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# Sustainable Water Management in the Texas Oil and Gas Industry

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## Introduction

In June 2013, the Atlantic Council convened a two-day workshop, "Produced Water: Asset or Waste?." It concluded that the potential for US energy self-sufficiency, if not outright independence, will substantially depend on public acceptance, which, in turn, will be predicated on industry's success in developing integrated and sustainable water management practices. Water is key to unleashing domestic energy resources, especially the "unconventionals."

The workshop pointed to the clear need for further conversation as to how energy and water industries can work together to ensure the success of domestic oil and gas production. Given the importance of the Texas oil and gas industry, to start this process, the Atlantic Council and Sebree & Tintera, an Austin-based energy consulting firm, initiated a follow-up effort with key Texas industry players to seek their views on water-related issues and opportunities. Out of this dialogue came the suggestion that policymakers, regulators, and stakeholders throughout the United States would benefit by understanding what states like Texas are doing to address energy-related water issues.

A series of white papers about how select US states are dealing with these issues will be needed. As pointed out in the *Produced Water* report,[1] water management strategies must be tailored to the particular situation's hydrocarbon resources, water availability, and quality, as well as the applicable legal and regulatory frameworks. What works in Pennsylvania will not necessarily apply to Texas. The white paper series should examine key energy-producing states and their approaches to water management.

This first report in the white paper series brings forth fact-based information about the use of water by the Texas oil and gas industry. There are legislative, regulatory, and operational solutions available to address the public's concerns and industry's needs. This paper critically examines the solutions at hand in Texas, along with what the industry and government has learned, done well, and could do better.

This paper briefly describes oil and gas production in Texas, specifically examining the varying geologic regions and water conditions in which energy production is particularly active. Although the paper provides an overview of water-related issues specific to Texas, these issues also have the potential to be applied to other states. It discusses the current landscape of water use for hydraulic fracturing, as

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[1] Blythe Lyons, *Produced Water: Asset or Waste?* (Washington, DC: Atlantic Council, May 2014), p. 6. http://www.atlanticcouncil.org/images/publications/Produced_Water_Asset_or_Waste.pdf.

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well as the future potential for water recycling, reuse, and use of non-freshwater sources statewide and in the Eagle Ford Shale, Permian Basin, and Barnett Shale regions. It recommends further actions, and concludes with an assessment of the role Texas legislators, regulators, and industry can play in achieving sustainable water and energy programs on a wider scale.

## What's at Stake?

Recent technological advancements by the oil and gas industry have allowed for increased production from unconventional resources, ushering the United States into a new energy-production era. Between 2005 and 2012, US oil and gas production increased 30 percent, reversing a three-decade decline.[2] In 2013, the United States produced 84 percent of its energy consumption domestically, up from a historic low in 2005 of less than 70 percent.[3]

> If US energy policy is not managed properly, the future of US energy security could be in jeopardy.

The United States' rise to become one of the world's top energy producers will continue to have far-reaching geopolitical impacts. The Organization of the Petroleum Exporting Countries (OPEC) is perceived to have lost some of its leverage as the United States relies less on imports, specifically from the Middle East. Because axes of power are constantly shifting, if US energy policy is not managed properly, the future of US energy security could be in jeopardy.

Texas oil and gas production is key for both US and state economies. Texas is the number-one US energy-producing state, accounting for almost 35 percent of total oil production[4] and almost 30 percent of all US natural gas production.[5] The oil and gas industry is one of the largest contributors to the Texas economy. State severance taxes in 2013 set an all-time high, accounting for nearly 10 percent of total sales tax collections.[6]

## Oil and Gas Production in Texas

### *Oil Production*

Texas has a long history of oil production dating back to the late 1800s. The first major oil discovery occurred in 1894 in Corsicana, located in the east-central portion of Texas. In 1901, the gusher at Spindletop marked a turning point, and is considered the first oil "boom" in Texas. In the following years, Texas oil exploration and production continued to grow, especially with the discovery of the East Texas Oil Field in 1930. Texas produced a record amount of oil in the 1970s.

However, increasing expenses associated with exploration made it difficult for companies to acquire the necessary capital. Additionally, demand for oil had fallen significantly, and as a result, there was a collapse of the booming oil industry by the early 1990s.[7] Texas oil production rebounded with the advent of hydraulic fracturing combined with horizontal drilling. In 2004, Texas produced on average 957,000 barrels of oil per day.[8] In March 2014, preliminary crude oil production averaged 2,014,480 barrels per day, an increase of 25 percent from the previous year, and a 110 percent increase over the past ten years.[9]

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[2] US Energy Information Administration (US EIA), Monthly Energy Review, May 28, 2014, http://www.eia.gov/totalenergy/data/monthly/pdf/sec1_3.pdf.
[3] US EIA, "Domestic Production Satisfies 84% of Total US Energy Demand in 2013," June 2, 2014, http://www.eia.gov/todayinenergy/detail.cfm?id=16511.
[4] US EIA, Petroleum Supply Monthly, March 2014, http://www.eia.gov/petroleum/supply/monthly/pdf/table26.pdf.
[5] US EIA, Texas Quick Facts, http://www.eia.gov/state/?sid=TX.
[6] Texas Taxpayers and Research Association, "The Rainy Day Flood: What the Oil and Gas Comeback Means for Texas," p. 2, http://www.ttara.org/files/document/file-52541a9f836e9.pdf.
[7] Roger M. Olien, "Oil and Gas Industry," *Handbook of Texas Online,* Texas State Historical Association, June 15, 2010, http://www.tshaonline.org/handbook/online/articles/doogz.
[8] Ibid.
[9] Railroad Commission of Texas (RRC), "Texas Monthly Oil and Gas Statistics," May 27, 2014, http://www.rrc.state.tx.us/news/052714a/.

***Texas Gas Production***

While Texas was producing a record amount of oil, natural gas production was also at its peak in the 1970s, at about 8.6 trillion cubic feet (TCF) per year. Like oil, production declined and remained relatively low through the 1980s. Natural gas production reached a low of approximately 5 TCF in 2004.

A new technique pioneered by George Mitchell, which combined hydraulic fracturing of tight rock formations and horizontal drilling, was first developed and applied in the natural gas–rich Barnett Shale in the 1990s. Within a few years, natural gas production in the Barnett Shale and statewide increased dramatically. By 2012, natural gas production in Texas reached about four-fifths of the record high in the 1970s, producing 7.2 TCF.[10] The shale revolution had begun in Texas, and would soon spread to the rest of the country.

The hydraulic fracturing technology pioneered by George Mitchell first led to a major expansion of production in the Barnett Shale in the 1990s. It quickly spread across Texas, boosting oil production to record levels and gas to highs close to 1970s records.

## Energy-Related Water Issues

***Water Use by the Oil and Gas Industry is Expected to Increase as a Result of the Shale Revolution***

Hydraulic fracturing is the process by which a liquid solution, typically composed of water, a proppant such as sand, and a small percentage of chemicals is injected at high pressures down a wellbore to create tiny fractures in the tight rock formations, which allows the oil and natural gas to escape the rock.[11] When combined with horizontal drilling, more area of the formation's producing zone is fractured, thus increasing the amount of oil and natural gas that has a path to the wellbore and can be produced.[12]

While hydraulic fracturing was utilized in Texas for over sixty years, and horizontal drilling was applied to formations for over twenty years, their combined application had gained widespread popularity by 2006. In 2005, it is estimated that there were more than 2,500 hydraulic fracturing jobs performed. By 2009, more than 6,600 fracturing jobs were performed in Texas.[13] In 2010, it is estimated that 85 percent of new wells, approximately 13,000, utilized hydraulic fracturing.[14] With this increase in production, there has been a parallel increase in water used for extraction purposes by the oil and gas industry. Horizontal drilling technology allows for ever longer horizontal "laterals," thereby increasing the amount of rock that can be stimulated from a single wellbore. Longer laterals means higher production, as well as more water used per well.

Table 1 shows the trends in water use in a dozen Texas shale plays. Water use is either steady or increasing in virtually every play.

[10] US EIA, "Texas State Profile and Energy Estimates," http://www.eia.gov/state/analysis.cfm?sid=TX.
[11] RRC, "Hydraulic Fracturing," http://www.rrc.state.tx.us/about-us/resource-center/faqs/oil-gas-faqs/faq-hydraulic-fracturing/.
[12] FracFocus, "Hydraulic Fracturing: The Process," http://fracfocus.org/hydraulic-fracturing-how-it-works/hydraulic-fracturing-process.
[13] Texas Water Development Board (TWDB), "Current and Projected Water Use in the Texas Mining and Oil and Gas Industry," June 2011, p. 57, http://www.twdb.state.tx.us/publications/reports/contracted_reports/doc/0904830939_MiningWaterUse.pdf.
[14] Anthony Cavender, "Texas Law Requires Disclosure of Hydraulic Fracturing Chemicals as of February 1, 2012," Pillsbury Law, December 21, 2011, p. 1, http://www.pillsburylaw.com/sitefiles/publications/elunrenergyoilgasalert12212011.pdf.

**Table 1. Recent Trends in Well Completion and Water Use in Hydraulic-Fractured Plays**

| Play | Well Type | ~# of Recent Wells/yr | Recent Trend (well/yr) | Water Use / well (Mgal) | Water Use Intensity (gal/ft) | Recent Trend (water use) |
|---|---|---|---|---|---|---|
| Barnett | H | 1500 | down / steady | n/a | 1200 | steady |
| Eagle Ford | H | 1000 | strongly up | n/a | 850 | down |
| TX-Haynesville | H | 250 | up | n/a | 1400 | steady |
| Granite Wash | H | 250 | strongly up | n/a | 1200 | steady / up |
| | V | 60 | strongly down | 1500 | 800 | steady |
| Cleveland | H | 100 | steady | n/a | 250 | steady |
| | V | 20 | down | 1.7 | 2000 | steady |
| Marmaton | H | 30 | strongly up | n/a | 250 | steady |
| | V | 10 | steady | 1.0 | 2500 | up |
| Cotton Valley | H | 100 | up | n/a | 1000 | steady |
| | V | 300 | strongly down | 0.8 | 1200 | steady |
| Olmos | H | 50 | up | n/a | 1000 | up |
| | V | 100 | strongly down | 0.15 | 2500 | steady |
| Wolfcamp | H | 150 | strongly up | n/a | 900 | strongly up |
| Wolfberry | V | 2000 | up | 1.0 | 350 | up |
| Canyon | V | 300 | down | 0.4 | 500 | up |
| Clear Fork | V | 800 | up | 0.8 | 350 | up |
| San Andres | H | 50 | strongly down | n/a | 350 | strongly up |
| | V | 800 | steady / up | 0.15 | 500 | steady |

*Source*: Jean-Philippe Nicot, Robert C. Reedy, Ruth A. Costley, and Yun Huang, "Oil & Gas Water Use in Texas: Update to the 2011 Mining Water Use Report," Bureau of Economic Geology, Jackson School of Geosciences, the University of Texas at Austin, September 2012, p. 54, http://www.beg.utexas.edu/water-energy/docs/Final_Report_O&GWaterUse-2012_8.pdf.

As mentioned above, as water-intensive drilling techniques spread across the state, the amount of water used[15] by the oil and gas industry increased accordingly. In 2008, the oil and gas industry used a total of approximately 57,000 acre-feet, with hydraulic fracturing accounting for 35,800 acre-feet.[16] By 2011, estimated water use for hydraulic fracturing increased to 81,500 acre-feet statewide.[17] In 2012, total water use for hydraulic fracturing decreased slightly to an estimated 76,722 acre-feet,[18] as water recycling and conservation efforts began to take hold, especially in water-stressed regions. Experts predict that water usage going forward will increase to about 125,000 acre-feet between 2020 and 2030, followed by a steady decrease in 2060 and beyond.[19]

[15] In the 2011 report of the Texas Water Development Board, *Current and Projected Water Use in the Texas Mining and Oil and Gas Industry*, usage numbers represent mostly consumption. In the update to the 2011 report, they differentiate between withdrawals and consumption.
[16] TWDB, "Current and Projected Water Use," p. 178.
[17] Jean-Philippe Nicot, Robert C. Reedy, Ruth A. Costley, and Yun Huang, "Oil & Gas Water Use in Texas: Update to the 2011 Mining Water Use Report," Bureau of Economic Geology, Jackson School of Geosciences, the University of Texas at Austin, September 2012, p. 54, http://www.beg.utexas.edu/water-energy/docs/Final_Report_O&GWaterUse-2012_8.pdf.
[18] Ceres, "Hydraulic Fracturing & Water Stress: Water Demand by the Numbers," February 5, 2014, p. 49, https://www.ceres.org/issues/water/shale-energy/shale-and-water-maps/hydraulic-fracturing-water-stress-water-demand-by-the-numbers.
[19] Nicot et al., "Oil & Gas Water Use in Texas: Update," p. 65.

While the amount of water used in hydraulic fracturing operations in Texas has increased, the amount is proportionally small compared to other users. In 2010, water use for hydraulic fracturing represented 0.5 percent of the total water used statewide.[20] Irrigation accounts for 56 percent, and municipal water supply requires 27 percent of water in Texas.[21] To give further context to the oil and gas industry's water use, the amount of water used to hydraulically fracture a well in Texas, approximately 4 million gallons, is the same amount of water used by one typical Texas golf course every eight days.[22] Competition from other water users or industries has increased, especially on a local basis, adding a layer of complexity to water sourcing in arid or water-scarce regions. Some research has indicated that producing shale gas is less water-intensive than producing other fossil fuels.

> As water-intensive drilling techniques were applied state wide, the energy industry's water use rose dramatically. Comparatively, however, the use is proportionally small compared to other users.

***Water Use in Barnett, Eagle Ford, and Permian Basin***

Due to Texas's varying climates and diverse geology, water use for oil and gas production is significant in certain areas that face prolonged periods of drought.[23] Water usage in the three major Texas shale plays, Barnett, Eagle Ford, and Permian Basin, demonstrates how factors such as the shale formation's geology (permeability, depth, and composition), local climate, and water sources influence the water management of specific regions. Differences in each of these three regions are discussed below.

The Barnett Shale, located in northeast Texas, was the first shale play to successfully apply hydraulic fracturing.[24] The climate is characterized as subtropical, sub-humid mixed savanna and woodlands.[25] The shale is located at depths between 6,500 and 8,500 feet, with a thickness ranging from 100 to 600 feet.[26] Although drilling operations have declined recently due to lower natural gas prices, the shale is still averaging gas production at 4,774,000 cubic feet per day.[27] Overall, water use remains steady at 25,000 acre-feet per year.[28] A majority of water used in drilling and stimulation operations is groundwater from the Edwards-Trinity and Woodbine Aquifers.[29] Although water use is a concern statewide, the relatively small amount of water used in the Barnett Shale, combined with existing water infrastructure, has made water shortage in this region less of a concern than in other, more-arid regions of the state.

The Eagle Ford Shale, spanning twenty-four counties in south Texas, has increased production dramatically since the first well was drilled in 2008.[30] The formation contains a high percentage of carbonate, making the rock more brittle and conducive to hydraulic fracturing.[31] The formation has an average thickness of 250 feet, and is located at a depth of approximately 4,000 to 12,000 feet.[32]

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20 Ibid, p.ii
21 Ceres, "Hydraulic Fracturing & Water Stress," p. 49.
22 Devon Energy, "Hydraulic Fracturing Water Use: A Comparison," http://www.dvn.com/CorpResp/Documents/HydraulicFracturingWaterUse.pdf.
23 Nicot et al., "Oil & Gas Water Use in Texas: Update," p. ii
24 Ibid, p. 11.
25 TWDB, "2012 State Water Plan," p. 147, http://www.twdb.state.tx.us/publications/state_water_plan/2012/04.pdf.
26 TWDB, "Current and Projected Water Use," p. 58.
27 RRC, "Texas Barnett Shale Total Natural Gas Production 2000–2014," http://www.rrc.state.tx.us/media/19557/barnettshale_totalnaturalgas_day.pdf.
28 Nicot et al., "Oil & Gas Water Use in Texas: Update," p. 11.
29 TWDB, *Northern Trinity/Woodbine Aquifer Groundwater Availability Model, Assessment of Groundwater Use in the North Trinity Aquifer Due to Urban Growth and Barnett Shale Development*, January 2007, https://www.twdb.texas.gov/groundwater/models/gam/trnt_n/TRNT_N_Barnett_Shale_Report.pdf.
30 RRC, "Eagle Ford Shale Information," http://www.rrc.state.tx.us/oil-gas/major-oil-gas-formations/eagle-ford-shale/.
31 Ibid.
32 Ibid.

The Eagle Ford is currently producing an average of over 800,000 barrels of oil per day, compared to 2010, when the play was producing 15,149 barrels per day.[33] Total water use is projected to be 19.2 billion gallons[34] (roughly 59,000 acre-feet), averaging over 4.4 million gallons per well.[35] The climate is considered semiarid.[36] Water used for oil and gas operations is typically groundwater from the Gulf Coast Aquifer in the northern portion of the play, and the Carrizo-Wilcox Aquifer in the southern portion.[37] Water concerns in the region are high, as the shale play has the highest water use in the nation, and about 28 percent of wells are located in areas of high or extremely high water stress.[38,39]

The shale formation's permeability, depth, and composition, local climate, and water sources influence the water management in each production region.

The Permian Basin, located in west Texas and extending into New Mexico, contains multiple, overlapping producing formations. The Permian Basin is one of the oldest producing regions in Texas, producing over 29 billion barrels of oil and 75 TCF of gas since 1921.[40] The area's climate is subtropical, arid desert, but traveling north into the Panhandle, the climate becomes semiarid savanna.[41] Since the Permian Basin is composed of several formations at varying depths, overall water use is relatively higher, at about 1,500,000 acre-feet in 2011, with individual wells using approximately 5 million gallons.[42] Water scarcity is a prominent issue in this area, as a reported 70 percent of wells in the Permian Basin are in a "high or extremely high water stress area."[43] Much of the water used is groundwater from the High Plains Aquifer (also known as the Ogallala Aquifer), the Edwards-Trinity Aquifer, and the Pecos River Basin.[44]

### *Changing Dynamics of Drought and Population Impact Water Management*

Texas has been experiencing varying degrees of drought conditions for the past several years. In 2011, Texas faced one of the worst one-year droughts on record, with 99 percent of the state experiencing severe, extreme, or exceptional drought conditions.[45] While conditions have improved slightly, almost 70 percent of Texas is still experiencing drought, and many reservoirs, especially in west Texas, are less than 25 percent full.[46] In the 2012 State Water Plan, the Texas Water Development Board (TWDB) states, "In serious drought conditions, Texas does not and will not have enough water to meet the needs of its people, its businesses, and its agricultural enterprises."[47]

Other factors strain Texas' water resources. The population is rapidly increasing at a projected rate of 82 percent between 2010 and 2060.[48] By 2030, the population is estimated to increase by 10

[33] RRC, "Eagle Ford Shale Oil Production 2008 through March 2014," http://www.rrc.state.tx.us/media/19555/eaglefordproduction_oil_perday.pdf.
[34] The report was based on water use data from oil and shale gas wells hydraulically fractured between January 2011 and May 2013.
[35] Ceres, "Hydraulic Fracturing & Water Stress," p. 9.
[36] TWDB, "2012 State Water Plan," p. 147.
[37] Stephen Jester, "Eagle Ford Shale Water Supply and Demand," http://www2.epa.gov/sites/production/files/documents/06_Jester_-_Water_Demand_508.pdf (slide 9).
[38] Ceres, "Hydraulic Fracturing & Water Stress," p. 50.
[39] The authors of the report note that some critics have expressed concern as to whether Ceres correctly used the WRI Aqueduct database in preparing their analysis.
[40] RRC, Permian Basin Information, http://www.rrc.state.tx.us/oil-gas/major-oil-gas-formations/permian-basin/.
[41] TWDB, "2012 State Water Plan," p. 147.
[42] Nicot et al., "Oil & Gas Water Use in Texas: Update," p. 13.
[43] Ceres, "Hydraulic Fracturing & Water Stress," p. 9.
[44] Ibid.
[45] TWDB, "2012 State Water Plan," p. 14.
[46] Ceres, "Hydraulic Fracturing & Water Stress," p. 49.
[47] TWDB, "2012 State Water Plan," Chairman's Letter, http://www.twdb.state.tx.us/publications/state_water_plan/2012/04.pdf.
[48] TWDB, "2012 State Water Plan," Quick Facts, http://www.twdb.state.tx.us/publications/state_water_plan/2012/04.pdf.

million, to 34 million,[49] and by 2060, the population is projected to reach 46.3 million.[50] Water demand is projected to increase 22 percent by 2060, although existing water supplies (the amount of water that can be produced with current permits, current contracts, and existing infrastructure during drought) are set to decrease about 10 percent during that time.[51] The TWDB projects that without new water supply projects or management strategies, residents and businesses will need an additional water supply of 8,300,000 acre-feet by 2060.[52]

Drought in almost 70 percent of Texas and increasing water demand from a growing population are straining Texas' water supplies. These factors drive changing water

## Evolving Water Management Practices

In light of current and projected water conditions, the oil and gas industry has received scrutiny and criticism over the amount of water used for hydraulic fracturing. As noted above, while it is a small percentage of statewide use in Texas, the water impacts of energy projects can be of significant concern to the local community. The public's perception of industry's water usage is one of several important factors encouraging water recycling and conservation in the energy sector. This can be seen in the evolving use of non-freshwater sources, as discussed in further detail below.

### *Freshwater for Fracturing*

The Railroad Commission of Texas (RRC)[53] defines freshwater (to be protected during drilling) as 3,000 mg/L; however, the Bureau of Economic Geology defines freshwater as water that contains less than 1,000 mg/L total dissolved solids. Freshwater, sourced from either ground- or surface water, typically has been used for hydraulic fracturing, because commonly used friction reducers have historically functioned optimally in freshwater.[54] Freshwater consumption by the oil and gas industry is estimated to reach approximately 100,000 acre-feet before 2020, and freshwater consumption for hydraulic fracturing will generally stay around 70,000 acre-feet during that time and decrease in future decades.[55] Research suggests freshwater consumption is decreasing,[56] with consumption for all operations projected to decrease to just a few tens of thousands acre-feet by the middle of the twenty-first century.[57]

Cost is a major factor in determining whether to use freshwater or an alternative source of water. Estimates show that freshwater withdrawal accounts for less than 1 percent of total water management costs.[58] Other estimates show front-end water acquisition, storage, transfer, and waste-disposal services associated with the initial hydraulic fracturing of a new well can represent about 10 percent of a well's total cost.[59] As referenced above, local conditions (drought, freshwater availability, competition from industrial and municipal uses, etc.) will dictate the costs of acquiring freshwater. In one instance in west Texas, an operator acquires its groundwater at essentially no cost, as the company owns

[49] Ceres, "Hydraulic Fracturing & Water Stress," p. 49.
[50] TWDB, "2012 State Water Plan," Quick Facts.
[51] Ibid.
[52] Ibid.
[53] See section 7 for a description of the RRC.
[54] Jean-Philippe Nicot and Bridget Scanlon, "Water Use for Shale-Gas Production in Texas, United States," Bureau of Economic Geology, Jackson School of Geosciences, University of Texas at Austin, March 2012, p. 3, http://www.beg.utexas.edu/water-energy/docs/Nicot+Scanlon_ES&T_March2012_es204602t+SI-lastdraft.pdf.
[55] Nicot et al., "Oil & Gas Water Use in Texas: Update," p. 65.
[56] Ibid, pp. i–ii.
[57] Ibid, p. 65.
[58] Kevin Reyntjens and Aaron Johnson, "Ensuring Sustainable Shale Operations through Water Management," World Oil, March 2014, p. S96, http://msdssearch.dow.com/PublishedLiteratureDOWCOM/dh_0906/0901b80380906cd5.pdf?filepath=liquidseps/pdfs/noreg/177-03531.pdf&fromPage=GetDoc.
[59] IHS "Water Management at Forefront of Exploration and Production Operators' Considerations, Says New IHS Study," November 6, 2013, http://press.ihs.com/press-release/ep-water-use/water-management-forefront-exploration-and-production-operators-considera#sthash.NxpKoVxO.dpuf.

165,000 acres of ranch land with an underground pipeline system that transports water directly to the well.[60] However, this is a unique case, and there are still likely costs associated with infrastructure and limited transportation. The cost associated with transporting freshwater is a major contributing factor to the overall cost of freshwater acquisition. In the Eagle Ford Shale and the Permian Basin, trucking water can cost 50 cents to several dollars per barrel of oil produced, in addition to the cost of purchasing freshwater.[61] There can also be additional costs relating to loss of freshwater due to evaporation from storage pits or open tanks, especially in the Permian Basin.

With the increased usage of water in more-arid climates, such as in south and west Texas, combined with factors such as drought, population growth, increasing costs, and public perception, the oil and gas industry has begun to search for ways to reduce freshwater consumption. Experts note that the industry is making strides in the reuse of flowback and produced water, finding alternative sources of recycled water (from treatment plants and/or produced water from conventional wells), and in using brackish water, as technology allows the use of more saline water with additives.[62]

***Alternative / Non-Freshwater Source Drivers***

Generally speaking, conditions that support using alternative, non-freshwater sources are:

- a limited availability of high-quality source water available;
- high quality and availability of produced or brackish water;
- a reduction in transportation and logistical costs;
- high compatibility with fracturing fluid chemistry; and
- high compatibility with reservoir.[63]

While the use of non-freshwater is gaining traction within the industry, there are still challenges associated with using alternative water sources, including:

- transportation and gathering of water (logistics, traffic, environmental concerns);
- treatment of water (cost, life-cycle environmental concerns);
- storage of non-freshwater (bacteria, corrosion, environmental concerns);
- blending of water from different sources (produced, fresh);
- consistent and predictable fracturing fluid performance (pretesting and consistent stream);
- impacts on reservoir and fracture conductivity (rock-fluid interaction and pack damage); and
- impacts on short- and long-term field production (emulsion, scaling, corrosion).[64]

Given the multitude of varying conditions that exist across the state, there is a corresponding variance in the potential to reduce the use of freshwater and employ water reuse, recycling, and other conservation methods. Given technological advances and other changes in industry practices, the amount of water recycled/reused and the use of brackish water have increased about 21 percent between 2008 and 2011, to approximately 17,000 acre-feet.[65] Alternative water sources to freshwater, specifically brackish water and produced water, are discussed in detail next. There is a complex matrix of variables pertaining to both brackish and produced water that will determine

[60] Jim Malewitz and Neena Satija, "In Oil and Gas Country, Water Recycling Can Be an Extremely Hard Sell," *New York Times*, November 21, 2013, http://www.nytimes.com/2013/11/22/us/in-oil-and-gas-country-water-recycling-can-be-an-extremely-hard-sell.html?pagewanted=1&_r=0.
[61] Collin Eaton, "Texas Heading for Major Water Shortage with Limited Oil Field Recycling," Fuel Fix, February 17, 2014, http://fuelfix.com/blog/2014/02/17/texas-heading-for-major-water-shortage-amid-limited-oil-field-recycling/.
[62] Nicot et al., "Oil & Gas Water Use in Texas: Update," p. 65.
[63] Stephen Jester, Kevin Bjornen, and Ramesh Sharma, "Evaluation of Produced Water Reuse for Hydraulic Fracturing in Eagle Ford," Presentation to the Atlantic Council, June 24–25, 2013, slide 8, http://www.slideshare.net/atlanticcouncil/produced-water-session-x-steve-jester.
[64] Ibid, slide 7.
[65] Nicot et al., "Oil & Gas Water Use in Texas: Update," p. i.

their viability and successful usage moving forward.

***Brackish Water as an Alternative***

Brackish water, defined as water with total dissolved solids between 1,000 and 10,000 parts per million (ppm), is one potential non-freshwater source.[66] Brackish water between 1,000 ppm and 3,000 ppm is typically considered slightly saline, and 3,000 ppm to 10,000 ppm is characterized as moderately saline.[67]

While brackish water must undergo desalination in order to be acceptable for public consumption,[68] recent technological advancements have allowed the oil and gas industry to use brackish water without the additional cost of treatment. Since 2011, many companies have reported at various conferences and public forums that they have increased their use of brackish water.

> Industry has begun to search for ways to reduce it use of freshwater. Brackish water is emerging as a viable alternative. Produced water use is also gaining traction.

Availability and quality will be determining factors. One advantage to using brackish water is the amount and widespread availability of this resource in Texas. Texas has an estimated 2.7 billion acre-feet of brackish groundwater, with nearly every geographic region containing some amount.[69] Brackish groundwater is more prevalent than freshwater in the southern Gulf Coast Aquifer, underlying the Eagle Ford Shale, and in many parts of west Texas, near the Permian Basin.[70] While its availability is beneficial, the quality of the brackish water is a major factor in determining whether it is an economically viable alternative. Statewide, reportedly there is twice as much slightly saline brackish (1,000 to 3,000 ppm) as moderately saline water (3,000 to 10,000 ppm).[71]

Initially, brackish water posed a challenge for operators due to a large variance in compatibility with the formation and the hydraulic fracturing fluid. High salinity can cause corrosion and integrity issues in the wellbore, damaging the well's producing potential and causing potential environmental concerns. A major issue was the composition of the fluid used to hydraulically fracture wells. Friction reducers are commonly added to the fluid mix to make the water more "slick."[72] Because these friction reducers function best in freshwater, companies using brackish water must revise their chemical recipes based on the composition of the brackish water. Recently, advancements in the field of chemical additives have allowed companies to utilize higher-salinity brackish water in their hydraulic fracturing operations.[73]

While brackish water is emerging as a viable alternative to freshwater use, constraints remain.[74] Companies note increasing competition from municipalities for brackish waters of low salinity, as all water consumers move away from freshwater usage. Additionally, while the acquisition cost for brackish water may be low, handling costs are higher for brackish water than for freshwater. For example, no-leak transfer lines must be used, and containments must be suitable for salt water. There is also increased liability to producers that store and/or transfer large volumes of salt water. Another concern with significant use of brackish water is the potential for impacting freshwater formations by drawing down the brackish water. Brackish water may have limited to

[66] TWDB, "2012 State Water Plan," December 2011, p. 247, http://www.twdb.state.tx.us/publications/state_water_plan/2012/2012_SWP.pdf.
[67] Jester et al., "Evaluation of Produced Water Reuse," slide 3.
[68] TWDB, "2012 State Water Plan," December 2011, p. 204.
[69] TWDB, "Brackish Groundwater in Texas," p. 3, https://www.twdb.texas.gov/publications/reports/numbered_reports/doc/R363/B2.pdf.
[70] TWDB, "2012 State Water Plan," December 2011, p. 204.
[71] TWDB, "Brackish Groundwater in Texas," p. 3.
[72] Nicot and Scanlon, "Water Use for Shale-Gas Production in Texas," p. 3.
[73] Ibid, p. 13.
[74] Ibid.

no recharge, so this resource is finite. Companies have raised concerns about a potentially burdensome, bureaucratic process for purchasing water from cities, including the need for permits. Transportation costs may undermine brackish water use if a source is not located nearby. Finally, there are concerns over the risks associated with storage and transfer. For example, spillage or a bird landing in a saltwater pond can create environmental liabilities for companies.

***Produced Water Management***

The terms *produced water* and *flowback fluid*[75] are used to describe water produced from an oil and gas wellbore. State regulators and oil and gas companies use this definition. However, some entities do try to distinguish between flowback fluid and produced water. Regardless, both are exempt from Resource Conservation and Recovery Act (RCRA) exploration and production regulations.

Using produced water as an alternative to freshwater is gaining traction within the industry, although it is considered more challenging due to the high composition variance between wells and formations. The characteristics of produced water vary greatly, and use of the term often implies an inexact or unknown composition.[76] Typically, produced water includes water in the formation that contains hydrocarbons and salts, toxic natural inorganic and organic compounds, chemical additives, naturally occurring radioactive materials (NORM), and oil and grease associated with production.[77] While the composition varies, produced water typically has high total dissolved solids, suspended solids, iron, hardness/scaling potential, boron, oil residue, and organic matter.[78]

There are three main options for managing produced water: recycling/reuse, disposal, or discharge. Specific options include on-site evaporation pits (no longer allowed in Texas);[79] on-site injection into disposal wells; disposal at a centralized off-site underground injection site; transportation to and then treatment at a treatment plant; on-site treatment by a mobile unit for oil field reuse; on-site mixing of produced and freshwater for reuse in hydraulic fracturing operations (if it is an unconventional play); discharge with a National Pollutant Discharge Elimination System (NPDES) permit (not allowed for onshore facilities in most cases);[80] or treatment for beneficial uses.[81] In *Produced Water: Asset or Waste?*, Blythe Lyons notes the context in which these water management decisions are made is changing due to the need for sustainable practices, the inability to obtain discharge permits, availability of and public concern over disposal wells, and the continued increase in water usage, especially in drought-plagued or arid portions of the state.

Oil and gas producers have substantially increased produced water recycling in Texas over the past couple of years, although it is more viable in some areas than others because the amount of flowback and produced water varies between formations. More plans are under way to continue to expand recycling operations.

Evidence of expanded recycling was presented at a public meeting organized by RRC Commissioner Christi Craddick in Austin in May 2014. Some companies have begun to blend a small percentage of produced water with source water for hydraulic fracturing operations. As with other alternative water sources, it is vital to examine factors such as

[75] Schlumberger defines *flowback* as the process of allowing fluids to flow from the well following a treatment, either in preparation for a subsequent phase of treatment, or in preparation for cleanup and returning the well to production. However, in *Produced Water: Asset or Waste?*, Blythe Lyons defines *flowback* as the stream of water and hydraulic fracturing fluids that comes back up through conventional wells for a few weeks right after the process is initiated. Flowback is primarily composed of the water that was injected into the formation during the hydraulic fracturing process, including the fracturing fluid and concentrations of chemicals that were dissolved from the shale rock.

[76] Lyons, *Produced Water: Asset or Waste?*, p. 19.
[77] Ibid.
[78] Jester et al., "Evaluation of Produced Water Reuse," slide 9.
[79] On April 3, 1967, the RRC adopted a statewide no-pit order prohibiting operators conducting oil and gas development operations from using salt-water disposal pits for storage and evaporation of oil field brines and mineralized waters effective January 1, 1969 (Statewide Rule 8).
[80] The exception is for stripper wells or west of the 98th meridian (40 CFR, pt. 435).
[81] Lyons, *Produced Water: Asset or Waste?*, p. 7.

compatibility with the formation and the fracturing fluid, reliability and consistent results, costs, and environmental considerations in determining the potential for using produced water. However, as freshwater availability is becoming more of a concern for companies, from both a logistical viewpoint and in terms of public perception, there is more interest in recycling and reuse. Water recycling technology has matured, and regulations are becoming increasingly conducive to supporting this emerging industry. The RRC revised Rule 3.8 in 2013, reducing regulatory burdens related to recycling and storing recycled produced water.

Although produced water recycling is becoming more prevalent, it was slow to gain traction for several reasons. Initially the interest in water recycling technologies caused the market to be saturated with too many varying technologies, which were often in early, untested stages. The ease and availability of acquiring freshwater and disposal (there are more than 35,000 active injection and disposal wells in Texas[82]) discouraged companies from paying for produced water treatment. In addition, transportation and handling costs are key site-specific factors when considering disposal versus treatment.

***Water Management Changes in the Barnett, Eagle Ford, and Permian Basin Formations***

Local conditions are key when it comes to determining whether brackish and produced water have the potential to replace freshwater for fracturing operations. For example, in the Permian Basin, brackish water accounts for 30 percent or more of the water used in hydraulic fracturing.[83] In the Barnett Shale, brackish water is used far less frequently.[84] Research and industry projections suggest that brackish water will continue to displace the use of freshwater in the future. As for produced water, the Eagle Ford Shale produces back less than 20 percent of injected water.[85] Because of this, the majority of produced water in the Eagle Ford is disposed of by injection.[86] The variations in the Barnett Shale, Eagle Ford, and Permian Basins are examined next to further demonstrate how local conditions drive water management strategies.

The Barnett Shale has maintained a steady level of water use since 2008 at 25,000 acre-feet per year.[87] An estimated 80 percent of "new" water is freshwater, although some operators are turning to brackish water in the portion of the shale that contains both oil and gas, and in the western portion of the area.[88] Other alternative water sources include wastewater treatment plants.[89] Compared to other shale plays, a small amount of recycling/reuse of produced and brackish water is being utilized.[90]

In the Eagle Ford Shale, it is estimated that 90 percent of "new" water is groundwater[91] from the Carrizo-Wilcox Aquifer. But long-term sustainability is a concern, as the aquifer is experiencing rapid depletion.[92] The shale play has the highest water use in the nation, and has a relatively high average water use per well, at 4.5 million gallons.[93] Twenty-eight percent of Eagle Ford wells are located in areas with high or extremely high water stress.[94] There are aquifers in the Eagle Ford that are brackish, and a significant amount of brackish water (about 20 percent, depending on the operator) is now being used.[95] However, some portions of the Eagle Ford have low volumes of flowback/produced water, lowering the potential for water recycling.[96]

The Permian Basin operations primarily use groundwater, with brackish water accounting for approximately 30 percent or more of the water used in hydraulic fracturing.[97] Aquifer depletion is a concern in west Texas, as the High Plains Aquifer

82 RRC, "Saltwater Disposal Wells," http://www.rrc.state.tx.us/about-us/resource-center/faqs/oil-gas-faqs/faq-saltwater-disposal-wells/.
83 Nicot et al., "Oil & Gas Water Use in Texas: Update," p. 54.
84 Ibid.
85 Ibid, pp. 65–66.
86 Lyons, *Produced Water: Asset or Waste?*, p. 7.
87 Nicot et al., "Oil & Gas Water Use in Texas: Update," p. 11.
88 Ibid, p. 54.
89 Ibid.
90 Ibid.
91 Ibid.
92 Ceres, "Hydraulic Fracturing & Water Stress," pp. 50–51.
93 Ibid.
94 Ibid.
95 Nicot et al., "Oil & Gas Water Use in Texas: Update," p. 54.
96 Ceres, "Hydraulic Fracturing & Water Stress," p. 54.
97 Nicot et al., "Oil & Gas Water Use in Texas: Update," p. 54.

has experienced some of the most dramatic water level declines in the United States.[98] In the southeast portion of the Permian Basin, including the portion in New Mexico, 87 percent of wells are located in high or extremely high areas of water stress.[99] Additionally, there is a high level of competition for water from agriculture.[100] Because of high flowback levels and low salinity of produced water, water recycling may have substantial potential, in addition to brackish water usage.[101] Some industry experts interpret the TWDB database to show that the Ogallala and Edwards-Trinity Aquifers have been stable or recharging since the 1980s, including during the drought of 2011. Additional analysis is likely necessary.

## Challenges and Opportunities for Evolving Water Management Options

***Induced Seismicity may Drive Produced Water Reuse***

The geologic characteristics of subsurface Texas allow for economic disposal of produced water. Currently in Texas there are over eight hundred commercial Class II disposal wells. The price per barrel for disposal can vary at the disposal well head, from $0.60 to several dollars per barrel. Disposal will remain a viable option for several reasons, such as local geology, economics, and the treatment residual (or unused recycled water). However, the concerns over induced seismicity from injection wells, discussed below, may encourage widespread treatment and recycling of produced water.

Regarding the concerns for the potential for induced seismicity from injection wells, most geologists would likely agree there is a theoretical possibility of a cause-and-effect relationship between injection and seismicity.[102] It will, however, be difficult to prove or demonstrate on a site-specific basis. It is significant to note that seismicity in Texas has occurred within small areas relative to the scale of oil and gas developments.

Texas regulators have recognized the public's concern. The RRC held a town hall meeting in Azle, Texas, in January 2014 to listen to public comments and concerns regarding this phenomenon. Unfortunately, the limited science and difficult facts do not offer a straightforward resolution; significant media coverage has further complicated the investigations. There are currently two separate investigations under way by the RRC and the United States Geological Survey (USGS). Data collection and support is being provided by Southern Methodist University in Dallas. In May 2014, the Texas Legislature held a hearing and received testimony on the subject, and concurred with the RRC's conclusion that additional data and research needs to be conducted. However, more legislative and regulatory actions may be forthcoming.

***Environmental Concerns***

The combination of water recycling and disposal addresses many, but not all, of the environmental concerns regarding water management. Non-freshwater sources may also increase environmental risks associated with water storage and water transfer. The Environmental Protection Agency (EPA) is currently evaluating a variety of concerns with its study on oil and gas hydraulic fracturing practices, due to be released in 2016.

There may always be the risk of accidental spillage or human error in any waste-handling scenario. While prevention with proper design construction and ongoing inspection and maintenance is the first step, investigation and assessment skills, response capability, and funding are all critical parts of any environmental protection framework. Texas has focused on these issues with the

[98] Ceres, "Hydraulic Fracturing & Water Stress," p. 55.
[99] Ibid.
[100] Ibid, p. 56.
[101] Ibid.
[102] Based on National Academy of Science, "Induced Seismicity Potential in Energy Technologies (2012)," http://dels.nas.edu/Report/Induced-Seismicity-Potential-Energy-Technologies/13355?bname.

development of a Site Remediation program,[103] along with the Oil Field Cleanup Fund, now called the Oil and Gas Regulation and Cleanup Fund.

In 2010, the EPA issued an emergency order against Range Resources for allegedly contaminating a pair of water wells in Parker County, Texas. The RRC held a two-day hearing regarding the alleged contamination, resulting in the RRC concluding that Range Resources was not responsible for the natural gas found in the Parker County wells. Instead, the scientific evidence supported the claim that the gas actually came from a shallow strawn formation nearby. The EPA eventually withdrew the emergency order. While this particular case was eventually resolved, the impasse between industry, state, and federal officials remains. Perhaps as a result, the EPA has now expanded its oil field studies to include numerous other production processes besides hydrofracking. This same scrutiny may eventually apply to water recycling.

With very few exceptions, the EPA's Effluent Limitation Guidelines for onshore oil and gas operations do not allow discharge of produced water. Because of this, there is a lack of NPDES permits for oil and gas flowback and produced water discharges, even when treated. To most observers, unless the current regulatory framework is revised, discharge will not be a viable option for this treated water waste stream. Therefore, recycling within the framework of the RCRA exemption remains vitally important. Any provision to the RCRA exemption to exclude the oil and gas wastewater would negatively affect oil and gas water recycling and conservation efforts in Texas.

***Regulatory Developments***

Experienced regulators, like the RRC, recognize that rules must adapt to technological developments. An example of this is the recent revision to Texas wellbore integrity rules, which took effect on January 1, 2014. The new rule requires extensive reporting and documentation during hydro-fracture operations. The same perspective has been applied by the RRC to water recycling. The general rules for environmental protection were updated in March of 2013 to encourage oil and gas field water recycling and to streamline the regulatory permitting process. This has been accomplished within the scope of the existing RCRA framework. For noncommercial water recycling by an oil and gas operator, the authorization lies in "permit by rule," or PBR. PBR refers to the regulatory requirements for the oil field activity to be listed in the rule itself, thereby eliminating the requirement for an applicant to submit a permit application. The initial response by both the oil and gas industry and water recyclers indicates that this effort has been successful.

The enhancements to Statewide Rule 13 on wellbore integrity have also served to increase the protection of the brackish reservoirs. As more demands are placed on freshwater aquifers, the more-saline brackish aquifers that typically lie at deeper depths are becoming a focus for potential use. Operators with wells that are in compliance with the revised wellbore integrity rules will not only protect freshwater aquifers, but also more-saline brackish formations.

***Additional Challenges to Use of Non-Freshwater and Recycling***

Landowners are stakeholders who can often have different objectives from the community as a whole, as well as from the oil and gas companies. Landowners may apply restrictions on water use that limit the ability of the company to recycle or use non-freshwater sources. For example, landowners may not want recycled water brought on-lease because it would displace water that they might otherwise sell to the oil or gas company.

For example, the most significant landowner in Texas, University Lands, is a state agency under the Land Commission. University Lands currently restricts the storage of brackish or recycled water in dual-lined earthen ponds, contrary to revisions in Rule 3.8 by the RRC. Some operators have

[103] This program oversees not just orphaned pollution sites and wells, but also voluntary operator cleanups by oil and gas industry representatives, multiple district offices, and inspectors throughout the state.

mentioned this limitation as an impediment to produced water recycling.

***Advancements in Water Recycling Technology***

New advancements in water recycling technology are being made; however, this information may be limited in the public domain, as some of the material, particularly chemical composition, is considered proprietary. There has been an increase in mobile recycling and wastewater treatment units during oil and gas field development, and RRC rules have been amended to allow for the use of such units without the need for a permit application. These units increase efficiency in the recycling process, eliminate the need for trucking and associated costs, and reduce the amount of freshwater used on-site. Some natural gas producers are using closed-loop water recycling systems, which allows them to capture and reuse 100 percent of the water in the production process.[104] A separation process known as electrocoagulation claims to separate and remove additives from the hydraulic fracturing fluid for reuse, saving an estimated twelve thousand truckloads of water to date.[105]

Challenges remain including landowners' resistance to recycled water supplies and environmental concerns as water storage and transfer may lead to accidental spillage.

In May of 2014, RRC Commissioner Christi Craddick hosted a water recycling symposium in Austin, where a number of water recycling companies made presentations. The table below is an illustrative snapshot highlighting the diversity of the various water treatment technologies that were displayed by participants at this symposium.

**Table 2. Water Treatment Technologies Highlighted by Participants at the Austin Water Recycling Symposium**

| | |
|---|---|
| **Fasken** | Nano filtration technology to remove sulfate; membrane unit that removes both the sulfate and chloride; electrocoagulation (EC) unit |
| **Water Rescue Services** | Electrocoagulation; chlorine dioxide |
| **AES Water Solutions** | The chemical coagulant/dissolved air flotation (CC/DAF) water recycling system |
| **Pioneer** | Desalination processes; established evaporation technology and new carrier gas extraction; chemical and dissolved air flotation (DAF) |
| **Baker Hughes** | H2prO technologies: heavy metals and solids; H2S and disinfection; solids removal |
| **RockWater** | Filtration; chemical biocides; on-site oxidant generation; neohydro extro-oxiation clean brine system |
| **PureStream Services** | Accelerated vapor recompression; water clarification—oil and suspended solids removal |
| **Halliburton** | CleanWave™ SeaWave™--Offshore<br>High TDS FR's; FDE-1078; UniStim™ & MC Scale; inhibitors, biocides, etc.; CleanStream™ |
| **Thermo Energy** | Evaporation methods |
| **Fountain Quail Water Management** | Mobile clarification system for recycling to a saltwater standard—22,035,000 bbls recycled to date; Mobile thermal evaporation systems for recycling to a freshwater standard—21,480,000 bbls recycled to date |

*Source*: Information compiled from presentations made at the RRC Water Symposium in Austin in May 2014.

[104] Texas Natural Gas Now, "Water," http://www.texasnaturalgasnow.com/natural-gas-in-texas/water.

[105] Ibid.

***Advancements in Fracking Fluid and "Waterless" Fracking***

There have been recent advancements toward using less water in fracking fluid and "waterless fracs," which substitute either a gel-like substance (although some water is still used) or, in some cases, propane, for water. A linear gel is water containing a polymer or gelling agent, such as guar, hydroxypropyl guar (HPG), carboxymethyl HPG (CMHPG), hydroxyethyl cellulose (HEC), and xanthan.[106] Cross-linked gel is water containing any of the gelling agents used in linear gel and a cross-linker like boron, zirconium, titanium, or aluminum.[107] One company has reported using a guar mix that, over the span of eighteen months, has reduced water use by 45 percent.[108] Another option for fracking fluid that operators are examining is the use of propane. GasFrac began performing propane fracturing operations in Texas in 2010, and by early 2013, had performed over one hundred fracs.[109] However, some experts have noted challenges with using propane, such as trucking costs and pressure issues when applying to deeper formations.[110] Furthermore, these diverse types of fracturing techniques perform differently and are employed in a variety of ways across geologic formations.

## What Texas Has Done Well

Texas is recognized as a leader in developing policies and regulations that promote energy production. Not only is oil and gas intrinsically tied to Texas's historical and cultural development, but the state also proactively encourages and supports oil, gas, and related industries. Notable laws, regulations, policies, and programs that promote sustainable water management by the energy industry include Texas' Accommodation Doctrine, groundwater protection regulations, the Oil and Gas Regulation and Cleanup Fund, public outreach programs, and coordination with other state agencies.

Texas oil and gas companies are responding to the technical and economic challenges of operating in a dry region. Substantial innovation and evolution of operating practices is under way regarding water management and recycling.

***Accommodation Doctrine Provides an Established Legal Framework***

Texas has developed a mature legal framework for managing issues related to ownership rights. Under US laws, it is possible to have both surface and mineral ownership rights related to a particular parcel of land.[111] When these rights are severed—if, for example, a person selling a property opts to sell the surface right but not the mineral right—the mineral estate is considered dominant.[112] In Texas, it is not uncommon for the mineral and surface rights to be severed, with the mineral owner maintaining ownership of the minerals beneath the land and the right to access and produce these resources below the surface.[113] Surface rights[114] include the rights to all the property not defined as a mineral, including water and subsurface water.[115]

The Texas Supreme Court established its Accommodation Doctrine in 1971 in the case of *Getty Oil Company v. Jones*.[116] The Accommodation Doctrine protects surface owners' rights in that it requires mineral owners to accommodate the surface owner's existing use of the land, within

[106] Halliburton, "Stimulation: Fracturing Fluid Systems," http://www.halliburton.com/public/pe/contents/Data_Sheets/web/H/H05667.pdf.
[107] Momentive, *FracLine*, "Fracturing Fluids 101," spring 2012, http://momentivefracline.com/fracturing-fluids-101.
[108] Kate Galbraith, "Waterless Fracking Makes Headway in Texas, Slowly," *Texas Tribune*, March 27, 2013, http://stateimpact.npr.org/texas/2013/03/27/waterless-fracking-makes-headway-in-texas-slowly/.
[109] Ibid.
[110] Ibid.
[111] Robert Burnett, "The Accommodation Doctrine: Balancing the Interests of the Surface Owner and the Mineral Owner," Houston Harbaugh Attorneys at Law, http://www.hh-law.com/news/20110421OilandGasBulletin-accommodationdoctrine.aspx.
[112] Ibid.
[113] The Law Dictionary, http://thelawdictionary.org/mineral-right/.
[114] The Law Dictionary, http://thelawdictionary.org/surface-rights/.
[115] Burnett, "The Accommodation Doctrine."
[116] Ibid.

reason.[117] The Texas Supreme Court states that the dominant mineral estate has the right to use the surface to extract mineral resources, as well as "incidental" rights to use the surface, which the Supreme Court defines as "the right to use as much of the surface as is reasonably necessary to extract and produce the minerals."[118] However, this "incidental" right also extends to groundwater and subsurface water, which mineral owners have the right to use as "reasonably necessary"[119] to extract minerals, even though the surface owner technically owns the water.[120] To summarize, the mineral estate may use as much of the surface estate as is reasonably necessary to access and produce the minerals from the tract.

In most cases, the surface owner owns the surface and subsurface water rights, unless expressly agreed upon in the severance deed or the lease agreement.[121] Because surface owners generally have private ownership of groundwater, many ranchers and landowners sell their water to oil and gas companies, benefiting both the operators and the landowners.[122] If the mineral rights and surface rights are both owned by the landowner, the landowners can add provisions in the lease agreement requiring that the company operating on their land must purchase water from them.[123]

These legal concepts have allowed Texas residents to benefit financially from oil and gas production. More than 672,000 Texans share an average of $11 billion in oil and gas royalty payments annually.[124] This has also allowed landowners, particularly cattle ranchers who have lost a significant share of business during the drought, to profit by selling water to the oil and gas industry, anywhere from $0.35 to $0.50 per barrel.[125]

### *Groundwater Protection Regulations*

The Railroad Commission of Texas (RRC), which has been in existence for over 120 years, is the state regulatory agency with primary jurisdiction over the oil and natural gas industry, pipeline transporters, natural gas and hazardous liquid pipeline industry, natural gas utilities, liquefied petroleum gas (LPG) / liquefied natural gas (LNG)/compressed natural gas (CNG) industries, and coal and uranium surface-mining operations.[126] The commission is also responsible for research and education to promote the use of LP gas and natural gas as alternative fuels in Texas.[127]

In addition, the RRC is a participant by statutory requirement in the Texas Groundwater Protection Committee, and annually reports all documented groundwater contamination sites to the Committee, which publishes these and all other industrial sites reported by almost a dozen state agencies in an annual report. The report typically carries approximately several thousand identified sites, of which only a few hundred[128] can be attributed to oil and gas operations.[129]

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[117] While the mineral owner has "incidental" rights to use the surface, if the mineral owner has an alternative course of action that would allow them to extract the minerals and allow the surface owner to continue their existing use of the land, then the mineral owner must choose that alternative.

[118] Supreme Court of Texas, *Merriman v. XTO Energy,* argued February 5, 2013, http://www.supreme.courts.state.tx.us/historical/2013/jun/110494.pdf.

[119] "Reasonably necessary" defined as not excessive or wasteful.

[120] *Texas Journal of Oil, Gas and Energy Law*, "Recent Developments in Texas, United States, and International Energy Law," December 4, 2006, p. 215, http://tjogel.org/wp-content/uploads/2009/10/rd_12_06_final.pdf.

[121] Ibid.

[122] John McFarland, "Who Owns Recycled Water?," *Oil and Gas Lawyer Blog*, April 15, 2013, http://www.oilandgaslawyerblog.com/2013/04/who-owns-recycled-water.html

[123] Ibid.

[124] Texas Oil and Gas Association, "Fueling the Texas Economy," http://www.txoga.org/assets/doc/PRINTABLE_2013_FUELING_THE_TEXAS_ECONOMY_download.pdf.

[125] Kate Galbraith, "In Texas, Water Use for Fracking Stirs Concerns, *Texas Tribune*, March 8, 2013, http://www.texastribune.org/2013/03/08/texas-water-use-fracking-stirs-concerns/.

[126] Commission staff performed more than 125,000 inspections on more than 410,000 wells statewide in fiscal year 2013, in addition to conducting 141 utility field audits, 505 inspections on 20 permitted lignite mines, 59 inspections on 14 uranium exploration sites, and more than 13,000 liquefied petroleum gas (LPG), compressed natural gas (CNG), and liquefied natural gas (LNG) safety inspections.

[127] RRC, "Legislative Appropriations Request for the Fiscal Years 2014–2015," August 2012, p. 1.

[128] For the 2013 calendar year, there were a reported 3,563 cases documented or under enforcement, 532 of which were reported by the RRC Oil and Gas Division.

[129] Texas Commission on Environmental Quality, *Joint Groundwater Monitoring, and Contamination Report 2013*,

The RRC's mature regulatory framework has been used as a model for energy policy worldwide. In fiscal year 2013, the RRC hosted delegations representing sixteen countries that met with staff to learn about its oil and gas regulations.[130] The RRC has developed over one hundred technical and complex oil and gas field regulations, and has an active inspection program. The RRC continually examines and amends its rules to account for current practices in the field and for the development of new technology. To date, there has not been a confirmed case of groundwater contamination due to hydraulic fracturing in Texas.[131]

In 2012, Texas was one of the first states in the nation to require mandatory reporting of chemicals used in hydraulic fracturing fluid. The Hydraulic Fracturing Chemical Disclosure Rule (Statewide Rule 29) requires operators to report on a public website, FracFocus.org, the chemicals and amount of water used in the hydraulic fracturing process.[132]

In 2013, the RRC adopted amendments to Statewide Rule 13,[133] the rule that governs casing, cementing, drilling, well control, and completion requirements, making it one of the most stringent well-integrity rules in the nation. The amendments to the rule clarified requirements for all wells, consolidated the requirements for well control and blow-out preventers, and updated the requirements for drilling, casing, cementing, and fracture stimulation.[134] The rule also requires that the surface casing of each well be set below the depth of usable quality water in order to further protect water from migration and contamination. These levels vary throughout the state, and the RRC's Groundwater Advisory Unit sets precise standards of protection for every well drilled.[135]

Also in 2013, the RRC amended Statewide Rule 8 in an effort to encourage water recycling and conservation in the oil field. The rule amendments remove regulatory barriers to water recycling, and allow recycling on-lease under the authority of the oil and gas operator, without the need for a Commission permit.

The major amendments to the RRC water recycling rules were put in place in the spring of 2013 to further enhance conservation, reuse, and recycling of water by oil and gas operators, while continuing to ensure that Texas' natural resources are protected. These changes included eliminating the need for an RRC recycling permit if operators are recycling fluid on their own leases, or transferring their fluids to another operator's lease for recycling. The revisions authorize certain on-lease, noncommercial recycling of hydraulic fracturing flowback fluid. The new rule distinguishes between permitting requirements for commercial or centralized recycling of hydraulic fracturing flowback fluid versus noncommercial recycling. The authorized reuse (PBR) focuses on allowing the reuse of treated or recycled water in the wellbore of an oil or gas well. However, no discharge is allowed to Texas waters. It also authorizes by rule certain pits, including a noncommercial fluid recycling pit.

### *The Oil and Gas Regulation and Cleanup Fund*

The Oil and Gas Regulation and Cleanup Fund—based on fees assessed on the oil and gas industry, not taxpayer dollars—allows the RRC to plug abandoned wells and remediate abandoned oil and gas field sites. Abandoned wells pose environmental concerns for several reasons. If not properly plugged, the well may communicate with

http://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/056-13.pdf.

[130] RRC, "2013: Year of Railroad Commission Accomplishments," January 17, 2014, http://www.old.rrc.state.tx.us/pressreleases/2014/011714.php.

[131] RRC, "Hydraulic Fracturing," http://www.rrc.state.tx.us/about-us/resource-center/faqs/oil-gas-faqs/faq-hydraulic-fracturing/

[132] RRC, "Hydraulic Fracturing," http://www.rrc.state.tx.us/about-us/resource-center/faqs/oil-gas-faqs/faq-hydraulic-fracturing/.

[133] 16 TAC 3.13.

[134] RRC, "Railroad Commission Today Adopts Amendments to Oil & Gas Well Completion Rules," May 24, 2013, http://www.rrc.state.tx.us/news/052413/.

[135] RRC, "Hydraulic Fracturing" http://www.rrc.state.tx.us/about-us/resource-center/faqs/oil-gas-faqs/faq-hydraulic-fracturing/.

other producing wells in the area and serve as a conduit for fluid to migrate and potentially contaminate groundwater. In 2013, the RRC completed 280 cleanup activities, including eight major cleanups, and plugged 778 orphaned wells, including 30 orphaned bay wells.[136] With this fund, Texas can work with industry to construct a regulatory safety net to protect the environment and groundwater from potential contamination or pollution. The significant amount of funds dedicated to correcting this decades-old problem illustrates the importance of having the solid regulations that Texas now has in place, even in the earliest stages of exploration and production.

> New technologies for waterless fracturing, advancements in recycling technologies, seismic concerns, and evolving regulations will increase opportunities for water management strategies.

***Incentives, Technology, and Representation***

Texas's regulatory environment includes several incentives designed to encourage oil and gas production and innovation, which could help to focus attention on the potential application of incentives regarding water recycling. These incentives to increase oil and gas production will also increase the need for water, water treatment, and subsequent waste disposal. The state has a variety of incentives for oil and gas producers in the form of special tax credits, deductions, exemptions, allowances, and property tax incentives. In 2006, prior to the recent explosion in oil and gas production, oil and gas accounted for the largest portion of state subsidies—an estimated 99.6 percent—with the state government offering an estimated $1.4 billion in exemptions to the oil and gas industry and its consumers.[137] The largest subsidy is incentives on the state's severance taxes, which produced almost $94.5 million in subsidies in 2006.[138] For example, Texas offers an exemption from oil and gas severance tax[139] to producers for reopening wells that have not been productive for the past two years.[140] Other subsidies include property tax exemptions for energy producers, franchise tax exemptions, and the high-cost gas program.

In November 2013, Proposition 6, based on House Bills 4 and 1025, was approved by Texas voters. It allows for the transfer of $2 billion from Texas's Economic Stabilization Fund (aka, "Rainy Day" Fund), into the State Water Implementation Fund, to be used for loans on water projects throughout the state. The one-time infusion of funding will serve as a revolving fund, with loan and interest payments coming in and then reissued as another loan.[141]

Additionally, Texas is home to twelve research universities, where new innovations and advancements are achieved and studied. In 2012, The University of Texas received more than $70 million in funding to conduct energy research in more than two dozen academic units and research centers across the state.[142]

There are many associations in Texas which serve as representatives, advocates, or discussion centers for water and energy issues. This has recently expanded to a nonprofit association representing the water recycling industry. The Texas Water Recycling Association, formed in 2013, represents the water recycling industry in the state as a nonprofit voice. With approximately

[136] RRC, "2013: Year of Railroad Commission Accomplishments," http://www.old.rrc.state.tx.us/pressreleases/2014/011714.php.
[137] Ibid.
[138] Ibid.
[139] The severance tax is imposed at a rate of 4.6 percent on the market value of the crude oil and 7.5 percent on the market value of gas produced and kept within the state.
[140] Texas Comptroller of Public Accounts, *The Energy Report*, "Chapter 28: Government Financial Subsidies," http://www.window.state.tx.us/specialrpt/energy/subsidies/.
[141] The proposal with details for the State Water Implementation Fund for Texas (SWIFT) and the State Water Implementation Revenue Fund for Texas (SWIRFT) is now out for public comment at http://www.twdb.texas.gov/newsmedia/press_releases/2014/06/draft_swift.asp.
[142] The University of Texas, Energy Institute, Energy Funding Chart, http://energy.utexas.edu/funding-chart/.

thirty members, the association consolidates opinions and recommendations for the industry into a single, viable voice.

***Public Outreach and Stakeholder Involvement***

Transparency and communication between industry and the communities in which they operate is essential. RRC Commissioner David Porter formed the Eagle Ford Shale Task Force in 2011 to bring together all stakeholders and to promote open, constructive communication as the region was rapidly being developed. The Task Force, comprised of a diverse group of community leaders, water representatives, environmental groups, oil and gas industry representatives, landowners, and mineral and royalty owners,[143] held regular public meetings. The discussion topics included water quality and quantity, workforce development, Railroad Commission regulations, economic benefits, flaring and air emissions, and more.[144] This was the first of several groups aimed at community outreach to form in the Eagle Ford Shale, including South Texas Energy and Economic Roundtable (STEER) and the Eagle Ford Shale Consortium. There are similar groups in the Permian Basin and the Barnett Shale, including the West Texas Energy Consortium and the Barnett Shale Energy Education Council (BSEEC).

As previously discussed, the RRC has become more proactive in establishing meetings to address public concerns. RRC Commissioner David Porter held a town hall meeting on January 2, 2014, in Azle, Texas, to hear residents' concerns over recent seismic events in the area, which some speculate are tied to oil and gas production. In May 2014, RRC Commissioner Christi Craddick held a symposium on water recycling in Austin to help stakeholders interact with their elected officials on issues pertaining to water recycling.

***Information Technology Systems Modernization***

During the 83rd Legislative session, the Texas Legislature approved an appropriation of $24.7 million to be used toward improving the information technology systems (ITS) at the RRC.[145] The RRC—criticized in the past for its antiquated computer systems and difficult-to-navigate public website—recently launched a more user-friendly website, in addition to making the following improvements: new GIS mapping functionality; an integrated compliance, enforcement, and docket system; and online filing and payment options for operators. Modernization of these online applications will provide greater public access and transparency to the regulatory issues, including those that involve oil and gas waste, waste-stream management, and water recycling activities.

***Coordination among Energy-Producing States***

Texas maintains communication and information-sharing programs with other energy-producing states regarding mutual challenges and successes. Appointed government officials represent Texas in the Interstate Oil and Gas Compact Commission (IOGCC), a multistate organization that serves as a unified voice for its member states on oil- and gas-related issues.[146] The IOGCC, in partnership with the Groundwater Protection Council (GWPC), recently launched the "States First" initiative aimed at information sharing between states in order to promote collaboration and innovation.[147] As part of the initiative, the State Oil and Gas Regulatory Exchange (SOGRE) forum was created to bring together technical experts, regulators, and policy staff to exchange ideas and experiences on policy, technology, and operating procedures, and to assist states with keeping their rules up-to-date.[148] As part of this initiative, the IOGCC and the GWPC have

[143] Texas Railroad Commissioner David Porter, The Eagle Ford Shale Task Force Report, March 2013, p. 7.
[144] Ibid, p. 9.
[145] RRC, "2013: Year of Railroad Commission Accomplishments."
[146] Interstate Oil and Gas Compact Commission, "About Us," http://iogcc.publishpath.com/about-us.
[147] States First Initiative website, "About Us," http://www.statesfirstinitiative.org/#!about/cipy.
[148] States First Initiative website, "Priorities," http://www.statesfirstinitiative.org/#!priorities/c1fp6.

formed the Induced Seismicity by Injection Work Group, which will utilize the SOGRE forum to share information on studies, research, and experiences between the research community and the states.[149] Texas also participates with other nationwide programs to help companies understand cross-state regulations and compliance issues, such as the Groundwater Protection Council, the State Review of Oil and Gas Environmental Regulations (STRONGER), and the Independent Petroleum Association of America (IPAA).

> Among Texas' notable successes are its Accommodation Doctrine, groundwater protection regulations, the Oil and Gas Regulation and Cleanup Fund, new public outreach efforts, and coordination with other state agencies.

## What Texas Can Do Better

Texas has made strides in setting up the ground rules for the oil and gas industry to continue efforts to manage its water use in an affordable, sustainable fashion. Several issues require further attention.

***Ambiguity and Conflict Exists in Some Rules***[150]

As discussed previously, the Accommodation Doctrine affords landowners protection regarding existing land use. Nearly all landowners have been able to profit by selling their water to oil and gas companies, although under the Accommodation Doctrine—along with the dominance of the mineral estate—oil and gas companies can also legally use water on the property on which they are operating without being required to compensate the surface owner, unless there is an agreement to the contrary.

Additionally, under the Accommodation Doctrine and with the dominance of the mineral estate, mineral owners have the right to reasonable disposal of salt water by means of injection into a subsurface formation.[151] As previously discussed, injection wells have recently caused concern among residents due to an increase in seismic events that some speculate are linked to saltwater disposal and injection. Since injection wells are under increased scrutiny, this right under the Accommodation Doctrine may be in jeopardy. The impact of these concerns on the Accommodation Doctrine has yet to be decided in both the realm of public opinion as well as that of the civil arena.

As perception of groundwater assets evolves to include brackish water, deciphering ownership and which agency or regulations have jurisdiction over such water will become increasingly convoluted issues that must be better addressed.

The permitting process and procedural requirements by the various Groundwater Conservation Districts (GCDs) across the state regarding water wells and "rig supply wells" also cause some confusion among operators. The Texas Water Code, Chapter 36, Section 36.117 (b) (2) provides that a GCD may not require a permit for "rig supply wells," specifically:

> "drilling a water well used solely to supply water for a rig that is actively engaged in drilling or exploration operations for an oil or gas well permitted by the Railroad Commission of Texas provided that the person holding the permit is responsible for drilling and operating the water well and the well is located on the same lease or field associated with the drilling rig."[152]

While rig supply wells are exempt from requiring a GCD permit, nonetheless, these wells must comply

[149] The Interstate Oil and Gas Compact Commission, "States Team Up to Assess Risk of Induced Seismicity," http://iogcc.publishpath.com/news.

[150] Another important case to reference in this discussion is the *Edwards Aquifer Authority v. Day*, decided on February 24, 2012

[151] *Texas Journal of Oil, Gas and Energy Law*, "Recent Developments in Texas, United States, and International Energy Law," December 4, 2006, p. 215, http://tjogel.org/wp-content/uploads/2009/10/rd_12_06_final.pdf.

[152] Texas Water Code, Chapter 36, Section 36.117 (b) (2).

with other GCD rules, such as well spacing, registration, completion requirements, and water withdrawal reporting.[153] Additionally, a GCD could require a permit for a water well that is no longer being solely used as a rig supply well.[154] Texas has over ninety-nine GCDs[155] with varying requirements and procedures, which creates layers of complexity and uncertainty.

There are disagreements regarding the application of the exemption for rig supply wells. The RRC understands a "rig that is actively engaged in drilling or exploration operations for an oil or gas well permitted by the Railroad Commission of Texas" to be a drilling rig, including hydraulic fracturing operations.[156] However, other interpretations given voice in the 83rd Legislature, which were not passed, indicate that there are those who would like to dispute or change this exemption.[157] These various interpretations can cause this exemption to be problematic and disputed in some cases.

Areas for improvement include reducing the ambiguity and conflicts in some regulation, improving public outreach and stakeholder involvement, assuring the public over recycling environmental concerns, and dealing with liability barriers.

***Public Outreach***

Both the oil and gas industry and regulators can improve their public outreach. For example, the oil and gas industry does not proactively publicize achievements made in regulatory and social responsibility, and this lack of information impacts the public's perception of the energy industry's water usage.

There are concerns over whether the industry as a whole is transparent, in order to gain the public's trust and confidence, and also, whether it delivers a consistent, fact-based message that will combat misconceptions. While it is important to promote the achievements and benefits of the energy industry, the concern is whether the industry sufficiently acknowledges that challenges do still exist.

***Stakeholder Involvement***

Stakeholder engagement in the early stages of new development was lacking, as evidenced by the drilling in the Barnett Shale. As the Barnett Shale was rapidly being developed in the early 2000s, many residents were concerned by the industry presence, as "urban drilling" was uncommon at the time. The majority of high-activity areas were historically in more-rural locations. Industry opponents seized the opportunity and formed activist groups. Some fault the industry and the RRC for not being more proactive in educating residents and gaining community support. As noted previously, the RRC attempted to be more proactive in the development of the Eagle Ford Shale with regard to public outreach by creating the Eagle Ford Shale Task Force.

***Legacy Wells***

In the early years of oil production in Texas, the industry was less regulated, and an unknown number of wells were drilled and abandoned, having never been properly plugged or documented. This led to the existence of thousands of "orphan wells." Today, any entity performing business in Texas within the jurisdiction of the RRC must file a P-5 Organization Report and provide financial security, such as a bond, letter of credit, cash deposit, or well-specific plugging insurance policy.[158] Since 1984, the RRC has plugged more

[153] John McFarland, "Groundwater Districts' Regulation of Water Supply Wells: What Landowners Should Know," *Oil and Gas Lawyer Blog*, May 8, 2012, http://www.oilandgaslawyerblog.com/2012/05/groundwater-districts-regulati.html.
[154] Texas Water Code, Chapter 36, Section 36.117(d).
[155] TWDB, Groundwater Conservation District (GCD) FAQs, http://www.twdb.state.tx.us/groundwater/faq/index.asp#title-02.
[156] RRC, "Water Use in Association with Oil and Gas Activities," http://www.rrc.state.tx.us/about-us/resource-center/faqs/oil-gas-faqs/faq-water-use-in-association-with-oil-and-gas-activities/.
[157] Senate Bill 873, 83rd Legislature.
[158] RRC, *Eagle Ford Shale Task Force Report*, p. 31, http://www.rrc.state.tx.us/media/8051/eagle_ford_task_force_report-0313.pdf.

than 33,860 orphaned wells at a cost of $225.4 million, and cleaned up, assessed, or investigated 5,230 sites at a cost of $64,590,839.[159] Regulators should provide assurance to both industry and the public that the same diligent effort applied to orphaned wells and abandoned sites will also be applied to any mishaps or pollution violations regarding water recycling.

***Liability Protection for Produced Water Reuse***

The Texas Legislature in 2013 passed a key piece of legislation, HB 2767, authored by Representative Phil King, regarding liability on recycling produced water. He sought to address liability concerns by proposing statutory changes to the law relating to treating and recycling, for beneficial use of produced water arising from or incidental to drilling for or producing oil or gas, and the subsequent use of that treated water by the person to whom the treated water is transferred. The Natural Resources Code was amended to specify that a person will not be liable in tort for a consequence which: (1) takes possession of fluid oil and gas waste; (2) produces from that waste a treated product generally considered in the oil and gas industry to be suitable for use in connection with the drilling for or production of oil and gas; and (3) transfers the treated product to another person with the contractual understanding that the treated product will be used in connection with the drilling for or production of oil or gas.

## Recommendations

### 1. Voluntary Water Recycling Reporting

The volume of recycled produced and flowback water is not reported on a statewide or national basis, making the impacts of recycling difficult to analyze. A national or statewide voluntary reporting mechanism, which could also differentiate between direct reuse and recycling via treatment, would provide both more data and more relevant information. This would help to build a solid foundation for planning and policy initiatives. Further discussion is required regarding the necessary flexibility as to who reports the recycled water data, to whom it is reported, and in what format. With regard to the latter, it will be important to allow some regions to record more-detailed information than others. It is important to note that this recommendation pertains specifically to reporting volumes of recycled produced and flowback water, *not* reporting overall water withdrawals and consumption data by the oil and gas industry.

### 2. Consider Recycling Tax Incentives

Incorporating economic incentives through tax policy revisions would promote water recycling. Water recycling must make good business as well as environmental sense. Mandates for recycling, given the limited recycling capacity that currently exists to fulfill such mandates, might stall rather than encourage it. A reduction in the severance tax equal to the cost of recycling on a well-by-well basis may provide the requisite incentive.

### 3. Preserve RCRA Exemption

It is essential to preserve the current federal regulatory scheme for oil and gas field waste, including residuals of any oil/gas field recycling operation, ensuring that water recycling fits into the existing federal regulatory framework, most notably the Resource Conservation and Recovery Act Exploration and Production waste exemption. Virtually every aspect of upstream oil and gas production revolves around this central waste statute, and any disturbance would create uncertainty and potential chaos in industry business plans.

### 4. NPDES Review

A review of federal NPDES discharge permit requirements and their impact on each state, including Texas, is an area that needs further study. The ability to expedite the permit process for

[159] RRC, *Oil and Gas Regulation and Cleanup Program Annual Report Fiscal Year 2013*, www.rrc.state.tx.us/media/18795/ofcu2013.pdf.

treated produced water, while ensuring environmental protection, could help to maximize the beneficial use of this water.

**5. Evaluate Permit by Rule (PBR) Model for Other States**

Although in its early stages, the PBR model, implemented in Texas for noncommercial recycling authority, appears to have streamlined the regulatory process for water recyclers and the customers of water recycling. The application of this process in other states is worth further evaluation.

**6. Liability Review**

The advancement of civil liability laws to reflect changes in ownership of treated produced water needs additional consideration. While protection of public health and safety is paramount, ensuring that liability truly reflects the risk of recycling is also a worthwhile goal.

**7. Advocate for Recycling**

The energy industry and water recycling industry need to support advocacy organizations that can collect and disseminate fact-based information. It is essential to ensure accurate reporting of regulatory, technological, and business developments. It is equally important to advocate for recycling and to help the public learn about the rapidly evolving technology of the recycling industry.

**8. Balanced Approach to Regulation of Energy Industry's Water Use**

The two issues of water-use regulation and water rights are poised to dominate the legislative landscape of Texas, and will continue to evolve for years to come. The oil and gas industry's need for water must be balanced against the needs of others. This may be best left to the marketplace to determine; however, if the public is not satisfied, they will seek legislative and/or regulatory redress.

**9. Expand Oil and Gas Field Cleanup Funds to Recycling Activities**

In order to ensure no ground- or surface-water pollution from water recycling activities, it is suggested that the Texas Oil Field Regulatory and Cleanup Fund be extended to include accidents at recycling facilities or orphaned recycling facilities. The preservation, continuation, and full funding of the overall upstream oil field pollution cleanup capability is managed and operated by state government, similar to the Oil Field Cleanup Fund in Texas. The latter funds not only the plugging of orphaned wells, but also the cleanup of any poorly managed oil field waste stream, and should also encompass the products and waste of water recycling, providing a final layer of environmental security to a state regulatory framework, as it does in Texas.

## Conclusion

With the increased usage of water for oil and gas production in drier, more-arid climates, such as in south and west Texas, combined with drought, population growth, increasing costs, and public perception, the oil and gas industry has been pressed to search for ways to reduce freshwater usage. While the amount of water used in hydraulic fracturing has increased due to the growing number of fractured wells in recent years, the energy industry is making significant strides toward reducing the use of freshwater in hydraulic fracturing operations. The energy industry has accomplished this through its reuse of flowback and produced water, finding alternative sources of water through recycling in treatment plants, and using brackish water.

While it is important to continue to encourage sustainable water use by the energy industry, it is equally important to put the industry's water profile into perspective, and to encourage integrated water planning at the local, state, and aquifer levels by all sectors. The goal is to make sure water is invaluable and not invisible, not merely a tool to advance an agenda. The public needs accurate information about every sector's water footprint—including agriculture, municipal, recreation, power production, industrial, fuels extraction, and processing sectors—and how these needs stack up against available water supplies locally. This gets to the heart of the important debate now going on in the nation's capital regarding the need for real-time data, as well as who collects and disseminates the information.[160]

This white paper highlights that local conditions, as well as a complex matrix of variables, will dictate the feasibility and economics of using non-freshwater sources, as well as recycling and reusing the produced and flowback waters. Note that more brackish water is being used in the Permian Basin and the Eagle Ford Shale than in the Barnett Shale, and research suggests that the most significant potential for produced water recycling may be in the Permian Basin, due to high flowback levels of produced water.

These realities further reinforce the conclusion voiced in the 2014 *Produced Water* report that in developing water management policies and regulations, the primary considerations must be local conditions, and how to best encourage recycling and reuse without stifling the oil and gas industry. This white paper provides important input on water management best practices and policies. There is a need for a series on water management in other states with significant fuels extraction and processing industries in order to add to the body of information required by the public and policymakers alike. The 2013 report also suggests that while more information is made available and states perfect their regulatory regimes, there needs to be a détente in the federal government's efforts to establish an additional layer of rules and regulations for water management on federal lands than currently exists for water management on private lands adjoining federal ones.

The Texas oil, gas, and water treatment industries are poised to consolidate their gains if legal, regulatory, and economic policies properly align. And since public acceptance will be a key factor in sustaining the impressive growth of the Texas oil and gas industry, both regulatory agencies and the energy industry must increase their public outreach and education efforts, always striving to acknowledge and address water-related issues as they arise.

160 S. 1971, The Nexus of Energy and Water for Sustainability Act of 2014, introduced by Senator Lisa Murkowski, R-AL.