E.) Scope Comment

December 15, 2008

Scope Comments
Bureau of Oil and Gas Regulation
New York State Department of Environmental Conservation
Division of Mineral Resources
625 Broadway, Third Floor
Albany, New York 12233-6500

Re: NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION DRAFT SCOPE OF DRAFT SUPPLEMENTAL GENERIC ENVIRONMENTAL IMPACT STATEMENT ON OIL, GAS, AND SOLUTION MINING REGULATORY PROGRAM, WELL PERMIT ISSUANCE FOR HORIZONTAL DRILLING AND HIGH-VOLUME HYDRAULIC FRACTURING TO DEVELOP MARCELLUS SHALE AND OTHER LOW-PERMEABILITY GAS RESERVOIRS

Delaware Riverkeeper Network submits these comments in addition to DRN's verbal comment submitted to the Department (DEC) on December 4, 2008 and the technical comments collectively submitted by Natural Resources Defense Council and others.

Overall, we have three main concerns that apply in a general manner to the Draft Scope.

- The use of high volume hydraulic fracturing is too intrusive (as a practice), resource intensive (water and related resources) and risky in terms of pollution from introduced and extracted contaminants, especially toxic and hazardous materials, to allow for its use under DEC's Generic Environmental Impact Statement (GEIS) or Supplemental GEIS (SGEIS) permitting process. Coupled with horizontal drilling, the well development practices that are proposed for use to extract natural gas from these shales are always going to have significant impacts. DRN submits that the Department consider and analyze the environmental impacts of always requiring an individual EIS when high volume hydraulic fracturing and/or horizontal drilling are used.

- The scale of natural gas development in the Marcellus shale and other shales is of such intensity and enormity that DEC must conduct a build-out analysis of the fully developed natural gas "project" in order to accurately assess the cumulative and long-lasting impacts of natural gas development in New York State on all aspects of the environment. The build-out is geographically defined by the extent of the Marcellus shale and other shale formations at full natural gas well development density with all water supplies and wastewater treatment/disposal and all other resource impacts included.

Delaware Riverkeeper Network
300 Pond Street, Second Floor
Bristol, PA 19007
tel: (215) 369-1188
fax: (215) 369-1181
drkn@delawareriverkeeper.org
www.delawareriverkeeper.org

· Due to the intensity of impacts that accompany development of natural gas in the Marcellus shale and other shales, there are areas and specific locations that DEC should place off-limits to all drilling ("no-drill" areas) and DEC should assess the impacts of removing these areas from drilling as part of the EIS. Similarly, there are locations and conditions that should be identified as not available or severely limited for water withdrawal for use in natural gas well extraction and development and not available for the discharge of wastewater from natural gas development. DEC should assess the environmental ramifications of prohibiting or restricting water withdrawals and discharges at these locations as part of the Scope of the EIS.

Examples of no-drill areas are (including but not limited to): the New York City Watershed drainage area; other major public water supply drainage areas; water wells and their wellhead protection areas as defined by the contributing aquifer based on wellhead and fracture trace analyses; major earthquake faults; carbonate rock formations; floodplains and riparian areas as defined by riparian soils; steep slopes (15% and greater); critical habitat for threatened, endangered and rare species (flora and fauna); wetlands and wetland buffers; vernal pools and their buffers; high quality forest areas as defined by dense patch areas, deep woods, mature trees and/or contiguous forest regions; prime groundwater recharge areas; unique rock formations; significant natural areas including vegetative communities; non-attainment zones for air pollutants; air pollution hotspots; federally or regionally recognized scenic and historic resources; agricultural preservation lands; public parks; preserved land, private or public; areas where density of existing natural gas wells already meets the spacing threshold for horizontal well bores; urban areas where population density exceeds the definition of high density as per Clean Water Act NPDES regulations. DEC needs to develop a complete list of areas to be designated as no-drill. These areas will need scientifically based buffers so that gas wells are not placed too close to these off-limit areas.

Examples of areas or conditions that should be prohibited from water withdrawals are: headwaters; first order streams; streams with no historic stream flow gauges above and below the withdrawal point; streams that flow to the New York City reservoirs in the Delaware/Catskill water supply system or to other public water supply reservoirs; streams that are already allocated at or beyond the safe yield of the stream based on the low flow margin of safety defined as the margin between two stream low flow statistics -- September median flow and the seven day-ten year low flow (7Q10) (New Jersey Highlands Regional Water Supply Master Plan, Supporting Information, 2008) labeled as "deficit streams"; streams that drain to deficit streams; streams that cannot support the ecological needs of the stream - including living ecosystem, fish, wildlife, macroinvertebrates, etc.-- if the withdrawal is made.

Examples of where groundwater withdrawals for natural gas development should not be allowed: aquifers that are located in watersheds that drain to deficit streams; wellhead protection areas defined as contributing aquifers based on wellhead and fracture trace analyses; prime groundwater recharge areas defined as the area in a HUC 14 that is the best recharge area for that subwatershed, contributing 40% of the total recharge volume of the subwatershed (New Jersey Highlands Regional Water Supply Master Plan, Supporting Information, 2008); floodplains and riparian areas as defined by soils; wetlands and wetland buffers; vernal pools and vernal pool buffers; within the contributory plume of a documented groundwater pollution point. This list is not exhaustive. DEC needs to develop a complete list as part of the Draft Scope.

There are also areas for which safe separation distances need to be developed. These separation distances are beyond the buffers that no-drill areas require. The 1992 FGEIS and existing GEIS cannot be accepted as adequate regarding standards for separation distances due to the gas well extraction and development practices (hydraulic fracturing and horizontal drilling) that are used in the Marcellus and other shale formations. Features that DEC needs to evaluate in the Draft Scope and then develop safe separation distances from natural gas wells for include: septic systems including all infrastructure such as tanks, lines and drainage fields, residences, open waters, water wells that are hydraulic fractured for greater volume, water and wastewater lines and aqueducts, other infrastructure such as roads, bridges, and parking areas, public buildings, hospitals and other health facilities, critical transportation facilities as defined by US Department of Transportation, and features that are vulnerable to specific impacts such as noise, light and vibrations. This list is not exhaustive. DEC needs to develop a complete list as part of the Draft Scope.

Examples of areas or conditions where natural gas drilling wastewater from the Marcellus and other shale "project" should not be allowed to be discharged: Special Protection Waters; streams that are critical habitat; streams that are designated as water quality limited and/or streams for which DEC has developed a TMDL (total maximum daily yield) for a pollutant; streams that flow to the New York City reservoirs in the Delaware/Catskill water supply system or to other public water supply reservoirs; deficit streams (as defined above); streams that do not have the capacity to assimilate discharged wastewater while still meeting designated uses and surface water quality standards; streams where the existing water quality exceeds standards and discharged wastewater will degrade the existing high water quality. This list is not exhaustive. DEC needs to develop a complete list as part of the Draft Scope.

In order to assess the impacts of Marcellus and other natural gas shale development, DEC must develop an inventory and mapping of the resources that will be affected; this work is required for the Draft Scope. Unless these resources and features are indentified and mapped, there will be no baseline data from which to measure changes and impacts caused by the natural gas development "project". The identification, evaluation, and mapping of all environmental aspects that may be impacted must be completed during the EIS review.

Also, water withdrawal and wastewater discharge decisions need to be informed by data and information that provides both protection of the resource and reliable and safe supply/discharge. For that purpose, baseline data characterizing the water quality of water bodies and aquifers needs to be gathered, evaluated, and where not available, sampling and monitoring programs put in place. Also, biological assessment and, where historic and present data is lacking, continuous biological monitoring needs to be established in waterways, water bodies and water features such as wetlands and vernal pools. The need to know what hydroperiod, for instance, is in place for a wetland or vernal pool or what creatures live on a stream bottom, cannot be satisfied by a snapshot measurement or a grab sample at a site prior to wastewater discharge or withdrawal of water. This data is only reliable and meaningful if developed over time with substantial data points in various seasons and conditions. This is particularly important from a regulatory perspective considering federal requirements to protect species such as the dwarf wedge mussel. Again, without this baseline and current information, the impacts to the resource will not be known or correctly interpreted (and possibly avoided) because there will be no baseline data to be measured against. The classic "we don't know what we've got till it's gone" will be the sad outcome and this is an avoidable failure that DEC has the responsibility and means to prevent.

The following are examples of items (in no particular order) that need to be mapped in order to accurately define the Scope and prepare an EIS. The list is not considered exhaustive; DEC needs to prepare a complete list:

Significant Natural Areas

Steep Slopes

Groundwater Aquifers

Critical Habitat

Endangered, Threatened and Rare Species or Species of Concern

Known intrusion of invasive species such as zebra mussels and *Didymosphenia geminata*

Water Availability based on water volume available per HUC 14, minus allocated water uses

Wastewater discharges to surface and groundwater

Superfund sites

Documented pollution sources, such as pollution plumes from underground storage fuel tank contamination and pollution incidents; water quality limited streams and water bodies with TMDLs

Permitted gas wells

Permitted water withdrawals, ground and surface water

Open Waters

Wetlands

Vernal Pools

Existing Land Use

Infrastructure such as sewage, water, transportation

Public buildings, hospitals, health facilities and other sensitive facilities

Significant historic sites, including but not limited to National and State Historic Register sites

Archeological Resources and Prehistoric sites as identified by SHPO

Scenic Resources

Floodplains and Riparian Areas as defined by soils

Forest Resources with separately mapped contiguous forest areas of 25 acres or greater

High quality forest defined by dense patch areas and biodiverse forest, deep woods, mature and rare trees

Agricultural Districts

Groundwater Recharge Areas and Prime Groundwater Recharge Areas

Karst Geology and Carbonate Rock

Geologic Formations

Preserved Land, both public and private

Public Parkland, Forest Preserves and other Resource Preserves

Important Bird Areas

Further, we suggest that definitions of all terms be added to the Draft Scope. The lack of specificity of terms and designations used throughout the Draft Scope makes it very difficult to comment precisely. This is a critically missing piece from DEC's document and should be remedied in the next iteration which is made available for public comment, before a Draft GEIS is prepared.

Comments on Sections:

Section 1.0 This section is not specific in its language; DEC should clarify what is meant. Examples of vague language:

- The Department propose to satisfy SEQRA for ***most*** (emphasis added) of these operations through an SGEIS...

- Other shale and low-permeability formations in New York...

Section 1.2 Mention of local laws assumes there is no area of local regulation outside of roads and taxes. DRN suggests that DEC analyze the regulation of stormwater runoff under the Clean Water Act NPDES program that requires municipal regulation of stormwater management under a municipality's NPDES 2 General Permit. Is DEC going to apply the NPDES 2 applicability for regulation to all stormwater management for natural gas well drilling and related land development activities? Will all land disturbance that is regulated for other development be equally regulated for natural gas development? Will DEC or the municipality or the Conservation Districts implement NPDES 2 in its entirety? Will there be a NPDES General or Individual Permit required when 5 acres of land or greater is disturbed? DEC needs to consider regulatory changes that will require state-of-the-art stormwater management for natural gas wells because of the nonpoint source pollution and erosion and sedimentation impacts of natural gas well drilling and development.

Section 1.4 The two key factors that DEC list as the determination that a new SGEIS is needed are not inclusive enough. A third factor, at least, should be added:

(3) Water quality impacts from chemicals and other substances used in hydraulic fracturing ("fracking") fluids, including toxic and carcinogenic substances, total dissolved solids and other constituents and substances such as NORMs, BTEX and arsenic produced in the water generated from beneath the ground by well development practices.[1]

DEC lists in this section instances that will be assessed for drilling permits that were not considered in the GEIS. To this list should be added:

- Issuance of a permit on or under lands protected by public funds with a purpose of protecting natural resources, agricultural soils, or other vulnerable resources.

When the public invests its hard earned taxes in protecting land and the natural or special resources and values held there, there is a covenant that must be respected by the State. These lands and their resources and features must be kept intact. This was not considered in the FGEIS and the issue represents a significant public policy that needs to be addressed by DEC: Will a permit for high volume hydraulic fracturing erode, undermine, or otherwise diminish the public's investment in preserving resources on publicly held or protected lands?

The last bullet should be corrected to read:

- Issuance of a well permit...in the Upper Delaware River Scenic and Recreational River and Watershed

The Upper Delaware River (Hancock New York 73 miles downstream to Milrift, PA) was designated by Congress as a Scenic and Recreational River by amendment to the Wild and Scenic Rivers Act in 1978. This part of the Delaware was included in the orginal Wild and Scenic Rivers Act in 1968 for further study. Ten years later Congress dcedied that the Upper Delaware River (and the Middle Delaware River, a 40-mile stretch from Port Jervis, N.Y. to the Delaware Water Gap near Stroudsburg, Pa.) indeed did possess the "outstanding remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural and similar values"[2] that a Wild and Scenic River must possess in order to be designated.

The designation is customarily considered by the National Park Service as ridge to ridge or at least ¼ mile on either side of the river. But the river is the expression of the entire contributing watershed. What happens on the land that makes up the Delaware River Watershed ends up in the Delaware River. Further, species that are identified as dependent on the Delaware River, such as the bald eagle, rely on the regional Watershed for nesting and foraging, requiring habitat that extends well beyond a river "corridor". This is also true for other species, including federally and state-protected species, such as salamanders, mussels and trout that require specific environmental quality and conditions to survive and thrive (such as temperature, clean rocky stream beds, etc.). Entire ecotourism industries have been built upon the clean cold waters of the Upper Delaware River's headwaters and main stem, serving a significant public purpose that defines and supports the communities of the Watershed's region. DEC should amend this bullet to reflect the fact that DEC action has potential impacts on the Upper Delaware River Scenic and Recreational River and Watershed, not just a limited corridor.

Section 1.4.1 The "project" should be defined as the entire changed land area related to a gas well development project as well as the underground disturbances related to the well bore, the storage of contaminated fluids on site in open pits or containers and the injection of fluids. It is forecasted by the industry and DEC that multiple wells will likely be installed at the well pads. It can also be expected that "fields of wells" will be developed by one or a few applicants over time and could be considered a "project". This means that there will be a longer period of disturbance for construction since each well bore will require drilling, fracking and development in sequence. It may mean larger basins to hold greater volumes of water for well development processes and to store large volumes of "produced water" or flowback. The increased intensity of well development required for multiple well bores attach pad compounds the movement of trucks and the use of equipment, and extends the opportunity for pathways of pollution over time as well as intensity. It is very important that DEC not define the project narrowly but expansively, to capture all potential impacts.

Further, the expanded project leaves the site open to erosion and sedimentation and delays the installation of permanent best management practices which will control stormwater runoff after the wells are completed and in production phase. In Pennsylvania, the oil and gas well general stormwater permit (General Permit)[3] is being interpreted to apply to the amount of surface disturbed "at one time". This is a mistake and results in inadequate stormwater management for sites five acres or greater. DEC should not make the same mistake in stormwater management.

Section 1.5 Regions of the Watershed are being and will be affected by the pipelines, compressor stations and processing facilties and other related infrastructure that will deliver natural gas to market. These pipelines are essential to natural gas wells and the impacts of these pipelines, whether feeder or gathering lines that leave the well field(s), or large pressurized pipelines that travel long distances, their impacts during construction and once established and in use must be considered in DEC's buildout analysis for natural gas well development.

Section 2.1 DEC should consider the density of natural gas wells in the Marcellus shale in Pennsylvania to gauge the expected density for New York. It is ASSUMED by DEC that "...the Department does not expect the rate of Marcellus drilling in any single county to match the peak Chautauqua County rate..." but this assumption may not hold true if industry expectations are realized for the amount of natural gas recoverable from the Marcellus shale formations.

The oil and gas industry projects that as much as 500+ trillion cubic feet (Tcf) of gas is contained in Marcellus Shale, with an estimate of 50 to 200 Tcf recoverable[4]; an early 2008 report by geologists Terry Engelder and SUNY Professor Gary Lash has projected up to 516 Tcf exists, with approximately 50 Tcf recoverable.[5] Chesapeake Energy has even higher estimates based on denser reserves per square mile; using their figures, Professor Engelder has now increased his estimate to a possible 363 Tcf, enough he says to fill the U.S.'s gas needs for 14 years.[6] The combination of the methods used to aggressively extract natural gas from the Marcellus shale (fracking and horizontal drilling) make it possible to extract far more gas than in New York previously and the volume of reserves to be harvested is forecasted to be much higher than any other formation.

Section 2.1.1 Have there been studies of subsidence or any other geologic impacts of horizontal drilling, particularly in unstable conditions or earthquake prone areas? It must be noted that grout in well casing does not last indefinitely and therefore cannot be relied upon to keep the bore separate from groundwater over time. Also, the combination of horizontal drilling and hydraulic fracturing must be analyzed since fracking is known to be not completely controllable, being subject to geologic conditions and may increase the possibility of vertical migration to drinking water aquifers or surface expression. DEC needs to research these issues before reaching conclusions about the possible environmental impacts of horizontal drilling.

Section 2.1.2 and 2.1.2.1 DEC ASSUMES that fracking uses 2.1 to 2.4 million gallons of water but this, as discussed earlier, varies well to well based on certain conditions and the experience in the Marcellus shale in Pennsylvania is averaging much higher.[7] DEC should revise its estimate.

DEC ASSUMES there are no groundwater pollution incidents but New York does not require well monitoring of water wells near natural gas wells. Therefore, the information is not known and it is wrong to assume anything. The well development practices being used in the Marcellus change the conditions that need to be studied regarding possible groundwater contamination (see DRN Section Comment 2.1.1 above).

Baseline data must be developed prior to drilling and ongoing water well monitoring must be required as well. Water wells in the zone of influence of a gas well must be monitored on an ongoing basis after gas wells are put into production and monitoring wells must be installed and regularly monitored and publicly reported around the gas well project. This is necessary to track groundwater quality and catch pollution problems before they have human health or other environmental impacts. This should be planned for now by DEC through the Draft Scope and EIS. Please see Appendix A.

DEC ASSUMES that additives to fluids used for fracking will be "significantly diluted" but this is an invalid assumption. DEC suggests later in the Draft Scope (Section 2.1.2.2 and Section 4.2.1.4) that other sources of liquid such as reused brine and flowback can be substituted and will be considered for substitution of fresh water for fracking purposes. The constituents of the liquids used for fracking may change with each frack. Further, surface water withdrawals may contain unknown pollutants. For these reasons, all frack fluids should be tested and reported before and after fracking of a natural gas well. Further, the "produced water" or flowback will contain constituents (such as "NORMs") that can cause pollution when discharged on the surface or into aquifers. The assumption that frack water or produced water is benign and "significantly diluted" is a wrong assumption and must be revised.

Also, DEC ASSUMES that prior experience is an accurate way to forecast what will take place with the projects under the new SGEIS. As stated above, that experience is very different due to very different methods and practices employed and the different geologic properties and gas yields of the Marcellus and other shale formations. DEC needs to consider secondary/tertiary containment and other pollution prevention best management practices for use while well development is ongoing that may not have been clearly necessary previously.

Further, DEC needs to consider the requirement that only closed containers be used to store all liquids (flowback and fracking fluids) at the well site, banning the use of open pits altogether due to the air and water pollution hazards that accompany the use of open pits.

Air quality impacts are emerging as a major impact in other areas of well development due to the volatilization of chemicals from fracking and flowback fluids. In Wyoming, for instance, the State Dept. of Environmental Quality commented to the Bureau of Land Management during the NEPA review for the Pinedale Anticline Project Area that significant mitigation measures, controls and monitoring were necessary to reduce NOx emissions, visibility impacts, and ozone elevation, including ambient air monitoring stations and regular inspections and reporting.[8] These problems are also surfacing in urban drilling areas as well, such as Ft. Worth, Texas in the Barnett shale.

A Houston study calculated the Volatile Organic Compounds (VOCs) in vapors released from permanent gas well storage tanks located at finished well sites. The storage tanks hold liquids that are bled off natural gas which contains moisture as it comes out of the ground; the moisture is made up of water and gas products, termed "condensates". These condensates easily evaporate and escape through pressure valves on the tanks. The study shows that natural gas extraction in Texas is contributing polluting emissions that are poorly tracked and regulated. Compressors used to pump gas through pipelines were also tracked and found to be a significant contributor to pollution that contributes to the classification of regions in Texas as severe non-attainment areas for ozone.[9] Considering the above, DEC will need to consider requiring air pollution filters on the vents on containers that store well development fluids.

Also, using a precautionary approach, DEC must consider an alternative that bans all toxic and hazardous substances as additives to fracking fluids. This approach can prevent pollution that is otherwise, as discussed above and in Appendix A, easily released to the environment through multiple pathways, accidentally and through regular practices proposed to be used by the industry in the Marcellus and other shale formations.

Section 2.1.2.2 DRN is concerned about the option to inject wastewater into the ground. This simply moves the pollution threat to another place and time. Even if there is no release of contaminated fluids to the water table presently used (which DEC must research further due to issues raised above and in Appendix A), the risk of contaminating deeper aquifers is not acceptable. Future generations may need to rely on deep aquifers (ancient waters) that will be tainted by these fluids. Further, recent research by hydrogeologists show that ancient waters from deep aquifers may be a significant contributor to the base flow of streams in extreme drought. This is a pollution pathway that needs to be considered in the Draft Scope and EIS.

The option of disposing of wastewater in other watersheds must be evaluated in light of the consumptive and depletive use that well development requires. DEC needs to consider the deficit that can be created in the source watershed on a HUC 14 basis. Transfer of fresh water out of one HUC 14 to another, much less out of a river's watershed altogether (such as "out of state") removes the water from the contributing stream and, over time, can deplete the hydrologic budget for a stream and its watershed, affecting the streams' designated uses, the 7Q10 of the stream and the ecological flow requirements of a stream. Also, sewage plants cannot safely or adequately treat this wastewater and DEC has acknowledged the inadequacy of existing wastewater infrastructure in the State.[10]

Similarly, the receiving stream needs to be considered in terms of assimilative capacity of the discharged wastewater and the treatment facility that discharges the waste must be capable of treated the contaminants in the hydrofrack fluids and produced water. Sewage treatment plants are not customarily equipped to treat this wastewater and in Pennsylvania this has led to a water quality crisis for the Monongohela River that is ongoing today (please see Appendix A). DEC must also consider that there are solids and sludge that will need processing at facilities equipped to treat these concentrated materials and at present these are not available.

In other locations at sewage treatment plants, it has been found that sludge accumulates over time in the plant's lagoons and pre-treatment facilities, requiring special disposal due to the concentration of contaminants. For example, in Pennsylvania, radioactivity concentrated in sludge in a treatment bed at the Royerfsord Sewage Treatment Plant that processed laundry water from Limerick nuclear power plant, requiring special action by PADEP.[11] Similar build up of solids can be expected at treatment plants, whether sewage or industrial, and DEC should consider how these will be treated and disposed in the Draft Scope and EIS. This analysis needs to be done not only for each permit but for the entire build-out project.

DEC needs to consider the concentration of dangerous and hazardous materials in fluids used at well sites in its analysis of the possible re-use of fracking and flowback fluids. For instance, the present experience of high TDS in the Monongohela River, due in part to gas drilling wastewater discharges, discussed above and in Appendix A, makes it clear the high levels of TDS pose water quality problems. These problems include drinking water impacts, the impacts to industries (who withdraw surface water for manufacturing and do not have the capability to remove TDS; some industries had to curtail operations on the Monongohela River), and harm to biota, fish and fishlife (please see Appendix A). High levels of TDS will be concentrated in re-used water, as will salts and other constituents such as the chemical additives and the materials produced from the deep geology.

Section 2.1.2.3 DEC should make all information regarding the materials used for hydrofracking public. Also, sampling of fluids and metering of volume of liquids before and after use, including flowback, must be done and the results posted publicly. The health hazards that accompany the fluids and wastewater that will be used and handled at gas well sites require full disclosure and easy public access (please see Appendix A).

Section 2.1.4 DEC should consider that "brine tanks" that are part of the permanent production well site will need vents with filters due to pollutants that are released from brine tanks (please see Appendix A and DRN comments under Section 2.1.2 and 2.1.2.1).

The evaluation of the larger well sites by DEC should consider how to prevent erosion and sedimentation from these sites and the need for permanent stormwater Best Management Practices that are physically separate from open pits on the well site to avoid comingling of stormwater and frack/wastewater. USEPA has identified nonpoint source pollution from stormwater runoff as the number one cause of water quality impairment in the U.S., accounting for the pollution of about 40% of all waters surveyed nationally. New industrial practices and resource extraction cannot be allowed to worsen this situation and, in fact, EPA has ordered through its NPDES 2 program that states implement programs to remedy the nonpoint source pollution problem, resulting in extensive public investment in this prevention/remedial program in New York. Please see DRN comments under Section 1.4.1.

DEC states that larger well sites may translate into less ground disturbance but considering the roads, feeder pipelines, parking areas, pads, and the length of time of disturbance due to sequential well bore development at a pad, this is not likely. DEC should consider that larger well pads will mean greater intensity of use, increasing pollution pathways and opportunities.

Section 2.1.5 DEC should consider post-production well monitoring for gas wells and water wells within the zone of influence of the gas well and of monitoring wells installed by the gas well company. Also, after closure, there should be consideration of a minimum safe separation distance for future water wells, ponds and stormwater systems.

Section 2.1.6 DEC should consider requiring recovery of soils to natural condition and full restoration to native vegetation conditions, including a range of plants, trees, and age of vegetation to match as much as possible the original condition and the region. Planting with grass is not enough. Turfed or grassed areas without mixed vegetation generate significantly more stormwater runoff than meadow, scrub vegetation or forests,[12] and can approach the imperviousness of asphalt if soil has been severely compacted.[13] Clearing and grading results in significant soil compaction, which reduces infiltration capacity and increases overland flow and runoff.[14]

Vegetation (other than turf grass) significantly enhances the infiltration capabilities of the underlying soil.[15] By allowing vegetation to become established with a well-developed root zone, poor soil permeability can be greatly improved. Whether damaged from construction practices or of a class of soil that doesn't percolate well naturally, vegetation, such as trees and shrubs, allows the land to capture and infiltrate stormwater runoff quite effectively.[16]

Woodlands renovate compacted and disturbed soils most effectively. As the humus layer builds in a succession forest, the soils change, becoming better able to support more mature vegetation and more able to infiltrate rain. "A mature forest can absorb as much as 14 times more water than an equivalent area of grass."[17]

DEC should consider that well spacing does impact environmental reviews. DEC ASSUMES that certain well spacing will occur, which is not a valid assumption. See DRN comments in Section 2.1.

Section 3.0 Please see DRN comments in Section 2.1 and Appendix A.

Section 4.0-4.1.2 DEC should consider that noise from the well site will be more intense due to the equipment used and the length of time that wells on multiple well pads will be constructed. Outside of the drilling equipment, compressors are especially noisy, estimated to produce about 95 decibels of noise in a consistent, low frequency pattern.[18] For comparison, a jackhammer is 100 decibels, truck traffic or a train whistle at 500 feet is 90 decibels.[19] Prolonged exposure to sounds over 90 to 95 decibels can cause hearing loss.[20] While the use of compressors may be limited to the period of well development - which takes several weeks to several months for each well - the permanent infrastructure that is required for gas pipelines require permanent compressor stations. Noise has documented human health impacts and has negative impacts on wildlife. DEC should consider these impacts in the Draft Scope and EIS.

Visual impacts are great during the construction and development phase. Greater numbers of permanent tanks will be needed on site for the Marcellus shale because the wells will be deeper and longer, yielding more gas to be processed before entering the feeder pipelines; this means greater visual impact. There are scenic vista impacts from other elements such as machinery, cleared and disturbed areas, and installation of overhead electric wires which is especially important where scenic and cultural resources are located, such as in the Upper Delaware Wild and Scenic River, Catskill Park and Forest Reserve, other parks and historic locations. The completed well site also requires some permanent vegetation removal and control, impervious surface, and access.

Lights are required for safety on the rig and at the operation during construction and, to some extent, at the finished well, disturbing natural light and causing glare into the night sky ("sky glow"). Light pollution can confuse wildlife; including migrating birds, and has human health impacts by disturbing sleep.[21]

Depending on the density of the gas wells in "fields" of wells, the visual impact may be greater at build-out when in-fill wells are in place. In Pennsylvania, the Allegheny National Forest is visually scarred by gas and oil well pads and their access roads through what was once deep forest.[22] The intact forest no longer exists and cannot be reclaimed within a lifetime; there are no plans to restore the forest. Aerial views prove the indelible disruption of the scenic forest. The scenic and visual impacts of a built-out well "field" should be considered in the Draft Scope and EIS.

DEC states that "grading and seeding" is required if the well is a dry hole. This is not adequate. Grass or turf alone does not replace a vegetative community and has negative environmental impacts. Soil compaction is likely to be severe when a well is being developed. Repairing soil compaction and replanting with mixed vegetation is necessary in order to prevent stormwater runoff, restore negative environmental functions, and repair scenic degradation. DEC should consider requiring compete restoration to the original condition or to match regional vegetative conditions, whichever is more protective and in keeping with the visual setting; please see DRN comments in Section 2.1.6.

Section 4.1.3 and 4.1.3.1 DEC should consider air quality impacts (please see DRN comments in Section 2.1.2 and 2.1.2.1), hydrogen sulfide, and greenhouse gas emissions such as methane and their impact on global climate change as part of the EIS.

Section 4.2- 4.2.1.2, 4.2.3, 4.2.3.1 DEC needs to consider the consumptive and depletive impacts that will accompany the large amounts of water that will be withdrawn for Marcellus shale development. Please see DRN General Comments and Section comments above.

It takes between many million of gallons of water (2 to 9 mg) to frack a well in the Marcellus Shale.[23] Amounts vary, depending on equipment, site specific conditions and the depth of the well (Marcellus shale wells are expected to be 5,000 to 8,000 feet deep).[24] In addition to the volume of water used in fracking, produced water or flowback expelled by the gas well when fluids and gas rise to the surface during the fracking process is an additional depletive loss; the black Devonian shale that holds the Marcellus formation is known to produce higher quantities of water than some other natural gas geologies.[25]

Potential impacts of over-withdrawal include aquifer depletion, stream flow depletion and disruption of natural flow regime, interference with hydroperiod flow to wetlands and other water dependent ecosystems. In turn, aquatic life, fish, wildlife and plant life can be affected. Drinking water supply can be depleted.

Water in the Delaware River is hotly contested and has been for nearly a century. The demands placed on the natural Delaware River are a perennial strain and over history the growth of the New York-Philadelphia Metropolitan region required the intervention of politics and the Courts to keep the needs met and the managed system functioning. From the settlement of Bethlehem in 1754 when the first public water supply system was built[26] to the present wrangling that has birthed the Delaware River Basin Commission's (DRBC) Flexible Flow Management Plan (FFMP)[27], the River has been forced to perform mightily. This despite the truth that the Delaware is long (330+ miles) and spans 4 states but is actually not a huge river with colossal flows. It is more aptly called a "Little Giant", as recounted by Richard Albert, River historian, because of the command performances it is required to meet every day[28].

The Supreme Court Decree sets out requirements for flow maintenance to protect the uses that the River fulfills. In addition to New York City and State, Delaware, Pennsylvania, and New Jersey rely on the river for water supply. The NYC reservoirs are used during dry times to add water that maintains flows to meet these demands and the needs of downstream aquatic life and recreational uses ("conservation releases"). Fresh water releases from New York allow minimum flow targets to be met downstream and keep the salt line from spoiling the drinking water supply for Philadelphia and New Jersey American Water Company and allow water supplies throughout the watershed to be provided. The City of Philadelphia, for instance, gets over half of its water from the Delaware River and its intakes are located in the tidal river, constantly exposing it to risk of salt water intrusion.[29] Flow management in the Upper Delaware River is a critical issue for these major downstream water supplies.

Unfortunately, the possibility of drought is always present. Drought conditions can develop quickly within a season; the water source for 15 million people is at stake and requires conservative management. DRBC points out that in 2001, the season began with 100% full, spilling reservoirs (holding 271 billion gallons of water) but less than 8 months later, the reservoirs were at 23.4% of capacity, holding just 63.348 billion gallons combined. It took until spring 2003 to refill.[30] There have been 11 droughts managed by the DRBC since 1980.[31] While other reservoirs exist in the Watershed for various purposes, NYC's reservoirs were built only for water supply.

The use of water for natural gas drilling from the Delaware River Watershed will have to fit into this picture. DEC will need to consider this reality when assessing the impacts of water withdrawals in the Delaware River watershed in the Draft Scope and the EIS.

DEC should consider management of water transfers to prevent worsening of emerging invasive species, flora and fauna. The zebra mussel is a known invader. Also, "rock snot", *Didymosphenia geminata*, also known as didymo, a species of diatom that grows in shallow water[32] is emerging as a seriously invasive species in the Upper Delaware River's streams below the reservoirs, apparently fueled by releases from the reservoirs. The algae can smother the bottom of streams, killing biota and the critters that are essential for fish life. Trout are directly affected in the streams below NYC's reservoirs.

DEC should not consider the SGEIS complete until DRBC and DEC regulations are aligned and there should be a clear understanding of primacy.

Section 4.2.1.4 Please see DRN comments on water supply and withdrawals in General Comments and in Section comments above. It is DRN's opinion that to successfully manage the water use for the natural gas "project", regulatory and legal reforms will be needed. DEC itself has stated that additional information, regulatory controls and funding needs to be put in place to protect the State's water resources.[33] Indeed, compared to other Delaware River Watershed states, New York is poorly equipped to regulate water use. DRN suggests DEC investigate and adopt regulations such as those in New Jerseys' Water Allocation Program (which is not perfect but is better than New York's) and, specifically the Low Flow Margin of Safety in place in New Jersey's Highlands (mentioned in General Comments) and the drought restrictions in place in New Jersey and DRBC which limit water withdrawals under certain conditions, restricting nonessential uses such as gas well development.

Further, to accurately track groundwater impacts DEC should consider requiring the installation of continuous water level monitoring devices in groundwater wells that will monitor the long term impacts to the static water level of the water table near wells and in the areas where water withdrawals are made.

DEC should consider the need to require best available technology to protect aquatic species from entrainment and impingement when withdrawals are made from surface water bodies.

Please see DRN comments above regarding the concentration of pollutants when used "brine", "flowback", and other non-fresh water sources are used for the fracking process.

Section 4.2.2 Please see DRN comments above and Appendix A. DEC should consider a wellhead protection program that is not based on a standard concentric circle but is based on aquifer testing that reveals the fractures and strike and dip of the underground geology in order to map the contributing aquifer to a well. Through the use of fracture trace analysis and other hydrogeologic analyses, the zone of influence can be mapped and the wellhead protection program organized on the protection of the contributing zones, which will likely not look like a circle in fractured shale. This method will be more effective in reaching a goal of well water quality protection. Pollution removal in groundwater is expensive and difficult and time consuming to accomplish, if it can be accomplished at all. Pollution prevention is more economical and protective of human health. DEC should consider the wellhead protection program developed by New Jersey Geologic Survey, a Division of NJ Department of Environmental Protection (NJDEP)[34].

DEC should also consider the impacts to quantity of yield for existing water wells in proximity to gas wells that will be fracked. Hydraulic fracturing used for water well development has been studied by NJDEP and the NJ Well Drillers Board; this water well development method is fairly commonly used in certain parts of New Jersey. There are known instances where water well fracking has caused nearby wells to lose production and some municipalities have regulated its use to protect residents' existing water wells[35]. Aquifer testing employing a pump test should be considered by DEC as a requirement for all proximate wells before a new gas well is fracked to measure possible impacts to yield of adjacent water wells. This is needed to protect existing well users from losing well water capacity.

Section 4.2.3.1 Please see DRN General Comments and Section comments above. Surface reservoir drainage areas for the New York City reservoirs (Pepacton, Cannonsville and Neversink) as well as other reservoirs for other municipal supplies should be designated as "no-drill" areas to prevent pollution of these water supplies.

The City's Watershed Program that was adopted to protect the water quality of the reservoirs has been a national, indeed an international, success story. By strictly controlling land use and stream discharges in the contributing watersheds of the reservoirs, including cleaning up existing pollution sources, New York City has been able to preserve the exceptionally high water quality of its drinking water, making it the largest unfiltered drinking water supply in the nation, according to Jim Dezolt of NYSDEC.[36]

DRN has supported the watershed program since its inception. Cleaning up pollution in headwater streams and comprehensively managing land use in the watershed drainage area protects these source reservoirs, supplying drinking water for 9 million New York City residents every day. This water quality effort has also benefited the entire downstream Delaware River by protecting the quality of the tailwaters and releases from the reservoirs.

Due to the depletive nature of water withdrawals for gas well development, water supply withdrawals from the watershed that flows to the NYC reservoirs should also be made off-limits. The quantity of water that is managed for NYC use in the reservoir system is, as discussed above and IN DRN's General Comments, a delicate balance that needs protection in terms of both quality and quantity. Each gallon taken has a direct impact on safe yield of the Delaware/Catskill reservoir system for NYC and the downstream Delaware River. In order to protect that supply, both well drilling and water supply withdrawals should be prohibited there.

Section 4.2.3.2 DEC should consider requiring stream disturbance permitting for all stream crossings for gas wells, even those that are directionally drilled under the stream bed. Erosion and sedimentation is not being well controlled at the Millennium Pipeline, as reported through New York's' Hotline pollution reporting system. To improve this record, all stream "jacking" and under-stream drilling should require stream disturbance permitting.

Section 4.2.3.3-4.2.3.3.1 Please see DRN Section comments above and General Comments. Uniform and prescriptive erosion and sedimentation plans must be required and implemented and permanent stormwater Best Management Practices required, as stated above. This will require gas well-specific stormwater permits for all land disturbance related to gas well development. In proximity to high value streams, special buffers and individual stormwater permits must be required to protect those special resources. DEC should refer to DRBC's Special Protection Waters program, in place for the Upper

Delaware River Watershed, for guidance. The exemption under federal regulation should not apply to state regulation of this critical issue.

Section 4.2.4 Please see DRN General Comments and Section comments above.

Section 4.3 Please see DRN General Comments. DEC should consider that the degraded habitat and forest fragmentation that results from gas well development will cumulatively change the region which is a key reason why a build-out analysis is needed. Further, the information needed on the location of critical habitats for species is not well enough developed and is not mapped and these must be done before gas well drilling proceeds in New York.

Section 4.4 Please see DRN General Comments. No gas well drilling should be allowed in the regulated floodplain and riparian areas, defined by riparian soils. It is essential that the flood damages that have occurred in New York and the Delaware River Watershed since 2004 not be exacerbated by gas wells. The flood frequency alone is reason enough not to allow gas wells to be placed in the floodplain, where they can be damaged and can cause damage and pollution. The most effective way to prevent flood damages is not to place structures, including gas wells and their required equipment, in the floodplain where they will be flooded.

Section 4.5 Please see DRN General Comments. Wetlands are impacted in a variety of ways by gas well development-through the construction itself, through required facilities, through access roads and feeder pipelines, through increased impervious surface that alters hydrologic regime, through stormwater runoff that can change hydroperiods and cause runoff into wetlands and by water withdrawals that affect hydrologic balance for the wetland's water sources. DEC should consider all of these when setting buffers, which must be wide enough to protect from these different means of impact. 100 feet is not adequate and if regulatory change is needed to provide protective buffers, this must be considered by DEC as part of the Scope.

Section 4.6 DEC should consider that Pennsylvania DEP representatives have stated that each well, at a minimum, requires 1400 truck trips for the frack process. The number of trips increases with multiple fracks and the need for many more millions of gallon of water hauled typically to the well site in 4000-5000 gallon trucks.

Section 4.7 Please see DRN General Comments. DEC ASSUMES that a limited number of rigs will be used on sites because that is the condition now and there will be less significant "rolling impact". But once the shale play is in progress, it is logical that more equipment will be brought in and made available and activity will be intense while "fields" are developed by companies. Further, DEC states that the development will take years but does not recognize that this means that the landscape will be disturbed in substantial ways for those many years as the wells are put in and go into production. The presently required site restoration is minimal, which will mean a degraded habitat and fragmented landscape. DEC cannot ASSUME that water withdrawals will be non-continuous. If the enormity of the reserves proves true (see DRN comments above) the develop of the Marcellus shale play and other shales will continue for years, equaling a continuous withdrawal and depletion of water, which will need to be assessed at a build-out level.

The cumulative impacts of natural gas development in the Marcellus and other shales requires, as stated in DRN General Comments, a build-out analysis before gas well drilling begins. This is the only way to accurately assess and prevent substantial environmental damages. There will need to be limits of water withdrawals and density of wells. There will need to be "no drill" areas.

Section 4.8 DEC should consider that natural gas development will be a new industrial activity in many areas that are predominantly rural and areas that are suburban and urban that are not accustomed to large scale gas well development. This will transform parts of these communities. Apart from environmental pollution and human health impacts related to pollution, safety issues include risk of explosion, blowouts, fire, and accidents, hazardous material releases, and other emergencies. For example, in Greene County, PA a worker was killed and another badly injured when a coalbed methane gas well exploded.[37] In Leidy Township, Clinton County, PA, a gas well exploded into flames Sept. 14, 2008; special firefighters from Texas were brought in to contain the fire, which was expected to burn for weeks.[38] In Appomattox County, also on September 14, a Williams Gas Co. pipeline that runs from the Gulf Coast to New York exploded without warning, destroying 2 homes and damaging 6 others, hurting 5 people, causing the evacuation of a neighborhood of hundreds, and leaving a 50 foot crater behind.[39]

Emergencies like these require emergency personnel and the expense attached to providing adequate response, rescue and interim care. Additional human impacts include trauma[40], worker health and safety risks, reduction of quality of life, loss of recreational use and customary vistas and the economic impact of harm to established ecotourism and nature-based economies, such as fishing and hunting.

Section 5.0 DEC should consider that there may be, as stated above, the need for new laws and regulations to adequately address all the important issues. Certainly DRBC cannot be the only regulator in the Delaware River Watershed, but there should be harmony of regulation and primacy should be established. DEC should consider adopting the Special Protection Waters Program that is in place in the Upper Delaware River Watershed for all of New York.

Section 5.1 DEC should consider requiring notification of local and county governments and the public of all gas well activity well in advance and work with local government to handle the disruptions that will occur. There should be a publicly accessible website where all approvals are posted with projected start dates for activities. Full public disclosure of well information will be of great help in preparations for the start-up of new wells. Funding of local costs should be born by the industry, not government. Notification of well construction within 100 feet of a flood hazard area is wholly inadequate. Please see DRN General Comments and Section 4.4 Comments above.

Thank you for the opportunity to comment on the Draft Scope. DRN advocates for an extension of the public comment period so hearings to be held in New York City and the New York City Watershed. DRN also advocates for at least one hearing in the downstream Delaware River Watershed, as expressed in our Verbal Comments submitted December 4, 2008. Finally, DRN advocates for a new Draft Scope that reflects the public input received so far and contains greater specificity as to how the EIS will be prepared and impacts measured, that corrects invalid assumptions in the Draft Scope and that contains definitions and a more fully developed Scope.

Sincerely,

Maya K. van Rossum Tracy Carluccio

the Delaware Riverkeeper Deputy Director

APPENDIX A Water Quality

The use of chemicals and the contaminants that are produced by well development processes expose water resources and features, including drinking water supplies, to significant risk of pollution.[41] The pathways for this pollution are multiple.

The extensive long-bore drilling and hydraulic fracturing ("fracking") processes introduce chemicals into the well and also disturb, distribute, and bring to the surface chemicals from various rock formations (such as salts, sulfides, and "normally occurring radioactive materials" or NORMS, which occur in the region; NORMS have required decontamination elsewhere such as at 140 sites since January 2005 in Texas in Barnett Shale)[42]. Chemicals are used in the fracking fluids and drilling muds. It is estimated that 20%-60% of the fracking fluids and the chemicals they contain can remain underground and can spread into deep aquifers. The storage of the fracking fluids in open pits and the action of the well development process exposes the chemical mix to the land surface, which provides another pathway for pollution to groundwater through infiltration and to surface water through overland flow and deposition on water from the volatilization of chemicals into the air.

Looking to the west, in Pennsylvania it is forecasted that the resulting volume of wastewater to be treated and discharged is beyond the capacity of existing treatment plants in the region.[43] This is due to the large amount of water used for fracking -- 2 to 9 million gallons per well, depending on the number of fracks, the depth of the well vertically and the length horizontally. Even if the toxics are removed from the fresh water or liquids used, the amount of toxics in liquid or solid form that will need to be treated and disposed is beyond present treatment capability, which begs the question: "Where will this waste go and how will it be treated"?

Existing sewage treatment plants are not equipped to process or safely manage the contaminants in the wastewater - particularly since the wastewater is high in total dissolved solids (TDS) and salts -- but some municipal facilities in the Delaware River Watershed and New York State are considering importing it nonetheless, including the Central Wayne Regional Authority in Honesdale, PA.[44]

Wastewater treatment facilities further west in Pennsylvania are already accepting the waste - and are experiencing serious consequences. The discharge of wastewater from gas development in the Marcellus shale in Pennsylvania has contributed to a currently unfolding contamination emergency for the Monongahela River, according to a PADEP news release October 22, 2008. PADEP is investigating unusually high levels of total dissolved solids (TDS) in the river that has affected 11 public water supplies that serve 325,000 customers.

TDS represents the dissolved elements in water and can include carbonates, chlorides, sulfates, nitrates, sodium, potassium, calcium and magnesium and causes water to be discolored and of poor taste.[45] PADEP issued a water quality advisory for consumers to use bottled water until the problem is addressed and has all but banned the acceptance of wastewater from gas well hydrofracking by local sewage treatment plants (requiring reduction of gas drilling wastewater to 1% of the daily sewage flow-some plants were taking in as much as 20%).[46] Water treatment facilities are not equipped to remove the TDS that has fouled the Monongahela River.

Total Dissolved Solids Search Results

Total Dissolved Solids (TDS)

Effect on Industry and Agricultural Operations

Irrigation water, withdrawn from a stream may adversely affect these industry

operations if elevated in-stream levels of pollutants such as chlorides and total dissolved solids (TDS) are present. (PADEP Response to Triennial Review of Water Quality Standards Comments. July 2008)

From Wikipedia

Generally, TDS is considered not as a primary pollutant (e.g. it is not deemed to be associated with health effects), but it is rather used as an indication of aesthetic characteristics of drinking water and as an aggregate indicator or presence of a broad array of chemical contaminants (wikipedia.org).

The US established a secondary water quality standard of 500 mg/l to provide for palatability of drinking water (wikipedia.org).

High TDS generally indicates hard water which can cause scale buildup in pipes, valves and filters-adding maintenance costs.

Most aquatic ecosystems involving mixed fish fauna can tolerate TDS levels of 1000 mg/l (Boyd, Claude E (1999) Water Quality: An Introduction. The Netherlands: Kluwer Academic Publishers Group.ISBN 0-7923-7853-9.

The Fathead minnow (*Pimephales promelas*), for example, realizes an LD50 concentration of 5600 ppm based upon a 96 hour exposure. LD50 is the concentration required to produce a lethal effect on 50 percent of the exposed population. *Daphnia magna*, a good example of a primary member of the food chain, is a small planktonic crustacean, about five millimeters in length, having an LD50 of about 10,000 ppm TDS for a 96 hour exposure.[5]

Spawning fishes and juveniles appear to be more sensitive to high TDS levels. For example, it was found that concentrations of 350 mg/l TDS reduced spawning of Striped bass (*Morone saxatilis*) in the San Francisco Bay-Delta region, and that concentrations below 200 mg/l promoted even healthier spawning conditions.[6] In the Truckee River, the EPA found that juvenile Lahontan cutthroat trout were subject to higher mortality when exposed to thermal pollution stress combined with high total dissolved solids concentrations.[2]

For terrestrial animals, poultry typically possess a safe upper limit of TDS exposure of approximately 2900 mg/l, while dairy cattle are measured to have a safe upper limit of about 7100 mg/l. Research has shown that exposure to TDS is compounded in toxicity when other stressors are present, such as abnormal pH, high turbidity or reduced dissolved oxygen with the latter stressor acting only in the case of animalia.[7]

Waters with high dissolved solids generally are of inferior palatability and may induce and unfavorable physiological reaction in the consumer. For these reasons, a limit of 500 mg dissolved solids/L is desirable for drinking waters. (Standard Methods: Examination of Water and Wastewater, 20th edition.1998.)

References

•1. ^ DeZuane, John (1997). *Handbook of Drinking Water Quality* (2nd edition ed.), John Wiley and Sons. ISBN 0-471-28789-X.

•2. ^ *a b* C.M. Hogan, Marc Papineau et al. *Development of a dynamic water quality simulation model for the Truckee River*, Earth Metrics Inc., Environmental Protection Agency Technology Series, Washington D.C. (1987)

•3. ^ USEPA. 1991. *Guidance for water quality-based decisions: The TMDL process*. EPA 440/4-91-001. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

•4. ^ Boyd, Claude E. (1999). *Water Quality: An Introduction*. The Netherlands: Kluwer Academic Publishers Group. ISBN 0-7923-7853-9.

•5. ^ *Position Paper on Total Dissolved Solids*, State of Iowa, IAC 567 61.3 (2)g et sequitur updated March 27, 2003

•6. ^ Kaiser Engineers, California, *Final Report to the State of California, San Francisco Bay-Delta Water Quality Control Program*, State of California, Sacramento, CA (1969)

•7. ^ Hogan, C. Michael; Patmore, Leda C.; Harry Seidman (August 1973). "*Statistical Prediction of Dynamic Thermal Equilibrium Temperatures using Standard Meteorological Data Bases*". EPA-660/2-73-003. U.S. Environmental Protection Agency. Retrieved on 2007-03-06.

•8. ^ ISBN 0-13-148193-2

Dissolved-solids values, in spite of the handicaps noted above, are widely used in evaluating water quality and are a convenient means of comparing waters with

one another. The residue left after evaporation can be used as an approximate check on the general accuracy of an analysis when compared with the computed dissolved-

solids value. In regions of high rainfall and relatively insoluble rocks, dissolved-solids concentrations in runoff may be as low as 25 mg/L. A saturated sodium chloride brine, on the other hand, may contain more than 300,000 mg/L. Robinove and others (1958) Assigned terms for water of high dissolved solids as follows:

U,uoIwd ,ohd, (mg/L)

Slightly saline _ l.OOO-3,000.

Moderately sahne .._ 3.000-10,000.

Very saline __ _ _ lO,OOO-35,000.

Bryny ._ __ _ _ __ More than 35,000.

RANGE OF HARDNESS CONCENTRATION

The adjectives "hard" and "soft" as applied to

water are inexact, and some writers have tried to improve

on this situation by adding qualifying adverbs. Durfor

and Becker (1964, p.27) used the following classification:

(mg/L of CaC03) Descrrprron

O-60 _______________________________________S_o_f.t... ....

61-120 __._________________................................M...o..d..e..r.a..t.e..l y hard.

121-180 ___._._........_..H.. ard.

More than 180 ____________________...................V..e..r.y.. .h..a..r.d...

In some areas of the United States, however, where most water has a low dissolved-solids content, a water containing 50 mg/L of hardness would be considered hard

by most residents. The standards by which water hardness is judged have tended to become more rigorous over the years. Many public water supplies now are softened to less than

100 mg/L of hardness. The U.S. Public Health Service (1962) and later U.S. drinking water standards do not specify any value for hardness. The World Health Organization

(1971) suggested an upper limit of 500 mg/L. According to the American Water Works Association (Bean, 1962), however, "ideal" water should not contain more than 80 mg/L of hardness.

Incidences of water contamination and environmental pollution have been reported around the country near natural gas wells either from spills, accidents or through customary practice[47]. For example, a recent incident reported in Newsweek recounted a fracturing fluid spill that sent a worker to the hospital and is being investigated as the cause of his nurse's near-death illness[48]. Incidents of methane from gas wells leaking into water wells have been reported in Ohio, ruining private wells and requiring water to be imported for a neighborhood.[49] Other incidents of pollution near natural gas wells include water wells in the Pinedale Anticline, a natural gas rich area in Wyoming where six wells are emitting potentially flammable gas in such high levels that they can't be safely tested[50] and also in Wyoming where hydrocarbons have been found in a water well for livestock[51]. The composition of the frack fluid is protected from disclosure despite health and environmental impacts.

There is a need for thorough study of the environmental and health impacts of well drilling and development; there is very little on the record. For instance, in Colorado a Health Impact Assessment has been called for as part of an Environmental Impact Statement due to documented pollution problems from natural gas development in Garfield County that require scientific analysis.[52]

Several issues compound the water quality impacts of natural gas development:

- What specific chemicals and materials are used in each fracking formula are not known, which poses pollution hazards because proper handling may not occur and exposure to the environment leads to unknown public health risks and pollution incidents. Drilling wastes, either from fracking or from the brines themselves, tend to be high in some trademark contaminants like chloride, sodium, iron, manganese, total dissolved solids and barium. Beyond that, commonly found in lab analyses of frack water (also called "slick water") are elevated levels of metals (arsenic, lead and others), surfactants and detergents (used in the drilling) and a variety of organic compounds, oftentimes toxic. The organics used in fracking have been extremely difficult to determine because the information is not released and they are very expensive to test for. Routinely benzene and toluene is found but other substances, considered protected from public disclosure, are difficult to indentify in lab analyses. Often labs use total dissolved solids (TDS) or chlorides as markers when looking for evidence of frack fluids and track these levels to determine when more specific testing is needed. (email communication to Faith Zerbe, DRN, Bryan Swistock, Penn State University, 12.04.08) The difficulty that arises from lack of information (even if the chemicals are revealed, the recipes and amounts of each chemical may not be made available to agencies or the public due to exemptions for the naturals gas industry) confounds the goal of protecting the environment from pollution from frack fluids.

- EPA's list of common fracking fluids and additives include liquid carbon dioxide, liquid nitrogen, crude oil, kerosene, and various lubricants, friction reducers, gels, surfactants, defoamers, biocides, polymers and proppants.[53]

- During well development, frack water is usually stored on site in an open pit, usually mixed with fresh water that is imported and stored for use in fracking. In New Mexico the state tested pit water to find out what was in it. They found that 30% of the tests showed the presence of chemicals being tested for, including polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), semi volatile organics (SVOs), including arsenic, lead, mercury, 2,4-Dinitrotoluene, 2-Methylnaphthalene, phenol, benzene, m,p-Xylene, sulfate, barium, cadmium, chromium. Most of the 154 constituents found in the pits can be classified as hazardous.[54] Impacts to water quality from the pits occur when liners fail or the pit is breached and pollutants escape into the environment, contaminating soil and surface water and putting groundwater at risk.

- A report submitted to Congress by an EPA whistleblower employee in 2004 revealed that acids, BTEX, formaldehyde, plyacrylamides, chromates, and other toxic substances may be introduced underground and to deep aquifers during fracking.[55] The concerns reported were ignored by EPA in their decision that fracking fluids do not pose significant environmental threats to drinking water.

- The fracking chemicals and drilling muds have health impacts for humans and animals that range from mild to severe skin and eye irritation to brain and nervous system effects. Some cause acute problems, others lead to slowly developed disorders.[56] Some chemicals are known carcinogens. The environmental and health impacts are not tracked or closely studied since well and stream monitoring, pit testing and disclosure of constituents used in well development have not been routinely required for natural gas well drilling.

- "Produced water" or "flowback" is fluid that is brought to the surface when gas is released from a well bore during natural gas development procedures. The constituents of produced water vary depending on the geologic conditions, the composition of the gas, and the chemical properties of any injected fluids, such as fracking fluids; produced water requires treatment before discharge under Clean Water Act requirements.[57] During natural gas production, produced water is separated from the gas.

The Department of Energy has found that this wastewater product has "higher contents of low molecular-weight aromatic hydrocarbons such as benzene, toluene, ethylbenzene and xylene (BTEX) than those from oil operations; hence they are relatively more toxic than produced waters from oil production."[58] The fluid also may contain salts (chlorides can be so high that the liquid, called "brine", is 10 times saltier than sea water) and may be acidic (typical range is 3.5-5.5).[59] It is estimated that the produced waters discharged by natural gas operations are about 10 times more toxic than those from offshore oil wells.[60] USGS also reports that natural gas condensates may also contain the chemicals known as "BTEX".[61]

BTEX Search Results

The information summarized below are excerpts from the online Environmental Contaminates Encyclopedia [62]. Numbers in parentheses include citations available in the NPS reports for each constituent and are not listed here.

The BTEX compounds represent some of the most hazardous components of gasoline. A variety of test are used to identify BTEX contamination (see the Laboratory section below for details).

Short term (acute) hazards of lighter, more volatile and water soluble aromatic compounds (such as benzenes, toluene, and xylenes) include potential acute toxicity to aquatic life in the water column (especially in relatively confined areas) as well as potential inhalation hazards.

Long term (chronic) potential hazards of lighter, more volatile and water soluble aromatic compounds include contamination of groundwater. Chronic effects of benzene, toluene, and xylene include changes in the liver and harmful effects on the kidneys, heart, lungs, and nervous system [609,764,765,767].

Except for short term hazards from concentrated spills, BTEX compounds have been more frequently associated with risk to humans than with risk to non-human species such as fish and wildlife. This is partly because only very small amounts are taken up by plants, fish, and birds and because this volatile compound tends to evaporate into the atmosphere rather than persisting in surface waters or soils [764]. However, volatiles such as BTEX compounds can pose a drinking water hazard when they accumulate in ground water.

Brief Summary of Carcinogenicity/Cancer Information:

Certain carcinogenic effects have been associated with benzene [465,609,767] (see the Benzene entry for more details). BTEX compounds are often found in association with a mixture of PAH compounds, many of

Fate of BTEX Compounds:

BTEX compounds have the potential to move through soil and contaminate ground water, and their vapors are highly

flammable and explosive [465].

Literature on Removing Contaminated Sediments with BTEX

The California State Leaking Underground Fuel Task Force in 1987 stated that (to protect groundwater)soils having a low leaching potential should be removed if the toluene, ethyl benzene, or xylene concentration exceeds 50 ppm; soils having a medium leaching potential should be removed if the

concentration exceeds 0.3 ppm benzene, 0.3 ppm toluene, 1 ppm ethyl benzene, or 1 ppm xylene [347]. State Total BTEX cleanup guidance levels range from 1 to 100 ppm [806].

Soil Concern Levels

Soil for Humans - Concern Levels(Soil Concentrations vs. Human):

Benzene:

Health Based Cleanup Levels [806].

Residential: 2.5 ppm

Industrial: 14 ppm

Recreational: 250 ppm

Agricultural: 400 ppm

Groundwater: Site-Specific

Runoff: Site-Specific

Wildlife: Site-Specific

Toluene:

Health Based Cleanup Levels [806].

Residential: 2,000 ppm

Industrial: 10,000 ppm

Recreational: 170,000 ppm

Agricultural: 2,000 ppm

Groundwater: Site-Specific

Runoff: Site-Specific

Wildlife: Site-Specific

Xylene:

Health Based Cleanup Levels [806].

Residential: 300 ppm

Industrial: 1,400 ppm

Recreational: 25,000 ppm

Agricultural: 1,000 ppm

Groundwater: Site-Specific

Runoff: Site-Specific

Wildlife: Site-Specific

Soil for Wildlife - Concern Levels (Soil Concentrations vs. Wildlife or Domestic Animals):

Soil cleanup levels for protection of wildlife, like protection levels for groundwater, will be very site specific for BTEX because of the variety of species that could be involved [806].

BTEX compounds are important in sampling strategies and

contamination studies since:

- •1) they are readily adaptable to gas chromatographic detection;
- •2) they pose a serious threat to human

  health (benzene is a carcinogen);
- •3) they have the potential to move through soil and contaminate ground water; and
- •4) 4) their vapors are highly flammable and explosive [465].

BENZENE

Although most public drinking water supplies are free of

benzene or contain <0.3 ppb, exposure can be very high

from consumption of contaminated sources drawn from wells

contaminated by leaky gasoline storage tanks, landfills,

etc.

While the major concern about the toxicity of benzene is

its chronic effects, benzene is nevertheless an acutely

toxic substance, with an estimated lethal oral dose being

1 teaspoon to 1 ounce for a normal adult [609]. Benzene

is causally linked with central-nervous-system disorders

[335].

Harmful amounts of benzene may be absorbed through the

skin, causing leukemia and cancer [261]. A latent period

of 2-50 years can occur between benzene exposure and

development of the leukemia [606].

Chromosome damage has been found among workers exposed to very low benzene levels [335]. Chromosome aberrations have been detected in animals and humans [368]. Occupational exposure to benzene has been associated with elevated frequencies of chromosome aberrations in peripheral lymphocytes (white blood cells) [606]. Human health issues related to this topic have been summarized by ATSDR [767].

Benzene is not teratogenic in experimental animals, although embryotoxic and fetotoxic effects have been reported at airborne concentrations less than those observed to be toxic to the mother rats [865]. Exposure to benzene has been associated with vaginal bleeding, hemorrhagic complications of pregnancy, heavy menstrual bleeding, menstrual cycle disorders, various obstetrical disorders including miscarriage, premature births, birth defects, and stillbirths [606,609]. Benzene crosses the human placenta, and similar levels are found in fetal and maternal blood [606,609]. In a few cases of benzene poisoning from high exposures during pregnancy, the fetus

ETHYLBENZENE

Br.Class: General Introduction and Classification Information:

Ethylbenzene is a volatile organic compound (VOC) [868,903]. Like toluene and xylenes, ethylbenzene is an alkyl benzene. It is different from benzene in having an ethyl group added to (substituted for a hydrogen) on the benzene ring.

Ethylbenzene has been designated as a hazardous substance under section 311(b)(2)(A) of the Federal Water Pollution Control Act and further regulated by the Clean Water Act Amendments of 1977 and 1978 (40 CFR 116.4 (7/1/87)). These regulations apply to discharges of this substance [609]. It is also a toxic pollutant designated pursuant to section 307(a)(1) of the Clean Water Act and is subject to effluent limitations (40 CFR 401.15, 7/1/87) [609].

Br.Haz: General Hazard

Except for short term hazards from concentrated spills, this compound has been more frequently associated with risk to humans than with risk to non-human species such as fish and wildlife. This is partly because only very small amounts are taken up by plants, fish, and birds and because this volatile compound tends to evaporate into the atmosphere rather than persisting in surface waters or soils [764]. However, volatiles such as this compound have can pose a drinking water hazard when they accumulate in ground water.

Effects of this volatile solvent to non-human biota would often result from high concentrations immediately after a spill (before the compound has volatilized into the atmosphere) or as the indirect result of contamination of groundwater. **For example, if highly polluted groundwater water comes into surface waters from springs or seeps, local effects may occur in the mixing zone where the groundwater enters surface water**.

Brief Summary of Developmental, Reproductive, Endocrine, and Genotoxicity Information:

One study indicated that acute oral exposure to 500 or 1000 mg/kg ethylbenzene decreases peripheral hormone levels and may block or delay the estrus cycle in female rats during the diestrus stage [910].

Environmental Fate/Exposure Summary [609]:

Ethylbenzene will enter the atmosphere primarily from fugitive emissions and exhaust connected with its use in gasoline. More localized sources will be emissions, waste water and spills from its production and industrial use. Once in the atmosphere, ethylbenzene will photochemically degrade by reaction with hydroxyl radicals (t1/2 hrs to 2 days) and partially return to earth in rain. Releases into water will decrease in concn by evaporation and biodegradation. The time for this decrease and the primary loss processes will depend on the season, and the turbulence and microbial populations in the particular body of water. Representative half-lives are several days to 2 weeks. Ethylbenzene is only adsorbed moderately by soil and may leach into groundwater where its biodegradation is possible. The primary source of exposure is from the air especially in areas of high traffic. However, exposure from drinking water is not uncommon [609].

Water Data Interpretation, Concentrations and Toxicity (All Water

W.Low (Water Concentrations Considered Low):

No information found.

W.High (Water Concentrations Considered High):

The geometric mean concentrations of ethylbenzene found at hazardous waste sites on the National Priorities List was 239 ppb in surface water and 69 ppb in groundwater (non-detect samples were not included in the mean calculations) [910].

Ethylbenzene has been detected in wells downgradient from landfills in Southern Ontario at concentrations ranging from 12 to 74 ug/L (ppb). Ethylbenzene was detected in private well water in Rhode Island with concentrations ranging from 1 to 156 ug/L. Groundwater near an underground coal gasification site in northeastern Wyoming contained concentrations of ethylbenzene ranging from 92 to 400 ug/L (ppb). Groundwater samples near a fuel spill in the Great Ouse Basin in Great Britain contained ethylbenzene concentrations as high as 1110 ug/L [910].

Water Concentrations Considered Typical:

The median ethylbenzene concentration in ambient surface waters in the United States in 1980-82 was less than 5.0 ug/L (ppb) according to EPA's STORET water quality data base. The chemical was detected in 10% of 1101 samples collected during that period. Ethylbenzene was detected in 7.4% of the 1368 industrial effluent samples collected during 1980-1983 at a median concentration of less than 3.0 ug/L [910].

Ethylbenzene was measured in seawater at an average concentration of 0.011 ug/L (ppb) and a concentration range of 0.0018-0.022 ug/L (ppb) over a 15-month observation period at Vineyard Sound, MA. It also has been reported in surface waters of the Gulf of Mexico at a concentration range of 0.0004-0.0045 ug/L (ppb) [910].

Ethylbenzene was measured in 4% of the municipal runoff samples collected in 15 cities of the United States as part of EPA's Nationwide Urban Runoff Program. Thea concentration range of 0.0004-0.0045 ug/L (ppb) [910].

Ethylbenzene was measured in 4% of the municipal runoff samples collected in 15 cities of the United States as part of EPA's Nationwide Urban Runoff Program. The measured concentration range was 1-2 ug/L (ppb) [910].

Ethylbenzene does not appear to be widespread in groundwater used for public drinking water supplies. The 1982 Ground Water Supply Survey conducted by EPA reported ethylbenzene in only 3 out of 466 random samples at a mean concentration of 0.8 ug/L (ppb) and a maximum concentration of 1.1 ug/L [910].

Ethylbenzene was detected in public drinking water in Rhode Island with concentrations ranging from 1 ug/L (ppb) to 3 ug/L [910].

Ethylbenzene was measured in all three water plants sampled as part of the New Orleans Area Water Supply Study conducted by EPA in 1974 [910]. The reported concentrations were 1.6, 1.8, and 2.3 ug/L [910].

Water Quality Criteria, LC50 Values, Water Quality Standards, Screening Levels, Dose/Response Data, and

Other Water Benchmarks:

The Netherlands' Preliminary Maximum Permissible Concentration (MPC) for the protection of all species in an aquatic ecosystem is 370 ug/L [655].

A limit of 0.25 mg/l has been recommended for the maximum level in ambient water to avoid tainting of fish and other organisms. [USEPA; Ambient Water Quality Criteria Document: Ethylbenzene (1980) EPA No 440/5-8-048] [609].

Canada's Interim Assessment Criterion for ethylbenzene in water is 0.5 ug/L [656].

NOTE: a) For most of the organic chemical parameters in [656], criteria are based on analytical detection limits; b) criterion is considered "Interim" since complete supporting rationale do not exist.

Canada's Remediation Criteria for ethylbenzene for freshwater aquatic life is 700 ug/L [656].

W.Plants (Water Concentrations vs. Plants):

The LC50 for algae is 33 mg/L [624].

W.Invertebrates (Water Concentrations vs. Invertebrates):

LC50s for Daphnia magna (water flea) were 77 and 190 mg/L for 24-hr exposures, and 75 mg/L for 48-hr exposures [998].

LC50s for Cancer magister (Dungeness or edible crab) were 40.0 and 13.0 mg/L (ppm) for 48- and 96-hr exposures, respectively [998].

LC50s for Crangon franciscorum (bay shrimp) were 2.2 and 0.49 ul/L (ppm) for 24- and 96-hr exposures, respectively [998].

LC50s for Mysidopsis bahia (Opossum shrimp) were >5.2, >5.2, 4.0 and 2.6 for 24-, 48-, 72- and 96-hr exposures. The lowest-observed-effect concentration

(LOEC) and the no-observed-effect concentration for Opossum shrimp were 2.7 and 1.0 mg/L, respectively, both for 96-hr exposures [998].

General Water Quality Standards, Criteria, and Benchmarks Related to Protection of Aquatic Biota in General; Includes Water Concentrations Versus Mixed or

General Aquatic Biota:

Oak Ridge National Lab, 1994: Ecological Risk Assessment Freshwater Screening Benchmarks for concentrations of contaminants in water [649]. For a definition of meaning of each benchmark, see entry entitled: Benchmarks. To be considered unlikely to represent an ecological risk, field concentrations should be below all of the following benchmarks (ug/L) [649]:

National ambient water quality criterion - acute: no information found

National ambient water quality criterion - chronic: no information found

Secondary acute value: 6970

Secondary chronic value: 389

Lowest chronic value - fish: >440

Estimated lowest chronic value - daphnids:

12,922

Lowest chronic value - non-daphnid

invertebrates: no information found

Lowest chronic value - aquatic plants:

>438,000

All organisms: >440

Lowest test EC20 - fish: no information found

Lowest test EC20 - daphnids: no information

found

Sensitive species test EC20: no information

found

Population EC2O: 398

Water Concentrations vs. Fish:

LC50s for Carassius auratus (goldfish) were 94.44

and 94.44 mg/L (ppm) for 24- and 48-hr exposures,

respectively [998].

LC50s for Cyprinodon variegatus (sheepshead minnow)

were 300, 360 and 320 mg/L for 24-, 48- and 72-hr

exposures, respectively. The no-observed-effectconcentration

(NOEC) for death is 88 mg/L for a 96-

hr exposure [998].

LC50 for Ictalurus punctatus (channel catfish) is

210 mg/L for a 96-hr exposure [998].

LC50s for Lepomis macrochirus (bluegill) were:

35.08 and 169.0 mg/L for 24-hr exposures; 32.0 mg/L

for a 48-hr exposure;

LC50s for Oncorhynchus mykiss (rainbow trout,

donaldson trout) were 14.0 and 4.2 mg/L for 96-hr

exposures [998].

LC50s for Pimephales promelas (fathead minnow)

were: 48.51 and 42.33 mg/L for both 24- and 48-hr

exposures;

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[1] See Appendix A

[2] U.S. Congress, Public Law 90-545, sec. 1 (b)

[3] PADEP ESCGP-1

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http://www.oilandgasinvestor.com/Headlines/WebJuly/item5211.php

[5] http://www.geosc.psu.edu/~engelder/

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[7]"Gas Well Drilling and Development, Marcellus Shale, June 12, 2008 Commission Meeting", www.srbc.net

[8] Wyoming Dept. of Environmental Quality, letter to BLM from John Corra, Director, d. 4.2.07.

[9] http://www.harc.edu/Search/Results.aspx?q=Storage+Tank+VOCs

[10] Testimony of Jim Dezolt, Director, Division of Water, NYSDEC, before NYS Legislature, Assembly Standing Committee on Environmental Conservation, August 6, 2008.

[11] **Permit Application No. T-1060 and G-2127.** Waste Mgmt of Pa Inc, 444 Oxford Valley Road, Langhorne, Pa 19047, Falls Township, Borough of Tullytown, Bucks County.

[12] DNREC and Brandywine Conservancy, <u>Conservation Design for Stormwater Management: A Design Approach to Reduce Stormwater Impacts from Land Development and Achieve Multiple Objectives Related to Land Use</u>, September, 1997, p. 4-16

[13] DNREC and Brandywine Conservancy, <u>Conservation Design for Stormwater Management: A Design Approach to Reduce Stormwater Impacts from Land Development and Achieve Multiple Objectives Related to Land Use</u>, September, 1997, p. 3-37

[14] DNREC and Brandywine Conservancy, <u>Conservation Design for Stormwater Management: A Design Approach to Reduce Stormwater Impacts from Land Development and Achieve Multiple Objectives Related to Land Use</u>, September, 1997, p. 2-32

[15] DNREC and Brandywine Conservancy, <u>Conservation Design for Stormwater Management: A Design Approach to Reduce Stormwater Impacts from Land Development and Achieve Multiple Objectives Related to Land Use</u>, September, 1997, p. 3-38

[16] DNREC and Brandywine Conservancy, <u>Conservation Design for Stormwater Management: A Design Approach to Reduce Stormwater Impacts from Land Development and Achieve Multiple Objectives Related to Land Use</u>, September, 1997, p. 3-5

[17] DNREC and Brandywine Conservancy, <u>Conservation Design for Stormwater Management: A Design Approach to Reduce Stormwater Impacts from Land Development and Achieve Multiple Objectives Related to Land Use</u>, September, 1997, p. 2-23

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