SUBJECT: WIND ENERGY ZONING ORDINANCE AMENDMENT AND GENERAL PLAN AMENDMENT TO THE MOUNTAIN EMPIRE SUBREGIONAL PLAN (BOULEVARD SUBREGIONAL PLANNING AREA) AND BORREGO SPRINGS COMMUNITY PLAN TO ALLOW WIND ENERGY DEVELOPMENT, POD 10-007 (DISTRICTS: ALL)

Memorandum for the Record

The following brief analysis is provided in response to the Volker letter received on May 7, 2013. The letter does not raise new issues that had not previously been considered nor does it change the conclusion of the Health and Human Services Agency (HHSA) Position Statement. HHSA staff members continue to monitor the literature on the possible health effects of wind turbines. More research on this topic is necessary to enlighten the scientific, medical, and legal communities, as well as the public. The analysis here concerns the **direct** effect of wind turbines on health, not possible **indirect** effects through annoyance and stress.

Infrasound and Low Frequency Noise (ILFN)

The Volker letter asserts "recent studies convincingly demonstrate that wind turbine-generated ILFN *does* have significant adverse health effects."[1] Exhibits are provided to support this assertion, however, the Volker letter misrepresents exhibit findings and does not balance them with reviews or research that present the prevailing consensus that ILFN has no demonstrated adverse health effects.

Exhibit 9 is a review article that presents no original research.[2] The article summarizes literature on annoyance and noise and the anecdotal literature on health effects, but does not demonstrate ILFN has significant health effects. A more recent review published in April 2013 by the Victoria (Australia) Department of Health reaffirms the current scientific consensus:

> Infrasound is audible when the sound levels are high enough. The hearing threshold for infrasound is much higher than other frequencies. Infrasound from wind farms is at levels well below the hearing threshold and is therefore inaudible to neighbouring residents. There is no evidence that sound which is at inaudible levels can have a physiological effect on the human body. This is the case for sound at any frequency, including infrasound.[3]

Other references that support this consensus are available.[4,5,6]

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[1] Volker letter, page 11.
[2] Punch J, James R, Pabst D. Wind-Turbine Noise: What Audiologists Should Know. *Audiology Today*, 2010;July/August;20-31.
[3] Victoria Department of Health. Wind farms, Sound and Health. White paper published by the Victoria State Government, Australia. April 2103, page 19. Accessed May 10, 2013 at: http://docs.health.vic.gov.au/docs/doc/5593AE74A5B486F2CA257B5E0014E33C/$FILE/Wind%20farms,%20sound%20and%20%20health%20-%20Technical%20information%20WEB.pdf
[4] Bolin K, et al. Infrasound and low frequency noise from wind turbines: exposure and health effects 2011 *Environ. Res. Lett.* 6 035103 doi:10.1088/1748-9326/6/3/035103
[5] Roberts JD, Roberts MA. Wind turbines: is there a human health risk? *J Environ Health.* 2013;75(8):8-13, 16-7.

Exhibit 10 is also a review article that presents no original research.[7] The article cites anecdotal reports of health effects, but it does not conclusively link these reports with infrasound exposure. The article states that:

> Although current research provides no conclusive evidence for infrasound hearing perception by humans, it is nevertheless a worthy exercise to investigate infrasound sources in the immediate environment, as they may contain detectable harmonics. Typical infrasound sources include ocean waves, thunder, wind, machinery engines, slow speed fans, and driving a car with open windows.... It is not unlikely for humans to be exposed to high levels of infrasound. For example, a child on a swing may experience infrasound around 0.5 Hz at 110 dB SPL.[8]

Despite the acknowledgment that humans are likely to be subjected to infrasound from many sources, the article focuses on only one (wind farms) related to health outcomes. The article speculates regarding the possible links between outer hair cell (OHC) sensitivity infrasound observed in animal research findings and perceptions by individuals of paranormal activity and adverse health effects. The article does not scientifically demonstrate correlation or causation between infrasound exposure and health outcomes.

There are recent studies that show that infrasound produced by wind turbines is within the range of what humans interact with in the environment. The following table summarizes common sources of infrasound:

Natural environment	Household and industry	Human body
Waves Wind Waterfalls	Air conditioning Rail traffic Power plants	Breathing Chewing Heart beat Head movement

[9]

A recent Australian study showed that:

> measured G-weighted infrasound levels at rural locations both near to and away from wind farms were no higher than infrasound levels measured at the urban locations. The most significant difference between the urban and rural locations was that human activity and traffic appeared to be the primary source of infrasound in urban locations, while localised wind conditions appeared to be the primary source of infrasound in rural locations.... This study concludes that the level of infrasound at houses near the wind turbines assessed is no greater

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[6] Health Protection Agency (HPA). Health effects of exposure to ultrasound and infrasound: report of the independent Advisory Group on Non-ionising Radiation. White paper, HPA, Oxfordshire, UK. 2010. Accessed May 10, 2013 at: http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1265028759369

[7] Hsuan-hsiu AC, Narins P. Wind Turbines and Ghost Stories: The Effects of Infrasound on the Human Auditory System. *Acou Today*, 2012;8:51-56.

[8] Ibid. page 53.

[9] Op. Cit., Victoria, page 1.

> than that experienced in other urban and rural environments, and is also significantly below the human perception threshold.[10]

Exhibit 11 is a research study reporting that OHC's in a guinea pig animal model are apparently sensitive to infrasound.[11] The Volker letter incorrectly states that the authors "have shown that there are at least three mechanisms through which OHC stimulation by ILFN **causes perceivable impacts**" (emphasis added). [12] The study only postulates mechanisms "that should be ruled out" and the authors state that their findings "may provide a physiologic basis for Krahé's psychoacoustical studies."[13] They do not demonstrate that OHC stimulation causes any health effect or perceivable impact. Although the authors extrapolate their findings to account for anecdotal reports that some types of noise may be more annoying than others, the paper does not demonstrate a connection between infrasound and annoyance.

Exhibit 12 has the same lead author as *Exhibit 11* and summarizes a theoretical argument regarding "possible ways that low frequency sounds at levels that may or may not be heard, could influence the function of the ear."[14] Although the paper speculates that OHC stimulation could lead to perception, it does not demonstrate adverse health effects and states in the conclusion:

> The fact that some inner ear components (such as the OHC) may respond to infrasound at the frequencies and levels generated by wind turbines does not necessarily mean that they will be perceived or disturb function in any way.[15]

Exhibit 13 also has the same lead author as the previous two exhibits.[16] Like the other two papers, the authors postulate, but do not demonstrate, that stimulation of OHC may be perceived by individuals without being consciously heard. The paper states:

> In contrast to other sounds, such as loud sounds, which are harmful and damage the internal structure of the inner ear, there is no evidence that low-level infrasound causes this type of direct damage to the ear. So infrasound from wind turbines is unlikely to be harmful in the same way as high-level audible sounds.[17]

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[10] Evans T, Cooper J, Lenchine V. Infrasound levels near windfarms and in other environments. White paper published by the Environmental Protection Authority, Adelaide, South Australia. 2013. Accessed May 10, 2013 www.epa.sa.gov.au/xstd_files/Noise/Report/infrasound.pdf

[11] Salt A, Lichtenhan J. Perception-based protection from low-frequency sounds may not be enough. A paper presented at InterNoise in New York City, New York. 2012;August 19-22, 2012.

[12] Volker letter, page 13.

[13] Op. Cit., Salt and Hullar, page 4.

[14] Salt A, Hullar T. Responses of the Ear to Low Frequency Sounds, Infrasound and Wind Turbines," *Hearing Res*, 2010;268: 12-21.

[15] Ibid. page 19.

[16] Salt A, Kaltenbach J. Infrasound from Wind Turbines Could Affect Humans. *Bull Sci Tech Soc*, 2011;31: 296-302.

[17] Ibid, page 300.

Exhibit 14 is a combination of ILFN measurements and anecdotal observations on the perceived health effects in proximity to wind turbines.[18] One investigator admits being "not qualified to make judgments regarding human response to normally subliminal sources of acoustic excitation,"[19] and it is unclear how the other investigators are qualified to assess health. The only investigator who reported symptoms is the investigator who interviewed residents regarding health effects. He is also a co-author of *Exhibit 15* where a similar occurrence of symptoms in the investigators was noted.[20] The ILFN measurements in both of these papers cannot be scientifically correlated with or inferred to be causal of any health effects.

It is worth noting that a recent paper from New Zealand may explain a mechanism that may account for symptoms in some individuals who believe that infrasound may be harmful. The article found that:

> Healthy volunteers, when given information about the expected physiological effect of infrasound, reported symptoms that aligned with that information, during exposure to both infrasound and sham infrasound. Symptom expectations were created by viewing information readily available on the Internet, indicating the potential for symptom expectations to be created outside of the laboratory, in real world settings. Results suggest psychological expectations could explain the link between wind turbine exposure and health complaints.[21]

The Volker letter includes *Exhibit 16* to illustrate the preference of G-weighted measurements compared to A-weighted measurements, however the conclusion of the article is not mentioned. The conclusion is:

> From a critical survey of all known published measurement results of infrasound from wind turbines it is found that wind turbines of contemporary design with the rotor placed upwind produce very low levels of infrasound. Even quite close to these turbines the infrasound level is far below relevant assessment criteria, including the limit of perception. **Such low infrasound levels are unimportant for the evaluation of the environmental effects of wind turbines.** Wind turbines with a downwind rotor generate considerably higher infrasound levels, which may violate relevant assessment criteria in distances up to several hundred metres. **At longer distances the level drops below these criteria, and it is questioned if the infrasound can be the objective cause of negative public reactions to large downwind turbines** (emphasis added). [22]

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[18] Walker B, Hessler GF, Hessler DM, Rand RW, Schomer P. A Cooperative Measurement Survey and Analysis of Low Frequency and Infrasound at the Shirley Wind Farm in Brown County, Wisconsin. Public Service Commission of Wisconsin Report #122412-1 dated December 24,2012.

[19] Ibid, Appendix A, page 11.

[20] Ambrose SE, Rand RW, The Bruce McPherson Infrasound and Low Frequency Noise Study: Adverse Health Effects Produced by Large Industrial Wind Turbines Confirmed. White paper dated December 14, 2011.

[21] Fiona Crichton, George Dodd, Gian Schmid, Greg Gamble, and Keith J. Petrie. Can Expectations Produce Symptoms From Infrasound Associated With Wind Turbines? *Health Psychol*, 2013; March 13 (E-publication ahead of print. Accessed May 3, 2013 at: http://www.scribd.com/doc/130279155/Can-Expectations-Produce-Symptoms-From-Infrasound-Associated-With-Wind-TurbinesChapman, et al. Spatio-temporal differences in the history of health and noise complaints about Australian wind farms: evidence for the psychogenic, "communicated disease" hypothesis. Pre-Print: March 27 2013. Accessed May 3, 2013 at: http://ses.library.usyd.edu.au/bitstream/2123/8977/4/Complaints%20FINAL.pdf

[22] Jakobsen J. Infrasound Emission from Wind Turbines. *Journal of Low Frequency Noise, Vibration and Active Control*, 24(3): 145-155. Page 154.

Exhibit 17[23] has been previous reviewed found not to have demonstrated a statistical link between wind turbines, distance, sleep quality, sleepiness and health. This paper has been criticized in the journal in which it was published for statistical and methodological flaws.[24,25]

In short, although one researcher has determined that OHC's in a guinea pig model appear to have a physiological response to infrasound, there is no conclusive evidence that demonstrates that low levels of infrasound are perceived by humans or have an adverse health effect.

[23] Nissenbaum M, Aramini JJ, Hanning, CD. Effects of Industrial Wind Turbine Noise on Sleep and Health," *Noise Health*, 2012;14: 237-243.
[24] Ollson CA, Knopper LD, McCallum LC, Whitfield-Aslund ML. Letter to Editor: Are the findings of "Effects of industrial wind turbine noise on sleep and health" supported? *Noise Health*, 2013;15:148-50.
[25] Barnard M. Letter to Editor: Issues of wind turbine noise. *Noise Health*, 2013;15:150-2.

Electromagnetic Frequency (EMF)

The studies mentioned in the Volker letter by Milham and Morgan, and Havas and Colling do **not** scientifically demonstrate a causal health impact of EMF on health.

The Havas and Colling article contains only anecdotal information linking measurements of so-called "dirty electricity" to health effects, including electromagnetic hypersensitivity syndrome (EHS).[26] The article contains spectra measurements from Ontario and Palm Springs "near where people were unwell," but there is not enough detail on how the measurements were made and what actual symptoms were in these individuals. A correlation or causation between the measured findings and health cannot be inferred.

EHS is not an accepted medical diagnosis, nor is it clear that it represents a single medical problem. The World Health Organization (WHO) has concluded that:

> EHS is characterized by a variety of non-specific symptoms that differ from individual to individual. The symptoms are certainly real and can vary widely in their severity. Whatever its cause, EHS can be a disabling problem for the affected individual. EHS has no clear diagnostic criteria and there is no scientific basis to link EHS symptoms to EMF exposure.[27]

The Milham and Morgan study on the possible effects of electromagnetic frequency in a school setting does not adequately demonstrate a scientific link between EMF and cancer.[28] The flaws in the study have been documented in a 2010 review article by DeVocht.[29] In addition, the journal that published the study also published a letter to the editor that noted that the research was "biased" and contained "significant inaccuracies and objectional research practices."[30] The letter highlighted the failure of the authors to have the design study reviewed by an institutional review board.

The PHS position statement relies on the consensus of the scientific community regarding exposure to low level EMF. The current WHO statement on EMF is noted here:

> In the area of biological effects and medical applications of non-ionizing radiation approximately 25,000 articles have been published over the past 30 years. Despite the feeling of some people that more research needs to be done, scientific knowledge in this area is now more extensive than for most chemicals. Based on a recent in-depth review of the scientific literature, the WHO

[26] Havas M, Colling D. Wind Turbines Make Waves: Why Some Residents Near Wind Turbines Become Ill. *Bull Sci Tech*, 2011;31:5414-426.
[27] WHO: http://www.who.int/peh-emf/publications/facts/fs296/en/ Accessed May 3, 2013.
[28] Milham S, Morgan L. A new electromagnetic exposure metric: High frequency voltage transients associated with increased cancer incidence in teachers in a California school. *Am J Ind Med*, 2008;51:579–586.
[29] DeVocht F. "Dirty electricity": what, where, and should we care? *J Expo Sci Environ Epidemiol*, 2010;20:399-405.
[30] Morgan JW. Letter to the Editor: RE: A new electromagnetic exposure metric: High frequency voltage transients associated with increased cancer incidence in teachers in a California school. *Am J Ind Med*, 2008;51:579–86.

> concluded that current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields.[31]

The report submitted by Ms. Tisdale on May 5, 2013 entitled "Electromagnetic Field (EMF) Exposure at Campo and Manzanita Reservation Residences near the Kumeyaay Wind Turbines, and Ocotillo-Area residences near the Ocotillo Wind Energy Facility Wind Turbine Electric Generator Installation" was reviewed. The Volker letter asserts that this report showed "high levels of *local* wind turbine-generated EMF exposure in the residences."[32] A careful reading of the actual report indicates that this is untrue. The report clearly states on page 21 that "AC magnetic field levels noted in the survey were **very low and within the normal range** of residential buildings in Southern California.... RF levels detects were **low and well below levels commonly encountered** in metropolitan areas in San Diego County." (emphasis added). Indeed, **none** of the residences had magnetic field levels either indoors or outdoors that were higher than the average noted in the survey of American homes in the 1993 EPRI survey (median = 0.6 mG, mean = 0.9 mG).[33] In addition to the failure to demonstrate higher EMF measurements in Manzanita than in other San Diego residences, there is no correlation between the measurements and the local wind turbines.

The documents provided by Ms. Tisdale and Mr. Volker do not alter the conclusion of the HHSA position statement that EMF exposure from wind turbines presents no established health threat. Further, there is evidence that the constant suggestion that EMF may be harmful to health is in itself a cause of symptoms in individuals who believe that they are exposed to it (the so-called "nocebo" effect.)[34]

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[31] WHO: http://www.who.int/peh-emf/about/WhatisEMF/en/index1.html. Accessed May 3, 2013.
[32] Volker letter, page 19
[33] Electrical Power Research Institute (EPRI). Survey of Residential Magnetic Field Sources, Volumes 1&2. Technical Report 102759 published by EPRI, October 1993. Accessed May 3, 2013 at: http://www.epri.com/search/Pages/results.aspx?sq=1&k=TR-102759-V1
[34] Witthoft, M, GL Rubin. Are media warnings about the adverse health effects of modern life self-fulfilling? An experimental study on idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF). *J Psychosomatic Research* 2013;74:206-12.