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CONSERVATION COMMISSION

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The documentary *Gasland* has attracted wide attention. Among other things, it alleges that the hydraulic fracturing of oil and gas wells has contaminated nearby water wells with methane in a number of states including Colorado. Because an informed public debate on hydraulic fracturing depends on accurate information, the Colorado Oil and Gas Conservation Commission (COGCC) would like to correct several errors in the film's portrayal of the Colorado incidents.

Background

Methane is a natural hydrocarbon gas that is flammable and explosive in certain concentrations. It is produced either by bacteria or by geologic processes involving heat and pressure. Biogenic methane is created by the decomposition of organic material through fermentation, as is commonly seen in wetlands, or by the chemical reduction of carbon dioxide. It is found in some shallow, water-bearing geologic formations, into which water wells are sometimes completed. Thermogenic methane is created by the thermal decomposition of buried organic material. It is found in rocks buried deeper within the earth and is produced by drilling an oil and gas well and hydraulically fracturing the rocks that contain the gas. In Colorado, thermogenic methane is generally associated with oil and gas development, while biogenic methane is not.

The analytical methods use to differentiate between the two types of methane are well-known, scientifically accepted, and summarized in a well-known presentation by Dennis Coleman and papers by I.R. Kaplan and Dennis Coleman. These works, in turn, cites nearly 75 other references related to the topics of methane generation, "fingerprinting," forensic investigations, and stable isotope geochemistry.

Based upon our review of hundreds of Colorado gas samples over many years, the COGCC is able to differentiate between biogenic and thermogenic methane using both stable isotope analysis of the methane and compositional analysis of the gas. In the Denver-Julesburg and Piceance Basins, the COGCC has consistently found that biogenic gas contains only methane and a very small amount of ethane, while thermogenic gas contains not just methane and ethane but also heavier hydrocarbons such as propane, butane, pentane, and hexanes. As explained below, *Gasland* incorrectly attributes several cases of water well contamination in Colorado to oil and gas development when our investigations determined that the wells in question contained biogenic methane that is not attributable to such development.

The Weld County Wells

Gasland features three Weld County landowners, Mike Markham, Renee McClure, and Aimee Ellsworth, whose water wells were allegedly contaminated by oil and gas development. The COGCC investigated complaints from all three landowners in 2008 and 2009, and we issued written reports summarizing our findings on each. We concluded that Aimee Ellsworth's well contained a mixture of biogenic and thermogenic methane that was in part attributable to oil and gas development, and Mrs. Ellsworth and an operator reached a settlement in that case.

However, using the same investigative techniques, we concluded that Mike Markham's and Renee McClure's wells contained biogenic gas that was not related to oil and gas activity. Unfortunately, *Gasland* does not mention our McClure finding and dismisses our Markham finding out of hand.

The Markham and McClure water wells are both located in the Denver-Julesburg Basin in Weld County. They and other water wells in this area draw water from the Laramie-Fox Hills Aquifer, which is composed of interbedded sandstones, shales, and coals. Indeed, the water well completion report for Mr. Markham's well shows that it penetrated at least four different coal beds. The occurrence of methane in the coals of the Laramie Formation has been well documented in numerous publications by the Colorado Geological Survey, the United States Geological Survey, and the Rocky Mountain Association of Geologists dating back more than 30 years. For example, a 1976 publication by the Colorado Division of Water Resources states that the aquifer contains "troublesome amounts of . . . methane." A 1983 publication by the United States Geological Survey similarly states that "[m]ethane-rich gas commonly occurs in ground water in the Denver Basin, southern Weld County, Colorado." And a 2001 report by the Colorado Geological Survey discusses the methane potential of this formation and cites approximately 30 publications on this subject.

Laboratory analysis confirmed that the Markham and McClure wells contained biogenic methane typical of gas that is naturally found in the coals of the Laramie–Fox Hills Aquifer. This determination was based on a stable isotope analysis, which effectively "finger-printed" the gas as biogenic, as well as a gas composition analysis, which indicated that heavier hydrocarbons associated with thermogenic gas were absent. In addition, water samples from the wells were analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX), which are constituents of the hydrocarbons produced by oil and gas wells in the area. The absence of any BTEX compounds in these water samples provided additional evidence that oil and gas activity did not contaminate the Markham and McClure wells.

The COGCC has also reviewed the records for all oil and gas wells located within one-half mile of the Markham and McClure wells, which is more than double the typical hydraulic fracture length in Colorado. This review indicated that: all oil and gas wells near the Markham well were drilled and hydraulically fractured in 1991, except for two wells that were fractured in 2005 and 2006, respectively; and all oil and gas wells near the McClure well were drilled and hydraulically fractured in 2002, except for one well that was hydraulically fractured in 2005. The records do not reflect any pressure failures or other problems associated with these wells that would indicate a loss of fracture fluid or gas from the well bore into the surrounding geologic formations.

In support of its thesis that the Markham and McClure water wells were contaminated by oil and gas development, the *Gasland* website makes several arguments that merit a brief response. First, the website quotes Professor Anthony Ingraffea of Cornell University for the proposition that drilling and hydraulic fracturing could cause biogenic methane to migrate into aquifers under certain circumstances. However, Professor Ingraffea's statement does not suggest that these circumstances apply to the Markham and McClure wells, nor does it address the extensive scientific literature establishing that biogenic methane is naturally present in the aquifer in question. Second, the website quotes Weston Wilson, an Environmental Protection Agency employee, speculating that oil and gas operators in Weld County are withdrawing large amounts of groundwater and that these withdrawals are releasing biogenic methane. However, oil and gas companies in Weld County obtain most of their water from municipalities, which obtain such water from surface water sources such as the Colorado-Big Thompson and Windy

Gap projects. Finally, the website asserts that the water in the Markham and McClure wells deteriorated after drilling and hydraulic fracturing occurred nearby. However, COGCC records indicate little or no temporal relationship between the Markham and McClure complaints and nearby drilling and hydraulic fracturing activities, which occurred several years earlier and in most cases many years earlier.

The West Divide Creek Seeps

Gasland also addresses complaints about oil and gas activity in the West Divide Creek area of the Piceance Basin in Garfield County, though it again confuses issues related to biogenic gas with those related to thermogenic gas. The film focuses on two seeps that are in close geographic proximity but derive from different origins. One of the seeps occurs in a wetland on property owned by Lisa Bracken, who appears in the film; it contains biogenic methane. The other seep, which the COGCC terms the West Divide Creek gas seep, is about 1,500 feet to the south on property owned by a neighbor; it contains thermogenic methane caused by EnCana's failure to properly cement a natural gas well.

Gasland adopts the claim that the West Divide Creek gas seep was caused by hydraulic fracturing. After investigating the matter thoroughly in 2004, COGCC staff concluded the seep was caused by gas migrating up a gas well borehole that had not been properly cemented and in which the upper portion of the gas bearing Williams Fork Formation had not been isolated. On August 16, 2004, following a public hearing, the COGCC commissioners approved an enforcement order (Order 1V-276) that incorporated the staff's causation conclusions and assessed a substantial fine against the operator.

In investigating the West Divide gas seep, the COGCC determined that it contains thermogenic methane. The gas composition and stable isotope signature of the gas closely matched that of the gas being produced from the Williams Fork Formation. The gas from both the West Divide Creek seep and the Williams Fork Formation is composed primarily of methane, but it also contains ethane, propane, butane, pentane, and hexanes. In addition, BTEX compounds were detected in ground and surface water in the vicinity of the West Divide Creek seep, which indicates that the gas is related to oil and gas activities and not of biogenic origin.

In contrast, the laboratory results for the gas samples collected from the seep on Ms. Bracken's property have demonstrated that the gas is biogenic. The COGCC has collected nine gas samples on six different occasions during 2004, 2007, 2009, and 2010. With respect to each sample, the gas composition was found to be 100 percent methane, no heavier hydrocarbon compound was detected, and the stable isotope ratio indicated that the gas is biogenic. The COGCC has also collected six water samples on four different occasions during 2004, 2007, and 2009 and ten soil samples on multiple occasions during 2008 and 2009 from Ms. Bracken's property. BTEX compounds and/or other hydrocarbons associated with oil and gas operations were not detected in any of these samples. Based on these results, the COGCC has concluded that the gas seep on Ms. Bracken's property resulted from the fermentation of organic matter by methanogenic bacteria. This is not uncommon in wetland areas, such as those that exist along West Divide Creek.

Other Information

Oil and gas development is an industrial activity, and property owners sometimes complain that it has contaminated their water well. The COGCC investigates all such complaints and reports the results individually to the complainant and collectively to the Colorado Water Quality Control

Division. In some cases, the COGCC has found that the well contains thermogenic methane linked to oil and gas development. In most cases, however, the COGCC has found that contamination is not present or that the methane comes from biogenic sources and is not attributable to oil and gas production. The following excerpt from a report summarizing the COGCC's investigation following the contamination of the Ellsworth water well is illustrative:

> In response to concerns regarding the presence of methane gas in water wells completed in the Laramie/Fox Hills Aquifer, COGCC, Noble Energy, and Anadarko/Kerr McGee sampled a total of 28 water wells between March 25, 2009 and April 7, 2009 across an approximately 170 square mile area. Sample results show that these wells contained either no methane gas or biogenic (biological generated) methane gas. None of these wells, other than the Ellsworth water well, contained thermogenic methane gas. The sample results along with letters discussing the results were sent by COGCC staff to the 28 well owners [who had requested testing].

Nevertheless, it remains important to establish prudent regulations to ensure that other resources, such as groundwater, are protected. Producing oil and gas formations in much of Colorado, including the Denver-Julesburg and Piceance Basins, lie at depths of up to 8,000 feet below the ground surface, while the aquifers that sustain domestic water wells are generally less than 1,000 feet below the ground surface. COGCC regulations establish casing and cementing standards to ensure that gas being produced from 8,000 feet down does not leak into the shallower aquifers. These regulations require wells to be cased with steel pipe and the casing to be surrounded by cement to create a hydraulic seal within the annular space between the wall of the well bore and the steel pipe. In addition, a number of recent amendments to the COGCC regulations address concerns raised about hydraulic fracturing:

- Rule 205 requires operators to inventory chemicals, including fracturing fluids, and to provide this information upon request to the COGCC and certain health care professionals;
- Rule 317 requires cement bond logs to confirm that aquifers are protected;
- Rule 317B imposes mandatory setbacks and enhanced environmental precautions on oil and gas development occurring near public drinking water sources;
- Rule 341 requires well pressures to be monitored during hydraulic fracturing;
- Rule 608 mandates additional pressure testing and water well sampling for coalbed methane wells; and
- Rules 903 , 904 , and 906 impose enhanced requirements for pit permitting, lining, monitoring, and secondary containment to ensure that pit fluids, including hydraulic fracturing flowback, do not leak.

Finally, it should be understood that the COGCC Director, Dave Neslin, offered to speak with *Gasland's* producer, Josh Fox, on camera during the filming of the movie. Because the issues are technical and complex and arouse concerns in many people, Director Neslin asked that he be allowed to review any material from the interview that would be included in the final film. Unfortunately, Mr. Fox declined. Such a discussion might have prevented the inaccuracies noted above.