This letter from Bill Hornbuckle was read into the record of the Lost Pines Groundwater Conservation District meeting on April 16, 2014.

My name is Bill Hornbuckle. I am a retired geophysicist, having spent 30 years at Shell Oil Company. I have worked plays all over the world, including domestic onshore and offshore plays with extensive experience in Texas, Gulf of Mexico, and Alaska. I served as the Chief Geophysicist for the Alaska offshore lease sales a few years ago, was the Geophysical Coordinator for a recent reevaluation of the offshore US East Coast, and participated in the assessment of the Eagleford Shale play in South Texas before my retirement. Linda Curtis asked me to summarize my views on the ongoing onshore hydraulic fracturing plays currently being pursued in Central Texas.

There are several key issues to be considered in the responsible development of these unconventional reservoirs that require fracturing, but a little context is required to understand the factors that influence the business practices. These wells are characterized by high initial production rates that decline rapidly (in only a few hours or days) and have a long production tail. They don't produce a large volume of hydrocarbon, take years to pay out, and are not highly profitable on a per well basis. Development depends on hundreds of wells drilled at a low cost; typically the wells must be completed for less than $3,000,000 apiece to be profitable, for a ballpark number. This often excludes major operators from these plays because their corporate overhead and required best practices simply make the wells too expensive.

The primary operators in these plays are companies like Chesapeake and Encana, who work hard to keep costs down, rig utilization high, and keep drilling practices and completion cost barebones and minimal. The cost structure also precludes any kind of extensive subsurface reservoir mapping and evaluation. The business model is similar in a lot of ways to onshore development in the 50's and 60's, when oil and gas was cheap ($0.25/gal) and would not support much besides poking a hole in the ground.

With this background, it is not surprising that the number one problem, by far, is poor completions and cement jobs that leak into shallow aquifers near the surface. Good completions and cement

jobs are expensive and take time. Every step of the way the operator is tempted to cut corners. Use less cement. Don't wait as long as you should for the cement to cure. Don't run a full suite of completion logs to verify the seal around the casing. Don't run a full suite of subsurface logs to make sure you set casing in solid shale intervals, etc., etc. As companies drill more wells in the same area, they cut back even more, reasoning they already know what they need to know from surrounding wells. The result, as one might expect, is completion failures and leaks into shallow aquifers, where the higher pressure in the well bore spews hydrocarbon into the low pressured shallow zone. Almost all documented contaminations result from this, and the economic pressure to cut costs never lets up.

It is clear that this problem, the primary real issue with these plays, can only be alleviated by requiring best practices to be followed, by careful regulation and monitoring to ensure quality completions. This needs to be backed up by tough enforcement and onerous penalties that are commensurate with the damaged caused by potential spills.

There is no other incentive for the operator to make these investments, because an occasional spill or bad cement job does not materially affect their production, so there is no economic incentive to perform the tasks in a more responsible manner.

Another issue that comes up is faults and small earthquakes. This is a red herring. Slight movement along existing faults is caused when pressure changes in a reservoir caused by injection alter the pressure gradient across the fault. But this is not a problem. Faults move all the time, even when they do not generate small earthquakes. Studies document fault movements on ocean seafloor that are caused by the moons gravity, like the tides. But these faults stay sealed, there are often hundreds of feet of shale on one side of a fault, transposed against the same shale on the other side. If it did leak anything, it leaks at the reservoir level, 7,000-10,000 feet below the surface, not into a shallow aquifer used by people. There are no documented cases of this causing aquifer problems.

Stepping back from operational aspects of the well bore, another big issue is a lack of understanding of the reservoirs and their connectivity. Because the economics do not support extensive 3D

seismic surveys, extensive well logging and monitoring, or detailed mapping, there is not a very good understanding of the connectivity of the reservoirs, the drainage area of the reservoirs, or the risk of commingling fluids from different reservoirs. This is a little bit like walking around in a room blindfolded. Sooner or later, you will walk into an unpleasant surprise. This same problem is even more acute when the issue of groundwater development comes up. Water marketers do not even practice reservoir management at all, they pump at maximum rates and encounter problems like drastically dropping water tables, surface subsidence, and well non-performance due to reservoir compaction and ‘coning', which in this case will pull briny water from deeper in the reservoir and pollute the shallower fresh water.

The O&G industry put regulations in effect to limit these obvious problems long ago because the problems damaged the economics of the project. The water marketers should be required to do the same diligence, and should be required to abide by the results. Failure to do so will cause problems like the subsidence of the Houston Ship Channel area in the 1970’s due to groundwater withdrawal.

In all, whether it is oil and gas, or groundwater, withdrawing fluids from the subsurface is a major engineering undertaking that can have far reaching consequences. There is no substitute for knowing what the subsurface looks like, knowing how to do the job right, and getting it done properly and responsibly. There are not always economic reasons to do the right thing, and when that incentive is not there in a capitalist enterprise, regulation and monitoring must play a role in managing the public asset and ensuring the safe, clean, publicly responsible operation of the enterprise. Failure to do so can and will have unintended and catastrophic results sooner or later.

Thank you for your time,
Bill Hornbuckle
William Hornbuckle <bill.hornbuckle@me.com>