Stephen Penningroth
2080 Cayuga View Road
Trumansburg, NY 14886

December 9, 2008

Attn: Scope Comments
Bureau of Oil and Gas Regulation
NYSDEC Division of Mineral Resources
625 Broadway, Third Floor
Albany, NY 12233-6500

Subject: Comments on draft scoping document for Draft Supplemental Generic Environmental Impact Statement on Oil and Gas Drilling

To Whom it may concern:

I am writing to offer comments and recommendations on the referenced scoping document. While I write as a private citizen, my comments are informed by my professional training and background. I hold a Ph.D. in Biochemical Sciences, and I served for 20 years on the faculty and staff of the University of Medicine and Dentistry of New Jersey and Cornell University, where I conducted research in cell biology and taught courses in Pharmacology and Toxicology. I have served as a consultant for citizens' groups at federal Superfund sites in New York and New Jersey. I am currently employed as the Executive Director of the Community Science Institute, a nonprofit organization in Ithaca, New York, which is supported by local governments and which partners with groups of citizen volunteers to monitor water quality in the southern Cayuga Lake watershed. I also serve as the Technical Director of the Community Science Institute's ELAP-certified water testing laboratory, ELAP ID# 11790.

My main concern with the Draft Scoping Document is the relative lack of attention being paid to the huge volumes of contaminated wastewater that will be generated by hydraulic fracturing of horizontal gas wells in the Marcellus shale. Disposal of contaminated wastewater from thousands if not tens of thousands of gas wells represents an unprecedented challenge, for two reasons. First, the sheer volume of contaminated wastewater could easily overwhelm currently available disposal options such as underground injection wells and specialized treatment facilities, resulting in billions of gallons of contaminated wastewater in search of disposal and setting up potentially dangerous financial incentives for gas companies to get rid of their wastewater in environmentally irresponsible ways, such as contracting with small sewage treatment plants that are unable to process the waste safely or, conceivably, dumping waste fluids in remote stretches of rivers or wetlands. Second, approximately 30% of the contaminated wastewater from hydraulic fracturing is not recovered but remains underground, where it poses a small but real risk of contaminating groundwater and surface water.

In addition to neglecting to factor in risks to human health and the environment resulting from the huge volumes of contaminated waste fluids that will be generated from hydraulically fractured horizontal gas wells, the Draft Scoping Document and GEIS also do not adequately address protection of drill sites from surface erosion.

Below I offer specific recommendations that I hope will help improve the Draft Supplemental GEIS, followed by explanatory comments.

Conclusions and Recommendations

Conclusion 1. The process of hydraulically fracturing horizontal gas wells in the Marcellus shale involves the chemical contamination of roughly 5,000,000 gallons of fresh water per well. Since the allowed well spacing is 40 acres, up to 80,000,000 gallons, or 245 acre-feet, of contaminated water will be generated per square mile of gas wells. (One acre-foot is a volume of liquid that covers one acre of land to a depth of one foot.) Roughly 30% of the contaminated waste fluid cannot be recovered and will remain in the ground, where it presents a risk of contaminating groundwater and, eventually, surface water. The 70% that can be recovered will require environmentally safe disposal. The volumes of recovered wastewater are completely unprecedented and will surely stretch the State's disposal options beyond their current limits. The unprecedented volumes of waste fluids left in the ground will require continuous monitoring to detect whether groundwater and surface water upon which humans and wildlife depend becomes contaminated.

Recommendations for Supplemental GEIS

1. Revise spacing from 40 acres to 640 acres for horizontal, hydraulically fractured gas wells.
2. Require as a condition for issuing a drill permit that an environmentally acceptable disposal facility for recovered waste fluids be identified, operational and available before a drill permit is issued.
3. Drastically increase the number of NYSDEC field inspectors in order to ensure that gas companies drill, cement, hydraulically fracture and ultimately plug their wells according to the highest industry standards.
4. Develop and publicize a framework for monitoring groundwater and surface water by state and local governments in partnership with citizen volunteers in order to detect and address any contamination from waste fluids that is created by drilling and hydraulic fracturing operations, be it due to human error or unknowable features of local hydrogeology.
5. As a condition for issuing a drilling permit, require that companies both provide to the NYSDEC and make available to the general public the following information on the composition of waste fluids from each and every gas well: a) A complete list of each and every chemical present in drilling fluids and hydraulic

fracturing fluids, their concentrations, and their known toxicities; b) A complete list of each and every chemical present in wastewater recovered from the well as determined by certified laboratory analyses of at least three wastewater samples collected by a NYSDEC field inspector, their concentrations and their known toxicities, including chemical additives such as biocides and surfactants, naturally occurring heavy metals and radioactive materials, volatile organic compounds (VOCs) such as natural gas, and proppants.

6. Institute a tax on gas companies and use it to create a Gas Well Trust Fund that will pay to clean up groundwater and surface water contaminated by waste fluids from gas wells or, if cleanup is not possible, to compensate landowners and local governments for the loss of water resources due to contamination; to provide medical care for people sickened by drinking or swimming in contaminated water; and to restore fish and wildlife habitat degraded by wastewater from gas wells.

Conclusion 2. While the GEIS requires that drill pits be removed within 45 days of completion of drilling and fracturing operations, it does not require restoration of soil and vegetation. This increases the risk of erosion and sedimentation of streams and lakes.

Recommendation for supplemental GEIS

1. As a condition for issuing a drilling permit, require companies, first, to set aside and reserve topsoil, and second, to use the reserved topsoil to restore a site within 45 days of completing drilling and fracturing operations.

Detailed Comments

Volume of contaminated drilling and hydraulic fracturing fluids: While the volume of fluids required for gas wells in the Marcellus shale is not yet known exactly, credible estimates indicate that a typical well requires approximately 3 x 10^6 gallons of water. Given the current allowed spacing in New York State of 40 acres, or 16 wells per square mile, the volume of fluids is estimated to be approximately 48 x 10^6 gallons (48 million gallons) to develop one square mile's worth of gas wells in the Marcellus shale. This assumes that wells are hydraulically fractured only once. However, it appears to be fairly common practice for wells to be fractured two or more times (Sumi, L., Shale Gas: Focus on the Marcellus Shale, Oil and Gas Accountability Project/Earthworks, May 2008, Figure 1, page 9, http://www.earthworksaction.org/pubs/OGAPMarcellusShaleReport-6-12-08.pdf). Thus, a reasonable but possibly still conservative estimate would be 5 x 10^6 gallons per well or 80 x 10^6 gallons (eighty million gallons) of contaminated fluid generated over the lifetime of the wells on one square mile of land. This volume is equivalent to 245 acre-feet, or 245 acres of fluid to a depth of one foot (1 cubic foot equals 7.49 gallons; one acre equals 43,560 square feet; one acre-foot equals 43,560 cubic feet). Stated differently, recovering gas from one square mile of Marcellus shale will require the creation of roughly four-tenths of a square mile of contaminated fluids to a depth of one foot, or one square mile to a depth of five inches. Such volumes are on the order of 100 (one hundred) times greater than the volumes of liquid that have been needed to fracture vertical wells in the past. They suggest that at a minimum, New York State should require that the State's capacity to dispose of contaminated drilling and fracturing fluids be increased by a factor of one hundred before beginning to issue permits for horizontal drilling and hydraulic fracturing in the Marcellus shale.

Risk of contamination of groundwater and surface water: While the amount of hydraulic fracturing fluid that is recovered appears to vary from gas well to gas well, there seems to be general agreement that recovery ranges from roughly 60% to 80%. Therefore, roughly 30% of the contaminated fluids generated by drilling and hydraulic fracturing is expected to remain in the ground, or something on the order of 30×10^6 gallons (thirty million gallons) over the lifetime of one square mile of gas wells. This is the equivalent of a square shaft of fluid that measures 5,000 feet (roughly one mile) deep and 28 feet on a side. While in the majority of gas wells this enormous volume of contaminated fluid will probably stay thousands of feet underground and not migrate upward and outward to contaminate groundwater and surface water, it seems reasonable to project a risk that in a small but significant fraction of cases, migration will occur and contamination will result. Indeed, the GEIS (Volume II, Section B.4 and 5, pages 16-15 to 16-20, http://www.dec.ny.gov/docs/materials_minerals_pdf/dgeisv2ch16.pdf) describes a variety of groundwater contamination scenarios due to human error such as improper cementing of the well bore and improper plugging of abandoned wells. In addition to the likelihood that drilling operations will not be performed flawlessly 100% of the time, risk of groundwater contamination can also arise from local geologic formations being different, or behaving differently, than anticipated. With all due respect to the state of geological science and the sophistication of computer models used by gas companies to guide their drilling and fracturing operations, it is virtually certain that some tiny but finite percent of wells will not behave as predicted, and that the failure to predict their exact behavior will result in groundwater contamination, even when drilling operations are conducted flawlessly.

Let us assume that drilling technology will work perfectly 97% of the time but that it will fail 3% of the time due to human error. Let us assume further that the geology of horizontal, hydraulically fractured gas wells will be as predicted 98% of the time but that 2% of the time, due to unavoidable limitations of scientific knowledge, the geology will differ in ways that can result in groundwater contamination. The risk of contamination of groundwater from these two types of failures is additive and would add up to 5%. This would mean, on average, that if everything goes perfectly 95% of the time, one well of the 16 wells per square mile will be predicted to fail. A failure frequency of 5% would translate into roughly 2×10^6 gallons (two million gallons) of uncontained hazardous fluid waste in the ground that could then be available to contaminate groundwater and, eventually, surface water. If it is assumed that a minimum dilution of 1,000-fold (one thousand-fold) were required to render the waste fluid non-toxic to human health and the environment, then 2×10^6 gallons of waste fluid are capable of contaminating 2×10^9 gallons (two billion gallons) of drinking water. Since the City and Town of Ithaca require approximately 10×10^6 gallons (ten million gallons) of drinking water per day, the failure of one gas well has the potential to contaminate the equivalent of 200 days' worth of drinking water in our area.

The contamination scenario described above is a hypothetical; however, it is a reasonable hypothetical. It illustrates the potentially catastrophic magnitude of the risks to groundwater and surface water inherent in the vast quantities of contaminated fluids generated by horizontal drilling and hydraulic fracturing. Because of the huge volumes involved, and because of the toxic composition of waste fluids from drilling and hydraulic fracturing (see below), the failure of a single well can have potentially cataclysmic consequences for drinking water and/or surface water in the local area where the well failure occurs. Numerous cases of groundwater contamination due to gas wells have been reported (Lustgarten, A., Buried Secrets: Is Natural Gas Drilling Endangering U.S. Water Supplies? ProPublica, Nov. 13, 2008, http://www.propublica.org/feature/buried-secrets-is-natural-gas-drilling-endangering-us-water-supplies-1113/ ; Ohio Department of Natural Resources, Division of Mineral Resources Management, Report on the Natural Gas Invasion of Aquifers in Bainbridge Township of Geauga County, Ohio, Sept. 1, 2008, http://s3.amazonaws.com/propublica/assets/natural_gas/ohio_methane_report_080901.pdf), providing evidence that the risk of groundwater contamination, however small, is very real.

A useful way to think of risk from contaminated wastewater is that a single well failure or the improper disposal of wastewater from a single well would be potentially equivalent to a State or federal Superfund toxic waste site in which groundwater contamination poses the principal threat to human health and the environment.

Groundwater contamination is notoriously difficult and expensive to remediate. In many if not most cases, groundwater contamination is remediated by "natural attenuation." That is, it is not remediated at all, rather, it is hoped that it will remediate itself. Even assuming that it eventually does remediate itself, it can take years to decades. Unlike urban areas with public drinking water supplies, rural residents with private wells would need to find alternative sources of drinking water if contamination occurred. Moreover, contaminated groundwater will eventually contaminate streams and lakes, which are fed by groundwater.

Composition of waste fluids generated by drilling and hydraulic fracturing: The exact composition of waste fluids varies from company to company and from well to well. However, the general requirements of drilling and hydraulic fracturing technology are likely to result in the following classes of contaminants: a) Extremely high concentrations of salt, or brine; b) High concentrations of organic materials such as guar gum used to increase the viscosity, or thickness, of drilling fluid as a means to help bring drill cuttings to the surface; c) Various concentrations of a wide array of organic chemicals used as surfactants and biocides in hydraulic fracturing fluid; d) High concentrations of small solid particles such as sand or other "proppant" material that functions to prop open fissures created by hydraulic fracturing of shale rock; e) Various concentrations of heavy metals such as aluminum, mercury, cadmium, zinc, lead, chromium and others that are released from underground geologic formations by the drilling and fracturing process; f) Naturally occurring radioactive materials, or NORMs, that are released by the drilling and fracturing process; and g) Natural gas, or methane, released by the drilling and fracturing process. It is important to note that waste fluids contain a mixture, first, of chemicals that are added to enhance the drilling and fracturing processes, and second, chemicals and possibly radioactive materials that are released from underground geologic formations as a result of the drilling and fracturing process. All of the added substances plus many substances released by the drilling/fracturing process end up in the waste fluid from gas wells. As stated previously, the volume of waste fluid is distributed roughly 30% below ground and 70% above ground.

Many although not necessarily all of the added and naturally occurring waste fluid constituents are classified as toxic chemicals. Each toxic constituent poses risks to human health and the environment when it is present in water, soil and/or air at concentrations that exceed its threshold of toxicity. The GEIS points out, correctly, that there is a long history of gas wells in New York State, and that these general kinds of waste fluids have been dealt with for decades. The difference is that with the advent of horizontal drilling and hydraulic fracturing technology, the volume of hazardous waste fluids has now increased by two orders of magnitude, from roughly 50,000 gallons per well to roughly 5,000,000 gallons per well. This 100-fold increase in the volume of hazardous waste means there is a similar 100-fold increase in the risk of exposure to the toxic chemicals in the waste fluids. A 100-fold increase in the risk of exposure means there is a 100-fold increase in the risk to human health and the environment, because risk is due, not solely to the toxicity of a chemical, but to the combination of toxicity and exposure.

One way to get a handle on the risk presented by the new technology proposed for gas wells in the Marcellus shale is to imagine that instead of one well per 40 acres, the actual spacing, in terms of the kinds of traditional wells addressed in the GEIS, is one well per 0.4 acre. It is as if, from the standpoint of the risk to human health and the environment from drilling and fracturing fluids, 100 traditional gas wells will now be collapsed into a single mega-well. From a risk perspective, the currently approved well spacing translates into roughly 1,600 traditional wells per square mile, not 16.

The GEIS addresses environmental risks from salt and thickening agents. High concentrations of salt can kill vegetation and sterilize soil. Organic thickening agents such as guar gum can result in increased biological oxygen demand (BOD) and fish kills when waste fluid gets into streams. The GEIS concludes that these risks are almost invariably short-term, and that they are effectively mitigated by dilution. Given the typical drilling scenario envisioned by the GEIS, i.e., a single isolated well involving 20,000 to 80,000 gallons of waste fluid, the conclusion that much of the environmental risk due to waste fluids can be mitigated by dilution is not unreasonable.

The GEIS does not address mitigation of risks from heavy metals, NORMs, surfactants and biocides explicitly. One possible reason for this omission is that when the GEIS was written in the 1980s, the potential for low concentrations of toxic chemicals to cause cancer and to interfere with normal development, especially sexual development, was less well appreciated than it is today. Since the 1980s, awareness of the risks associated with long-term, low-dose exposure to toxic chemicals has grown considerably. For example, an entire sub-discipline of toxicology has developed around the effects of endocrine disrupting chemicals shown to alter sexual development in wildlife and suspected of having analogous effects on humans (Colborn, T., Dumanoski, D., and Meyers, J.P., Our Stolen Future: Are We Threatening Our Fertility, Intelligence and Survival? A Scientific Detective Story, 1996; written testimony by Theo Colborn to Congress on toxicity of chemicals used in natural gas drilling and hydraulic fracturing, Oct. 25, 2007, http://s3.amazonaws.com/propublica/assets/natural_gas/colburn_testimony_071025.pdf ; list of chemicals used in drilling and hydraulic fracturing fluids in Western states at http://www.endocrinedisruption.com/ , click on "Products"; Steingraber, S., The Falling Age of Puberty in U.S. Girls, Breast Cancer Fund, August, 2007). The U.S. Environmental Protection Agency (USEPA) bases cancer risk assessments on the default assumption that cancer can be triggered by exposure to as little as one single molecule of a toxic chemical. The European Union recently passed legislation entitled "Registration, Evaluation and Authorization of Chemicals" (REACH) which initiates a toxicological review of all of the approximately 100,000 chemicals in commerce with the goal of requiring that companies doing business in EU countries remove from their products chemicals judged by EU scientists to be too toxic to justify human exposure; this is the first full-scale toxicological review of commercial chemicals ever undertaken and effectively picks up where the 1976 U.S. Toxic Substances Control Act left off (Schapiro, M., Exposed: The Toxic Chemistry of Everyday Products and What's At Stake for American Power, Chelsea Green Publishing Co., 2007, chapter 7).

Drilling companies point out that the concentrations of individual chemical additives in drilling and fracturing fluids, and hence in waste fluids, are low, roughly on the order of 0.01%, or 100 ppm (parts per million), and that these concentrations are similar to those in other industrial and household products containing the same or similar chemicals. This is certainly true, but it is completely beside the point, for several reasons. First, from the standpoint of risk to human health and the environment, the issue is not the concentration of chemical additives in drilling and fracturing fluids, rather it is their concentrations in the environment combined with the probability that biological receptors will be exposed to concentrations that exceed the threshold for triggering a toxic effect such as cancer or abnormal development. For some endocrine disrupting chemicals, thresholds for toxic effects are measured in parts per billion (1 in 10^{-9} or micrograms per liter) or even parts per trillion (1 in 10^{-12} or nanograms per liter), not parts per million. Second, while concentrations are low, the fact that the volumes of waste fluids are about 100 times greater than traditional wells means that the amount, or mass, of toxic chemicals is also about 100 times greater than the mass of toxic chemicals associated with traditional wells, because mass is the product of concentration times volume. Third, in addition to chemicals that are added to drilling and fracturing fluids, chemicals such as heavy metals, naturally occurring radioactive materials and methane gas that are mobilized by drilling and hydraulic fracturing also present risks to human health and the environment. While gas companies cannot be held responsible for creating naturally occurring chemicals, they can and should be held responsible for the risks created by their release into the environment, particularly since companies stand to profit handsomely from those risks. Fourth, the chemicals in waste fluids cannot be viewed individually and in isolation from one another, as if exposure occurred one chemical at a time. In reality, exposure is almost always to multiple chemicals simultaneously (for documentation of multiple chemical exposure supporting the European Union's REACH legislation, see Generations X: Results of World Wildlife Fund's European Family Biomonitoring Survey, October 2005, http://assets.panda.org/downloads/generationsx.pdf). The USEPA makes the default assumption that the toxic effect of exposure to multiple chemicals is additive. In other words, exposure to the same concentration of two chemicals with similar carcinogenic potencies tends to carry roughly the same risk as exposure to one of the chemicals at twice that concentration. In some cases, the effect of exposure to multiple chemicals is synergistic rather than additive, e.g., exposure to two chemicals may carry more than a two-fold greater risk of disease than exposure to one chemical. In other cases, the effect of exposure to multiple chemicals is antagonistic, e.g., exposure to two chemicals may carry less than a two-fold greater risk of disease than exposure to one chemical.

The Supplemental GEIS needs to address the dramatically increased risk of exposure to toxic chemicals resulting from the extraordinary increase in the volume of waste fluids from gas wells. The supplemental GEIS needs to be grounded in the best available research on the health effects of low-dose, long-term exposure to multiple chemicals.

Failure to require companies to restore drill sites following well completion: Preparation of a drill site requires stripping vegetation and topsoil from approximately five aces of land. The GEIS points out that while companies are required to remove pit waste within 45 days of completing a well, they are not required to reclaim and restore the drill site until after the well stops producing (GEIS, Volume II, chapter 16, section 1.b). The GEIS acknowledges that failure to restore the drill site can result in serious erosion lasting years or decades. The GEIS notes that the remedy is for a company to be "conscientious" and restore the drill site on its own initiative once the well is completed. The GEIS discusses the importance of setting aside productive top soil and using this top soil to restore the drill site (GEIS, Volume II, chapter 16, section 1.a). Given the size and anticipated density of drill sites in the Marcellus shale, the supplemental GEIS should require companies to set aside top soil and restore a site within 45 days of completion of drilling and fracturing operations, the same time frame as the removal of pit waste.

In closing, I would like to thank you for considering these comments and recommendations aimed at broadening the scope of the Draft Supplemental GEIS to address the risks to human health and the environment resulting from the unprecedented volumes of hazardous chemical waste fluids that will be generated by gas wells that utilize horizontal drilling and hydraulic fracturing technology in the Marcellus shale.

Sincerely,

Stephen Penningroth