center for ENERGYSTUDIES
Rice University's Baker Institute

RICE

Central Texas Groundwater Market Conditions Update: Spring 2023

Gabriel Collins, J.D.

Baker Institute for Public Policy, Center for Energy Studies

gabe.collins@rice.edu
https://www.bakerinstitute.org/expert/gabriel-collins
https://texaswaterintelligence.com
https://collinsresearchportal.com/

Disclaimer & Disclosure

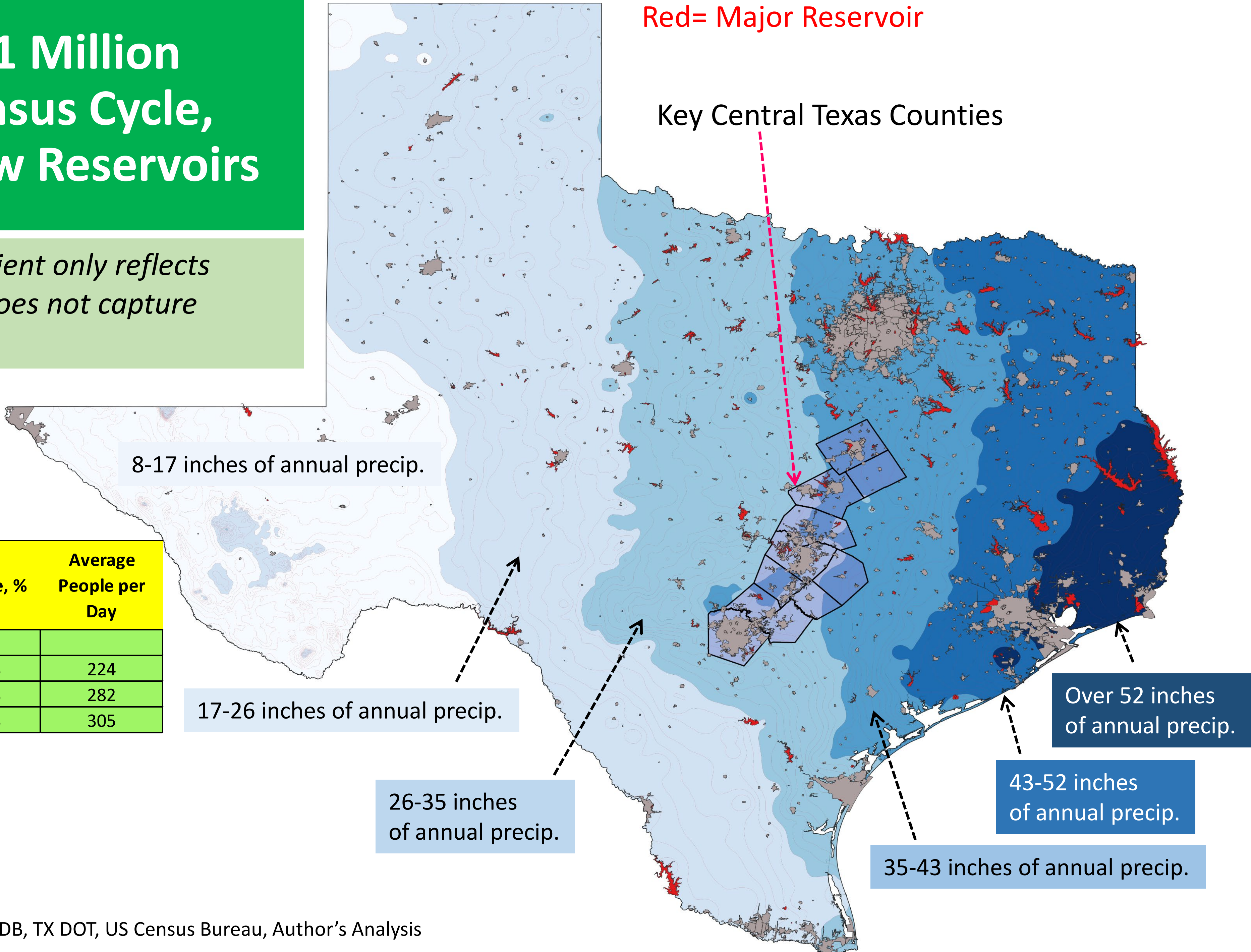
This analysis reflects personal opinions and assessments only. It is designed solely to be illustrative and stimulate broader thought, with the objective of elevating the conversation in the energy and water space. It IS NOT an investment analysis or investment advice. It is also NOT offering any legal opinions or advice and does not create an attorney-client relationship with any reader or consumer of the information presented herein. Readers rely on the information in this analysis at their own risk. Neither the authors nor the Baker Institute for Public Policy are liable for any loss or damage caused by a reader's reliance on information contained in any of the charts, data series, opinions, or other information presented herein. The information and opinions contained in, and expressed by this analysis, are based on sources deemed reliable. However, there is no warranty, assurance, or guarantee, express or implied, about the completeness, reliability, or accuracy of this content. The views expressed herein are my interpretations as of the date the report is published and are subject to change without notice.

Central Texas & Groundwater:
Why the Focus?

Central Texas: +1 Million Residents Per Census Cycle, Limited Rainfall, Few Reservoirs

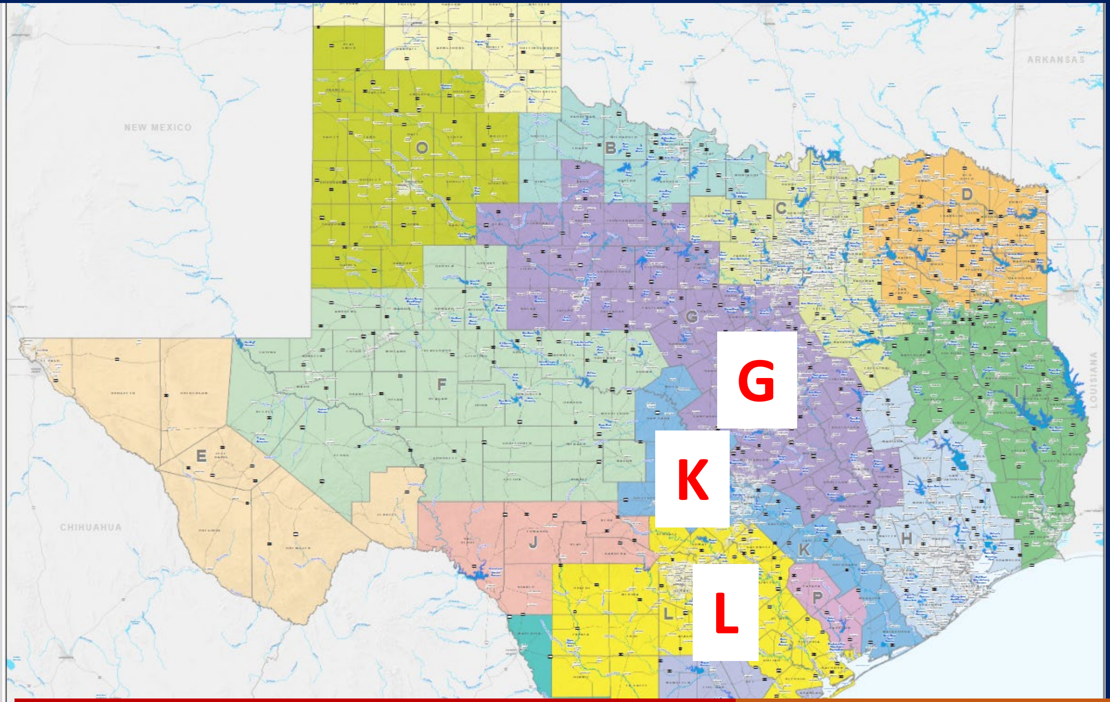
Note that the precipitation gradient only reflects cumulative annual averages and does not capture increasing rainfall volatility.

	Central TX Key MSAs' Population	Change, Persons	Change, %	Average People per Day
1990	2,853,315			
2000	3,669,853	816,538	29%	224
2010	4,699,523	1,029,670	28%	282
2020	5,811,928	1,112,405	24%	305



Source: TWDB, TX DOT, US Census Bureau, Author's Analysis

TWDB Regions G, K, and L: Water Demand Outlooks



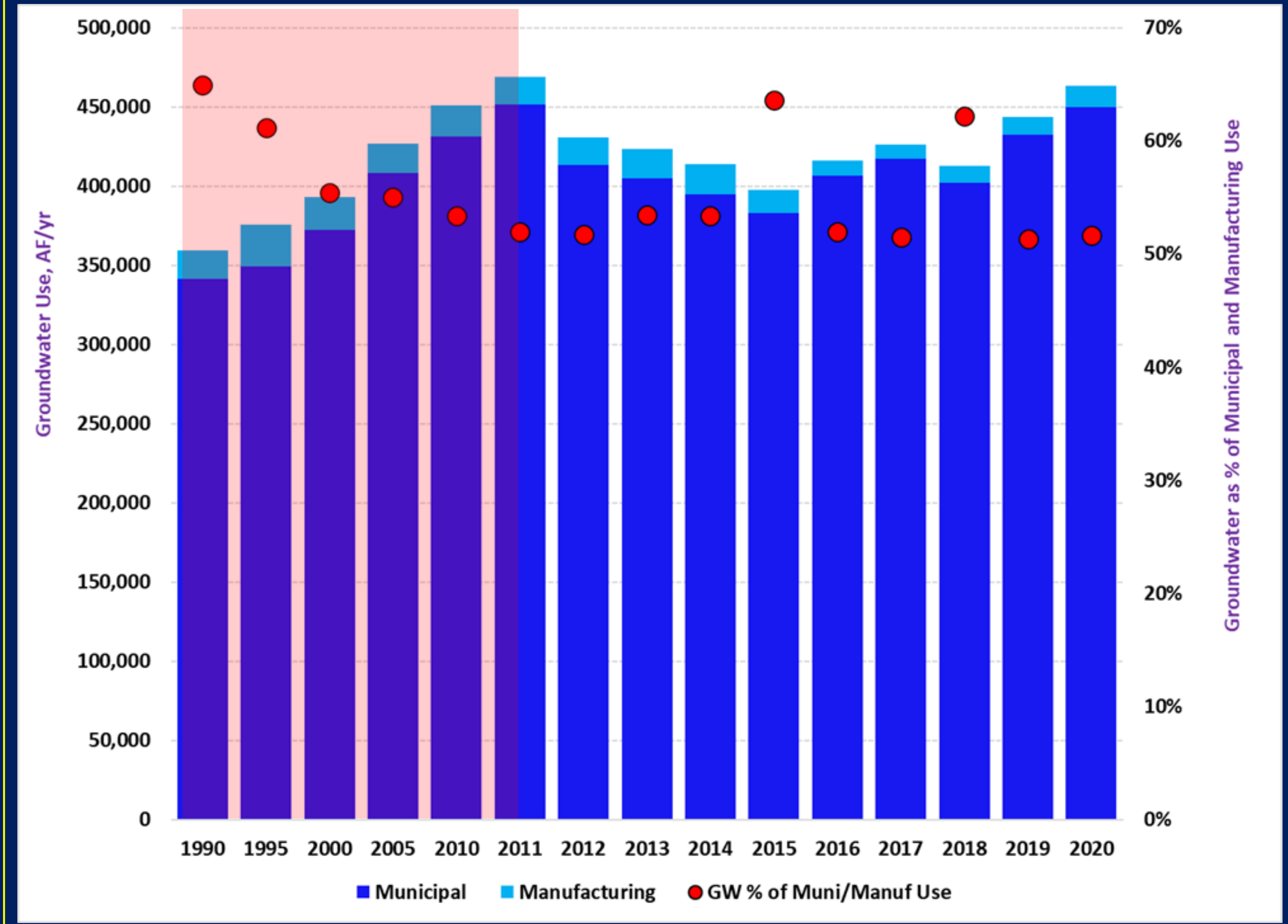
- Municipal demand growth will be the chief driver during next 50 years
- Thermoelectric power use likely to decline further as more gas, more renewables, and more modern modular nuclear technologies come to comprise more of the power generation stack.
- Irrigation use may decline much more.
- Key outstanding risk question—how does climate change influence these numbers moving forward? Surface water sources are most immediately exposed but groundwater not immune during prolonged drought, esp. Edwards Aquifer

	2020	2030	2040	2050	2060	2070	2020-2070 Change
Municipal	1,150,651	1,303,632	1,462,216	1,619,728	1,787,425	1,964,550	**813,899**
Manufacturing	104,919	121,433	121,433	121,433	121,433	121,433	16,514
Thermoelectric	505,015	505,015	505,015	505,015	505,015	505,015	0
Mining	131,172	142,352	135,932	130,562	122,955	127,488	(3,684)
Irrigation	1,300,603	1,285,705	1,265,275	1,249,898	1,239,281	1,225,924	(74,679)
Livestock	91,447	91,447	91,447	91,447	91,447	91,447	0
Total	3,283,807	3,449,584	3,581,318	3,718,083	3,867,556	4,035,857	752,050
Population	7,146,794	8,306,697	9,451,221	10,549,124	11,683,857	12,860,912	5,714,118
Municipal Intensity AF/1000 Persons	161	157	155	154	153	153	(8)

Groundwater and the I-35 Corridor

- The I-35 Corridor has some of the nation's fastest population growth, both in terms of rate and absolute numbers. San Antonio added nearly a quarter-million people between the 2010 and 2020 Censuses, while the city of Austin added over 205,000 additional residents during that time.
- The Central Texas suburbs and exurbs are also rapidly growing. The broader Austin-Round Rock-Georgetown, TX metropolitan statistical area (MSA) added more than 500,000 new residents between 2010 and 2019.
- Demand for groundwater by cities grew substantially between 1990 and 2010. After the 2011 drought, usage dropped due to efficiency improvements. From 2015 onwards, the downward trend appears to be reversing, likely on the basis of continuing robust demographic and industrial activity growth.
- Annual population growth in the key I-35 Corridor metro areas is approximately 100,000 persons/yr. Using the past 5 years' trailing average, each thousand people create nearly 45,000 gal/yr of total "municipal + manufacturing" water usage.
- This use category is dominated by municipal usage and about 55% of that demand is met by groundwater. **Thus, every thousand additional I-35 Corridor residents creates approximately 76 acre-feet of annual groundwater demand**.

Municipal and Manufacturing Groundwater Use For Key Central Texas MSAs



Source: TWDB, Author's Analysis

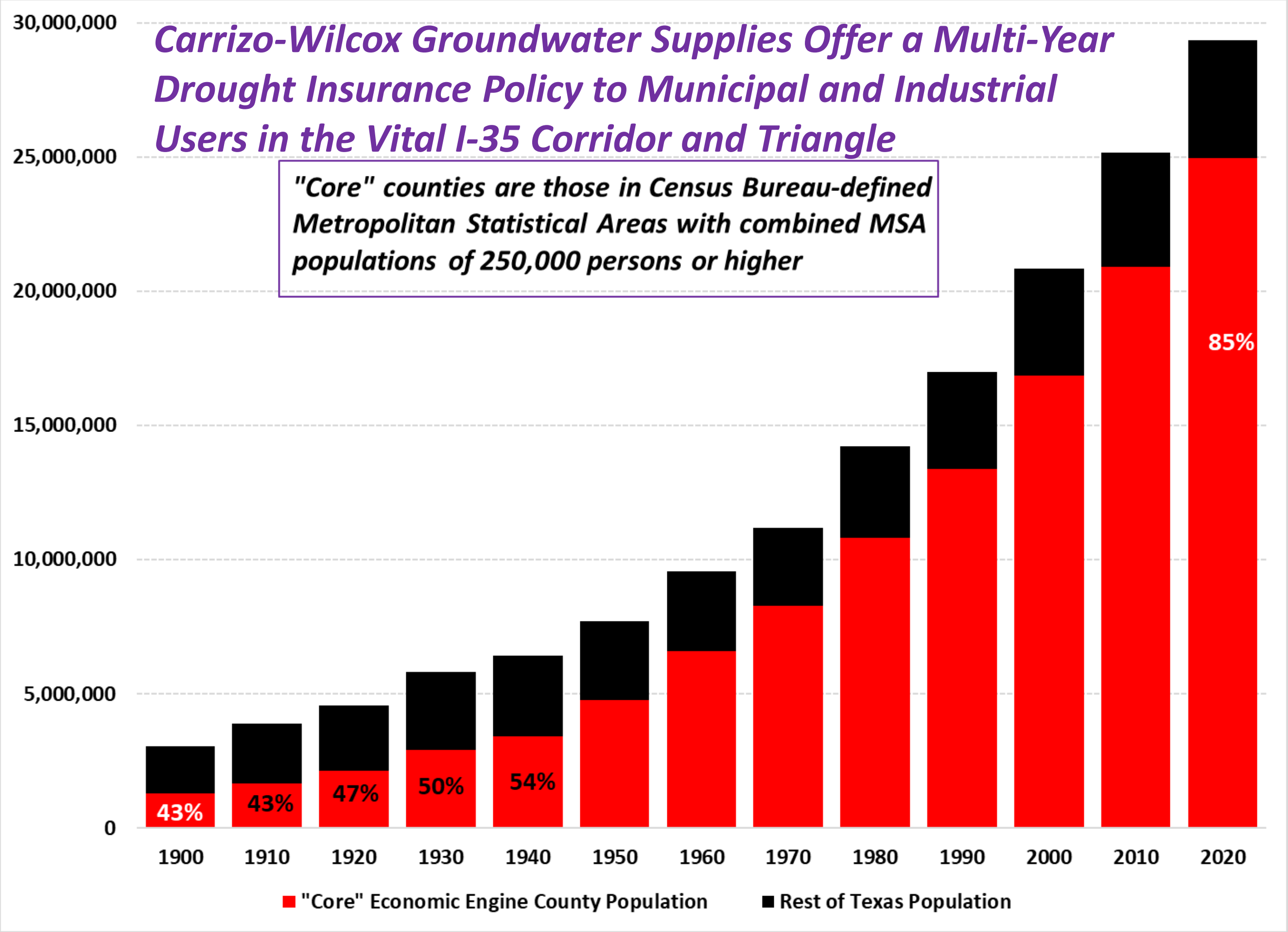
Groundwater Offers an Industrial and Municipal "Insurance Policy"

Serious Droughts Are Question of "When," Not "If" in Texas…

- **1917-1918**: Native grasses are so severely damaged that invasive species permanently take over many areas. The federal government sends 1,400 boxcars to evacuate starving Texas cattle.
- **1925**: High temperatures and low rainfall set records for the worst one-year drought that stand for the next 86 years.
- **1930-1936**: Dust Bowl
- **1950-57**: Catastrophic drought lasts for years and galvanizes Texas into adopting scientific water planning, with 1950s conditions enshrined as the "drought of record" (meaning, the worst-case scenario).
- **1971**: Severe drought destroys wheat and cotton crop and kills 100,000 cattle. Especially severe in North Texas, where the Red River goes dry.
- **2010-2011**: Hottest, driest one-year period ever recorded in Texas.

Source: Texas State Library and Archives Commission

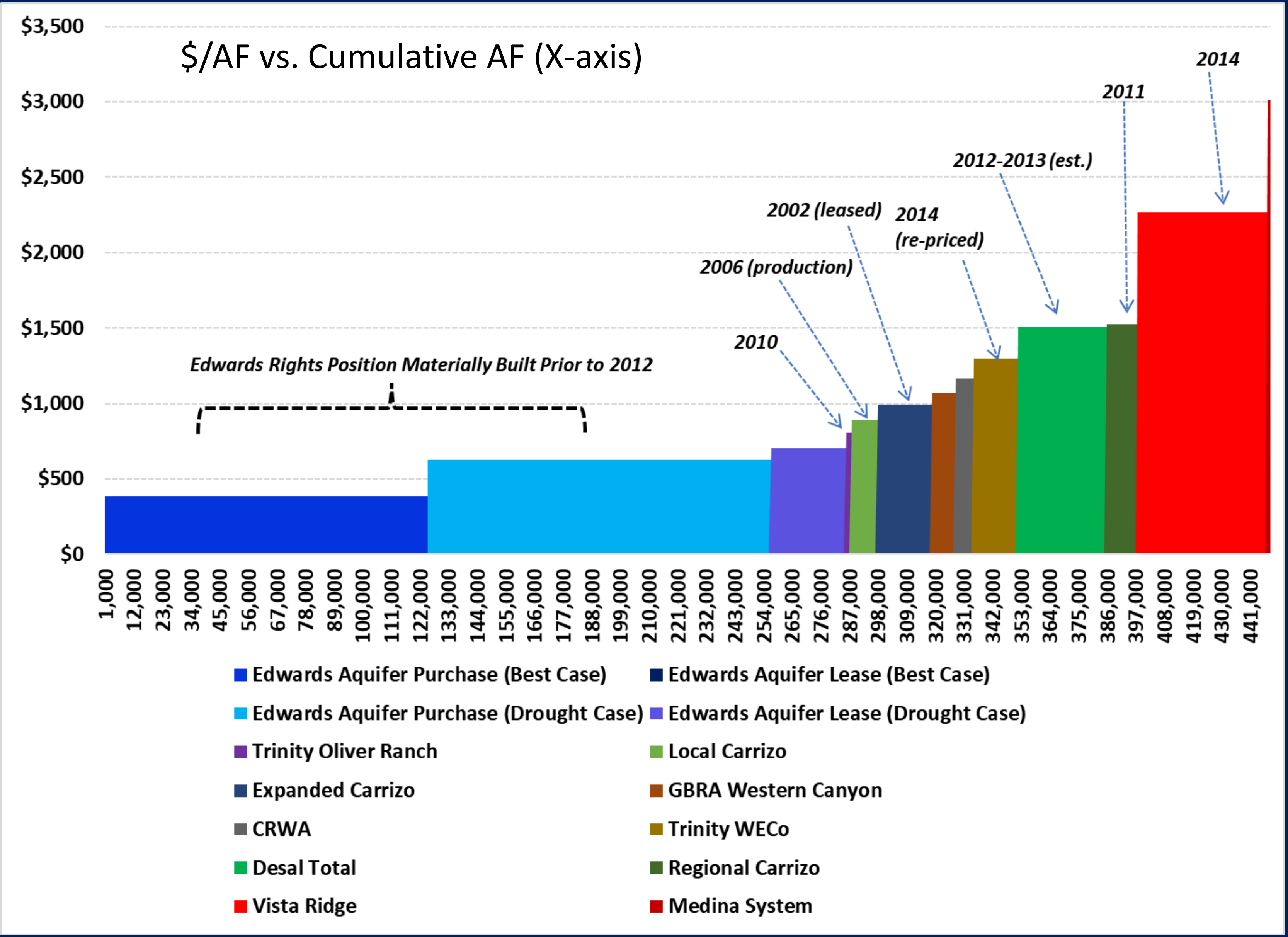
…And the State is Now Predominantly Urban, With Nearly 30 Million Residents and A Canada-Sized Economy



Source: U.S. Census Bureau, Author's Analysis

Water Competition Likely to Intensify

SAWS Water Sourcing Price and Vintage Curve

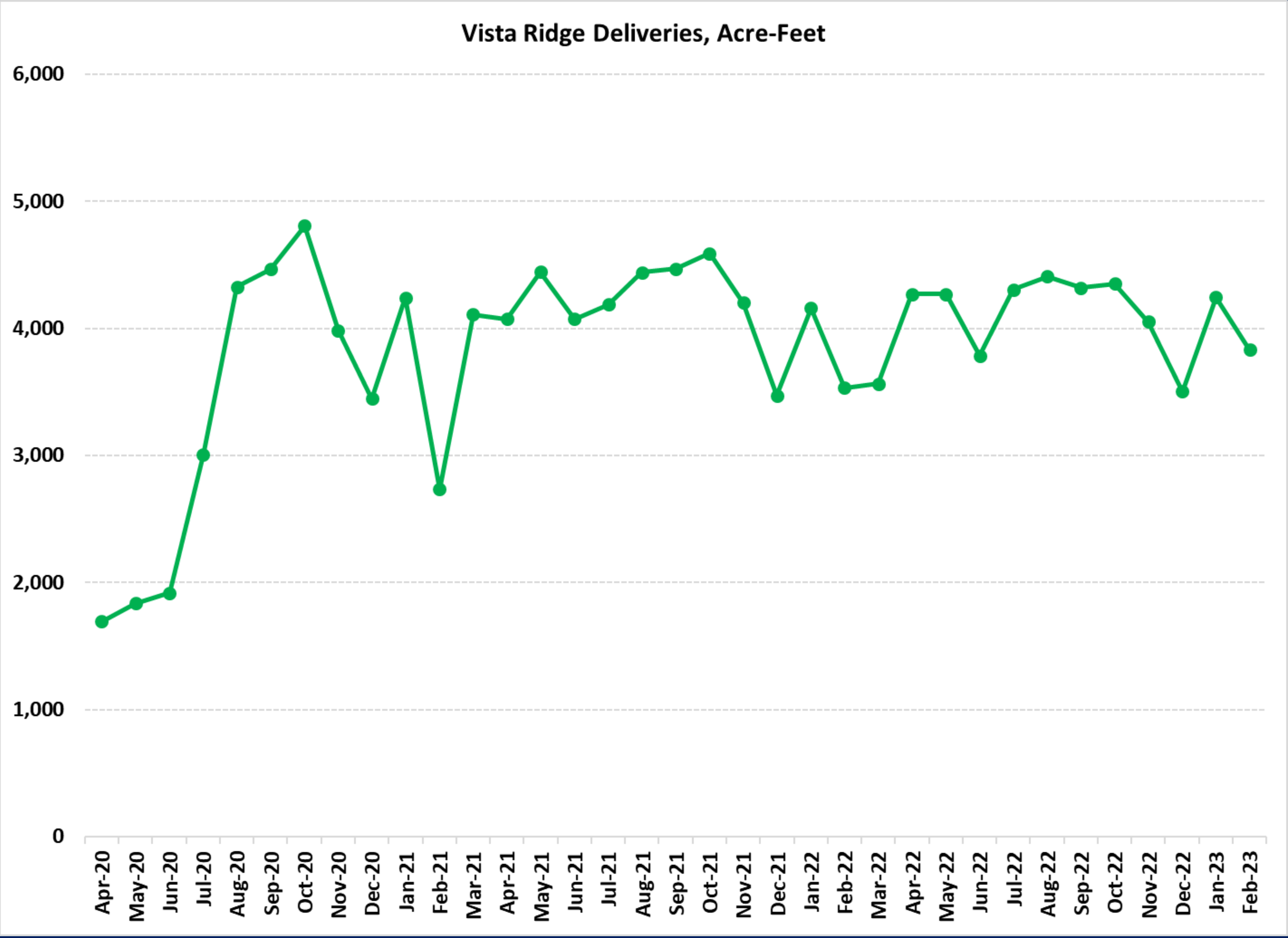


- Water is becoming more expensive for San Antonio as it seeks water sources further afield or through higher cost local sources such as brackish desalination
- Distance and the associated infrastructure costs play a major role in cost inflation.

Source: SAWS, Texas Water Development Board

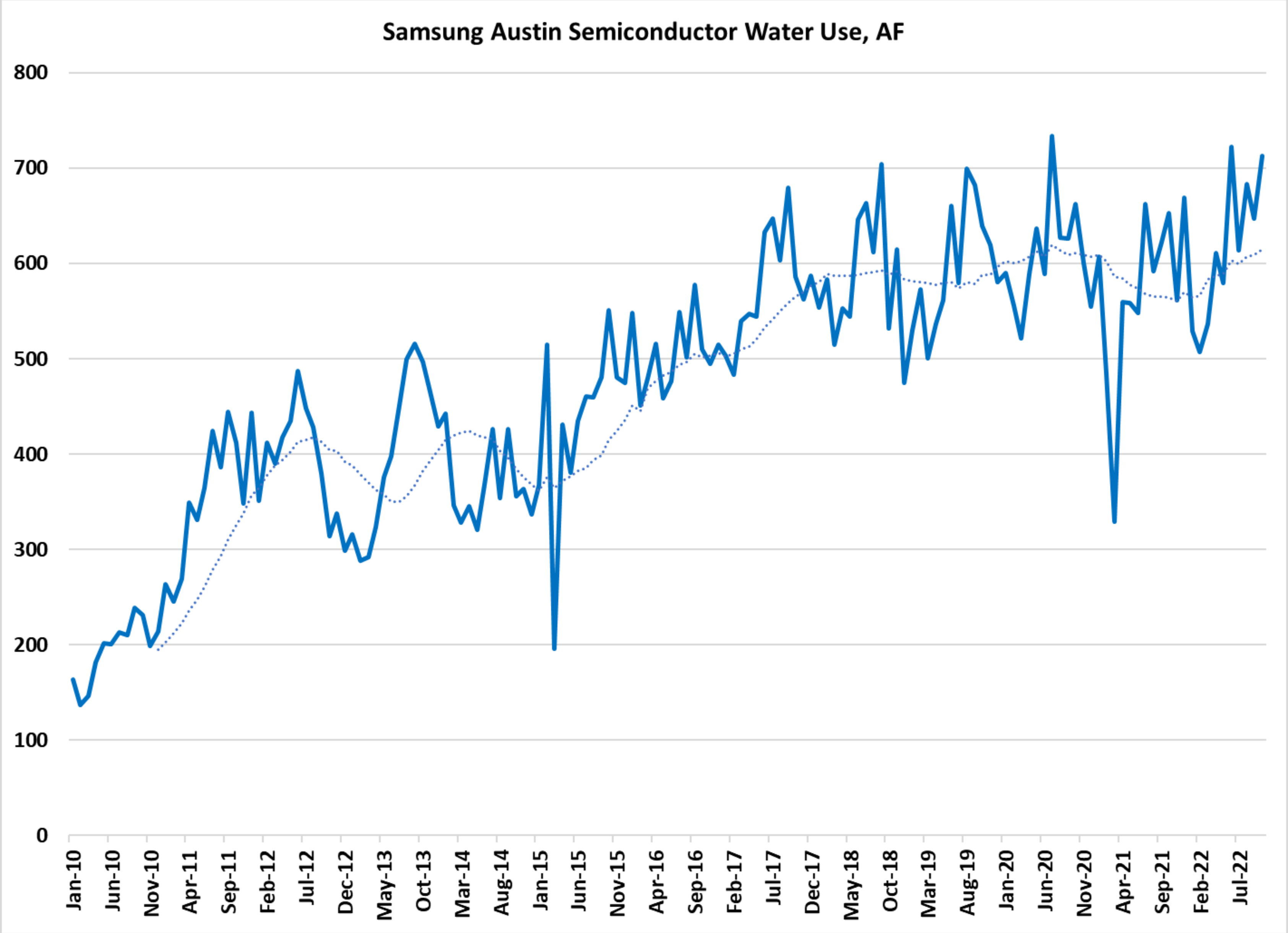
Vista Ridge Pipeline Now Fully Online

- Provides approximately 20% of SAWS supply on annualized basis
- Vista Ridge water costs $460/AF for the water itself, according to SAWS Agreement with Blue Water Systems.
- https://apps.saws.org/Your_water/waterresources/projects/VistaRidge/docs/20210317_WTPA_CAM_2021-1%20-%20Conformed%209th%20A&R%20WTPA%20(Execution%20Version).pdf



Source: Post Oak Savannah GCD

CHIPS Act Meets Groundwater: Semiconductor Fabs a Key New Consumer



- Samsung's existing Austin semiconductor facility already uses over about 700 AF/y of water per month. On an annualized basis, this equates to more than 8,000 AF/yr.
- The company's facility now under construction in Taylor, about 30 miles north of Austin, will cover nearly 2 square miles (larger than the firm's Austin plant).
- Samsung's Austin numbers suggest 5-6 world-class fabs and the associated demand could absorb the water supply from a Vista Ridge-sized project.

Source: City of Austin

Likely Water Impact of Samsung's Pending World-Class Taylor, TX Semiconductor Fab

- 5 million + sq. ft site near Taylor Texas
- $17 billion in expected total investment. Commercial operations likely to commence in 2024.
- Based on new TSMC fab in Taiwan (global standard-setter), can reasonably expect around 940,000 annual wafer starts per year (12-in equivalent)
- TSMC, an analogous semiconductor manufacturer that reports detailed ESG data, used 1,656 gallons of water per 12-in wafer equivalent shipped in 2020.
- On that basis, at full production, Samsung's Taylor Fab will likely require approximately 4,800 AF/yr for direct use.
- Samsung anticipates that the plant itself will create 2,000 direct jobs. Assuming families plus associated supply chains multiplies that number by 4. It can be reasonably assumed that the local population will increase by at least 10,000 total persons.
- The total water demand impact is thus likely to be at least 6,100 AF/yr.

Direct Water Needs		Indirect Water Needs	
Estimated Taylor Foundry Size, M^2		*Anticipated Direct Job Creation*	
570,000		2,000	
Ultimate Anticipated Investment, $ Billion		*Families plus Supply Chain*	
$17		8,000	
Anticipated Monthly Wafer Starts (at Full Capacity) **Note* Based on TSMC Fab 18 Facility*		*Total New Residents*	
		10,000	
84,000	High		
72,000	Low	*Municipal/Industrial Consumption Per Capita*	
78,000	Median	44728	gal
TSMC (Analogue) Enterprise-Wide Water Consumption, 2020		*Incremental Municipal/Industrial Consumption, Annual*	
1,656	gal/12-inch equivalent wafer	447,280,000	gal
		1,373	AF
Projected Samsung Taylor Median Annual Water Consumption			
1,549,662,802	gal		
4,245,652	gal/day		
4,756	AF/Yr		
Total		**6,128**	

Source: TSMC, Local Media, Author's Analysis

Emerging Treatment Technologies a Key X-Factor For Industrial Water Demand

Massachusetts Institute of Technology

Education Research Innovation Admissions + Aid Campus Life News Alumni About MIT

MIT News
ON CAMPUS AND AROUND THE WORLD

SUBSCRIBE BROWSE SEARCH NEWS

Manufacturing a cleaner future

Startups founded by mechanical engineers are at the forefront of developing solutions to mitigate the environmental impact of manufacturing.

Mary Beth Gallagher | Department of Mechanical Engineering
December 22, 2022

Semiconductor manufacturers require ultrapure water for fabrication. Unlike drinking water, which has a total dissolved solids range in the parts per million, water used to manufacture microchips has a range in the parts per billion or quadrillion.

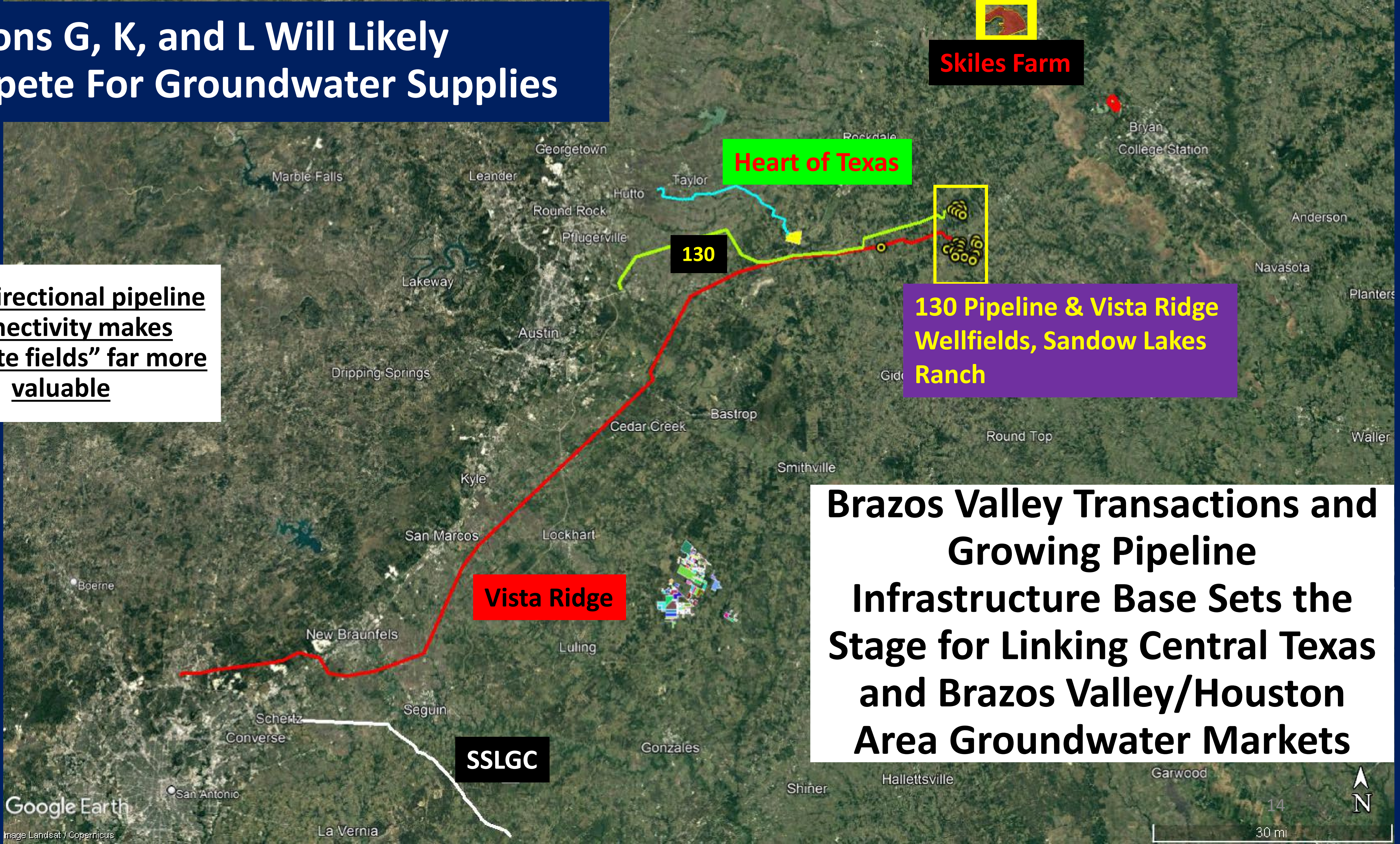
Currently, the average recycling rate at semiconductor fabrication plants — or fabs — in Singapore is only 43 percent. Using Gradiant's technologies, these fabs can recycle 98-99 percent of the 10 million gallons of water they require daily. This reused water is pure enough to be put back into the manufacturing process.

"What we've done is eliminated the discharge of this contaminated water and nearly eliminated the dependence of the semiconductor fab on the public water supply," adds Bajpayee.

Key technoeconomic question: How will cost of treatment compare to cost of procuring external water supply?

Regions G, K, and L Will Likely Compete For Groundwater Supplies

Multidirectional pipeline connectivity makes "satellite fields" far more valuable



Brazos Valley Transactions and Growing Pipeline Infrastructure Base Sets the Stage for Linking Central Texas and Brazos Valley/Houston Area Groundwater Markets

Central Texas Water Transactions and Pricing to Date

Key Central Texas Groundwater Transactions: Timeline

2016: GBRA purchase of TWA
$31 million, 15 KAF

2014: SAWS Vista Ridge Project
50 KAF

Dec. 1998:
SAWS-Alcoa Simsboro Project
(abandoned August 2005), 90 KAF

2020 2022

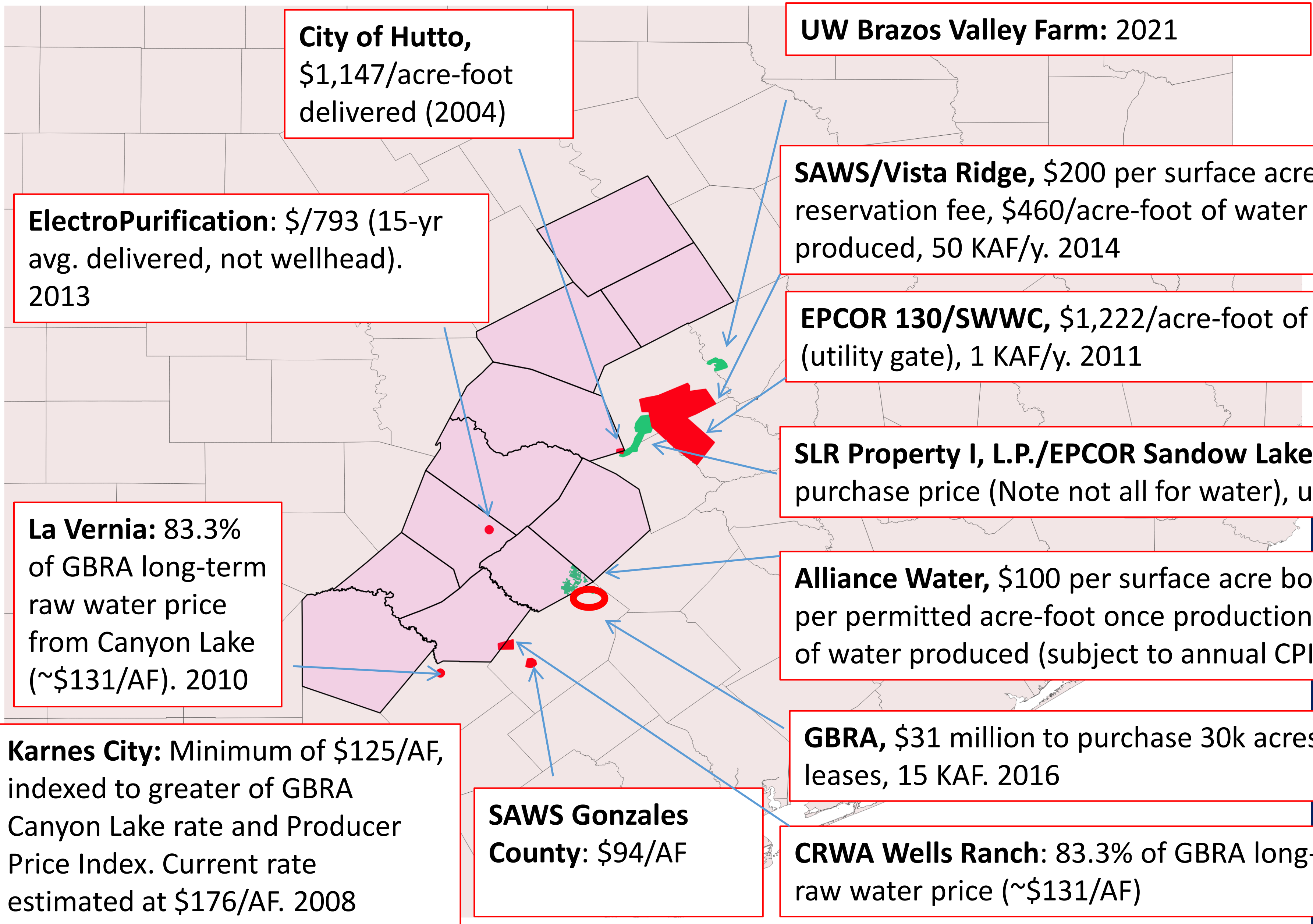
1999-2011, SAWS/LCRA Colorado River, sourcing discussion
Up to 150 KAF (abandoned, litigated)

UW Brazos Valley Farm.

SLR Property I, L.P./EPCOR Sandow Lakes Ranch:
$240 million purchase price (Note not all for water),
up to 58 KAF/y

Source: SAWS, GBRA, Local Media, Court documents

Key Central Texas Groundwater Transactions: Map



City of Hutto, $1,147/acre-foot delivered (2004)

ElectroPurification: $/793 (15-yr avg. delivered, not wellhead). 2013

La Vernia: 83.3% of GBRA long-term raw water price from Canyon Lake (~$131/AF). 2010

Karnes City: Minimum of $125/AF, indexed to greater of GBRA Canyon Lake rate and Producer Price Index. Current rate estimated at $176/AF. 2008

SAWS Gonzales County: $94/AF

UW Brazos Valley Farm: 2021

SAWS/Vista Ridge, $200 per surface acre annual reservation fee, $460/acre-foot of water produced, 50 KAF/y. 2014

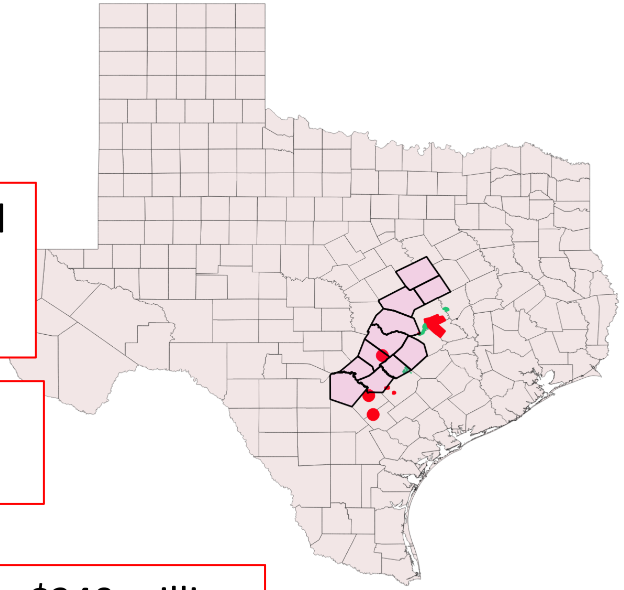
EPCOR 130/SWWC, $1,222/acre-foot of water (utility gate), 1 KAF/y. 2011

SLR Property I, L.P./EPCOR Sandow Lakes Ranch: $240 million purchase price (Note not all for water), up to 58 KAF/y. 2021

Alliance Water, $100 per surface acre bonus, $40 per surface acre thereafter, $80 per permitted acre-foot once production permit issued by District, $100/acre-foot of water produced (subject to annual CPI adjustment), 15 KAF

GBRA, $31 million to purchase 30k acres groundwater leases, 15 KAF. 2016

CRWA Wells Ranch: 83.3% of GBRA long-term raw water price (~$131/AF)

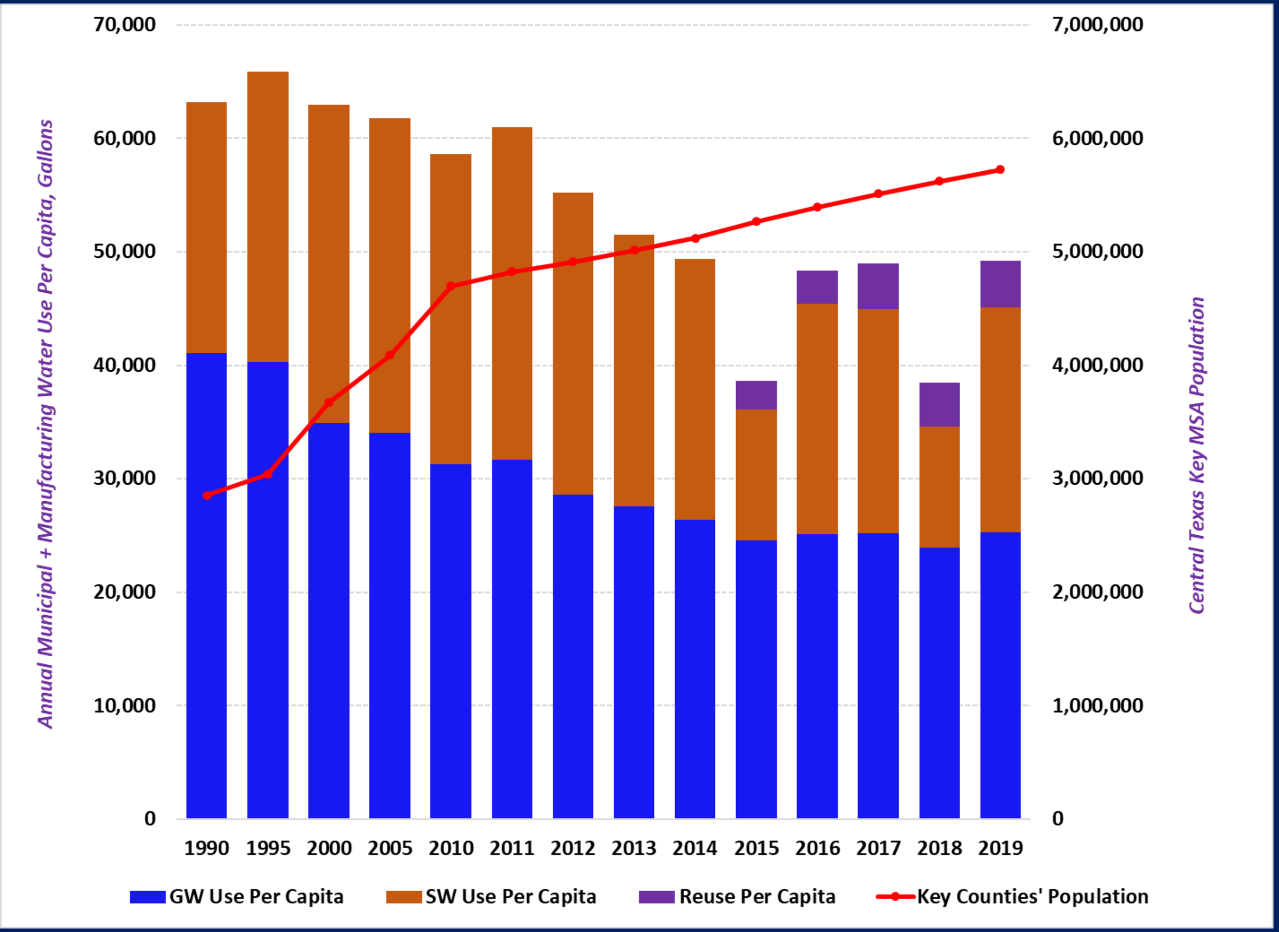


Source: Contracts obtained via TPIA requests, Author's Analysis

Looking Forward: Supply, Demand, Infrastructure, and Markets + Technology Collide

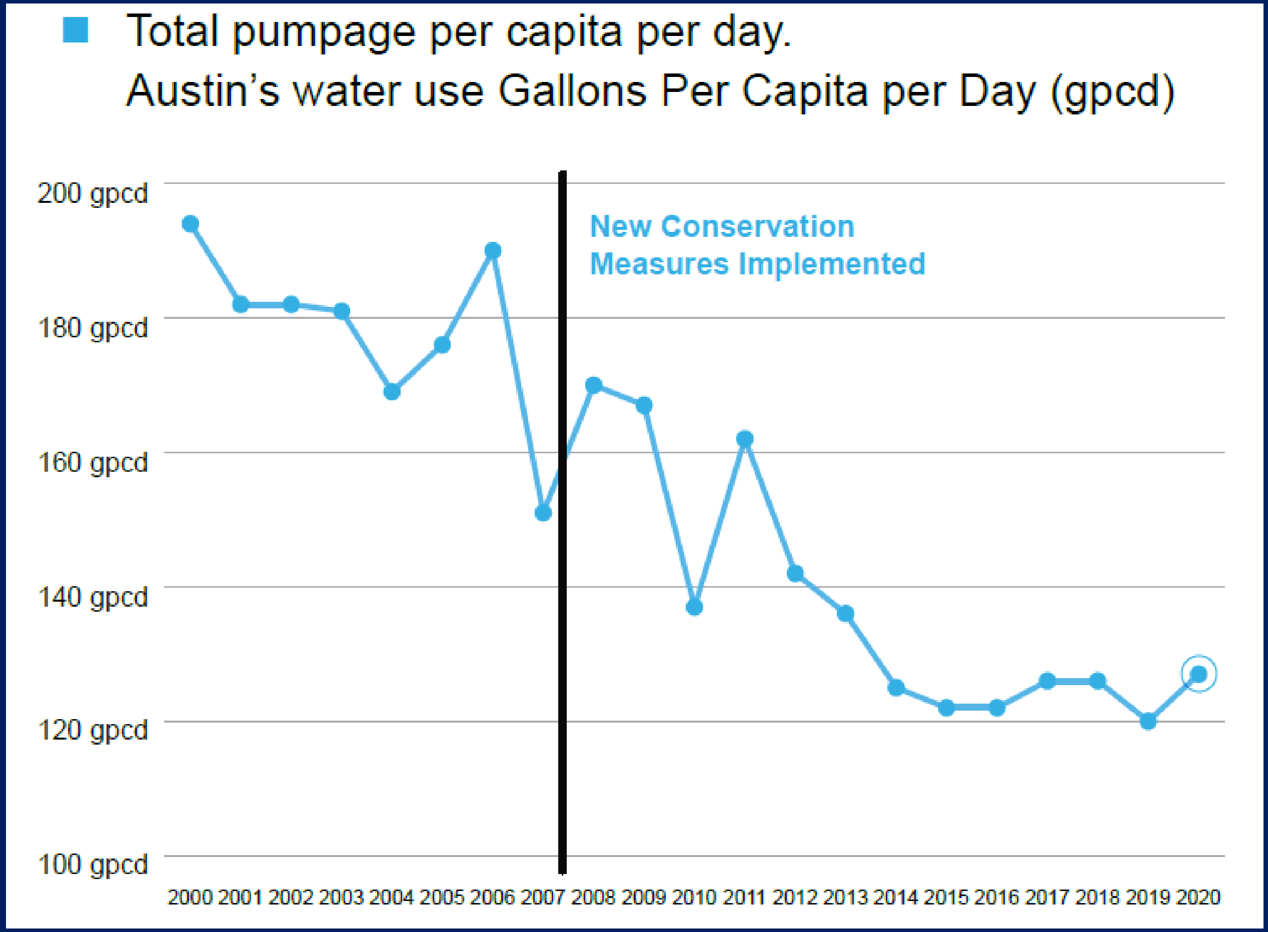
Rising Water Use Efficiency Means Less "Fat" To Be Trimmed in Future Droughts, Deeper "Lock-In" of Firm Supplies—Enhancing Groundwater Value

Water Use Per Capita and Population Growth in Central TX



Source: TWDB, Author's Analysis

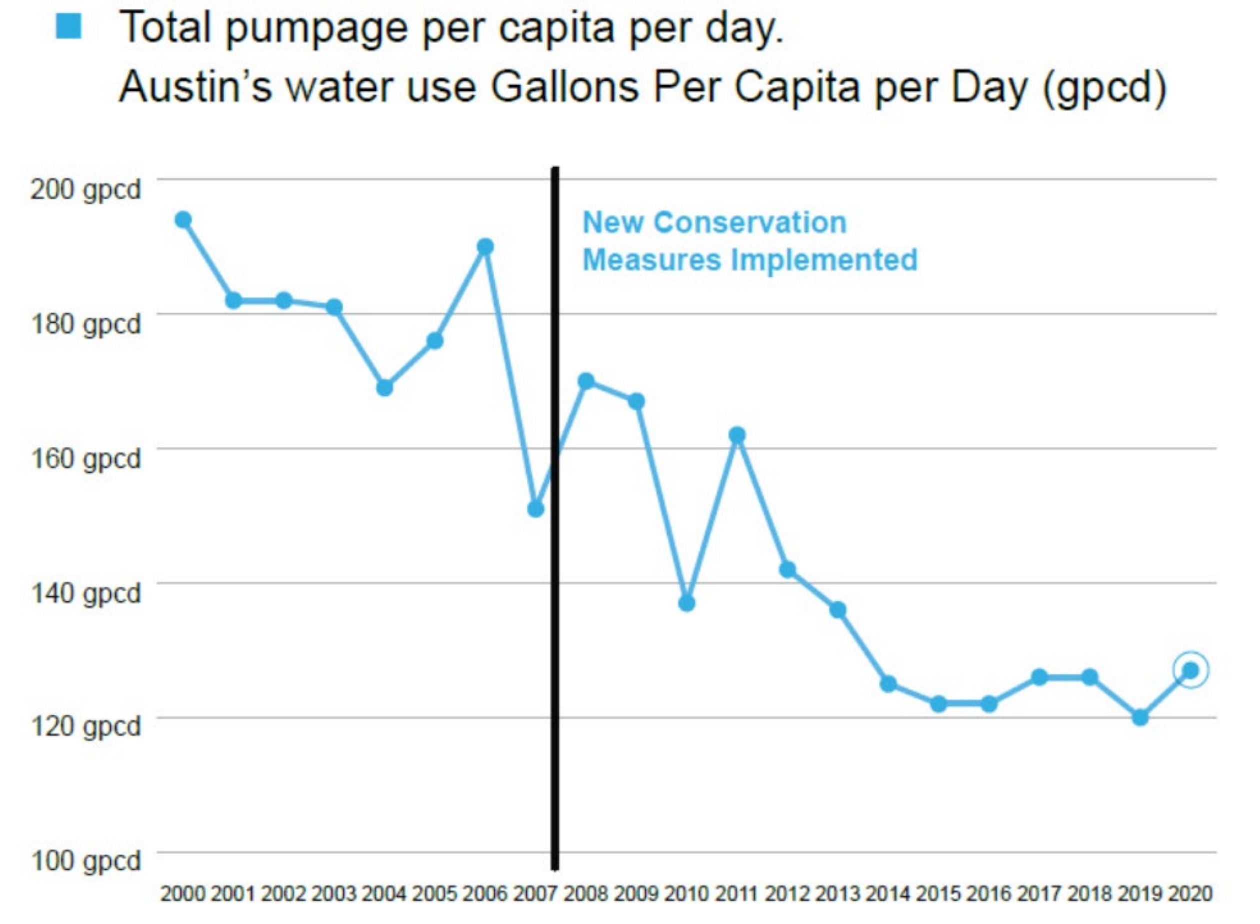
Water Use Efficiency and Diminishing Returns—Austin Example



Source: Austin Water 2020 Progress Report

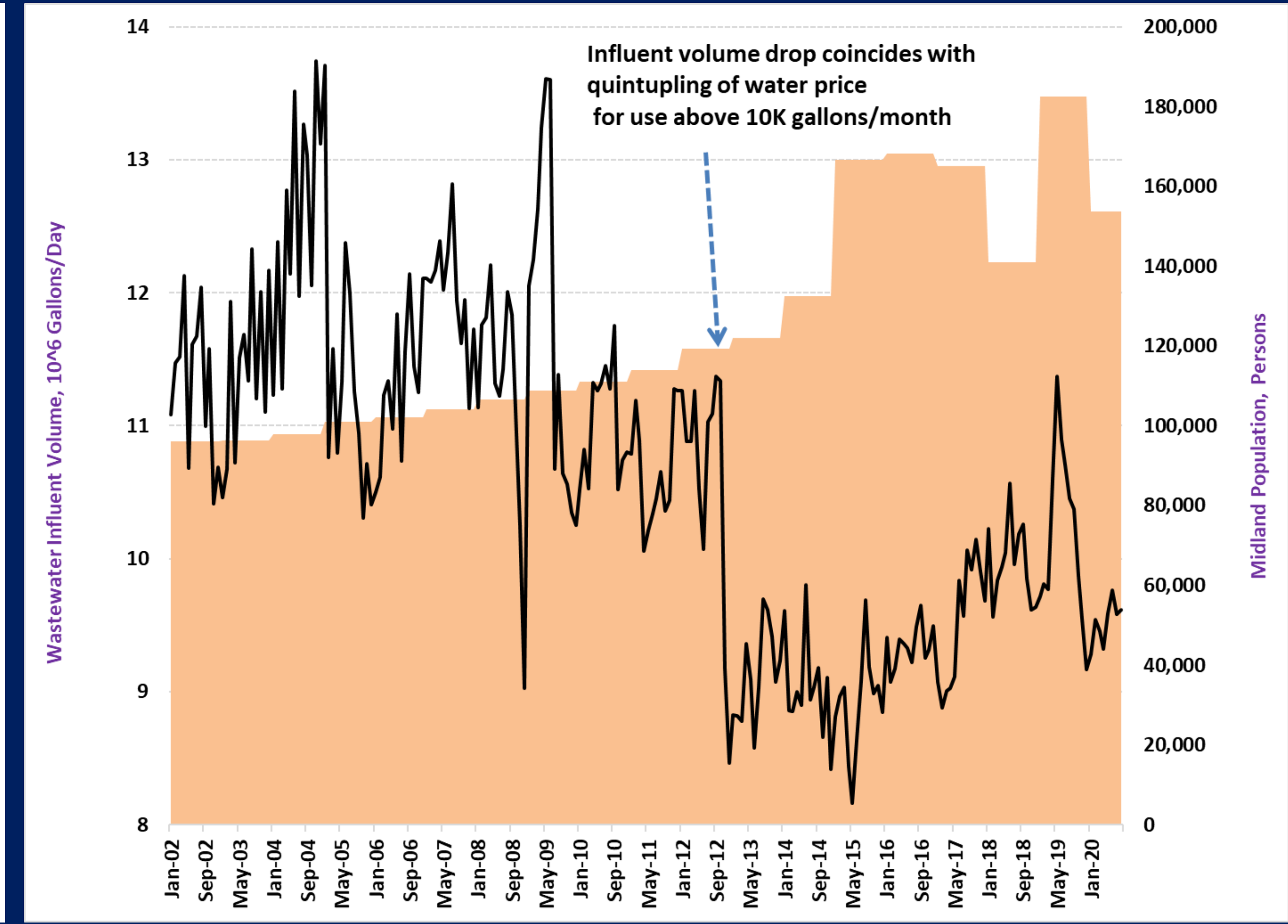
Water Conservation Impacts on Demand: Education/Persuasion-Based and Price-Based Examples

Austin, Texas: Long-Term Education and Persuasion-Based Conservation Approach



Source: Austin Water 2020 Progress Report

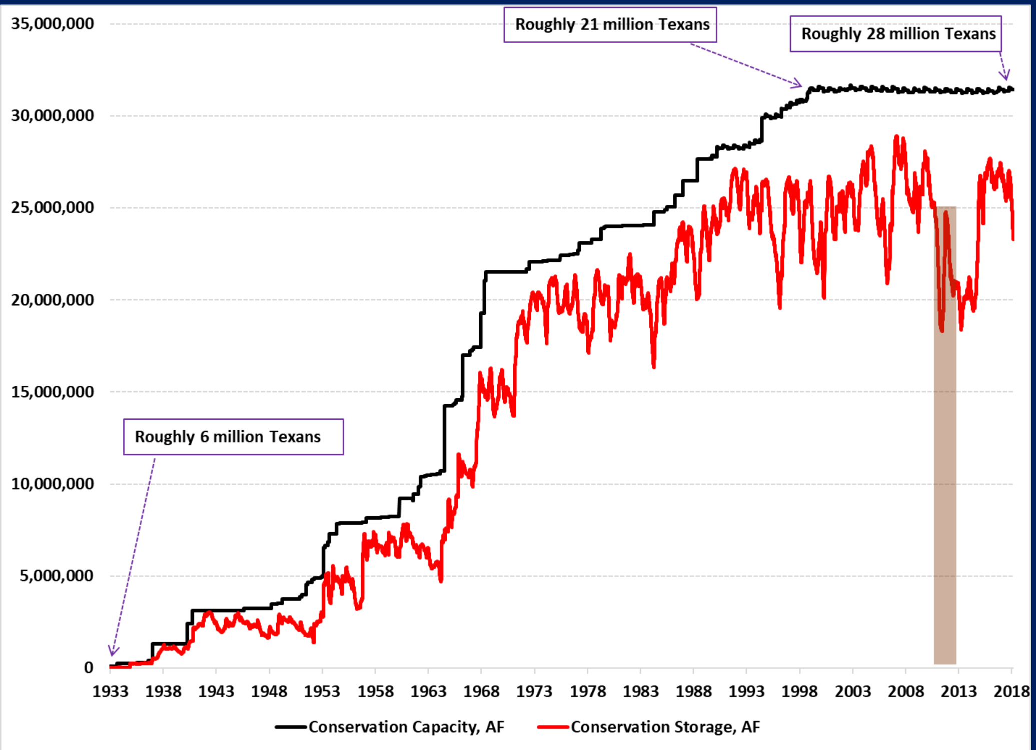
Midland, Texas: Price-Based Approach During Water Emergency, Lingering Impact Despite 25% Population Growth



Source: City of Midland, Author's Analysis

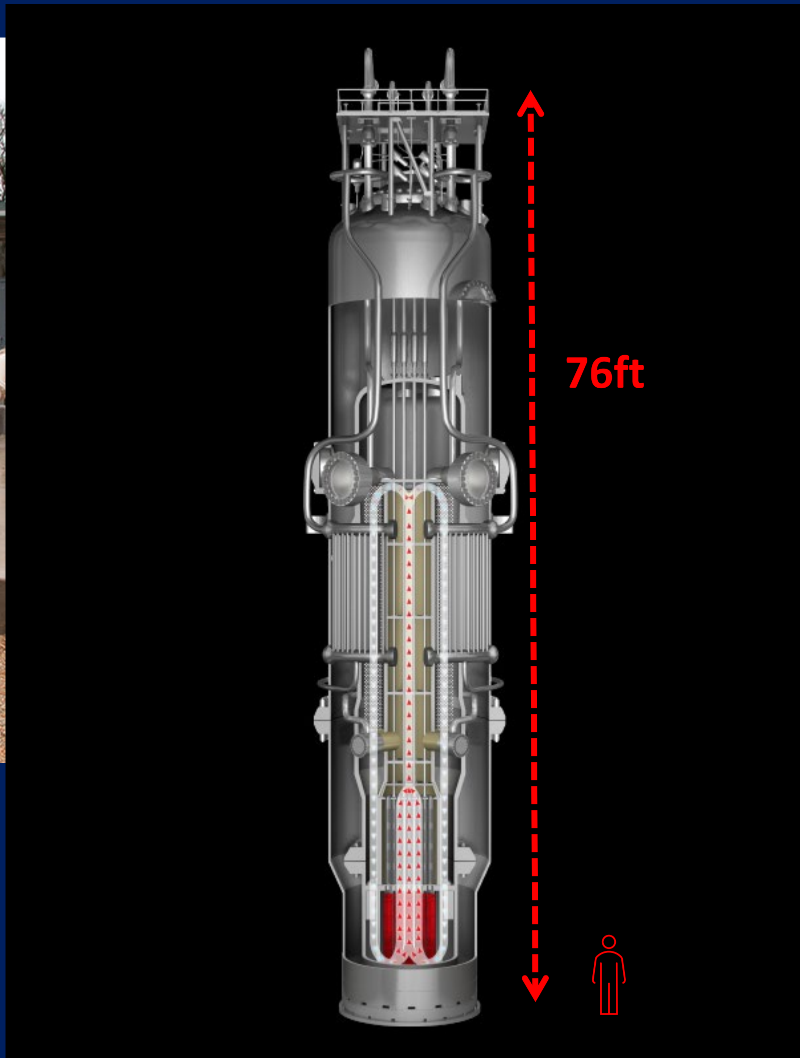
Future Water Supplies From Non-Conservation Resources

Option 1: Surface Water



Option 2: Groundwater

Option 3: Desalination



https://www.waterdatafortexas.org/reservoirs/statewide. Edwardsaquifer.net, https://www.nuscalepower.com/en/products

Thank You!