



Department
of Health

A Public Health Review of

High Volume Hydraulic Fracturing for Shale Gas Development

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HEALTH

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Hon. Joseph Martens
Commissioner
New York State Department of Environmental Conservation
625 Broadway
Albany, NY 12207

Dear Commissioner Martens:

In September 2012, you asked Dr. Shah, then Commissioner of Health, to initiate a Public Health Review of the Department of Environmental Conservation's draft Supplemental Generic Environmental Impact Statement for High Volume Hydraulic Fracturing (HVHF). I assumed responsibility for this review when Dr. Shah left. It became clear during this assessment that DOH's Public Health Review needed to extend beyond the scope of the initial request to consider, more broadly, the current state of science regarding HVHF and public health risks. This required an evaluation of the emerging scientific information on environmental public health and community health effects. This also required an analysis of whether such information was sufficient to determine the extent of potential public health impacts of HVHF activities in New York State (NYS) and whether existing mitigation measures implemented in other states are effectively reducing the risk for adverse public health impacts.

As with most complex human activities in modern societies, absolute scientific certainty regarding the relative contributions of positive and negative impacts of HVHF on public health is unlikely to ever be attained. In this instance, however, the overall weight of the evidence from the cumulative body of information contained in this Public Health Review demonstrates that there are significant uncertainties about the kinds of adverse health outcomes that may be associated with HVHF, the likelihood of the occurrence of adverse health outcomes, and the effectiveness of some of the mitigation measures in reducing or preventing environmental impacts which could adversely affect public health. Until the science provides sufficient information to determine the level of risk to public health from HVHF to all New Yorkers and whether the risks can be adequately managed, DOH recommends that HVHF should not proceed in NYS.

I appreciate the opportunity to conduct this Public Health Review. It furthers the long history of close collaboration between the two Departments carrying out our shared responsibility to protect human health and the environment.

Sincerely,



Howard A. Zucker, M.D., J.D.
Acting Commissioner of Health

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| Executive Summary

The New York State Department of Health (DOH) is charged with protecting the public health of New Yorkers. In assessing whether public health would be adequately protected from a complex activity such as high volume hydraulic fracturing (HVHF), a guarantee of absolute safety is not required. However, at a minimum, there must be sufficient information to understand what the likely public health risks will be. Currently, that information is insufficient.

In 2012, the New York State Department of Environmental Conservation (DEC) requested that DOH review and assess DEC's analysis of potential health impacts contained in DEC's draft supplemental generic environmental impact statement (SGEIS) for HVHF. In response to the original request from DEC, DOH initiated an HVHF Public Health Review process. In conducting this public health review DOH: (i) reviewed and evaluated scientific literature to determine whether the current scientific research is sufficient to inform questions regarding public health impacts of HVHF; (ii) sought input from three outside public health expert consultants; (iii) engaged in field visits and discussions with health and environmental authorities in states with HVHF activity; and (iv) communicated with multiple local, state, federal, international, academic, environmental, and public health stakeholders. The evaluation considered the available information on potential pathways that connect HVHF activities and environmental impacts to human exposure and the risk for adverse public health impacts.

Based on this review, it is apparent that the science surrounding HVHF activity is limited, only just beginning to emerge, and largely suggests only hypotheses about potential public health impacts that need further evaluation. That is, many of the

published reports investigating both environmental impacts that could result in human exposures and health implications of HVHF activities are preliminary or exploratory in nature. However, the existing studies also raise substantial questions about whether the risks of HVHF activities are sufficiently understood so that they can be adequately managed. Furthermore, the public health impacts from HVHF activities could be significantly broader than just those geographic locations where the activity actually occurs, thus expanding the potential risk to a large population of New Yorkers.

As with most complex human activities in modern societies, absolute scientific certainty regarding the relative contributions of positive and negative impacts of HVHF on public health is unlikely to ever be attained. In this instance, however, the overall weight of the evidence from the cumulative body of information contained in this Public Health Review demonstrates that there are significant uncertainties about the kinds of adverse health outcomes that may be associated with HVHF, the likelihood of the occurrence of adverse health outcomes, and the effectiveness of some of the mitigation measures in reducing or preventing environmental impacts which could adversely affect public health. Until the science provides sufficient information to determine the level of risk to public health from HVHF to all New Yorkers and whether the risks can be adequately managed, DOH recommends that HVHF should not proceed in New York State.

Scope of the Public Health Review

DOH evaluated whether the available scientific and technical information provides an adequate basis to understand the likelihood and magnitude of risks for adverse public health impacts from HVHF activities in New York State. DOH reviewed how HVHF activities could result in human exposure to: (i) contaminants in air or water; (ii) naturally occurring radiological materials that result from HVHF activities; and (iii) the effects of

HVHF operations such as truck traffic, noise, and social changes on communities. DOH also reviewed whether those exposures may result in adverse public health outcomes.

Public Health Review Process

The initial component of the Public Health Review focused on understanding how public health concerns were addressed in the draft SGEIS. Three nationally recognized experts participated as consultants to the initial phase of the review process. The expert consultants reviewed elements of the draft SGEIS and documentation developed by DOH, and provided extensive input through multiple rounds of communication.

As a result of this input, as well as broader consideration, it became clear that DOH's Public Health Review needed to extend beyond this initial assessment to consider, more broadly, the current state of science regarding HVHF and public health risks. This required an evaluation of the emerging scientific information on environmental public health and community health effects. This also required an analysis of whether such information was sufficient to determine the extent of potential public health impact of HVHF activities in NYS and whether existing mitigation measures implemented in other states are effectively reducing the risk for adverse public health impacts.

In addition to evaluating published scientific literature, former Commissioner Shah, Acting Commissioner Zucker, and DOH staff consulted with state public health and environmental authorities to understand their experience with HVHF. Former Commissioner Shah, Acting Commissioner Zucker, and DOH staff also engaged in a number of discussions and meetings with researchers from academic institutions and government agencies to learn more about planned and ongoing studies and assessments of the public health implications of HVHF. In total, more than 20 DOH

senior Research Scientists, Public Health Specialists, and Radiological Health Specialists spent approximately 4500 hours on this Review.

Major Findings

Summarized below are some of the environmental impacts and health outcomes potentially associated with HVHF activities:

- **Air impacts** that could affect **respiratory health** due to increased levels of particulate matter, diesel exhaust, or volatile organic chemicals.
- **Climate change impacts** due to methane and other volatile organic chemical releases to the atmosphere.
- **Drinking water impacts** from underground migration of methane and/or fracking chemicals associated with faulty well construction.
- Surface spills potentially resulting in **soil and water contamination**.
- **Surface-water contamination** resulting from inadequate wastewater treatment.
- **Earthquakes** induced during fracturing.
- **Community impacts** associated with boom-town economic effects such as increased vehicle traffic, road damage, noise, odor complaints, increased demand for housing and medical care, and stress.

Additionally, an evaluation of the studies reveals critical information gaps. These need to be filled to more fully understand the connections between risk factors, such as air and water pollution, and public health outcomes among populations living in proximity to HVHF shale gas operations (Penning, 2014; Shonkoff, 2014; Werner, 2015).

Some of the most significant environmental and health-outcome studies are briefly summarized here.

Air Impacts

Studies provide evidence of uncontrolled methane leakage, emissions of other volatile organic chemicals, and particulate matter from well pads and natural-gas infrastructure. State authorities in both Texas and Pennsylvania have documented methane leakage from natural gas infrastructure by the use of infrared cameras. A recent West Virginia study also determined that heavy vehicle traffic and trucks idling at well pads were the likely sources of intermittently high dust and benzene concentrations, sometimes observed at distances of at least 625 feet from the center of the well pad (McCawley, 2012, 2013; WVDEP, 2013). These emissions have the potential to contribute to community odor problems, respiratory health impacts such as asthma exacerbations, and longer-term climate change impacts from methane accumulation in the atmosphere (Allen, 2013; Bunch, 2014; CDPHE, 2010; Macey, 2014; Miller, 2013; Petron, 2012; Weisel, 2010).

Water-quality Impacts

Studies have found evidence for underground migration of methane associated with faulty well construction (Darrah, 2014; EPA, 2011). For example, a recent study identified groundwater contamination clusters that the authors determined were due to gas leakage from intermediate-depth strata through failures of annulus cement, faulty production casings, and underground gas well failure (Darrah, 2014). Shallow methane-migration has the potential to impact private drinking water wells, creating safety concerns due to explosions.

Other studies suggest additional sources of potential water contamination, including surface spills and inadequate treatment and disposal of radioactive wastes (Warner, 2013). A recent review paper presented published data revealing evidence for stray gas contamination, surface water impacts, and the accumulation of radium isotopes in some disposal and spill sites (Vengosh, 2014). One recent study also suggests that chemical signals of brine from deep shale formations can potentially be detected in overlying groundwater aquifers (Warner, 2012). These contaminants have the potential to affect drinking water quality.

Seismic Impacts

Recent evidence from studies in Ohio and Oklahoma suggest that HVHF can contribute to the induction of earthquakes during fracturing (Holland, 2014; Maxwell, 2013). Although the potential public health consequence of these relatively mild earthquakes is unknown, this evidence raises new concerns about this potential HVHF impact.

Community Impacts

There are numerous historical examples of the negative impact of rapid and concentrated increases in extractive resource development (e.g., energy, precious metals) resulting in indirect community impacts such as interference with quality-of-life (e.g., noise, odors), overburdened transportation and health infrastructure, and disproportionate increases in social problems, particularly in small isolated rural communities where local governments and infrastructure tend to be unprepared for rapid changes (Headwaters, 2013). Similar concerns have been raised in some communities where HVHF activity has increased rapidly (Stedman, 2012; Texas DSHS, 2010; Witter, 2010; WVDEP, 2013).

A recent study from Pennsylvania also reports that automobile and truck accident rates in 2010–2012 from counties with heavy HVHF activity were between 15% and 65% higher than accident rates in counties without HVHF. Rates of traffic fatalities and major injuries were higher in 2012 in heavy drilling counties in southwestern Pennsylvania compared to non-drilling counties (Graham, 2015).

Health Outcomes near HVHF Activity

Although well-designed, long-term health studies assessing the effect of HVHF activity on health outcomes have not been completed, there is published health literature that examines health outcomes in relation to residential proximity to HVHF well pads. One peer-reviewed study and one university report have presented data indicating statistical associations between some birth outcomes (low birth weight and some congenital defects) and residential proximity of the mother to well pads during pregnancy (Hill, 2012; McKenzie, 2014). Proximity to higher-density HVHF well pad development was associated with increased incidence of congenital heart defects and neural-tube defects in one of the studies (McKenzie, 2014).

Several published reports present data from surveys of health complaints among residents living near HVHF activities. Commonly reported symptoms include skin rash or irritation, nausea or vomiting, abdominal pain, breathing difficulties or cough, nosebleeds, anxiety/stress, headache, dizziness, eye irritation, and throat irritation in people and farm animals within proximity to HVHF natural gas development (Bamberger, 2012; Finkel, 2013; Steinzor, 2012). Federal investigators have also reported that sub-standard work practices and deficient operational controls at well pads contributed to elevated crystalline silica exposures among workers during HVHF operations (USDOL, 2012). While this report focused on worker exposures, it highlights

a possible exposure concern for residents living close to HVHF operations if silica emissions from onsite operations are not properly controlled.

Substantial Gaps Remain

Systematic investigations studying the effects of HVHF activity on groundwater resources, local-community air quality, radon exposure, noise exposure, wastewater treatment, induced seismicity, traffic, psychosocial stress, and injuries would help reduce scientific uncertainties. While some of the on-going or proposed major study initiatives may help close those existing data gaps, each of these alone would not adequately address the array of complex concerns related to HVHF activities.

For example:

Marcellus Shale Initiative Study

Geisinger Health System, the lead organization in the collaborative Marcellus Shale Initiative, cares for many patients in areas where shale gas is being developed in Pennsylvania. They began pilot studies in 2013 using well and infrastructure data to estimate exposures to all aspects of Marcellus shale development in Pennsylvania. According to the National Institutes of Health (NIH) abstract, they will use these exposure estimates to evaluate whether asthma control and pregnancy outcomes are affected by Marcellus shale development by studying 30,000 asthma patients and 22,000 pregnancies in the Geisinger Health System from 2006-13. Results from this study are not expected to be available for several years.

University of Colorado at Boulder, Sustainability Research Network

A five-year cooperative agreement funded by the National Science Foundation (NSF) under NSF's Sustainability Research Network competition, this program involves a multidisciplinary team of investigators and is intended to address:

“the conflict between natural gas extraction and water and air resources protection with the development of a social-ecological system framework with which to assess the conflict and to identify needs for scientific information. Scientific investigations will be conducted to assess and mitigate the problems. Outreach and education efforts will focus on citizen science, public involvement, and awareness of the science and policy issues” (Univ. Colorado, 2012; Shonkoff, 2014).

Published research has been produced from this program investigating associations between HVHF activity and birth outcomes and potential for methane leakage from natural gas infrastructure. The cooperative agreement extends to 2017.

EPA's Study of Hydraulic Fracturing and Its Potential Impact on Drinking Water Resources

Begun in 2011, the purpose of the study is to assess the potential impacts of hydraulic fracturing on drinking water resources, if any, and to identify the driving factors that may affect the severity and frequency of such impacts. The research approach includes: analyses of existing data, scenario evaluations, laboratory studies, toxicity studies, and case studies. US EPA released a progress report on December 21, 2012 and stated that preliminary results of the study are expected to be released as a draft for public and

peer review as soon as the end of 2014, although the full study is not expected to be completed before 2016.

Pennsylvania Department of Environmental Protection (PA DEP) Comprehensive Oil and Gas Development Radiation Study

Started in early 2013, PA DEP is analyzing the radioactivity levels in produced and flowback waters, wastewater recycling, treatment sludges, and drill cuttings, as well as issues with transportation, storage, and disposal of drilling wastes, the levels of radon in natural gas, and potential exposures to workers and the public. According to a July 2014 update from the PA DEP, publication of a report could occur as soon as the end of 2014.

University of Pennsylvania Study

A proposed study of HVHF health impacts was announced several months ago. The study is led by researchers from the University of Pennsylvania in collaboration with scientists from Columbia University, Johns Hopkins University, and the University of North Carolina.

Pennsylvania Department of Environmental Protection

Recently proposed community air monitoring will determine concentrations of fine and coarse (silica-sized) particles near a transfer facility that handles hydraulic fracturing silica sand.

These major study initiatives may eventually reduce uncertainties regarding health impacts of HVHF and could contribute to a much more complete knowledge base for

managing HVHF risks. However, it will be years before most of these major initiatives are completed.

Other governmental and research institutes have also recently conducted health impact assessments of HVHF (Institute of Medicine, 2014). These include: the European Commission; University of Michigan, Graham Sustainability Institute; Research Triangle Environmental Health Collaborative; Nova Scotia Independent Panel on Hydraulic Fracturing; Inter-Environmental Health Sciences Core Center Working Group on Unconventional Natural Gas Drilling Operations funded by the National Institute of Environmental Health Sciences; and the Maryland Institute for Applied Environmental Health, School of Public Health, University of Maryland. While these assessments identify many of the same potential environmental impacts mentioned above, more importantly, they reiterate that significant gaps exist in the knowledge of potential public health impacts from HVHF and of the effectiveness of some mitigation measures.

Conclusions

HVHF is a complex activity that could affect many communities in New York State. The number of well pads and associated HVHF activities could be vast and spread out over wide geographic areas where environmental conditions and populations vary. The dispersed nature of the activity magnifies the possibility of process and equipment failures, leading to the potential for cumulative risks for exposures and associated adverse health outcomes. Additionally, the relationships between HVHF environmental impacts and public health are complex and not fully understood. Comprehensive, long-term studies, and in particular longitudinal studies, that could contribute to the understanding of those relationships are either not yet completed or have yet to be initiated. In this instance, however, the overall weight of the evidence from the

cumulative body of information contained in this Public Health Review demonstrates that there are significant uncertainties about the kinds of adverse health outcomes that may be associated with HVHF, the likelihood of the occurrence of adverse health outcomes, and the effectiveness of some of the mitigation measures in reducing or preventing environmental impacts which could adversely affect public health.

While a guarantee of absolute safety is not possible, an assessment of the risk to public health must be supported by adequate scientific information to determine with confidence that the overall risk is sufficiently low to justify proceeding with HVHF in New York. The current scientific information is insufficient. Furthermore, it is clear from the existing literature and experience that HVHF activity has resulted in environmental impacts that are potentially adverse to public health. Until the science provides sufficient information to determine the level of risk to public health from HVHF and whether the risks can be adequately managed, HVHF should not proceed in New York State.