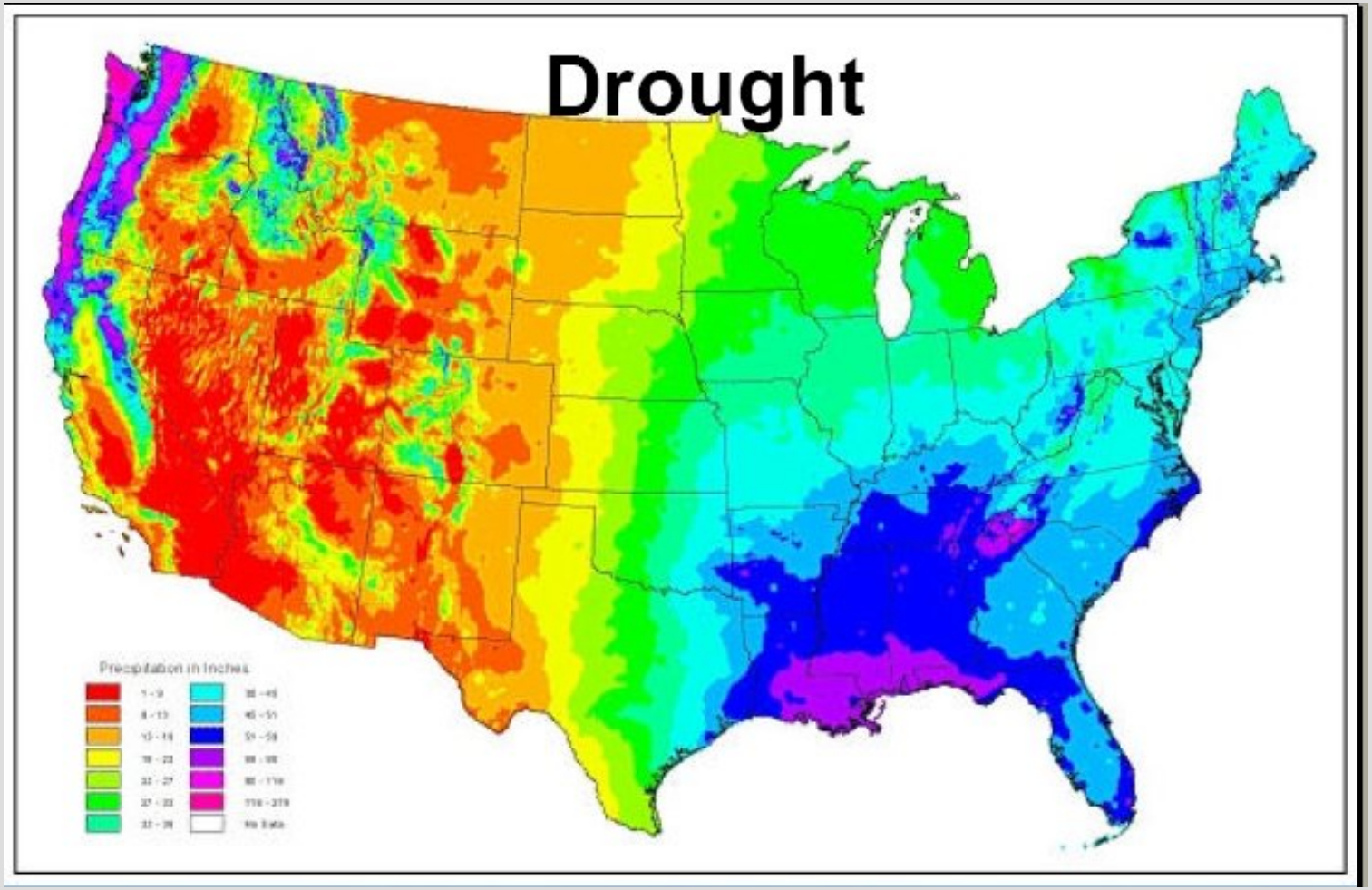
Desalination of Oil Field Brine

D.B. Burnett Global Petroleum Research Institute

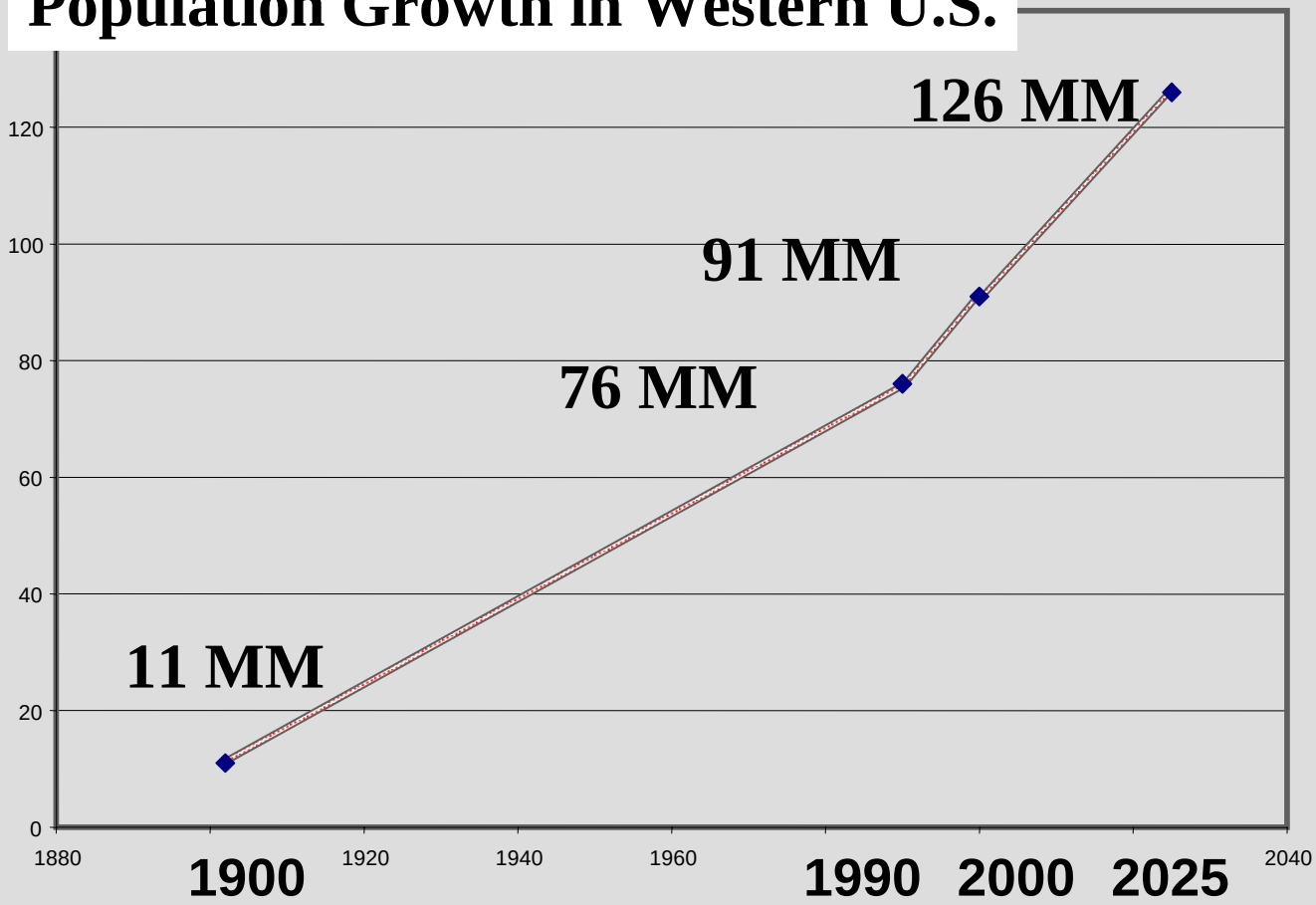
C.J. Vavra Separation Sciences Guru
Food Protein Research Center

Lack of Fresh Water Resources



Why the U.S. Worries about Water Resources

Population Growth in Western U.S.



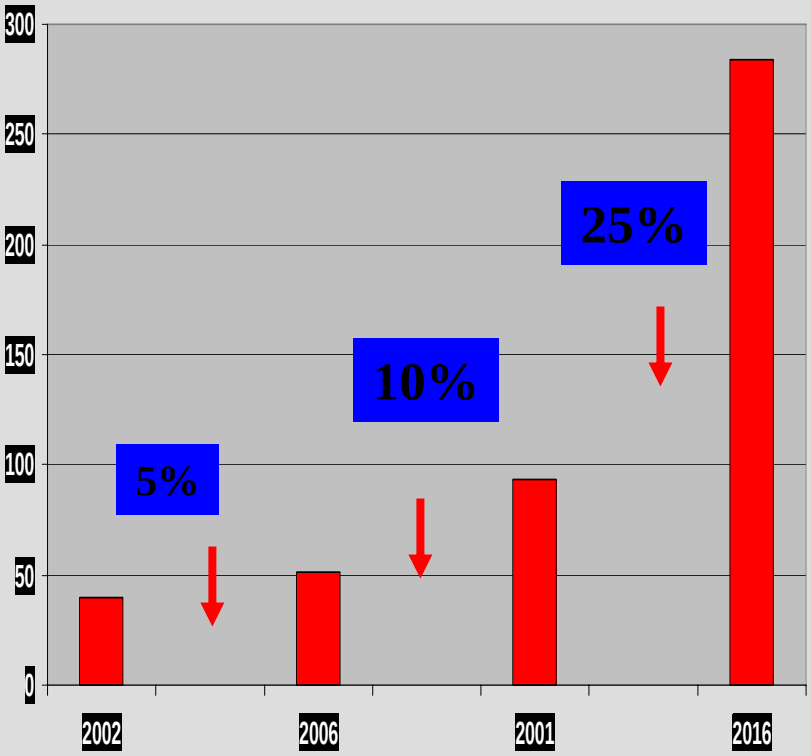
For more Info see:

http://www.wrri.nmsu.edu/

ced Water Treatment

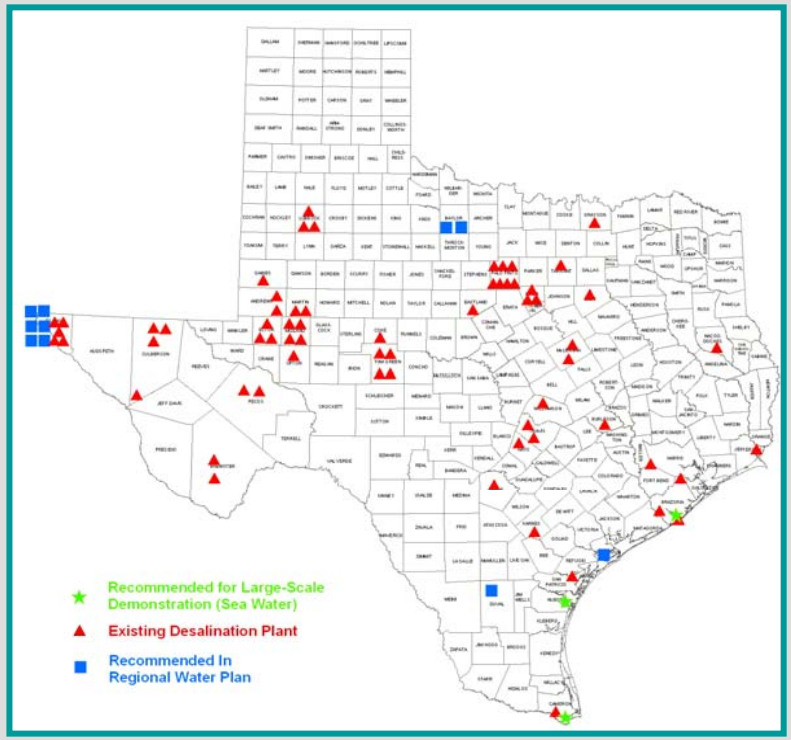
RO Desalination In Texas (2004).

A&M Estimates



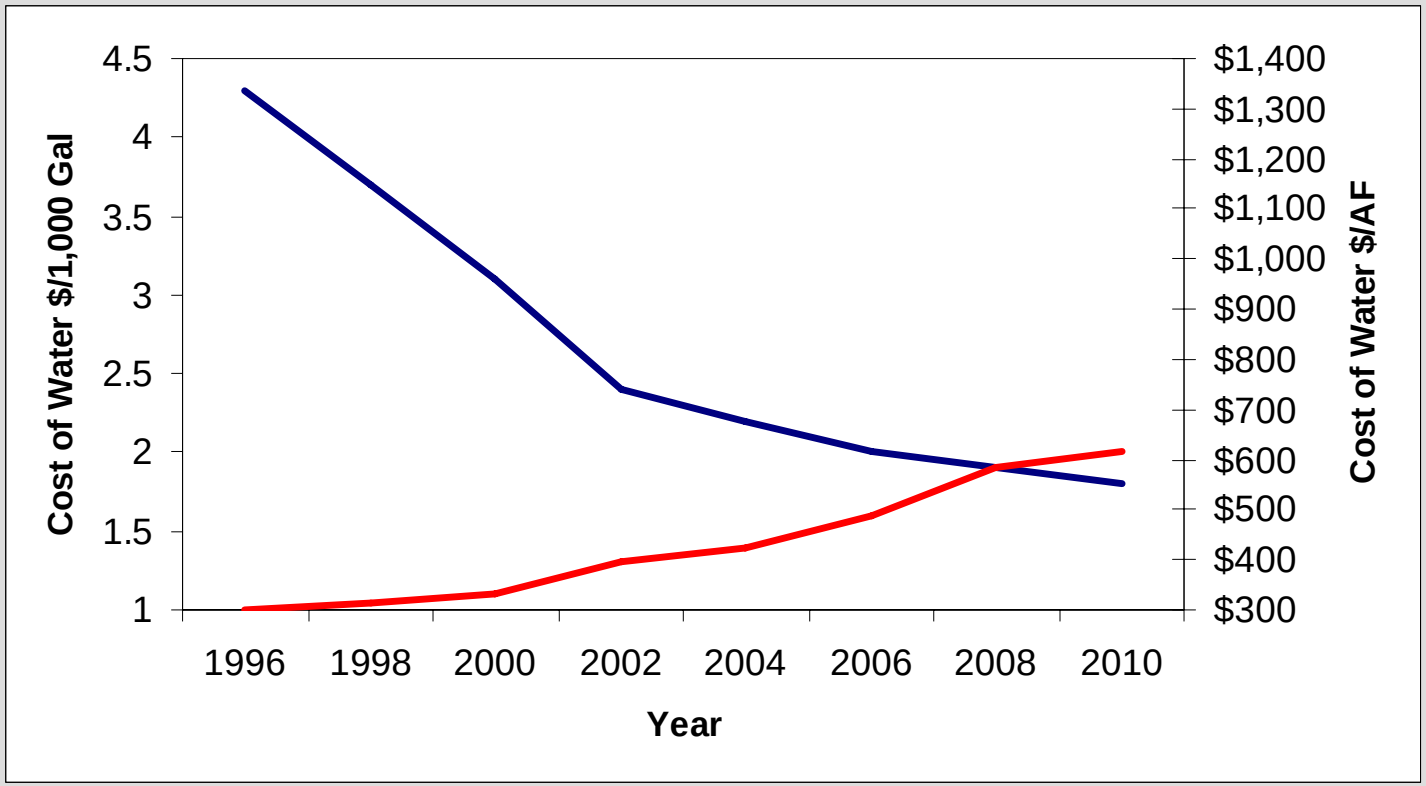
Projected Growth of Facilities

Texas Water Development Board



Current Desalination Facilities

Membrane Desalination Becoming the Technology of Choice



http://www.brazos.org

Introduction

Texas Long Range Water Plans call for at Least 7 New Reservoirs

The human dimensions of the issue may prevent timely development.

IN Chron.com Go Sell yo

Houston & Texas EMAIL THIS STORY PRINTER FRIENDLY FORMAT

Max Shumake, co-founder and president of the Sulphur River Oversight Society, is organizing the effort to keep the Marvin Nichols project from being built.
AARON STREET: TEXARKANA GAZETTE

May 14, 2006, 11:04AM

Dallas region's reservoir plans irk East Texas

Residents say projects threaten their way of life

By THOMAS KOROSEC
Copyright 2006 Houston Chronicle

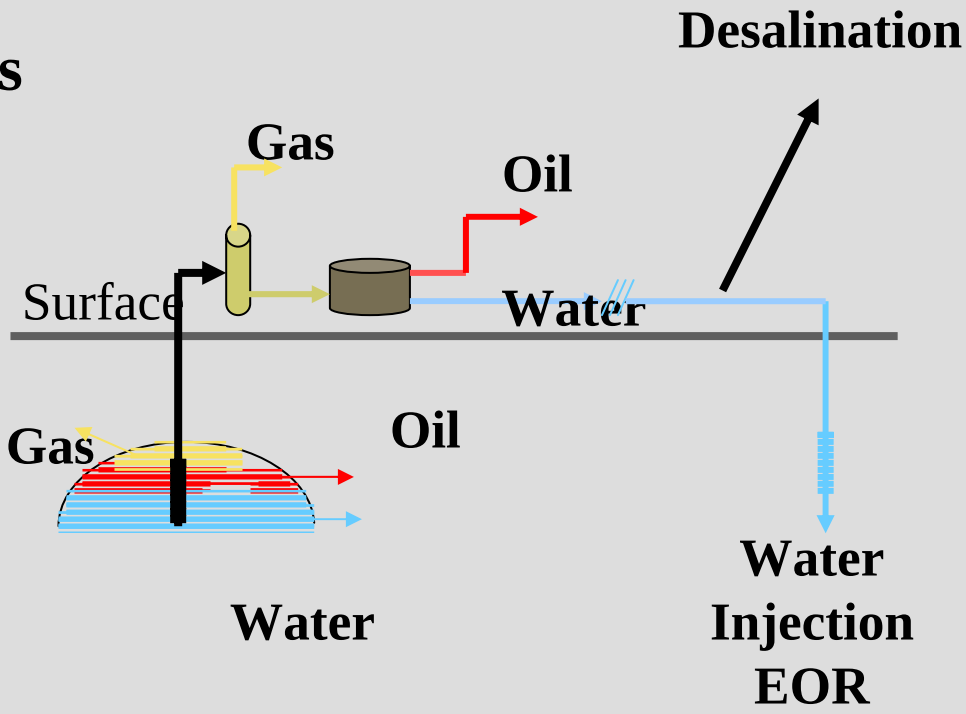
The name Dallas has become a fighting word in some quarters of East Texas.

As the Dallas-Fort Worth region moves ahead on long-range plans to build two new reservoirs in East Texas, landowners, environmentalists and timber interests have united in opposition, pulling many local politicians along.

Miffed at the prospect of job losses in the timber industry and destruction of choice wildlife habitat, opponents have begun calling Dallas a spoiled and selfish bully that wants its swimming pools and green lawns, even in droughts, and has the political muscle to do as it pleases.

New Resources: Produced Water Desalination

Brine re-injection represents a significant fraction of the cost of operating a desalination facility.
In the oil and gas industry, high salinity brines are routinely injected into formations for pressure maintenance and secondary recovery by water flooding.

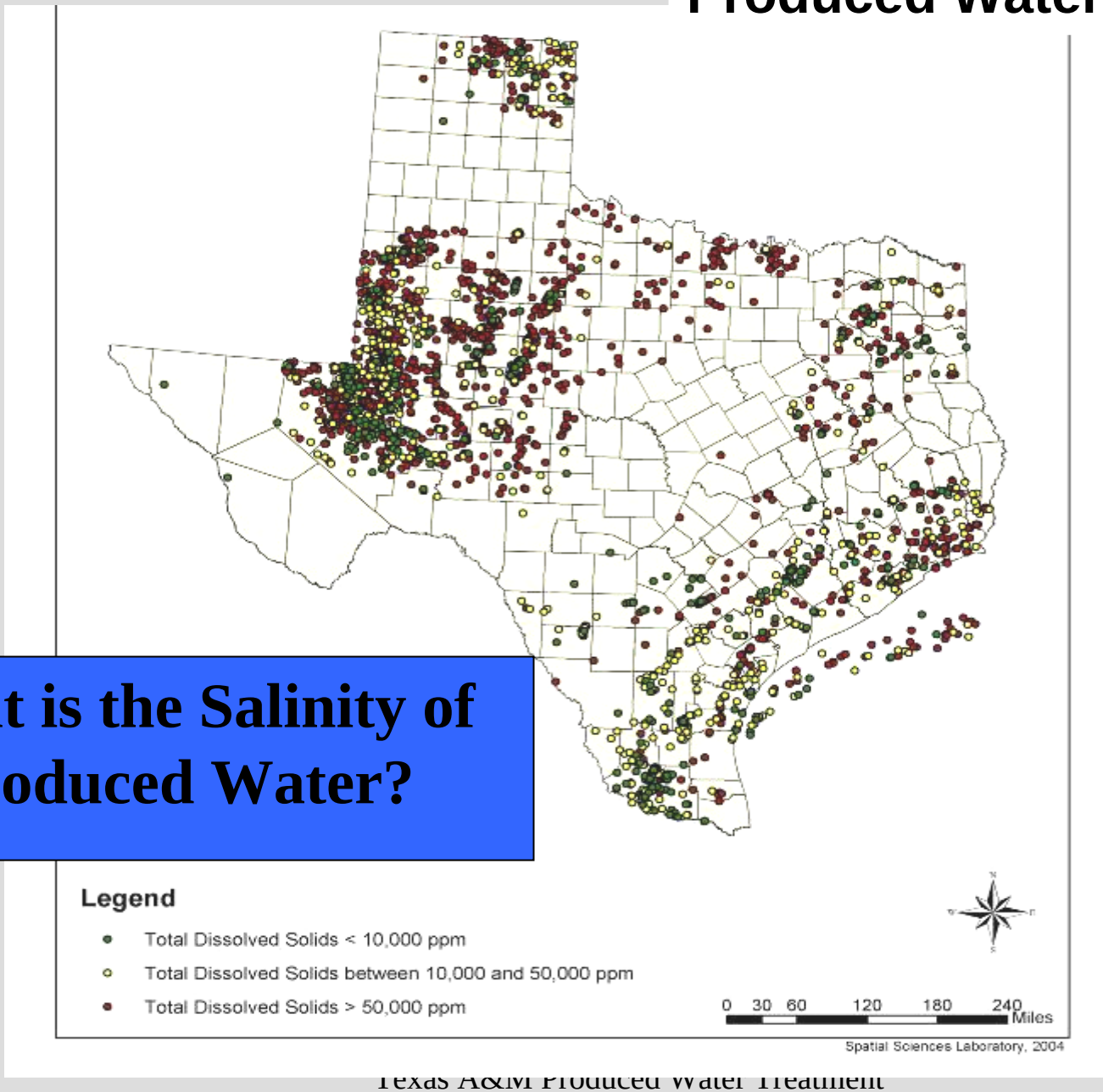


For more Info see:

http://www.gpri.org

Where do you Find Water in West Texas???

Produced Water Resources



What is the Salinity of Produced Water?

Produced Water Processing & Re-Use

The Problem

Limited sources of fresh water for communities and industry
Oil and gas production operations, increased cost of disposal of waste water

The Proposed Solution

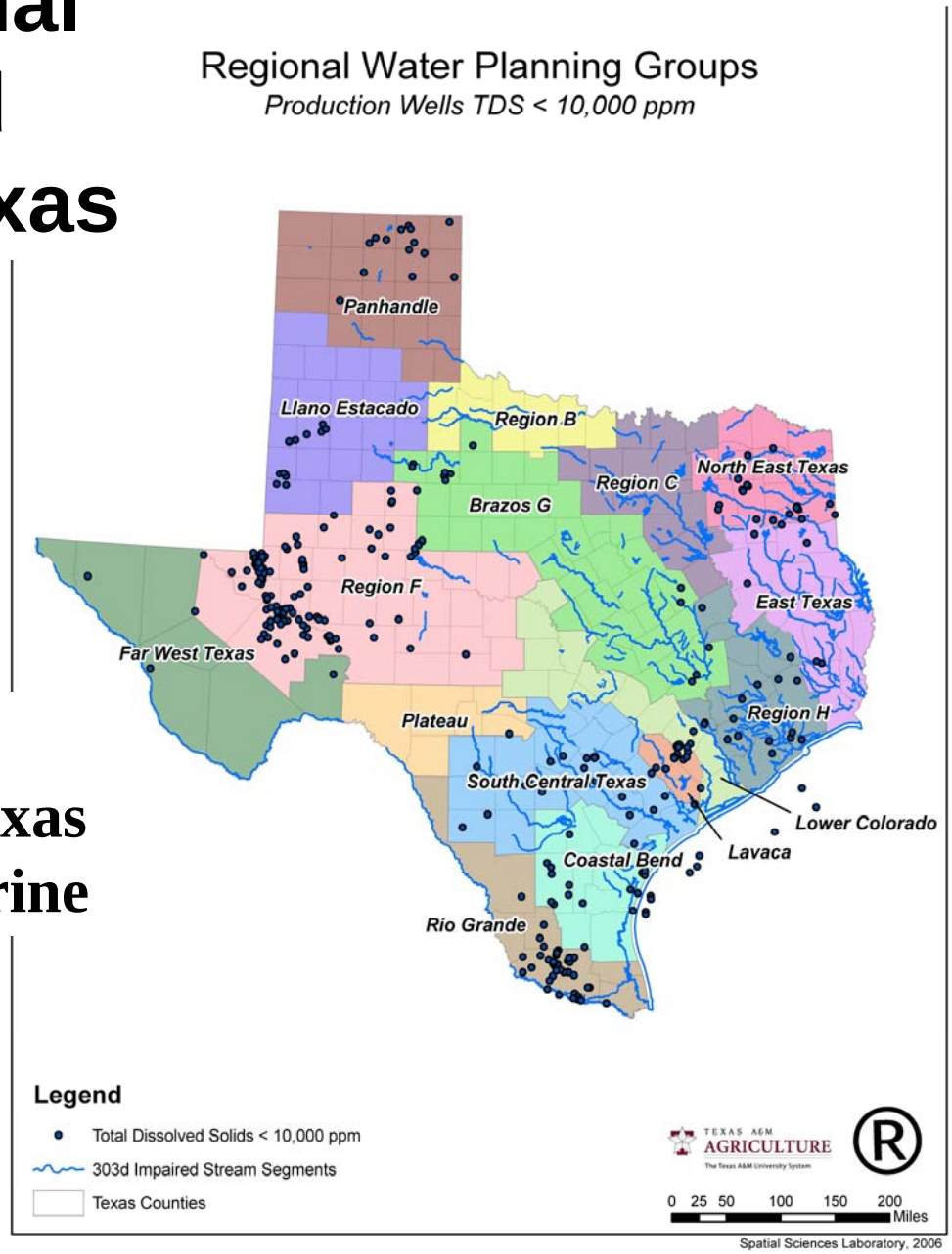
On-site re-use of water
New modular technology for water treatment, including filtration, desalination, and disinfection

The Benefits of the Proposed Solution

To A&M, increased service to the community, increase in value of research to the department involved.
To commercial partner, way to reduce costs of oil and gas production associated with brine production, handling and disposal.
To community, a new source of fresh water for use

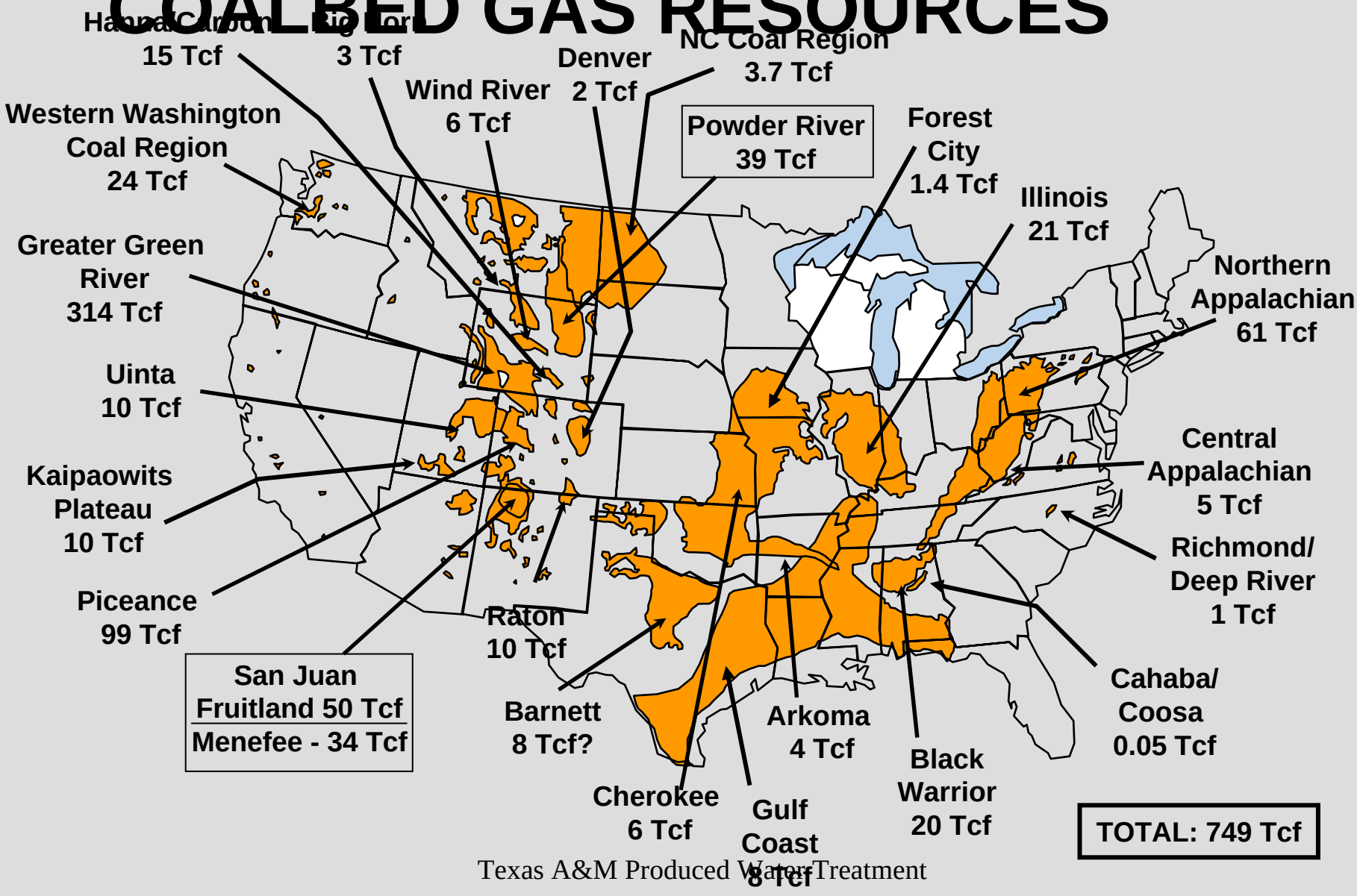
Our Goal is to prove that co-production and re-use of produced water is economical and environmentally acceptable

Conventional produced brines in Texas



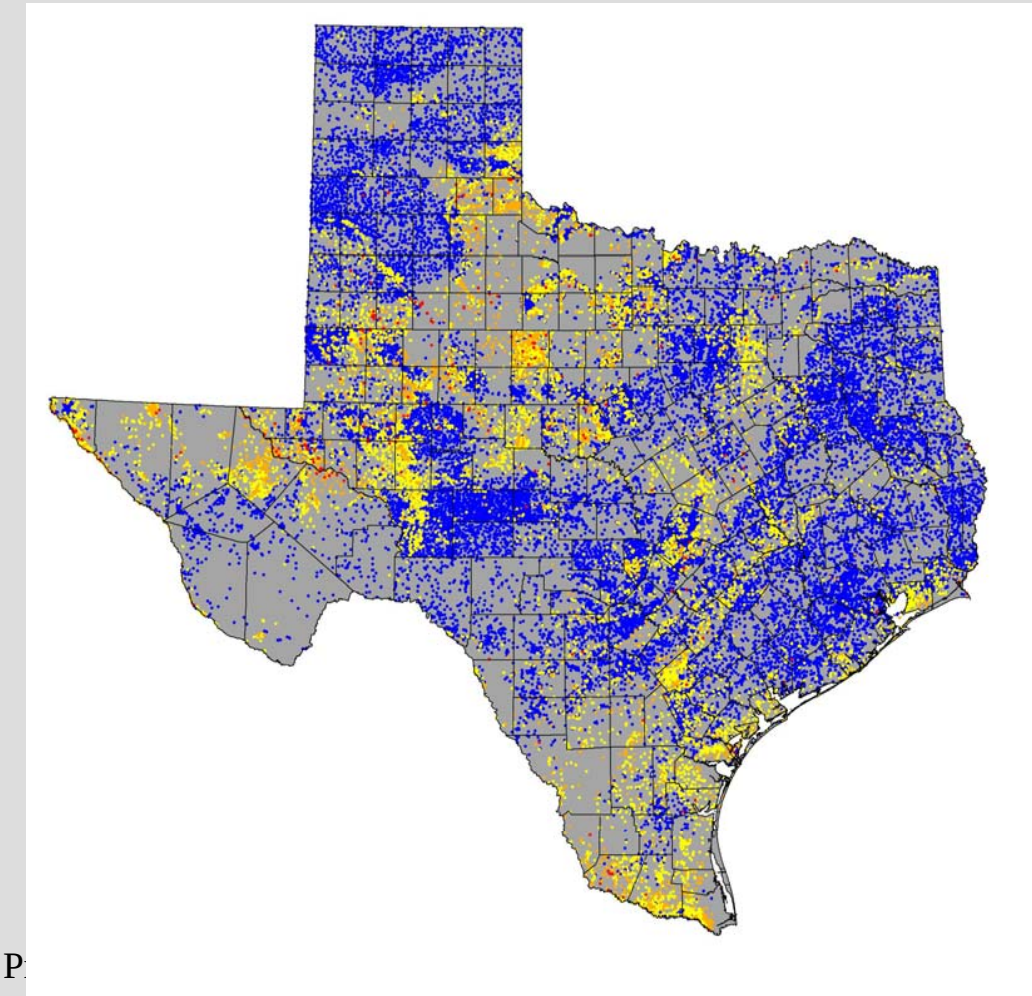
Oil & Gas Wells in Texas
Brackish Produced Brine

COALBED GAS RESOURCES



New Resources: Brackish Ground Water Desalination

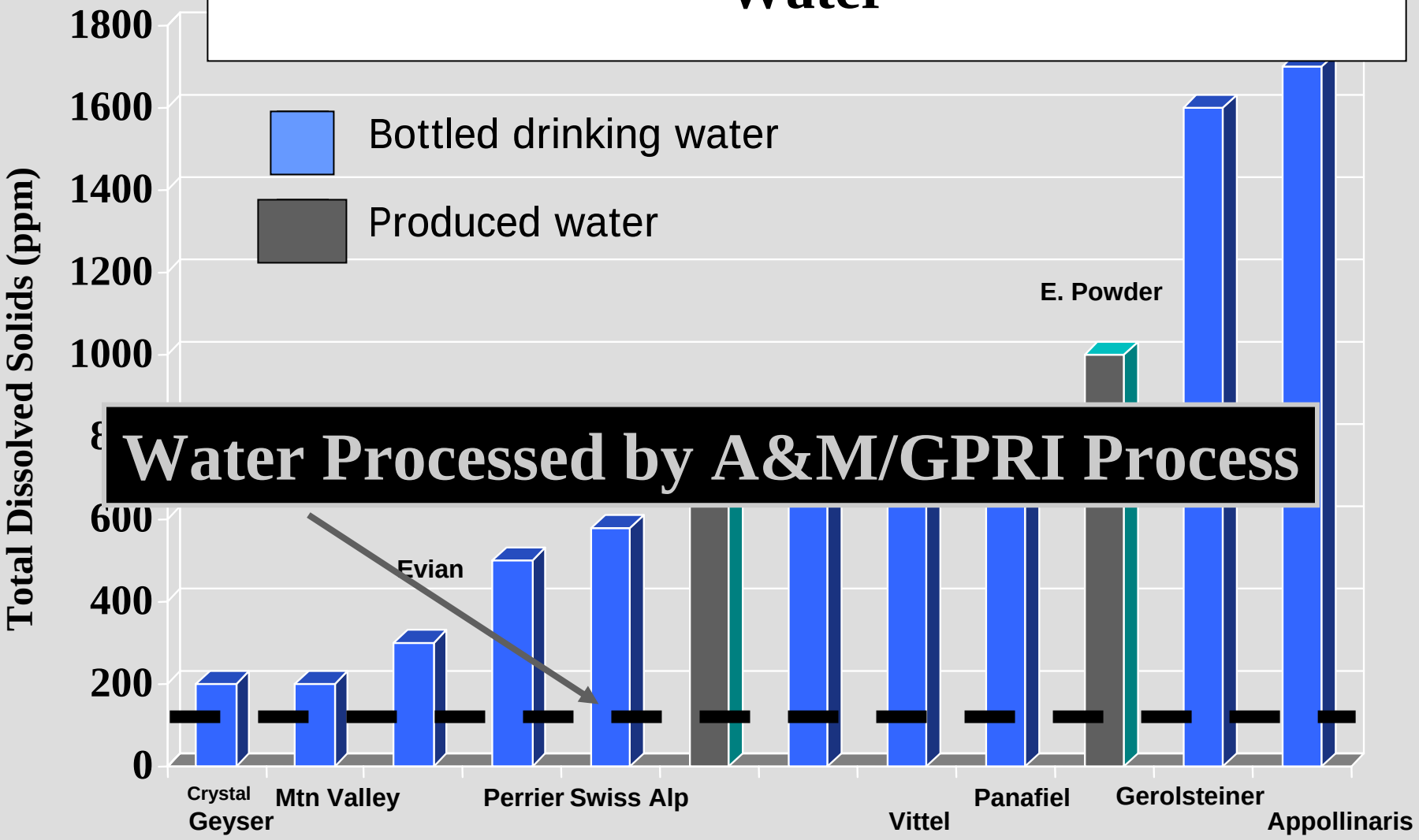
TWDB identified the saline ground water aquifers in Texas. The study found more than 780 million acre feet of brackish aquifers that would be amenable to desalination.



For more Info see:

http://www.TWDB.state.TX.us

Relative CBM Water Quality vs. Bottled Water



Water Processed by A&M/GPRI Process

Source: S. DeAlbuquerque, ConocoPhillips

Separation and Filtration Technology

- **Conduct tests and demonstrations at different sites**
- **Determine feasibility of various separation technologies applications**
- **Provide hands-on training programs**
- **Help industry reduce their energy usage by employing new technologies**
- **Develop new products**
- **Allow water recycle and reduce water usage**

Separation Sciences Program

Telephone: 1-979-845-2749

Fax: 1-979-845-2744

Email: cjvavra@tamu.edu

URL: http://www.tamu.edu/food-protein

Synopsis of A&M Program

To utilize new technology to develop compact, transportable units that can be integrated into traditional field production systems.

The units are expected to cost less to manufacture and operate, and offer higher output than any system commercially available.

Our goal is to achieve a 50% reduction in treatment costs over less efficient methods used in the past.

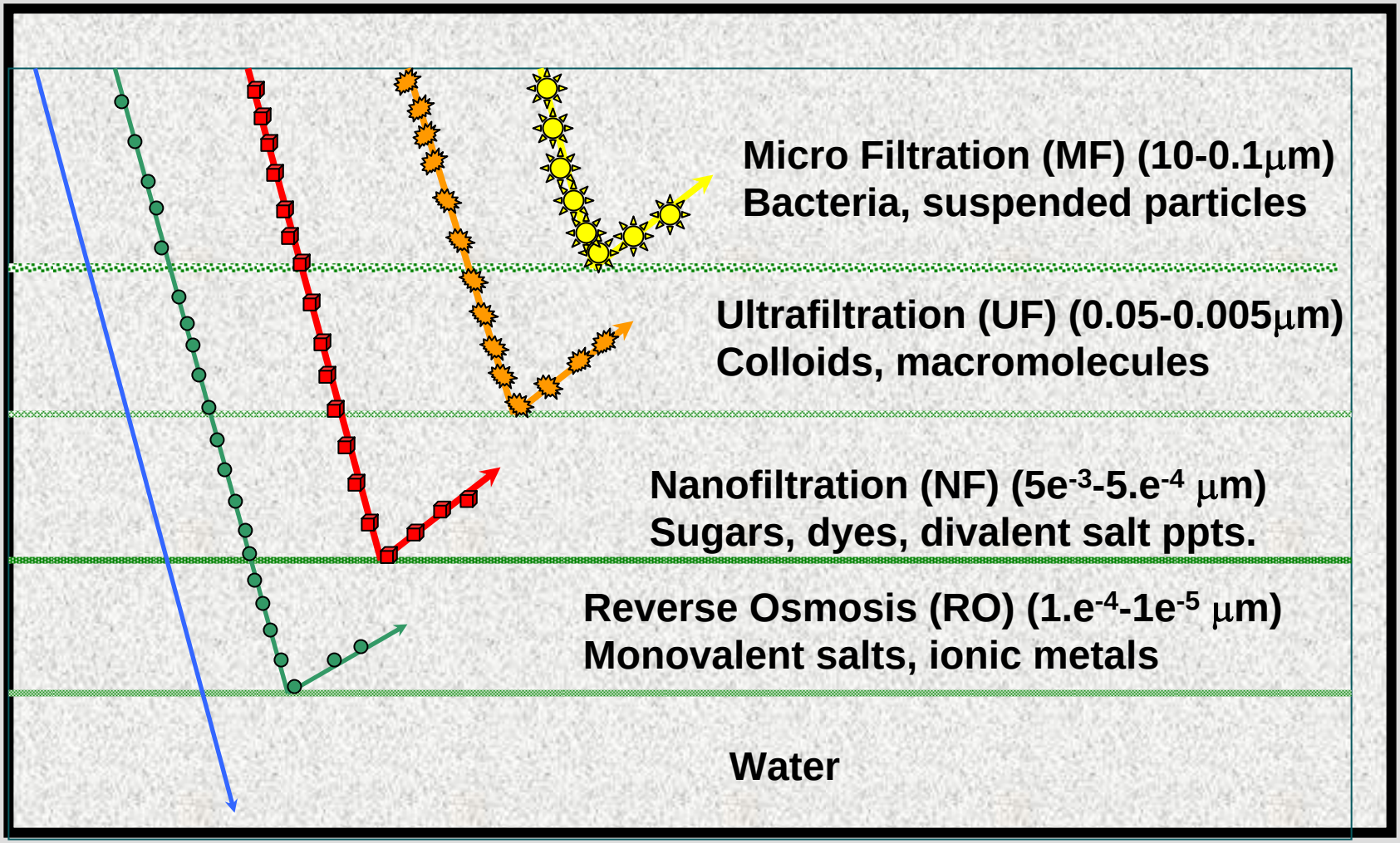
Our secondary goal is to show that if treated properly, produced water is a resource, not a pollutant.

GPRI Desalination Process – Field Trials with Pre-Treatment-Desal unit

Size of Unit:	Trailer or Skid Mounted
Capacity of Unit	1500 - 3,000 gal./day (1-2 gpm)
Components	Prefiltration conditioning Membrane filters (upstream) Membrane filters polishing Robust, online, remote sensor monitoring Water storage
Power Requirements	220v max. 5hp motor. (est.)
Operations:	Operate unattended. Servicing Schedule weekly

A&M Pilot Plant Capabilities

Filtration and Reverse Osmosis Membranes

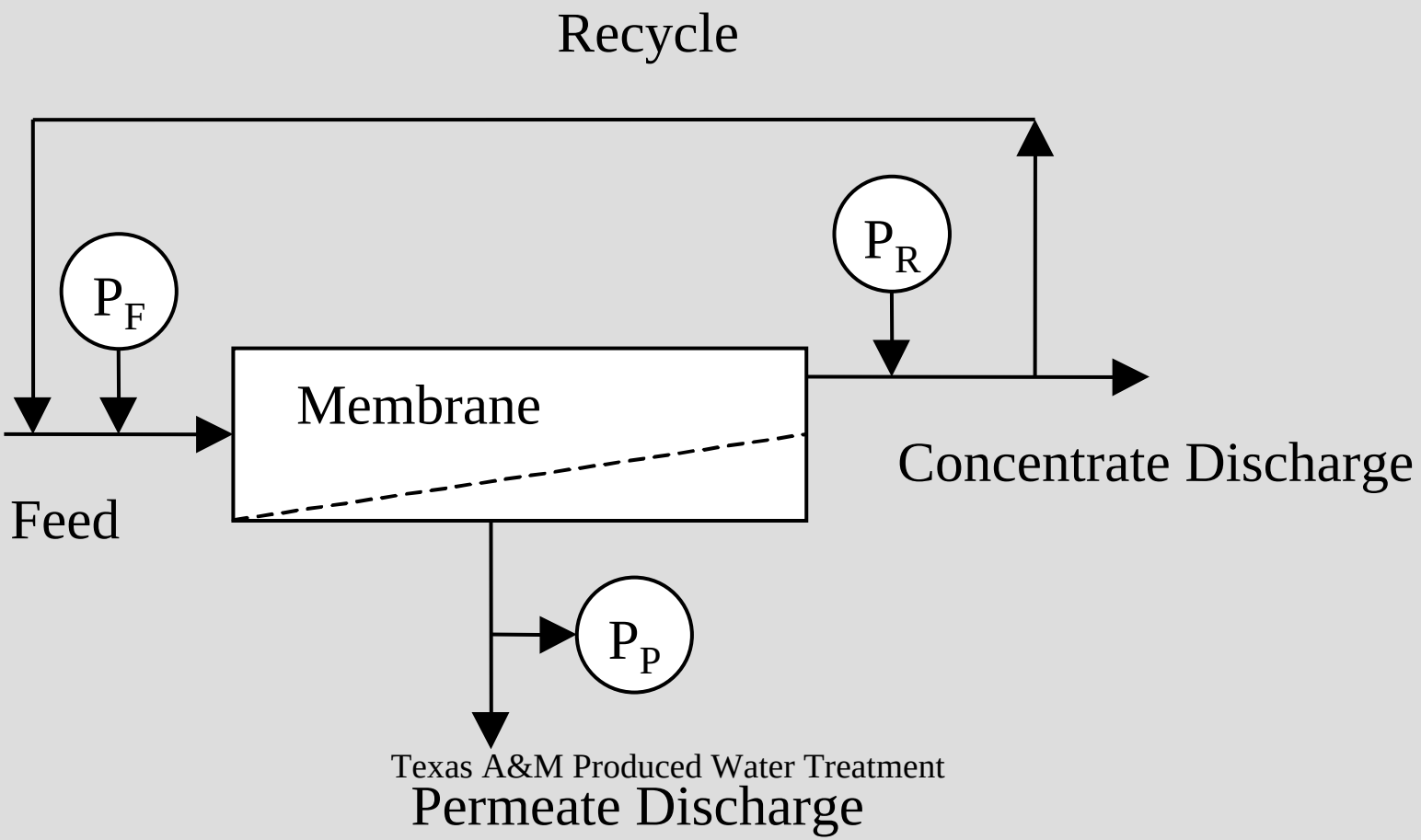


Membrane Characteristics

Geometrical features (area, length, thickness)

Technical specs (recommended operating range: pH, T, P)

Permeability/conductance



Progress -2005 Operations

Analyte	Raw Feed	RO filter permeate	Reduction
Alkalinity, Total as CaCO3	188	34	82%
Bicarbonate as HCO3	230	41	81%
Carbonate as CO3	< 1.2	1	n/d
Hydroxide as OH	< 1	1	n/d
Conductivity	33000	2270	93%
Magnesium	73	1	99%
Silicon	78	2	97%
Calcium	1055	23	98%
Potassium	124	5	96%
Sodium	11570	416	96%
Boron	87	34	61%
Silica	1664	4	99%
pH	6.1	7	
Solids, Total Dissolved TDS @ 180 C	38300	1291	97%

Comparison of Desalinated Produced Water with Municipal Water from College Station. TX

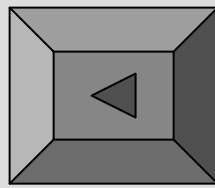
		College Station Municipal Water (1)	Desalinated Produced Water (2)	Desalinated Produced Water (3)
	Substance	Amount	Amount	Amount
Agronomic Properties				
	pH	7.8	7.1	6.2
Physical Properties				
	Conductivity	882	2270	17
	TDS	523	1290	17
	SAR		23	0.1
Major Ions				
	Alkalinity (CaCo3)		34	5
	Bicarbonate (HCO3)	450	41	6
	Chloride	54	706	1
	Sulfate	9	3	ND
	Ca, Mg, K, Na, B	203	94 ppm	1.3
Metals, Dissolved				
	Barium, etc	2 ug/L	0.9 mg/L	ND
Volatile Organics				
	Chloroform, +	14 ug/L	3.4 ug/L	85 ug/L
-1	http://www.cstx.gov/home/index.asp?page=822			

Representative power costs of desalination of oil field brine

Salinity of Feed Brine, tds (ppm)	*Power Costs Kw Hr per 1,000 gal. Permeate*			
	Pre- treatment	*RO desalination*	*Operating Cost, $ per 1,000 gal.*	*Operating Cost, $ per bbl*
Contaminated Surface water ~1,500 tds.	*$.65*	*$1.25*	*$1.90*	*$0.08*
Gas well produced brine ~ 3,600 tds.	*$2.50*	*$2.00*	*$4.50*	*$0.19*
Oil well produced brine ~50,000 tds	*$2.20*	*$6.00*	*$8.20*	*$0.34*
Gas well produced brine ~ 35,000 tds	*$2.00 (est.)*	*$4.20 (est.)*	*$6.20 (est.)*	*$0.26*

Produced Water in the Barnett Shale Play: Potential for Beneficial Use

It is estimated that more than 170 million gallons of water per month are used in fracturing operations. Most then goes to re-injection disposal.



Re-Use of Fracturing Fluids

Current Situation

Salt water storage and transport are major issues.

Composition of frac return brines not well monitored

Frac return brine mixing with fresh water not established. – most companies cut off use after 30,000 chlorides.

Friction reducers (cost and functionality vs horsepower) economics not well established.

As Barnett Shale play moves West sources of fresh water become more limited.

Fresh Water Resources for Fracturing Fluids

Current Situation

Barnett Shale horizontal well completions now using 5 to 6 MM gallons of water for multi-stage fracs.

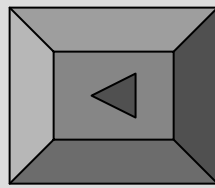
Limited sources of fresh water for fracturing
TCEQ has put restrictions on use of surface water (lakes and rivers)
O&G exemption for ground water use (well withdrawals) are in danger of being canceled.
Cities now charging premium for city water and restrict amounts.
Drought has made cities water supplies limited.
City water sales to O&G are limited.

As Barnett Shale play moves West sources of fresh water become more limited.

Produced Water in the Barnett Shale Play: Potential for Beneficial Use

It is estimated that more than 5 million gallons of water per day are used in fracturing operations. Most then goes to re-injection disposal.

More than 50% of this brine can be re-used in subsequent well fracs. As much as 24% can be recovered as fresh water for beneficial use.



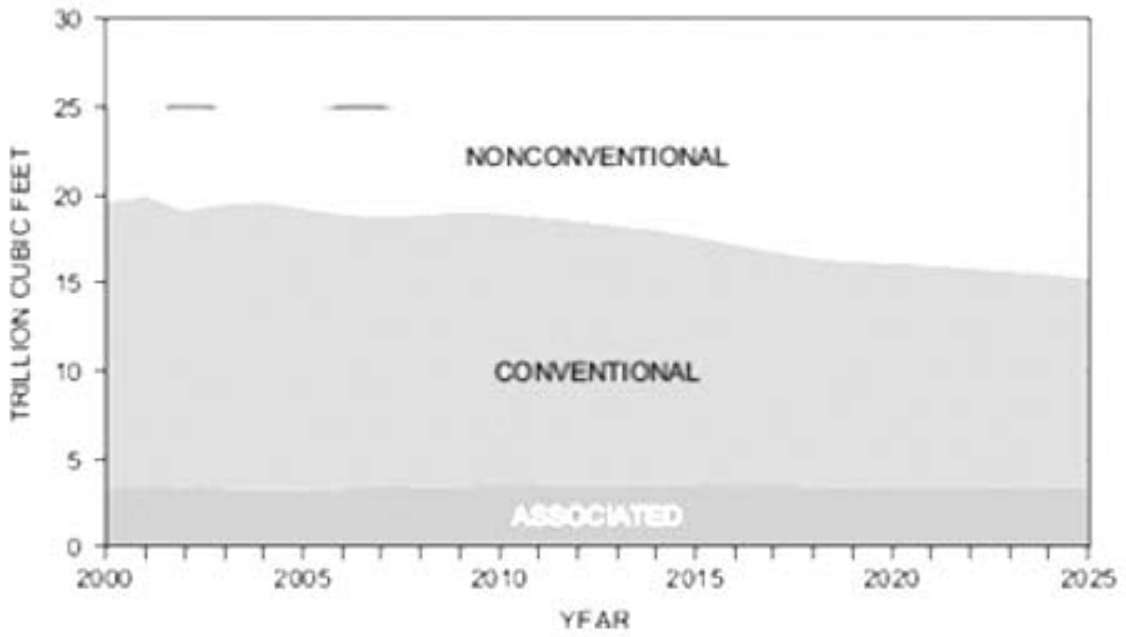
Texas A&M Produced Water Treatment

Unconventional Gas Resources Development in Texas

Barnett Shale (North Central Texas)

- **Barnett Shale (West Texas)**
- **Fayetteville Shale (Arkansas, Oklahoma, Texas)**
- **Woodford Shale (West Texas)**
- **Palo Duro Play (West Texas)**
- **Cherokee (South Texas)**
- **Gulf Coast**

Future Energy Needs to be Met by Unconventional Resources



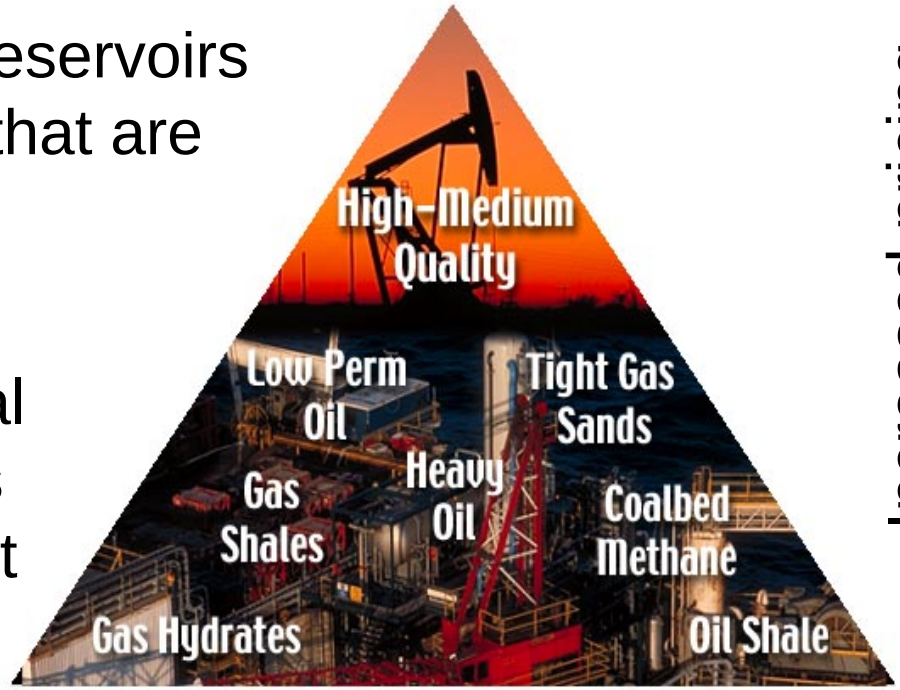
U.S. Lower 48 and Non-Arctic Canadian Gas Production by Type

Crisman Institute for Petroleum Research

Resource Triangle

Conventional Reservoirs
Small volumes that are easy to develop

Unconventional
Large volumes that are difficult to develop



Increased pricing

Improved technology

Crisman Institute Projects (www.pe.tamu.edu/crisman)

- **1.1.4 – Water fracture treatments: A User's Guide**
- **1.1.10 -The Evaluation of Waterfrac Technology in Low-Permeability Gas Sands in the East Texas Basin (WCP)**
- **1.1.12 - Expert System for Drilling, Completions and Stimulation in TGS**
- **1.1.13 - Using Multilayer Models to Forecast Reserves in Tight Gas Reservoirs (RDD)**
- **1.1.14 -Evaluation of Water Production in Tight Gas Reservoirs in the East Texas Basin**
- **1.1.15 - Evaluation of Water Fracture Treatments in the East Texas Cotton Valley Formation**
- **1.2.4 Natural Fracture Characterization in the Woodford Shale**
- **1.4.2 -Effects of New Technology on Economically Recoverable Coal Bed Methane**
- **1.6.2 - Quantifying Uncertainty in Unconventional Gas Resource Assessments in North America**
- **2.4.10 - Optimization of Horizontal Well Performance in Low-Permeability Gas Reservoirs**

- **2.5.9 – Advanced Hydraulic Fracturing Technology for TGS**
- **4.2.2 - CO2 Sequestration Potential of Texas Low-Rank Coals**
- **4.2.8 - Desalination of Brackish Water & Disposal into Waterflood Injection Wells**
- **4.2.9 - Low Impact O&G Activity; Environmentally Friendly Drilling Systems**

Theodori/Anderson; "Social Cost of Energy"

- **The value of oil and gas resources will increase in the coming decade.**
- **The value of protecting the environment will become more important.**
- **The public's interest in energy development will be more and more significant.**

Environmentally Friendly Drilling Systems

Department of Petroleum Engineering
Crisman Institute, GPRI
Department of Civil Engineering
Texas Water Resources Institute
Park Recreation, and Tourism Department

Replacing Conventional Operations Developing Low Impact Oil and Gas: Drilling, Transportation and Production

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