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Abstract

Baseline sampling and monitoring of surface and groundwater resources has become a significant risk mitigation option for operators in Colorado's unconventional gas basins. First instituted by coalbed gas operators in the San Juan basin, the practice has now become an integral part of Colorado Oil and Gas Conservation Commission regulatory permit requirements in the San Juan, Raton, and Wattenberg basins. Several operators in the Piceance basin have been conducting their own groundwater monitoring operations since the turn of the century. Similar work in the Piceance basin has been supplemented by funding from both Garfield County and the COGCC.

Baseline sampling is based on sampling one or more water wells and surface water resources within a pre-defined radius around the planned location of an infill gas well. In that sense, the term "baseline sampling" is somewhat of a misnomer because results usually record existing groundwater conditions after historic drilling operations. Monitoring consists of sampling the same water wells one or more times after a planned well is drilled. Sample analysis includes major ions, selected trace minerals and anions, dissolved methane concentration, dissolved BTEX, BARTTM cultures, Coliform bacteria cultures, and both chromatography and stable isotope analysis of fixed gases and hydrocarbons whenever dissolved methane concentrations exceed 2 mg/L.

Results from hundreds of sampled wells over large areas in Colorado show that most water wells draw water from more than one aquifer regardless of screened interval placement. This is evident from observed seasonal changes in water quality which show signatures of shallow, intermediate, and deep aquifer fluid sources harboring distinct water types. The well bore becomes a mixing zone. Most wells are aggressively infected with iron-related, sulfur reducing, and slime-forming bacteria. Such results explain most complaints related to apparent progressive losses in water yield and declining water quality. Results also serve to educate water well owners on the importance of proper well maintenance practices. The majority of water wells (>60%) contain measurable amounts of dissolved biogenic methane, with about 5-10% of those containing more than 1 mg/L.

A small number of water wells and springs are impacted by oil and gas operations. The weak link in all drilling-related problems is a compromised annulus, not drilling fluids or completions practices. Drilling blowouts, uncemented annuli of both old and new wells in areas with shallow gas, lost cement, and poor cement bonding across highly fractured intervals in both vertical and deviated wells can allow gas and condensate to escape into shallow aquifers. Illegal "midnight dumping" of produced water and other disposal pit fluids is another occasional source of contamination. The availability and consistency of baseline water quality data facilitates interpreting forensic geochemical data, makes it possible to routinely and directly identify polluting point sources, and is necessary for evaluating the efficacy of remedial actions.