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General Guidance Document on Well Water Monitoring In Advance of High Volume Horizontal Hydrofracturing

Background: With the potential for wide-spread, high-volume, horizontal hydrofracturing natural gas development to take place within Otsego County, many residents and local municipal officials have expressed concern over the possibility of well water contamination that may come as a result. While the New York State Department of Environmental Conservation (DEC) does recommend, and may require, gas companies to test wells within a particular distance of a drilling operation, individuals or local governments outside this area may still wish to establish a 'pre-drilling baseline' on the water quality of their own private or municipal well.

One factor keeping such individuals and municipalities from beginning this process has been the lack of any 'official' guidance from DEC or Department of Health (DOH). Although the draft Supplemental Generic Environmental Impact Statement (dSGEIS) currently being reviewed by DEC does suggest a list of parameters (Chapter 7, pages 40 & 41), any official recommendations that come from that process will most likely be included final SGEIS. At that point in time, permits for drilling could be issued and the opportunity to collect a pre-drilling baseline data set would have passed for some.

In the interim, and until official guidance is provided by the State, a local working group consisting of the Otsego County Soil and Water Conservation District, Otsego County Planning Department, SUNY Oneonta faculty and Hartwick College faculty, are providing this *unofficial general guidance* for those who would like to acquire water quality data on their wells now.

This general guidance was developed by comparing lists of parameters previously made available by industry, environmental consulting firms, DEC (as identified above), Penn State Cooperative Extension (Water Fact Sheet #28) and other Counties in NY. This comparison was assisted by H2H Associates, a private environmental consulting firm, and concluded with a list of 24 parameters seen as most appropriate and cost effective in detecting potential contamination. To address the issues of frequency and duration, the working group also consulted with a representative of the United States Geological Service (USGS).

Thanks go out to all these individuals, agencies, departments and all of those who have commented and advised during the formulation of this general guidance. Additional thanks go to all of those participating in the public discussion for making so much good information readily available.

What to Test for and Why: Below is the list of parameters recommended for testing along with a brief explanation as to why they are relevant and, where appropriate, US EPA drinking water guidelines.

1. **Alkalinity** – Alkalinity is often the dominant anion in groundwaters. Monitoring changes in alkalinity can indicate other changes in water chemistry.
2. **Arsenic** – Arsenic may be found in biocides used in hydrofracking fluids. It may also be liberated from shales when reacting with drilling fluids. US EPA (1986) drinking water guideline is 0.05 mg/L.
3. **Barium** – A principle component of drilling muds. US EPA (1986) specifies a drinking water guideline of 1.0 mg/L
4. **BTEX** –Benzene, Toluene, Ethylbenzene, and Xylene. The US EPA drinking water standards for each of these parameters are: 0.005, 1.0, 0.7, and 10.0 mg/l respectively. These are sometimes added to fracking fluids to provide lubrication for the injection of propants used to keep fractures open.
5. **Bromide** – Bromide salts may be added to water as a mild biocide.
6. **Chloride** – A possible component of shale brines. US EPA (1986) drinking water guideline is 250 mg/L.
7. **Conductivity** – Electrical conductivity is one of the simplest and least expensive water quality indicators. As the amount of dissolved substances in water increase, so too does the ability of water to conduct an electrical current. Electrical conductivity is then a useful proxy for the amount of substances dissolved in water.
8. **Dissolved Methane & Ethane** – Occurs naturally in local aquifers but may also leak into aquifers as a product of drilling and production.
9. **Hydrogen Sulfide** – H2S is a naturally occurring gas that forms under similar environmental conditions that generate methane. H2S concentrations in deep shales are likely to be higher than surface concentrations. H2S is also a by-product of certain bacteria.
10. **Iron** – Commonly found in local waters, iron may also be present in shale beds and may be liberated from shales during gas development. New York State maximum contaminant level of 0.3 mg/l.
11. **Lead** – Lead is a known neurotoxin. The US EPA (1986) specifies a drinking water standard of 0.05 mg/L. Rock cuttings from the Marcellus shale may release small amounts of lead and other metals when washed with rain water.
12. **Manganese** – Commonly found in deep groundwater aquifers, manganese produces a black stain in the presence of oxygen. The US EPA (1986) specifies a drinking water guideline of 0.05 mg/L.
13. **MBAS (Surfactants/Detergents)** – Detergents are used in the hydrofracturing process to aid the liberation of gas from rock. Measuring MBAS levels in water can help indicate the presence or absence of hydrofracturing fluids in water supplies.
14. **pH** – A basic water parameter sensitive to small changes in water chemistry. Acids used in hydrofracking fluids may lower the pH of water. US EPA (1986) drinking water guideline is 6.5-8.5.

15. **Potassium** – Like sodium, potassium is commonly found in deep shale brines and gas well flowback.
16. **Radium 226/228** – Black shale beds commonly have elevated concentrations of uranium. The radioactive decay of uranium results in the production of radium gas, which in turn decays into radon gas (a well known cause of lung cancer). There is concern that natural gas development may increase the migration of radium from deep shale beds to shallow aquifers. US EPA (1986) drinking water guideline is 5 pCi/L combined.
17. **Sodium** – Sodium is commonly found in deep shale brines and gas well flowback.
18. **Strontium** – Strontium has been commonly found in waters associated with shale beds. Strontium levels may help fingerprint water migrating from natural gas formations.
19. **Sulfate** – Sulfate is produced by both the oxidation of iron sulfide minerals commonly found in black shales, as well as the dissolution of gypsum found in deep rock units in New York. Shale brines can be expected to have elevated concentrations of sulfate. The U.S. EPA has a drinking water quality guideline of 250 mg/L.
20. **Total Dissolved Solids** – Deep shale brines may have a high TDS. Also indicates all dissolved species in water. US EPA (1986) drinking water guideline is 500 mg/L.
21. **Total Hardness** – Hardness is a measure of all the calcium and magnesium dissolved in a water sample and are common in areas with limestone. Both calcium and magnesium levels may be affected by changes in water chemistry due to mixing with natural gas fluids.
22. **Total Organic Carbon** – TOC can indicate the presence or absence of dissolved organic compounds in water. In the case of natural gas flowback waters, changes in TOC could indicate changes in methane, BTEX, detergents, and biocides.
23. **Total Petroleum Hydrocarbon** – Hydrocarbons may be injected into shales as a lubricant in hydrofracturing fluids. Hydrocarbons may also occur naturally in shale beds.
24. **Total Suspended Solids** – This is a direct measurement of all particulate matter transported by water which can cause water to look cloudy or turbid. Changes in suspended sediment in groundwater can be caused by the growth of organic material, the precipitation of iron minerals, or the mobilization of fine grained sediments caused by injecting water or pumping water from an aquifer.

In addition to the list of parameters provided above, we also recommend that s*tatic water level* be measured by the commercial lab (see below) at the time of sampling. This requires opening the well cap and measuring depth to water with a probe when the pump is not running. The static water level reflects the level of the water table and can influence the water quality of the well. Therefore knowing what your static water level is important to the interpretation of the results and should be measured when the sample is taken. The best time to measure static water level is mid-day after morning water use is done and the well has had time to recover.

The Environmental Laboratory Approval Program (ELAP): Who performs the work of collecting and then analyzing well water samples is of critical importance. One purpose of the data collected may be to demonstrate well contamination. This makes properly collected, documented, accurate and reliable environmental analyses critical. The Wadsworth Center was established in 1984 under Section 502 of the Public Health Law and is responsible for the certification of laboratories performing environmental analyses on samples originating from New York State.

In all cases, it is highly recommend that landowners and municipalities only use laboratories certified in ELAP when testing for the parameters recommended here. To view a list of New York State ELAP labs and laboratories in other states certified under the national program, go to: http://www.wadsworth.org/labcert/elap/comm.html.

It is further recommended that the commercial laboratory selected be provided any well specific information available (age, depth, location, water source, etc) to assist in interpretation the results and so that modifications to this general guidance can be made if necessary.

Sampling Strategies: The two sampling strategies offered here focus on detecting a significant change in the concentration of any of the recommended parameters over a time period that spans pre- and post-drilling. This is done by first establishing the normal variation in concentration of a parameter prior to drilling (due to change in season and annual precipitation) and then looking for a much different measurement (out of the normal variation) during and after drilling.

The key to establishing variation is to measure the parameter repeatedly at different times of year and for multiple years. However, sampling for the number of parameters recommended here is not inexpensive and cost must also be considered when deciding how frequently and for how long to sample. For this reason two sampling strategies are offered here.

First is a 'base-line' sampling strategy that relies on regular sampling with additional comparisons of indicator parameters during and after drilling activities. This approach may be most suitable for municipalities or clusters of similarly situated wells. The second strategy is a less costly and less intensive protocol that does not establish a baseline but rather provides a one-time 'snapshot' of pre-drilling water quality with subsequent comparisons of indicator parameters until such time that another 'snapshot' may be warranted.

Results should be compared against the limits described in the '*What to Test for and Why'* section of this document and previous measurements. In all cases, consultation with the selected commercial laboratory regarding the interpretation of results is recommended.

Base-Line Sampling Strategy:

In order to establish the baseline water quality, seasonal sampling prior to any drilling activity is recommended. The ideal schedule would be to sample for the parameters described above in the late fall and the spring of each year to account for the natural variability characteristic of the changes in ground water hydrology. As noted above, measuring the static water level at the time of each sample is strongly recommended.

During drilling in proximity of the water well under consideration, such as the initial drilling of a well, drilling of subsequent wells on the multi-well pad, or high-volume hydrofracturing of a well, monitoring of indicator parameters should be conducted.

Indicator parameters are reflective of a wider array of parameters and their use is a cost effective way to reduce the number of analysis needed to detect a change in water quality. The presence of, or change in, indicator parameters may signify contamination has occurred. The recommended schedule for monitoring of indicator parameters is once every 2 months after an event until the next regular base-line (spring or fall) test of all the parameters described above.

The recommended indicator parameter list is:

pH	Conductivity
Chloride	Barium
Sulfate	Potassium
Total Dissolved Solids	Dissolved Methane & Ethane

If one or more of the indicator parameters is outside of the normal baseline range of results or previous results of indicator testing, the full suite of 24 parameters should be tested for again. As noted above, consultation with the commercial laboratory used for analysis in interpreting results is recommended.

Considering that local precipitation may vary from year to year which will effect the natural variability of water quality, that potential gas development may be long term and the possibility that well contamination from well drilling activities may not occur for several years (owing to the slow movement of groundwater in some circumstances), it is recommended that base-line sampling be ongoing.

Snap-Shot Sampling Strategy:

In those cases where the cost of base-line sampling is prohibitive but where the concern level is such that some water quality information is desired, a ‘snap shot’ sampling strategy is recommended. In order to establish a ‘snap shot’ of a well’s water quality, one sample analyzed for the full suite of parameters described above is required. The

ideal time to sample would be the fall, if time permits. If drilling is about to commence, a 'snap shot' sample should be taken prior to drilling, regardless of season.

If possible, seasonal sampling of the indicator parameters as identified and described above is recommended. If not, sampling for indicator parameters during drilling activities (as described above) should be conducted. The recommended schedule for sampling of indicator parameters is once every 2 months after an event for a period of 6 months after which sampling for indicator parameters should take place annually to coincide with the date of the initial 'snap shot' analysis or until the next regular indicator test (spring or fall).

If one of the indicator parameter results is significantly higher than the "snap shot" test results or previous results of indicator testing, the full suite of 24 parameters should be tested for again. As noted above, consultation with the commercial laboratory used for analysis is recommended.

Note: The information provided here is meant to serve as general guidance until such time as New York State (DEC or DOH) provides an official protocol to the public for the purpose of monitoring water quality well water as it relates to potential contamination from high volume, horizontal hydrofracturing natural gas development.

For questions or comments on this guidance, please contact the Otsego County Soil and Water Conservation District at (607) 547-8337 x4.