



United States Department of the Interior

U.S. GEOLOGICAL SURVEY

425 Jordon Road
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Mr. Jack Dahl, Director
Bureau of Oil and Gas Regulation, 3rd Floor
NYSDEC
625 Broadway, Albany, NY 12233-6500

Mr. William Boria, WR Specialist
Chautauqua County Dept. of Health
Hall R. Clothier Bldg.
7 North Erie Street
Mayville, NY 14757

Dear Mr. Dahl and Mr. Boria:

I have read the discussion of the water-quality issues at the Ferrugia household in your letters (dated June 1, 2009 and the response July 6, 2009). Because I have been included, by way of copies, in this discussion I wanted to comment on the scientific evidence presented. Based simply on the information provided in these two packages, there may not be sufficient data or information to show that the water-quality changes were or were not related to gas well development.

The comments on the variability of water quality in the region are worth considering and to some extent are shown by the additional sample analyses from the neighbor wells provided in the DEC response. The shift in ratios at the Ferrugia well shown in the Piper diagrams appears to be consistent with a shift towards gas field brine. However, ratios alone may not be sufficient to understand the changes. Concentrations of major ions and trace elements should be considered.

Barium, a trace element that can be associated with gas-field brines, shows a 6-fold increase at the Ferrugia well from 2005 to 2007. This increase was accompanied by a 50 percent drop in sulfate concentration, which is also consistent with the introduction of deep, anoxic source waters or brines (where gypsum is absent in bedrock). These two 2007 concentrations at the Ferrugia well differ significantly from those at the other domestic wells.

Given the concentrated nature of gas well brines, only very small percentages (tenths of percents) need mix with local groundwater to have adverse water-quality effects. This kind of contamination could be in the form of discrete slugs of contaminated water and (or) gradual leaching as recharge passes through contaminated overburden material.

I should also note that the 2009 water analysis is suspect. The charge balance (the balance between positive and negative ions) is in error by 28.4 percent, which is considered unacceptable. The two previous samples had errors of 0.7 and 6.4 percent. The likely cause of this imbalance is either the chloride concentration (low) and (or) the sodium concentration (high). Given the consistency or

increase of most other major ion concentrations (and TDS) with those measured in 2007, it is most likely that the chloride concentration is in error. If the chloride concentration is considered the primary source of the charge balance error, the actual concentration is likely about 250 mg/L.

I would suggest that basing a determination of the water-quality changes at this well on 3 samples (one that is suspect) over a four-year period is insufficient. Additional seasonal sampling may be warranted. A surface electromagnetic (EM) geophysical survey would be a cost effective way to evaluate gas well surface sites as sources of high conductance ground water.

In the DEC response, there was also discussion of the direction of groundwater flow; groundwater flow in hillside settings is typically downslope. Shallow bedrock is typically more fractured and permeable than deeper bedrock because of the weight of the overlying rock. The interior of hills are also less permeable for the same reason. Thus, a gentle southward dip may not divert significant groundwater flow away from the downslope direction. Also, septic contamination cannot be ruled out without E. coli testing, but typical septic contamination is not consistent with the water-quality changes observed at the Ferrugia well.

If you have questions, or would like to discuss this further, please feel free to contact me.

Sincerely,



Paul M. Heisig

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