To: Edward Hanlon/DC/USEPA/US@EPA
Date: 05/03/2010 03:00 PM
Subject: Research on Cementing of Gas Wells

Hello Mr. Hanlon,

I obtained your name from Miriam Bloom of Deposit, NY.

Miriam mentioned that you are working on the EPA study and perhaps some of my research would be helpful. Thus, I have attached:

1.) An article that I wrote regarding cementing of gas wells that was published in the Binghamton Press and Sun Bulletin newspaper on April 25, 2010.

2.) My December 2009 comments on New York States' dsGEIS (draft scope Generic Environmental Impact Statement)

3.) My December 2008 comments on NY States' dsGEIS

4.) A paper written by several members of the Oil Industry entitled, "From Mud to Cement-Building Gas Wells" wherein the Oil Industry itself admits that the cementing of oil/gas wells is a complex, tricky process.

It would be helpful if you could get a hold of the March 2008 issue of "National Geographic". There is an article called "The Canadian Oil Boom, tar sands yield millions of barrels-but at what cost?" I would be glad to copy this article for you, just provide me with the address where you would like it sent.

I would be glad to help you folks in any way I possibly can! Please let me know if all four files transmitted.

Thanks-so-much for all your hard work,

Jilda Rush
Windsor, NY

Article prepared for publication in the Press/Sun

Research looks at Gas Well Cement Compositions/Procedures

Everyone is familiar with cement. But have you ever thought about its' use in gas wells?? In the oil/gas industry, cement plays a crucial role!! First, the driller drills through all the strata and the "cuttings" (drilled-out rocks) are removed. What remains at this point is a bare hole. Next, the driller lowers a large metal pipe called a "casing" down into the hole almost as far as he has drilled. The casing alone will not protect the underground aquifer. Pollution can still occur in the space between the outside of the metal casing and the inside of the borehole. This space is called the "annular space". Cement is forced down the inside of the casing, around the bottom of the casing, and then up the outside of the casing into this "annular space" until the cement completely fills this area and returns to the surface. This cement will fasten and seal the pipe casings in place, thus becoming the CHIEF mechanism for isolating/ protecting water sources from gas and drilling fluid contamination. Having been a former Asphalt and Concrete Materials Tester for Oregon DOT, I became concerned over the rigidity of Portland Cement and the extreme conditions deep gas well drilling operations would exert on this concrete. Portland Cement by nature is too brittle and low in tensile strength to withstand shocks or impacts generated by drilling operations. Wellbore cements are subjected to internal stresses from vibrations caused by stringlines and casing pipe assemblies being moved inside the wellbore; and external stresses from surrounding formation pressures, formation temperatures, and formation shifting. Conventional wellbore cements typically react to excessive stress by failing!

As a borehole reaches deep into the earth, previously isolated layers of formation are exposed to one another, with the borehole as the conductive path! **Proper cementing is critical for the protection of aquifers to prevent gas and drilling fluids from leaking into zones that would otherwise not be contaminant bearing.** Thus, the primary Gas drilling contractor frequently subcontracts this important aspect of drilling to a company that exclusively performs cementing; such as, Schlumberger. Yet, Schlumberger themselves admit "much work remains to be done in simulating downhole conditions and developing new cement technologies/compositions for thermal applications and high pressure conditions." No one ideal cement design exists for cementing all gas wells; the cement for each job is tailored for that specific situation (or at least it better be).

Halliburton notes "Wellbores exist in extremely dynamic environments; therefore, cement must be able to perform as intended over time. When cementing a well, the primary concern is to prevent fluids from migrating into an annulus. As a well ages, the annular seal may be compromised as a result of stresses brought on by temperature and pressure cycling that occurs as the well is operated. **By industry tradition the effect of stresses on the cements mechanical properties are not ordinarily assessed during the design and construction phase of a well. ……."**

The above are quotes from two BIG drilling companies, yet IOGA (Independent Oil & Gas Association of New York) representatives are distributing a 9 page pamphlet with only one small paragraph explaining cementing which declares that the cement will "protect the fresh water zones from ANY CHANCE OF CONTAMINATION." This is an all

encompassing blatant statement that is in direct opposition to what the experts, Halliburton and Schlumberger, have to say.

The following are excerpts from a paper titled **"From Mud to Cement-Building Gas Wells"** found at www.slb.com/media/services/resources/oilfieldreview/ors03 . **This study illustrates the complexity of cementing and extols it as one of the most UN-failsafe aspects of drilling!** "Since the earliest gas wells, uncontrolled migration of hydrocarbons to the surface has challenged the oil and gas industry. Gas migration can lead to sustained casing pressure (SCP). By the time a well is 15 years old, there is a 50% probability it will have measurable SCP in one or more of its casing annuli. However, SCP may be present in wells of any age. Cement damage can occur long after the well construction process. Even a flawless primary cement job can be damaged by rig operations or well activities occurring after the cement has set. The mechanical properties of the casing and the cement vary significantly. Consequently they do not behave in a uniform manner when exposed to changes in temperature and pressure. As the casing and cement expand and contract, the bond between the cement and casing may fail."

"**Sealing an annular space against gas migration can be even more difficult in gas wells than in oil wells. Wellbore construction, particularly in the presence of gas bearing formations, requires that borehole, drilling fluid, spacer and cement designs, and displacement techniques be dealt with as a series of interdependent systems, each playing an equally important role. Often, the relationships among these systems is overlooked, or at the very least, poorly appreciated." Special materials are required to give cement flexibility.** "Cement is traditionally designed for optimal ease of placement and strength development rather than long-term post-setting performance. Emphasis on strength at the expense of durability often leads to the development of SCP (sustained casing pressure)." Conventional Portland cements are known to shrink during setting. In contrast, specially engineered "FlexSTONE" cements can be designed which expand, further tightening the hydraulic seal. This type of cement flexes in unison with the casing rather than failing from tensile stresses!!

Also, one encounters more difficulties with cementing horizontal wells as opposed to vertical wells. There is an "inability to effectively cement voids along the horizontal section because the density of the cement does not allow sufficient displacement of drilling mud and other residue, resulting in channeling of cement and improper tubing or pipe/formation bonding."

You see, GAS DRILLING ISN'T AS SIMPLE OR FAIL-PROOF AS YOU FOLKS ARE LED TO BELIEVE!! In the August 23rd "Press" Issue, Broome County Executive Darcy Fauci says "Broome County has examined the potential impacts of natural gas development from many perspectives, not just economic. We have educated ourselves and continue to study issues surrounding natural gas. We would be extremely negligent if we failed to look at all the obvious impacts, whether negative or positive." Well, the impact I have presented has NOT been examined by Broome County and they have NOT educated themselves regarding this critical aspect drilling. Infact, cementing is rarely discussed; yet casing-cement failure is suspected to be the cause of several recent Dimock, PA. gas wells leaking hazardous contaminants!!

Submitted by, Jilda Rush, a former Oregon Dept. of Transportation Associate Transportation Engineer & Asphalt/Concrete Materials Tester who is a Town of Windsor landowner.

December 12, 2008

I am resubmitting my comments originally dated November 6, 2008. I have added the references that I used for my information and have also enclosed this reference material with this submittal.

Bureau of Oil & Gas Regulation
NYSDEC Division of Mineral Resources
625 Broadway, Third Floor
Albany, NY 12233-6500
Attention: dsGEIS Scope Comments

Dear NYSDEC regulators,
I am a small landowner who is concerned that proposed gas drilling on the two large farms adjacent to my property could contaminate my water well or deplete the aquifer that supplies my well. I plan on selling my home in the near future and need the monetary gains as part of my retirement income. My home & property value would be rendered virtually worthless if there were no water supply. I have read the dsGEIS and feel the following items need more emphasis/study or inclusion:

- Procurement of professionally trained Gas Drilling Inspectors
- Require Gas Drilling Companies to prepare Plans and Specifications for submittal to DEC
- DEC needs to thoroughly research current gas well casing cement compositions and procedures
- DEC should require a gas drilling company to furnish proof of adequate liability insurance

Issue 1: <u>The need for **PROFESSIONALLY TRAINED INSPECTORS**</u>
I worked for NYSDOT for 8yrs in the Bridge Design Unit and ODOT (Oregon DOT) for 16 yrs as a Construction Inspector and Materials Tester and later on advanced to an Associate Transportation Engineer as a Roadway Designer. I will tell you from first hand experience that a project as simple as State Highway Asphalt Paving required an ON-SITE-DAILY- OREGON D.O.T. TRAINED FIELD INSPECTOR and an ON-SITE-DAILY ODOT ASPHALT MATERIALS INSPECTOR testing the asphalt for such things as moisture content, percentage of asphalt in the mix, aggregate gradation sieve analysis and density. I know this because I was this Asphalt Materials Inspector. Thus, an operation the magnitude of the Gas Drilling Operations certainly demands the same attention!! I stated this at the DEC meeting held in Greene and also the Coalition meeting held in Harpursville. I also backed my concerns up with two letters to Judith Enck with a copies sent to Assemblyman Clifford Crouch asking both of them to make sure my concerns were carried to the governor prior to him signing the Bill. I also sent an extremely detailed position description for a Canadian Oil & Gas Drilling Inspector in British Columbia, Canada. (I have attached this job description.) The job description serves to illustrate the importance the Canadian government places on FIELD INSPECTIONS, and the degree of detail contained in the job description shows that gas drilling is not a simple process nor should it be treated as such! I am extremely grateful to Gov. Paterson and his close advisors for realizing the critical need for Gas Drilling Inspectors and imposing a moratorium on all gas

drilling until the state can provide a means of enforcing gas regulations. But, recognizing the need for inspectors and finding the funding for these positions are two different things especially with the current economy. Thus, if DEC can not currently fund inspector positions, the gas drilling should only advance as fast as the current DEC inspectors can monitor them!!

Issue 2: Need for **CONTRACT PLANS AND SPECIFICATIONS** prepared by the Gas Drilling Companies themselves with submittal to the DEC for review and approval.
I attended a meeting at the Binghamton Public Library conducted by The Independent Oil & Gas Association. I expressed the need for contract plans/specs and John Holko insisted that the Gas Drillers already provide such plans to the DEC. The next day, I called Linda Collart of the DEC and conveyed what Mr. Holko had said. The only thing she knew of that would be a detailed drawing of any sort consisted of ONE SHEET! I asked her to send me a copy of one of these sheets for a recent DEC approved gas well. This sheet shows the geological strata, depths, hole & casing design, etc. But, this one sheet is a far-far-cry from what I am referring to and accustomed to seeing on a Dept. of Transportation project.

During my tenure with NYSDOT and ODOT, I was involved in preparing Preliminary Bridge Plans and specs for interstate bridges on 110 miles of I-88. I also prepared Preliminary Plans for many Oregon Highway Construction projects from projects as simple as asphalt resurfacing projects all the way up to a modernization project involving widening a two lane highway to four lanes and the creation of a new alignment to meet 70mph design speeds which would avoid impacting 100yr old oak trees, four historic homes, a high power transmission line, and wetland areas. These plans were extensive in nature, covering every known aspect of the construction and typically entailing 50 or more contract sheets with accompanying specifications of 100 or more sheets. Thus, I don't see a Gas Drilling Project as requiring anything less since the impacts can be every bit as far reaching.

To further drive this point home I will explain a project that I have first hand knowledge of that was in the hands of our very own New York State DEC for review. These were Contract Plans (24" x 36" size) drawn up by Keystone Engineers for a large pond my neighbor, located on the hill directly above me, was proposing to build. I became very concerned with the location of this proposed pond and the fact that no one was going to be on site as an inspector to ensure adherence to the specifications. Thus, I was successful in having DEC deny the permit for this pond. But the main reason I bring this up is to illustrate that the division of **DEC requires rather extensive PLANS and SPECS for a pond when it reaches a certain size and volume. And I might add that a pond does not pose any risk to underground water tables nor does it contain any toxic chemicals to pollute water supplies!! Thus, why isn't this requirement for plans and specs carried over to the Gas Drilling Operations??** The Plans and Specs would succeed in one huge accomplishment, that being --- there would be no mystery and no doubt about what the Gas Companies might be up to; their procedures would have to be clearly explained with accompanying detailed drawings and construction notes showing every aspect of their operation. It would be very refreshing and assuring for landowners and DEC personnel to know exactly what the Gas Drilling Plan is.

You might be thinking, what is there about a Gas Drilling Operation that would require a detailed drawing plan with accompanying specifications? ….. I will give you just one example:

Environmentalist Bob Williams gave a presentation at the Coalition meeting in Harpursville wherein he showed a picture of a gas drilling pad. The pad was quite large and required that the earth be leveled with a berm constructed around the perimeter. This picture caused me to immediately think of my neighbors Pond Plans and Specs. The gas drilling berm is very much like the pond berm. The pond berm specs state that "the embankment is to be constructed in maximum 8" thick layers running continuous for the entire length of the fill with each layer being compacted prior to placement of the next layer, and the fill is to have at least 30% passing the #200 sieve." Now, do you actually think the drilling pad berm was constructed in this manner?? I would bet the drill pad berm was constructed by a dozer pushin' dirt up into an unkempt pile that was never even compacted. **Now, what was the pond berm serving to contain? Yep, pure water. Now what is the drill pad berm supposed to contain? You got it, impure hazardous materials!!** As you already know, the Gas Companies are not required to disclose these hazardous materials. However, Colorado Environmentalist Theo Colburn, PhD has discovered over 200 chemicals directly injected into the gas well during the fracturing process yet she (and I quote) "had been unable to find any information on the chemical content of waste pits until we were sent results of a chemical analysis of the residues from six waste pits in New Mexico. The 51 chemicals that were detected in those pits produced a health pattern even more toxic than anything we found in the past. Most important is that 43 of the 51 chemicals detected in the pits were not even on our original list of chemicals used during natural gas operations!" **Thus, this drill pad and waste pits need the same careful plan drawings and specifications as DEC requires for a fairly innocuous pond berm!!** And this is just one example of drilling details that need to be spelled out in a drawing with construction notes/specs. I know you are thinking how requiring the gas companies to develop and submit plans would slow up the gas drilling process even more than the procurement of inspectors, but this could be a good thing. It could give the state more time to ascertain how it will obtain funding for inspector type staff. And most of the onus of time and money to develop the plans would be placed on the Gas Drilling Companies with our DEC merely reviewing the plans which takes far less time than developing the plans.

Issue 3**: DEC needs to <u>RESEARCH GAS WELL CEMENT COMPOSITIONS AND CEMENTING PROCEDURES and HIRE AN OUTSIDE PROFESSIONAL IN THIS FIELD SUCH AS "SCHLUMBERGER" TO REVIEW GAS DRILLING APPLICATIONS SUBMITTED TO DEC FOR APPROVAL since this is such a complicated and critical aspect of gas drilling.</u>**

In the above mentioned example of a current DEC approved gas well that Linda Collart sent me, I noticed that Class A cement was being used. I called her to ask if this was regular Portland Cement and she said yes. Since I used to be an Asphalt and Concrete Materials Tester for Oregon DOT, I became concerned over the rigidity of Portland Cement and the extreme conditions deep gas well bore holes and drilling operations would exert on this concrete after the casing was cemented. Thus, I researched this topic and present the following findings:

Proper cementing is critical for the protection of subsurface aquifers and the prevention of gas leaking into zones that would otherwise not be gas bearing. Tubing and casing leaks, poor drilling and displacement practices, improper cement selection and design, and production cycling may all be factors in the development of gas leaks. Thus, the primary Gas drilling contractor frequently subcontracts this aspect of gas drilling to a company that exclusively performs this cementing operation. DEC personnel may have heard of “Schlumberger” since they are internationally renowned experts in this field. I contacted them for help via email and they responded by saying “IF the DEC is interested in soliciting our help we would be willing to participate.” (I have enclosed a copy of this email.) Here are some of my findings on this complicated aspect of drilling that even the professionals in the Oil & Gas Industry admit that they are still in the process of perfecting. Schlumberger says “much work remains to be done in simulating downhole conditions and developing new cement technologies/compositions for thermal applications and high pressure conditions.” (This is from Schlumberger’s Gunnar DeBruijn’s paper “Expert Viewpoint-Well Cementing” which is enclosed.)

“During the life of a well, the cement sheath may be exposed to stresses imposed by well operations including perforating, hydraulic fracturing, high temperature-pressure differentials, and so on. Further, if the well is completed using complex completion such as a multilateral system, the cement sheath may be subject to shattering and subsequent loss of bond to pipe impact. Conventional well cement compositions are typically brittle when cured. These conventional cement compositions often fail due to stresses, such as radial and/or tangential stresses, that are exerted on the set cement.” “In other cases, cements placed in wellbores may be subjected to mechanical stress induced by vibrations resulting from operations, for example, in which wireline and pipe conveyed assembly are moved within the wellbore. Hydraulic, thermal and mechanical stresses may be induced from forces and changes in forces existing outside the cement sheath surrounding a pipe string. For example, overburden and geological formation pressures, formation temperatures, formation shifting, formation compaction, etc. may cause stress on cement within the wellbore. Conventional wellbore cements typically react to excessive stress by failing.” (This is from Cement compositions useful in oil and gas wells – Patent 7156173 which is attached.)

Halliburton offers the following: “Wellbores exist in extremely dynamic environments; therefore, a cement sheath must be able to perform as intended over time. When cementing a well, the primary concern is to prevent fluids from migrating into an annulus. As a well ages, the annular seal may be compromised as a result of stresses brought on by temperature and pressure cycling that occur as the well is operated. **By industry convention and tradition the effect of stresses on the cement sheath’s mechanical properties are not ordinarily assessed during the design and construction phase of a well.** Although short term considerations are necessary for effective slurry mixing and placement, a sole focus on liquid cement slurry properties and the 24 hour compressive strength does not account for long-term cement integrity, which is critical if the well is subjected to stress on a large scale.” Halliburton has devised an analytical tool, “Welllife” computer software which analyzes properties such as Young’s modulus, friction angle, cohesion of cement sheath and simulates failure events that could occur during various field operations to determine the best cements for particular geological stratum.

Schlumberger says “cement sheath damage or debonding can allow gas to migrate to the surface and cause sustained casing pressure (SCP). The presence of such flows can require a well to be shut in for remediation or abandoned altogether.” Schlumberger has designed a “FUTUR active set-cement” which provides long-term zonal isolation and prevents the flow of hydrocarbons through potential leak paths up and along the annulus. Any hydrocarbon that comes in contact with FUTUR active cement technology will activate the self-healing properties of this unique sealant material. Once activated, cracks in the cement sheath are healed. Even if the cement sheath is damaged again, FUTUR active set-cement will continue to self-repair on multiple, independent occasions.

Schlumberger also mentions how important it is to have a clean wellbore prior to cementing. “It is important to get the initial cementing job right, with good mud removal. Mud pockets in the annulus can cause catastrophic failure, including broken wellbores and collapsed casing. Shlumberger uses WELLCLEAN methodology to ensure that there are no channels or pockets of mud that can cause well failure.” “Soft formations offer little constraining pressure, and tensile pressures may lead to breakage. Cements with a low Young’s modulus, such as the flexible cement system using FlexSTONE technology, can deliver mechanical properties appropriate for these downhole stress environments.” (This is from Schlumberger’s Gunnar DeBruijn an Expert Viewpoint-Well Cementing” paper which is enclosed.)

The following are excerpts from a paper titled **“From Mud to Cement-Building Gas Wells”** dated Autumn 2003 by Tom Griffin of Griffin Cementing Consulting LLC, Joseph R. Levine of the US Minerals Management Service, Dominic Murphy of BHP Billiton Petroleum to name but a few of the authors. (I have enclosed a copy of this paper.) **This study serves to illustrate the complexity of the cementing process; if the experts in this field attest to the complexity of this aspect of drilling, I think NYSDEC should pay more attention to cement designs and cementing procedures.** “Since the earliest gas wells, uncontrolled migration of hydrocarbons to the surface has challenged the oil and gas industry. Gas migration, also called annular flow, can lead to sustained casing pressure (SCP), sometimes called sustained annular pressure (SAP).” “In the Gulf of Mexico, there are approximately 15,500 producing, shut-in and temporarily abandoned wells in the outer continental shelf area. United States Minerals Management (MMS) data show that 6692 of these wells, or 43%, have reported SCP on at least one casing annulus.” “By the time a well is 15 years old, there is a 50% probability that it will have measurable SCP in one or more of its casing annuli. However, SCP may be present in wells of any age. In Canada, SCP occurs in all types of wells-shallow gas wells in southern Alberta, heavy-oil producers in eastern Alberta and deep gas wells in the foothills of the Rocky Mountains. Most of the pressure buildup is due to gas.” “Long-term, durable zonal isolation is key to minimizing problems associated with annular gas flow and SCP development.” “Determining the precise source of annular flow or sustained casing pressure is often difficult, although likely causes can be divided into four primary categories: tubing and casing leaks, poor mud displacement, improper cement-slurry design, and damage to primary cement after setting. Leaks can result from poor thread connection, corrosion, thermal stress cracking or mechanical rupture of the inner string, or from a packer leak. If the pressure from a leak causes a failure of the production casing the outcome can be catastrophic. Leaks to the surface or underground blowouts may jeopardize personnel safety, production-platform facilities and the environment.” “Inadequate removal of mud or spacer fluids from the borehole prior to cement placement is a major contributing factor to poor zonal isolation and gas migration.” “Improper cement-slurry designs –Flow occurring before cement has set is a result of loss in hydrostatic pressure to the point that the well is no longer overbalanced – hydrostatic pressure is less than formation pressure. This decrease in hydrostatic pressure results from several phenomena that occur as part of the cement-setting process. The change from a highly fluid, pumpable slurry to a set, rock-like material involves a gradual transition of the cement. This may require several hours, depending on the temperature, and quantity and characteristics of retarding compounds added. As the cement begins to gel, bonding between the cement, casing and borehole allows the slurry to become partially self-supporting. This self-supporting condition would not be a problem if it occurred alone. The difficulty arises because, while the cement becomes self-supporting, it loses volume as a result of at least two factors. First, where the formation is permeable, the hydrostatic pressure overbalance drives water from the cement into the formation. The rate of water loss depends on the pressure differential, formation permeability, and fluid loss characteristics of the cement. A second cause pf volume loss is hydration volume reduction as the cement sets. This occurs because set cement is denser and occupies less volume than liquid slurry. Volume loss coupled with the interaction between partially set cement, borehole wall and casing cause a loss of hydrostatic pressure, leading to an underbalanced condition. While the hydrostatic pressure in the partially set cement is below formation pressure, gas may invade. If unchecked, the invasion of gas may create a channel through which gas can flow, effectively compromising cement quality and zonal isolation. Also, cement damage can occur long after the well construction process. Even a flawless primary cement job can be damaged by rig operations or well activities occurring after the cement has set. Changing stresses in the wellbore may cause microannuli, stress cracks, or both, leading to SCP. The mechanical properties of the casing and the cement vary significantly. Consequently they do not behave in a uniform manner when exposed to changes in temperature and pressure. As the casing and cement expand and contract, the bond between the cement sheath and casing may fail, causing microannulus, or flow path, to develop.

As the borehole reaches deeper into the earth, previously isolated layers of formation are exposed to one another, with the borehole as the conductive path. Isolating these layers, or establishing zonal isolation, is key to minimizing the migration of formation fluids between zones or to the surface where SCP would develop. Crucial to this process are borehole condition, effective mud removal, and cement-system design for placement, durability and adaptability to the well life cycle. Wellbore condition depends on many factors, including rock type, formation pressures, local stresses, the type of mud used and drilling operation parameters, such as hydraulics, penetration rate, hole cleaning and fluid density balance. The ultimate condition of the borehole is often determined early in the drilling process as drilling mud interacts with newly exposed formation. If mismatched, the interaction of the drilling mud with formation clays can have serious detrimental effects on borehole gauge and rugosity. Once a well is drilled, displacement, cementing and ultimately, zonal isolation efficiency are dependent on a stable borehole with minimal rugosity and tortuosity. Drilling fluid engineers and related technical specialists have applied various techniques to investigate rock response to drilling fluid chemistry under simulated downhole conditions. Mud companies have created high-performance water-base muds that incorporate various polymers, glycols, silicates and amines, or combination thereof, for clay control. Like the fluids themselves, drilling fluid hydraulics play a fundamental role in constructing a quality borehole. Balance must be maintained between fluid density, equivalent circulating density (ECD) and borehole cleaning. If the static or dynamic fluid density is too high, loss of circulation may occur. Conversely, if it is too low, shales and formation fluids may flow into the borehole, or in the worst case, well control may be lost. Improper control of density and borehole hydraulics can lead to significant borehole rugosity, poor displacement and failure to achieve isolation. Rheological properties of drilling fluids must be optimized in such a way that the frictional pressure losses are minimized without compromising cuttings-carrying capacity. Optimal fluid properties for achieving good borehole cleaning and low frictional pressure loss often appear to be mutually exclusive. Detailed engineering analysis is required to obtain an acceptable compromise that allows both objectives to be satisfied. During drilling, optimal fluid characteristics may change depending on the task, such as running casing or displacement borehole fluids. Modeling and simulation with software tools such as the M-I Virtual Hydraulics application can be useful in optimizing fluid properties in anticipation of changes in rig operations. Integrating carefully designed drilling fluids with other key services is critical for achieving successful wellbore construction, zonal isolation and well integrity.

Proper mud selection and careful management of drilling practices generally produce a quality borehole that is near-gauge, stable and with minimal areas of rugosity, or washout. To establish zonal isolation with cement, the drilling fluid must first be effectively removed from the borehole. Mud removal depends on many interdependent factors. Tubular geometry, downhole conditions, borehole characteristics, fluid rheology, displacement design, and hole geometry play major roles in successful mud removal. Optimal fluid displacement requires a clear understanding of each variable as well as inherent interdependencies among variables. The availability of computer technology has significantly advanced the way drillers approach wellbore displacement. Fluids can be built, complex interactions predicted, and displacements simulated on the computer screen rather than at the wellsite where minor mistakes may result in major costs. CemCADE cementing design and simulation software and WELLCLEAN II software are two software applications used for this purpose.

Integration of drilling fluids, spacer design and displacement techniques provide the foundation for optimal cement placement. Long-term zonal isolation and control of gas require the cement to be properly placed and to provide low permeability, mechanical durability and adaptability to changing wellbore conditions. Cement permeability depends on the solid fraction of the formulation. For high-density slurries, a high solid fraction is inherent, thus the permeability tends to be low. For low-density slurries, special products and techniques create low-density, high solid-fraction slurries. Mechanical durability varies with strength, Young's modulus of elasticity and Poisson's ratio. The cement should be designed so these properties are sufficient to prevent failure of the cement when exposed to changing well pressures and temperature fluctuations, which create stresses across the casing-cement-formation system. Special materials are required to give the cement flexibility in this environment. **Sealing an annular space against gas migration can be more difficult in gas wells than in oil wells. Wellbore construction, particularly in the presence of gas bearing formations, requires that borehole, drilling fluid, spacer and cement designs, and displacement techniques be dealt with as a series of interdependent systems, each playing an equally important role. Often, the relationships among these systems is overlooked, or at the very least, poorly appreciated.** Preventing gas migration and SCP has been helped by recent developments in cementing technology that offer significant advantages in durability and adaptation to changing wellbore conditions. Cement properties have traditionally been designed for optimal placement and strength development rather than long-term post-setting performance. The rapid development of high cement-compressive strength after placement was generally considered adequate for most wellbore conditions. Today, operators and service companies realize that the emphasis on strength at the expense of durability has often led to the development of SCP (sustained casing pressure) and reduced well productivity. Cement particle characteristics and size distribution can contribute significantly to both the resistance to gas influx and maintenance of a sustainable hydraulic seal, particularly in wellbores subjected to pressure and temperature cycling. FlexSTONE advanced flexible cement technology, part of the CemCRETE concrete-based oilwell cementing technology, is one of several solutions that effectively address cement flexibility and durability. Conventional Portland cements are known to shrink during setting. In contrast, FlexSTONE slurries can be designed to expand, further tightening the hydraulic seal and helping to compensate for variations in borehole or casing conditions. This capability helps avoid microannuli development. By adjusting specific additive characteristics and by blending the cement slurry with an engineered particle size distribution, a lowering of Young's modulus of elasticity in cement can be achieved. Annular cement can then flex in unison with the casing rather than failing from tensile stresses. Thus, the potential development of microannuli and gas communication to the surface or to zones of lower pressure are minimized." The original complete version of the above paper can be found at www.slb.com/media/services/resources/ oilfieldreview/ors03.

Issue 4: DEC should not provide a well license to a person who does not furnish proof that the person has liability insurance of at least $5,000,000 per occurrence that provides compensation for all damages caused by drilling, pipeline construction, production, servicing or abandonment operations or caused by any vessel, craft or barge used to transport people or materials to the site of the drilling, pipeline construction or production operations.

I sincerely thank NYSDEC for welcoming the public's comments! Since I have spent a considerable amount of time researching these topics, plus I have given this written material in the form of oral testimony at Broome Community College and SUNY Oneonta; would you please respond in writing to this input? Thank You!

Jilda Rush
Windsor, NY

Attach: email from Schlumberger dated 10/26/2008
British Columbia, Canada OGC Oil and Gas Commission Position Description
Stumberger's Gunnar DeBruijn paper an "Expert Viewpoint–Well Cementing"
Research paper titled "From Mud to Cement-Building Gas Wells" Autumn 2003

December 28, 2009

Attention: dsGEIS Comments Bureau of Oil & Gas Regulations
NYSDEC Division of Mineral Resources
625 Broadway, Third Floor
Albany, N.Y. 12233-6500

RE: Comments on the NYSDEC Draft Scope for the dsGEIS on Oil and Gas submitted by Jilda Rush, Windsor, N.Y. (Associate Transportation Engineer, Oregon Dept. of Trans.);

Dear NYSDEC representatives:

Please note that quotes from the dsGEIS are in Times New Roman font, and my comments are in Comic Sans MS font.

Page 4 mentions that issuance of a "standard", individual oil or gas well drilling permit anywhere in the state, when no other permits are involved, does not have a significant environmental impact." Also, "issuance of an oil or gas permit for a surface location above an aquifer is also a non-significant action".

"Well stimulation, including hydraulic fracturing, was expressly identified and discussed in the GEIS as part of the action of drilling a well, and the GEIS does not recommend any additional regulatory controls or find a significant environmental impact associated with this technology, which has been in use in New York State for at least 50 years." I would ask how many wells used high compression horizontal hydro-fracturing with 200+ chemicals during the past 50 yrs.? DEC needs to undertake a period of discovery wherein the department needs to study/research the inspection reports from other states and Canada to discover/uncover the real dangers and risks of hydro-fracturing.

Page 5 says SEQRA requires a supplement to a final generic environmental impact statement for two reasons, water volumes in excess of GEIS descriptions, and drilling in N.Y.C. watershed ….. I would say there are several more reasons; such as, the array of chemicals used to stimulate the gas well that were not being used in 1992 or else they were not discovered or disclosed at that time, and the documented gas drilling violations that have occurred in other states/provinces.

Page 7 mentions that the drilling application does not stand alone and is supported by a "proposed site-specific drilling and well construction plans". I would like to see an example of these "construction plans". I spoke with Linda Collart from the DEC about this and she said there is just one plan sheet showing a detail drawing for the cementing of the well casing. She sent me a copy of this one sheet for "Fortuna Calhoun S1 (Area S21)" horizontal well. Page 7 also mentions that the permit will be backed up with a "Department staffs site visit". This sounds like one isolated visit. There is a definite need for ongoing daily inspections during the drilling process.

Page 10 says "The dsGEIS will examine whether there are any potential environmental impacts associated with horizontal drilling itself that have not already been sufficiently reviewed and mitigated." My question is HOW the dsGEIS will examine. As stated above, I feel the DEC should study inspection reports and violations from other states as well as N.Y.

Going back to Page 7 which mentions that the drilling application does not stand alone and is supported by a "proposed site-specific drilling and well construction plans". I would like to elaborate on what a proper set of plans and specifications should contain. I used to work for NYSDOT for 8 years preparing Preliminary Bridge Plans, and 16 yrs as an Associate Transportation Engineer for Oregon DOT preparing Highway Construction Plans. These DOT plans covered every known aspect of the highway construction and typically entailed 50 or more contract sheets with accompanying specifications of 100 or more sheets. Here is a list of just some of the gas drilling operations that should be included in the plans/specs:

The results of exploratory underground formation studies such as - core samples, rock formation densities/porosity/permeability, formation temperatures, formation pressures, the chemical composition of the underground components.

The results of computer simulated borehole studies

The proposed type of cement design and casing design with supporting geological data as to why a particular cement/casing design was selected.

The plan for cementing of the well casing, the pumping procedure, the depth of cement (i.e. 500 feet above the top of gas), amount of water.

How the wellbore will be constructed, type of drilling mud/fluids to be used, how the borehole will be cleaned prior to cementing

A plan view of the drilling pad showing the location of the proposed well and all of the surrounding property lines and lease lines, along with the location of all building, water wells, drainage ditches, and streams within a mile and a half radius of the proposed well since the horizontal fracturing can extend underground a mile from the vertical portion of the well. The top of the target zone, bottom of the target zone, and end of target zone need to be clearly identified on this plan view. The plan view needs to have contours with elevations marked on them. All of this will require a land survey to collect spot elevations to develop a digital terrain model of the area and location of aforesaid buildings and drainage features. It is important to know the difference in elevation from the proposed well/pad and these other surrounding features. A gas well may have to be set back a certain linear distance from these surrounding features, say 500'; but if the gas well is located on top of a hill, 500' may not be enough to protect properties located at the bottom of the hill from damage in the event of a spill or a breach in the impoundment dam. The contaminant run-off could extend 5,000 feet or more. Difference in elevation becomes just as important as linear measurements when it comes to deciding setback distances!!

A plan view and cross-sectional view of the impoundment dam/waste pits with construction detail notes pertaining to how the berm/dam is going to be constructed - such specifics as the embankment being constructed in maximum 8' thick layers running continuous for the entire length of the fill with each layer being compacted prior to the placement of the next layer, size of pit, and specifications for the pit liner.

The plan for when, where and how the wastewater will be disposed.

What type of pressure tests will be done on the cemented casing to determine if it is sound with no leaks or cracks in it. The best methods of testing use acoustic sonic or ultrasonic tools. One such instrument is called an "Isolation Scanner" which provides radial imaging of the cement sheath. DEC should require the best methods of testing.

Pre-drilling and ongoing water well monitoring and testing plans and schedules with a list of elements to be tested.

Plans for testing production flowback fluids for NORM prior to removal from site.

A narrative of the gas drilling companies expertise and technological ability to drill without causing harm.

Identification of proposed fracturing fluids, and volume of fracturing fluid and % by weight of water.

Identification of proposed water resources and volumes of water.

Page 7-34 mentions storing flowback water (actually, you should rephrase this & call it flowback contaminants) in steel tanks. DEP officials in Pennsylvania say that one of the most worrisome naturally occurring contaminants in the Marcellus Shale is a gritty substance called total dissolved solids, or TDS, a mixture of salt and minerals that lie deep underground. The drilling wastewater contains so much TDS that it can be five times as salty as seawater. Thus, this will have a corrosive effect on steel storage tanks and steel casings. This is an issue that needs to be addressed, though I do not know the remedy. Perhaps some type of sealant needs to be applied to the steel casing and steel tanks, but I do not know what would hold-up to salts. The salt will have a corrosive effect on the cement casing also. The cement design will need to be altered to resist these salts. When well casings eventually corrode, concrete casings crack, and the pipes rust-out, who is going to deal with this mess?? Just another issue yet to be dealt with. But this is a future problem and we seem to concentrate on the here and now which is going to come back to bite us!

Also, a leading geologist, Art Berman, says that rock in deep shale formations like the Marcellus collapses as gas is produced, and crushes the proppant. As the fractures are drained you have to frac and frac and frac. Repeated continuous fracing operations will subject the cement to stresses caused by vibrations from these drilling operations. Thus, specific cement will need to be designed to combat these type of stresses. Also, one encounters higher underground pressures in the Marcellus formation. One would want to know the bottom hole pressure and make sure it corresponds with the casing and cement design. Also, any uphole high pressure zones need to be identified. Over pressurized conditions call for a 5,000 psi rated casing. The dsGEIS only calls for a minimum of 1,100 psi!!

7.1.4.1 calls for "Sampling and testing of residential water wells within 1,000 feet of the well pad ….".
And *3.2.2.4 Water Well Information* The EAF addendum for high-volume hydraulic fracturing will require evidence of diligent efforts by the well operator to determine the existence of public or private water wells and domestic-supply springs within half a mile (2,640 feet) of any proposed drilling location. The operator will be required to identify the wells and provide available information about their depth, completed interval and use.
And *3.2.3 Projects Requiring Site-Specific SEQRA Determinations* The Department proposes that site-specific environmental assessments and SEQRA determinations be required for the high-volume hydraulic fracturing projects listed below, regardless of the target formation, the number of wells drilled on the pad and whether the wells are vertical or horizontal.
Additional review of site topography, geology and hydrogeology will be required for any proposed centralized flowback water surface impoundment at the following locations: b) within 500 feet of a perennial or intermittent stream, wetland, storm drain, lake or pond, or within 300 feet of a public or private water well or domestic supply spring.
5) Any proposed well pad within 150 feet of a private water well, domestic-use spring, watercourse, perennial or intermittent stream, storm drain, lake or pond;

The distances of 150', 300', 1000' or even 2,640' are not enough when you consider that the horizontal section of the well can extend 1 mile! Thus, this radius needs to be increased to 1,000' plus 5,280' = 6,280'. Also, the existing topography needs to be taken into account when a water well is located down hill from the well pad or impoundments. A breach of an impoundment pond could reach distances of say 10,000 feet. This certainly would complicate the issue of water testing resulting in the need to create a distinct and separate department to handle this work load. Thus, let's call the whole thing (Gas Drilling) off!! Ha.

Page 7-36 calls for "baseline water quality testing of private wells within a specified distance of the proposed well". This is totally necessary, but nothing is mentioned in regards to who is going to pay for the tests – it should be none-other than the gas drillers who pay for this!!! A lot of the private wells that will need to be tested will be owned by people who did not lease their land to begin with and never asked for the gas drilling to begin with, so it would be unconscionable to require those people to pay for testing!!! There needs to be a New York State law that would require the gas company to pay for independent hydrogeological testing of all water wells within a mile plus 1,000' = 6,280' radius of the proposed gas well, especially those downhill from the gas well site.
Also, the timing of the testing is important. In Pennsylvania, if contamination of a water well is documented within six months of a gas well being drilled, the burden of proof is on the gas company to show that they are not responsible for the contamination. After six months, the burden of proof shifts to the landowner.

7-36 also mentions ensuring the "adequacy of surface casing", "adequacy of cement in the annular space", and "adequacy of cement on production (and intermediate) casing" and Page 7-37 goes on to list all the glorious studies and state level decisions (Harrison, 1984; DEC Commissioner's Decision, 1985, etc.) that attest to the importance of proper casing/cementing. This is fine and dandy to state that these aspects of drilling are "adequate" but ***how is DEC going to determine if they are in fact "adequate"???*** This is where DEC needs to require that the Gas Drillers submit a complete set of construction plans with accompanying specifications explaining the method of placement of cement, the cement design, and the methodology/studies that went into the selection of the cement design. In fact every aspect of the drilling process (not just the cementing) needs to be spelled out on paper in the form of actual construction plans which entail plan views, cross-sectional views, details, and specifications which are submitted with the permit application. Then DEC has something substantial to review in the first place prior to the issuance of the permit, and something in writing for DEC inspectors to use in monitoring the gas drilling operations from "cradle to grave".

7-36 also mentions "the opportunity for state regulators to witness casing and cementing operations". Well, if this is one of the most important aspects of the drilling process in that it is going to be the primary mechanism for protecting aquifers; then the "state regulators" better dam well be there at least for this. Please make the witnessing of the casing and cementing operation and any pressure testing or ultrasonic testing of the cemented casing by state regulators mandatory!
The GEIS calls for pressure testing the cemented casing to determine if it is sound with no leaks or cracks in it. Better methods of testing exists which use acoustic sonic or ultrasonic tools. One such instrument is called and "Isolation Scanner" which also provides radial imaging of the cement sheath.

7.1.4.1 goes on to say "If no contamination is detected a year after the last hydraulic fracturing event on the pad, then further routine monitoring should not be necessary." Well, Halliburton themselves say "Since the earliest gas wells, uncontrolled migration of hydrocarbons to the surface has challenged the oil and gas industry. Gas migration can lead to sustained casing pressure (SCP). <u>By the time a well is 15 years old, there is a 50% probability it will have measurable SCP in one or more of its casing annuli.</u> However, SCP may be present in wells of any age. Cement damage can occur <u>long</u> after the well construction process. Even a flawless primary cement job can be damaged by rig operations or well activities occurring after the cement has set. The mechanical properties of the casing and the cement vary significantly. Consequently they do not behave in a uniform manner when exposed to changes in temperature and pressure. As the casing and cement expand and contract, the bond between the cement and casing may fail." Conventional Portland cements are known to shrink during setting. In contrast, specially engineered cements such as "FlexSTONE" can be designed which expand, thereby further tightening the hydraulic seal. This type of cement flexes in unison with the casing rather than failing from tensile stresses!!" (This is an excerpt from a paper titled "From Mud to Cement-Building Gas Wells" written by several Halliburton members.) In light of this, testing of water wells needs to go on for 15 yrs since the gas well can fail many years later. Here again, this adds more complexity to the problem of who is going to oversee testing for this for this length of time; so, lets call the whole thing (Gas Drilling) off!!!

Table 7.3 lists the Water Well Testing Recommendations. I spoke with Pennsylvania DEP's Lead Gas Migration Inspector, Fred Baldasarre, to ask him for advice to convey to NYS DEC and he emphatically stated that New York DEC needs to conduct methane stable-isotope testing of water wells prior to any gas drilling. The methane isotopes that are found in shallow gas formations are different than the methane isotopes found in the deep Marcellus formation. Isotopes are similar to genetic DNA, fingerprints, or footprints in that they are unique to that particular gas.
Also, I do not see a simple flow test included in this table. The minimum standard is 5-7 gpm; anything below this causes the property to have no resale value since the FHA will not approve a loan for anything less.
Also, I would recommend testing for any chemicals that are known to occur naturally in any of the geological strata that the wellbore passes through, not just the chemicals found in the target zone, since the cement casing can fail thereby allowing chemicals to pass through any where along the entire length of the wellbore. Also, test for chemicals used to drill the well hole and chemicals used to enhance the fracturing process. Add Uranium, radium, and mercury to the table of items to be tested.

On Page 7-42 and elsewhere in the dsGEIS, the DEC delegates the duty of overseeing the water testing to the county health departments. - Broome County Health Department recently stated that it lacks adequate personnel to oversee this operation. A mere $28,000 was added to Broome County's budget to oversee the Marcellus. Why this wouldn't even cover 1 persons wages! And who is going to oversee soil testing?? And who is going to oversee radioactivity testing??? The problems associated with testing private water wells, soil testing, and radioactivity testing will necessitate the creation of a department or departments specifically set aside to perform this work.

Page 7-44 says the "surface casing shall consist of new pipe with a mill test of at least 1,000 pounds per square inch,". The driller should be required to report actual expected pressures whereby over pressurized conditions would call for perhaps a 5,000 psi rated casing. A 1,000 psi casing seems woefully inadequate for Marcellus pressures!!

Page 2-20 is a map showing the principle and primary aquifers in New York State. It looks like there are a few principle aquifers in Broome County, but no primary. Page 2-21 says "The remaining portion of the State is underlain by smaller aquifers or low-yielding groundwater sources that typically are suitable only for small community and non-community public water systems or individual household supplies.

Page 7-44 says "more stringent requirements are implemented as permit conditions in primary and principal aquifers: …. Casing must be API grade with a minimum 1,800 psi etc. Well, I live in a rural area of Broome County which according to the map on Page 2-20 is not served by a principle or primary aquifer. Thus, the dsGEIS does not deem my area where I live to be significant and thus my area will not be afforded the same "stringent" protection afforded to other areas of the state that do have principle/primary aquifers. All water wells should be considered equally important just as all people are created equal. This inequality makes me mad-as-hell, because the gas drillers are not stupid – they are going to see this area as open-season and move in for the kill, I mean drill, in this area!! The gas drillers are going to go where the regulations are less stringent, and I know this for a fact due to what has already taken place concerning the proposed gas pipeline on the property next door to me. I know from first-hand experience how they are (the gas drillers) – a proposed centerline of gas pipeline has been surveyed and staked-out on the property joining my property. I was never notified even though this pipeline is only about 100' from my property line. This pipeline is 37 miles long and will connect the millennium pipeline in southern New York to a major pipeline in northern Pennsylvania. The gas drillers are required to notify surrounding property owners if a pipeline is more than 10 miles long, which this one is. Thus, I called Keystone surveyors to ask why I had not been notified. Keystone said I was correct about this requirement, but the portion of this 37 mile long pipeline that is located in New York is 9.8 miles long. Keystone said you better believe the gas company planned it this way so they would not have to deal with New York state regulations. He said this pipeline will require boring under Interstate 81 and the Susquehanna River at some point, so the gas company is going to construct these under crossings in Pennsylvania for the very same reason, because Pennsylvania's regulations are not as strong. So, going back to the original topic, considering Broome County (and many others) to be in non-significant areas because no principle or primary aquifers have been identified is going to make the people/properties in this area sitting-ducks for the gas drillers!!!

Page 7-46 calls for a "cement slurry preparation to the manufacturer's or contractor's specifications to minimize free water in cement". How are you going to determine if there is free water in the cement? Conventional above ground construction concrete testing would use a slump test. You need to designate what type of testing will be used to determine free water. Also, concrete has to hydrate. I don't understand how the water in the mixture will dissipate since it is underground.

Page 7-46 calls for "remedial action prior to drilling out of and below the surface casing if there is evidence or indication of flow behind the surface casing." But No specific remedial actions are spelled out.

Page 7-46 calls out several "requirements for production casing cement", but I do not see any specific requirements pertaining to the cement design. The cement design is of crucial importance and should be tailored to the specific geological formation. I used to test asphalt and concrete for the Oregon Department of Transportation and know that Conventional Portland cement by nature is too brittle and low in tensile strength to withstand stresses generated by drilling operations, or to withstand stresses due to formation pressures, formation temperatures, and formation shifting. Conventional wellbore cements typically react to excessive stress by failing! Also, the mechanical properties of the casing and cement vary significantly. Consequently, they do not behave in a uniform manner when exposed to changes in temperature and pressure. Halliburton says that "as the casing and cement expand and contract, the bond between the cement and casing may fail". "Special materials are required to give cement flexibility. Cement is traditionally designed for optimal ease of placement and strength development rather than long-term-post-setting performance. Emphasis on strength at the expense of durability often leads to the development of SCP (sustained casing pressure). Conventional Portland cements are known to shrink during setting. However, specially engineered cements, such as "FlexSTONE" can be designed which expand, thereby further tightening the hydraulic seal. This type of cement will flex in unison with the casing rather than failing from tensile stresses!

John Heathman of Halliburton offers the following advice in his paper titled "Critical Application Cementing Redefining the Issues" – He says "Understand that in today's environment, cementing requires a true multi-disciplinary approach.
It requires – Chemical engineering to understand the thermodynamic variables that affect cement design and longevity.
It requires mechanical engineering including fluid mechanics to understand the material behavior of cement, rocks, and metals and how they interrelate to each other.
It requires chemistry to understand the effects of long term corrosion on both metals and cements.
It requires petroleum engineering to understand the reservoir changes that contribute to stresses on a cemented wellbore.
It requires that the mechanical behavior of the entire system- the cement, casing, formation, and associated interfaces be studied with Finite Analysis under realistic wellbore conditions."
This translates into the need for underground formation studies of formation densities, formation temperatures, formation chemicals, etc., prior to any drilling taking place. Then all of these aspects can be incorporated into computer modeled simulated wellbores wherein the model can be subjected to the pressures, temperatures, and chemicals that were actually found in the Marcellus Shale formation. Various cement designs can be tried in the laboratory to test their interactions with the formation characteristics.
DEC needs to demand that the drillers include these background studies in the plans/specifications as supporting evidence of the methodology behind selecting the proposed cement design. At least it would be proof that there was A methodology to begin with; currently, I suspect there are just a few canned-generic cement designs being applied across the board. In other words, no ONE, or even two or three ideal cement designs exist for cementing all gas wells. The cement needs to be tailored for the specific geological situation.

I ask you, if you needed to have open heart surgery, would you just lie down on the operating table and let the surgeons cut you open without having any exploratory bloodwork, x-rays, or heart catherization studies done first?? Hell no!! Gas drilling demands the same careful attention since it involves peoples and animals lives!! If you don't require underground geological studies and simulate downhole conditions ……..don't drill!!!

Also, while on the subject of cementing – in speaking with Fred Baldasarre (Pennsylvania DEP's Lead Gas Migration Geologist Inspector), he mentioned that New York DEC should require that only API grade cements be used. The fact that Pennsylvania employs a full-time geologist to investigate gas drilling leaks, tells you that leaks are common. When the source of the leaks is within the wellbore itself, it has been proven that the leaks are related to flaws in the cement, the well casing, and over-pressurizing of the casing. Mr. Baldasarre also told me that the geology of the area is not fully known by DEP. He says "Pennsylvania and New York are not Texas, our geology is more complex, our rocks have been through more deformation. Deep-horizontal fracturing does not have a track record in the northeast! More geological tests are needed! State and County regulators need to tread carefully!" Take this advice from one who is in the thick-of-it all right now in PA and also says they are having trouble changing the regulations.

Congressional proposals are in the works to change cementing regulations. I would recommend that DEC wait to see what develops from this, wait to see what other problems occur in Pennsylvania, and wait for the results of the EPA study before moving forward with gas drilling here in New York!

Also, “scratchers” can be used which are placed on the outside of the casing so that when it is rotated in place it will scratch the walls of the borehole and remove any mud-cake that may have been left behind on the walls of the wellbore, so as to give a better bond between the cement and the rock walls. This is similar to “scarifying” road concrete/asphalt pavements prior to placing a new overlay to help the new asphalt adhere to the existing asphalt.

Page 7-47 requires the use of centralizers. There are different types of centralizers designed for specific wellbore situations. One such device is called an “external casing packer” which comes in 4’, 10’ and 20’ lengths. Steel reinforcement slats ensure that the packer self-centers itself in vertical, deviated, or horizontal wellbores to ensure even distribution of cement around the casing. The packer fits around the casing and is inflated with cement displacement fluid such that the packer can expand and soundly conform to irregular or washed-out hole diameters. Sometimes these “external casing packers” can be used to prevent gas migration through cement slurry by placing the external casing packer directly above a high pressure gas zone. These external casing packers (ECP) are manufactured by “World Oil Tools Inc.”. These packers function somewhat like the centralizers that are called for in the dsGEIS, but those type of centralizers only help to hold the casing in the center of the wellbore but do not contain any cement to seal off the annulus. This is one example of a detail that could be included in a set of plans prepared by the gas driller.

Requirements for POTW’s begin on page 7-56. From all reports that I have heard, POTW’s are incapable of filtering or neutralizing the type of contaminants contained in fracing wastewater. The Monongahela River in Pennsylvania is one recent example of POTW’s that were thought to be capable of filtering gas drilling contaminants but reality proved otherwise! The Colorado River is another example. The coal tar sands of Canada’s Lake Athabasca and Athabasca River are another huge example of 150 square miles being converted into dust, dirt, and tailings ponds. An article in the March 2009 National Geographic says the Alberta oil sands propelled Canada to second place in 2003, only behind Saudi Arabia among oil-producing nations. I have attached a copy of this article; though they are extracting oil rather than gas, and are using different extraction methods than gas drilling, the end result of having to deal with contaminants is much the same. The article refers to the “steam and smoke and gas flames belched from the Syn-crude and Suncor upgraders” as “dark satanic mills”. Also, what corrosive effects will the salts in the wastewater have on the sewage treatment plants equipment? And talk about satanic mills, that description would fit our sewage treatment plants and POTW’s when we start running radioactive materials through these systems!! As if the chemicals weren’t bad enough, now we are finding out that the Marcellus is radioactive! Only Satan himself would be privy to handling this brew! Therefore, the use of POTW’s for this purpose should not be allowed!

The list of fracing chemicals was considered proprietary information until just recently, so this entire section of the dsGEIS was based on incomplete information. The other thing to consider is the chemical reactions that will happen when various individual chemicals are combined with other chemicals. Dan Brown, a Cornell University Chemical professor, gave testimony at the Chenango Bridge Public Hearing in regards to this. He said MSD sheets describe hazards of chemicals in their pure states, but not about their hazards when mixed with other chemicals. Nobody knows the possible combinations of chemicals that could occur nor the effects of the combined fracing chemicals. So, how can a POTW begin to render these newly created toxic compounds into safe drinking water when the chemical composition isn't even known or understood in the first place!! A proper evaluation of the contaminants can not be conducted under these circumstances. Forget it, don't rely on POTW's to clean up the mess from gas drilling! Much more study and retrofitting and designing of equipment would have to go into POTW's to even begin to think they might remotely treat the vast array of gas drilling chemicals and radioactive elements!!

Page 4-36 says "Normal disturbance of NORM-bearing rock formations by activities such as mining or drilling do not generally pose a threat to workers, the general public or the environment." I do not understand how this can be the case!! Where ever the fracing flowback wastewater winds up going, be it storage in an open impoundment pond, disposal off site, or treatment at a plant, the radioactive materials are going to contaminate those areas. Also, the drilling equipment is going to pick-up radioactive substances and the drilling personnel are going to handle this contaminated equipment. If DEC does not consider NORMS/radioactive substances a threat, then I seriously doubt they will consider much of anything else a threat either!!! This is a serious oversight to say the least!!!

7.4 Protecting Ecosystems and Wildlife
Water withdrawal, invasive species concerns, and use of centralized flowback water surface impoundments are identified in Chapter 6 as the ecosystem and wildlife concerns specifically related to high-volume hydraulic fracturing that are not addressed by the GEIS.

There is an article in the March 2009 issue of the National Geographic related to problems with contaminated water contained in "tailings ponds". Tailings ponds are similar to what the dsGEIS refers to as impoundments. "Last April, 500 migrating ducks mistook one of these tailings ponds as a hospitable stopover, landed on the surface and all 500 died. These ponds are contaminated with toxic chemicals such as naphthenic acid and polycyclic aromatic hydrocarbons (PAH) that would take centuries to dry out on its own. Under the terms of their licenses, the oil companies are required to reclaim it somehow, but they have been missing their deadlines and still have not fully reclaimed a single pond." There is a picture of a radar device that floats atop the mats of leftover bitumen on a huge tailings pond. This radar device scans for incoming birds, and a fake falcon mounted on top of the device "flaps its wings and predator calls blare to scare off waterfowl that would die if they landed on the surface and their feathers became soaked with sludge." Therefore, if DEC is going to allow open "impoundment ponds" you better make these falcon radar devices a requirement. Here again, better yet, lets call the whole thing (gas drilling) off!

While on the subject of adverse effects to wildlife, I would like to convey an experience that I had as a Roadway Designer working for the Oregon Department of Transportation. I once had a project involving widening of the shoulders of the roadway canceled because the environmentalists sited "white-footed voles" in the area. I had another project involving construction of an additional lane that was canceled because the environmentalists went out and called for the owls and they came so I could not disturb their nesting area. Another project involved widening a two lane highway to a four lane and straightening out several sharp curves to make the design speed safe for 70 mph. This project was a go and went to completion, but I was required to weave my highway alignment around in such a way to avoid impacting several historic homes, a stand of 100 yr old Oak trees, a wetland area, and an area where monarch butterflies congregated. Now I realize this was Oregon and not New York State, but I would imagine that New York's Dept. of Transportation would be bound by similar environmental constraints – so, why is it that the gas industry is allowed to play by a different set of rules than our own Departments of Transportation are required to abide by!!!! The cards (Laws) are clearly stacked in favor of the gas industry.

In reference to the Canadian oil sands, (page 4 of the March 2009 National Geographic) says "there is no feast which does not come to an end", "a Chinese proverb warns, and the story of Canadian oil sands is a cautionary tale about the consequences of large appetites." Page 44 says "Clawing and cooking a barrel of crude from the oil sands emits as much as three times more carbon dioxide than letting one gush from the ground in Saudi Arabia"! The legacy of gas drilling very likely will be a similar tale since the moral or catch is --- extracting gas or oil is messy and costly to the environment. If New York State DEC used the sense that God gave them, and not the politicians or gas industries high pressuring mind-set, they would not have any part in writing this tale in New York State!! DEC is in absolutely NO position to regulate gas drilling given all of the unknowns and knowns listed above with virtually NO inspectors and NO $$$$'s in the budget to hire!!!! Three "NO"'s don't make a "YES" to gas drilling! (Actually there are a lot more "NO"'s). Just like three wrongs don't make a right!!

Page 8-6 and 8-7 says that "The regulatory discussion in Chapter 5 concludes that adequate well design prevents contact between fracturing fluids and fresh ground water sources, and text in Chapter 6 along with Appendix 11 on subsurface fluid mobility explains why ground water contamination by migration of fracturing fluid is not a reasonably foreseeable impact. Chapters 6 and 7 include discussion of how setbacks, inherent mitigating factors, and a myriad of regulatory controls protect surface waters. Chapter 7 also proposes a water well testing protocol using indicators that are independent of specific additive chemistry." My reply to this declaration is that written regulatory words do not protect anything by themselves!! Also, when you take all of my comments mentioned above into consideration it reveals considerable holes in the regulations! Then, page 8-7 goes on to say, "The only potential exposure pathway to fracturing additives identified by this Supplement is via air emissions from uncovered surface impoundments used to contain flowback water." This all encompassing blatant generalization tells me that DEC does not fully understand what can happen when the cementing of the casing fails! The cemented casing is the chief mechanism for isolating/protecting water sources from gas and fluid contamination. If the cement fails, the cracks and voids will create a conductive path for contaminants to enter and possibly reach underground aquifers. Failure of the casing cement recently caused contamination of several water wells in Dimmock Township, Pennsylvania. How DEC can overlook this as a source of contamination causes me to doubt the premises and motives that went into the development of the dsGEIS in the first place. If one pretty much thinks there isn't much of a problem to begin with, then one pretty much doesn't see the need to establish protective regulations and means of enforcing said regulations; thereby creating a powerless document.

There is another section of the dsGEIS that causes me to wonder about DEC's perspective and motives; this is Appendix 15 which contains 15 statements from various regulatory officials across the nation. These letters reflect the same attitude, motives, thesis, premise or whatever you want to call the basis of the entire dsGEIS as the statements I reference above that are written on pages 8-6 and 8-7; that being, DEC feels there really isn't much to worry about folks, they've got it under control with the current regulations. All of these letters state that hydraulic fracturing does not pose a significant threat to ground water sources. The program manager for Pennsylvania's Ground Water Protection Program states that "no groundwater pollution or disruption of underground sources of drinking water has been attributed to hydraulic fracturing of deep gas formations." This letter was written on June 1, 2009; developments since then contradict these findings since contamination of 13 water wells in Dimmock Township were proved by stable-isotope testing to be caused by fracturing of the Marcellus formation and failure of the cement casing. This has led to Mr. Fred Baldasarre (DEP's Lead Gas Migration Inspector) and Mr. John Hangar (DEP's Secretary) unveiling an "early draft of regulations in September that would change the way wells are built and sealed off from drinking water aquifers; mandate that existing wells are tested to ensure they don't leak; increase cementing and casing standards and strengthen rules for replacing drinking water if gas drillers disturb it. The rules would mandate that companies create a casing and cementing plan before each well is drilled, outlining the type and strength of casing and cement to be used and more fully incorporating national standards for the cement and pipe. They would also create an annual reporting requirement for companies to inspect every operating well to make sure there is no obvious leak, corrosion or excess pressure." Although the lessons of past well mistakes are helping to shape the state's new regulatory direction, Mr. Hangar admits that it is an uphill battle to turn the proposed rules into law!

Going back to the declarations contained in the 15 letters, there seems to be a deliberate underlying deceptive play on words through-out all of these letters. The letters state that no contamination of usable water was caused by "hydraulic fracturing". Well, that's totally correct if you literally focus on the specific act of hydraulically fracturing the rock all by itself. The wellbore has already been constructed, all the various casings installed, the annulus cemented, and now all that is left to do is fracture the rock lying deep underground. It's obvious that the act of creating fractures in the rock does not stand a chance of contaminating water sources unless the fractures were to extend some 2,000' upward or more to reach the aquifers. Thus by virtue of isolating this one facet of drilling, all of these officials can unequivocally state that hydraulic fracturing does not contaminate water aquifers! IF the phrase "hydraulic fracturing" was replaced with "the entire hydraulic fracturing <u>process</u> of drilling the gas well", the regulatory officials would not be able to report no contamination to water wells. This reveals widespread corruption and deception at the national and state level by the officials that are directed and empowered to protect their constituent's people and lands!! This matter goes beyond the scope of New York State's dsGEIS and I intend to take it beyond!

Actually, aquifers can be contaminated in the beginning stages of drilling before any casing is placed in the wellbore or any cementing takes place. Contamination can occur while the wellbore is being drilled through groundwater strata. The groundwater can drain out into the wellbore where it can be mixed with whatever additives are being used to lift the cuttings out of the hole and this mixture can drain back into the aquifer. Also, once the drill is pulled out and all that remains is the open hole, there is nothing to stop the water from the underground aquifer from pouring out into the open hole. So much water can pour out into the deeper gas well open hole that it can deplete the groundwater aquifer where the surface owners water well is.

8.2.1.2 Required Hydraulic Fracturing Additive Information
"As set forth in Chapter 5, NYSDOH reviewed information on 260 unique chemicals present in 197 products proposed for hydraulic fracturing of shale formations in New York, categorized them into chemical classes, and did not identify any potential exposure situations that are qualitatively different from those addressed in the 1992 GEIS. The regulatory discussion in Chapter 5 concludes that adequate well design prevents contact between fracturing fluids and fresh ground water sources, and text in Chapter 6 along with Appendix 11 on subsurface fluid mobility explains why ground water contamination by migration of fracturing fluid is not a reasonably foreseeable impact. Chapters 6 and 7 include discussion of how setbacks, inherent mitigating factors, and a myriad of regulatory controls protect surface waters. Chapter 7 also proposes a water well testing protocol using indicators that are independent of specific additive chemistry.

The only potential exposure pathway to fracturing additives identified by this Supplement is via air emissions from uncovered surface impoundments used to contain flowback water." The operative words here are "adequate well design prevents contact between fracturing fluids and fresh ground water sources". Even if the cement casing is flawless on completion, it can and does fail later on. I used this quote from Halliburton in another comment but it is applicable here as well – "Cement damage can occur long after the well construction process. Even a flawless primary cement job can be damaged by rig operations or well activities occurring after the cement has set. The mechanical properties of the casing and the cement vary significantly. Consequently they do not behave in a uniform manner when exposed to changes in temperature and pressure. As the casing and cement expand and contract, the bond between the cement and casing may fail." Also, -

The following are excerpts from a paper titled **"From Mud to Cement-Building Gas Wells"** dated Autumn 2003 by Tom Griffin of Griffin Cementing Consulting LLC, Joseph R. Levine of the US Minerals Management Service, Dominic Murphy of BHP Billiton Petroleum to name but a few of the authors. **This study serves to illustrate the complexity of the cementing process; and disproves the statement in the dsGEIS that says "**The only potential exposure pathway to fracturing additives identified by this Supplement is via air emissions from uncovered surface impoundments". This statement should be retracted from the dsGEIS and the entire premise of the GEIS needs to be altered from one that deems gas drilling as a simple, safe process to an affirmation that gas drilling is complex and unsafe. **If the experts in this field attest to the complexity of this aspect of drilling, I think NYSDEC should pay more attention to cement designs and cementing procedures.** "Since the earliest gas wells, uncontrolled migration of hydrocarbons to the surface has challenged the oil and gas industry. Gas migration, also called annular flow, can lead to sustained casing pressure (SCP), sometimes called sustained annular pressure (SAP)." "In the Gulf of Mexico, there are approximately 15,500 producing, shut-in and temporarily abandoned wells in the outer continental shelf area. United States Minerals Management (MMS) data show that 6692 of these wells, or 43%, have reported SCP on at least one casing annulus." "By the time a well is 15 years old, there is a 50% probability that it will have measurable SCP in one or more of its casing annuli. However, SCP may be present in wells of any age. In Canada, SCP occurs in all types of wells-shallow gas wells in southern Alberta, heavy-oil producers in eastern Alberta and deep gas wells in the foothills of the Rocky Mountains. Most of the pressure buildup is due to gas." "Long-term, durable zonal isolation is key to minimizing problems associated with annular gas flow and SCP development." "Determining the precise source of annular flow or sustained casing pressure is often difficult, although likely causes can be divided into four primary categories: tubing and casing leaks, poor mud displacement, improper cement-slurry design, and damage to primary cement after setting. Leaks can result from poor thread connection, corrosion, thermal stress cracking or mechanical rupture of the inner string, or from a packer leak. If the pressure from a leak causes a failure of the production casing the outcome can be catastrophic. Leaks to the surface or underground blowouts may jeopardize personnel safety, production-platform facilities and the environment." "Inadequate removal of mud or spacer fluids from the borehole prior to cement placement is a major contributing factor to poor zonal isolation and gas migration." "Improper cement-slurry designs –Flow occurring before cement has set is a result of loss in hydrostatic pressure to the point that the well is no longer overbalanced – hydrostatic pressure is less than formation pressure. This decrease in hydrostatic pressure results from several phenomena that occur as part of the cement-setting process. The change from a highly fluid, pumpable slurry to a set, rock-like material involves a gradual transition of the cement. This may require several hours, depending on the temperature, and quantity and characteristics of retarding compounds added. As the cement begins to gel, bonding between the cement, casing and borehole allows the slurry to become partially self-supporting. This self-supporting condition would not be a problem if it occurred alone. The difficulty arises because, while the cement becomes self-supporting, it loses volume as a result of at least two factors. First, where the formation is permeable, the hydrostatic pressure overbalance drives water from the cement into the formation. The rate of water loss depends on the pressure differential, formation permeability, and fluid loss characteristics of the cement. A second cause pf volume loss is hydration volume reduction as the cement sets. This occurs because set cement is denser and occupies less volume than liquid slurry. Volume loss coupled with the interaction between partially set cement, borehole wall and casing cause a loss of hydrostatic pressure, leading to an underbalanced condition. While the hydrostatic pressure in the partially set cement is below formation pressure, gas may invade. If unchecked, the invasion of gas may create a channel through which gas can flow, effectively compromising cement quality and zonal isolation. Also, cement damage can occur long after the well construction process. Even a flawless primary cement job can be damaged by rig operations or well activities occurring after the cement has set. Changing stresses in the wellbore may cause micro annuli, stress cracks, or both, leading to SCP. The mechanical properties of the casing and the cement vary significantly. Consequently they do not behave in a uniform manner when exposed to changes in temperature and pressure. As the casing and cement expand and contract, the bond between the cement sheath and casing may fail, causing micro annulus, or flow path, to develop.

As the borehole reaches deeper into the earth, previously isolated layers of formation are exposed to one another, with the borehole as the conductive path. Isolating these layers, or establishing zonal isolation, is key to minimizing the migration of formation fluids between zones or to the surface where SCP would develop. Crucial to this process are borehole condition, effective mud removal, and cement-system design for placement, durability and adaptability to the well life cycle. Wellbore condition depends on many factors, including rock type, formation pressures, local stresses, the type of mud used and drilling operation parameters, such as hydraulics, penetration rate, hole cleaning and fluid density balance. The ultimate condition of the borehole is often determined early in the drilling process as drilling mud interacts with newly exposed formation. If mismatched, the interaction of the drilling mud with formation clays can have serious detrimental effects on borehole gauge and rugosity. Once a well is drilled, displacement, cementing and ultimately, zonal isolation efficiency are dependent on a stable borehole with minimal rugosity and tortuosity. Drilling fluid engineers and related technical specialists have applied various techniques to investigate rock response to drilling fluid chemistry under simulated downhole conditions. Mud companies have created high-performance water-base muds that incorporate various polymers, glycols, silicates and amines, or combination thereof, for clay control. Like the fluids themselves, drilling fluid hydraulics play a fundamental role in constructing a quality borehole. Balance must be maintained between fluid density, equivalent circulating density (ECD) and borehole cleaning. If the static or dynamic fluid density is too high, loss of circulation may occur. Conversely, if it is too low, shales and formation fluids may flow into the borehole, or in the worst case, well control may be lost. Improper control of density and borehole hydraulics can lead to significant borehole rugosity, poor displacement and failure to achieve isolation. Rheological properties of drilling fluids must be optimized in such a way that the frictional pressure losses are minimized without compromising cuttings-carrying capacity. Optimal fluid properties for achieving good borehole cleaning and low frictional pressure loss often appear to be mutually exclusive. Detailed engineering analysis is required to obtain an acceptable compromise that allows both objectives to be satisfied. During drilling, optimal fluid characteristics may change depending on the task, such as running casing or displacement borehole fluids. Modeling and simulation with software tools such as the M-I Virtual Hydraulics application can be useful in optimizing fluid properties in anticipation of changes in rig operations. Integrating carefully designed drilling fluids with other key services is critical for achieving successful wellbore construction, zonal isolation and well integrity.

Proper mud selection and careful management of drilling practices generally produce a quality borehole that is near-gauge, stable and with minimal areas of rugosity, or washout. To establish zonal isolation with cement, the drilling fluid must first be effectively removed from the borehole. Mud removal depends on many interdependent factors. Tubular geometry, downhole conditions, borehole characteristics, fluid rheology, displacement design, and hole geometry play major roles in successful mud removal. Optimal fluid displacement requires a clear understanding of each variable as well as inherent interdependencies among variables. The availability of computer technology has significantly advanced the way drillers approach wellbore displacement. Fluids can be built, complex interactions predicted, and displacements simulated on the computer screen rather than at the wellsite where minor mistakes may result in major costs. CemCADE cementing design and simulation software and WELLCLEAN II software are two software applications used for this purpose.

Integration of drilling fluids, spacer design and displacement techniques provide the foundation for optimal cement placement. Long-term zonal isolation and control of gas require the cement to be properly placed and to provide low permeability, mechanical durability and adaptability to changing wellbore conditions. Cement permeability depends on the solid fraction of the formulation. For high-density slurries, a high solid fraction is inherent, thus the permeability tends to be low. For low-density slurries, special products and techniques create low-density, high solid-fraction slurries. Mechanical durability varies with strength, Young's modulus of elasticity and Poisson's ratio. The cement should be designed so these properties are sufficient to prevent failure of the cement when exposed to changing well pressures and temperature fluctuations, which create stresses across the casing-cement-formation system. Special materials are required to give the cement flexibility in this environment. **Sealing an annular space against gas migration can be more difficult in gas wells than in oil wells. Wellbore construction, particularly in the presence of gas bearing formations, requires that borehole, drilling fluid, spacer and cement designs, and displacement techniques be dealt with as a series of interdependent systems, each playing an equally important role. Often, the relationships among these systems is overlooked, or at the very least, poorly appreciated.** Preventing gas migration and SCP has been helped by recent developments in cementing technology that offer significant advantages in durability and adaptation to changing wellbore conditions. Cement properties have traditionally been designed for optimal placement and strength development rather than long-term post-setting performance. The rapid development of high cement-compressive strength after placement was generally considered adequate for most wellbore conditions. Today, operators and service companies realize that the emphasis on strength at the expense of durability has often led to the development of SCP (sustained casing pressure) and reduced well productivity. Cement particle characteristics and size distribution can contribute significantly to both the resistance to gas influx and maintenance of a sustainable hydraulic seal, particularly in wellbores subjected to pressure and temperature cycling. FlexSTONE advanced flexible cement technology, part of the CemCRETE concrete-based oilwell cementing technology, is one of several solutions that effectively address cement flexibility and durability. Conventional Portland cements are known to shrink during setting. In contrast, FlexSTONE slurries can be designed to expand, further tightening the hydraulic seal and helping to compensate for variations in borehole or casing conditions. This capability helps avoid micro annuli development. By adjusting specific additive characteristics and by blending the cement slurry with an engineered particle size distribution, a lowering of Young's modulus of elasticity in cement can be achieved. Annular cement can then flex in unison with the casing rather than failing from tensile stresses. Thus, the potential development of micro annuli and gas communication to the surface or to zones of lower pressure are minimized." The original complete version of the above paper can be found at www.slb.com/media/services/resources/oilfieldreview/ors03.

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Horizontal and directional wells – These techniques are already in use in the Marcellus Shale. While these techniques require larger quantities of water and additives per well, horizontal and directional wells are considered to be more environmentally-friendly because these types of wells provide access to a larger volume of gas/oil than a typical vertical well. Also, Analyses of flow conditions during hydraulic fracturing of New York shales help explain why hydraulic fracturing does not present a reasonably foreseeable risk of significant adverse environmental

impacts to potential freshwater aquifers. Specific conditions or analytical results supporting this conclusion include:

The historical experience of hydraulic fracturing in tens of thousands of wells is consistent with the analytical conclusion. There are no known incidents of groundwater contamination due to hydraulic fracturing.

In the September 2, 2009 issue of “Environmental Science & Technology” Pennsylvania’s Lead Gas Migration Inspector, Fred Baldassare, says “Deep horizontal drilling and hydraulic fracturing don’t have a track record in the northeast. Pennsylvania and New York aren’t Texas. Our geology is more complex, our rocks have been through more deformation. Companies and regulators need to tread carefully.” Gas drilling has been going on in northern PA and southern NY, but mostly at much shallower depths than the Marcellus Shale. Also, a World Intellectual Property Organization patented invention paper titled “Method for Cement Placement in Horizontal Wells” found at www.wipo.int/pctdb/en says, “Although horizontal wellbores allow more contact with the producing formation, one encounters some difficulties in well completions associated with horizontal wellbores not commonly dealt with in vertical wells. One area of concern in well completions is the inability to effectively cement voids along the horizontal section during a cementing operation. Effective cementing of the tubing to the wellbore is routinely accomplished in vertical wellbores. However, in horizontal wellbores and severely inclined wellbores, i.e. those having an angle of deviation greater than about 45 degrees, cementing is much more difficult. Therefore, the efficiency of zone isolation diminishes considerably. Often a failure of the cementing operation occurs in horizontal wellbores because the density of the cement does not allow sufficient displacement of drilling mud and other residue from the tubing/wellbore annulus, thereby resulting in channeling of cement and improper tubing or pipe/formation bonding.”
This paper goes on to explain an invention to improve the effectiveness of the cementing operation in deviated or horizontal wellbores.

This concludes my comments on the NYSDEC Oil & Gas dsGEIS. Thank You for the opportunity to submit these comments for your consideration,

Jilda Rush (former Oregon DOT Assoc. Trans. Engineer)
Windsor, NY

Paper entitled "From Mud to Cement-Building Gas Wells"

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Please see the following link to the article on Oilfield Review's Web site at
http://www.slb.com/resources/publications/oilfield_review/en/2003/or2003_aut.aspx