Assessing Risk of Hydraulic Fracturing Fluid Spills in Colorado Oil and Gas Development

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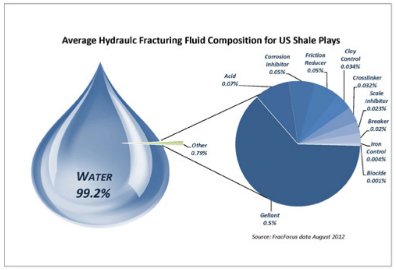
Introduction

•Hydraulic fracturing has enabled previously unviable oil and natural gas deposits to be extracted economically.
•Gaining access to a greater amount of oil and gas resources has major positive economic and environmental implications for the United States.
•Many stakeholders have expressed concern that both the fluids used to fracture the oil and gas formations and the produced water that is a byproduct of oil and gas extraction can harm waterways if they are released.
•Currently, there is not much reliable, unbiased data available concerning the true risks posed by hydraulic fracturing fluid spills.

Background

•Hydraulic fracturing involves injecting fluid at high pressure deep below the Earth's surface to create fractures that trapped oil and gas can flow through.
•Hydraulic fracturing fluid is typically composed of water, sand, and a small percentage of various chemical additives.
•Some of the chemical additives are hazardous to human health.
•During a well's lifetime, some of the hydraulic fracturing fluid flows back to the surface (flowback). Also, water contained in the oil or gas reservoir (produced water) flows to the surface during a hydraulic fracturing operation.



Purpose

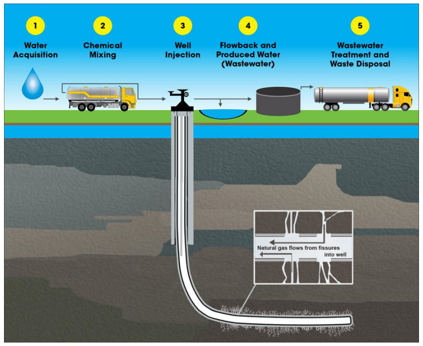
•The purpose of this project is to determine the probability of a hydraulic fracturing fluid, flowback water, or produced water release.
•This research focuses on Colorado oil and gas development in the Denver-Julesberg Basin and the Piceance Basin.

Methods

•We identified the following pathways through which a release may occur include: transportation to and from the site via truck, transportation to and from the site via pipeline, well integrity failure, well blowout, transport via fractures and old wells, and waste disposal.
•A risk equation was developed for each pathway.
•An example of the equation for truck transport to site can be found below. V_{tts} is the volume of contaminant released (m^3), V_{HF} is the volume of hydraulic fracturing fluid per well (m^3), f_{haz} is the fraction of fluid that is hazardous, N_{spill} is the number of spills for trucks transporting fluid to a single well, $N_{shipment}$ Is the number of truck shipments made to a single well, $f_{rel,truck}$ is the fraction of fluid that is released in a spill.

$$V_{tts,truck} = V_{HF} f_{haz} \left(\frac{N_{spill}}{N_{shipment}} \right) f_{rel,truck}$$

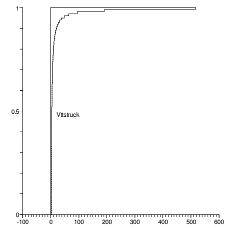
•Data was collected from journal articles, government reports, and databases in order to quantify each parameter.
•Probability bounds analysis was used to determine the likelihood of releases.
•Risk Calc 4.0 was used to perform probability bounds analysis and to produce probability boxes.



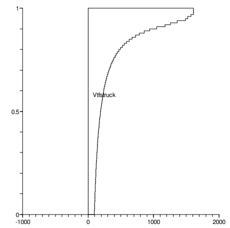
Results

The probability boxes for each pathway are below. The x-axis gives the contaminant volume in m^3. The y-axis of each plot gives the cumulative probability.

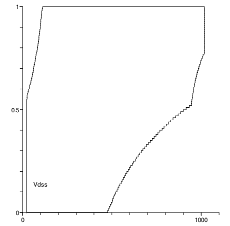
Truck transport to site



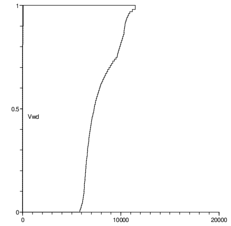
Truck transport from site



Drill site spills



Waste disposal



Analysis

Pathway	Best Case 50th Percentile Contamination Volume (m^3)161	Worst Case 50th Percentile Contamination Volume (m^3)	Maximum Epistemic Uncertainty Between Best and Worst Case (m^3)
Transport to site by truck	<0.01	3.88	516
Transport from site by truck	<0.01	192	1610
Drill site spill	23	917	907
Waste disposal	<0.01	7290	11,400

•According to both the graphs and the table above, the pathway that poses the risk of significant spill is the waste disposal pathway. However, this pathway also has a large uncertainty, so it is just as likely for a small release to occur as it is for massive spill to occur.
•Attention should also be paid to the drill site spill pathway because even in the best case there will be a small spill.

Discussion

•In order to improve this research, each pathway that we identified should be assessed for risk.
•Also, better data should be collected for each pathway in order to decrease uncertainty.
•It is recommended that more research go into high risk pathways such as drill site spills and waste disposal so that releases can be minimized.

Acknowledgments

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