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GAS WELL/WATER WELL SUBSURFACE CONTAMINATION - PLAN FOR INVESTIGATION

Rick Railsback
CURA Environmental & Emergency Services

Listed below are tools and methods which will be useful in the investigation and litigation support for a claim involving contamination of a water well by the operations conducted at an oil and/or gas well. None of these technologies are new, though they may be unfamiliar to the layman and to environmental consultants who have no specific background in oil and gas drilling and production. One of the oil and gas industry's essential tasks is to figure out how and where gas, oil, and water are migrating in the subsurface and around wellbores. The list below is loosely organized from simplest to most complex and from the least expensive to the most expensive methods. Every investigation will be unique, and the list may be utilized in any sequence or combination that satisfies the client's needs and objectives.

1. Proximity. Obviously, the closer an oil/gas producing well is to the affected water well the higher the likelihood of potential impact. Conversely, at some distance, depending on subsurface conditions and geometry, the likelihood of impact becomes improbable or even impossible.

2. Timing of the impact. When was the water well impacted relative to the drilling and completion of the oil and gas well?

3. Are other potential contaminant sources viable (naturally occurring methane in the groundwater; surface sources such as septic systems, landfills, animal waste; organics in the well casing, pump, and/or the storage tank; etc.)? Methane is naturally occurring, and a wide variety of sources can generate nuisance amounts in well water. Numerous potential sources may also exist for total petroleum hydrocarbons (TPH); benzene, toluene, ethylbenzene, xylenes (BTEX); volatile organic compounds (VOC), and polycyclic aromatic hydrocarbons (PAH).

4. Oil/gas well records (casing, cementing, frac, and completion information). Much of this is publicly available information, and the remainder can be obtained from the operator. Can we demonstrate that the well was drilled and completed properly and in accordance with all applicable regulatory guidelines?

5. Pressure data from the gas well. Pressure gauges can be placed on all casing strings that are tied in at the surface to the Christmas tree. Elevated pressures on any of the casing strings (other than the tubing) may be indicative of a cement job breakdown and subsurface migration of gas and fluids in the annulus of the wellbore.

6. Pressure data from the water well. Significant migration of gas from deeper horizons into the shallow aquifer and the water well will inevitably result in elevated pressures (water levels) in the water well.

7. Data on frac geometry (frac height and frac half length). The operator will have detailed engineering data data and may also have microseismic data recorded during the frac job. A properly designed and performed frac job will not affect aquifers located several thousands of feet above the fraced zone. Though some attorneys may still argue this point, blaming the frac job for aquifer contamination is not a scientifically defensible position. Lacking very unusual geologic conditions (faults and/or natural fractures which extend from the oil and gas producing horizon up to the shallow aquifer), the only viable pathway from the deep reservoir to the shallow aquifer is the wellbore and the annulus of the well (the space between the casing and the formation), which is cemented at the time of well drilling and completion. In some cases, the frac job may break down the annular cement job.

8. Natural gas composition. A general differentiation between microbial gas (generated at shallow depths by the activity of microorganisms) and thermal gas (generated at deeper depths by heat) can be achieved by analyzing carbon and hydrogen isotopic composition of the gas. Nitrogen and carbon dioxide content have been utilized in some cases to differentiate between deep and shallow natural gas sources.

9. Condensate composition. Total petroleum hydrocarbons (TPH); benzene, toluene, ethylbenzene, and xylenes (BTEX), volatile organic compounds (VOC), and polycyclic aromatic hydrocarbons (PAH) are constituents of natural condensates.

10. Water composition. TPH, BTEX, VOC, and PAH can be present in a dissolved phase in water. These contaminants are not normally present in water well water. Methane (CH_4) and other hydrocarbon gases may also be dissolved in water. Methane and other hydrocarbon gases are not normally present in high concentrations in water well water. Minerals and salts are also dissolved in water. Water well water typically exhibits a total dissolved solids (TDS) in the range of 500 – 1,800 parts per million (ppm) and chlorides in the range of 20 – 500 ppm. Water from deeper oil and gas reservoirs typically exhibits TDS and chlorides in excess of 20,000 ppm.

11. Seismic data. The occurrence of significant accumulations of free natural gas in the shallow subsurface will have a definitive signature (“bright spots” – amplitude anomalies) on seismic data. The definition of these accumulations with seismic data may be limited by the physical constraints of the data itself and the focus of the data acquisition techniques; i.e., thin (less than 30 feet) accumulations of gas may not be discernible. Seismic data is available over most producing areas. Obviously, the timing of data acquisition will affect applicability to any particular investigation.

12. Cement bond logs. The cement bond log is obtained with an acoustic (sonic) device which demonstrates cement bonding (or lack thereof) between the casing and the cement and the cement and the formation in the annulus of the well.

13. Noise logs. Movement of gas and fluids within the well or behind casing creates noise which can be logged by an underwater microphone.

14. Temperature logs. The migration of gas and fluids within the well or behind casing will cause measurable temperature differentials in the wellbore.

15. Gamma ray logs. The migration of gas and fluids behind the casing of the well will cause the deposition of salts and other minerals with a higher than normal radioactivity signature. The gamma ray log measures this radioactivity.

16. Radioactive tracers. Radioactive tracers can be introduced into the oil/gas well and then monitored within and adjacent to the wellbore and/or at the affected water well.

17. Pressure interference tests. A downhole pressure gauge is installed in the affected water well, and a pressure wave or series of waves is created in the oil/gas producing well by producing the well then shutting the well in intermittently. If the wells are hydraulically connected, the pressure wave(s) generated in the oil/gas well will be recorded in the affected water well.

18. Installation of monitoring wells between the oil/gas well and the affected water well. Installation and sampling of water wells located between the oil/gas well and the affected water well will define the area of contamination and the migration pathways.

Rick Railsback
Cura Environmental and Emergency Services
Texas Professional Geoscientist No. 299
rick@curaes.com