From: Mark Kram
Sent: Tuesday, February 11, 2014 9:06 PM
To: Members of the SAB Hydraulic Fracturing Research Advisory Panel
Cc: Lorne Everett, Thomas Ballestero
Subject: Hydraulic Fracturing Monitoring Observations and Recommendations

Dear Esteemed Colleagues,

It gives us great pleasure to congratulate you for your selection to the prestigious EPA Hydraulic Fracturing Research Advisory Panel. We have had the honor of working with many of you in the past, and are encouraged by your selection to this very important technology review organization. A second objective is to share with you selected observations made over the past few years that we feel could play a key role in the safe implementation of hydraulic fracturing endeavors.

Like you, we are well aware of the sensitivities associated with questions regarding whether hydraulic fracturing can be safely performed in all hydrogeological settings. We are convinced that the key to ensuring safe practices, as well as gaining public and regulatory sector confidence, will depend upon the specific monitoring approaches adopted by the industry and regulatory communities. There is much we can learn from traditional environmental site characterization and assessment methodology – both good and bad – that can be applied to the hydraulic fracturing applications.

Recently, we've documented that vapor intrusion risk conditions can be dynamic. For instance, in 2011 we deployed continuous automated monitoring devices at a site where two homes had previously exploded. We evaluated the spatial distributions of vadose zone methane, H2S, CO2, O2, TVOCs and atmospheric pressure every 15 minutes for approximately 6 continuous weeks. We observed that O2 tracked atmospheric pressure perfectly, while methane was inversely correlated to atmospheric pressure conditions. Methane values ranged episodically from completely safe to highly explosive within a matter of hours. After sharing our initial observations, we were encouraged by California regulators preparing their vapor intrusion guidance to publish our findings. Our resulting paper (Kram et al., 2011) was soon followed by ASTM sponsorship of an international conference on continuous monitoring, as well as a recently released book on the subject (ASTM, 2013). Since our initial discovery, we've documented dynamic methane risks in the vadose zone at more than sixty sites. Furthermore, others (Holton et al., 2013) have documented dynamic risks both indoors and in the vadose zone for TCE.

The implications of these observations point to potential flaws in currently accepted non-continuous monitoring practices. Recall that soil vapor surveys (for which we developed currently accepted ASTM standards) were originally intended to serve as field screening methods to help guide subsequent investigations. However, these approaches have more recently been used for real property transaction due diligence purposes, which have us greatly concerned. For instance, if a soil vapor survey is performed during pleasant weather high pressure climatic conditions, the chance of observing hazardous vapors is significantly reduced. Similarly, Holton

et al. (2013) concluded that use of conventional methods will have a high probability of false negative results for indoor vapor monitoring applications.

We believe that these observations have merit in the hydraulic fracturing quality control arena as well. When Dr. Everett and Dr. Kram co-Chaired the ASTM symposium on continuous monitoring in January of 2013, audience participants described how they've observed similar dynamics in landfills, and one participant provided them with data showing a dramatic drop in methane concentrations in the headspace of a fracking well as the atmospheric pressure rose, followed by a methane concentration increase when pressure began dropping as a storm moved into the area. This is consistent with what we observed in the vadose zone at the site where the homes exploded. Furthermore, our colleagues from the United Kingdom informed us that the Royal Society and Royal Academy of Engineering have concluded that vapor leaks associated with shale gas extraction methods are related to the well bore and associated seal, and recommend continuous monitoring around these locations (Royal Society, Royal Academy of Engineering, 2012).

In summary, the key points we would like you to consider include the following:

1) Practitioners have documented that soil vapor conditions are dynamic for both petroleum as well as halogenated compounds and methane (Kram et al., 2011; ASTM, 2013; Holton et al., 2013);

2) The risks associated with vapor intrusion appear to be episodic and random in nature (Holton et al., 2013), but can track other parameters such as barometric pressure (Kram et al., 2011; ASTM, 2013), soil moisture (ASTM, 2013), and seasonal variabilities (Schumacher et al., 2012; ASTM, 2013);

3) Preliminary observations of methane in head space within hydraulic fracturing wells suggests that similar phenomenon control concentrations in the subsurface and can be applied to hydraulic fracturing operations;

4) Continued use of conventional environmental assessment techniques (including non-continuous spot sampling without consideration of dynamics) will result in a high probability of false negative results (e.g., risks are not detected or responded to);

5) We are convinced that the best way to adequately assess potential risks is through continuous high frequency monitoring;

6) New sensor based monitoring technologies exist and should be considered and possibly required (consistent with what is currently being considered in the United Kingdom);

7) Fugitive emissions of greenhouse gases could be significantly addressed at the wellheads rather than more expensive handling and removal methods;

8) Vadose zone and above-ground vapor monitoring can be more efficient than groundwater monitoring, as the zone of investigation is much larger and more sensitive to change; and

9) Vapor monitoring enables distinction of the sources of any potential fugitive emissions.

California Senate Bill 4 recently passed, and requires monitoring for all hydraulic fracturing projects. However, the legislation does not require use of specific monitoring approaches and does not consider continuous monitoring. As a result, our concern is that local regulators will most likely require protocol similar to traditional quarterly monitoring approaches which are now recognized to be prone to flawed results. If your efforts point to the benefits of continuous monitoring, and if the message is successfully transferred to the local level, our concerns could be greatly alleviated.

Like you, we are strong advocates for incorporation of best available science and technologies that match industry understanding of dynamic natural processes. Given the extent of hydraulic fracturing, and the fact that initially established policies and protocol are difficult to change in the future, we want to strongly encourage EPA to take a pragmatic and science-based position by requiring continuous monitoring of vapors as well as shallow groundwater quality where necessary.

Thank you again for your willingness to work on this very important issue, and for your commitment to our industry.

Kindest Regards,

Mark Kram, Ph.D. (Groundswell Technologies, Inc.)
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Thomas Ballestero, Ph.D. (University of New Hampshire)

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“Water is the most critical resource issue of our lifetime and our children’s lifetime. The health of our waters is the principal measure of how we live on the land.” Luna B. Leopold