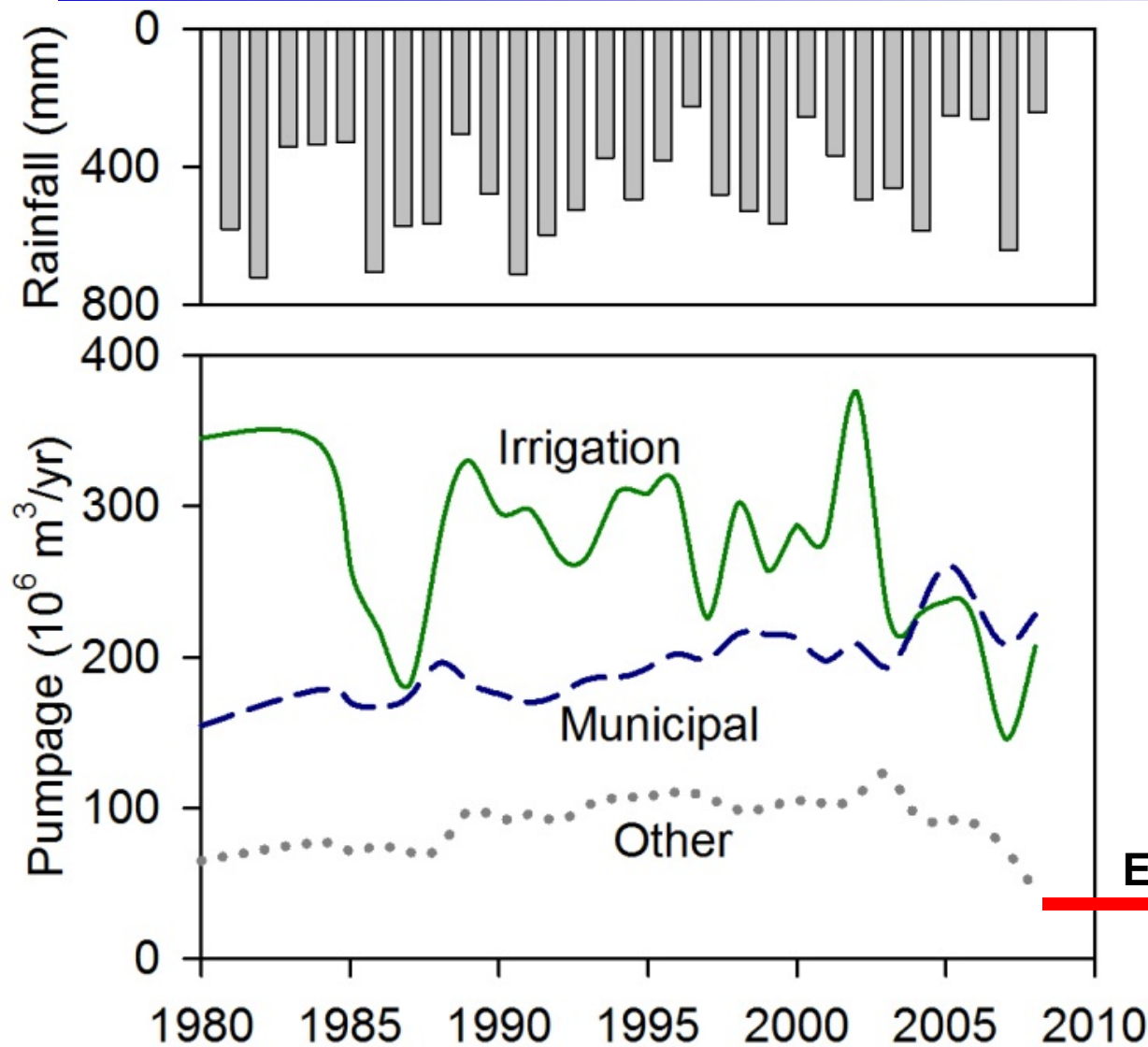
Preliminary Results
Document in Review

Bureau of Economic Geology

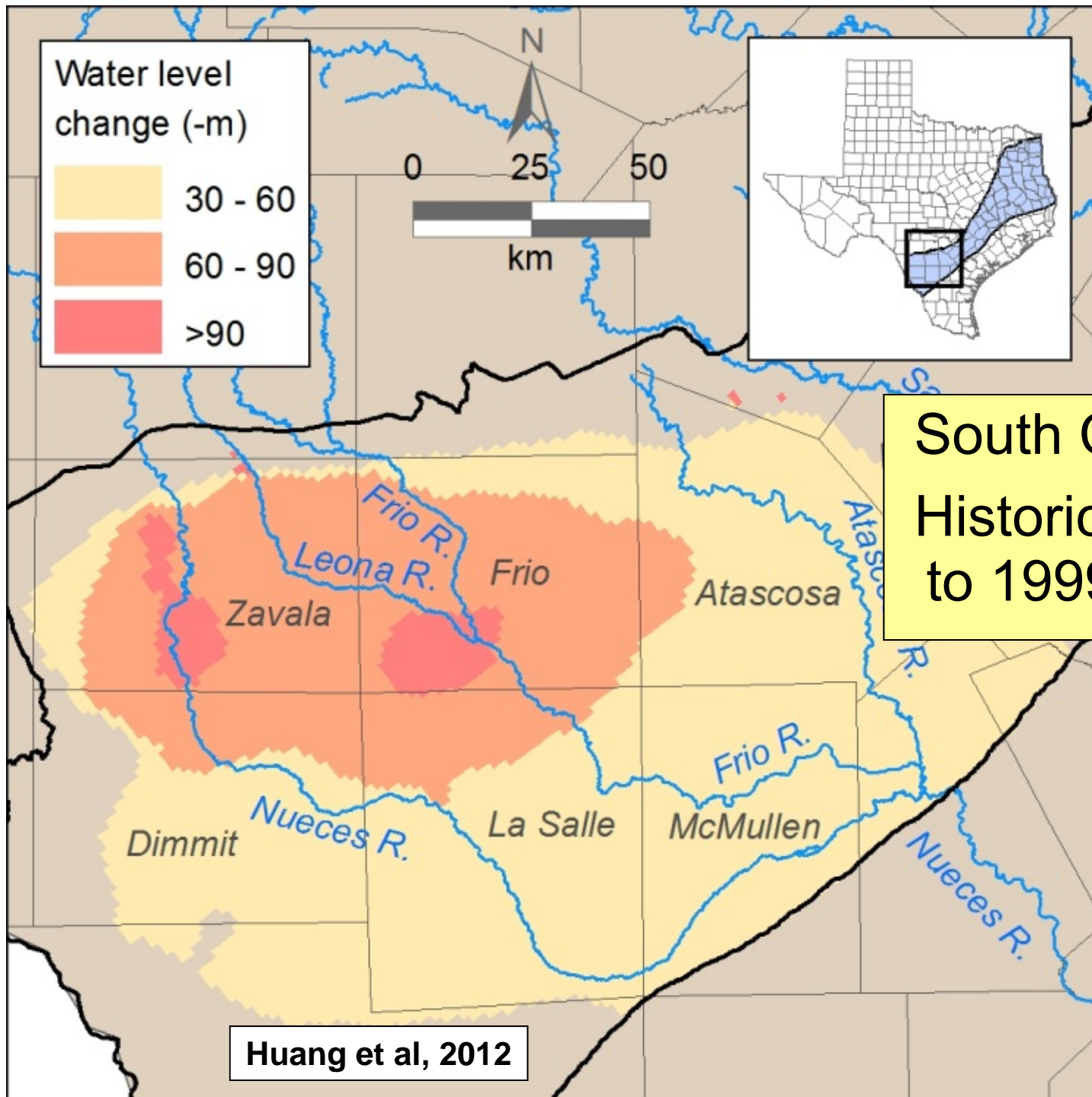


Historical water use Carrizo-Wilcox aquifer (state-wide)

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Huang et al, 2012



Bureau of Economic Geology

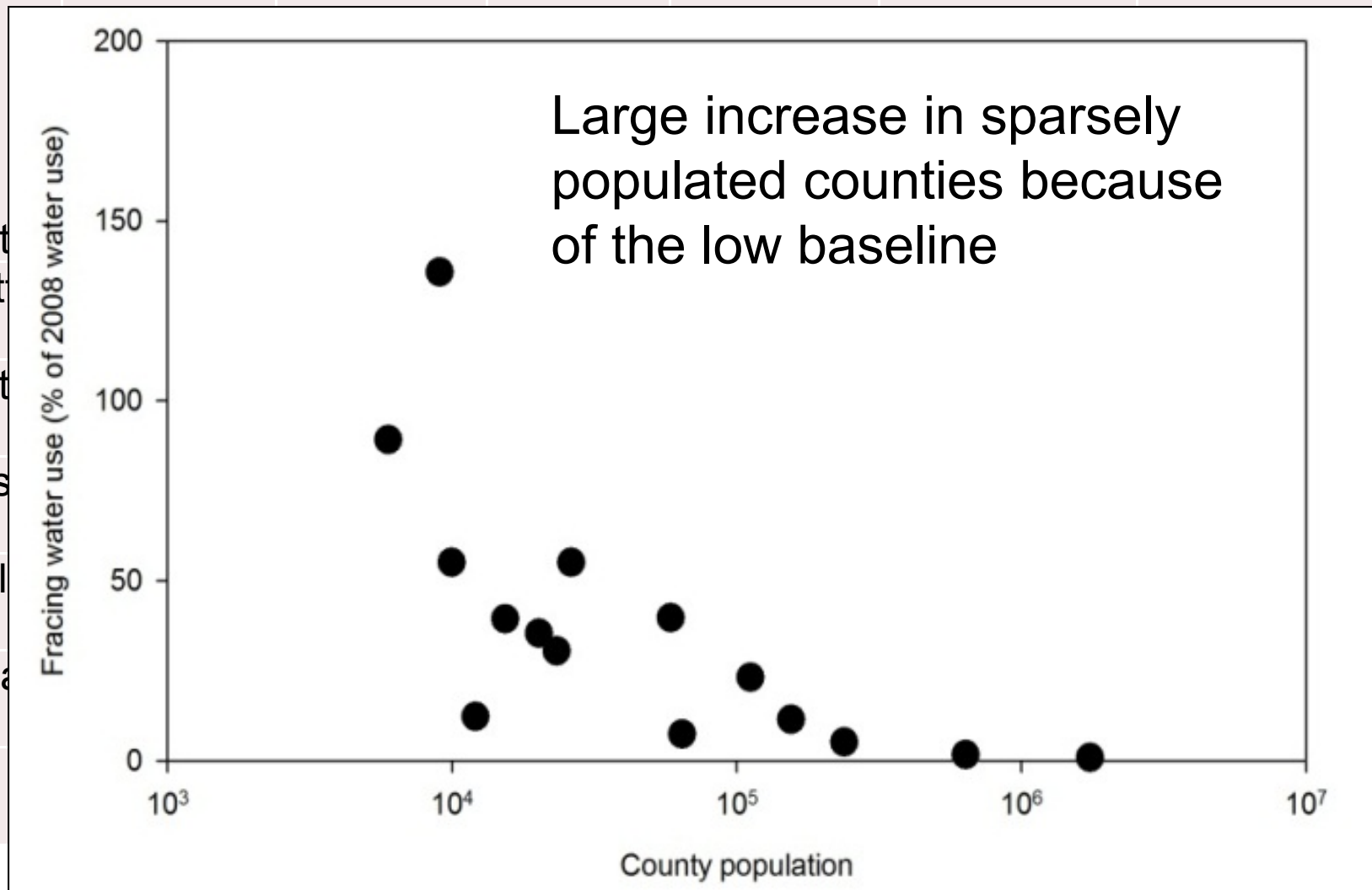
A few Eagle Ford counties

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County	Census 2010 / Area (mi ²)	Total water use in 2008 (kAF)	GW (%)	Max HF Water use (kAF)	Max HF water use (% of 2008 water use)	Max HF water use (% of 2008 GW water use)
De Witt	20,097 / 909	6.4	86	2.2	35	41
Dimmit	9,996 / 1,336	9.9	88	5.1	51	58
Karnes	14,824 / 759	5.1	91	3.9	76	83
La Salle	6,886 / 1,481	6.5	95	4.8	74	78
Live Oak	11,531 / 1,074	6.8	66	1.1	16	24
Webb	250,304 / 3,394	45.4	3	4.7	10	345

A few Eagle Ford counties

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Conclusions and final thoughts

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- Upstream oil and gas uses little water at the state level
- Aquifers of the Eastern half of the state: limited impact; western half: unknown
- However:
 - Frac water use can have a large impact locally, particularly on groundwater
 - Diffuse, transient pumping, no interlocutor (\neq well field)
 - Population growing in a state where droughts are frequent: competition with other users
- There is a need to develop alternative sources of water (brackish, reuse, etc) and less water-intensive techniques for HF

Reference list

- Nicot, J. -P., and Potter, E., 2007, Historical and 2006–2025 estimation of ground water use for gas production in the Barnett Shale, North Texas
- Bené, P. G., Harden, R., Griffin, S. W., and Nicot, J.-P., 2007, Northern Trinity/Woodbine aquifer groundwater availability model: assessment of groundwater use in the northern Trinity aquifer due to urban growth and Barnett Shale development, contract report prepared for the Texas Water Development Board
- Nicot, J. -P., 2009, Assessment of industry water use in the Barnett Shale gas play (Fort Worth Basin): Gulf Coast Association of Geological Societies Transactions, v. 59, p. 539–552.
- Nicot, J. -P., Hebel, A. K., Ritter, S. M., Walden, S., Baier, R., Galusky, P., Beach, J. A., Kyle, R., Symank, L., and Breton, C., 2011, Current and projected water use in the Texas mining and oil and gas industry: The University of Texas at Austin, Bureau of Economic Geology, Contract Report prepared for Texas Water Development Board, 357 p.
- Nicot, J.-P. and B. R. Scanlon, 2012, Water Use for Shale-Gas Production in Texas, U.S., Environmental Science & Technology, 46 (6), p.3580-3586
- Nicot, J.-P., 2012, Current and Future Water Demand of the Texas Oil and Gas and Mining Sectors and Potential Impact on Aquifers, GCAGS Journal,1, p.145-161
- Nicot, J.-P., R. C. Reedy, R. A. Costley, and Y. Huang, 2012, Oil & Gas Water Use in Texas: Update to the 2011 Mining Water Use Report: Contract Report to Texas Oil and Gas Association, Austin, TX, September 2012, 97p.