Stephanie L. Sloman
387 Courthouse Lane
Pascoag, RI 02859

September 21, 2016

TO: EFSB
RE: Docket SB2015-06 - Invenergy

(I am a retired environmental engineer.)

REPORT REGARDING LOW-OCTAVE BAND NOISE/LOW FREQUENCY NOISE

WHAT IS LOW FREQUENCY NOISE?

I did a tremendous amount of research on this subject. Low frequency noise has to do with the frequency of sound (31.5 Hz, 63 Hz, 125 Hz, and 250 Hz). Depending on what you read, low frequency noise (LFN) is defined as "low octave band noise". Usually, this low octave band noise (or LFN) is 250 Hertz (Hz) or below. (There is also "infrasound" which is below 10 Hz or 16 Hz, depending on what you read. Also, keep in mind that even though Burrillville's ordinance does not have anything to do with infrasound and Invenergy does not discuss it, the proposed power plant may emit these very low frequency bands.) What is very interesting about LFN is that people can still hear/feel it. Why? The noise wavelengths are tremendously long. This means two things: 1) Noise at these long wavelengths can travel through buildings, trees, ground (hills), and human/wildlife tissue (unlike high frequency noise); and 2) LFN can travel tremendous distances (unlike high frequency noise). The first issue (LFN traveling through building, etc.) shows that temperature, humidity (meteorological effects), ground absorption, and air absorption will not change LFN levels. The second issue shows that this is why the LFN is "heard"/felt from long distances. This is one of my points: Not only will the LFN affect the humans/wildlife "abutters", if you will, it will also negatively affect the humans/wildlife not even within the confines of the receptor distances. In other words, the LFN will negatively affect residents and wildlife living beyond the M5 receptor @ approximately 7,000 feet away. (And, as I have written many times, I can "hear"/feel the LFN from the Algonquin/Spectra Compressor Station which is approximately 3 miles as the cross flies from my house!)

[In Mr. Hessler's report (page 2) he states: "In general, octave band limits are fairly uncommon because, among other things, it takes somewhat sophisticated instrumentation to measure them.....". Doesn't Mr. Hessler have the instrumentation to measure these? I found one quickly and it can be found at: http://scantekinc.com/files/PDFs/NL-62_Datasheet_1112-4.pdf.]

IS IT POSSIBLE FOR INVENERGY TO MITIGATE LFN? *ANSWER: YES!:*

→On page 97 of Invenergy's application concerning low-frequency octave-bands (31.5 Hz, 63 Hz, and 125 Hz) and the fact that Burrillville's ordinance is "among the stringent we have seen in the United States", it states: "**This is particularly relevant since low-frequency emissions are generally more difficult to mitigate than are high-frequency noise emissions.**" ***This statement PROVES that it is indeed possible to mitigate the low-octave / low-frequency noise that Invenergy's proposed power plant will produce.***

In Mr. Hessler's report submitted to the town, he states on page 2: "In this particular case, there is no need for a special restriction on lower frequencies, or on any other frequencies, because combined cycle plants like the CREC do not produce problematic levels of low frequency noise and more generally emit a bland [?????], broadband sound that is evenly spaced across the frequency spectrum; a sound that is not typically [typically???] considered noticeable or intrusive at the levels and receptor distances associated with this project." It continues (page 3): "Consequently, in our decades of experience designing and testing combined cycle plants we have never seen complaints or issues specifically associated with low frequency noise, irrespective of the plant sound level at nearby neighbors or its proximity to sensitive receptors." On page 4, he writes: "Invenergy has repeatedly argued that it is not feasible to meet the lower octave band limits...." He continues: "We would agree that it is probably [notice the word "probably"] technically impractical..." **I believe that Mr. Hessler knows that it is possible to mitigate the low frequency noise, but he knows**

that it is very expensive. However, I contend that Invenergy has the money to mitigate the low frequency noise which will keep the facility well within the Ordinance limits. Also, when Invenergy states that "it is not feasible to meet the lower octave band limits" (as stated above), they really mean that "it is not ECOMICALLY feasible"... they do NOT want to spend the extra money if they do not have to. PERIOD.

[Also, I read (and I cannot cite it because I don't remember where I read it due to the volume of documents/reports that I have read) that LFN increases in combined cycle power plants during start-ups and shut-downs.]

NOTE: I HAVE BEEN IN TOUCH (VIA EMAIL) WITH *NOISE SOLUTIONS* (A noise consulting company based in Canada) AND THEY SAID THAT IT IS INDEED POSSIBLE (after I gave them the specifics of the proposed power plant,... and I mean details, "my town's" ordinance low-octave band levels, and "the energy company's" proposed Facility's estimated low-octave band levels). I have a "conversational" email with Lindsey Apland who handles projects in the United States. I will be happy to produce this email "conversation" if you would like to read it. The last email that I received from Ms. Apland contained her request for a "Noise Impact Assessment" (which "would provide octave band levels [including LFN] for each noise source so we could determine what noise control methods may be required") and a plot plan ("showing the proposed equipment in the planned orientation"). So I had to email her back stating: "You are not going to believe this, but the energy company did not do a Noise Impact Assessment" [which includes the octave band levels, including LFN]. Also I continued: "The energy company does not have a "final" plot plan showing the proposed equipment in the planned orientation. This was requested from our Planning/Zoning boards and the final plot plans were not given to them...." I am waiting to hear from Mr. Apland. Perhaps she does not want to even deal with an energy company that does not seem to be honest or forth-coming????

IMPORTANT: I emailed Mr. Hessler, anonymously, concerning combined cycle natural gas power plants and low frequency noise. This is a quote from his email: "For critical sites with nearby houses and/or very low permissible noise limits, the plate thickness on this part of the HRSG is increased from a standard ¼" thickness to ½"." (I believe that Invenergy is already doing this to mitigate the dBA limit of Burrillville's noise ordinance.) He continued however: "When more of a reduction is required, an external shroud is often used, which consists of metal panels forming barrier walls on the sides or a complete enclosure with a roof over the HRSG transition duct. These panels are typically 20 ga. Steel on the exterior, 4" of fiberglass insulation and 24 ga. Perforated metal on the interior face. The exterior sheet resists the penetration of noise to the outside and the acoustically absorptive lining prevents noise from reflecting back and building up inside the noise enclosure." Mr. Hessler continued: "Another source of moderate low frequency noise in a combined cycle plant are the fans in the cooling tower or air cooled condenser (ACC), as the case may be." [Me-Invenergy has the ACC.] "When needed, which is often, low noise fans are used instead of standard fans, which usually produce significant noise in the 125 to 250 Hz octave bands. Low noise fans typically rotate at a slower speed, which leads to much less noise, and the FRP blades have a very wide width, or chord, that allows them to move more air at a slower speed." He continued: "The very quietest fans, the Model SX made by Howden Fans in the Netherlands, are extremely wide to the point where there is almost no open area in the fan wheel."

As you can see above, Mr. Hessler has relayed to me other ways that Invenergy has not included in its noise mitigation (i.e., low frequency noise). It is possible for Invenergy to reduce the low octave band (LFN) levels in its proposed design.

According to ATCO Structures and Logistics (http://atcosl.com/en-ca/Media-Room/News-2012/103012-ATCO-Awarded-Accoustical-Design-of-Power-Plant) "ATCO Awarded Acoustical Design of Power Plant", dated October 30, 2012, it states: "ATCO designed the noise control solution for the new power plant to meet the design requirements for low frequency noise emissions desired for the client. Low frequency sound of 250 Hz and below can be experienced as a 'rumble' or 'felt' instead of heard. ATCO's attenuation design will eliminate the rattling of doors and windows caused by low frequency sound emissions within the surrounding neighborhood." It continues: "The natural gas, combined cycle power plant replaces the Lower Colorado River Authority's (LCRA) existing facility, built in 1974." As you can see, this consulting company can mitigate LFN in combined cycle power plants!

See http://www.powermag.com/major-noise-sources-and-mitigation-cost-estimates-for-gas-fired-power-facilities/?pagenum=2 . The article is "Major Noise Sources and Mitigation Cost Estimates for Gas-Fired Power Facilities, written by Patrick Saussus, PE on October 12, 2012. My point here is that it is the exhaust stacks that cause MOST of the low frequency noise in natural gas power plants (according to this report). It states: "The exhaust stack or HRSG is often the primary noise source in situations where low frequency is a concern. These situations include dBC or octave band limits in the 31.5 Hz to 125 Hz octave bands. Vertical silencers in the stack and horizontal silencers within the HRSG are typically used to mitigate noise caused by the exhaust stream itself. Stack and HRSG construction is also important to address. The casing thickness is increased or cladded incorporated to help decrease vibration-induced airborne noise." Remember this has to do with LFN.

In the website, http://poweracoustics.com/Power-Plant-Industrial-Community-Noise.html, it states under "450 MW Peaker Units": "Power Acoustics, Inc. was involved at the power plant design/construction stages by evaluating the design for Harza Engineering. The critical low frequency sound pressure levels were achieved at all residential locations. **Although ignored by many acoustical consultants, low frequency noise, or infra sound, can be observed as vibration in homes and is often the primary complaint from neighbors located near gas turbine installations."**
I bold-faced and underlined that sentence because Mr. Hessler, in his report on page 3, states: "....in our decades of experience designing and testing combined cycle plants we have never seen complaints or issues specifically associated with low frequency noise, irrespective of the plant sound level at nearby neighbors or its proximity to sensitive receptors." [Also, see below in "A Simple Criterion for Low Frequency Noise Emission Assessment" (stating that there have been complaints about LFN).]

Although this next article has to do with simple cycle peaking gas turbines, it is interesting that Mr. Hessler was one of the authors and there is good information here:
http://proceedings.asmedigitalcollection.asme.org/proceeding.aspx?articleID=2110504. The name of the article is "The Reduction of Low Frequency Gas Turbine Exhaust Noise: A Case Study". It states: "A team of specialists and outside consultants was formed to investigate the problem, and a development program found that a thick absorber could be effective against infrasound. This led to the design of a thick panel absorber which was installed at the rear of a 90 degree turn in the exhaust system. Field testing verified that the low frequency noise from the turbine exhaust was reduced by 5.9 and 6.7 dB in the 31.5 and 63 Hz octave bands respectively, and by 5.5 dB© overall." (I included this in this report because it is the stack vibrations of all natural gas power plants (including combine cycle) which produce the most LFN.)

In http://www.efsec.wa.gov/Sumas2/eis/seis/fseisch3-4.pdf, under the "Low-Frequency Noise" it states: "Some of the potential mitigation measures identified by SE2 could be applied as retrofits to original equipment after the facility has commenced operation. These include the following: Thicker HRSG walls; Heavier building walls; Reactive silencers; Noise barrier or enclosures at outdoor equipment; Absorptive panels at the bottom of the stacks." This all has to do with LFN. The rest of this article is very interesting.

NEGATIVE EFFECTS OF LFN ON HUMANS:

It seems that they are no limits for LFN in agencies in the United States; however, there are towns and counties that have their own limits in their ordinances (like Burrillville). Even the World Health Organization does not have any limits for the LFN. However, concerning the WHO, (quotations found at http://www.areco.org/LowFrq.pdf) ("Aviation Low Frequency Noise", April 13, 2001, 3.9 "Effects of Combined Noise Sources", last page) states: "The evidence on low-frequency noise is sufficiently strong to warrant immediate concern.... Health effects due to low-frequency components in noise are estimated to be more severe than for community noises in general. Since A-weighting underestimates the sound pressure level of noise with low-frequency components, a better assessment of health effects would be to use C-weighting." (It has been proposed that the LFN will be regulated at some future date.)

According to a noise consulting company's ("Noise Solutions") article, "Low Frequency Noise: Identification and Mitigation" (https://www.noisesolutions.com/low-frequency-noise-identification-and-mitigation/), written by Scott MacDonald on May 6, 2014: "Low frequency noise is known to produce a number of negative physiological reactions

(e.g., changes to blood pressure and heart rate, headaches, vertigo, sleep disturbance, difficulty breathy, anxiety) and subjective complaints (e.g., feelings of vibration, pressure, and annoyance as well as mental and physical performance impairment (e.g., fatigue, irritability, lack of concentration)." It continues: "In conclusion, low frequency noise poses health risks for communities as well as complaint risks for industry. This is increasingly being addressed by noise regulations, and should be factored in when considering noise control measures on new or existing facilities. Identifying low frequency noise through a Noise Impact Assessment is the first step to successful mitigation. Noise control measures must also take into account the need for space and volume of machinery in order to most effectively attenuate low frequency noise—because when it comes to low frequency noise, size matters." (This company is based in Canada.) (This company can mitigate the LFN as well.) This is the company that I have been in communication.

In the *Journal of Low Frequency Noise, Vibration and Active Control,* specifically "A Simple Criterion for Low Frequency Noise Emission Assessment (found at http://multi-science.atypon.com/doi/pdf/10.1260/0263-0923.29.1.1), written by N. Broner, on April 9, 2010, it states: "Complaints about the effect of higher level Low Frequency Noise (LFN) in the form of a rumble, a 'feeling of pressure', and resultant headaches and nausea have been known for decades..." Also, interestingly enough, Mr. Hessler is mentioned on page 8: "In 2005, Hessler described the low frequency noise problems that have occurred in the USA due to incorrect siting of gas turbine power plants close to residential areas. Typically, neighbors expressed complaints of low frequency rumble noise, vibration rattle, nausea, and headaches in some people. At low frequencies, apart from the spectral imbalance issue, a major factor in causing annoyance is the significant temporal level fluctuations that may occur." This articles continues: "Hessler, considered that his experience since 1971 had shown that the recommendation of ANSI B133.8 was 'woefully inadequate' for protecting residential areas against low frequency noise problems..."

In http://www.efsec.wa.gov/Sumas2/eis/seis/fseisch3-4.pdf, under the "Low-Frequency Noise" it states: "This is characterized by noise levels at frequencies less than about 100 hertz (Hz). For this SEIS, low-frequency noise is described as noise levels in the 16 Hz, 32 Hz, and 64 Hz octave bands. Noise at those frequency can be annoying to some people even at relatively low levels that might not be discernible to other people standing nearby.... Low-frequency noise can propagate through closed windows and lightweight walls typical of most homes, so in many cases the indoor and outdoor levels at homes near sources of low-frequency noise can be nearly identical.... If the low-frequency noise level is sufficiently high, it can cause discernable vibration and rattling of windows or other lightweight structures." Sumas Energy company also recommended "potential retrofit noise mitigation measures" [for LFN] which is stated above in the "**Is it possible for Invenergy to Mitigate LFN?**"

In http://www.hc-sc.gc.ca/ewh-semt/consult/_2013/wind_turbine-ecoliennes/research_recherche-eng.php, "Health Impacts and Exposure to Sound from Wind Turbines: Updated Research Design and Sound Exposure Assessment", it states: "Low frequency sound is not generally well perceived by the human ear; however, it may induce vibrations in lightweight structures in residences or sleeping quarters that may be perceptible or cause a "rattle". Research indicates that an individual's annoyance related to noise is greater when low frequencies are present. One of the main reasons is that very little change in the sound pressure level at lower frequencies is needed to have a disproportionate increase in subjective loudness." This document is from Health Canada at www.hc-sc.gc.ca.

I could go on with this subject, but I think you understand. Low frequency noise is not good for the health of humans, specifically the residents of Burrillville.

Okay, I changed my mind. I have found a research paper that is unbelievable!!!! It was written by Ivan Buxton in 2006 called "Low Frequency Noise and Infrasound (some possible causes and effects upon land-based animals and freshwater creatures)". http://ontario-wind-resistance.org/wp-content/uploads/2009/09/buxton-infrasoundandlandbasedanimals1.pdf
Now you may ask why I am putting information from this article in the "Negative Effects of LFN on Humans". On page 28 of this fantastic document, it states (and bear with me): "Moviemakers used infrasound to produce unease and disorientation in the audience...." It continues: "In order to bring the levels of infrasound [me-remember infrasound is below 16 Hz] into perspective it should be remember that the human brain functions as a transmitter and receiver. In

his paper, 'EEG Measurement', G. Blundell states: 'The brain operates: Normal activity 13Hz – 30Hz; Relaxed 8Hz – 13Hz; Drowsiness 4Hz – 7Hz; Deep Sleep 0.5Hz – 4Hz'". Mr. Buxton continues: "Interrupting, conflicting or overriding signals of unwanted sound (perceived as noise) at any frequency will have an effect on the brain and associated senses but predominantly auditory functions and those directly connected via the ear. The lower frequency sounds (<20Hz) stand a greater chance of interference with operation of the brain." He continues: "The evidence appears to show that harm created by LFN to humans, ranges from simple sleep disturbance (aggravating in small does, dangerous through fatigue if prolonged) through temporary disablement (sometimes deliberately imposed) to the extreme cases of permanent injury and possible death. In the circumstances the medical implications are worrisome. A number of studies have been conducted into the health risks caused by body vibrations from infrasound, increased cortisol from infrasound, endocrine effects and cardiovascular risks arising from noise exposure. The problem with infrasound is that a doubling of loudness occurs when the level of the sound is increased in air by 5dB and at the same time it becomes about three times as intense. Therefore only a small increase in source sound can be significant." So you can understand if the brain during sleep is disturbed by increased levels of LFN, it will cause the person to wake up and perhaps not totally. Without continued complete cycles of sleep, human beings cannot fully function with their daytime activities. This causes fatigue which could cause accidents. Sleep is the most important function of the human condition. (Again, this article is concerned with the LFN from wind turbines; however, it specifically "talks" about the dangers of LFN in detail.)

NEGATIVE EFFECTS OF LFN ON WILDLIFE:

According to "How Well do Dogs and Other Animals Hear?" (http://www.lsu.edu/deafness/HearingRange.html) 2003, the following table shows "approximate range (Hz)" of certain species. Please note that LFN falls between 0 Hz and 250 Hz.

Species	Approximate Range (Hz)
human	64-23,000
dog	67-45,000
cat	45-64,000
cow	23-35,000
horse	55-33,500
sheep	100-30,000
rabbit	360-42,000
rat	200-76,000
mouse	1,000-91,000
gerbil	100-60,000
guinea pig	54-50,000
hedgehog	250-45,000
raccoon	100-40,000
ferret	16-44,000
opossum	500-64,000
chinchilla	90-22,800
bat	2,000-110,000

beluga whale	1,000-123,000
elephant	16-12,000
porpoise	75-150,000
goldfish	20-3,000
catfish	50-4,000
tuna	50-1,100
bullfrog	100-3,000
tree frog	50-4,000
canary	250-8,000
parakeet	200-8,500
cockatiel	250-8,000
owl	200-12,000
chicken	125-2,000

I also found on line "The Physics Hypertextbook". In http://physics.info/sound/, I found "The Nature of Sound" where there are other species and Hz ranges including: pigs @ 45-45,000 Hz, salamanders @ 10-10,000 Hz, mallard ducks @ 300-8,000 Hz, and grasshoppers @ 100-50,000 Hz.

FARM ANIMALS:

Please note that what is interesting is that there are many species that may be found within the proposed site as well as inside the LFN travel distances. According to http://www.hc-sc.gc.ca/ewh-semt/consult/_2013/wind_turbine-eoliennes/research_recherche-eng.php, it states that it has been found that **low frequency noise can travel up to 10 km (6.2 miles)**. What bothers me is that the LFN may disturb farm animals in farms located within this "zone". As I wrote in my last report, there are several farms located in the air emission dispersion "impact zone" of the proposed Facility. Specifically, as far as chickens go, there are 8 farms which raise chickens for eggs within 5 miles of the site (and 4 farms within 2 miles). There are 5 farms which raise cows for dairy (and 3 farms within 2 miles). My point here is that chickens can hear down to 125 Hz in the low frequency noise range, and cows can hear down to 23 Hz. There are farms within 5 miles of the proposed Facility that raise some types of farm animals for "meat"; however, I do not know what type of farm animals. Will the chickens and cows living within that 5 mile (or even just 2 mile) area be disturbed by the LFN?

In the article, "Bad Vibrations: Health Hazards of Geothermal and Wind Turbine Noise", written by Sydney Ross Singer on Nov. 26, 2012, at http://www.hawaiireport.com/bad-vibrations-health-hazards-of-geothermal-and-wind-turbine-noise, on page 3, it states: "And it is not just humans who are affected. Animals pick up the vibrations, too, which can drive them away, if they can get away, and interfere with their reproduction. Nesting birds are known to be disturbed by LFN. Endangered species in critical habitat, however, may not be able to get away from the noise and vibration, making LFN a serious threat to their survival." Just because this article is about wind turbines and geothermal plants, does not make it not significant. It is still talking about the dangers of low frequency noise.

BIRDS:

One article that I found (http://www.avweb.com/avwebflash/news/InfrasonicBirdRepellentShowsPromise_208054-1.html?zkPrintable=true) is titled "Infrasonic Bird Repellent Shows Promise", written by Mary Grady on January 23, 2013. [Infrasound is very low "Low Frequency Noise"... it is the opposite of Ultrasonic sound.] This really interesting piece states: "A nine-month test using infrasound to repel birds has been successful, Technology International Inc., of Louisiana, has reported. Low-frequency sounds, which are not heard by humans, were generated using a rotary woofer, the company said. The sounds "jam the birds' acoustic navigational system ... [and] mimic the atmospheric disruptive features of unstable weather conditions that birds instinctively avoid." "The sounds don't harm the birds, the company said. The company hopes to use the technology at airports to create bird-free zones, and plans to test a prototype system at an airport soon." It also continues: "Bird strikes continue to be a major problem for aircraft around the world, causing about a billion dollars in damage each year. The frequencies used in the test are similar to infrasound emitted by thunderstorms, Technology Intl. CEO Abdo Husseiny told New Scientist, which may explain why the birds are averse to

the sounds. The system can also be used to create zones that are attractive to birds and establish wildlife sanctuaries in safe areas. Husseiny said the technology could also be used in other settings besides airports, such as urban squares, harbors and wind farms. The equipment should be available commercially in about two years." This piece show the impact (pardon the pun) of LFN on keeping birds away from airports. To me, this indicates that there will be birds, sensitive to the LFN, which will not go anywhere near the proposed power plant. This is change the biodiversity of the proposed plant site substantially. And if birds, such as owls and raptors (like hawks), avoid this area (and other distant areas due to the LFN long distance traveling), there will be an increase in the mice and other rodents in this area. The whole ecosystem will be disrupted!!!!

In the article, "Methods of Bird Control: Advantages and Disadvantages", published on 7/13/16, found at http://www.jneurosci.org/content/27/15/4191.full#sec-1, it states that Barn Owls can hear under 300 Hz. This means that even Barn Owls can hear low frequency noise and can be disturbed. These owls are found in this area (although not mentioned, as no owls were, as being observed or heard in Invenergy's application). This article also states: "According to scientists, birds can detect low frequency sounds of 0.06 Hz using their inner ear." This quote does not concern any specific bird species.

In the article, "Bad Vibrations: Health Hazards of Geothermal and Wind Turbine Noise", written by Sydney Ross Singer on Nov. 26, 2012, at http://www.hawaiireport.com/bad-vibrations-health-hazards-of-geothermal-and-wind-turbine-noise, on page 3, it states: "And it is not just humans who are affected. Animals pick up the vibrations, too, which can drive them away, if they can get away, and interfere with their reproduction. Nesting birds are known to be disturbed by LFN. Endangered species in critical habitat, however, may not be able to get away from the noise and vibration, making LFN a serious threat to their survival." (Yes, you read this same quote above, but I wanted to include it also in the "Bird" section. Also, please remember that there are various bird species that are of "greatest conservation need" according to the RI Fish and Game. These species have been heard and seen at the proposed Project's site.

According to various articles regarding bird migration and low frequency noise, birds can hear these Hz levels so that they can use the ocean waves and disturbances in the atmosphere during migration. This proves that many migrating bird species will be negatively impacted by the LFN from the Facility. One article concerning this can be found at http://huffingonpost.com/2013/01/31/homing-pigeon-navigation-birds-sound-waves_n_2589507.html.

I emailed Dr. David E. Anderson, PHD and Professor at the University of Minnesota and a member of the Minnesota Cooperative Fish and Wildlife Research Unit, who stated in his reply: "The only delve into low-frequency sound I have been involved with related to a hypothesis we offered as an explanation for an unusual pattern of movement in migratory birds. I've attached a pdf of that manuscript, and wish you the best in your efforts to compile information to aid in constructing an informed plan for development that incorporates concerns for wildlife." This pdf has to do with a strange migratory pattern of a species of warblers which were flying north until they seemed to "hear" the LFN from a huge thunderstorm at which time they deviated from their normal path to circumnavigate around it. The pdf can be found at: http://dx.dol.org/10.1016/j.cub.2014.10.079. Specifically, this manuscript states: "Responses of multiple bird species to infrasound have been documented. The cochlear mechanism of this sensitivity has been identified. The use of natural infrasound for orientation during migration has been described. Birds can detect changes in intensity and Doppler shifts in infrasound, suggesting they can sense the movement and direction of severe weather systems from great distances."

One other report concerning Golden-winged Warblers: http://www.newsweek.com/songbirds-may-avoid-storms-hearing-them-coming-hundreds-miles-away-293201.

There are several other articles/web sites that I will list here which have to do with the negative impacts that low frequency noise has on birds. If birds leave a forested site, for example, they will have an impact on the reproduction of plants. They will, for example, not eat blueberries, thereby not spread the seeds to other areas via their "droppings". Bigger birds can hear lower noise frequencies and can be forced out their nesting sites and not reproduce. http://phys.org/news/2011-11-large-birds-low-frequency-songs-noisy.html

http://www.eurekalert.org/pub_releases/2011-11/nesc-bba110811.php
http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=10768&context=icwdm_usdanwrc

OTHER WILDLIFE:

This research paper (which is also cited above in my "Negative Effects of LFN on Humans") was written by Ivan Buxton in 2006 called "Low Frequency Noise and Infrasound (some possible causes and effects upon land-based animals and freshwater creatures)". http://ontario-wind-resistance.org/wp-content/uploads/2009/09/buxton-infrasoundandlandbasedanimals1.pdf. On page 62, Mr. Buxton writes: "There is no reason to suppose the effect [of LFN] upon other mammals, birds, or aquatic species would be any different, especially those with nervous systems similar to man." He continues: "Annoyance is not peculiar to human beings, it is just easier to grasp as a human concept as the type or degree can be communicated in ways we more readily understand. Unfortunately we cannot simply ask for example, a frog, if the noise gets on its nerves." More: "Accordingly, it appear the type of noise, frequency (in terms of period scale or regularity as well as the actual Hz level), unexpectedness and 'loudness' may play a part in habituation as much as the nature of the species themselves. Yet such apparent habituation may simply be that certain species are more tolerant than others to certain levels of disturbance [LFN]." On page 3, Mr. Buxton states: "Because of the limitations of our hearing it would be easy to suppose that noises beyond our receiving range do not exist and should therefore be of no concern to us. Yet both very high and extremely low inaudible sounds may be harmful to us and other animals with similar but not identical ranges of hearing. Different people perceive sounds differently and much depends upon the individual levels of tolerance and what to them constitutes disturbance. Other creatures have lower acceptance levels, as their survival is more reliant upon instinct and interpretation of unusual sounds as a source of danger."

According to "Highway Traffic Noise – Noise Effect on Wildlife", found at http://www.fhwa.dot.gov/environment/noise/noise_effect_on_wildlife/effects/wild04.cfm, "The sensitivities of various groups of wildlife can be summarized as: Mammals <10 Hz to 150 150 kHz [150,000 Hz); sensitivity to -20 dB; birds (more uniform than mammals) 100 Hz to 8-10 kHz [8,000 – 10,000 Hz], sensitivity at 1-10 dB; reptiles (poorer than birds) 50 Hz to 2 kHz [2,000 Hz] sensitivity at 40-50 dB; amphibians 100 Hz to 2 kHz [2,000 Hz] sensitivity from 10-60 dB." It continues: "Earthworms have been shown to move toward the surface near roadways at low frequencies ~ 5 Hz exposing them as a food source for birds." (Although this article is concerned with the noise levels and dangers of roads to wildlife, it still discusses important information about LFN.)

According to "Low Frequency Noise and Infrasound", found at https://www.wind-watch.org/documents/low-frequency-noise-and-infrasound/, states: "Studies have been made of the effects of noise upon some bird species and quite clearly low frequency noise played a significant role in creating bird disturbance/displacement and was sufficient to cause serious reduction in breeding numbers in the study areas." "Anthropological sources of LFN and infrasound are increasing and will continue to do so. There is clearly a cause for concern because of the likely effects upon wildlife and current protective measures seem inadequate. Thus it is recommended that better environmental assessments be made to accompany all planning applications involving erection or construction of plant, machinery, buildings, infrastructure or other potential sources of low frequency noise and infrasound, irrespective of project size. The measurement methods should be reviewed to embrace 'C' weighting and 'G' weighting as well as the usual 'A' weighting so that a proper appreciation of the extent of LFN and infrasound is achieved before, during and after the noise source is installed."

At https://www.nps.gov/subjects/sound/upload/radle_effect_noise_wildlife.pdf, "The Effect of Noise on Wildlife: A Literature Review", written by Autumn Lyn Radle, it states: "The study of acoustic ecology began in the late 1970's, but it has just recently been recognized as a useful means for determining the health of both marine and terrestrial habitats (Krause, 1998). In his article 'Niche Hypothesis', Bernard Krause suggests that every creature has an 'aural niche' or its own particular voice and specific place in a habitat based on the relative frequency, amplitude, timbre, and duration of the sound it produces. Taken together, the vocalizations of all the creatures in a given habitat zone produce a unique vocal fingerprint which Krause believes can be used to infer the biological integrity of the area. With increasing destruction and loss of habitat, many creatures are forced into different areas with consequently different aural zones in

which they lack an established niche. The inability of creatures to successfully communicate or otherwise employ their auditory senses is detrimental to the long-term survival of these displaced creatures and the overall biological integrity of the environment." Although this article does not specifically "talk" about LFN, it shows that any disruption of the ecosystem due to such noise will cause an ecological problem.

The EPA's "Effects of Noise on Wildlife and Other Animals", dated December 31, 1971, found at https://nepis.epa.gov/Exe/ZyNET.exe/9101NNCV.TXT?ZyActionD=ZyDocument&Client=EPA&Index=Prior+to+1976&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear, states on page 45: "Clearly, the animals that will be directly affected by noise are those that are capable of responding to sound energy, and especially the animals that rely on auditory signals to find mates, stake out territories, recognize young, detect and locate prey, and evade predators. These functions could be critically affected even if the animals appear to be completely adapted to the noise (i.e., they show no behavioral response such as startle or avoidance). Ultimately it does not matter to the animal whether these vital processes are affected through signal-masking, hearing loss, or effects on the neuro-endocrine system. Even though only those animals capable of responding to sound could be directly affected by noise, competition for food and space in an ecological niche appropriate to an animal's needs, results in complex interrelationships among all the animals in an ecosystem. Consequently, even animals that are not responsive to or do not rely on sound signals for important functions could be indirectly affected when noise affects animals at some other point in the ecosystem. The 'balance of nature' can be disrupted by disturbing this balance at even one point." Although this huge document does not mention LFN (written in 1971), it is a wonderful insight into what mankind is doing to Earth and its wildlife. There are sections in this report which mention lower band levels of noise and how that they could disrupt wildlife behavior.

FOREST/PLANT IMPACTS:

It does not take a rocket scientist to understand the impact of lack of birds and other wildlife in a forest. The LFN will reduce the number of birds reproducing in the forested area of the proposed site. This will cause a reduction in the seed "spreading" of various plant species. All species (whether plant or animal) are connected in an ecosystem. When there is an impact with the number of birds, for example, there will be an impact with other parts of the ecosystem. If there are no owls, for example, then the mouse, mole, etc. populations will explode. If there are no bird species in the forest or wetlands that is specific to the seed dispersion of a specific plant, that plant species will suffer. Each ecosystem is perfect. If the wildlife species change, so do the plant species. If you want me to, I can cite various articles I found on the Internet.

AGAIN:

MY CONCLUSIONS:

1- **MAIN POINT: There is obviously technology in the field that would allow Invenergy to mitigate low-frequency noise. INVENERGY ITSELF STATES THIS ON PAGE 97. Also, I have supplied multiple companies that are capable of delivering this technology, including Noise Solutions and an email communication from Mr. Hessler himself.**
   a) **I have an email from Mr. Hessler to me (anonymously) that shows what a combined cycle power plant can do to mitigate low octave band noise. (This is not what Invenergy has planned to do.)**
   b) **I have emailed Noise Solutions (a Canada based noise consulting company) who can mitigate the LFN (low octave band noise) from this particular type of combined cycle natural gas power plant. I gave them all the detailed information about the plant as well as the town's noise ordinances (low octave band) and Invenergy's estimated ones at various Hz frequencies.**
2- **There is obviously a health risk to humans from low frequency noiseLFN will cause a negative impact on surrounding farm animals…. Cows may not produce the same volume of milk and chickens may not lay the same number of eggs. This will impact the farms' incomes.**

3- **LFN will cause a negative impact on many species of birds, and other wildlife.**
4- **LFN will cause a negative impact on species of plants.**
5- **LFN will cause disruption in the ecosystem within the proposed Facility site.**
6- **LFN may cause disruption in the ecosystems outside of the proposed site's limits.**

***Please read this quote from Dr. Mariana Alves-Pereira, University of Portugal, which can be found in the article, "Bad Vibrations: Health Hazards of Geothermal and Wind Turbine Noise", written by Sydney Ross Singer on Nov. 26, 2012, at http://www.hawaiireport.com/bad-vibrations-health-hazards-of-geothermal-and-wind-turbine-noise,: "I cannot stress this enough. If you know people who are complaining of LFN is their homes, please urge them to leave, at the very least, leave for a few hours a day, or better still, be there in the day but do not sleep in that house. Look at it this way: If people were told that there was a poison contaminating their homes, would they live in them? Although you cannot see nor smell LFN, and sometimes you cannot even hear it, if it is infesting the home 24/7, it becomes a most dangerous and fast debilitating agent of disease."* (Yes, this has to do with wind turbines and geothermal plants, but LFN is the subject.)

Respectfully submitted,

Stephanie L Sloman

Stephanie Sloman
Pascoag
9/21/16