LAW OFFICE OF GARY A. ABRAHAM

170 No. Second Street
Allegany, New York 14706
716-372-1913; fax is same (please call first)

gabraham44@eznet.net
www.garyabraham.com

May 11, 2011

Bob Phillips, Planning Board Chair
Town of Allegany
52 West Main St.
Allegany, NY 14706

Re: Everpower project proposal; FEIS

Dear Mr. Phillips:

Please accept this letter as comments on the FEIS on behalf of Concerned Citizens of Cattaraugus County. Several CCCC members will also be submitting their own comment letters, as will CCCC's acoustic consultant Richard James.

The comments below address portions of the FEIS that either appear not to comply with Allegany's zoning ordinance and guidelines imposed by the Planning Board, or appear insufficiently protective of local residents even where arguably the proposal may formally comply with the rules.

I am also focusing particularly on those concerns that were raised in our previous comment letters that are insufficiently addressed in the FEIS. I submitted comments on the DEIS on February 20 and December 3, 2009, February 23 and April 23, 2010. (*see* FEIS, Appendix N, Comment 3, p. 1; Comment 4.) Please consider these previous letters when making a final determination whether, in the board's view, the FEIS supports project approval.

This introduction would not be complete without noting that the Planning Board is not bound to approve the Everpower project even if it meets all the requirements in the Allegany zoning ordinance. As the SEQRA lead agency, the board has authority to impose more stringent requirements than those required under the local law. The board has exercised this authority by requiring project noise be limited to 40 decibels at a dwelling. To approve the project as proposed, SEQRA also directs the board to balance the environmental impacts identified in the FEIS (as evaluated by the board, not the applicant) against "social, economic and other essential considerations," find that the balance weighs in favor of the project, and explain how the balance was arrived at in a way that "provides a rationale for the [lead] agency's decision." 6 NYCRR §§ 617.2(p), 617.11(d)(2.) If the project is approved, SEQRA requires the board to "certify that consistent with social, economic and other essential considerations from among the reasonable alternatives available," including the "no action" alternative, the board has imposed conditions on the applicant that ensure that "adverse environmental impacts will be avoided or minimized to the maximum extent practicable." 6 NYCRR § 617.11(d)(5). Thus, while in most cases the requirements of the local law could be reduced to a compliance "checklist," SEQRA requires a qualitative evaluation of potential impacts, the effect of mitigations, and "social, economic and other essential considerations."

Mitigating conditions may not be enough to outweigh the inherent adverse impacts of the project. This is what most people said who commented on the DEIS. (*see* FEIS, Appendix N.) Most of those comments said the adverse effects of a wind farm on wildlife, local ecology and people were so obvious and unacceptable that they are compelled to oppose this project. Even major projects such as the proposed Bona Square project would not have such impacts.

A. <u>Noise impacts</u>

CCCC continues to have serious concerns about noise impacts. How to properly evaluate noise impacts is, at best, unsettled and subject to much controversy. For example, *see* Robert Bryce, "The Brewing Tempest Over Wind Power," *Wall Street Journal*, March 2, 2010, found in the FEIS, Appendix N, Comment 4, attachment. Town of Sheldon town board member Glenn Cramer has written:

> Sound is a huge concern to many people living near these turbines. But, vibrations are another emerging problem. Turbines secured into the bedrock can pose a problem for neighbors and animals. . . I wouldn't use Sheldon as an example of a successful wind farm. It is another example of why industrial wind farms do not belong anywhere near people. When someone from Sheldon supports the wind farm, ask him or her what he or she stands to gain financially from it. I think you will see a direct relationship. Some residents have gained from the wind farm, but it has been at the expense of their neighbors. (*Id.*, attachment.)

Many of the concerns about noise raised in our previous comments were also raised in a comment letter on the DEIS submitted on April 30, 2010 by the state's Department of Environmental Conservation. DEC's noise concerns are found in Comment 1 in FEIS, Appendix N, pages 8-11.

The quality of wind turbine noise has raised several issues about whether the impacts predicted in the FEIS can be relied on. Specifically, concern has been focused on whether background or ambient sound levels reported in the FEIS are sufficiently conservative, and whether the intrusiveness of project noise against background is adequately discussed in the FEIS. During "worst case" conditions, the difference between the sound level and quality of background noise, on the one hand, and sound level and quality of turbine noise on the other hand determine how intrusive project noise can be. These concerns about noise effects were shared by DEC and CCCC, but are rejected or simply not addressed in the FEIS:

> **1. A "worst case" condition should be evaluated by comparing the quiet lulls between sporadic noise events to the maximum sound level expected to be generated by the project, but the FEIS fails to do so.**

In agreement with our concerns, DEC stated that background sound levels should be determined using the L90 statistic, which measures the sound level exceeded 90% of the measurement period. (FEIS, Appendix N, Comment 1, p. 8.) This has the effect of capturing the quiet lulls between temporary or sporadic noises, (as noted in the FEIS, Appendix K, p. 3), consistent with DEC's concern that the results "not be unduly biased toward higher readings by non-representative events," such as road noise or spring stream flow sounds. (FEIS, Appendix N, Comment 1, p. 9.)

According to DEC, in order to evaluate the "short term worse case" impacts, project noise is determined using the L10 statistic, which is meant to capture the loudest 10 minutes that can be expected in an average hour. (*see id.*, p. 10, bottom.) Thus the approach DEC recommends is to compare the loudest noise the project is expected to make to undisturbed quiet times.

This is not the approach taken by noise report in the FEIS. Instead, the FEIS takes the average of background sound levels. The average of background sound levels was determined not by direct measurements, but instead by applying a "regression analysis" that estimates the amount of wind-induced background sound that would be expected when turbines are operating, on the assumption that whenever turbines operate there will be ground-level wind-induced background sound that "masks" the noise of turbines.

DEC disagreed with this assumption, but the FEIS has not been modified to address DEC's comment. DEC commented that atomospheric stability at ground level can be coupled with wind shear, resulting in little or calm wind below while wind speed at turbine hub height (80 meters, measured from ridgetops) reaches cut-in speed (3 m/s, or 6.7 mph) or greater, generating noise.

In the "Response to Written Comments 16F and 38B," the FEIS states: "atmospheric stability can enhance the generation and propagation of wind turbine noise; however, there is no way this effect can be quantitatively calculated or modeled." (FEIS, Sec. 4.8, at p. 28.) The conclusion, that it is impossible to model for atmospheric stability, was controverted by Dr. Paul Schomer, an acoustic engineer commenting on the same approach in a wind project application reviewed by the Cape Vincent, New York Planning Board. In that case, Dr. Schomer noted that atmospheric stability is not an infrequent occurrence and urged that modeling take this into account by assuming, as a worst case condition, that residents would experience no wind-induced masking noise, since this is the effect of atmospheric stability:

> regularly and frequently, especially at night, the relation between wind speed and altitude cited by Hessler breaks down completely. It is simply wrong. This is not some idle theory; it is a well known and well documented fact. (FEIS, Appendix N, Comment 4, attachment, p. 3 [R. James report, dated May 3, 2010, quoting Schomer].)

CCCC's acoustic engineer points out that the difference between the approach to noise taken in the FEIS and Schomer's reflects two different goals of noise assessment. Schomer's (and James' and DEC's) approach is meant to "predict[ ] community response to any new noise source us[ing] the LA90 sound level." (*Id.*, at p. 4.) The FEIS approach is to provide "a reasonable degree of protection to wind farm neighbours, without placing unreasonable restrictions on wind farm development or adding unduly to the costs and administrative burdens on wind farm developers or local authorities." (FEIS, Appendix, Comment 3, attachment 6 to G. Abraham comments dated February 23, 2010, at p. 3.) This is a description of a procedure for assessing wind turbine noise developed by a private group of experts working in the British wind industry. The author contrasts this procedure to the British government's guidelines for assessing noise, which require a noise source avoid exceeding 5 dBA over background. The government standard has a different purpose, "assessing the likelihood of complaints." (*Id.*, at p. 2.)

It is not true that "there is no way this effect [i.e., atmospheric stability] can be quantitatively calculated or modeled." One need only calculate noise effects without factoring any wind-induced "masking" sound. That is the worst case condition, and it is reflected in actual measurements taken by CRA and James. By failing to account for the worst case condition, the FEIS is seriously deficient, since actual effects can frequently be more serious that the FEIS calculation, resulting in complaints.

2. "Penalty" decibels should be added to project noise levels estimated in the FEIS to reflect the modulating and low frequency qualities of the noise.

The Town zoning ordinance identifies low frequency modulating (impulsive) sound as a potential issue for wind projects. *See* Zoning Ord. II, Secs. 5.25(B)(h)(i) (requiring a report on "the tonal and frequency characteristics expected"), and 5.25(C)(2)(b) (prohibiting impulsive low frequency sound that "adversely affects the habitability or use of any dwelling").

Low frequency sound travels farther than mid-frequency sounds reflected in the A-weighting of reported decibels, and the low frequency sound level inside a dwelling is only minimally reduced by walls and windows compared to the sound level outside. Both the L90 and L10 statistics are determined based on "A-weighted" decibels, which reflect a steady state sound level in frequencies most easily heard by people. Measuring sound in A-weighted decibels does not reflect the quality of wind turbine noise, which is unlike natural background sounds. It often includes low-frequency rumbling or thumping noises, beating (pulsing) in time with the spin of the blades. Measuring noise impacts in terms of "A-weighted" decibels alone does not take this into account. The FEIS appears to agree. (*see* FEIS, p. 4.8-5.)

Accordingly, DEC advised that the FEIS "add a calculated number of dBA to the generated sound in an attempt to compensate for this characteristic." (FEIS, Appendix N, Comment 1, at p. 10.) DEC refers to its guidelines for support for this comment. The guidelines are found in the FEIS at Appendix N, Comment 4, attachment.

DEC's advice is specifically based on the following discussion in the agency's guidelines, at p. 12:

> Frequency and Tone - Frequency is the rate at which a sound source vibrates or makes the air vibrate. Frequency is measured in Hertz (Hz). Frequency can also be classified as high ("sharp"), low ("dull"), and moderate. Pure tones are rare in nature. Tonal sounds usually consist of pure tones at several frequencies. Pure tones and tonal sounds are discerned more readily by the human ear. Pure tones and tonal sounds are compensated for in sound studies by adding a calculated

number of dB(A) to the measured sound pressure.

Thus, low frequency tonal sound should be compensated for by adding decibels to calculated project-generated sound levels.

The FEIS rejects DEC's recommendation, that an evaluation of "short term worse case" impacts must address modulated noise. DEC's comment, by referencing "short term" impacts, recognizes that modulated noise does not happen all the time. Nevertheless, the FEIS relies on the fact that modulated noise does not happen all the time as the basis for rejecting the comment:

> This phenomenon . . . occurs sporadically and variably depending on atmospheric conditions or other factors. If it happened all the time one might consider it to be similar in nature to a tonal or impulsive sound and apply a 5 dBA penalty - but it does not happen all the time and the application of a 5 dBA factor (added to the predicted level, for example) would dramatically increase and probably overstate the apparent impact of this or most wind projects. (FEIS, Sec. 4.8, at p. 5.)

Thus, the FEIS is unresponsive to the comment, as DEC clearly understands modulated noise effects are "short term worse case" impacts which call for a penalty to be added to calculated sound levels.

The FEIS is also unresponsive to DEC's recommendation to penalize for low frequency noise. The FEIS states: "As indicated in the DEIS, sound levels are expected to be 10 to 20 dBA lower inside a dwelling with windows shut." (FEIS, Sec. 4.8, at p. 28.) However, this statement does not apply to low frequency sound. At low frequencies, sound is not significantly lower inside a dwelling with windows shut, compared to outside. (Half the year people can leave windows open anyway.)

The FEIS goes farther, asserting that there is no evidence to support the opinion of CCCC's acoustic engineer Richard James that low frequency noise is common at wind farms:

> James produced no study or data to address the very conditions he asserts will exist. Please see Hessler's November 9, 2010 letter report (Reference: L-110510-A) in FEIS Appendix K for additional detail. At best James relies on reference to an irrelevant study conducted in Europe for an area of flat topography, near the ocean. As such, the European study does not carry much weight in the face of Hessler's in depth analysis of actual on site wind and sound conditions for the Everpower Project which will be located, well inland on very hilly terrain in western New York. (FEIS, ch. 4.8, at p. 19.)

In fact, James refers to the leading study of wind shear by G.P. van den Berg, based on measurements of a wind farm every half-hour for one year. Van den Berg found that calm or stable atmosphere at near-ground altitude accompanied by wind shear near turbine hub height occurred 47% of the time over the course a year on average, and most often at night.[1] Van den Berg concluded:

> A high wind shear at night is very common and must be regarded a standard feature of the night time atmosphere in the temperate zone and over land. In fact the atmosphere is neutral for only a small part (approximately 10%) of the time. For the rest it is either stable (sun down) or unstable (sun up).[2]

Van den Berg's measurements were far more in-depth than Hessler's, as reported in the FEIS, and his conclusions are clearly general, not tied to the specific topography of the German wind farm he studied. By contrast, no independent support for Hessler's position is provided in the FEIS.

3. An additional 10 dBA penalty should be added to project noise levels estimated in the FEIS to reflect the night time noise effects.

DEC also advised that a penalty of 10 dBA be added to the noise levels generated by the project, to reflect the fact that the project will operate at night and night time noise is more disruptive than noise during the day. (FEIS, Appendix N, Comment 1, at p. 10.) This would mean the 40 dBA contour line on Everpower's noise compliance map reflects more accurately an experience of 50 dBA at night. (*see* FEIS, Fig. 2.) This would also mean the 30 dBA contour line on CRA's Sound Level Contour Plot reflects more accurately the nighttime effect of 40 dBA on Chipmonk Rd. and Four Mile Rd. residents, since CRA did not apply any penalties. (*see* FEIS, Appendix K, CRA Memo dated April 20, 2010, Fig. 1.) (The FEIS does not model an unpenalized 30 dBA contour.)

DEC states that such a penalty for night time project noise is warranted because, as we also previously noted, it is common for wind velocity at turbine hub height (80 meters, or 262 feet) to be double the wind velocity at ground level. (FEIS, Appendix N, Comment 1, at p. 11.) Under those circumstances, "resultant sound levels might be much higher than anticipated relative to background." *Id.*

The FEIS rejects DEC's penalty recommendation for reasons that are, at best, obscure. The FEIS, at p. 4.8-6, states erroneously that DEC's approach, adding a penalty to *project sound levels*, "is based on the hourly Leq *background level*." In further justification for rejecting the recommendation, the FEIS dismisses DEC's two grounds for the recommendation, that (1) background sound levels are substantially lower at night than during the day, and (2) wind velocity at turbine hub height is commonly sufficient to operate turbines when ground level wind velocity is low:

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[1] G.P. van den Berg, *The sound of high winds: the effect of atomospheric stability on wind turbine sound and microphone noise*, Doctoral Dissertation (May 12, 2006), Groningen Univ. (Rotterdam), p. 96. This study has been favorably reviewed by independent acoustic experts. *See* Acoustic Ecology Institute (Santa Fe, NM), *Wind Turbine Noise Impacts* (January 6, 2009), available at <http://www.acousticecology.org/srwind.html>.

[2] G.P. van den Berg, *The sound of high winds*, p. 104.

> Because the *nighttime levels were substantially similar to the daytime levels* it is likely that *the same relationship between sound and wind speed* would have been arrived at if only the nighttime data were used. (*Id.*, italics added)

However, the FEIS never reports nighttime data. Fortunately, CRA measured background sound levels at three locations outside the project area, finding the lowest minimum L90 is about 18 dBA, over 10 decibels lower than comparable day time readings. (FEIS, Appendix K, CRA Memo of September 27, 2010, p. 7, table.)[3] Yet both the FEIS and CRA elect to average the high and low readings, rather than discuss the worst case condition that has support in measured data, the minimum nighttime L90.

The board unable to look to the FEIS for conclusions about how often this condition is expected to occur, because there is no discussion of the special problem of nighttime project noise impacts. We know that wind farms operate more often at night than during the day, and atmospheric stability resulting in calm surface winds while high winds occur aloft occurs most often during the night. By not adding dBA penalties or otherwise considering the effect of wind turbine noise at night, the FEIS has simply avoided any discussion of the worst case condition.

4. The cumulative effect of several turbines beating synchronously should be evaluated.

Also in agreement with our previous comments, DEC notes that the cumulative effect of wind turbines arrayed in a line, as Everpower proposes, is not reflected in an evaluation of the noise generated by single turbines. (p. 12.) Particularly at night, according to DEC, the beating sound of several turbines can synchronize, because the blades are at most 60 degrees (out of 360 degrees) out of synch. If the blades sweep through air with differing wind speeds, as a blade moves from one wind speed to another within the blade swept area, the result is a "thump." When blade rotation among turbines is synchronized these thumps occur all at the same time. This occurrence may come and go throughout the period turbines are operating, but each time an "unexpected additive effect" is heard at receptors. *Id.*

DEC guidelines identify a 20 dBA increase as "very objectionable to intolerable." (FEIS, Appendix N, Comment 4, attachment, p. 15.) When background is 18 dBA (L90), a 20 dBA increase would occur when project noise reaches 38 dBA. If DEC's penalty recommendation is credited, this could occur when project noise is 10 decibels lower, or 28 dBA. According to

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[3] Nevertheless, CRA concluded, "The overall average L90 values range from 33 to 35 dBA during the wind conditions of interest, which are similar to Hessler's previous study that established the overall L90 background levels as a function of the 7 m/s wind speed design value." (FEIS, Appendix K, CRA Memo of September 27, 2010, p. 8.) However, CRA does not say why the minimum L90 it measured should be replaced by an overall average of all measurements, if the concern is to evaluate a worse case condition. Also, as noted in the text, above, both DEC and CCCC question the assumption that wind-induced "masking" noise at ground level in neighboring valleys (where most people live) is "a function of" wind speed several hundred feet higher, since turbines would operate well above the ridgeline. This assumption may be more appropriate for relatively flat topography. (The FEIS, at p. 48-2, notes: "The homes in the Project area are at a dramatically lower elevation than the Project at the bottom of a steep grade . . .") Both DEC and CCCC recommend that the FEIS evaluate the condition where there is no wind-induced "masking" noise at ground level and turbines are operating.

DEC, even this may not be conservative enough to capture the worse case condition, since DEC also recommends adding additional decibels to the estimate of project noise to account for its impulsive or modulating quality.

5. Other examples of failure to respond to comments.

The Town amended its zoning ordinance in February 2011 to require:

> The measurement of the sound pressure level may be done according to the American National Standard, Quantities and Procedures for Description and Measurement of Environmental Sound (ANS1/ASA S12.9 1993, Parts l, 2 and 3, Reaffirmed by ANSI April 2008), published by the Acoustical Society of America (ASA)and the American National Standards lnstitute (ANSI), or other accepted procedures. (Amendment to Zoning Ord. II, Sec. 2.02.)[4]

By contrast, the FEIS has rejected any accepted procedures, asserting instead that "there are no standards in existence that address the measurement of general background sound levels for wind turbine projects," and, "[t]he techniques employed in Hessler's study are based on extensive field experience with wind projects." (FEIS, Sec. 4.8, at p. 17.)

While, as noted at the outset, the procedures for assessing *operational noise* from wind farms remain unsettled and subject to some controversy, this is not the case for the procedure for calculating background sound levels.[5] Thus, "extensive field experience with wind projects" does not excuse failure to comply with the Town's directive to apply published professional acoustic standards.

The FEIS rejects a comment by CCCC's acoustic engineer Richard James, that the standards found in ANSI S12.9-1993/Part 3 *Quantities and Procedures for Description and Measurement of Environmental Sound* apply. The reason for this conclusion provided in the FEIS is that, for purposes of "studying wind turbine sound emissions," "specialized techniques are required for which no standards currently exist." (FEIS, Sec. 4.8, at p. 17.)

However, Mr. James commented that ANSI S12.9-1993/Part 3 applies to the calculation of *background sound levels*, not wind turbine sound emissions. The ANSI procedures prohibit wind-induced noise from being included in measurements of background sound level. (FEIS, Appendix N, Comment 3, attachment [R. James, letter to G. Abraham dated February 22, 2010, pp. 1-2].) This is consistent with the concept of background sound, that it reflects the quiet lulls

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[4] *Compare* R. James, *A Report on Background (Ambient) Sound Levels at Selected Sensitive Receivers, Olean/Allegany, NY, April 22-24, 2010* (May 3, 2010), found in FEIS, Appendix N, Comment 4, attachment, p. 1 (listing ANSI and ISO procedures followed); *and* R. James, letter to G. Abraham dated February 22, 2009, p. 1 ("There is no basis in any recognized peer-reviewed acoustic standards for considering the sounds that winds may produce as the basis for establishing the background sound levels.").

[5] It is also not true that no ANSI or other generally accepted standards or procedures exist for measuring operational noise. As DEC comments indicate, generally accepted penalties for noise sources emitting modulating noise, low frequency noise, and night time noise should be applied when assessing wind turbine operational noise.

between sporadic noises.

The fact that a project is proposed does not change the nature of background sound. Even if, as the FEIS states, the noise-generating features of the project are "unique," this conclusion does not justify abandoning standards for measuring background sound.

6. Conclusion regarding noise impacts

Because none of DEC's recommendations are accepted and incorporated into the FEIS, because the FEIS fails to adequately discuss the worst case noise condition, and because the FEIS fails to adhere to ANSI or equivalent standards for assessing noise, the Planning Board should conclude that the project cannot be approved without further modification of turbine locations to avoid unacceptable noise impacts.

Among the conditions the board should impose on this project, if it approves it, are to relocate some turbine sites, require that potentially offending turbines be remotely shut down in the event of nighttime wind shear, and require additional noise easements from neighbors within the 40 dBA contour lines, appropriately modified by applying DEC recommended penalties.

B. Blasting impacts

Initially we commented on the lack of a blasting plan. A preliminary blasting plan has been added to the FEIS, but it is short on specifics. In particular, the plan repeats the DEIS assertion that blasting may not be necessary, but the project area is characterized by the same rock outcropping that characterizes Rock City, and thus the ability to avoid blasting to anchor cement pads nine feet thick for each turbine seems highly improbable.

Evidence of the risks of well casing failures in Marcellus Shale drilling sites is relevant to an evaluation of risks of blasting in the project area because the area includes closely spaced oil and gas wells. (*See* DEIS, Fig. 3, "Proposed Project Layout.") Except for active oil wells between turbine locations 3W and 7W, (FEIS, Appendix M, at p. 2), most of the wells in the project area are abandoned or closed, but that does not eliminate the risk that rock strata exposed to explosive stress will result in nearby well casing failure. Closed and capped wells may leak into groundwater when their casings are cracked.

For example, Maurice B. Dusseault, with the University of Waterloo's Porous Media Research Centre, co-authored "Why Oil Wells Leak: Cement Behavior and Long-Term Consequences," reporting that oil and gas wells can develop leaks along the cement casing years after production has ceased and the well has been plugged and abandoned:

> . . . in North America, there are virtually tens of thousands of abandoned, inactive, or active oil wells and gas wells, including gas storage wells, that currently leak gas to surface . . . some of the gas enters shallow aquifers... where the methane itself can generate unpleasant effects such as gas locking of household wells, or

gas entering household systems to come out when taps are turned on.[6]

In another paper, Dusseault confirms that casing failure can be "linked to reactivation of old faults, high-pressure injection, slurry-fracture injection, or massive solids production."[7] Dusseault reports that drilling in seismically active areas or regions where the presence of underground faults and fissures is not well understood (such as in New York State) creates the risk of microseismic "shear," which can lead to well casing failures over time.

Usually impairment arises through shear owing to displacement of the rock strata along bedding planes or along more steeply inclined fault planes. These displacements are shear failures. They are triggered by stress. (*Id.*) . . . [R]educing the incidence and rate of casing impairment through stress can be achieved through a number of tactics. Favored ones include avoidance of the most troublesome regions. (*Id.*)

More recently, DEC has been quoted in an investigative news report about the dangers of leaks from unplugged gas and oil wells, stating "there are thousands of these [unplugged wells] out there that need to be addressed," and noting that of about 40,000 deteriorating wells in New York, only about 125 have been plugged.[8]

More details need to be included in the FEIS blasting report. The report should identify all oil and gas wells in and around the project, identify whether each well is active or inactive, plugged or unplugged, and assess the risk of fractured well casings that could result from nearby blasting. The applicant should also provide baseline water quality testing for residential water wells within the potential impact zone identified in the risk analysis, and post-operational water quality testing at the same homes soon after blasting, and several months thereafter.

Sincerely yours,

/s/

Gary A. Abraham

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[6] Dusseault, Maurice B.; Gray, Malcom N.; and Nawrocki, Pawel A.: "Why Oil Wells Leak: Cement Behavior and Long-Term Consequences," Society of Petroleum Engineers, Inc., OnePetro, paper number 64733-MS, presented at the International Oil and Gas Conference and Exhibition, Beijing, November 7-10, 2000, <http://www.onepetro.org/mslib/servlet/onepetropreview?id=00064733&soc=SPE>.

[7] Dusseault, Maurice B. et al., "Well Casing Shear: Causes, Cases, Cures," *SPE Drilling & Completion*, June 2001, <http://www.terralog.com/article/spe72060.pdf>.

[8] Nicolas Kuznetx, "Deteriorating Oil and Gas Wells Threaten Drinking Water, Homes Across the country," *ProPublica,* April 4, 2011, <http://www.propublica.org/article/deteriorating-oil-and-gas-wells-threaten-drinking-water-homes-across-the-co>.