The Potential Health Impacts of Hydraulic Fracturing Wastewater and Drill Cuttings

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Senator Grisanti, Senator Gallivan, and distinguished members of the committee:

Thank you for convening this hearing on a topic that is of urgent concern to all New Yorkers. As we consider whether to permit or prohibit high volume, horizontal hydrofracking in our state, it is essential that we understand the fate of the toxic waste that is necessarily generated during the process of fracking. Where does it go? Who is exposed? What are the health effects? What are the costs?

My name is Sandra Steingraber. I serve as Distinguished Scholar in Residence at Ithaca College, and my Ph.D. is in biology from the University of Michigan. My field of study is environmental health, and I am the author of three books on the topic, the most recent of which investigates the impact of fracking on children's health.[1] Last month, I received a Heinz Award for my work on health and the environment. I am devoting the $100,000 prize money to the fight against fracking in New York State. I hope my testimony today will help explain why.

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1 S. Steingraber, Raising Elijah: *Protecting Children in an Age of Environmental Crisis* (Cambridge, MA: Da Capo Press, 2011).

Hydraulic fracturing relies on pressure, water, and high volumes of inherently toxic chemicals to shatter the bedrock beneath our feet and beneath our drinking water aquifers. Once shattered, the bedrock releases more than just bubbles of natural gas. The rock itself releases inherently toxic materials that have been bound together with the shale for 400 million years.

The toxic waste from fracking takes three forms.

The first are vapors—such as benzene and toluene—which are released at the wellhead itself. Benzene is known human carcinogen. Toluene is a potent reproductive toxicant with the power to extinguish human pregnancies. (I'll return the issue of reproductive health effects at the close of my remarks.) These volatile organic gases also combine with tailpipe exhaust to create smog.[2] This kind of air pollution is lethal. Exposure to smog is definitively linked to stroke, heart attack, diabetes, and premature death. In children, it is linked to premature birth, asthma, cognitive deficits, and stunted lung development.[3]

Last May and again in October, I provided testimony before the New York Assembly on the potential health effects of the air pollution created by hydrofracking. Today, I'll focus on the other two forms of toxic waste: liquid wastewater and solid drill cuttings. As with air contaminants, the present technology does not ensure public health, nor does the draft supplemental generic Environmental Impact Statement (sGEIS) provide a regulatory framework that would compel such technology.

A Natural History of the Marcellus Shale

As prelude, I'd like to begin with visual description of the Marcellus Shale itself.

A mile or so below us lies the floor of an ancient, shallow ocean. Four hundred million years ago, silt sifted down through its waters and piled up on this floor. This ocean's inhabitants—sea lilies, squids, and plankton—also sifted down, upon their deaths, and their bodies turned into bubbles of methane. To the east of this ocean was ancient mountain range that slowly eroded into the sea, contributing to its silty bottom the various elements that mountains contain. These include heavy metals, like arsenic, and radioactive substances, like uranium and its chemical daughter, radium. With time and under pressure, the silt turned into shale and in it was trapped a petrified fizz of natural

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2 C.D. Volz et al., "Potential Shale Gas Extraction Air Pollution Impacts," FracTracker—Marcellus Shale Data Tracking, Foundation for Pennsylvania Watersheds, 24 Aug. 2010.

3 American Lung Association, "Health Effects of Ozone and Particle Pollution," *State of the Air, 2011*; President's Cancer Panel, *Reducing Environmental Cancer Risk: What We Can Do Now, 2008-2009 Annual Report* (National Cancer Institute, May 2010).

gas bubbles—along with other vaporous hydrocarbons—together with all those metals from inside of the old mountains.

So the Marcellus Shale is a graveyard. It is also a living ecosystem. As geo-microbiologists now understand, the biosphere extends much further down into the dark heart of the planet than we had previously known. Deep geological strata contain relic organisms—bacteria, fungus, and members of a primitive group called Archaea. All together, these organisms are called *deep life*, and they appear to make up, by weight, more than half of the living organisms on Earth.[4] Biologically speaking, then, the Marcellus Shale is akin to a subterranean coral reef.

The aliveness of the unseen landscape below us is important because it helps explain why the waste products of fracking are so toxic. Among the many chemicals that make up fracking fluid—the friction reducers, gelling agents, and acids—are biocides. These are all-purpose cellular poisons that are forced into the fractured shale in order to kill the microflora living there and/or kill the organisms present in the fracking water that is drawn from lakes and streams.

The problem for which biocides is the solution is called *bio-fouling*. A mile below the Earth's surface, where temperatures are warm, microbes can feed on the fracking gels, sheathe the pipes, and interfere with the flow of gas.

Toxic Materials in Fracking Waste

The presence of biocidal poisons in the water used for fracking is only one reason why fracking wastewater is so toxic. Fracking fluid also picks up a lot of additional toxicants in its trip down to the bedrock and back up again. These include salts, heavy metals (lead, arsenic, barium, chromium, uranium), liquid hydrocarbons (benzene, toluene, ethylbenzene, xylene) and radioactive elements (radium and radon): all those materials deposited by the ancient mountain range and the ancient seawater itself.[5] So the fracking fluid returns to the surface of the earth even more poisonous than when it when was pushed down the borehole.

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4 F. Reith, "Life in the Deep Subsurface," *Geology* 39 (2011): 287-88. See also, K. Kohhauser, *Introduction to Geomicrobiology* (Wiley-Blackwell, 2006) and E.V. Pikuta et al., "Microbial Extremophiles at the Limits of Life," *Critical Reviews in Microbiology* 33 (2007): 183-209.

5 R.E. Bishop, *Chemical and Biological Risk Assessment for Natural Gas Extraction in New York*, Jan. 2011. U.S. Geological Survey, "Naturally Occurring Radioactive Materials (NORM) in Produced Water and Oil-Field Equipment—An Issue for the Energy Industry," USGS Fact Sheet FS-142-99, Sept. 1999.

What brings us together today, of course, is the sleight-of-hand legal exemption that classifies dozens of the chemical constituents used in fracking fluid as hazardous but spares the flowback fluid from wearing this same label, even though it contains those very chemicals along with a bunch of others.[6] By any definition known to toxicology, the wastewater from fracking operations is hazardous. Hydrofracking fluid sprayed in a forest in West Virginia, for example, defoliated and killed more than half the trees, and elevated the sodium and chloride levels of the soil by 50 fold. When spilled on the ground, fracking waste sows barrenness where nothing will grow. Those ancient Roman conquerers who salted the fields of their enemies would be impressed.

Fracking wastewater is also radioactive. According to the DEC's own findings, flowback waste contains radium-226 at more than 200 times higher than the limit safe for discharge into the environment and more than 3000 times higher than the U.S. EPA drinking water standard.[7] And yet, the sGEIS does not ensure that this truly hazardous fluid is treated as a truly hazardous substance, nor does it attempt to make it less hazardous.

Where the Waste Goes

The volume of wastewater generated by fracking is immense. In the Marcellus Shale, between four and nine million gallons of water are required to frack a single well. At least one million of these gallons returns to the surface as wastewater. Sixty-two thousand gas wells are envisioned for New York State. If all those wells are fracked only once—a highly conservative assumption—the total amount of wastewater generated is the number 62…with nine zeros after it. To visualize that amount of water, consider that 500,000 gallons of water go over both sides of the Niagara Falls every second. The amount of wastewater that would be generated in New York State from fracking, if we decide to permit it, is equal to the volume of water cascading over Niagara Falls for 35 straight hours.

So, imagine standing in front of the Niagara Falls for 35 hours. Now imagine that all the cascading water you see is radioactive and full of toxic chemicals, and your job is to figure out where to put it so that it won't come in contact with any person or any other body or water or the soil or the air. Forever. And keep in mind that our neighbor Pennsylvania is already generating a Niagara Falls-worth of wastewater of its own and will be competing with us for storage space.

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6 U.S. EPA, "Exemption of Oil and Gas Exploration and Production Wastes from Federal Hazardous Waste Regulations." www.epa.gov/waste/nonhaz/industrial/special/oil/oil-gas.pdf.

7 A. Lustgarten, "Natural Gas Drilling Produces Radioactive Wastewater," *Scientific American*, Nov. 2009.

The where-to-put-it question is not adequately addressed in the draft generic Environmental Impact Statement, which does not put forth a comprehensive plan for waste disposal nor explicitly prohibit fracking waste from entering sewage treatment plants. Studies from Pennsylvania clearly show that, when it is run through sewage treatment facilities, fracking fluid passes its salts, metals, hydrocarbons, and radionuclides straight through the filters. Chemicals such as barium, strontium, and benzene then end up in rivers and streams, some of which are drinking water sources for downstream communities. In the Finger Lakes area of New York State, we have personal experience with this method of disposal as wastewater from Pennsylvania has been trucked here for dumping. As revealed in a *New York Times* investigation last spring, fracking wastewater was quietly discharged into a sewage treatment plant that empties into Cayuga Lake.[8] The effluent from this plant is within a mile of the beach where my kids and I swim in the summer. Like everyone else, I first learned about the dumping of fracking wastewater into the lake I live along by reading about it in the *Times*.

Fracking wastewater dumped into sewage treatment plants also undermines the ability of those systems to do their job. The biocides intended to exterminate deep-life organisms in the shale work equally well to kill off the bacteria that break down fecal matter in sewage ponds. Downstream communities that rely on surface water for drinking may thus be exposed to more than just the chemicals in fracking wastewater.

Roadways are also a destination for fracking waste. Radioactive brine from (currently out-of-state) fracking operations is spread on New York State roads for purposes of dust control and de-icing.[9] This practice exposes unknown numbers of people, without their consent, to unknown amounts of a known human carcinogen, and yet the sGEIS is silent on the possible health consequences. One of these roads, as I first learned from Walter Hang of Toxics Targeting, is in my own village. It's the route my ten-year-old follows when he walks back and forth to school each day. I trust that Walter, who is scheduled to testify later today, will provide you more details on this issue.

Deep injection wells are another repository for fracking wastewater. These are mostly are located in Ohio. How much fracking wastewater can be shoved into the underground rock formations of Ohio? (One Niagara Falls of wastewater? Two?) I have not been able to find an answer to this question in the geological literature, and neither can I find it

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8 I. Urbina, "Regulation Lax As Gas Wells' Tainted Water Hits Rivers," *New York Times*, Feb. 26, 2011.

9 NYSDOH Bureau of Environmental Radiation Protection. *Supplemental Generic Environmental Impact Statement on the Oil and Gas Regulatory Program Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and other Low-Permeability Gas Reservoirs, NYSDOH Bureau of Environmental Radiation Protection Comments. NYSDOT, Transportation Impacts of Potential Marcellus Shale Gas Development: Draft Discussion Paper*, June 22, 2011.

in the sGEIS. Certainly, citizen opposition to the importation and deep-well injection of fracking wastewater in Ohio appears to be growing, especially now that earthquakes are an officially recognized risk of fracking fluid injection.[10]

Unlike fracking itself, the creation of injection wells to store the resulting waste is not a jobs creator. As a town councilman in Mansfield, Ohio noted last week, "The promise of four or five jobs isn't necessarily worth living with a chemical dump site for hundreds of years, and God knows what can happen with this thing down the road." This comment came in response to a *no* vote by the Mansfield city council to a Texas company that proposed to drill two injection wells for Pennsylvania-based fracking waste.[11]

Meanwhile, in Youngstown, Ohio, seven protesters were arrested recently for blocking trucks at another brine-injection well site. As one of them explained, the group took this action to stop an "assault on the environment." "We have a responsibility to take a stand," he said to the *Youngstown News.* "If these companies are poisoning our water and our air, they are the real criminals, not us."[12]

Such actions raise another question. Even if the subterranean landscape of Ohio could hold all the toxic waste New York and Pennsylvania can send it, should we in New York State move forward with an energy plan that hinges on the successful transfer of large amounts of hazardous materials to a placed where residents are willing to lay their bodies in front the trucks to prevent that transfer?

Much recent attention is focused on the possibility of removing chemical toxicants from fracking wastewater and then reusing and recycling it.[13] Forward osmosis using polyamide membranes. Desalination. Onsite decontamination using closed loop systems. Rather than compare the relative merits and drawbacks of each proposed method, I would like to point out the features that they share. First, they are all energy intensive and so add to the already-considerable air pollution burden created from natural gas extraction via hydrofracking. Second, Newton's laws of nature still apply: matter can neither be created nor destroyed; elements like arsenic are absolutely persistent; radionuclides don't just disappear. The *volume* of the wastewater may decrease, but the total mass of toxic, radioactive chemicals stays the same and, indeed, is even more concentrated within the smaller volume of fluid that remains. And this even-more-

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10 A. Corbyn, "Method Predicts Size of Fracking Earthquakes," *Nature*, 9 Dec. 2011.

11 S. Hendron,"Opposition to Fracking Wastewater Grows in Mansfield," radio broadcast, WOSU, National Public Radio, Dec. 6, 2011.

12 J.W. Goodwin, Jr., "Fracking Protesters Vow to Fight Charges in Court," *Youngstown News*, Dec. 2, 2011.

13 C. Volz, written testimony before the Senate Committee on Environment and Public Works and its Subcommittee on Water and Wildlife, Joint Hearing, "Natural Gas Drilling, Public Health and Environmental Impacts, April 12, 2011.

poisonous material still requires transfer and injection in underground wells or disposal somewhere.

Furthermore, the recycling of fracking wastewater does nothing to reduce the amount the solid toxic waste that is produced during natural gas extraction in the form of drill cuttings. Like liquid wastewater, solid toxic waste is generated in prodigious quantities. As with liquid wastes, drill cuttings from the Marcellus Shale contain heavy metals and are radioactive. Most worrisome, drill cuttings contain radium, which has a half-life of 1,600 years. From the slow decay of radium comes the water-soluble gas radon. The routine burial of drill cuttings on site or in municipal waste landfills is of great concern to me.

Health Risks from Fracking Waste

A few weeks ago, a letter was sent to Governor Cuomo from dozens of cancer advocacy organizations in New York State—from Buffalo to Long Island—demanding that a rigorous health impact assessment precede and inform the decision whether or not to open our state to fracking. I include a copy of this document in the appendix of my testimony and summarize here our findings on fracking fluids.

Cancer risks for fracking wastewater arise both from the chemicals it contains as well as from its radioactivity. More than 25% of the chemicals used in natural gas operations have been demonstrated to cause cancer or mutations. Between 2005 and 2009, according to the Committee on Energy and Commerce, hydraulic fracturing companies used 95 products containing 13 different known and suspected carcinogens. These include naphthalene, benzene, and acrylamide.

The sGEIS does not prohibit the use of cancer-causing chemicals in fracking fluid.

Thirty-seven percent of chemicals in fracking fluids have been identified as endocrine-disruptors. By definition, these substances have the power, at vanishingly low concentrations, to alter hormonal signaling pathways within the body. Many can place cells on the pathway to tumor formation. Exposure to endocrine-disrupting chemicals has been implicated in cancers of the breast, prostate, pituitary, testicle, ovary, and neuroendocrine system. These exposures may exert changes in gene expression and developmental pathways that span generations, so raising the risk for cancer in the children of those so exposed.

The word “children” does not appear in the sGEIS.

Radium causes bone, liver, and breast cancers. As with all exposure to ionizing radiation, there is no safe threshold level of exposure. According to the EPA, radon is the second leading cause of lung cancer in the United States, responsible for 21,000 cases each year

in the U.S. The vast majority of these cases end quickly in death. Lung cancer has one of the lowest survival rates of all cancers.[14]

Lung cancer from radon exposure is not a topic taken up by the sGEIS.

A new, very conservative report from the Institute of Medicine on the environmental causes of breast cancer concluded that the evidence linking toxic chemical exposure to breast cancer is plausible but weak. Nevertheless, it singled out for special mention two agents that are known breast carcinogens: benzene and ionizing radiation.[15] Both are found in fracking wastewater.

The words "breast cancer" do not appear in the sGEIS.

It is important to note that volatile organic chemicals do not need to end up in drinking water in order to cause harm, especially to pregnant women. A new study conducted in the village of Endicott, New York in the southern tier offers a lesson in the ways that waterborne pollutants can turn into airborne exposures: In 1979, a spill from an IBM plant contaminated groundwater with volatile organic chemicals. Because residential drinking water is supplied from wells outside the plume area, residents assumed they were protected. But contaminants evaporated and traveled as vapor through the soil under people's homes, through the cracks and fissures of the foundations, into indoor airspace, and from there into people's bloodstreams. As we now know, babies born to pregnant women living in homes above contaminated soil were significantly more likely to suffer from cardiac birth defects, low birth weight, and fetal growth restriction.[16]

Vapor intrusion of volatile organic chemicals is not mentioned in the sGEIS.

The Human Rights Implications of Fracking Waste

A new human rights assessment of hydrofracking released today by the Environment and Human Rights Advisory details 26 human rights norms of concern relevant to fracking, ranging from the right to security of person and the right to prior, free, and informed consent. This report concludes that--

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14 U.S. Environmental Protection Agency, "Radon: Health Risks." www.epa.gov/radon/healthrisks.html.

15 Institute of Medicine, *Breast Cancer and the Environment: A Life Course Approach, National Academy of Sciences*, Dec. 2011.

16 S.P. Forand et al., "Maternal Exposure to Tetrachloroethylene and Trichloroethylene through Soil Vapor Intrusion and Adverse Birth Outcomes in New York State," Environmental Health Perspectives, Dec. 2011, epub ahead of print.

> The current state of knowledge about potential human health and environmental impacts of these airborne and waterborne contaminants as well as of their mixtures and interactions, is poor, though some fracking chemicals even now are known to be endocrine disruptors and neurotoxins and some have been designated by the EPA as probably or known carcinogens. This suggests **a need for caution and for gathering further information before proceeding with licensing**, especially since vulnerable and disadvantaged populations would be at even greater risk.
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> Viewed in light of human rights standards, **these facts may raise liability concerns for the New York State Department of Environmental Conservation**" *(my emphasis).*[17]

In other words, the Supplemental Draft Environmental Impact Statement should be withdrawn until a comprehensive study of the human health impacts related to fracking is conducted.

I'd like to close by putting a personal face on the human rights issues. In 1979, at the age of twenty, I was diagnosed with bladder cancer. My diagnosing physician asked me about my possible exposures to toxic chemicals. I didn't know then that his questions would become my life's work. Years later, to return to my hometown in Illinois and investigate an alleged cancer cluster there. Among other things, I discovered the presence of dry-cleaning fluid in the drinking water wells. That was a surprise because the underlying geology of the area should not have allowed toxic contamination to happen. But there it was. I came to appreciate how little we really know about the unmapped landscape below the ground, which has intimate, unseen connections to the world above ground. It's not just an inert lump of rock down there.

At the time of my diagnosis, the newspaper headlines were full of stories about a woman named Lois Gibbs and a toxic place in upstate New York called Love Canal. I found it inspiring that a single woman could organize a community in ways that not only prevented her own further exposure to cancer and birth-defect causing chemicals that that been buried years before in her neighborhood but also compelled changes in our federal environmental laws to ensure that all Americans are protected from such exposures. And yet it was sad for me to learn, as a young cancer patient, that evacuation was the only way to protect people.

Fracking literally turns the earth inside out. It turns precious freshwater at the earth's surface into poison and then buries it in fractured geological strata where it is no longer part of the hydrologic cycle. In its place, it brings toxic rocks, heavy metals, poisonous vapors, radioactive substances and massive amounts of wastewater out of the earth,

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17 T.A. Kerns, *A Human Rights Assessment of Hydraulic Fracturing for Natural Gas*, Environment and Human Rights Advisory, Dec. 2011.

which then require permanent containment on the surface of the earth for time immemorial. Fracking could easily become Love Canal on an epic scale. And there is nothing in the current sGEIS that indicates that the lessons of Love Canal have remembered and applied.

Here are two first steps: First, waste that is hazardous should be called hazardous waste and treated as such. Second, a human health impact assessment must precede and inform the decision whether or not to move forward with fracking. To skip this step and risk exposing New Yorkers to inherently toxic chemicals without their consent is a violation of basic human rights.

Thank you.