Croton Watershed Clean Water Coalition, Inc.

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OUR WATER OUR FUTURE

Shale Gas – The Bridge to Global Warming?

By Marian Rose, PhD, Treasurer

From being considered the bridge fuel to a non-carbon, zero-polluting future, shale gas is coming to be regarded, even among former supporters, as being more polluting than its carbon-based brethren, such as coal. And the initial enthusiasm is dying off as people are becoming aware of the huge destructive impacts needed to extract the gas from the layers of hard shale rock that lie thousand of feet below the surface of the earth.

The low-hanging fruit among gas wells has been picked - the easy drill that has been compared to sticking a straw in a bowl containing liquid and sucking up the contents. These easily accessible pools of natural gas that were found throughout New York State, Pennsylvania and elsewhere have been fully exploited, and the wells abandoned. For the most part, no subsequent records of these tens of thousands of abandoned wells have been kept. But these shallow wells are included in the oil/gas industry's statements that there has never has been a proven case of pollution of drinking water from gas drilling.

Drilling for gas in shale rock, a near-impermeable formation that holds the gas in small bubbles, is very different from the just-described conventional drilling. High volume fracturing with a horizontal arm (HVHF or "fracking") that can extend 5,000 thousand feet at a depth of several thousands feet into the shale requires anywhere from 3 million to 6 million or more gallons of water laced with sand and chemicals, some unknown because they are trade secrets, and others, known carcinogens. Holes are blasted in the horizontal arm of the pipe and water, under tremendous pressure up to 15,000 pounds per square inch (psi) is sent into the pipe to blast open the tiny fissures in the shale. These fissures, propped open by the sand in the water, allow the gas to escape into the pipe and up to the surface. Each well may be fracked several times. NYS regulations would allow at least 128 wells per square mile drilling unit.

Depending on the drilling company's procedures, up to 80% of the injected chemically laced water may be left underground. The liquid that surfaces will be highly contaminated with salts, heavy metals and, in NYS Marcellus shale, dangerously high levels of radium-226 and radon. How to dispose of this toxic mix remains an unsolved problem for which the NYS Department of Environmental Conservation (DEC) has failed, so far, to find an acceptable solution. However, we do know that water, in the billions of gallons, will be forever lost to this consumptive use.

Another fundamental difference is that the gas that surfaces is at least 80% methane, a greenhouse gas (GHG) that, on a molecule-for-molecule basis, has about a 72 times

IN THIS ISSUE:

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stronger GHG effect than carbon dioxide over a 20 year time frame. This, together with the eventual inevitable leakage of the methane into the atmosphere, provides a vast feedstock for global warming.

In an article – Why Not Frack? – in the March 8 , 2012 issue of the New York Review of Books, Bill McKibben lists three key concerns with fracking. They are: "First, how much damage is being done to water wells and underground aquifers from methane migration and the chemicals mixed with water and then injected into fracking wells under high pressure?... *A second concern has to do with the damage being done to rivers and streams – and the water supply for homes and industries – by the briny soup that pours out of the fracking wells in large volume…What is the effect of this surge of gas on national and global efforts to cope with climate change…this may be the most important question of all* (emphasis added)."

Shale gas is coming to be regarded, even among former supporters, as being more polluting than its carbon-based brethren, such as coal. People are becoming aware of the huge destructive impacts needed to extract the gas from the layers of hard shale rock that lie thousands of feet below the surface of the earth.

DEC's inadequate analysis of underground pathways to pollution, including methane pollution

A recently published study by the U.S. Geological Survey (USGS) [i], widely regarded as impartial and highly expert, is critical of DEC's analysis of possible pollution pathways.

1. The delineation of NYS's Principal Aquifers is outdated and "highly inaccurate" when projected to the 1:24,000 scale.

2. The proposed 500-foot buffer around Primary Aquifers is one-size-fits-all and may provide only partial protection to these aquifers.

3. The revised dSGEIS affords limited protection to domestic well owners with a proposed 500-foot buffer around domestic wells and springs unless waived by the homeowner.

4. The fault map, "Mapped Geologic Faults in New York State", presented as figure 4.13 in the revised dSGEIS, grossly under represents the number and extent of faults in the Appalachian Basin of New York which is where the fracking could occur. "… Through an integrated analysis of lineament, geologic, geophysical, and seismic epicenter data, Jacobi (2002) concluded that *there are more faults in New York's Appalachian Basin than previously suspected, and that many of these faults are seismically active* (emphasis added).

5. The possibility of damage to the aqueduct from hydraulic fracturing operations is an issue of concern given the proposed infrastructure buffer zone. [ii] DEC's failing analysis of possible underground pathways for methane migration will call into question any claim that methane will not find its way to the surface, most likely through failing wells but also possibly, through faults and fissures.

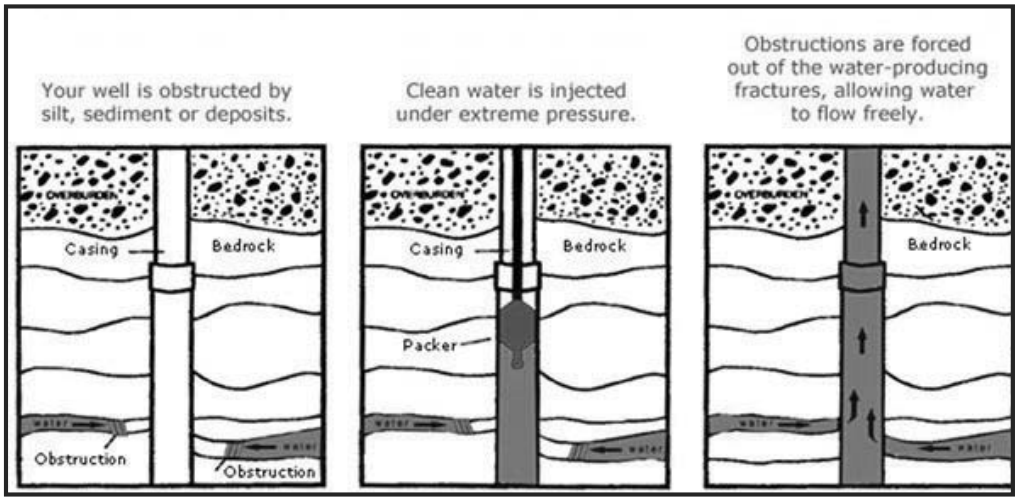
The contribution of methane leakage to global warming

A scientific research paper to quantify the contribution of methane leakage from HVHF to global warming was presented in a March 13, 2011 peer-reviewed letter by Robert W. Howarth et al [iii]. The following excerpts from this study point to the probability that shale gas will make

It is important for you to write and express your concerns to the responsible agencies and officials such as:
Andrew M. Cuomo, Governor of NYS, Capitol Building, Albany, NY 12224
Joe Martens, Commissioner, Dept. of Environmental Conservation
625 Broadway, Albany, NY 12233-0001
Dr. Howard Freed, Director, Center for Environmental Health,
NYS Dept. of Health, Flanigan Square, 547 River St., Troy, NY 12180-2216

a larger contribution to global warming than coal, particularly over a 20-year period. "Compared to coal, the footprint of shale gas is at least 20% greater and perhaps more than twice as great over the 20-year horizon and is comparable when compared over 100 years… The large GHG footprint of shale gas undercuts the logic of its use as a bridging fuel over coming decades if the goal is to reduce global warming."

conventional gas. Here is their conclusion: "Methane dominates the GHG footprint for shale gas over the 20-year time horizon, contributing 1.4- to 3- times more than does direct CO2 emissions. At this time scale, the GHG footprint for shale gas is 22% to 43% greater than that for conventional gas"…On a100-year time scale, "the GHG footprint for shale gas is 14% to 19% greater than for conventional gas…Considering the 20-year



Drilling deep underground to shatter shale bedrock

Table 2 of this Letter gives a comparison between fugitive methane emissions (expressed as the percentage of methane produced over the lifecycle of a well) associated with development of natural gas from conventional wells with methane emissions from shale formations. Whereas for conventional gas, the emissions during well completion, and routine venting and equipment leaks at well-site, range from 0.3% to 1.9%, for shale gas the methane emissions are nearly twice that amount - from 2.2% to 3.8%. Thus, extraction of methane from shale formations has the potential of a far greater contribution to global warming than extraction from conventional wells. Indeed, if emissions during liquid unloading, gas processing, transport, storage and distribution are added (these are the same for conventional gas as for shale gas), the numbers are 1.7% to 6.0% for conventional gas compared to 3.6% to 7.9% for shale gas. The authors of the report then estimate the relative contributions to global warming of shale gas vs. horizon, the GHG footprint for shale gas is at least 20% greater than and perhaps twice as great as that for coal when expressed per quantity of energy available during combustion…Over the 100-year frame, the GHG footprint is comparable to that of coal… *The large GHG footprint of shale gas undercuts the logic of its use as a bridging fuel over coming decades, if the goal is to reduce global warming* (emphasis added)."

A major study by Tom Wigley at the National Center for Atmospheric Research (NCAR) [iv] concludes that "…methane leaks would need to be held at 2% or less in order for natural gas to have less of a climatic impact than coal due to the life cycle of methane." The afore-mentioned Howarth et al study shows that even conventional wells could exceed this 2% limit, whereas shale wells always do.

In a study reported in the February 7, 2012 edition of Nature/News: "Air sampling reveals high emissions from gas field – Methane leaks

during production may offset climate benefits of natural gas"[v], Jeff Tollefson describes the results of a study by the National Oceanic and Atmospheric Administration (NOAA) and the University of Colorado scientists at Boulder, on air pollution from the gas field in the Denver-Julesburg basin. The study showed a 4% loss of gas in that area, mainly from pipelines and the distribution system. The lead scientist, Gabrielle Pétron, claims that "Some of the emissions come from the storage tanks, but *a big part of it is just raw gas that is leaking from the infrastructure* (emphasis added)". Their best guess at methane loss is 4% whereas the EPA loss estimate is 2.8%, far less but still sufficient to drive global warming. A complete analysis of EPA's methodology and the reasons they give for their conclusion is analyzed by Howarth et al in a February 25th, 2012 background paper:
"Methane Emissions from Natural Gas Systems". [vi]

Don't Let the Genie out of the Bottle

Given the present concerns with HVHF – global warming; water and air pollution; destruction of agricultural lands and forests together with their economic benefits, it is understandable that little thought has been given to the lingering effects of HVHF after the wells have been closed.

Yet, we should realize that we are passing on to future generations some very difficult problems with which they will have to deal.

This problem has been brilliantly explained and described by Marc Durand, professor emeritus of geological engineering at the University of Quebec in Montreal. Entitled "THE EXPERIMENT – The Longevity of Structures", the text [vii] complements a video [viii].

Briefly, Prof. Durand makes the following points: "…hydraulic fracturing initiates the migration of methane in the volume of the geologic unit, while only a small amount of this gas is recovered. The extraction takes place over only a few years, but the migration of the gas, once begun by fracturing, continues at least a thousand times longer. The flow is initially very high, but falls fairly quickly below a level deemed profitable for extraction…At the end of the exploitation of the well, only 20% has been liberated and extracted… The shale still contains 80% of its gas, which continues to be released slowly following an exponential diminution curve… The closed and abandoned wells are sealed deep underground with cement and on the surface with a steel plate. Between the tubing and the drilled rock, porous grout, which was put in place when the well was constructed, serves as a stopper…In the more critical case of shale gas wells…the shale, formerly watertight, has been rendered a million times more permeable by the fracturing operation; certainly it liberates the gas, but also many other elements that were formerly imprisoned in the rock: radium, high concentrations of mineral elements…"
Clearly, over time, the 80% of the remaining gas will build up pressure on the capped wells. And, over time, the wells will inevitably degrade. Prof. Durand compares this situation to an experiment in which 20,000 propane tanks that are 80% full, are buried in a large field – over time, all the tanks will fail and leak their propane contents into the air.

Of the tens of thousands of wells that could possibly be drilled in the NYS Marcellus shale, all will eventually be sealed and abandoned, and all will eventually fail, leaking methane - the ultimate global warming gas. And because the wells in this area contain extremely high levels of radium-226, we can also expect radon gas, a decay product of radium-226, to accompany the methane. Radium-226 has a half-life of 1600 years, roughly 80 generations, so the problem is not going to disappear in the near future!

Ownership of abandoned wells and responsibility for their safety will open up the proverbial "can of worms." Think about it.

The Future

It is becoming increasingly evident that the environmental problems (global warming is

only one of them, albeit an important one) that are the consequences of shale gas drilling far outweigh any possible benefits.
Ironically, we have an over-production of gas, so there is no need to initiate more gas drilling to satisfy domestic needs. Indeed, several ports situated at natural gas pipe terminals, are converting their liquid natural gas (LNG) facilities from import to export facilities.

To put it plainly – are we going to allow the oil/gas companies to rip apart our beautiful and productive NYS land in order to export our natural gas to China and elsewhere? Are we going to allow NYS to become a colony of the oil/gas companies?

The answer is a clear "No". As proud New Yorkers, we will mobilize our human resources, second to none, to bring about sustainable ways of supplying our basic needs.

It will require an immense effort, but it's an exciting challenge. Let's do it!

[i] http://www.scribd.com/doc/83492110/USGS-Comment-to-DEC

[ii] D2EC's buffer 1,000 foot zone is seriously inadequate. Rock fractures that intersect with the NYC aqueducts and other infrastructure extend for 7 miles or more. Therefore, the buffer should be at least seven miles.

[iii] Methane and the greenhouse-gas footprint of natural gas from shale formation, by Robert W. Howarth, Renee Santoro and Anthony Ingraffea. Letter to Climatic Change, March 13, 2011. This article is published with open access at Springerlink.com

[iv] NCAR Atmos News, Sept.08, 2011 UCAR - http://ww2.ucar.edu/atmosnews/news/5292/switching-coal-natural-gas-would-do-little-global-climate-study-indicates

[v] http://www.nature.com/news/air-sampling-reveals-high-emissions-from-gas-field-1.9982

[vi] http://www.eeb.cornell.edu/howarth/Howarth%20et%20al%20--%20National%20Climate%20Assessment.pdf

[vii] http://www.facebook.com/note.php?note_id=211286908907240

[viii] http://www.youtub.com/watch?v=-vzMIRc0CSCc

Letter to NY Times unpublished
David Ferguson, Vice President

RE: "Environmentalists Get Down to Earth", by Leslie Kaufman,
New York Times, Sunday, December 18, 2011

NO FRACKING COMPARISON

Dear Editor,

The Natural Resources Defense Council's consultant proposes to make the consequences of fracking (drilling for gas reserves) palpable to the public by equating the "fat and calorie content" of a brownie mix with the perpetual, ruinous risks of cancer and ignitable homes. Many millions of gallons of water taken out of the hydrological cycle, laced with toxic poisons, and sequestered deep within the earth, leaking for untold generations into the water supply (of many who resisted the landman's cunning enticements), disgorging radioactive waste, devastating lives, land and livelihoods, hydracide in perpetuity, posing incredible risks far greater threat to human health than mere excess calories.

Perhaps consultants should suggest a campaign to have those ubiquitous TV ads that present this highly complex industrial process as a walk in the park; list the ingredients of fracking's toxic mix along with side-effects just as drug companies are required to do, alerting consumers to dangers ranging from nausea to death.

What the Frack is in That Water?

by Lena Groeger,

Environmentalists have repeatedly pressed regulators to compel oil and gas companies to report what chemicals they use in the drilling and fracking process. According to a 2011 congressional report, many of the chemicals used can pose a serious health risk. No one knows the exact makeup of the frack mixture, drilling muds and other stuff used at well sites, but this list breaks down the main ingredients revealed so far.

Crystalline silica	Methanol	Isopropanol	Hydrotreated light distillate
Found in concrete, brick mortar and construction sands. Dust is harmful if inhaled repeatedly over a long period of time and can lead to silicosis or cancer.	Found in antifreeze, paint solvent and vehicle fuel. Vapors can cause eye irritation, headache and fatigue, and in high enough doses can be fatal. Swallowing may cause eye damage or death.	Found in glass cleaners, antiperspirant, cosmetics, perfumes and soaps. Vapors can cause irritation of the eyes and the upper respiratory track. Ingestion causes drunken-ness and vomiting.	Found in the fuel for the US Air Force's U-2 Aircraft. In acute cases can cause skin and eye irritation, headache and dizziness. Long term exposure can damage liver, kidneys or blood.

2-Butoxyethanol	Ethylene glycol	Diesel	Sodium hydroxide (lye)	Naphthalene
Found in paints and varnish. Vapors irritate the eyes and nose. Ingestion or skin contact can cause headache, nausea, vomiting and dizziness.	Found in de-icing agents, automotive antifreeze, household cleaners. Ingestion causes stupor or coma and can lead to fatal kidney injury.	Found in fuel oil. Contact with skin may cause redness, itching, burning, severe skin damage and cancer.	Found in drain cleaner, manufacturing products. Dust may cause damage to lungs. Exposure to solid or liquid forms can severely burn the eyes, skin and mucous membranes, or lead to death.	Found in mothballs. Inhalation can cause respiratory tract irritation, nausea, vomiting, abdominal pain, fever or death.

Formaldehyde	Sulfuric acid	Benzene	Lead	Boric acid
Found in embalming agent for human or animal remains. Ingestion of even one ounce of liquid can cause death. Exposure over a long period of time can cause lung damage and reproductive problems in women.	Found in lead-acid batteries for cars. Corrosive to all body tissues. Inhalation may cause serious lung damage and contact with eyes can lead to a total loss of vision. The lethal dose for humans is between 1 teaspoonful and one-half ounce.	Found in gasoline. Long time exposure can cause cancer, bone marrow failure, or leukemia. Short term effects include dizziness, weakness, headache, breathlessness, chest constriction, nausea, and vomiting.	Found in paint, building construction materials and roofing joints. Can damage the nervous system and lead to brain and blood disorders. Lead poisoning typically results from ingestion of contaminated food or water.	Found in insecticides, antiseptics, flame retardants. Poisonous if taken internally or inhaled in large quantities. Long term exposure can cause kidney damage and eventual kidney failure.

Fuel oil #2	Kerosene	Hydrofluoric acid	Hydrochloric acid	Formic acid
Found in heating oil. Harmful if swallowed. May cause dizziness, drowsiness, eye and skin irritation. Long-term exposure may cause skin cancer.	Found in jet and rocket fuel. Vapor can cause irritation of the eyes and nose, and ingestion can be fatal. Chronic exposure may cause drowsiness, convulsions, coma or death	Found in rust removers, aluminum brighteners and heavy duty cleaners. Fumes are highly irritating, corrosive, and poisonous. Repeated ingestion over time can lead to hardening of the bones, and contact with liquid can produce severe burns. A lethal dose is 1.5 grams.	Used in the treatment of steel, found in household cleaners and stomach acid. Corrosive to tissues and will irritate eyes. Inhaling fumes can be dangerous and lead to respiratory problems. Prolonged exposures will result in death.	Used for tanning leather, as a preservatives for livestock feed, and in toilet bowl cleaner. Liquid causes skin and eye burns. Inhaling vapors can be irritating and painful, and may cause nausea and vomiting.

Sources: Department of Energy, TEDX, House Committee ProPublica March 7, 2012

Please consider participating in this crucial issue according to your abilities, talents and time by volunteering or contributions.

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Thank you for your efforts toward a sustainable future.

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The Croton Watershed Clean Water Coalition strives to protect and improve the waters of NYC's Croton Watershed as well as all New York State watersheds. We are an alliance of individuals and groups who believe that safe, clean and affordable drinking water is a basic human right.

Send in your membership and receive membership mailings and a subscription to CWCWC newsletter "Our Water, Our Future." Most importantly, your membership will help you get involved with the preservation of one of our most precious resources, our water.

Croton Watershed Clean Water Coalition Membership Application

Name:_____

Address:_____

City:_____State:_____Zip:_____

Email:_____

☐ Group/Coalition Membership	$50/year	☐ Students/Seniors	$10/year
☐ Family Membership	$25/year	☐ Other	$_____
☐ Individual Membership	$20/year	☐ Additional Contribution	$_____
☐ Renewal		☐ New Membership	

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