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# Fracking Up the Future: Recommendations for Hydraulic Fracturing in Gonzales County, TX

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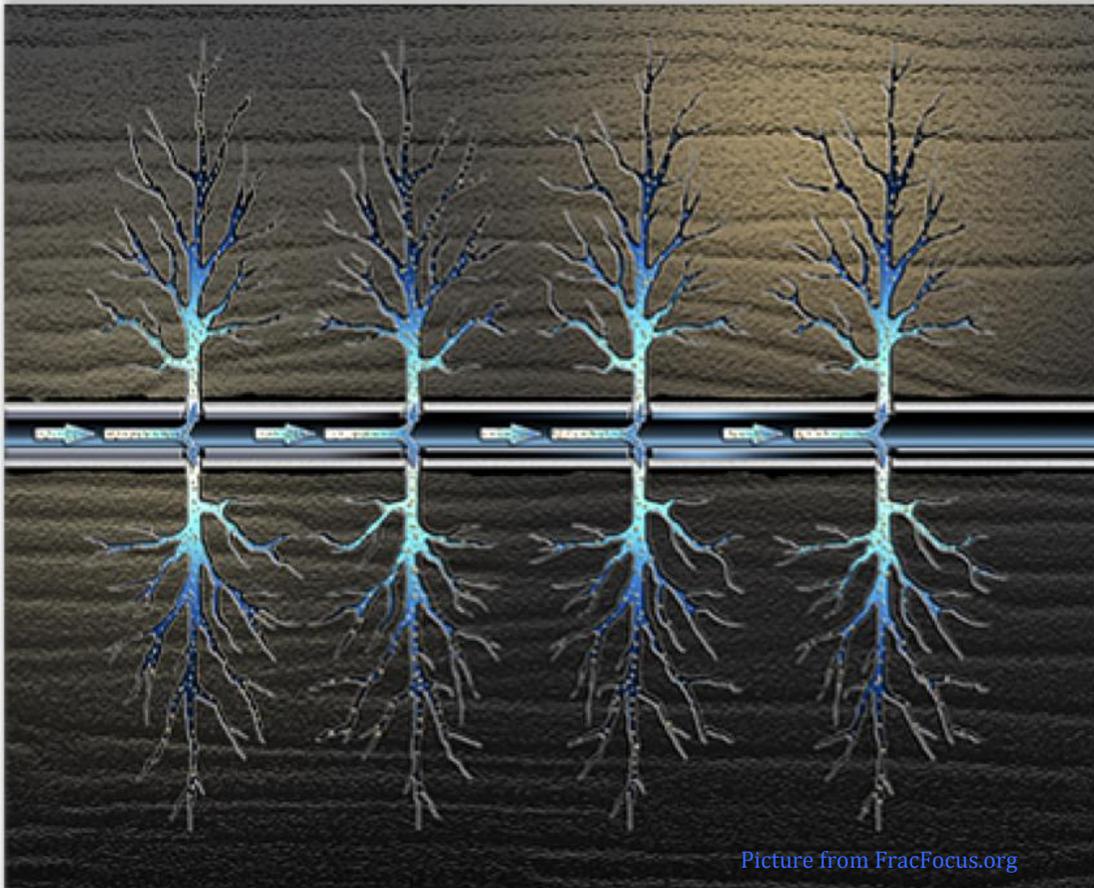
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# Fracking Up the Future:

Recommendations for Hydraulic Fracturing in Gonzales County, TX



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ENVI/GEOS 4301: Land Use, Geology, and the Environment

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**List of Acronyms and Abbreviations**

BOEM	Bureau of Ocean Energy Management
BP	British Petroleum
BSEE	Bureau of Safety and Environmental Enforcement
DEP	Department of Environmental Protection
EFWD	Eagle Ford Water Disposal
EIA	Energy Information Administration
EPA	Environmental Protection Agency
FRAC Act	Fracturing Responsibility and Awareness of Chemicals Act
Fracking	Hydraulic fracturing
GCUWCD	Gonzales County Underground Water Conservation District
GIS	Geographic Information Systems
GWCD	Groundwater Conservation Districts
GWPC	Groundwater Protection Council
IOGCC	Interstate Oil and Gas Compact Commission
MMS	Minerals Management Services
NETL	National Energy Technology Laboratory
NPDES	National Pollutant Discharge Elimination System
ONRR	Office of Natural Resources Revenue
TCEQ	Texas Commission on Environmental Quality
TRC	Texas Railroad Commission
TWDB	Texas Water Development Board
TXDOT	Texas Department of Transportation
UICP	Underground Injection Control Program
USGS	United States Geological Survey

### **Abstract**

Despite its economic appeal, hydraulic fracturing (fracking) has sparked bitter controversy. Allegations of toxic fracking fluids and fracking-induced droughts have made fracking a major public health and environmental concern in the United States. Fracking is dependent on local conditions to a large degree; therefore, we focus on Gonzales County, located within Texas' Eagle Ford shale region, in order to address county-specific concerns. However, our findings can be applied to help create sustainable practices for fracking in any context. Unfortunately, regulations are limited due to the 2005 Energy Policy Act that prevents federal agencies, including the EPA, from regulating fracking. In order to minimize the external costs of fracking, our research indicates that effective regulations need to be enacted to protect people and the environment from major fracking concerns including overdrawn water sources, wastewater contamination, and chemical releases. We propose that implementing effective regulation will make fracking safer and more profitable for all stakeholders in the long run. Using the catastrophic Deepwater Horizon oil spill in the Gulf of Mexico, we provide a comparison model that is analogous to the current Railroad Commission of Texas' regulations on fracking. Furthermore, we outline a case study on post-fracking water to demonstrate how a thorough analysis of current practices can create robust recommendations for safer and sustainable fracking practices in the Eagle Ford shale. Finally, our recommendations for fracking in Gonzales County provide possible solutions to many of the concerns associated with fracking.

## **Introduction**

Hydraulic fracturing, commonly known as fracking, is a process of fossil fuel extraction that has supplied a significant portion of the nation's oil and gas since the practice was combined with new horizontal drilling techniques. Fracking has been around for about 50 years and the technique has opened up unconventional fossil fuel reserves that were previously too expensive and difficult to extract. The recent increase in fracking wells has not only impacted water use, but it raises concerns about this industry's impact on ecological and human health.

Our study is tailored to oil and gas extraction from the Eagle Ford shale in Gonzales County. We explain the fracking process and discuss some of the benefits of this advance in extraction technology. Furthermore, we discuss the unique features of the Eagle Ford shale and Gonzales County in order to provide some context for our recommendations.

We also contrast the major benefits of fracking to the lack of regulations currently in place. We investigated the influx of money and related creation of jobs in areas where the fracking process is used. In order to better understand the viewpoints of the people that our eventual recommendations affect, we outline the important stakeholders of fracking. Furthermore, we break down the roles of current regulatory bodies in the Eagle Ford shale region. While examining the structure of the leading regulatory body in the region, the Texas Railroad Commission, we discovered that its system of permitting and regulating wells shared many haunting similarities with the agency responsible for monitoring the oilrig responsible for the Deepwater Horizon oil spill. We also explain this failure in regulation, known as regulatory capture.

In addition, we address the risks associated with heightened water use in a drought-prone state and how these concerns are addressed. We discuss the current uses of water in Gonzales County. Next, we discuss the various sources of water in the region and analyze how regulatory bodies try to control the amount of water used in the fracking process. By critically analyzing the current regulatory systems, we hope to pinpoint any sources of bias or conflicts of interest that may compromise the effective regulation of water use.

We also address the risks and regulations associated with potential water contamination in South Texas. We analyze the chemicals used in fracking because many drilling and fracturing fluid additives contain chemicals that are known to be poisonous to

the environment and hazardous to human health. While there are many concerns regarding fracking's impact on ecological systems, we focus on the contamination of natural waterways and habitat destruction. We address the causes of contamination, which include leakage from holding tanks, wastewater releases, and well casing blowouts. We will also examine the small amount of research on human health concerns linked to the chemicals used in fracking, such as benzene. We also address other societal concerns associated with water contamination, and we will critically analyze the current regulations in the context of water contamination.

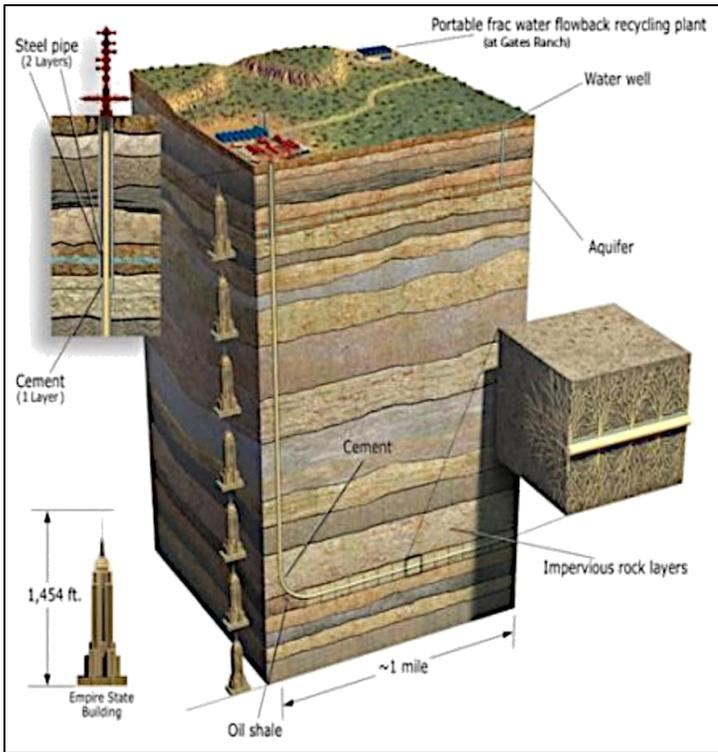
Finally, we analyze the feasibility of water recycling using a case study on post-fracking water. Water recycling demonstrates the complexity of the fracking process and the difficulty of creating strong recommendations that can be applied to every aspect of the fracking process. We compile a final set of recommendations for the various aspects of fracking based on our research. Our primary goal is to recommend effective regulatory practices for the fracking industry's water use and water contamination, specifically in Gonzalez County. To accomplish this, we have researched the federal, state, and local regulatory bodies responsible for controlling fracking in Texas. Furthermore, we have critically analyzed the current literature available on fracking, and we have also contacted fracking authorities from multiple sides of the issue.

We highlight the problems with current regulations on fracking and provide a series of recommendations regarding the improvement of these regulations as they apply to Gonzales County. We are not arguing for a ban on fracking; instead we are advocating for more research and stricter regulations on the process and the wastewater it generates. Current regulations on the chemicals and wastewater of fracking are lacking and pose a serious issue for the health and safety of local residents. If this process is conducted haphazardly, fracking-related issues have the potential to harm humans, animals, ecosystems, and may have even larger significant implications for society. However, if these risks can be minimized, then fracking can provide social and economic benefits for South Texas.

**Background**

**The Process of Hydraulic Fracturing**

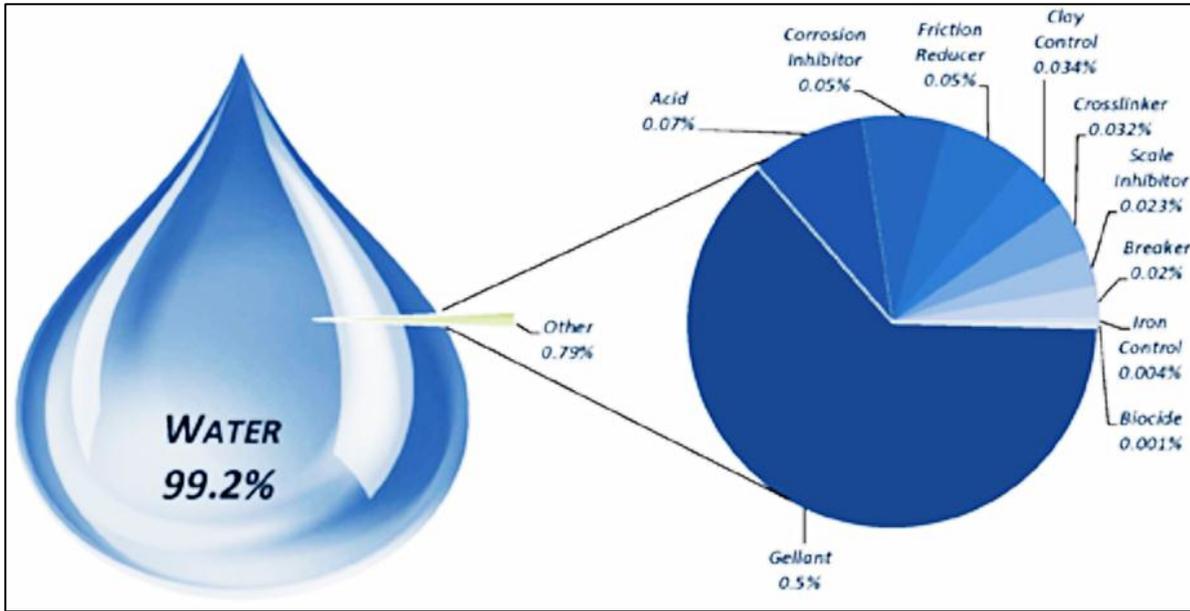
In order to understand the controversies regarding fracking in South-central Texas, the drilling process needs to be explained first. Contrary to popular belief, fracking is not an actual drilling process; it is used after the drilling is completed in order to increase the permeability of the target formation (Peters; Appendix 1). In the Eagle Ford shale, the source rock is approximately 8,000 feet underground (Chesapeake Energy Fact Sheet). After a suitable location has been chosen, pipe casings are inserted into the well, roughly 1,000-4,000 feet at a time, and filled with cement as shown in Figure 1 (FracFocus). Special precautions are taken to reinforce any segments of the well that pass through an aquifer as shown in Figure 2. As the drilling process approaches the shale play layer, a special drilling motor is used to angle the drill allowing for a traditional vertical well to become a horizontal well (American Petroleum Institute). After the horizontal segment of the well is properly reinforced, small explosives are set off during the “perf job” to create the preliminary fractures in the shale. Finally, the actual fracking process is initiated.



**Figure 1—Diagram of the process of hydraulic fracturing**  
 Source: FracFocus



**Figure 2—Design of the well casings used to protect aquifers**  
 Source: FracFocus



**Figure 3—The average composition of hydraulic fracturing fluids for US shale plays.**

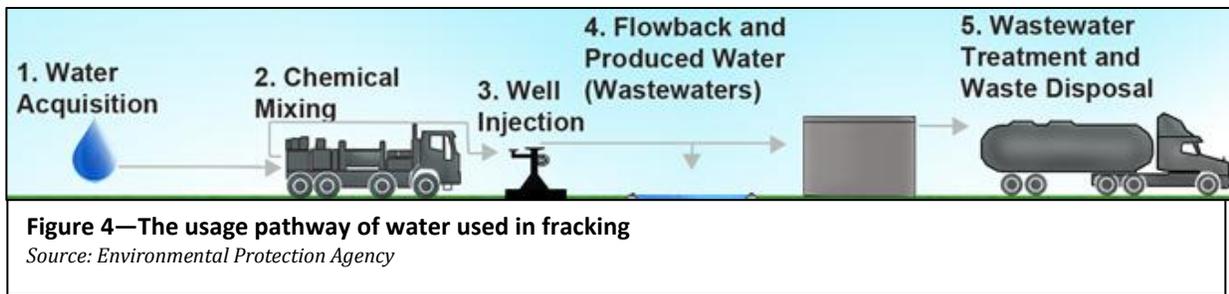
*Source: FracFocus*

Fracking is the process by which water, chemicals, and propping agents are pumped into a well to generate external stress. Between 98 and 99.5% of the total volume of fracturing fluids consists of water and sand; the remaining 2 to .5% of fracking fluids consist of chemical additives (Figure 3). The additives needed depend on the conditions of the specific well and their relative proportions will vary depending on the target formation’s depth, thickness, and other characteristics. The predominant additive used is called slickwater, which contains friction-reducing additives. Other additives include biocides that prevent microorganism growth, oxygen scavengers and stabilizers that inhibit the corrosion of metal pipes, and acids that help remove drilling mud damage (FracFocus).

Approximately 4.8 million gallons of highly pressurized fracking fluids are pumped into a well to generate enough pressure to propagate small fractures in the formation (FracFocus). The propping agent, most often sand, then holds these fractures open so that the targeted fossil fuels and the wastewater, called flowback, can be retrieved (FracFocus, Stewart and Surpress). This process, along with advancements in drilling technology, helps promote the flow of resources like oil and natural gas in unconventional fossil fuel reserves that were previously too expensive and difficult to extract. Furthermore, fracking is a way to extend the life of already existing wells, leading many experts to “believe that 60 to 80 percent of all wells

drilled in the United States in the next ten years will require hydraulic fracturing” in order to remain in operation (FracFocus).

The fracking fluids that are drawn back to the surface are known as flowback. Along with these fracking fluids, the flowback also contains water from the formation rock known as produced water. Together, the flowback and produced water is treated as contaminated wastewater. The wastewater is stored on-site in above ground holding tanks until it is collected for either reinjection into underground waste wells or transported to a water recycling plant (Environmental Protection Agency). The complete pathway of the water used in fracking is shown in Figure 4 below.



### Features of the Eagle Ford Shale

The Eagle Ford shale and other Mesozoic and younger units dip gently toward the Gulf of Mexico, to the southeast (Figure 5). Since the depth of the Eagle Ford’s geologic layer increases as you move to the southeast, different types of petroleum are produced at different locations (Stewart and Surplless). The producing interval of the Eagle Ford shale is found at depths between 4,000 and 14,000 feet. The Eagle Ford Shale Play produces three primary products: oil, wet gas, and dry gas (Figure 6). The oil window (green shading) is located between 4000-12000 feet in depth, and the gas window between 6000-14000 feet in depth (red and orange shading). Because the Eagle Ford is relatively impermeable, standard drilling methods cannot access the oil or gas within the formation. Instead, horizontal drilling that utilizes fracking technology is necessary for production (Eagle Ford Shale; Stewart and Surplless).

A map-based analysis of the Eagle Ford Shale Play by Stewart and Surplless found that given the significant vertical separation between the base of the Carrizo-Wilcox aquifer and the top of the Eagle Ford shale at most locations, it is unlikely that the aquifer would

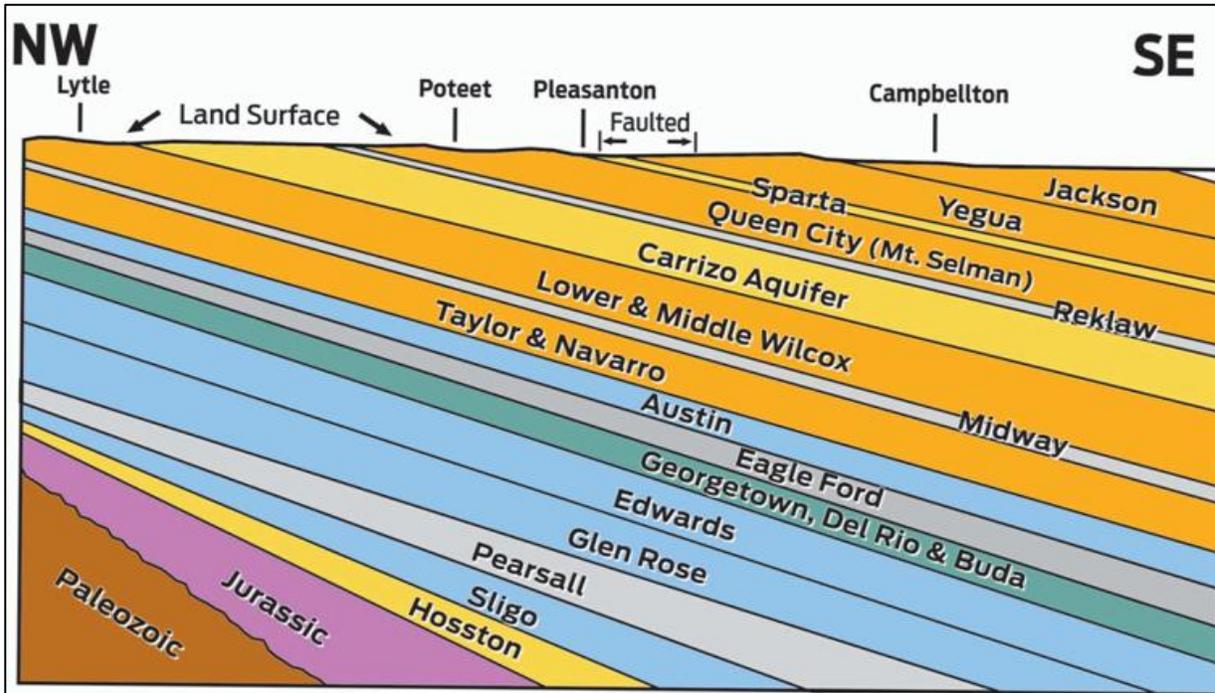


Figure 5—Geologic cross section of Atascosa County, TX

Source—Created by Troell; Retrieved from Zabava, 2011

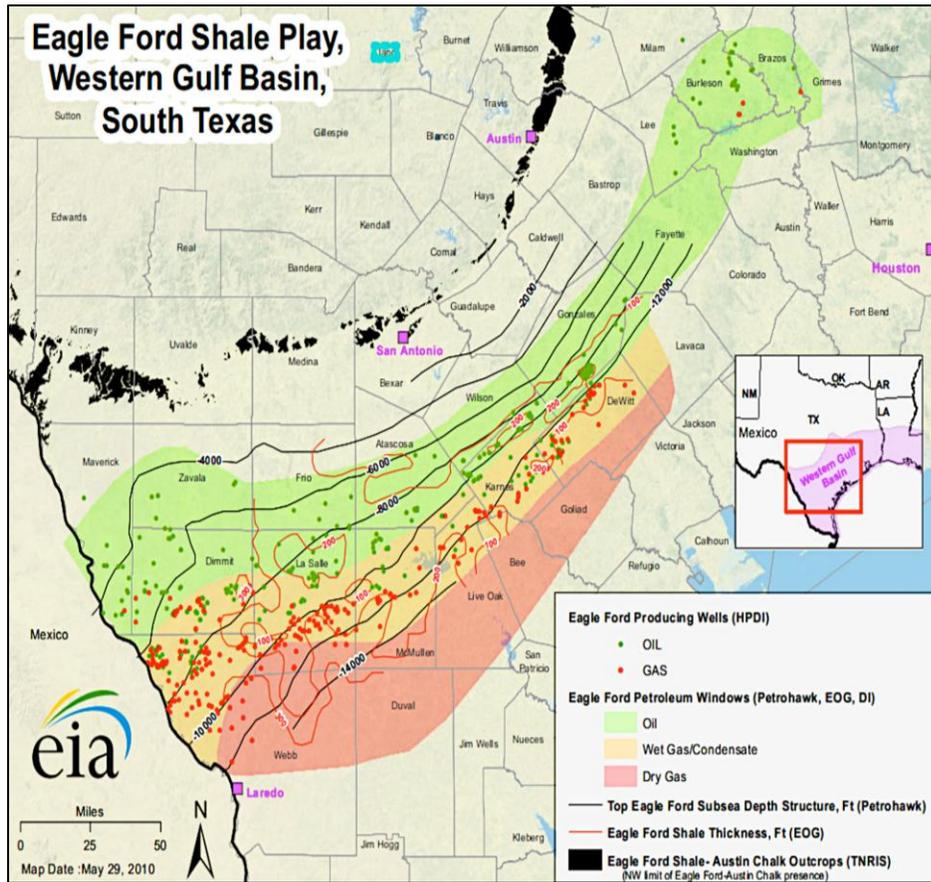
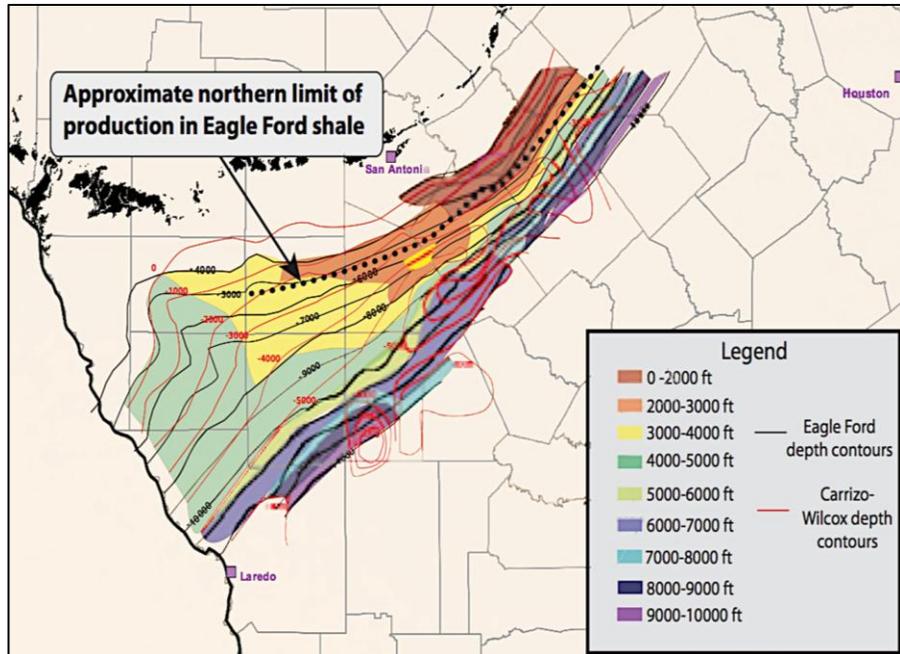


Figure 6—Map of the Eagle Ford Shale Play and its oil and gas windows

Source: Energy Information Administration

become contaminated directly from the fracturing of the source rock. Not only would the leak have to pass through multiple aquatards, but the process is taking place thousands of feet below the aquifer. If oil or gas were to escape from a leak in the casing within the horizontal section of the well, then their findings, depicted in Figure 7, show that it would have to travel a minimum of 2000 feet upward, and in most cases significantly further, to reach the base of the aquifer (Stewart and Surpless).

Stewart and Surpless suggest that the more critical and likely source of groundwater contamination is from the surface operations of fracking. Chip Groat, the Director of the Energy and Earth Resources Graduate Program and the Center for International Energy and Environmental Policy at the University of Texas at Austin agrees that



**Figure 7—Distance between the Carrizo-Wilcox aquifer and the Eagle Ford Shale.**

*Source: Stewart and Surpless, 2013*

“we’re seeing some classes of issues that are going to have to be dealt with no matter where it takes place, that are not so much hydraulic fracturing itself but well integrity and protection of water at the surface, as well as in the shallow subsurface” (Buchele). Simple spills or leaks in a recharge zone can lead to the direct infiltration of contaminants into an aquifer. Another point of contamination that needs investigating is a well casing failure. During the fracking process, the well casings are put under extra pressure, which can be particularly dangerous for parts of the well that pass through aquifers. Although well casings have several layers of cement and steel casing, cement is permeable and fractures as it ages. More scientifically rigorous studies are required to completely evaluate the risk of groundwater contamination in fracking operations (Stewart and Surpless).

### **New Technology leads to New Reserves**

Currently “Texas provides 27% of the domestic onshore oil production, and 36% of the domestic onshore gas production in the United States” (“Texas State Review”). A large portion of these resources is being extracted from tight shale formations across the state. Some of the key shale plays in the region include Dallas’ Barnett shale, North Texas’ Bend shale, West Texas’ Woodford shale, and South Texas’ Eagle Ford shale (FracFocus). These shale plays are critical sources of domestic oil and gas and the local towns are greatly benefiting from this advance in technology.

Many of the tight shale formations in Texas actually helped spur the original oil booms of the 1900s (Wray). The upward migration of oil from these source rock layers over millions of years helped fill the conventional reserves that were easily exploited by early drilling techniques (World Ocean Review). Geysers of crude oil, like Spindletop, created boomtowns across Texas as farmers converted their land to densely packed oilfields over these rich sources of oil (Wray). After the final patches of easily accessible oil were extracted during the last round of exploration in the 1980s, many of these once thriving boomtowns fell onto hard times (Price).

Most of these drilling booms targeted the conventional reservoirs of fossil fuels, not the actual source rocks that produced them. Therefore, these source layers have often been untouched by extraction practices until recently. This means that Texas will continue to be a leading producer of oil and gas for years to come. According to the United States Energy Information Administration, Texas still has “remaining proven oil reserves of 4.9 billion barrels and proven gas reserves of 40.8 trillion cubic feet” (“Texas State Review”).

The immense amount of natural gas still available in Texas means that it can be a major supplier of this cleaner energy source as developed countries try to switch from fossil fuels to more renewable sources of energy. The transition from coal-fired power plants to natural gas plants is currently underway at small electrical plants, such as the one that powers Vanderbilt University (Lewis). Not only would this switch lead to less air pollution, because the combustion of natural gas only produces carbon dioxide and water, but it is also a cheaper source of energy (Gjelten). Furthermore, these unconventional reserves are helping increase the production levels of domestic oil supplies. Right now, the United States is “on track to increase domestic production by 25 percent by the second half

of the decade” (Crooks and McNulty). This increase in the production of local reserves helps make the United States less dependent on foreign fossil fuels and increases the United States’ energy independence.

### **Features of Gonzales County**

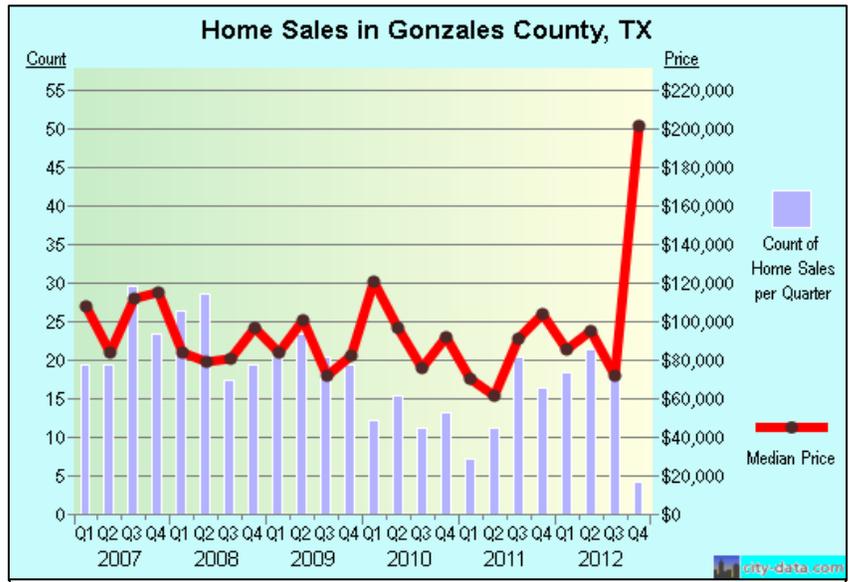
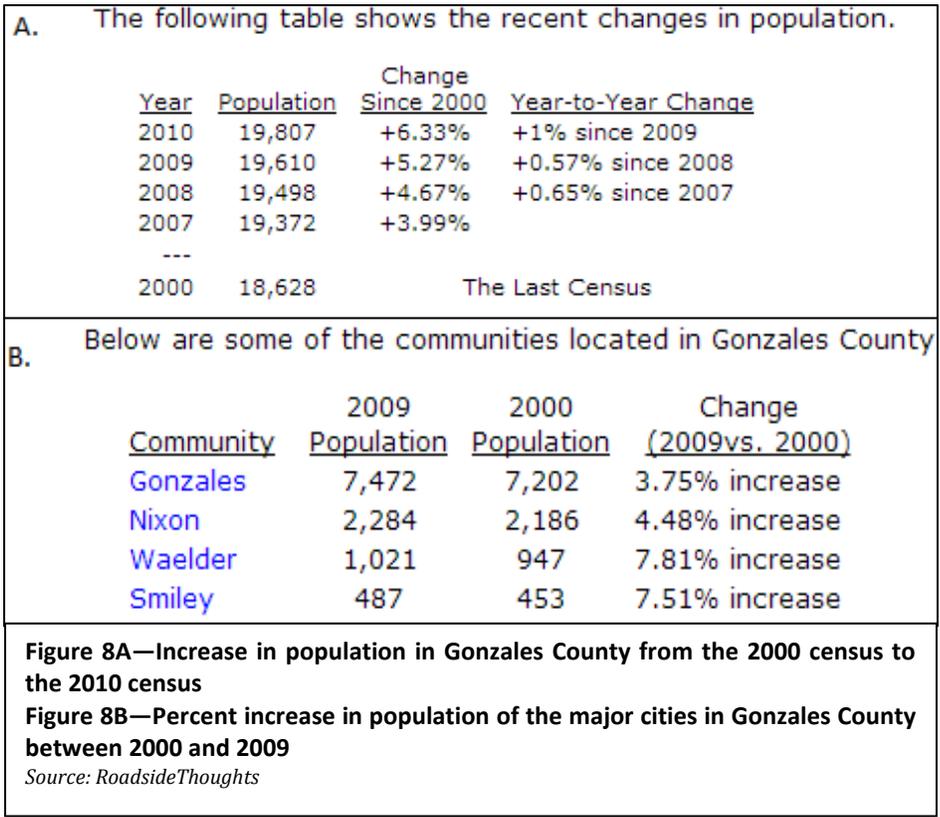
The fracking process has been particularly beneficial to some of the historically poorest counties in Texas. Since the last drilling boom ended in the 1980s, “the land in Gonzales [was] the setting for hard lives tending cattle and poultry” (Price). Living from drought to drought, Gonzales County “had a median income of \$28,368” in 2010 and many landowners were on the verge of bankruptcy under the harsh Texas sun (Price). Now, with the oil and gas industry’s pilgrimage back to the oil fields of Texas, the Eagle Ford shale is supporting over 116,000 jobs across the South Texas region (Hiller, “\$61 billion”). These new jobs have a noticeably higher starting salary than the median income for residents in the area in 2010. For example, oil and gas companies pay truck drivers close to \$50,000 a year in Gonzales County (Price).

The huge influx of money and people into this region becomes apparent after a closer examination of Gonzales County’s physical features and demographics (Price). Gonzalez County, established in 1836, is the 120<sup>th</sup> most populated county in Texas out of 254 (City-Data). There are four major cities in Gonzales County—Gonzales, Nixon, Smiley, and Waelder. These cities, as well as the smaller towns, withdraw 4.6 million gallons of freshwater per day, with 47 percent of it consisting of groundwater and 53 percent of the daily water use coming from surface water (City-Data). The Texas Water Development Board has identified two minor aquifers, the Sparta and Queen City, and two major aquifers, the Gulf Coast and Carrizo-Wilcox, beneath Gonzales County. The Carrizo-Wilcox Aquifer is the main water-bearing aquifer for Gonzales County (Sengelmann and Klempt). There are two major rivers that flow through Gonzales County, the Guadalupe River and the San Marcos River. Gonzales County is also home to three endangered species, the Whooping Crane, the Red Wolf, and the Interior Least Tern, as well as several threatened species (Texas Parks and Wildlife).

The 2010 census put the Gonzales County population at 19,807 and the estimates for the population in 2012 are 20,045. Since the 2000 census there has been nearly a 6.5%

increase in the population of Gonzales County and each of the four major cities have seen an increase in its population (Figure 8). While the population has boomed in Gonzales County, home sales have seen dramatic fluctuations since 2007 (Figure 9). However, the most dramatic fluctuation has occurred since the second half of 2012; the

price of homes has dramatically increased from about \$60,000 to almost \$200,000. The 2013 data on home sales is needed to identify whether this dramatic increase is a permanent shift or is simply an extremely high peak in prices. As house prices fluctuate monthly, many local residents are being forced to live in rented apartments or homes. Likewise, RV parks are proliferating like “wildflowers



on the edges of shale towns” and are now home to welders, pipe fitters, and truck drivers from as far away as the Dakotas (Price).

### **Why Frack At All?**

#### **Economic Benefits**

The increase in jobs is not exclusive to the fracking fields and roads of South Texas. Across the state of Texas, fracking has increased economic output by \$25 billion and has created 47,097 new full time jobs (Fish). Oil and gas companies are pumping billions of dollars into their Gulf Coast refineries to keep up with the increased output of oil stimulated by fracking (Hiller, “From the shale plays”). Cities surrounding the Eagle Ford shale, such as San Antonio, Floresville, and Hondo are also cashing in on the surplus of jobs and revenue. The San Antonio Economic Department Foundation reported the creation of more than 4,000 new jobs in the city thanks to the Eagle Ford shale (Hiller, “Oil boom produces”). Floresville residents are capitalizing on the Eagle Ford shale’s boom in production by building homes for oil company managers and executives close to their wells, but away from the truck traffic (Hiller, “Floresville”).

Some industries, such as the railroad, are shifting their hubs even closer to the Eagle Ford shale. On the verge of bankruptcy, the Hondo Railway shifted its main terminal from the South Texas Liquid Terminal in San Antonio to a new terminal in Hondo in 2006 (Hiller, “South Texas rail”). Predominantly used to ship high fructose corn sweetener to Texas, these railcars now run the opposite direction, delivering crude oil to the rest of the country. The Hondo Railway currently owns 80,000 feet of track, processes 15,000 rail cars a year, and moves 40 to 50 railcars of sand a day all thanks to fracking (Hiller, “South Texas rail”).

Gonzales County is in a prime location to reap many of these benefits induced by fracking. Directly, landholders in the region are receiving \$3,000 to \$5,000 an acre to lease their land (Hiller, “Drilling raises complex issues”). Refineries within Gonzales County, such as the Nixon Refinery, now process close to 15,000 barrels a day (Hiller, “Eagle Ford to see”). It is estimated that the oil and gas industry will invest close to “\$28 billion in the South Texas region” in 2013 with a large chunk of that money going to Gonzales County, located in the shale play’s “sweet spot” (Hiller, “Eagle Ford to see”). If counties are

proactive about investing this flood of money into their cities and create responsible regulations, than the positive impacts can be large and long lasting.

### **Main Stakeholders**

There are several stakeholders that would be affected by changes to the regulation of fracking in the Eagle Ford shale. The key stakeholders driving the exploitation of the Eagle Ford shale are oil and gas companies. Drilling companies such as EOG Resources and Marathon Oil, as well as fracking companies like Platinum Energy Solutions, are heavily invested in the Eagle Ford Shale Play and will likely see their profits decrease slightly if regulations increase. On the other hand, the main regulatory body of the drilling sites is the Railroad Commission of Texas, also referred to as the Texas Railroad Commission (TRC). The TRC is considered an important stakeholder because they control where wells are drilled and oversee the regulation process. Other federal, state, and local regulatory bodies that monitor the oil and gas industry's drilling are also key stakeholders in the future of fracking.

Although the TRC and drilling companies control many aspects of the fracking process, there are still a multitude of stakeholders invested in the water used in fracking. Water recycling plants in northern states are often heavily invested in the fracking process because they treat and release large quantities of the wastewater. However, in Texas these water recycling plants are not widely established and instead, mobile water recycling units and waste well injection companies fill this niche. Therefore, it is important to include the wastewater disposal groups in the conversations regarding changes in regulations to help incorporate their side of the process. There has also been a boom in the transportation of water, chemicals, and sand in South Texas leading to the creation of new hauling companies coordinating the movement of trucks and railcars across the region. These groups help collect and transport the large quantities of fracking fluid elements, so their investment in fracking is often a large one and should not be ignored.

Environmental activist groups who are dedicated to conservation and environmental protection are also considered critical stakeholders. These groups often wish to see fracking completely banned or reformed to promote the most sustainable practices possible. Many of the environmental groups concerned about water use advocate

for more control and involvement of potential regulatory bodies such as the Environmental Protection Agency (EPA), the Texas Commission on Environmental Quality (TCEQ), and the Gonzales County Underground Water Conservation District (GCUWCD). In the future, empowering and involving these federal, state, and local regulatory bodies can help create an effective set of regulatory stakeholders for all aspects of the fracking process.

Finally, the most important stakeholder concerned with fracking in Gonzales County is the general public in the county. This group of stakeholders is a diverse array of local people and institutions including schools, businesses, landowners, and townspeople; these groups are directly impacted by the risks associated with fracking, but they only receive some of the benefits. Furthermore, each faction within this broad group has their own specific viewpoint regarding fracking, often leading to a complex and conflicting set of recommendations from these stakeholders. Regulation reform should prioritize minimizing the risks incurred by the general public in the form of water contamination and consumption, while trying to involve as many of the stakeholders as possible in the reform process.

**A Lack of Regulations and Potential for Disaster**

<b>Table 1—The current regulatory bodies involved in fracking</b>			
<b>Regulatory Body</b>	<b>Area of Regulation</b>	<b>Regulatory Role</b>	<b>Section</b>
<b>TRC</b>	Wells and Extraction	They are in charge of both granting permits as well as collecting royalties	<i>Current Regulations by the TRC</i>
<b>EPA</b>	None	Oversight of fracking was taken away by the Energy Policy Act of 2005	<i>Other Regulatory Bodies</i>
<b>GWCDs</b>	Groundwater	Due to a loophole in Texas Water Code, counties control whether or not fracking companies need permits to use groundwater based on the county’s definition of fracking (drilling and exploration does not require a permit, production does require a permit)	<i>Other Regulatory Bodies</i>
<b>UICP</b>	Injection Wells	Regulates the pumping of wastewater into underground disposal wells	<i>Other Regulatory Bodies</i>

## Fracking Up the Future

<b>NPDES</b>	Wastewater	Sets the acceptable levels of chemicals that can be discharged into natural waterways	<i>Other Regulatory Bodies</i>
<b>GWPC and the IOGCC</b>	Chemicals	Requires the disclose all of the chemicals used for fracking in Texas on the FracFocus website	<i>Other Regulatory Bodies</i>
<b>TCEQ</b>	Surface Water	Requires that a permit be attained in order to divert surface water for any reason	<i>Current Water Demands and Regulations</i>
<b>TWDB</b>	Water Allocation	Resolves water allocation issues and tries to insure that all consumers receive the amount of water they need	<i>The Future of Water Use in the Eagle Ford Shale Region</i>

### **Current Regulations by the TRC**

A full list of the various regulatory groups and their current roles in controlling the fracking process is included in Table 1. The first and foremost regulator of fracking in Texas is the TRC, which is responsible for issuing well permits (FracFocus). It is a very large and complex regulatory body responsible for regulating the oil and gas industry as well as a wide variety of its extensions including pipelines, utilities, and some mining operations (Railroad Commission of Texas). However, many of the TRC’s rules and regulations are considered outdated. In order to improve the safety regulations on gas and oil wells, the TRC needs to update its regulations on well integrity “that Texas regulators have essentially left alone for more than 30 years” (Galbraith, “Commission that Oversees Drilling”). Simply put, the TRC’s regulations are from another era and need major overhauls in current policy ranging from recycling wastewater to safer disposal wells. However, the most prevalent concern regarding the regulatory control of the TRC is the commission’s lack of inspectors. Currently, the TRC hires about 81 full time employees responsible for investigating and inspecting “more than 350,000 sites, averaging about 5,000 sites per inspector” (“Texas State Review”).

The TRC is also obligated to protect the general public from water shortages and contamination due to oil and gas industries practices (Railroad Commission of Texas). The TRC has established the Eagle Ford Task Force that diligently examines the current water supplies in Texas and how the oil and gas industry plans to use those supplies in the future (Eagle Ford Shale Water). Not only does this task force have an inherent conflict of interest,

considering that it is mainly funded by the oil and gas industry, but it does very little to monitor the sources of contamination. In fact, the measures that the TRC does take to insure water quality are not widely publicized. The main way that the TRC prevents contamination is by regulating the parameters of well casings and enforcing their proper installation (Railroad Commission of Texas). Unfortunately, surface spills are a relatively common and overlooked occurrence at drilling sites, and at least one well casing blowout has been documented in the United States (Helman). A well casing blowout is the largest risk associated with fracking. When a well casing ruptures, thousands of gallons of wastewater, oil, and gas are leaked into groundwater supplies. Therefore, it is imperative that rigorous regulation be put in place to reduce the likelihood of these risks.

Based on the current regulatory system, concerns are mounting that the TRC's existing regulations and their proposed revisions are neither strict enough nor thorough enough to address these issues (Galbraith "Commission that Oversees Drilling"). Another issue that needs to be addressed is the inherent conflict of interests built into the TRC's regulatory and campaign procedures. One proposed change "would bar the commissioners from knowingly accepting contributions from groups contesting cases before the commission" (Galbraith "Commission that Oversees Drilling"). Furthermore, the TRC receives royalties from the oil and gas companies and this extra revenue helps support its various projects (Railroad Commission of Texas). These conflicts of interest suggest that the TRC may not regulate the wells as effectively as a completely independent entity because they will lose profits from stringent regulations that shut down or delay fracking operations.

### **Model for Comparison**

In order to better understand the risks that accompany mixing regulation with revenue during the extraction of oil and gas, it is useful to consider the regulatory structure that oversaw a catastrophic failure—the Deepwater Horizon oil spill in the Gulf of Mexico. On April 20, 2010, the well casing to this offshore well's pipe burst open causing the oilrig to explode (Klein). Not only were several workers killed in the explosion, but 4.9 million gallons of crude oil were spilled into the Gulf (Walsh). The blowout was caused by negligence of safety regulations mandated by the Minerals Management Service (MMS), the federal regulator of oil

production. Later reports showed that the MMS performed 16 fewer inspections on the Deepwater Horizon rig than it should have since January 2005 (Rose).

The BP oil spill is an applicable comparison model for two reasons. First, the cause of the Deepwater Horizon spill was a break in the well casing. If the rig operators had been following all of the precautionary measures recommended by the MMS, then such a failure would have been considered a highly unlikely risk (Rose). Interestingly, the oil and gas industries on land appear to have the same confidence in their well casing designs. However, the process has the same inherent risk of massive amounts of contamination from a well blowout when fracking wells go through aquifers; the only difference is that the same kind of failure in a land-based fracking process can directly contaminate the drinking water of local residents with crude oil and harmful formation water. If the well casing were to rupture, a large section of an aquifer could become contaminated. Additionally, the MMS was collecting billions in royalties from the same companies that it was supposed to regulate (Rose). This creates a serious conflict of interests that inevitably allows drillers to cut corners. Furthermore, regulators had been accepting bribes from the industry (“Minerals Management Service”). The flawed regulatory system was created in such a way that these injustices multiplied and went unchecked for years; however, these problems are not isolated incidents. Similar conflicts of interest can accumulate in any regulatory body that does not have strong policies that separate regulation from the generation of revenue.

An effective regulatory body should be completely independent from the operation it regulates. Since the MMS stood to gain profits from oil extraction, the MMS could not be an effective regulator; in fact, being an effective regulatory body would have reduced the MMS's revenue from royalties because they would have been shutting down rigs that did not meet safety standards. Extraordinarily similar conflicts of interest can be seen in the current regulatory structure of the TRC. The TRC is in charge of issuing extraction permits as well as regulating oil and gas extraction in Texas. Interestingly, the TRC receives royalties from the same industry it is supposed to regulate (Railroad Commission of Texas). A blowout due to fracking has not yet happened in Texas, but Chesapeake Energy, one of the largest natural gas recovery operations in the country, was responsible for a well blowout in Bradford County, Pennsylvania. The accident released thousands of gallons of fracking fluid that flowed freely onto nearby farming land and creeks (Helman). Therefore, despite the industry's claim that

well casings will not crack under pressure, there have been incidents on land and sea that prove otherwise. It is critical that the TRC require frequent tests on the integrity of well casings to prevent a serious blowout from occurring in Texas.

It was only after the Deepwater Horizon spill that steps were taken to reduce the conflicts of interest and improve the regulatory system of BP offshore oilrigs. The Secretary of the Department of the Interior redistributed the responsibilities previously performed by the MMS into three separate organizations: the Bureau of Ocean Energy Management (BOEM), the Bureau of Safety and Environmental Enforcement (BSEE), and the Office of Natural Resources Revenue (ONRR) (Jaffe and Olinger). Only after the catastrophic spill did the government realize that it needed to separate the regulatory body from the portion of the organization responsible for managing revenue. It is important that the same division is made in Texas *before* we have a catastrophe like the Deepwater Horizon spill.

### **Regulatory Capture**

The biggest issue with fracking is the lack of regulation. The federal government cannot regulate this industry because of the Halliburton Loophole in the Energy Policy Act of 2005; this clause excludes “underground injections of fluids or propping agents, other than diesel fuels, [used] in hydraulic fracturing activities” from federal regulation (Environmental Protection Agency). Likewise, current state regulations are not very strong. The biggest concern that arises from this restriction on regulations is that the main regulatory body that can currently oversee aspects of fracking, the TRC, is in charge of enforcing regulations and collecting royalties. When an agency is collecting royalties, it has little motivation or incentive to regulate the industry; with fewer wells in operation, there will be fewer sources of revenue. This lack of regulation due to a conflict of interest is a form of “regulatory capture.” There are many definitions of this concept, but one narrow definition is “the process through which regulated monopolies end up manipulating the state agencies that are supposed to control them,” (Bó 203). It is also stated that regulations are needed in order to prevent the regulatory agencies from exercising too much power (Bó 204).

Regulatory capture helps explain what happened with the Deepwater Horizon oil spill. The MMS was in control of giving out regulatory permits for off-shoring drilling and

also received royalties from this industry; they had little incentive to regulate the practice properly. After the disaster, the failure of the MMS to properly regulate offshore drilling led to the agency's subdivision. By splitting the MMS into three new agencies, there was a smaller chance that regulatory standards would be compromised. Thus, the issue of regulatory capture was resolved.

### **Other Regulatory Bodies**

As fracking operations increase in number in the United States, the existing and potential impact of the process on water and air contamination continues to grow. Regulatory bodies are urgently needed to control the fracking fluids used. Furthermore, regulatory procedures should be put in place to ensure that safety checks are conducted regularly, contamination is actively avoided, and that the involved parties will be held responsible if a contamination event does occur. Currently, there are no such regulatory bodies with the power to do this.

Through the Safe Drinking Water Act, Clean Water Act, and Clean Air Act, the EPA was given authority to ensure that companies, as well as governments, complied with established environmental standards. However, these acts give the EPA very little actual authority over environmental issues. Many problems regarding regulation and enforcement arise due to the EPA's lack of personnel and money. Additional problems have arisen due to the historical exemptions that the oil and gas industry received (Hamilton). In the Energy Policy Act of 2005, the "Halliburton loophole" exempts fracking from the Safe Drinking Water Act because it was believed that fracking posed no risk to drinking water (Manuel). The Clean Water Act and Clean Air Act encounter similar blockades to their enforcement when they try to regulate fracking (Fracking: Laws and Loopholes). Since there are loopholes in all three of the acts that the EPA can enforce, fracking can produce detrimental impacts on the environment before any agency will step in to curtail the problem. Therefore, the EPA has little to no actual authority over this booming industry.

Other regulatory systems that have a role in the fracking process include the Underground Injection Control Program (UICP), which regulates the pumping of fluids into wells, and the National Pollutant Discharge Elimination System (NPDES), which regulates runoff from waste pits and surface spills (Environmental Protection Agency). Both of these

groups set standards for acceptable practices regarding aspects of the fracking process. In the case of the UICP, one would assume that they would monitor the fracking fluids injected into the wells. However, it turns out that this group has very little control over the well site injection process. Under the 2005 Energy Policy Act, all injection fluids and propping agents other than diesel fuels were excluded from the regulation standards of the UICP (Environmental Protection Agency). Instead, this group mainly regulates the back half of the fracking process during the disposal of the fracking fluids in underground waste wells.

The NPDES sets the acceptable levels of chemicals that can be discharged into natural waterways (Environmental Protection Agency). In the northern states, such as Pennsylvania, the NPDES's standards are highly controversial because wastewater treatment plants dump a majority of the wastewater from fracking back into local waterways. These facilities were originally intended to clean municipal wastewater and are inadequately prepared to filter out the chemicals and radioactive substances found in produced water, which often mixes with the flowback. Therefore, these facilities often do very little to actually remove contaminants from the wastewater before releasing it into the surface waters, exposing the general public to a potentially dangerous cocktail of chemicals. Due to South Texas's arid climate and lack of municipal wastewater plants, the NPDES's standards are not as controversial. However, the regulations set forth by the NPDES are often used to regulate the flowback holding ponds located at pad sites. Due to Texas' unique climate based on long, hot droughts periodically interrupted with flashflood events, evaporation and storm water become major points of concern; evaporation can increase the concentration of the chemicals in the holding tanks while flash flooding can cause the holding ponds to overflow into local waterways. Therefore, the NPDES's standards are critical regulations on the fracking operations' holding tanks and ponds that attempt to reduce the risks of these chemicals harming humans and animals during Texas' extreme weather conditions.

The federal government and some state governments have acknowledged the lack of regulations on fracking. In 2009, and again in 2011, a bill known as Fracturing Responsibility and Awareness of Chemicals Act (FRAC Act) was introduced to Congress to repeal the exemption of fracking from the Safe Drinking Water Act. However, the bill failed to pass both times (FRAC Act fact sheet). Nonetheless, there are some unique regulations in

the state of Texas that protect groundwater. In 2011, a bill was passed by the Texas Senate that requires oil and gas operators to disclose all of the chemicals they use for fracking on the FracFocus website which is maintained by the Groundwater Protection Council (GWPC) and the Interstate Oil and Gas Compact Commission (IOGCC) (FracFocus). This law is unique to Texas, and while it does not actively address the Safe Drinking Water Act exemption, it does provide some regulation of fracking in the state.

Additionally, Texas has groundwater conservation districts (GWCDs) that regulate groundwater use, and there are some counties that require groundwater permits. In both cases, fracking companies are limited in the amount of ground water they can use. Nonetheless, there are some counties that strictly adhere to the Texas water rights practice of the 'rule of capture' and have no restrictions on groundwater usage (Texas A&M University). The discrepancy between counties is due to the flexible interpretation of a provision in the Texas water code. The code states that a permit cannot be required for water used for the drilling and exploration of oil and gas wells; whereas, water used for the production of oil or gas, does require a permit. Counties can bend this rule to allow different regulations on water permitting which leads to an inefficiency in regulation (Galbraith "Fracking"). Several bills have been filed in order to solidify the permitting of water used in fracking, but as of March 2013, none of these bills have been passed.

Comparatively, it has been determined that the Deepwater Horizon oil spill was caused in large part due to the lack of regulation, mismanaged agencies, and conflicts of interest. This blowout had huge impacts on both ecological and human health. The Deepwater Horizon incident has demonstrated what can happen when potentially dangerous actions, such as deep water drilling or fracking, proceed without effective regulations. Since the federal government stripped the EPA of its regulatory powers of fracking in 2005, it is now the states' responsibility to regulate fracking practices. However, without consistent inter-state and intra-state regulation, there is still a high risk that there will be contamination events and depleted water sources. If the fracking industry is allowed to continue to expand unregulated, then there will be an increased likelihood of a large-scale incident occurring and causing irreversible damage to humans and the environment.

## **Water Use**

### **Current Water Demands and Regulations**

Shortages often trigger the most action to protect a precious resource. The 1979 energy crisis created a panic about current and future oil resources that pushed America's oil and gas industry to invest more in extraction technology (Verleger). Similarly, due to recent droughts, water has become the hottest news topic in Texas. Every day during the dry summer months, San Antonio's newspapers are full of information regarding the lack of water, from the facts about the current aquifer level to articles about drought restrictions ("Stage 1 water restrictions in effect"). With such an arid climate, it is important that individuals in South Texas examine current and historical uses of water and the impacts these uses have on the general public's access to water.

Gonzales County is located above the Carrizo-Wilcox Aquifer, a rechargeable aquifer, which serves as the main source of water for the county ("GCUWCD"). The water extracted from this aquifer in Gonzales County is used in the following ways: 66% irrigation, 17% municipal, 5% steam electric, 4% livestock, 3-6% drilling, 3% mining, and 1% manufacturing (Jester). The rivers and springs of Gonzales County help naturally recharge and discharge the water in the Carrizo-Wilcox Aquifer as it migrates to the southeast ("GCUWCD"). Some of the major surface water features critically linked to the Carrizo-Wilcox Aquifer in Gonzales County include the San Marcos River, Guadalupe River, Lake Wood, Lake Gonzales, and the Gonzales Warm Springs (Texas State Historical Association). This water is not only used for human consumption, but is critical for maintaining natural ecosystems along the riparian corridors. While it is hard to identify the exact points of water extraction in Gonzales County by fracking operations, it can be assumed that these operations use both groundwater and surface water sources close to their pad sites.

Water use in Texas is regulated by several organizations. Surface water is owned by the State of Texas and is regulated by the TCEQ. Anyone who wants to divert surface water for any reason must first acquire a permit from the TCEQ (Dotson 4). Groundwater supplies are regulated differently. The State of Texas does not own the groundwater; instead, groundwater is owned and controlled by landowners and is regulated by the 'rule of capture' (Brock). This doctrine states that any individual may use any amount of groundwater as long as it is put to 'beneficial use,' regardless of the downstream effects on

total supply. Therefore, there is very little regulation on groundwater pumping (Lusk). Additionally, Chapter 36 of the Texas Water Code created GWCDs that “conserve preserve, protect, recharge, and prevent waste of groundwater resources” (Dotson 4). GWCDs can be created through four different processes: special legislation, designation by the TCEQ as a priority groundwater management area, submission of a signed petition to the TCEQ by local landowners, or submission of a petition requesting to be annexed into an adjacent groundwater district (Lehman 1).

### **The Future of Water Use in the Eagle Ford Shale Region**

There is a fiery debate between the highly publicized economic benefits of fracking and the water concerns in the region above the Eagle Ford shale. The initial drilling of a well only requires approximately 125 thousand gallons of water, yet the actual fracking process requires approximately 4.8 *million* gallons of water (Chesapeake Energy Fact Sheet). It is estimated that 25,000 wells will be drilled in the Eagle Ford shale over the next 20 years requiring more than 15,000 acre-feet of water per year (Vaughan). This is two-times the storage capacity of the largest lake in Gonzales County, Lake Gonzales (Guadalupe-Blanco River Authority). Stated another way, if 83 wells were drilled, the number of wells projected to be drilled per year per county, they would require the same amount of water needed to grow 6320 acres of corn (Vaughan). Despite the tremendous amount of water used in fracking, it is still significantly less than the amount used for agriculture. According to the Texas Water Development Board (TWDB), the total water used for agriculture was approximately 64.8 billion gallons in 2008. However, this total is “dwarfed by region wide water usage” considering that irrigation only accounts for 70% of the water use in the region (Chesapeake Energy Fact Sheet).

The relatively small amount of water withdrawn for the oil and gas industry compared to agriculture is an argument that fracking advocates and lobbyists often use to justify their support of the process; current estimates say that for every 1 acre-foot of water used in fracking, 280 acre-feet will be used for other purposes (Chesapeake Energy Fact Sheet). Also, from an economics point of view, the opportunity cost of using water for agriculture instead of hydraulic fracking is high. The Texas Ground Water Association estimates that one acre-foot of water invested in well development in the Eagle Ford shale

has a “gross revenue potential of approximately \$2,080,000/acre-foot as compared to one acre-foot of water used to irrigate corn, peanuts or coastal hay, which has an estimated gross revenue potential of about \$250/acre-foot of water” (Chesapeake Energy Fact Sheet). Based on these economic facts, water should be devoted to oil and gas drilling because it has a higher return on the investment per acre-foot of water. While the opportunity costs of not using water for fracking may be high, there are externalities that need to be considered. After the freshwater used for fracking in South Texas is converted to wastewater, it is usually injected deep underground and is essentially removed from the water cycle. Considering that water is a precious resource in this arid region, this unsustainable form of water usage should be examined more carefully.

In this drought prone region, “even small withdrawals can have a significant impact on the flow regime” causing severe impacts on local environments (Cooley and Donnelly 16). Furthermore, the oil and gas industry’s thirst is directly pitting them against municipal and agricultural land users. Local studies have found a 1/3 reduction in the amount of water recharging the Carrizo-Wilcox Aquifer due to the increase in fracking activity (Galbraith, “As Fracking Increases”). Thus, the increased demand for water by the oil and gas companies in the Eagle Ford Shale is causing local ranchers to fear that a devastating drought is on the horizon for the region. A recent study by The University of Texas at Austin has demonstrated that the water used for fracking has increased sharply over the past couple years (Galbraith “Report”). More specifically, there was a 125% increase in the total water used for fracking between 2008 and 2011 (Galbraith “Report”). Furthermore, in counties where drilling is taking place at a high rate, the process is accounting for about 50% of all the water consumed (Galbraith “Report”). This dramatic increase in water use is becoming an increasingly publicized concern due to the intense droughts in South Texas.

Many locals fear that fracking will place an additional strain on local water supplies that will drive the entire region into more severe dry periods (Dukes). The increase in long term droughts and hotter temperatures in Texas needs to be taken into consideration as local water boards decide on the future allocation of water. According to the TWDB, when Texas is in a serious drought, local water sources cannot provide enough water to meet the residential, agricultural, and business needs of the population (Long). This is an alarming

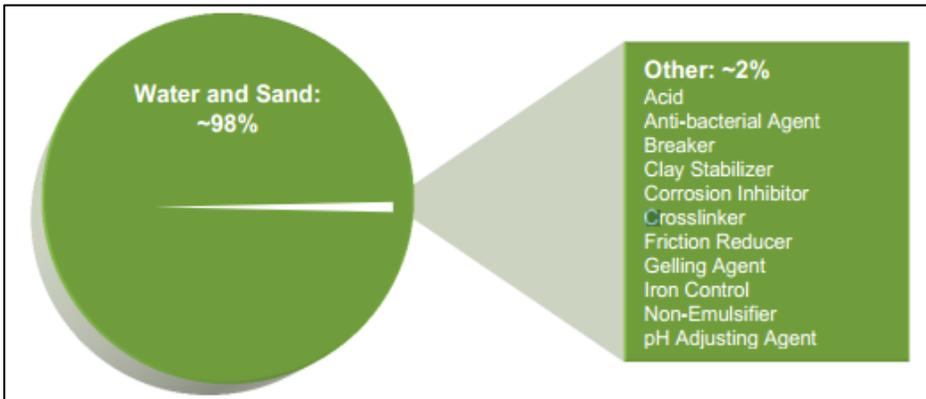
statement because if the current drought conditions continue, the TWDB will have to decide on critical water allocation issues and try to insure that all parties receive the water they need. These decisions will have far-reaching implications if the fracking industry is not allowed to use water from the immediate area. This kind of restriction on local water sources may push the oil and gas industry to obtain water from distant sources. Consequently, this will increase the cost of production, lead to longer routes for water truck, and add more demands on water sources surrounding the Eagle Ford shale region (Dukes).

**Water Contamination**

**The Chemicals Used in Fracking**

In addition to the large volumes of water and sand, there are a variety of chemical additives that are used in fracking. Fracking companies and advocates of this process are quick to point out that water and sand make up approximately 98% of the fracking fluids, while chemical additives are only 0.5 to 2% of the total volume of fracking fluids as shown in Figure 10 (Chesapeake Energy Fact Sheet). However, it is important to remember that

this information is presented as a proportion; therefore, when millions of gallons of water are needed to frack a single well, the total amount of each chemical used per well is immense. For



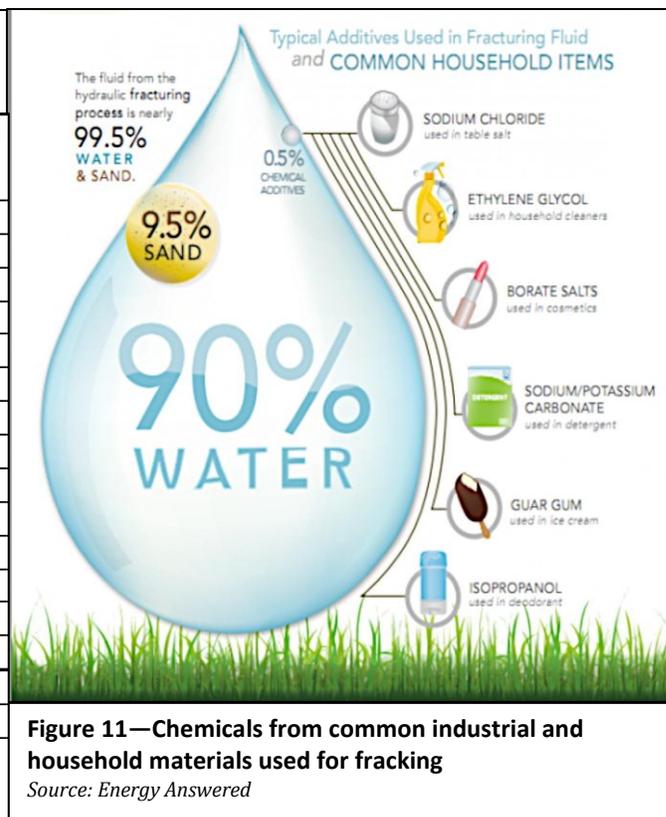
**Figure 10—Composition of the typical fracking fluid used in the Eagle Ford Shale**  
 Source: Chesapeake Energy Fact Sheet

example, a well that requires four million gallons of fracking fluid would use anywhere from 80 tons to close to 300 tons of chemicals (Table 2). Therefore, it can be misleading when companies advertise the small percentage of chemicals they use rather than the actual mass or parts per million of the chemicals they use.

**Table 2—The mass by percentage and ton of the components of fracking fluids**  
*Source: New York City Department of Environmental Protection*

	Percent by mass <sup>1</sup>	Mass required for one 4 MG fracturing operation (tons)
Water	90.6%	16,690
Proppant	8.96%	1,651
Acid	0.11%	20.3
Surfactant	0.08%	14.7
Friction Reducer	0.08%	14.7
Gelling Agent	0.05%	9.2
Clay Stabilizer/Controller	0.05%	9.2
Scale Inhibitor	0.04%	7.4
pH Adjusting Agent	0.01%	1.8
Breaker	0.01%	1.8
Crosslinker	0.01%	1.8
Iron Control	0.004%	0.7
Bactericide/Biocide	0.001%	0.2
Corrosion Inhibitor	0.001%	0.2
Total (all constituents)	100.0%	18,423 tons
<b>Total (chemicals only)</b>	<b>0.446%</b>	<b>82.2 tons</b>

Notes:  
 1. dSGEIS, URS Technical Report *Water-Related Issues Associated With Gas Production in the Marcellus Shale*, Figure 2-1.



Not only is the sheer volume of chemicals required to hydraulically fracture a well immense, but the types of chemicals used are also a point of concern (Figure 11). The chemicals used for fracking can be as harmless as citric acid, used to add flavor to food and beverages, or as dangerous as ethylene glycol, a key component to automotive antifreeze (Ground Water Protection Council). Many of the chemicals associated with the fracking process are known to be toxic to humans and wildlife and yet fracking operations use on average 150 to 230 tons of chemicals per day per well (New York City Department of Environmental Protection).

Benzene, a known carcinogen, is toxic in water at levels greater than 5 parts per billion (Earth Works). The dangers with chemicals like benzene depend greatly on their concentrations; therefore, even small quantities can be lethal if they are not properly diluted. Unfortunately, benzene is found in several of the chemical additives used to make fracking fluids. Not only could this cocktail of different chemicals have a synergistic effect, but the use of the same chemical in multiple additives may cause the concentration of a compound to be higher than it is actually stated. Furthermore, when these harmful compounds are brought back to the surface in the form of flowback, they are stored in open

impoundments where the volatile organic chemicals can be released into the air. Even if the chemicals do not become air-borne, their concentrations will increase as water evaporates from these impoundments. This can create holding tanks with high concentrations of chemicals that are dangerous to animals and the environment (Waldner et al.).

### **Ecological Concerns**

Despite the lack of published research on the environmental effects of fracking, there is still evidence that suggests that there can be detrimental ecological impacts if fracking is not properly regulated. Because fracking has not been widely publicized until recently, its long-term effects on flora and fauna have not been intensely studied; the majority of research focuses on the effects of contaminated drinking water on human health, not ecological health. Nonetheless, there are enough studies on the impacts of wastewater on animals, like livestock, to begin to draw conclusions with regards to the potential impacts of fracking on ecological health.

Water contamination from fracking can have an immediate and large effect on local fauna. One of the most cited studies regarding the effects of water contamination on animals comes from Bamburger and Oswald. This study focused on one property that contained 96 cattle; 60 cattle drank from a creek that became contaminated by wastewater dumping from a fracking operation, while 36 other cattle were restricted access to that creek. Of the 60 that were exposed, 21 died and 16 failed to reproduce calves the following spring. Of the 36 not exposed to the wastewater, there were no health problems and all but one reproduced the next spring.

On a second property, a different type of water contamination event occurred with similar impacts on livestock (Bamburger and Oswald). A pond that was used as a source of drinking water for a herd of cattle was contaminated when the liner of a wastewater impoundment was slit and the fluid drained into the cattle's pasture and pond. There were 140 cattle exposed to the water from the wastewater impoundment and 60 that had been held on a separate pasture. All 60 of the separated cows showed no health or growth problems. On the other hand, 70 of the 140 exposed cattle had a noticeably higher incidence of stillborn and stunted calves. Unfortunately, fracking sites are usually located close to rivers and large bodies of water, increasing the likelihood of these contamination

events. Additionally wells occur at high densities that could cause cumulative effects (Entrekin et al.). Therefore, it is critical that further research on the impacts of fracking be conducted to help clarify the potential impacts of wastewater on all aspects of the environment including plants, invertebrates, fish, herpatofauna, birds, and mammals.

The fracking process and its subsequent contamination from a major blowout would have far-reaching ecological impacts. However, there are very few scientifically rigorous studies that have been released regarding the actual ecological impact of such an event. For example, after a well blowout in Canton, Pennsylvania, a spokesperson for the Department of Environmental Protection (DEP) stated that “the only evidence of impact to aquatic life was... that an unknown number of amphibians died” in the pond adjacent to the drilling site (Hrin). Despite the critical role of indicator species, such as frogs, at verifying the health of an ecosystem, this well blowout has received very little national attention. In fact, there still has not been a report released detailing the environmental, or even herpetological, impacts of wastewater at this site. The company responsible for the blowout, Chesapeake Energy, reported in 2011 that “additional testing will be done in conjunction with DEP to fully assess and remediate any environmental impacts” (Hrin). However, no such report has been released to the public.

Other effects of fracking practices on animals include cases of aspiration pneumonia in sheep following exposure to gas condensate (Adler et al.), the movement of wildlife away from areas of gas extraction (Sawyer et al.), and as much as a 45% decline in deer populations in a single year coupled with a lower survival rate in areas with a higher level of gas released (Sawyer and Nielson). Another contamination issue is sour-gas flaring. This practice of disposing of gas containing contaminants, such as dihydrogen sulfide and carbon dioxide, can led to an increased risk of stillbirth and calf mortality (Waldner et al.).

Habitat destruction, specifically fragmentation and soil salinization, is another major ecological concern that can result from fracking operations. One of the main drivers of habitat fragmentation in South Texas is clear cutting, a controversial clearing practice by which a majority or all of the vegetation in an area is uniformly cut down to construct fracking sites and new roads. Another method promoting fragmentation and destruction occurs due to the alteration of stream flows, which is caused by withdrawing massive amounts of water for fracking (Entrekin et al.). Fragmentation driven by fracking is

extremely harmful to vulnerable species that already have restricted geographic ranges. Many species of mammals and amphibians, such as salamanders, are experiencing this added stress as well as some kinds of butterflies and plants (Gillen and Kiviat).

In addition to habitat fragmentation, clear cutting is detrimental because it increases sediment run-off and erosion (Entrekin et al.). Much of the flowback that is discarded during fracking is brackish saltwater, which can leak into the environment and increase the concentration of salt in the soil and water (Gillen and Kiviat). Most notably, this increase in salt levels has led to an increase in salt-tolerant invasive species. This influx of invasive species disrupts natural ecosystems and decreases biodiversity (Stearns et al.).

### **Human Health Concerns**

Fracking and its impact on human health is a fiercely debated topic. Proponents of fracking have ensured the public that fracking does not have any proven negative effects on human health. Yet, both environmentalists and scientists are worried that the wastewater and noxious fumes produced at a fracking site could be dangerous to human health due to their chemical composition (Bachran et al.). Scientists have expressed concern about how quickly fracking has been approved without the necessary scientific studies to examine its environmental and human health risks. At the Society of Toxicology's annual conference in San Antonio in March 2013, scientists explained that more time was needed to assess the toxicology of the chemicals used in fracking, as well as their long-term effects.

This call for more research on the fracking process is alarming because, while more time is needed to assess its effects, fracking is pressing on unabated. This means that everyday fracking fluids are being used in large quantities without understanding all of their potential effects. If there are major health risks related to fracking, then expansion of this industry will only compound these problems. Bernard Goldstein, emeritus professor of environmental and occupational health at the University of Pittsburgh's Graduate School of Public Health stated that fracking is expanding too quickly and warns that the "story is being managed in such a way to downplay the potential for risk" (Hiller, "Scientists consider"). For example, studies have found that there are elevated levels of methane in groundwater sources located close to drilling sites. However, no one is completely sure of the risks that elevated levels of methane in drinking water pose to humans (Schmidt). This

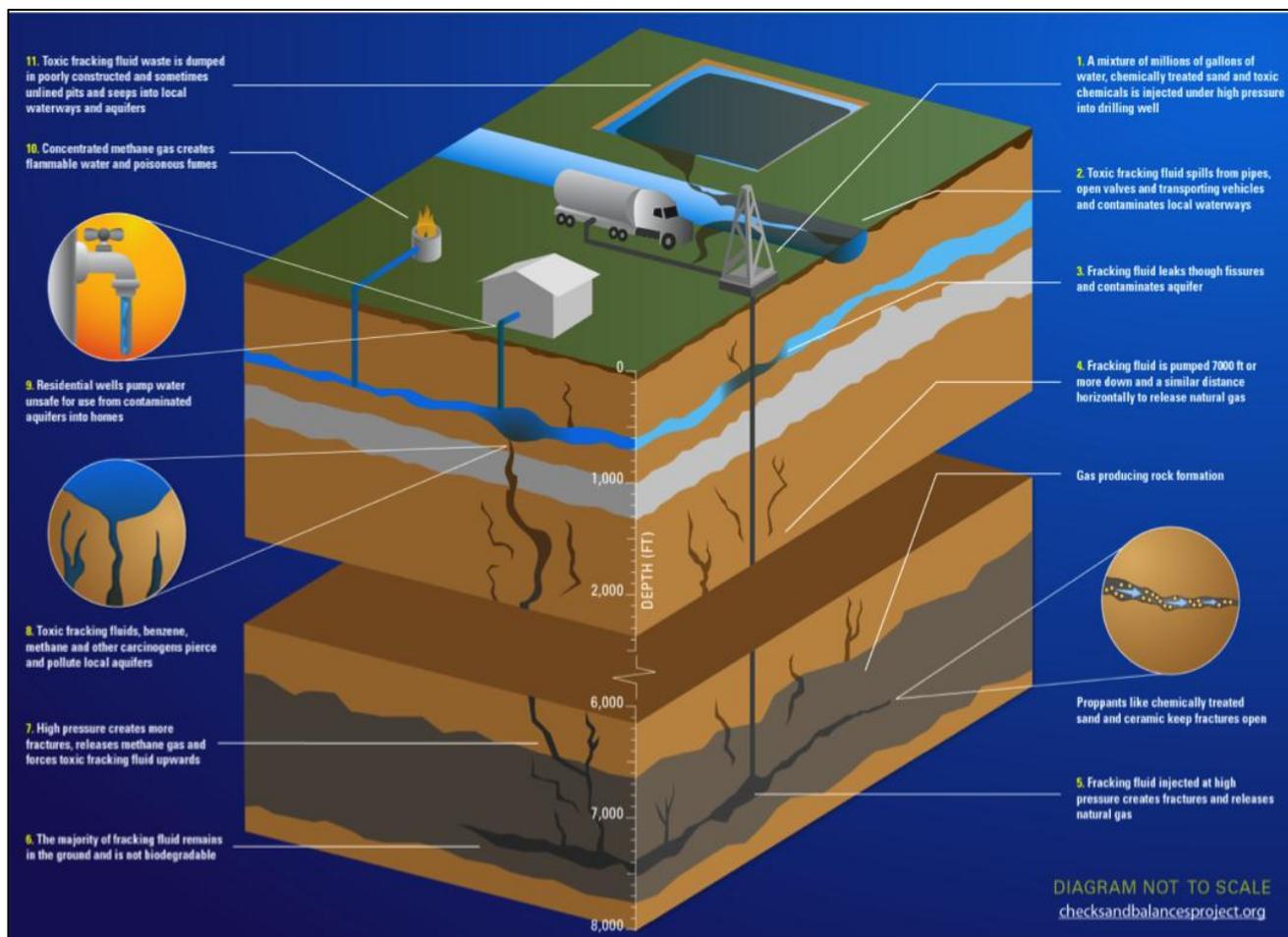
is one of the many reasons that scientists and environmentalists have demanded that more studies need to be conducted focusing on the human health risks tied to fracking.

There have been some studies that attempt to explain the toxicity of the chemicals used in fracking and their potential side effects on humans. Long-term studies on the effects of certain toxins are particularly important because these effects may not be visible immediately. Bachran et al. found that many of the 353 chemicals used have adverse effects on humans and 37% of them can affect the endocrine system. The endocrine system is incredibly sensitive to minute traces of chemicals and problems with this system can have long-term effects on reproduction. Although the oil and gas industry has clearly stated that these chemicals are safe at low parts-per-million concentrations, the sensitivity of the endocrine system leads one to wonder if there are unknown adverse effects that some of these more than 300 chemicals could have even in small concentrations (Bachran et al.). Additionally Bachran et al. found that more than 75% of the chemicals used in fracking could affect the eyes or skin, 40-50% could affect the brain and nervous system, and 25% could cause cancer.

Currently there are many more anecdotal stories regarding the side effects of fracking fluids on human health than scientific studies. Residents who live near fracking operations have reported increases in health conditions such as nosebleeds, diarrhea, and headaches; yet, there is very little evidence that these conditions are due to fracking (Schmidt). This is why oil and gas companies can continue to drill— there is no concrete link between the fracking process and health concerns. Despite the lack of a well-documented link between fracking and health problems, there are several examples that link fracking to contaminated sources of water. Contamination of ground or surface water is a realistic fear that can occur during multiple stages of the fracking process (Bamburger and Oswald). Unfortunately, various parts of the drilling and fracking process involve inherent risks (Figure 12).

In 2009 in Dimock, Pennsylvania, a drinking water well exploded due to high levels of dissolved methane (Cooley and Donnelly). An investigation conducted by the Pennsylvania DEP discovered that Cabot Oil and Gas had contaminated 18 drinking water wells with methane and had “several cases of improper or insufficient casing and excessive borehole pressure” (Cooley and Donnelly 18). This failure in regulation was highlighted

## Fracking Up the Future



**Figure 12—Points of contamination of drinking water created by fracking**

1. A mixture of millions of gallons of water, chemically treated sand, and toxic chemicals are injected under high pressure into drilling well.
2. Toxic fracking fluid spills from pipes, open valves, and transporting vehicles and contaminates local waterways
3. Fracking fluid leaks through fissures and contaminates aquifer.
4. Fracking fluid is pumped 7000 ft or more down and a similar distance horizontally to release natural gas that can travel upwards.
5. Fracking fluids injected at high pressure create fractures and releases natural gas. Proppants like chemically treated sand and ceramic keep fractures open.
6. The majority of fracking fluid remains in the ground and is not biodegradable.
7. The fractures created by high pressures release methane gas and forces toxic fracking fluid upwards.
8. Toxic fracking fluids like benzene, methane, and other carcinogens can pierce and pollute local aquifers.
9. Residential wells pump water unsafe for use from contaminated aquifers into homes.
10. Concentrated methane gas creates flammable water and poisonous fumes.
11. Toxic fracking fluid waste has the potential to be dumped in poorly constructed and sometimes unlined pits and can seep into local waterways and aquifers.

Source: *The Checks and Balances Project*

when the EPA declared Dimock's water safe to drink in 2011, only to be quickly contested by local residents who were conducting their own tests; this public outcry spurred the EPA to begin an investigation on the drinking water of 60 households near the well explosion in order to examine the actual levels of contamination. While water contamination is the main source of concern publicized by the media, the noxious fumes produced on-site are also a critical point of concern. The condensate tanks found at a fracking site are used to remove non-methane hydrocarbons from the gas. These tanks often release fumes that are known to cause cardiovascular, neurological, and liver problems when humans are exposed to them at high concentrations for long periods of time (Schmidt). Additionally, vapors and particles in the air can affect more people than water contamination because these particles can travel further.

Furthermore, the increase in fracking in South Texas is causing the surrounding cities to tip over the environmental air quality cliff. On August 21<sup>st</sup>, 2012, San Antonio teetered over the edge of the EPA's acceptable ozone level (McDonald). A major source of this increased air pollution can be traced south of the city to the truck exhausts associated with oil and gas production in the Eagle Ford shale. Not only does this failed test mean that San Antonio will have to actively try to reduce its air pollution levels, but this increase in ground-level ozone is detrimental to its citizen's health. Ozone can cause chest-pain, emphysema, coughing, asthma, and even death (McDonald).

In addition to water and air contamination, fracking also poses a human health risk due to the increase in truck traffic. When a fracking well is installed in rural counties, the first and most noticeable change is the significant increase in road traffic. One well will need an average of 3,950 trucks during its lifetime (Cooley and Donnelly 26). Considering that some trucks can weigh "more than 170,000 pounds" they have an "equivalent impact of 8 million cars" (Hiller, "Eagle Ford boom"). If this is the impact of a single well in a county, you can imagine the net impact from the 5400 wells drilled in the Eagle Ford Shale Play (Hiller, "\$61 billion").

The rural roads of South Texas often crack under the constant pressure of these trucks and become an obstacle course full of "potholes, alligator cracks, dust and other dangerous driving conditions" (Hiller, "Eagle Ford region"). Before any county embraces the oil and gas industry, they should consider the report conducted by Naismith

Engineering Inc. on the roads in DeWitt County. The study found that the county's "400 miles of roadway... needed more than \$400 million in repair work" in order to handle the increase in truck traffic (Hiller, "Eagle Ford boom").

Furthermore, the increase in trucks promotes an increase in noise, traffic, pollution, and automobile related fatalities (Cooley and Donnelly 26). As more companies flock to the Eagle Ford shale, roads are busier than ever and deteriorating rapidly. Roads in the past that saw one or two trucks a day now carry upwards of 500 trucks daily. This makes it incredibly dangerous to be driving in and around boomtowns. Karnes County Sherriff, David Jalufka, said "you take your life in your own hands by being out on the road right now" (Konnath). South Texas as a whole has seen a sharp increase in crashes. In the first half of 2012, Karnes County alone saw 12 people die in traffic accidents. Although this may seem like a small number of deaths, consider that this is a twelve-fold increase in the number of fatalities reported to TXDOT in all of 2008. Similarly, LaSalle County has had a 418% increase, and McMullen County a 1,050% increase, in fatalities from car crashes (Konnath).

### **Other Impacts on Society**

Economic booms, similar to the one induced by fracking along the Eagle Ford shale, have proven fleeting and disastrous for communities in the past. The flood of wealth and the hype surrounding the Eagle Ford shale is shockingly similar to "the mythic 'Golden West' [that] is synonymous with whiskered prospectors, boom towns, and gold strikes" (Wilshire, Nielson, Hazlett 102). However, the gold rush proved to be dangerous, deadly, and full of falsities (103). Likewise, there is a multitude of detrimental tall tales associated with the Eagle Ford shale's oil boom. Many counties are realizing that the fabled saloons of the gold rush are being reincarnated as strip clubs in their small towns, now submerged in an excess of male workers (MacCormack). Due to this influx of workers, there is a severe shortage in housing across the region and "RV parks [are] proliferating like wildflowers on the edges of shale town" (Price). While these RV parks are modern-day boomtowns that create short-term economic prosperity, they have a series of societal problems including the disruption of the area's culture and added pressure on the county's infrastructure; some major concerns include doctor shortages, inadequate medical facilities, deficiencies in

educational centers, housing shortages, waste disposal issues, and the investment in adult entertainment rather than family recreation (Campbell).

However, the housing shortage is not exclusive to out of town workers. Low-income families cannot afford their previous homes and have moved into “temporary or substandard housing” (Kastner “Oil boom wealth”). This has a huge impact on local schools. For example, in the Carrizo Springs Consolidated Independent School District the number of students classified as homeless has jumped from 85 to 200 in one year (Kastner, “Oil boom takes toll”). This increase in the market value of houses has even forced teachers to start living in trailers. The schools are also having a hard time competing for workers considering the immense starting salaries the oil and gas companies are throwing at potential employees (Kastner, “Oil boom wealth”). To add insult to injury, many of these schools are not only understaffed, but unable to reinvest the oil and gas company’s boom of money into their under privileged schools due to the state legislature. Many of these once low-income schools are now considered part of the top 25 richest school districts based on property values; this means that these schools are “required to return money to the state [through] a process known as recapture” (Kastner, “Oil boom wealth”). Unfortunately, using property values as the deciding factor of recapture proves ineffective when a large portion of the community’s families cannot afford electricity or running water.

### **Case Study: Post-Fracking Water**

#### **Injection Wells**

With fracking companies using such a large amount of water, many people may wonder where all of the water goes once it has been used in the process. Currently, a majority of oil and gas companies in South Texas deal with wastewater by injecting it in disposal wells. After the hydraulic fracking process is completed, “about a third of the water used in fracking emerges as flowback before a well starts producing” followed by a steady extraction of water from the formation itself known as produced water (Dlouhy). As the second type of water flows out of the well and separates from the targeted resource, well operators generally store it in tanks or holding ponds until the water can be collected for processing and disposal. However, the produced water has to be handled with care due to the presence of pollutants like heavy metals and radioactive elements (Ames).

According to the National Energy Technology Laboratory (NETL), “the most common commercial disposal method for produced water involves injection” onsite at the end of a well’s life or through a commercial disposal operation for about \$1.00 per barrel (bbl). This process effectively removes the wastewater from the water cycle if it is injected deep enough underground. In South Texas, Eagle Ford Water Disposal (EFWD) has served as one of the main commercial disposal companies for both produced water and flowback. They have five commercial disposal well sites in the Eagle Ford shale, including one in the southwestern section of Gonzales County (Eagle Ford Water Disposal).

### **Current Regulations**

Companies that wish to dispose of wastewater in underground injection wells must obtain a permit to do so. Permits are issued and regulated by both the TRC and GWCDs. However, due to a clause in the 2005 Energy Act and a separate section in the Texas Water Code, injection wells related to the oil and gas industry do not fall under the jurisdiction of the EPA or GWCDs (Dotson 4). Wells that have been permitted by the TRC may not require a separate permit by the GWCDs, but they must still follow a GWCD’s regulations on installation of casing, pipe, and fittings. Therefore, the TRC regulates both the creation of oil and gas wells and the creation of injection wells for storing this industry’s wastewater. This represents a conflict of interest for two reasons. First, the TRC receives royalties from oil and gas companies for issuing permits (Railroad Commission of Texas). It is against their interest monetarily to strictly regulate these companies, as this would lower both their revenue and their royalties. Second, the TRC is supposed to regulate the creation of wastewater disposal wells. It seems prudent that a different regulatory body should manage the storage of these wastewaters as a way of double-checking their safety.

### **Problems with Injection Wells**

Despite the low-price of disposal and close-proximity of injection wells, local, state, and national policymakers are harshly scrutinizing this practice (Sengelmann and Klemt). Converting freshwater to briny wastewater and then injecting it thousands of feet below the surface locks away precious potable water and effectively removes it from that area’s water cycle. Furthermore, “federal scientists have determined that a rise in mostly small earthquakes nationwide might be tied to the disposal of drilling wastewater through deep-

well injection;” the hypothesis is that injecting water deep within a formation may be reactivating ancient fault lines thus creating earthquakes (Dlouhy). These two major concerns are helping promote the development of hydraulic fracking wastewater recycling units.

### **An Alternative**

Recycling water is becoming a popular practice in the Eagle Ford shale, and many fracking companies are making the switch to this alternative method of dealing with wastewater. Recycling in this context does not mean simply returning the water to its source; it means using the water again in other fracking wells. “Reusing water in multiple wells” makes economical and environmental sense because “oil and gas producers don’t have to pull freshwater out of the drinking supply,” consequently combating the water shortage issues common in drier areas like South Texas (Dlouhy). Recycling fracking wastewater has slowly gained support across the nation. The EPA claims that recycling wastewater “has the potential to reduce discharges to treatment facilities or surface water, minimize underground injection of wastewater, and conserve water resources” (Environmental Protection Agency). However, more research needs to be conducted on this practice to verify its sustainability and to insure that it is properly regulated.

Currently, “recycling of produced water is not widely reported” and costs close to \$5.00/bbl (National Energy Technology Laboratory). However, the Marcellus shale in Pennsylvania in particular “has become a proving ground for [the] reuse of water flowing back to the surface in the weeks after fracking, as well as the flow of produced water” (Rossenfoss, 49). This shale play is experiencing a monumental shift from predominately processing the wastewater at municipal treatment plants, which dispose of the inadequately filtered water directly into major waterways, to the more environmentally friendly wastewater recycling units that allow fracking companies to reuse their flowback and produced water (Rossenfoss, 48).

### **The Push for Recycled Water**

This new drive for innovation in wastewater recycling has created two very competitive mobile recycling groups in South Texas. Dallas’s Aqua-Pure, a global leader in recycling shale wastewater, has installed two portable water purification treatment centers

in Kennedy, Texas (Fountain Quail Water Management LLC). Likewise, Austin's Omni Water Solutions is investing heavily in three to four mobile water treatment units that were originally intended to "provide emergency drinking water supplies with technology capable of purifying brackish groundwater, seawater, storm water runoff, and sewage" (Hendricks). Both of these groups rely on the mobility of their water recycling units because this allows them to respond to the largest problem associated with recycling fracking water—the dynamic flux in "contamination levels and types of contamination... from fracking wells over hours and days" (Hendricks). Being on site with high-tech water monitoring, these units can effectively recycle the wastewater back to fracking fluids ready for reuse without extra costs, like transportation. Hopefully, with organizations like the Texas Water Recycling Association beginning to raise awareness in Austin about the many advantages to wastewater recycling plants, new tax breaks and water conservation incentives can be implemented to promote this environmentally-favorable switch to recycling rather than injection (Waller).

### **Recommendations**

Based on these findings, the best recommendation for dealing with wastewater in Gonzales County would be a two-part program that utilizes the strengths of both injection wells and recycling units. Onsite, water recycling units should be implemented because they reduce the demand for new freshwater inputs and help lower the risk of contaminating surface water during storage and transportation. The water recycling units would be remarkably useful for recycling flowback water that mainly contains sand, salt, and chemical additives; however the produced water would be more difficult to recycle due to the heavy metals and radioactive materials found in it. Therefore, it still makes sense to utilize injection wells for the water from the shale formations that cannot be easily purified. More research needs to be conducted on the actual impact of these disposal wells and time will need to be devoted to finding geologically stable spots for injection (Appendix 2). Hopefully, a dual disposal method maximizing the strengths and minimizing the weaknesses of injection wells and recycling units will help counties like Gonzales County continue to profit from hydraulic fracking, while protecting their water resources.

## **Overall Recommendations for Fracking in Gonzales County**

Effective recommendations must consider the current practices, local conditions, and multiple alternatives available for dealing with the environmental and human health concerns surrounding fracking. After researching the various aspects of fracking and their lack of strong regulations, we have created a series of recommendations for fracking in Gonzales County.

### **Avoid Regulatory Capture Issues with the TRC**

The TRC is in a similar position as the agency that was in charge of the Deepwater Horizon oil spill. Another similarity between fracking operations and the Deepwater Horizon incident is that fracking operations also present the risk of an explosion that would affect humans as well as the environment. Therefore, it is recommended that the TRC splits its duties of collecting royalties and handling permits in order to avoid regulatory capture. Since the federal government is unable to be an effective regulatory body, the job of regulation will fall to either the state or county level. County level regulations would be the best option in the Eagle Ford Shale Play because the area is large and the counties differ in terms of demographics, as well as in the relative density of fracking operations. These county level regulatory bodies could be funded by the state or could be funded from excess royalties from fracking. The second funding option would have to be carefully designed to ensure that the regulatory agency remained independent of the royalties received from the oil and gas industry; otherwise, their job as a regulatory body would be compromised due to their fear that retracting permits would cut their revenue.

This new group of regulatory bodies would be in control of permitting as well as ensuring that post-fracking materials, such as wastewater, were properly disposed of. The creation of this agency would be extremely beneficial for each county because it would have the best interests of the county, including both human and environmental health, at the forefront of their mission. It would not be the goal of these regulatory bodies to eliminate fracking, but rather they would be responsible for weighing the costs and benefits of this practice and approving the safest possible course of action.

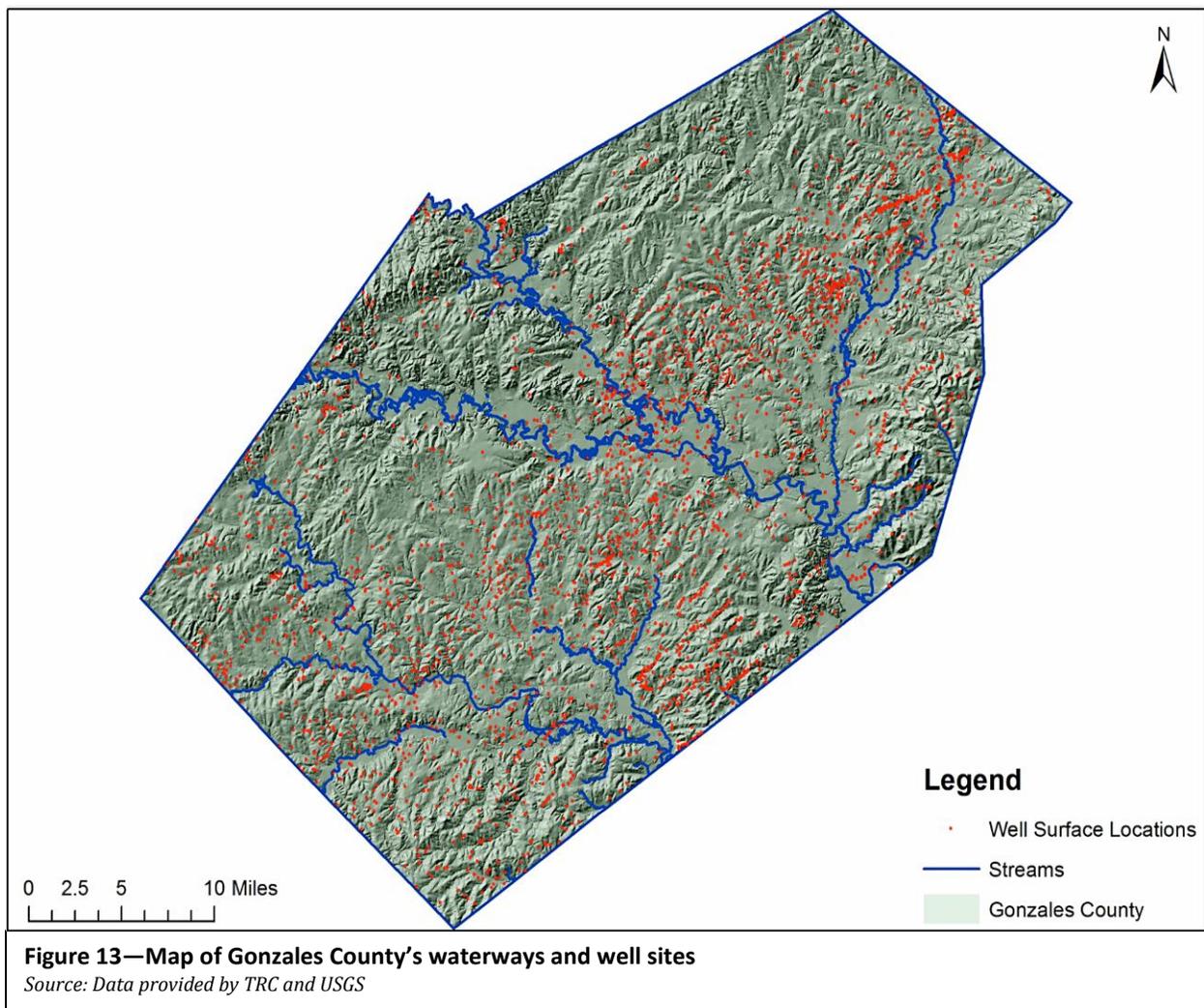
### **Control Water Use**

Besides the creation of a regulatory body at the county level, another recommendation for fracking in Gonzales County is to create a law at the county level that

would force fracking companies to recycle fracking water. As discussed earlier in this paper, water use is of concern in many of the counties in the Eagle Ford shale area due to South Texas' semiarid climate. Thus, recycling the wastewater generated by fracking would be an answer to some of the concerns regarding fracking's high demands for water. Recycling this water not only reduces water use, but it also reduces the risks associated with wastewater ponds and the transportation of flowback. The creation of such a law might meet some resistance from fracking companies, but it would not be difficult to create or enforce.

### Monitor Point Source Contamination

Unfortunately, fracking sites are usually located close to rivers and large bodies of water; Gonzales County is no exception. The map of Gonzales County in Figure 13 was



generated using the TRC's GIS data on the wells currently drilled as well as elevation and hydrology maps from the USGS. This map clearly shows that there are many wells that are located adjacent to the local rivers and lakes. Since most of these drilling operations have holding tanks or ponds located onsite to hold the wastewater they generate, there is a high likelihood that these containers and their contents may accidentally leak or overflow and contaminate these surface bodies of water. The areas of dense drilling are particularly worrisome, because multiple pad sites along one river may cause cumulative wastewater effects.

More stringent regulations on the storage and management of flowback and produced water should be enacted to help mitigate the risks of contamination. Researchers are finding that this last stage of water use onsite is the least regulated and most likely point of contamination (Bamberger and Oswald; Buchele; Dlouhy; Sengelmann and Klemt; Stewart and Surpress). Conducting baseline environmental and health studies in areas before fracking processes commence can help better evaluate the actual impacts of fracking. From these kinds of long-term studies, better policies can be created. By creating set standards enforced by local inspectors on the building of storage tanks, their monthly upkeep, and the minimum distance between them and a creek bed, then these sources of contamination can be monitored and reduced.

### **Utilize Countywide Contracts and Ordinances**

In order to combat some of the truck-induced issues, many counties have created voluntary repair contracts with oil and gas companies that requires drillers to pay approximately \$8,000 per well for road repairs (Hiller, "Eagle Ford boom"). These local agreements bring in close to \$2 million worth of revenue to help mitigate the road degradation and helps build a stronger infrastructure to accommodate the truck bonanza (Hiller, "Eagle Ford boom"). Along with this potential for revenue, the increase in infrastructure improvements provides an even greater commodity for these rural regions—jobs.

An indirect way that some counties are controlling the impacts of fracking is through local ordinances. For example, Dimmit County "drafted a 'sexually oriented business' ordinance" in order to strictly regulate any strip clubs that are established in the

area (MacCormack). Many of the towns within these booming counties are creating strip club and bar regulations in hope that the money from well workers will be redirected to other local businesses.

### **Empower Landowners**

Local landowners are also utilizing contracts with oil and gas companies to insure that their land is protected and restored if they allow drilling on it. Through Surface Use Agreements, landowners specify what oil and gas companies can and cannot do on their land (Seeligson). Some of the requirements include purchasing any surface or groundwater they use, replacing the topsoil at a pad site, and re-vegetating any areas they used with native grasses. Furthermore, multiple aspects of the fracking process, such as where roads and storage ponds are placed, are left to the landowner's discretion. These contracts can not only be used to restore the pad sites, but they can also monitor the traffic and techniques of the drilling companies to insure that the safest and most sustainable practices are being used. It is critical that landowners are provided with more information about how they can protect their land, so it would be beneficial to have drafts of these agreements accessible online. Empowering landowners in Gonzales County with these Surface Use Agreements will help protect critical water and soil resources and will legally hold fracking companies responsible for any damage they may inflict on the land.

### **Enforce Safer Regulations**

Currently, both the TRC and fracking companies lack qualified inspectors. As stated earlier, the TRC only employs 81 full-time inspectors to monitor wells. Likewise, oil and gas companies need more people out on the Eagle Ford shale monitoring the process. EOG Resources have three people responsible for writing tickets and responding to emergencies for all of the EOG wells in the Eagle Ford shale. The inspectors responsible for enforcing the few regulations currently in place are working long days, sometimes 70-80 hours a week; this leads to a high turnover of inspectors who get worn-out and overworked. If companies and regulatory agencies employed more field agents to inspect the various aspects of fracking, it could reduce the workloads of each inspector, thus lowering the risk of oversight and potential accidents. Similarly, a lack of qualified inspectors and the failure to monitor drilling led to the Deepwater Horizon oil spill. It is clear that there is a link

between catastrophic failures in drilling and a lack of inspectors. If the regulatory bodies, fracking companies, and oil and gas industry hire and properly train more inspectors, then the risk of huge contamination events would be reduced.

### **Fund More Scientific Studies on Fracking**

One of the most common recommendations was the demand for more information. People want to know more about the fracking process itself, as well as its water consumption and health and ecological impacts. Residents and landowners want more facts about fracking so they can protect themselves from its negative impacts. Scientists want more time to research the chemicals to insure that drilling accidents will not harm local communities. Environmental groups want more examples of safe water use and disposal by fracking companies to help protect fragile riparian ecosystems. Elected officials want more reports about the process so they can implement smarter regulations. Regulatory bodies want more power and funding to help them enforce their regulations. Fracking companies want more confidence in the science behind their process to insure that they are not shut down based on invalid science. Ultimately, all of these stakeholders want more information about fracking and want this information to be readily available to everyone involved in the process.

Therefore, the distribution of information on the various aspects of fracking is the most critical recommendation that we have. Fracking companies should create educational programs for the general public to explain the process and potential hazards of fracking. Regulatory bodies should invest a large amount of their budget into hiring and training inspectors to monitor the various aspects of fracking. Elected officials should help create stronger regulations on fracking at the federal, state, and local level. Environmental groups should work diligently to investigate the facts behind well failures and their impacts. Scientists should continue to analyze the effects of fracking chemicals. Field researchers can monitor areas where fracking is taking place in order to find health concerns directly associated with the fracking process. Finally, residents and landowners need to evaluate all of the information generated by the other stakeholders and use it to empower themselves to protect their communities.

While these recommendations may seem extreme, there are serious risks with fracking that need to be properly evaluated. This industry needs stronger regulations and stricter enforcement of those regulations in order to insure that a catastrophic contamination event does not occur. Thus, if Gonzales County wishes to continue to allow fracking within its county lines, then they should consider creating a regulatory body specifically focused on fracking. Proper regulations may cost the oil and gas industry some short-term revenue, but they will protect local communities and environments in the long run.

### **Conclusion**

The recent oil and gas development in the Eagle Ford shale has led to a menagerie of economic, ecological, health, and social impacts for the South Texas region. Drilling and production in these unconventional reserves has created an economic boom for these small communities, but it comes at a cost. The most powerful stakeholders concerned about fracking in South Texas are the TRC and the oil and gas industry. However, the TRC has major regulatory capture issues that are compromising its regulatory position over fracking; regulatory capture is a serious concern because it was a critical factor in the Deepwater Horizon oil spill. The similarities between this disaster and the current drilling practices under the TRC need to be addressed in order to prevent another catastrophic well blowout.

The increased use of the fracking process has raised numerous concerns about the large amount of water this type of activity requires. The drought that South Texas is facing only exacerbates concerns about water use because many water sources are already at critically low levels. Pushing fracking companies to switch to recycled water in order to decrease their consumption of freshwater can help diminish their contribution to ground and surface water depletion. The chemicals used in fracking as well as the by-products of the drilling process worry scientists and local residents. Very little research has been conducted on the actual effects of these chemicals; however, previous studies have established that wastewater from fracking can kill cattle and amphibians. The various points of contamination will continue to distress local communities and environmental groups in heavily fracked areas until stronger regulations are put in place to prevent mass

contamination events. The ecological and human health impacts from fracking are not limited to the wastewater; noxious fumes, methane gas accumulation, habitat degradation, and increases in traffic related deaths are just some of the major concerns induced by fracking in the Eagle Ford shale region.

For air quality, the EPA has been effective at identifying San Antonio's breach of the safe levels of ozone. However, the EPA has failed to target or even regulate the cause of the concern—fracking. The Energy Policy Act of 2005 exempts fracking from the Clean Air Act, Safe Drinking Water Act, and Clean Water Act; thus, unarmed regulatory bodies, including the EPA, have proven to be ineffective at protecting humans and the environment from the risks associated with fracking. Perhaps the only accomplishment of the EPA has been its recent allocation of \$1.9 million to its new study on the effects of fracking (Manuel). Hopefully, this study and similar ones on the impact of fracking will provide enough information to legislatures and local communities to empower them to properly regulate fracking.

Interestingly, after water and air contamination worries, the lack of information regarding fracking and its potential impacts is the largest concern. Across the nation, elected officials are demanding facts about fracking to help them create more effective regulations on the process (Riverkeeper). Even specialists within the oil and gas industry agree that there is a need for more research on fracking to insure the safety of the local communities (Helman). The father of modern day fracking, George Mitchell, strongly believes that fracking needs to be controlled “because if they don't do it right there could be trouble—and there's no excuse not to get it right” (Helman).

Currently, the oil and gas industry and poorly organized regulatory bodies are using fracking as an experiment as they manipulate ecosystems, geology, and modern technology. Since there is still ambiguity regarding the long-term effects that fracking will have both on the environment and human health, we need to be critical of the process. Our recommendations on fracking include avoiding the regulatory capture issue with the TRC, controlling water use, monitoring the points of contamination, utilizing countywide contracts and ordinances, empowering landowners, enforcing safer regulations, and funding more scientific studies on fracking. If future research deems it practical to put more regulations in place to protect humans and the environment, then these regulations

should be enforced. These regulations could be subsidized by the large influx of money that the oil and gas industry brings to these areas as long as the regulatory body does not directly control the rules and revenue. No matter how much money fracking generates, or what kind of political implications it has regarding energy independence, it is critical that fracking be monitored by a series of regulatory bodies free of conflicting interests and devoted to protecting the local communities and ecosystems.

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## **Appendix**

### **Appendix 1—Interview with Sean Peters**

Interview with Sean Peters  
EOG Resources  
Pipeline Compliance and Integrity  
17 April 2013

1. When you talk to people about what you do, what do people know? Do you think the average person knows what fracking is?

People generally know very little about the oil and gas industry. They never think about all of the everyday conveniences that they have such as gasoline, plastics, cosmetics, etc. and where they come from.

I think the average person thinks they know what fracking is, but in reality they have no clue. Many people I talk to consider fracking the entire process of drilling wells and producing wells. Fracking is a process that takes a few days in the life of a well that can last up to 20-30 years.

2. Can you describe your interactions, in general, with well owners?

Typically interactions with well owners are very pleasant. Our company does a great job of giving the landowner what they want while preserving natural resources and remediating any damages that are needed.

3. Why do you think that the fracking and natural gas industry has exploded the way it has?

Simple, there is demand for oil and gas. Same reason the cell phone industry has exploded supply and demand. Improved technology has given Americans the opportunity to exploit these resources in our own country, rather than send our money overseas.

4. Do you believe this is a band-aid (temporary solution) or a permanent fix?

It is both. Getting Americans energy independent in the short run will allow us to invest in new technologies to harvest renewable energy more effectively.

5. Do you think rig operators are aware of the types of chemicals they are handling?

All of the rig operators that I speak to know exactly what chemicals they are handling. The MSD sheet is always available and many companies train their employees on what they are handling. The notion that frac or drilling chemicals is a secret thing is preposterous.

6. Do you personally believe that there are valid/real health concerns related to fracking?

I believe that fracking can be a concern when done incorrectly. Larger companies never compromise on safety or take short cuts. Smaller operators pressed with smaller budgets, may be more inclined to take risks. However, if done correctly, drilling and fracking a well is a safe operation that has been happening since the early 1970's.

7. Are we currently fracking as safe as we could be?

Most frack operations are currently safe. Only when companies break current regulations, do we have a problem. Ensuring that companies do not do this is what the focus should be. However, people will always break laws and rules. I will never murder anyone, but others might.

## Appendix 2—Recommendations for Injection Wells in the Wilcox Formation

There are five important areas where proposed Wilcox injection wells could be made safer.

1. The wells should be located a sufficient distance away from faulting.
2. The wells should be located in areas where the base of the brackish water resource (>3,000 – 10,000 mg/l TDS) in the Wilcox is sufficiently protected by the same amount of impervious strata as required to protect the fresh to slightly saline (1,000 – 3,000 mg/l tds) water resource.
3. Injection tests should be run on the well after completion to determine the actual fracture pressure gradient.
4. The long string casing should be cemented from top to bottom and a mechanical integrity test such as a cement bond log should be required to confirm an adequate cement job.
5. After completion and final testing, the findings should be evaluated, and only then, should a final permit decision be made by the permitting agency.

*Source: Sengelmann and Klemt*