

## **Summary of Cited Literature**

Review by Ben Jones, Petroleum Engineer

After reviewing the cited literature that was attached to the petition for rulemaking, it was determined that essentially only three papers had discussion that could be used to justify the rule suggestions in the petition. The three papers are Beak et al. 2015, DiGiulio and Jackson 2016, and Llewellyn 2015. A brief summary of each of these papers is below.

**Beak et al. 2015** – This paper examined an incident involving a blowout and parted casing that occurred during a multi-stage hydraulic fracture treatment in Killdeer, ND. It found that chemicals most likely related to the stimulation were detected in monitor wells drilled subsequent to the blowout. This event occurred prior to the Board’s current hydraulic fracturing rules and was considered in the drafting of the rules for safety and well control requirements related to hydraulic fracturing (ARM 36.22.1106).

**DiGiulio and Jackson 2016** – This paper evaluated the impact to Underground Sources of Drinking Water (USDW’s) as a result of acid stimulation and hydraulic fracturing in the Pavillion, WY, Field. The study suggests there was an impact to USDW’s due to a likely loss of zonal isolation during stimulation, upward solute migration to depths of current groundwater use, and legacy pit disposal practices. There have been numerous other studies on the subject that offer differing conclusions including one by the Wyoming DEQ that suggests the gas in the USDW’s was the result of upward gas seepage which could have been happening naturally before gas well development and it is unlikely that hydraulic fracturing fluids have risen to shallow depths intercepted by water supply wells.

**Llewellyn 2015** – This paper investigates a case where it was suspected that Marcellus Shale gas wells in PA caused inundation of natural gas and foam in initially potable groundwater. Through the investigation, they conclude that the data does not implicate upward flowing fluids along fractures from the target shale as the source of contaminates. The paper also suggest that shallow to intermediate depth contaminant flow paths are not limited to wells that are hydraulically fractured but can also occur in conventional wells. There have been other articles written that question much of the information in this paper that are worth looking at for viewpoints from both sides.

All three of these papers suggest that well construction is the key to preventing contamination, and without appropriate well construction, there might be issues whether the well is conventional or unconventional. In Montana well construction is considered at the time the well is permitted. Further discussion of these types of concerns can also be brought before the board through the board’s current permit notification rule and proposed homeowner notification rule.

The rest of the papers contain discussions of general health hazards that could be associated in some aspect to oil and gas development, however, they either don’t contain evidence to support that the current rules in Montana are inadequate or, that the rule changes suggested in the petition would resolve the issues presented in the papers. A brief overview of those papers can be found attached.

Below is a brief review of each of the references that were attached to the petition to support the statements regarding the hazards of hydraulic fracturing in the petition. The Board recognizes the public concern and potential hazards of the chemicals used in hydraulic fracturing operations and did adopt rules in August of 2011 to address these concerns.

**Casey et al. 2016** – This paper looked birth outcomes as it relates to unconventional natural gas development. The authors looked at health record data and the mother’s proximity to unconventional natural gas development to draw conclusions about the effect the drilling activity had on birth outcomes. The paper doesn’t provide any factual reasons to suggest the current hydraulic fracturing rules in Montana are inadequate or that the suggested rulemaking would resolve issues presented in paper.

**Colborn et al. 2011** – This paper looks at the chemicals in hydraulic fracturing fluid and the hazards associated with them. It does not provide evidence that there are any risks related to hydraulic fracturing operations, just that chemicals in frac fluid can be hazardous. It doesn’t provide any evidence that current chemical disclosure rules are inadequate.

**Haley et al. 2016** – The discussion in this paper suggests that presently utilized setbacks may leave the public vulnerable to explosions, radiant heat, toxic gas clouds, and air pollution from hydraulic fracturing activities. None of these issues can be address with the rulemaking petition.

**Hays and Shonkoff 2016** – This paper concludes there may be health risks associated with unconventional natural gas development based solely on the fact there is an increasing number of papers that suggest there may be health risks associated with unconventional natural development. It contains no science or facts that can be used to evaluate the merits of the rulemaking petition.

**Jemielita et al. 2015** – This paper suggests that hospital utilization rates increase as well density increases. The paper has no evidence to suggest the cause for its findings (water well contamination, air pollution, etc.). The paper doesn’t provide any factual reasons to suggest the current hydraulic fracturing rules in Montana are inadequate or that the suggested rulemaking would resolve issues presented in paper.

**Lund et al. 2015** – This paper gives a general overview of the hydraulic fracturing process in Montana as well as potential hazards. The paper references a National Groundwater Association study of 33 domestic and 25 production wells in the Williston basin for evidence of negative impacts from oil and gas activities. The study showed no water quality issues. This also leaves no reason to believe the current hydraulic fracturing rules in Montana are inadequate.

**McKenzie et al. 2014** - This paper observed an association between density and proximity of natural gas wells to birth defects. The paper seems to lean toward suggesting air pollution is the most likely cause. The paper doesn’t provide any factual reasons to suggest the current hydraulic fracturing rules in Montana are inadequate or that the suggested rulemaking would resolve issues presented in paper.

**Rabinowitz et al. 2015** – This paper looks at the proximity of natural gas wells to homes and how it relates to health status. The research in the paper was done through household surveys in Washington County, PA. Based on the survey results, the authors attempt to tie the health issues reported to a process of natural gas development without any supporting evidence stated. The paper doesn't provide any factual reasons to suggest the current hydraulic fracturing rules in Montana are inadequate or that the suggested rulemaking would resolve issues presented in paper.

**Webb et al. 2014** – This paper looks at the health hazards caused by chemicals found in fluids used with unconventional oil and gas operations by giving examples of negative health effects related chemicals caused in unrelated industries in different countries. There is no original evidence provided that shows actual negative health effects from unconventional oil and gas operations.

**Webb et al. 2016** – This paper looks at the effects unconventional oil and gas air pollution has among infants and children. Air pollution is not an issue that can be addressed by the request in the petition for rulemaking.