



December 22, 2014

Eldon Ackerman
17125 North CR 15
Wellington, CO 80549

Subject: Produced Water Sample Results - Ackerman #1 Oil Well
API 05-069-05209 (PRAW AKER)

Dear Mr. Ackerman:

The Colorado Oil and Gas Conservation Commission (COGCC) has been investigating the need to properly plug and abandon a dry and abandoned oil well known as the Ackerman #1 (API 05-069-05209) located on your property. The well is located in the northeast quarter of the northeast quarter of Section 19, Township 10 North, Range 68 West of the 6th Principal Meridian at 40.825188 degrees latitude and -105.040984 degrees longitude.

The Ackerman #1 oil well was drilled in 1963 and subsequently abandoned as a dry hole. The well was re-entered in 1973 by Alpha-Omega Exploration Company and again determined to be a dry hole. However, Alpha-Omega obtained permission to leave the casing unplugged and give the well to Albert Ackerman for use as a water well. Records in the COGCC well file indicate that the well may have been plugged back to 2464 feet below the surface and perforated at several intervals from 1790 - 1800 feet, 2068 - 2074 feet, 2164 - 2165 feet and 2193 - 2199 feet.

A COGCC Field Inspector discovered in 2013 that the oil well casing was open and flowing water to the surface. The Ackerman #1 oil well was added to the COGCC Plugging and Reclaiming Abandoned Wells (PRAW) project list.

COGCC Environmental Staff inspected the location on September 25, 2014 and again on October 23, 2014 to collect a water sample. COGCC collected a sample by using a submersible pump lowered approximately 110 feet down the open 4.5-inch steel casing. COGCC pumped the well at a rate of one-half gallon per minute until 20 gallons of water had been purged from the well. COGCC monitored the recharge of the well using a downhole probe and detected a very slow recharge rate of 0.02 feet in 7 minutes. COGCC purged an additional five gallons of water from the well and collected the water sample for laboratory analysis.



The purpose of analyzing the water was to determine if the well was producing water from a hydrocarbon bearing zone and if the water posed a threat to public health of the environment. COGCC analyzed the water sample for several analytes including: major cations and anions, dissolved gases, and dissolved hydrocarbons. Results of the analysis are discussed below and are summarized in Table 1. A copy of the full analytical report is included as Attachment 1.

INORGANIC ANALYTICAL RESULTS

Total Dissolved Solids were detected in the water sample at a concentration of 1,800 milligrams per liter (mg/l). There are no primary health based drinking water standards for TDS. An aesthetic standard of 500 mg/l has been applied for domestic drinking water. The agricultural standard for TDS is 1,500 mg/l for irrigation and 5,000 mg/l for livestock watering. However, the individual ions composing the TDS should be evaluated individually for their potential toxicity.

Major ions included in the TDS concentration of 1,800 mg/l include: *sodium (790 mg/l), chloride (390 mg/l), bicarbonate (1,000 mg/l) and iron (11 mg/l)*. There are no primary health based standards for these ions, and no agricultural standard for sodium, chloride, or bicarbonate. However a high concentration of sodium in irrigation water may stress vegetation and degrade the soil structure in areas where the water is applied.

Fluoride was detected at a concentration of 4.8 mg/l, which is above the domestic water supply health based standard of 4.0 mg/l and the agricultural standard of 2.0 mg/l.

Several other ions were present at concentrations below domestic water or agricultural use standards and are summarized on Table 1.

ORGANIC COMPOUNDS ANALYTICAL RESULTS

Dissolved Hydrocarbons: The sample was analyzed for total petroleum hydrocarbons as gasoline range organics (TPH-GRO) and total petroleum hydrocarbons as diesel range organics (TPH-DRO), as well as the individual hydrocarbons benzene, toluene, ethylbenzene, and total xylenes (BTEX). BTEX are the most common hydrocarbons present in water produced from oil and gas bearing strata in the Denver Basin. The laboratory detected trace amounts of TPH-DRO and BTEX in the water sample. There are no health based standards for TPH-DRO because TPH-DRO represents a range of compounds. None of the BTEX constituents were detected at a concentration that exceeds the health based standards for domestic drinking water set by the Environmental Protection Agency and the Colorado Department of Public Health and Environment.

DISSOLVED GASES

The laboratory analyzed the water sample for the dissolved gases methane, ethane and propane. Methane was detected at a concentration of 13 mg/l, while ethane was detected at 0.12 mg/l and propane was detected at 0.009 mg/l. COGCC also submitted the water sample for gas composition and isotopic analysis.

Methane gas alone is physiologically inert and non-toxic to humans. Normal breath exhalation contains methane at a ratio of 1 to 99 parts per million. Based on the results of extensive testing for methane gas in water wells throughout Colorado, concentrations of methane gas below 1 mg/l are considered harmless, with concern for possible hazards from the methane increasing at concentrations in well waters at or exceeding 7 mg/l. The presence of methane in drinking water does not present a known health hazard to humans or other animals via ingestion; however, methane in domestic water supplies can be associated with undesirable and potentially serious side effects. Methane gas dissolved in water "exsolves" when exposed to the atmosphere and dissipates rapidly because it is lighter than air. This is often responsible for the "fizzing" observed in water wells that contain methane gas. If the methane occurs at a high enough concentration and if it is allowed to accumulate in a confined space, such as a well pit, crawl space, closet, etc., an explosion hazard can be established. In addition, if methane concentrations in well water are high, bubbles of free gas form within the water and cause the well pump to cavitate and no longer bring water to the surface.

Origin of Methane in Produced Water

The gas produced from oil and gas wells in the Denver Basin is thermogenic methane. Thermogenic methane gas is formed by thermal breakdown of organic material in rocks resulting from high temperatures created by deep burial. With the methane gas are other high carbon number compounds ("heavier") gases such as propane (C3), iso-butane (iC4), normal butane (nC4), iso-pentane (iC5), normal pentane (nC5), and hexane (C6). Biogenic methane gas occurs in most near-surface environments and is a principal product of the decomposition of buried organic material.

Laboratory results of the gas sample collected from the Ackerman #1 well show it contains methane (63.48 percent), nitrogen (35.47 percent), ethane (0.213 percent), argon (0.507 percent), carbon dioxide (0.15 percent), oxygen (0.14 percent) and trace amounts of helium, ethylene, propane, propylene, n-butane, iso-butane, iso-pentane, and hexanes. The nitrogen, oxygen, argon, helium, and carbon dioxide are components of air.

The methane gas in the water sample was also analyzed for isotopic composition of deuterium/hydrogen and carbon-13/carbon-12. The deuterium/hydrogen isotope ratio is -248.9 per mil and the carbon-13/carbon-12 isotope ratio is -64.91 per mil.

I have included a cross-plot of the methane stable isotope ratios for the water sample collected to help illustrate the results. The gas from the Ackerman #1 water sample plots in the sub-surface microbial gas (biogenic) area of the plot, indicating the gas does not originate from a deeper oil and gas bearing source.

SUMMARY

The laboratory analytical results indicate that the total dissolved solids concentration may be suitable for livestock use, but is likely unpalatable for human consumption. The sodium concentration is high enough that the water may be unsuitable for irrigation. A good source of information on livestock and water, in addition to your local veterinarian, is the publication

titled *Water Quality for Wyoming Livestock and Wildlife*, which is available from the University of Wyoming Extension at <http://www.uwyo.edu/uwe/pubs/b1183>.

Dissolved methane is present at a high enough concentration that precautions should be taken to prevent the buildup of methane gas if the well is enclosed in a pump house or well pit to house well equipment. Depending on the source of the methane, the concentration may be lowered after significant pumping and cleaning and sanitizing of the wellbore to remove any bacterial growth. Additional sampling for the presence of dissolved methane may be warranted if the well is put into production for use as a water source.

The trace amounts of BTEX and TPH-DRO present indicate there may be contact with a hydrocarbon source, but the concentrations are so low that it is difficult to ascertain whether significant hydrocarbons will be present in the produced water. Additional analysis for BTEX and TPH-DRO is recommended after additional pumping of the well.

If you decide to claim ownership of the well for use as a water well, you will be required to register the well with the State of Colorado Division of Water Resources (DWR). COGCC's removal of the well from the PRAW program does not guarantee that you will be granted a water right or water well permit by the DWR. In addition, the well will require a proper pad and cap to prevent surface water from infiltrating the wellbore and causing potential contamination of the subsurface.

COGCC's Engineering Staff will contact you to discuss the next steps and whether you wish to pursue registration of the well as a water well for personal use, explore potential economic benefits through an agreement with a third party, or have COGCC proceed with making plans for plugging the well.

Please contact me at 970-461-2970 with any questions regarding the data summarized in this letter.

Regards,



Richard Allison, P.G.
Environmental Protection Specialist - Northeast Colorado

C: Mark Schlagelhauf - COGCC Area Engineer
Well file

Attachments: Attachment 1 - Table 1 Summary of Analytical Results
Attachment 2 - Stable Isotope Analysis Plot
Attachment 3 - ALS Environmental Laboratory Analytical Report
Attachment 4 - Isotech Dissolved Gas Composition and Isotopic Analysis

Attachment 1
Table 1 Summary of Analytical Results

Attachment 2
Stable Isotope Analysis Plot

Attachment 3
ALS Environmental Laboratory Analytical Report

Attachment 4
Isotech Dissolved Gas Composition and Isotopic Analysis