Inglewood Oil Field Hydraulic Fracturing Study Outline

March, 2012

The Inglewood Oil Field Hydraulic Fracturing Study is being conducted in accordance with the settlement agreement between PXP and The County of Los Angeles and Petitioners, including Community Health Councils, Inc., Natural Resources Defense Council, Culver City, Citizens Coalition for a Safe Community and Concerned Citizens of South Central Los Angeles. The report is being prepared by an Independent Expert, Dr. Daniel Tormey, and will be subject to a peer review by an unaffiliated expert selected by the County and PXP.

The report will be broken in two sections. A general "Background" section and a section specific to the "Inglewood Oil Field". Specific identified topics for each section are outlined below.

Background

This section of the report will provide an overview of the practice, discussion of different types of hydraulic fracturing (HF) treatments, and summarize current policy issues and regulatory requirements associated with HF worldwide, with an emphasis on concerns expressed in the United States. Subject areas that will be covered include:

1. *Potential for Groundwater and Surface Water Contamination*
2. *Potential Environmental Effects of Chemical Packages*
3. *Potential for Vibration and Induced Seismicity*
4. *Potential for Gas Migration*
5. *Air Emissions from Fracturing Operations*

Inglewood Oil Field

This section of the report will evaluate the specific application of HF at the field. This evaluation will include a description of the existing environment as well as the impacts and results noted from site-specific testing of HF and high rate gravel packing at the Inglewood Oil Field.

The description of the existing environment will highlight the following subjects:

1. *Geology*
2. *Ground Water*
3. *Surface Water*
4. *Oil and Gas Formations*

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Site specific testing was conducted at two HF completions and two high rate gravel packs in 2011/12. These events were extensively monitored. The study will include the following information from the site specific tests:

1. *Coring to identify physical properties*
2. *Fracture Modeling*
3. *Fracture testing*
4. *Well integrity testing*
5. *Chemical disclosure (to requirements of current regulations)*
6. *Water demand/source*
7. *Produced Water management*
8. *Groundwater monitoring*

The report will use these data to evaluate the following potential concerns:

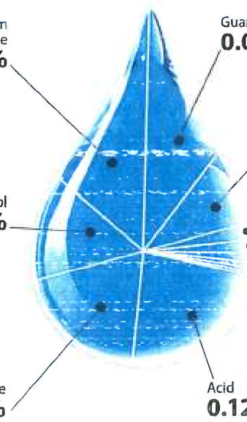
1. *Potential for Groundwater and Surface Water Contamination*
2. *Potential for Ground Movement or inducement of seismic events*
3. *Potential for Gas Migration*
4. *Vibration and Noise*
5. *Community compatibility (lighting, water demand, etc)*
6. *Air Emissions from Fracturing Operations*

The report will include technical appendices, and the qualifications of the preparers and the peer reviewer.

A FLUID SITUATION:

TYPICAL SOLUTION* USED IN HYDRAULIC FRACTURING

0.49%
ADDITIVES*



Compound*	Purpose	Common application
Acids	Helps dissolve minerals and initiate fissure in rock (pre-fracture)	Swimming pool cleaner
Glutaraldehyde	Eliminates bacteria in the water	Disinfectant; Sterilizer for medical and dental equipment
Sodium Chloride	Allows a delayed break down of the gel polymer chains	Table Salt
N, n-Dimethyl formamide	Prevents the corrosion of the pipe	Used in pharmaceuticals, acrylic fibers and plastics
Borate salts	Maintains fluid viscosity as temperature increases	Used in laundry detergents, hand soaps and cosmetics
Polyacrylamide	Minimizes friction between fluid and pipe	Water treatment, soil conditioner
Petroleum distillates	"Slicks" the water to minimize friction	Make-up remover, laxatives, and candy
Guar gum	Thickens the water to suspend the sand	Thickener used in cosmetics, baked goods, ice cream, tooth-paste, sauces, and salad dressing
Citric Acid	Prevents precipitation of metal oxides	Food additive; food and beverages; lemon juice
Potassium chloride	Creates a brine carrier fluid	Low sodium table salt substitute
Ammonium bisulfite	Removes oxygen from the water to protect the pipe from corrosion	Cosmetics, food and beverage processing, water treatment
Sodium or potassium carbonate	Maintains the effectiveness of other components, such as crosslinkers	Washing soda, detergents, soap, water softener, glass and ceramics
Proppant	Allows the fissures to remain open so the gas can escape	Drinking water filtration, play sand
Ethylene glycol	Prevents scale deposits in the pipe	Automotive antifreeze, household cleansers, deicing, and caulk
Isopropanol	Used to increase the viscosity of the fracture fluid	Glass cleaner, antiperspirant, and hair color

On average, **99.5%** of fracturing fluids are comprised of freshwater and compounds are injected into deep shale gas formations and are typically confined by many thousands of feet or rock layers.

Source: DOE, NETL Modern Gas Shale Development in the United States: A Primer (2009)

The Real Facts about Fracture Stimulation:

The Technology Behind America's New Natural Gas Supplies

The shale-gas breakthrough

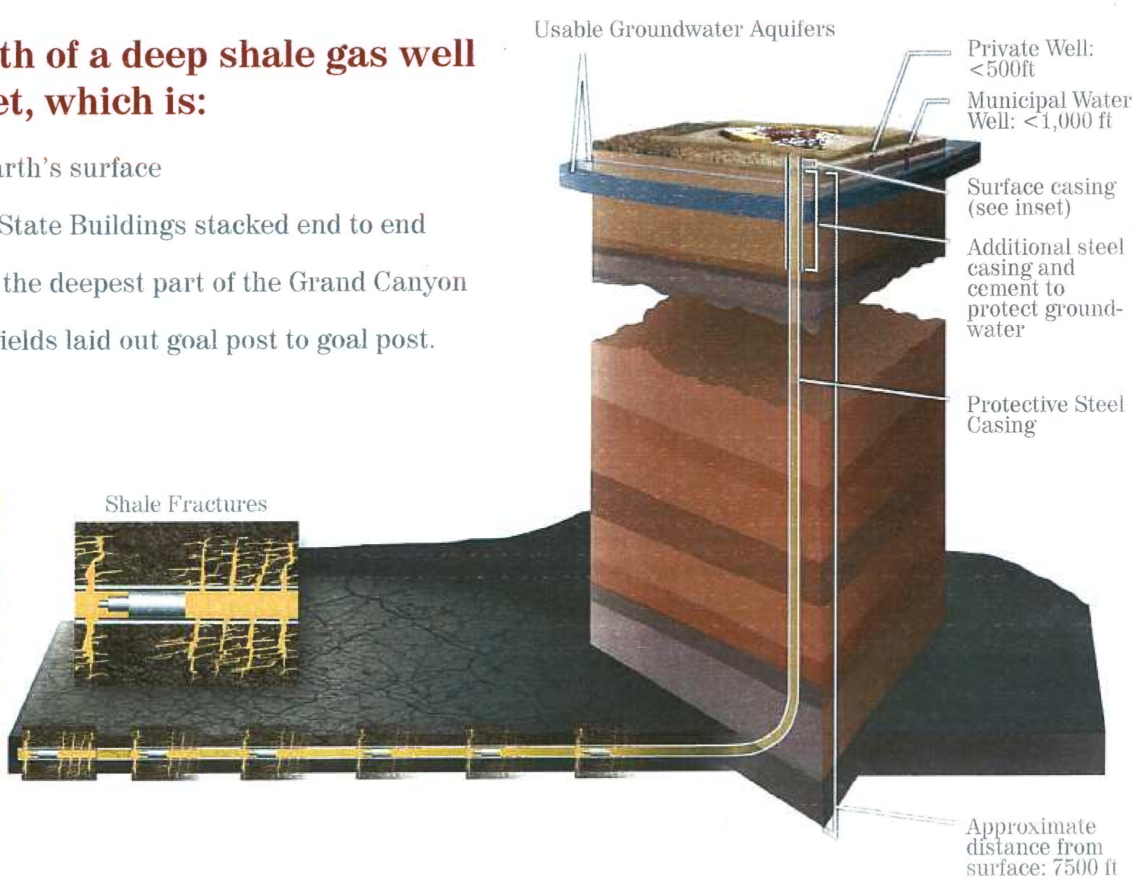
Fracture Stimulation is a proven technology that enables natural gas producers to safely and effectively recover natural gas from hard-to-produce resources trapped in deep shale and other unconventional formations thousands of feet below ground. Fracture Stimulation has been safely applied for the last 60 years, and recently, the combination of the advanced technology and sophisticated horizontal drilling techniques has efficiently unlocked significant amounts of domestic natural gas. Today, 46 percent of all natural gas in the U.S. comes from unconventional formations like shale, tight sandstone and coal formations, and 90 percent of all natural gas wells drilled in America (about 35,000 a year) require fracture stimulation.

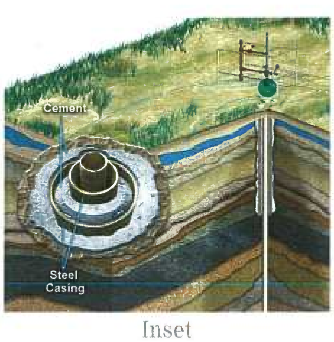
What is fracture stimulation?

Fracture Stimulation is a sophisticated process that is carefully regulated by natural gas-producing states. When fracture stimulation is applied, fractures (cracks) are created in deep underground rock formations to help recover the clean-burning natural gas resources that we all use to heat our homes, generate electricity, cook our food, increasingly fuel transportation and serve many other consumer needs. Shale rock and tight sand formations are so dense and tightly compacted that fracturing is required to release the trapped natural gas.

The average depth of a deep shale gas well is about 7,500 feet, which is:

- 1 ½ miles below the Earth's surface
- More than six Empire State Buildings stacked end to end
- 1 ½ times deeper than the deepest part of the Grand Canyon
- More than 25 football fields laid out goal post to goal post.





Inset

After a well is drilled, a fracture stimulation operation is performed to ready the well for production. The following illustrates the process for a horizontal, deep shale gas well.

- First, the well is engineered to ensure the casing and cementing program protects fresh water, and the well can reach the intended targets.

- A well is then drilled vertically through many thousands of feet of solid rock layers – well below any drinking water aquifers – and then horizontally into the shale formation.

- As the wellbore is drilled, state regulations require that it be reinforced with multiple layers of protective steel casing and cement, designed to stabilize the wellbore and to protect groundwater and fresh water aquifers. The casing is pressure tested after cementing to ensure the integrity of the system.

- Then, a fracture design tailored to the specific formation's geology is created using fracture modeling software.

- When fluids are used in fracturing, the liquid is composed mostly of water and sand and is then pumped into the formation at a calculated rate and pressure to generate carefully designed millimeter-thick fissures or fractures in the target formation. The fluid is typically comprised of 99 percent water and sand, with less than 1 percent special-purpose additives. These additives are needed to enable the water-sand mixture to transport the sand deep into the fracture and then change its properties to allow the water to be removed while the sand remains, holding the fracture open. During the fracturing operations, injection pressure, volume and rate are carefully monitored to ensure the fracture meets the design parameters.

- For the well to produce natural gas, an initial volume of produced water and sediment is removed and collected at the surface to be recycled or disposed of at state-regulated disposal facilities once the operation has been completed.

- The newly created fissures are propped open by the sand. This allows the natural gas to flow into the wellbore and be collected at the surface.

How is fracture stimulation regulated?

The development and production of natural gas in the U.S. is vital to improve our nation's energy security, address climate change and stimulate our economy. It is also highly regulated under a comprehensive set of federal, state, and local laws that address every aspect of exploration and operation. Taken together, existing federal and state requirements along with technologies and practices developed by the natural gas industry serve to protect the environment and public health.

The U.S. Environmental Protection Agency (EPA) administers most of the federal laws, and each state also has regulatory agencies that enforce delegated federal laws, as well as administer their own regulations, including the review and approval of permits for all aspects of drilling activities, such as well design, location, spacing, operation, water management and disposal, waste management and disposal, air emissions, wildlife protection, surface use, and health and safety.

Federal laws that govern environmental aspects of natural gas drilling include:

- **The Clean Water Act (CWA)** -- regulates discharges of pollutants to surface water and storm water runoff.
- **The Safe Drinking Water Act (SDWA)** - regulates specifically the injection of fluid wastes (produced water) under the ground.
- **The Clean Air Act (CAA)** – sets rules for air emissions from engines, gas processing equipment, tanks and other sources associated with production and drilling activities.
- **The National Environmental Policy Act (NEPA)** –requires environmental impact assessments for development of federal lands.
- **Occupational Safety and Health Act** – administered through OSHA, sets safety standards with which employers must comply to protect their employees. Also requires Material Safety Data Sheets (MSDS's) be maintained and readily available for chemicals used on locations for employee use.
- **Emergency Planning & Community Right-to-Know Act (EPCRA)** – requires storage of regulated chemicals above certain quantities be reported to local and state emergency responders on an annual basis.

Given the many geologic, environmental and population-density differences among each state, federal laws provide for the delegation of regulatory responsibilities to states with federal oversight. This proven partnership more effectively addresses the regional and state-specific character of drilling activities, compared to one-size-fits-all regulation at the federal level. States have been regulating fracture stimulation operations for more than 60 years. With 32 natural-gas producing states in America, federal agencies simply do not have the resources to administer all the diverse environmental programs for all the drilling sites around the country. By statute, states may adopt their own standards; however, these must be as protective as the federal standards and may be even more protective in order to address local conditions.

What studies have been done?

The Environmental Protection Agency (EPA), Ground Water Protection Council (GWPC) and the Interstate Oil and Gas Compact Commission (IOGCC) have all studied fracture stimulation and found the process to be non-threatening to the environment and public health.

A GWPC survey of state energy regulatory agencies in 2009 found no documented cases of contaminated drinking water linked to fracture stimulation. The GWPC also concluded that state regulations were sufficient to ensure the integrity of the water supply.

In 2004, the EPA conducted an extensive survey of fracture stimulation practices and the potential effect on drinking water. Focusing on the shallowest of wells (those that are geologically closest to subsurface water supplies), the EPA found that several factors (fluid recovery, the small amount of chemicals contained in fracturing fluids, their dilution in water and their absorption by rock formations) minimize the potential risks associated with fracture stimulation. The EPA agreed with the GWPC and the IOGCC that fracture stimulation is safe. More specifically, the EPA concluded that fracture stimulation does not create pathways for fluids to travel between rock formations to affect the water supply.

A 2002 study conducted by the IOGCC—a multi-state government agency that represents 37 governors—confirmed the GWPC's conclusion that there has been no evidence of contaminated drinking water caused by fracture stimulation

What are the advantages of horizontal well fracture stimulation?

The combination of horizontal drilling and fracture stimulation technologies provide several environmental and economic advantages over conventionally drilled vertical wells. These technologies significantly reduce the overall environmental footprint of drilling activities by giving access to more of the natural gas resources underground from fewer wells above the ground, and creating less surface activity and disturbance. Fewer wells yielding more recovered natural gas also means more cost-effective economics per well and works to make natural gas more affordable and in abundant supply. Technological advances allow natural gas companies to:

- Use less surface area. The average well-site footprint today is 30 percent of the size it was in 1970, and an average well can now access more than 60 times more below-ground area than possible previously.

- Drill fewer wells to add the same reserves. Today, six to eight horizontal wells drilled from a single pad can access the same amount of natural gas as 16 vertical wells drilled from separate locations. Half as many wells are needed to produce the same amount of energy as 20 years ago.

- Generate less waste. The same level of reserve additions is achieved with 35 percent of the generated waste of a decade ago.

- Reduce air emissions. Greater efficiency and improved technologies means less energy consumption per barrel of oil and unit of natural gas produced, and thus less air pollution per unit produced.

What is the environmental track record?

Every aspect of the fracture stimulation process is carefully monitored by as many as 35 people on site and well regulated by multiple federal, state and local laws. The natural-gas-bearing formations are separated by thousands of feet of impermeable protective rock barrier, well below any usable source of underground water. This wide separation prevents the migration of fluids and gases upward into fresh water aquifers and groundwater zones. To date, fracture stimulation technology has been safely applied more than one million times.

What chemicals are involved?

The additives used in fracturing fluids are used in many common household products and foods we eat.
Water and sand constitutes over 99 percent of the fluid, and the remaining ingredients each serve a specific purpose, with amounts adjusted depending on the type of rock and specifics of the well site.

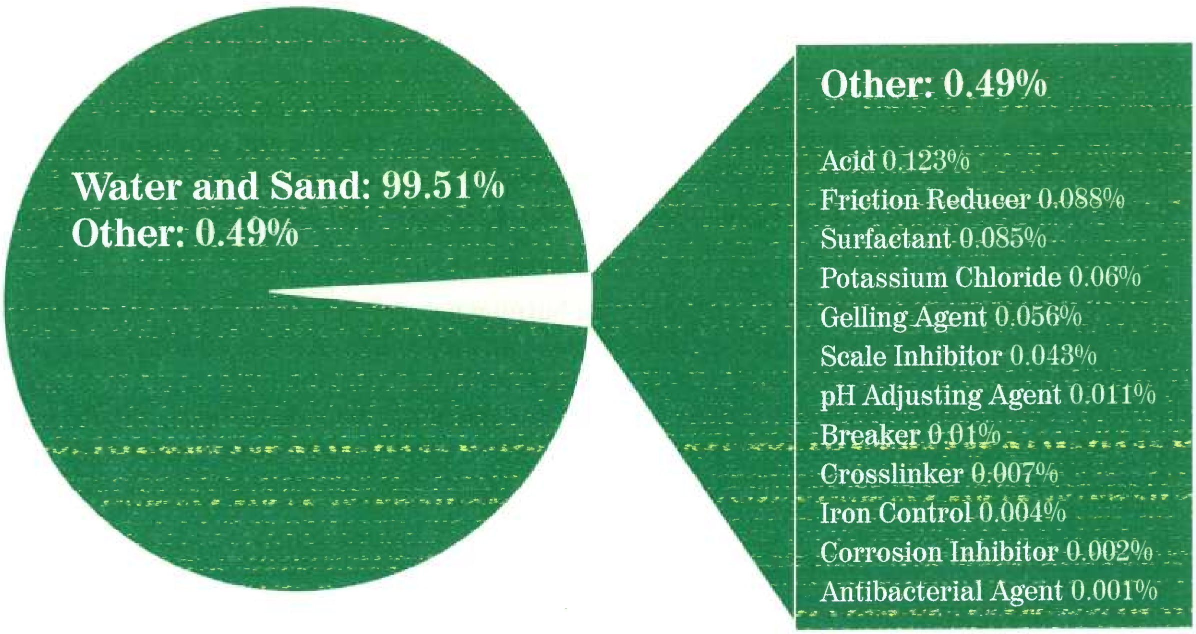
- Guar, made from beans, is added to make the fluid more gel-like to help ensure effective delivery.

- Inert nitrogen gas also is sometimes added to help recover the fluid from the well after the fracturing is complete.

- Once the fluid is ready to be removed, an enzyme or oxidizer undoes the work of the guar, and thins its consistency.

- In addition to these main ingredients, there are small amounts of other chemicals that each play a critical role in the process. Material Safety Data Sheets are prepared and available onsite that contain information regarding the chemical makeup of the product used in the fracturing process. These chemicals make up less than half-a-percent of the mixture, appearing at levels well below what could constitute a threat to drinking water. Further, they are removed during the extraction process, prevented from migrating through the rock bed to the water table and are separated from drinking water formations by steel casings and cement.

Examples of Typical Shale Fracturing Mixture Makeup



Also found in:

.12% Diluted Acid: Household Cleaner, Swimming Pool Cleaner

.09% Friction Reducer: Water Treatment, Candy, Make-up Remover

.09% Surfactant: Glass Cleaner, Antiperspirant, Hair Color

.06% Potassium Chloride: Low Sodium Table Salt Substitute

.06% Gelling Agent: Toothpaste, Baking Goods, Ice Cream, Sauces, Cosmetics

.04% Scale Inhibitor: Household Cleaners. Deicing Agent

.01% pH Adjusting Agent: Detergents, Washing Soda, Water Softener, Soap

.01% Breaker: Hair Cosmetics, Household Plastics

.007% Crosslinker: Soaps, Laundry Detergent

.004% Iron Control: Food Additive, Lemon Juice, Flavoring in Food & Beverage

.002% Corrosion Inhibitor: Pharmaceuticals, Plastics

.0001% Antibacterial Agent: Disinfectant, Used to Sterilize Medical Equipment

How much water is used?

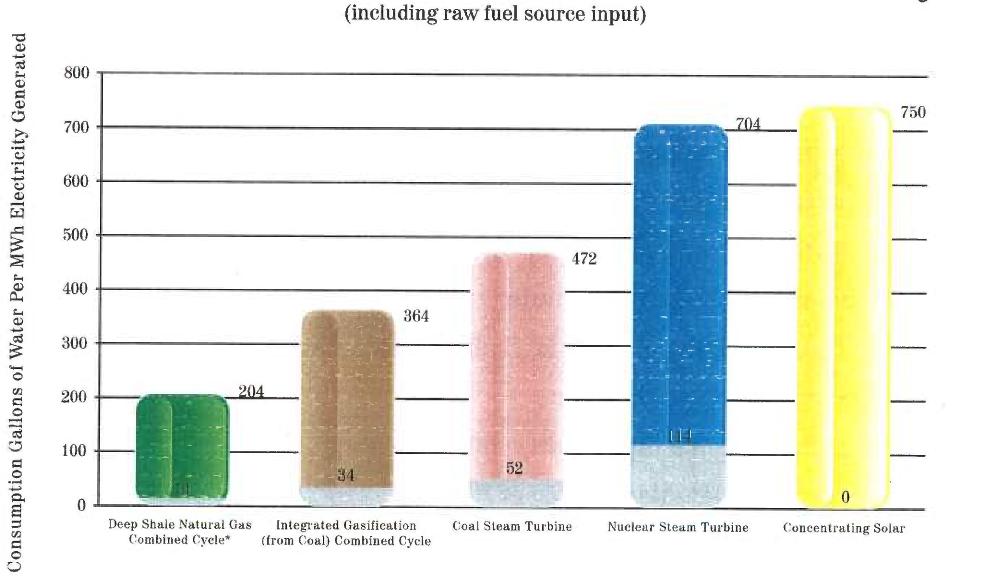
The amount of water necessary to successfully stimulate production in a gas well varies greatly. It primarily depends on the type of well drilled – horizontal or vertical – and the depth of the formation to be stimulated – shallow or deep. The deeper shale formations can use over four million gallons of water. Shallower, vertical wells typically require much less water to complete the stimulation. While the larger volumes can seem high, the amount is relatively small when compared to other industrial uses of water, which can use volumes in the billions of gallons, like agriculture, electric power generation, golf course irrigation and municipal use.

Also, the amount of water used in fracture stimulation generally represents a small percentage of the total water-resource use in each shale gas area. For example, the total withdrawals of water from surface waters in New York State total 9 to 10 billion gallons per day for all uses. Within the Delaware River Basin, nearly 150 million gallons are used daily for power generation, far more than would be used on a one-time basis for fracturing a well. Complementing the lower relative use of water in fracture stimulation is the increasing practice of reuse and recycle of the water as it is collected when the well is put into production. When a well that has been fracture stimulated is first "turned on" a significant amount of the water that was used to stimulate the well can be collected and reused on other fracture stimulation jobs.

The water used in fracture stimulation as a tool to produce clean-burning natural gas compares favorably to the volumes of water used to produce other forms of energy such as nuclear, coal and even concentrating solar power. All forms of energy production invariably require use of water resources, and clean-burning natural gas is no exception. When water costs are considered in producing electricity from some of the most common methods, natural gas uses about 56% less water than coal, 71% less water than nuclear, and 73% less than concentrating solar.

Power Generation Water Use Efficiency

(including raw fuel source input)



Source: Hightower 2008 (other than CHK data)
*Average consumption for fuels: Chesapeake data
Note: Wind turbines and photovotaic solar panels have negligible water demands
MWh = megawatt-hour