1.7 Assessment of Potential Human Health Impacts From High-Volume Hydraulic Fracturing Operations

A report by the National Research Council on Health Impact Assessment (NRC, 2011) noted (at pg. 12 and Appendix F) that environmental impact assessments developed under the National Environmental Policy Act (NEPA) are required to consider potential impacts of a proposed action on human health. The NRC report points out that the steps involved and the approaches used to conduct environment impact assessments and health impact assessments are compatible. NRC also concluded that the health determinants that might be considered and analyzed in the scope of an EIS would be the same as those considered in a formal health impact assessment, and would include both direct effects of a proposed action from environmental emissions or contamination as well as indirect effects on economic measures (e.g., housing, employment, income, government revenues and expenditures), government and community services (e.g., public safety, education, health care, transportation systems) and other factors related to quality of life and community character. Similarly, under the Department's SEQR regulations (6 NYCRR 617), consideration of environmental impacts is explicitly defined to include not only effects on environmental media (i.e., air, water, soil, biota) but also potential impacts of the proposed action on "patterns of population concentration, distribution or growth, existing community or neighborhood character, and human health" (6 NYCRR 617.2 (l)). Furthermore, the NRC's (2011) definition of health impact assessment (pg. 46) notes that impact assessments should include recommendations to monitor and manage potential impacts, similar to proposed mitigation measures in an EIS. Assessment of potential human health impacts has been integrated into various sections of the 1992 GEIS and this Supplemental GEIS, consistent with recommendations in Appendix F of the NRC report.
The 1992 GEIS considers potential direct and indirect impacts on human health from conventional gas development, including low-volume hydraulic fracturing of vertical wells. This supplement extends that assessment to consider potential direct and indirect human health impacts from HVHF. The Final scoping document for this Supplemental GEIS (NYSDEC, 2009 chapter 4) specifically identified noise impacts, visual impacts, road use impacts and community character impacts (including changes in land use, traffic, needs for public services, economic effects, energy supply effects and environmental justice effects) as factors to be addressed in addition to potential direct impacts to human health through chemical releases or emissions to environmental media.

1.7.1 Identifying and Assessing Potential Human Health Impacts

The Department, the NYS Department of Health (DOH) and outside consultants hired by the Department each contributed to the evaluation of the potential for significant adverse environmental and public-health impacts that could be associated with HVHF gas development. In the 1992 GEIS, and in this Supplemental GEIS potential adverse impacts are identified by analyzing all of processes involved in carrying out the proposed actions.

Potential adverse impacts may be identified qualitatively (i.e., recognized as a potential hazard but without quantifying the magnitude or likelihood of the hazard) or the impact may be characterized more quantitatively in terms of its potential magnitude or likelihood of occurring. It is not necessary to quantitatively characterize the magnitude of a potential impact or the likelihood of its occurrence (i.e., the risk posed by the identified hazard) to require mitigation measures intended to prevent or manage the potential adverse impact. The NRC (2011) report on health impact assessment notes that while quantitative characterization of potential impacts can be valuable, information gaps will often make obtaining reliable, objective quantitative estimates of potential health impacts difficult or impossible.

Potential adverse public-health impacts are interpreted broadly in this Supplemental GEIS to mean any potential adverse impact that might have a direct or indirect effect on the health, wellbeing or quality of life of people as a result of the entire high-volume hydraulic fracturing development and production process. In addition to the potential impacts identified in the 1992 GEIS, this Supplemental GEIS, within its various sections and subsections, analyzes:

- impacts that could lead to human exposure to environmental pollutants in water or air (Sections 6.1, 6.2, 6.3, 6.5, 6.6 and 6.7)
- impacts on drinking water availability (Section 6.1)
- socio-economic impacts on income, employment, population, housing, education resources, police, fire and other emergency services, local infrastructure resources and healthcare delivery services Sections (6.8, 6.11, 6.12 and supplemental Economic Analysis report from Ecology & Environment Inc.)
- visual impacts on the landscape (Section 6.9)
- noise impacts (Section 6.10)
- impacts on local emergency planning and potential community-character impacts (Section 6.12).

This introductory section briefly summarizes the breadth of potential significant adverse impacts identified in this Supplemental GEIS that have potential to affect public health. Subsequent sub-sections provide additional explanation of the existing and proposed mitigation measures identified to address potential adverse impacts related to public health, as well as other identified adverse impacts. Public-health mitigation measures related to potential direct significant adverse impacts such as air or water contamination are intended to reduce or prevent human exposure to contaminants, thereby preventing potential adverse health outcomes, even in the absence of complete information about the types of potential health outcomes or their likelihood if human exposure were to occur. A mitigation strategy focused on reducing or preventing human exposures addresses a broader range of possible health impacts than attempting to identify specific mitigation measures for particular health outcomes like cancer or birth defects. A discussion of potential significant adverse impacts that could affect public health and related mitigation measures is presented in specific sections of Chapters 5, 6 and 7 of this Supplemental GEIS. These chapters supplement identification of potential significant adverse impacts affecting public health and related mitigation measures presented in the 1992 GEIS.

By implementing the proposed mitigation measures identified and required in this Supplemental GEIS, the Department expects that human chemical exposures during normal HVHF operations will be prevented or reduced below levels of significant health concern. Thus, significant adverse impacts on human health are not expected from routine HVHF operations. When spills or accidents occur, the Department has identified numerous additional mitigation measures, including emergency-response planning, setbacks and buffers, so that significant exposures to people and resources on which they rely are unlikely.

1.7.2 Potential Human Health Impacts Due To Significant Adverse Impacts on Water Resources

The impact analysis for this Supplemental GEIS identified potential impacts that could result in contamination of drinking water resources during all phases of the high-volume hydraulic fracturing development and production process. The 1992 GEIS and the current Supplemental GEIS recognize that, if not managed properly, gas development and production has the potential to result in water-quality impacts due to a variety of possible accidental or upset conditions, as well as during the normal course of waste treatment and disposal. These

potential significant adverse impacts are discussed in detail in Chapter 6 (Sections 6.1, 6.2 and 6.3) and include increased aquifer turbidity; aquifer depletion; surface spills that could affect surface water or shallow drinking-water aquifers; well failures and resulting sub-surface migration of contaminants related to improper well design, construction or operation; containment failures; poorly-controlled stormwater runoff; blowouts; leakage from pits, pipes, trucks or tanks; flooding; inadequate wastewater treatment and drilling into sub-surface drinking-water infrastructure such as NYC drinking-water tunnels. The Department proposes numerous controls, including but not limited to liners and secondary containment for storage of chemicals on the well pad, and increased standards for well construction, cementing, and blow-out prevention equipment (rdSGEIS 7.1.3 & 7.1.4). Further, the transport of flowback water will be subject to recordkeeping requirements similar to treatment of medical waste, which are more stringent than requirements for conventional wastewater hauling (rdSGEIS 7.1.6.1). Prior to disposal of flowback water, testing of the water and a disposal plan would be required to ensure safe disposal occurs (rdSGEIS 7.1.7.3). Additional proposed enhanced mitigation measures designed to prevent or substantially reduce these potential significant adverse impacts, and thereby prevent or substantially reduce human exposure to contamination are discussed in detail in sections 7.1, 7.2 and 7.3.

As a further measure to mitigate potential impacts on water resources, and to promote advances in fracturing fluid technology, the Department has included a provision in its proposed regulations that requires an analysis of less toxic, but still effective, alternatives to chemical fracturing fluid additives (see Section 8.2.1.1 and proposed 6 NYCRR 750-3.4(8)).

A potential public-health consequence of impacts to drinking water resources could be human exposure to drilling-related chemical contaminants, including fracturing chemical additives, methane and other petroleum products liberated from the target formation and other materials such as metals, salts or naturally-occurring radioactive material (NORM) derived from the geologic formations being drilled. Chapter 5 of this Supplemental GEIS presents the New York State Department of Health's analysis of potential adverse health effects associated with exposure to various fracturing chemical additives, based on qualitative health hazard information for 10 chemical categories inclusive of all fracturing additive chemicals from fracturing product information disclosed to the Department by well service companies. This information indicates types of toxic effects that these chemicals might cause under certain circumstances, but does not mean that use of these chemicals would cause exposure in every

case or that exposure would cause those effects in every case. Whether or not people actually experience a toxic effect from a chemical depends on whether or not they experience any exposure to the chemical, along with many other factors including, among others, the amount, timing, duration and route of exposure and individual characteristics that can contribute to differences in susceptibility (see, for example, ATSDR 2005 or) http://www.health.ny.gov/environmental/about/exposure.htm .

The chemical health-hazard information presented in Chapter 5 does not include quantitative estimates of the human-health risks (i.e., the likelihood of a particular adverse effect) associated with any particular ~~HVHF~~ additive chemical. A quantitative risk analysis would require that specific exposure scenarios have occurred or are assumed, such as exposure to chemicals affecting a drinking-water well from the site of a spill. A quantitative assessment of this exposure scenario would require a large amount of site-specific data to describe the processes by which the spilled chemicals are transported from the site of the spill to points of possible human exposure (*e.g.*, air, surface water, groundwater used as household drinking water). For each of these potential pathways, data would be needed for many site-specific variables to ultimately estimate whether the pathway can contribute to human exposure, and if so, how much. In addition, detailed information would be needed for each chemical on its inherent toxicity by different exposure routes (*i.e.*, the relationship between exposure level and the type and severity of toxic effect by ingestion, inhalation, direct contact) as well as how toxicity varies with the duration and frequency of exposure. Only then would it be feasible to estimate people's exposure levels for each exposure route and combine exposure and toxicological data to estimate the health risks associated with the estimated exposures.

Although hypothetical site-specific quantitative risk assessment could be attempted to characterize the potential health risk from natural gas drilling, any such assessment would be a poor basis for risk management decisions because it would involve making a large number of assumptions about the many scenario-specific variables that influence the nature and degree of potential human exposure and toxicity. The results of such a hypothetical analysis could not be used to characterize human health risks with any reliability, because they will only be able to speak to a particular set of assumptions made about a hypothetical scenario. Many of the variables involved in such an analysis can have a large degree of uncertainty, and so different sets of assumptions can make the risks associated with a hypothetical scenario appear to be very different

The identification of potential significant public-health impacts in this Supplemental GEIS does not depend on quantitative estimates of health risk. The goal of the impact assessment is to identify all potentially significant public-health and environmental impacts from the proposed action. For each potentially significant impact identified, specific mitigation measures are proposed to manage or prevent that potential impact. The 1992 GEIS and this Supplemental GEIS establish protective mitigation measures that do not depend on showing actual harm or a high likelihood of harm.

With the aforementioned mitigation measures in place, human exposure due to HVHF-related contamination of water resources would be prevented or reduced below levels posing a health concern, and thus significant adverse impacts on human health are unlikely.

1.7.3 Potential Human Health Impacts From Naturally Occurring Radiological Material (NORM)

Chapter 6 analyzes potential significant adverse health impacts related to NORM in drilling wastes. These can include NORM in both solid and liquid wastes. Gas wells can bring NORM to the surface in the cuttings, flowback fluid and production brine, and NORM can accumulate in pipes and tanks (pipe scale and sludge.) Based upon currently available information it is anticipated that cuttings and flowback water will not contain significant levels of NORM, whereas production brine is known to contain elevated NORM levels. The primary radionuclide of concern from production brine is Radium-226. Elevated levels of NORM in production brine may result in the buildup of pipe scale containing elevated levels of radium. The amount and concentration of radium in the pipe scale would depend on many conditions, including pressures and temperatures of operation, amount of available radium in the formation, chemical properties, etc. Any potential worker-health or waste-disposal impacts related to concentrated NORM are already subject to controls under existing DOH and DEC regulations. Existing and proposed mitigation measures designed to minimize any human health impacts from exposure to NORM are identified and discussed in detail in section 7.7. With those measures in place, potential significant adverse impacts on human health from NORM exposure are unlikely.

1.7.4 Potential Human Health Impacts From Air Emissions

Another major area of potential public-health impacts from HVHF multi-well gas drilling that was identified in the impact analysis is airborne contaminant emissions during all phases of gas

development and production, including emissions of criteria air pollutants, volatile organic chemicals, hazardous air pollutants and greenhouse gases. The air-impact analysis in Chapter 6 of the SGEIS recognizes that airborne pollutant emissions are expected as a result of routine gas development and production activities due to emissions from: equipment powered by internal combustion engines, operation of glycol dehydrators, flaring, short-term venting of gas constituents without flaring, condensate tank venting, trucking activity, fugitive dust and offsite gas gathering equipment such as line heaters and compressors. Information for these emissions sources is used in detailed modeling analyses to assess whether activities associated with proposed multi-well HVHF gas development and production are estimated to result in ambient air levels of pollutants that exceed existing federal and state air standards and guidelines intended to protect public health. In the case of the greenhouse gas analysis, the results compare estimated emissions between conventional vertical wells and multi-well HVHF drilling. The results of all air pollutant analyses are used to identify mitigation measures aimed at reducing potential air-related impacts and preventing exceedances of state and federal air standards and guidelines. Proposed enhanced mitigation measures related to potential air-quality and greenhouse gas-emissions impacts are briefly summarized in sections 1.7.11 and 1.7.12 below and existing and proposed mitigation measures are discussed in detail in sections 7.5 and 7 6.

With the proposed mitigation measures in place, human exposure levels to HVHF-related air contaminants would be reduced below established health-based standards or guidelines. Therefore, significant adverse human health impacts from air emissions associated with high-volume hydraulic fracturing operations are unlikely.

1.7.5 Potential Adverse Human Health Impacts From Potential Socioeconomic and Quality-of-Life Impacts

Chapter 6 and an Economic Assessment Report included as an addendum to this supplement provide impact assessments for a number of socio-economic and quality-of-life factors that have potential to affect public health either directly or indirectly. Economic impacts assessed include income, employment, population, housing and government revenues and expenditures. Quality-of-life factors assessed include visual landscape impacts, noise and impact on community character. Other potential impacts that can have both economic and quality-of-life dimensions discussed in Chapter 6 include impacts on transportation systems and infrastructure, environmental justice impacts and community emergency planning. The level of

detail varies in these analyses depending on the quality and quantity of available information to assess each factor. For example, noise impacts and associated mitigation measures are assessed following existing Department protocols and transportation system impacts are informed by industry data on truck, rail and air traffic comparing conventional vertical drilling activities to multi-well HVHF drilling. Order-of-magnitude estimates of impacts on local and state government revenues are based on gas development projections and existing tax structures. Increased government expenditures in areas such as education, law enforcement, health and welfare, recreation, solid-waste management, transportation infrastructure construction and maintenance and state agency administrative costs such as review of permit applications and agency oversight of drilling activities are acknowledged qualitatively. Visual landscape impacts and community character impacts are not readily quantified, but are identified qualitatively based on previous experience in NYS and other states. Existing and proposed enhanced mitigation measures related to indirect health impacts are discussed in detail in sections 7.8 - 7.13.

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