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An Exploration of the Development and Proliferation of Hydraulic Fracturing

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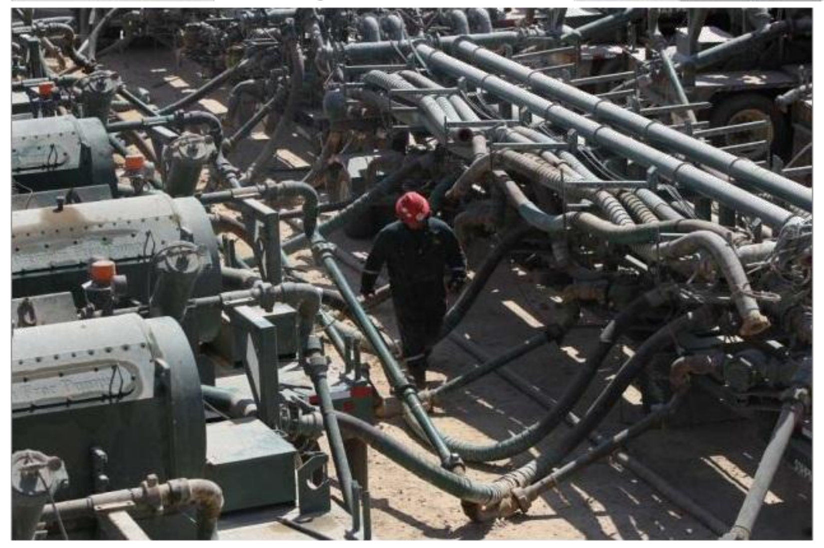
RATIONALIZING HYDRAULIC FRACTURING

TECHNOLOGY, EARTH'S RESOURCES, AND THE ECONOMY

Amidst growing concern about our changing environment, a debate continues regarding the planet's resources—are there infinite supplies waiting to be accessed or are there limited pools that we are rapidly exhausting? Participants in this debate exhibit general attitudes towards technology tied to the availability of resources ranging between two extremes:

- Techno-optimist: This is someone who believes that resources are infinite due to a steadfast faith in human ability to continually develop new and improved technologies; humans will always find a solution.
- Techno-skeptic: Is someone who believes that resources are finite and a change in technology alone will not be able to make up for depleting resources; we need new values, not new technological solutions

Drilling rigs like this one in McMullen county, Texas near Tilden are are becoming a common sight. Drilling companies are now drilling into the Eagle Ford shale formation south of San Antonio using deep wells that employ a process called hydraulic fracturing that produces dry gas, wet gas and oil. J Photo: JOHN DAVENPORT, SAN ANTONIO EXPRESS-NEWS



An oil worker walks pass the manifold (right) and frac pumps (left) at a Chesapeake Energy hydraulic fracturing operation near Carrizo Springs. Hydraulic fracturing is a method of removing oil and gas from rock formations such as the Eagle Ford shale formation. Photo: JOHN DAVENPORT/jdavenport@express-news.net, SAN ANTONIO EXPRESS-NEWS

The attitude toward technology that one adopts is fundamentally tied to economics. How one considers Earth's resources, infinite or finite, determines which of two general economic models that one believes to be ideal:

- Growth-mania economy (also known as a cowboy economy): The goals of this economy include using infinite resources to increase wealth and expand the economy. Growth and production are a measure of success.
- Steady state economy: The goals of this economy include maintaining wealth and minimizing throughput to reduce the amount of energy being converted into inaccessible energies (i.e., waste) and changing our way of life to reducing our use of finite resources.

Fracking advocates take a more techno-optimist standpoint. It is believed that if we need more resources, like energy, we do not need to change our worldview, rather we just need to create new or enhance old technologies. We need not alter our energy needs in the face of rising oil prices, but develop new technologies like hydraulic fracking that provide resources we need to sustain our current way of life. Fracking technology unlocks previously inaccessible energy sources, which in turn leads to increased economic profit—supporters of the growth-mania economy thus view fracking as a positive contribution to economic progress.

WATER USE IN FRACKING

One of the chief concerns regarding hydraulic fracking is the immense amount of water that is used during the process. Completion of a single well needs approximately 4.8 million gallons of water (Chesapeake Energy Fact Sheet). Estimates are that 25,000 wells will be drilled over the next 20 years in the Eagle Ford Shale. This would require 4.8 billion gallons of water per year (Vaughan).

The Texas Ground Water Association estimates that one acre-foot of water used for Eagle Ford Shale well development 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.

One acre-foot is a unit of a volume equivalent to 325,871 gallons.

Sand and stone mined near Brady is washed and sent through a vibration and screening process. Much of the sand produced there is used by the oil and gas drilling industry in areas such as the Eagle Ford shale formation. Photo: JOHN DAVENPORT/jdavenport@express-news.net

CHEMICAL USAGE

Table 4-3: Mass of Water, Sand and Major Classes of Fracturing Fluid Chemical Additives Required for one 4 MG Fracture Operation

	Percent by mass[1]	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
Total (chemicals only)	**0.446%**	**82.2 tons**

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

New York City Department of Environmental Protection
Table 4-3 summarizes the proportion and the mass of water, proppant (sand), and each of the twelve major classes of chemical additives required for a sing well

Water and sand make up approximately 98% of the frack fluid with chemical additives making up the rest ranging between 0.5% and 2% of the total volume (Chesapeake Energy: Eagle Ford Shale Hydraulic Fracturing Fact Sheet)

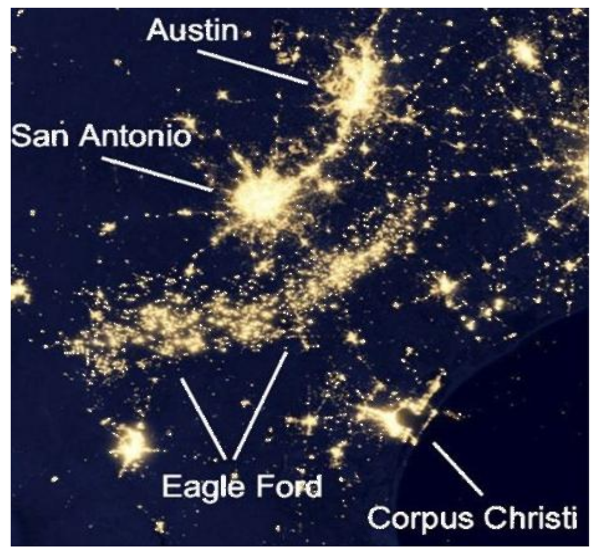
- Given that about 4.8 millions of gallons of water are needed to frack a single well, the total amount of each chemical used per well is very large.
- Firgure 4-3 shows that when a well that requires four million gallons of fracking fluid, it would use anywhere from 80 tons of chemicals at 0.5% chemical composure up to 300 tons of chemicals at just 2% chemical composure (New York City Department of Environmental Protection).

Modern humanity exists in an unprecedented state, and is facing novel challenges as a result. There are more human beings on the planet today than ever before, and the world population continues to grow—at least for now (Lutz et al. 2001). Whether or not the planet can sustain the present population or its projected growth remains undetermined; regardless, a variety of consequences resulting from massive growth require addressing. For example, as our population has grown, so has our collective need for resources. Few resources have gained as much attention as energy—questions of how much we need, what sources it will come from, and how much it will cost are subjects of concerns of developed and developing nations alike.

The widespread adoption of a capitalistic consumer economy has been at the root of habits of energy use and concerns regarding the future of energy. This class of economic thought is fundamentally based on the Judeo-Christian ideal that every human has—or should have—the opportunity to better his or her condition (Novak). Economic progress and growth are the marks of both individual betterment and overall success among capitalistic consumers, and as a result, participants in this economy have come to seek more, bigger, better, and new. Producing more for less money in a shorter period of time has become the ultimate goal, and this goal requires a lot of energy—a lot of energy that some say we may not have (Greene et al.). We have long relied on petroleum products from crude to gas to fuel our energy needs—to run our cars, make our medicines, and wrap our sandwiches in plastic (Guthrie).

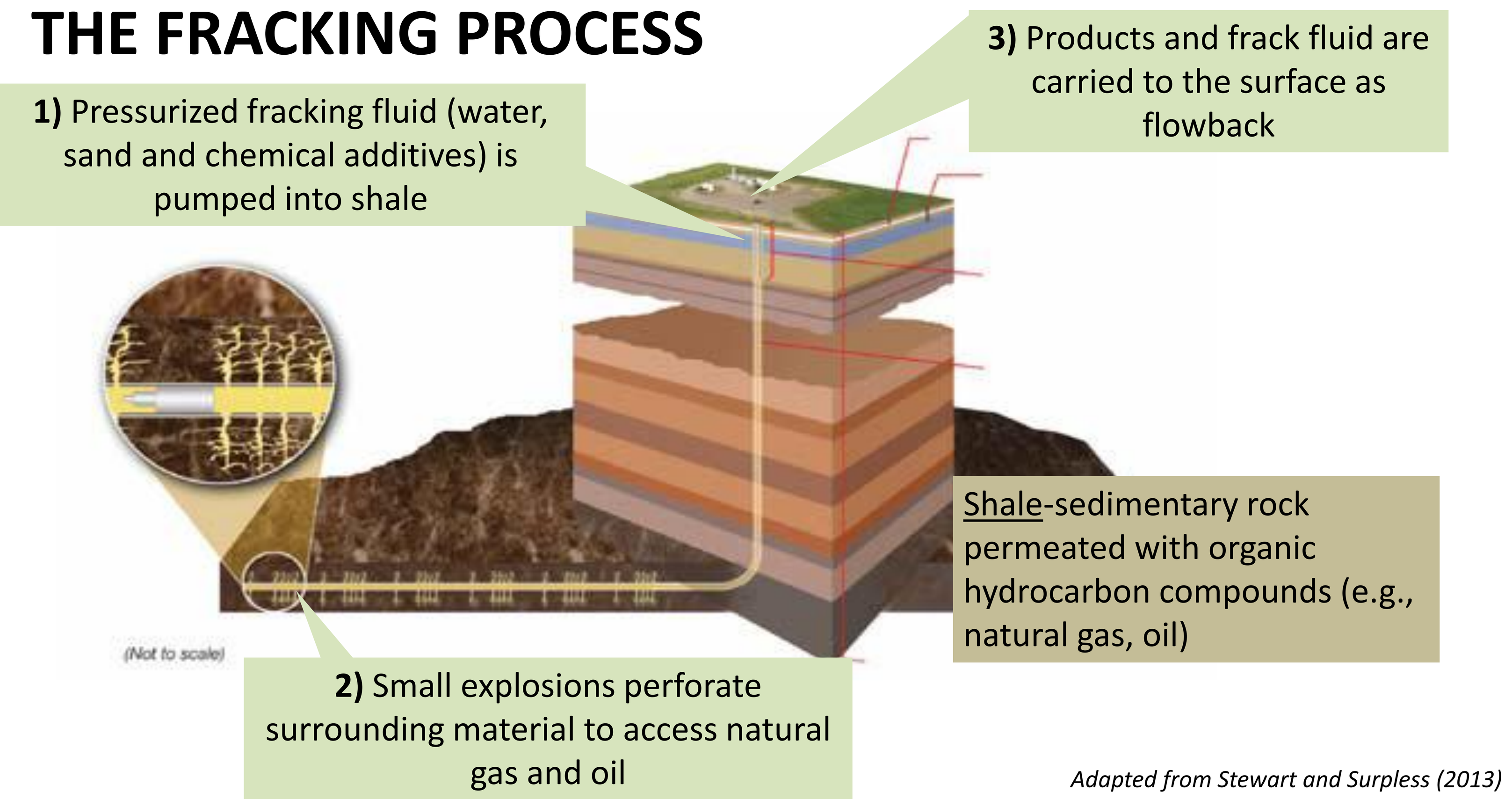
As a result of our widespread dependence on, and extensive use of, these resources, it has become increasingly difficult to obtain the quantities we require at prices we are willing to pay. So instead of changing our energy demands, we demanded a change in efficiency. The dominant opinion has not demanded changes in the quantities and ways in which we use energy, but rather it has spurred efforts to change and improve our methods such that we can meet existing needs without incurring large costs.

Our thirst for energy has birthed **hydraulic fracturing (fracking)** a process through which large quantities of natural gas are obtained by pumping pressurized water into a source of petroleum and forcing the product to the surface for capture and use.



This satellite image of South Texas clearly shows electrical lights and gas flares in the Eagle Ford Shale region south of San Antonio. This giant arc of lights was not visible on a NASA poster from 1994-95. Photo: Courtesy of NASA's Goddard Space Flight Center.

THE FRACKING PROCESS



Adapted from Stewart and Surpless (2013)

WHAT HAPPENS TO FRACK FLUID?

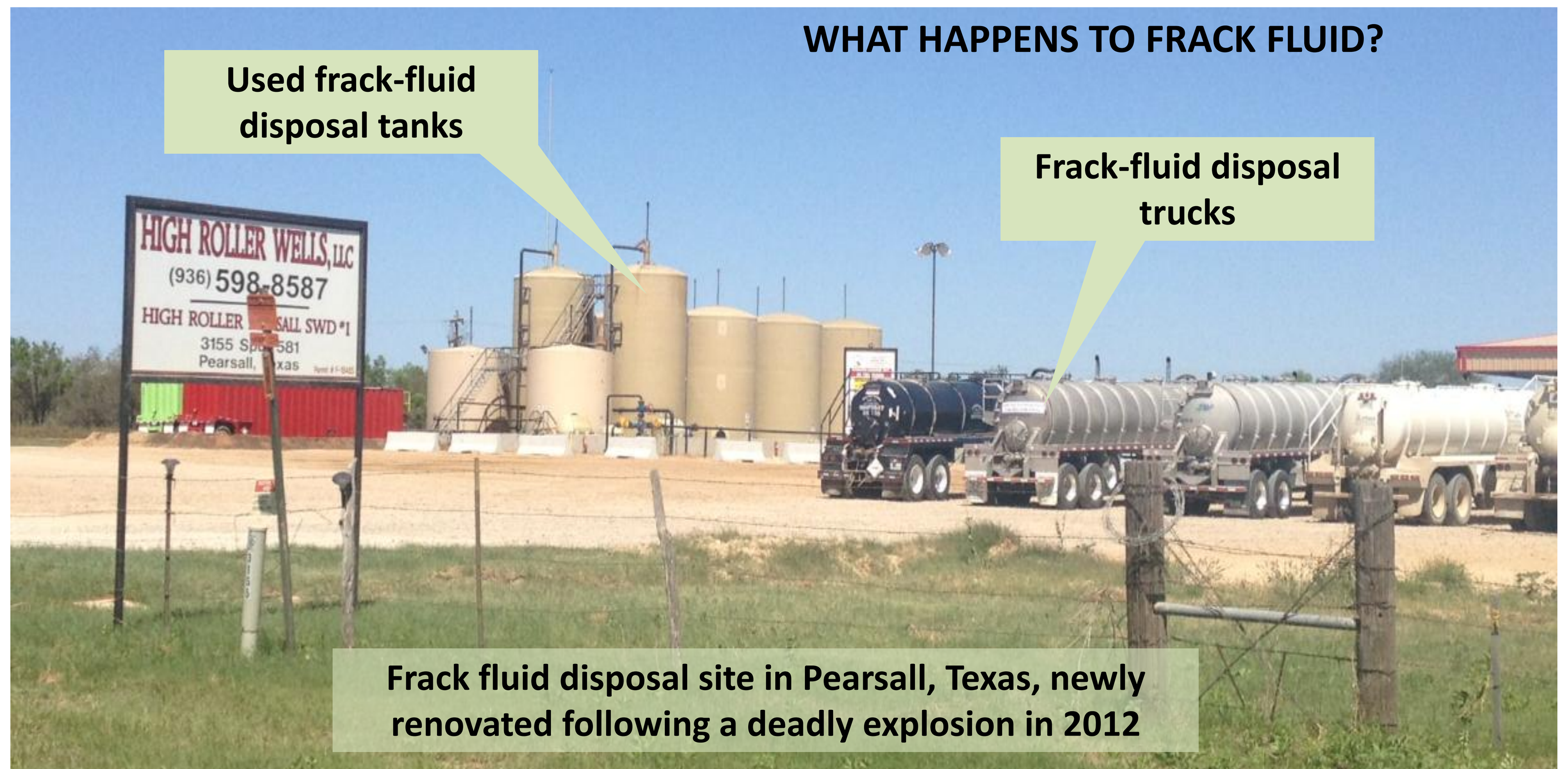


Photo Credit: Ellee Cook and Travis Dodson

THE POLLUTION-HEALTH CONNECTION

HEALTH CONCERNS DUE TO LARGE AMOUNTS OF CHEMICALS

In addition to large volumes of water and sand, there are a variety of chemical additives that are used in hydraulic fracturing fluids. Many chemicals used in the fracking process are known to be toxic to humans and wildlife. Fracking simply just has not been around long enough for us to fully understand the potential implications of it or perform the research to back up anecdotal evidence.

353 chemicals used in the fracking process (Bachran *et al.)*.
-37% could affect the endocrine system
-75% of the chemicals used in fracking could affect the eyes or skin
-40-50% could affect the brain and nervous system
-25% could cause cancer

A gas processing plant in seen on former farmland off Texas Farm Road 81 in Karnes County, Texas, Tuesday, Jan. 15, 2013. Photo: Jerry Lara, San Antonio Express-News

- Residents who lived near fracking operations have reported health conditions such as nosebleeds, diarrhea, headaches and more; however because this is anecdotal evidence it is hard to correlate these symptoms to fracking in the area (Schmidt).
- Employees working an oil and gas sites also face increased risks associated with direct skin contact with the chemicals or wastes, breathing in vapors from flow back wastes stored in pits or tanks, and accidents during well construction. (EarthWorks)

These chemicals can have effects to both humans though water contamination, air contamination, ecological impacts, as well as the increase in traffic as a result fracking. In spite of these concerns, the economic benefits of fracking seem to have eclipsed these negative impacts in the minds of many. Fracking development continues at a faster pace than ever.

WATER CONTAMINATION

- There are elevated levels of methane in groundwater near drilling sites. However, more research needs to be done to be completely sure of the risks to humans who are exposed to elevated levels of methane in drinking water (Schmidt).
- In 2009 in Dimock, Pennsylvania, a drinking water well exploded due to high levels of methane in its water. An investigation conducted by the Pennsylvania Department of Environmental Protection discovered that Cabot Oil and Gas had contaminated 18 drinking water wells with methane (Cooley and Donnelly).

An oil & gas drilling rig is drilling a well for Pioneer Natural Resources in the Eagle Ford Shale formation near Yorktown. The Texas Tribune (Galbraith: Natural Gas) Eddie Seal for The Texas Tribune Photo: Eddie Seal For The Texas Tribune

In this 2010 Express-News file photo, the Patterson-UTI Drilling Co. rig can be seen alongside Ranch Road 624 just southeast of Cotulla. Photo: LISA KRANTZ/lkrantz@express-news.net

AIR CONTAMINATION

- There is concern about noxious fumes produced on frack sites. The condensate tanks used on-site to remove non-methane hydrocarbons in the gas release fumes that are known to cause cardiovascular, neurological and liver problems when humans are exposed to these fumes at high concentrations for long periods of time (Schmidt).

Vapors and particles in the air could potentially affect more people than water contamination because those particles may go unnoticed and can travel further, affecting not only those residents who live near fracking locations.

ECOLOGICAL IMPACTS

- Habitat destruction, though fragmentation and soil salinization has led to:
  - alteration of stream flows and cause increases in sediment run off and erosion (Entrekin *et al.*).
  - increasing salt concentration in ground water (Gillen and Kiviat)
- Ecological conditions could affect not only sources of drinking water, but could also affect irrigation and agriculture in the area that many people rely on.

The sight of big trucks has become the norm in Kenedy because of the Eagle Ford Shale energy boom. Photo: Billy Calzada / San Antonio Express-News

TRAFFIC IMPACTS

- One well will need an average of 3,950 trucks during its lifetime (Cooley and Donnelly) and considering that some trucks can weigh more than 170,000 pounds, which has an equivalent impact of 8 million cars (Hiller, "Eagle Ford boom"), there will be gigantic impacts on the road for *a single well*. Now imagine the net impacts on roads for the 5,400 wells currently 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").
- Roads in the past that saw one or two trucks a day now carry upwards of 500. This makes it incredibly dangerous to be driving in and around boom towns. Karnes County Sherriff, David Jalufka, agrees and said that "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. That is twelve times the number of fatalities reported to TXDOT in 2008. LaSalle County has had a 418% increase and McMullen County a 1,050% increase in crashes involving fatalities (Konnath).