IBERDROLA RENEWABLES

May 3, 2011

Mr. Iain Fisher, CEQA Project Manager
Energy Division
California Public Utilities Commission
505 Van Ness Avenue
San Francisco, CA 94102-3296

Re: Tule Wind Project - Response to Data Request No. 14

Dear Mr. Fisher:

Tule Wind, LLC (Tule Wind), a wholly owned subsidiary of Iberdrola Renewables, Inc. (IRI) received your Data Request No. 14 regarding the Tule Wind Project. Enclosed is a consolidated package of IRI's response to Data Request No. 14 Items 1 through 40.

Please note that additional information will be forthcoming to supplement the analysis and response for Item #39. Geo-Logic is currently preparing responses to the County of San Diego water supply comments. The supplemental analysis will include: 1) additional analysis completed by Geo-Logic for the two identified wells for the proposed project; 2) a summary of analysis performed to develop a qualitative evaluation of a sustainable pumping rate of groundwater within Thing Valley in the Ewiiaapaayp Reservation; and 3) additional analysis to estimate the aquifer drawdown that would result in the McCain Valley from the construction phase of the project. The Groundwater Investigation Report will be subsequently updated to reflect this additional information.

Many responses to Data Request No. 14 have been peer reviewed by Dr. Mark Roberts of Exponent. A letter stating his review and qualifications is included herein. If you have questions regarding this information, please contact Patrick O'Neill at 858 712-8313.

Sincerely,

Jeffrey Durocher
Wind Permitting Manager

cc (via e-mail): Greg Thomsen, BLM (GThomsen@blm.gov)
Thomas Zale, BLM (Thomas_Zale@blm.gov)
Jeffery Childers, BLM (jchilders@blm.gov)
Rica Nitka, Dudek (rnitka@dudek.com)
Patrick O'Neill, HDR Engineering (Patrick.oneill@hdrinc.com)

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Attached:

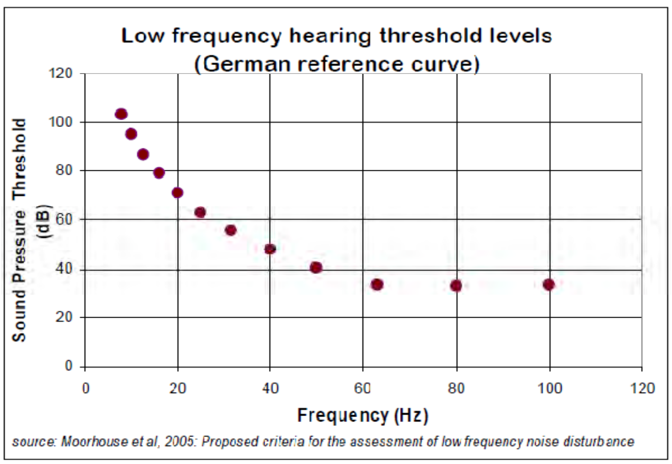
- Figure 3, Roadway Construction Temporary Noise Impacts
- Figure 4, Transmission Line Construction Temporary Noise Impacts
- Shadow Flicker Modeling Results Figure 1 of 2
- Shadow Flicker Modeling Results Figure 2 of 2
- Shadow Flicker Model Output
- Viewshed Figure – Modified Project Layout
- Groundwater Availability Confirmation Letter from John Gibson, Hamann Companies (April 6, 2011)
- Groundwater Availability Confirmation Letter from William Micklin, Ewiiaapaayp Band of Kumeyaay Indians (April 6, 2011)
- Geo-Logic Associates, Groundwater Investigation Report (December 2010)
- Geo-Logic Associates Modified Construction Water Supply Evaluation Memo (February 28, 2011).
- GIS meta data (sent via FTP site April 8, 2011)

NOISE

1. *Please explain the characteristics of audible and inaudible sound as they relate to wind turbines, as well as a discussion regarding the appropriate metric for measuring both.*

Response: Wind turbine sound is created by mechanical components in the nacelle and through aerodynamic generation. The dominant source of sound for modern turbines is the interaction of the rotating blades with the air, called aerodynamic sound. Modern upwind-configured wind turbines produce noise throughout the range of infrasonic, low, midrange, and high frequencies. These broadband sound emissions typically exhibit peak spectral emissions around 500 Hz[1] to 1 kHz. The noise emitted by modern upwind-configured wind turbines contains very low amounts of energy in the infrasonic range, low amounts of low frequency energy, and relatively more energy in the audible range. Modern up-wind configured wind turbines are recognized as emitting less low-frequency noise than older down-wind configured wind turbines[2], illustrated in Figure 1-1.

Figure 1-1. Low Frequency Hearing Threshold Levels



Sound is perceived and recognized by its loudness (pressure) and pitch (frequency). Human hearing of sound loudness ranges between 0 dB (threshold of sound for humans) and 140 dB (very loud and painful sound for most humans)[3,4]. Not all sound pressures are perceived as being equally loud by the human ear due to the fact that the human ear does not respond equally to all

[1] The frequency of sound is expressed in Hertz (Hz) which is equal to 1 cycle per second.
[2] Anthony L. Rogers, Ph.D., James F. Manwell, Ph.D., Sally Wright, M.S., PE, " Wind Turbine Acoustic Noise" prepared by the Renewable Energy Research Laboratory, Department of Mechanical and Industrial Engineering, University of Massachusetts at Amherst, January 2006.
[3] NASD.National Agricultural Safety Database. Noise: The Invisible Hazard. (1993), Available at http://www.nasdonline.org/docs/d000801-d000900/d000882/d000882.html.
[4] NMCPHC. Navy and Marine Corps Public Health Center. Physics of Sound. (4-15-2009), Available at http://www-nmcphc.med.navy.mil/downloads/occmed/toolbox/PHYSICSOFSOUND.ppt.

frequencies. The frequency range of human hearing has been found to be between 20 Hz and 20,000 Hz for young individuals with a declining upper frequency range correlating with increasing age[5]. The sound perception, "hearing," for humans is less sensitive to lower frequency (low pitch) and higher frequency (high pitch) sounds. As a result, the human ear can most easily recognize sounds in the middle of the audible spectrum, which is ideally between 1 kHz to 4 kHz (1,000 to 4,000 vibrations per second)[6]. Figure 1-2 from Rogers, et al. shows the hearing threshold for the human ear for low frequency noise expressed as sound pressure. The figure shows that humans do not hear sounds below 20 Hz very well.

Figure 1-2. Spectral Content of Vestas V80 Noise Showing Infrasonic and Low Frequency

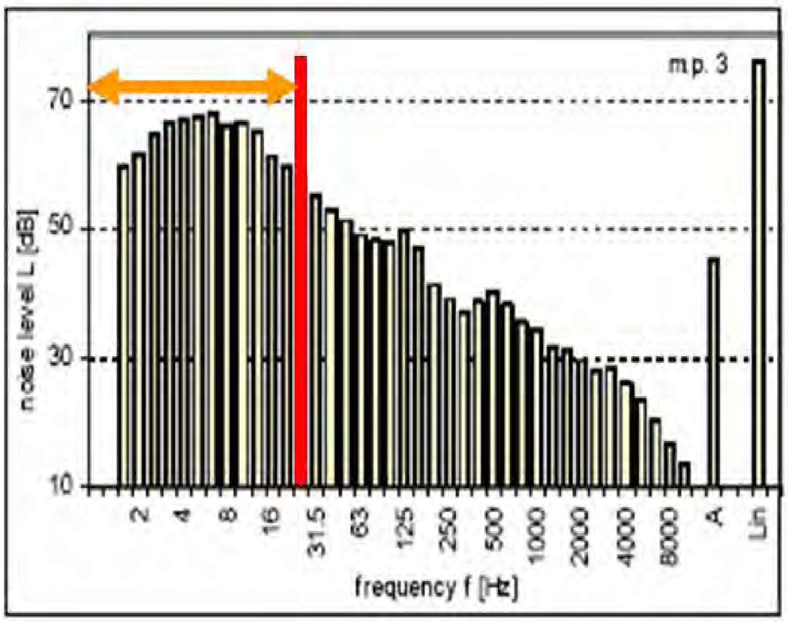


Figure 1-2 from Rogers, et. al shows noise levels downwind of a Vestas V80. When compared with the threshold shown in the figure above, the figure below shows that the infrasonic and low frequency content of the Vestas noise emissions are below the hearing human perception threshold.

The data in Figure 1-2 are supported by data reported in "InfraSound, Low Frequency Noise & Vibration from Wind Turbines"[7] by Dr. Andy McKenzie of the Hayes McKenzie Partnership Ltd, as shown in Figure 1-3 below.

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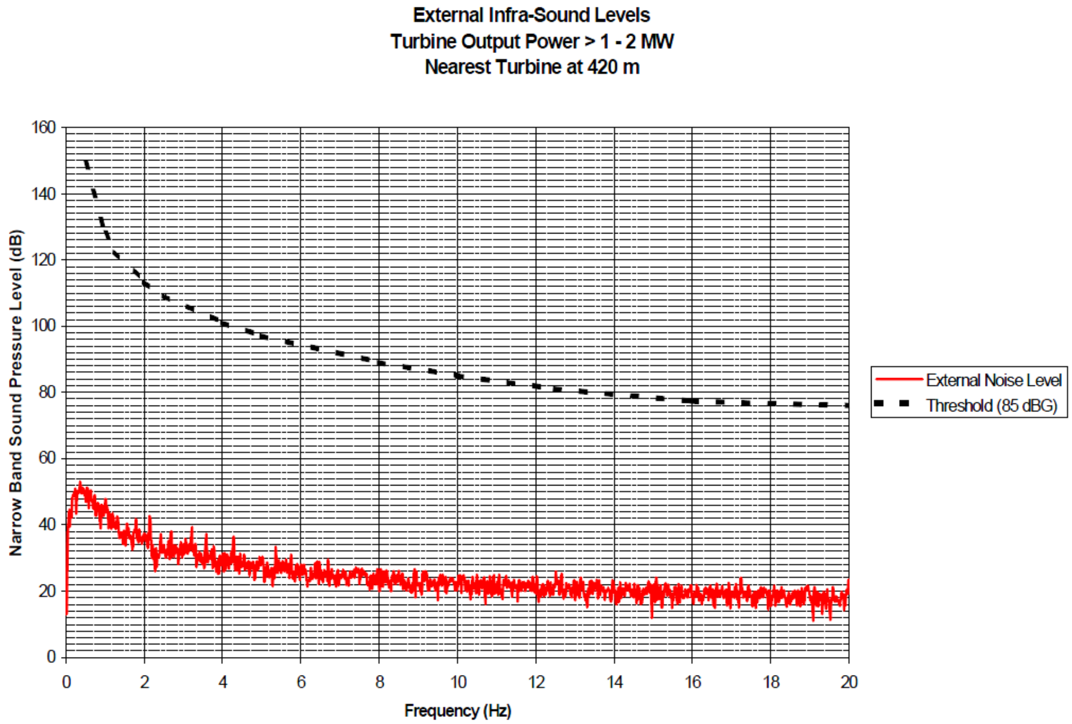
[5] Berglund, B., Hassmen, P., and Job, R. F. (1996). Sources and effects of low-frequency noise. *Journal of the Acoustical Society of America.* 99(5), (2985 -3002).

[6] UNSW.The University of New South Wales. dB: What is a decibel? (2005), Available at http://www.phys.unsw.edu.au/jw/dB.html.

[7] Available at http://www.envis.sk/storage/25McKenzie.pdf

Figure 1-3. Wind Turbine Noise Measurement Data



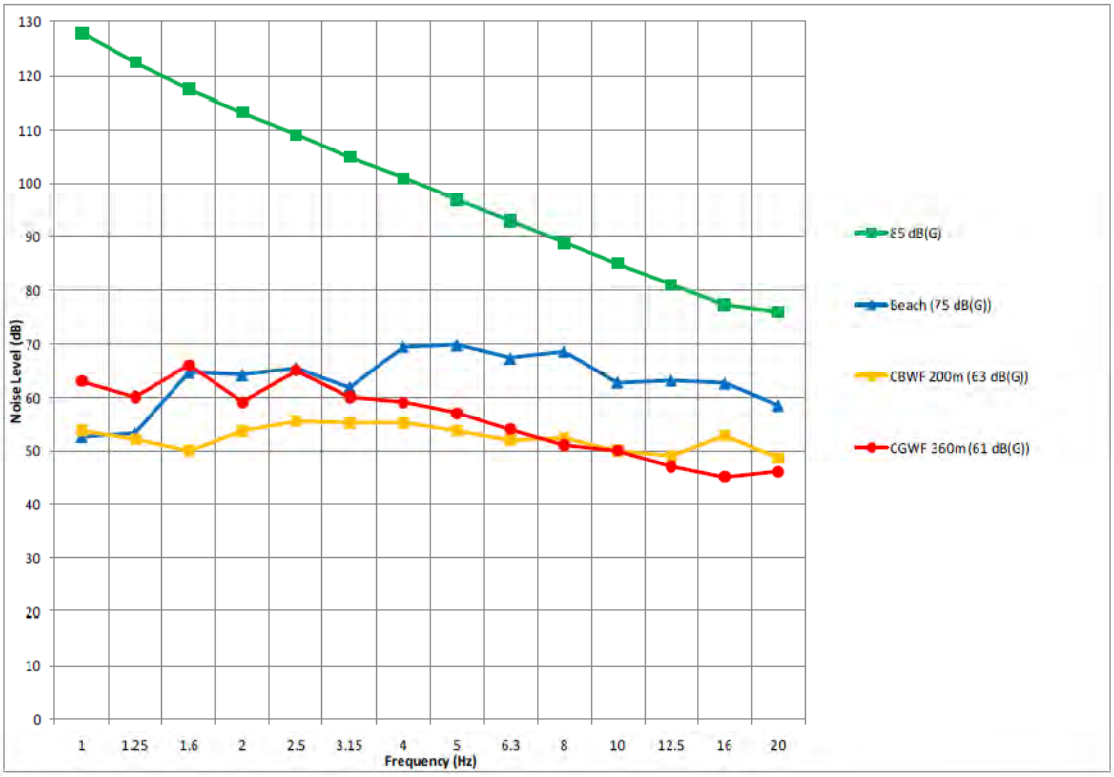
Data in Figure 1-3 above shows that infrasound from a 1-2 MW (megawatt) wind turbine operating approximately 420 m away from the receiver are well below the threshold for perception of infrasound.

Additionally these data are supported by measurement data reported in Australia by the consulting firm Sonus Pty, Ltd[8]. The graph (Figure 1-4) below by Sonus compares infrasound measurements at two operating wind farms, Clements Gap (CGWF – 61 dBG) and Cape Bridgewater) (CBWF – 63 dBG), with data measured at a beach in the absence of wind turbine noise. These three data sets are compared with the internationally recognized audibility threshold for infrasonic noise.

The Sonus measurement results indicate that the levels of infrasound in the vicinity of the two Australian wind farms are well below the audibility threshold of 85 dB(G) established by international research.[9] The measurement results are of the same order as that measured from a range of sources including a beach.

[8] Sonus Pty, Ltd. in "INFRASOUND MEASUREMENTS FROM WIND FARMS AND OTHER SOURCES" prepared for Pacific Hydro Pty Ltd, November 2010.
[9] Sonus Pty, Ltd. in "INFRASOUND MEASUREMENTS FROM WIND FARMS AND OTHER SOURCES" prepared for Pacific Hydro Pty Ltd, November 2010.

Figure 1-4. Infrasound Summary Results from Two Australian Wind Farms



Summary Graph – Infrasound measurement results from two Australian wind farms (Clements Gap at 61 dB(G) and Cape Bridgewater at 63 dB(G)) compared against measurement results at a beach (measured at 75 dB(G)) and the internationally recognised Audibility Threshold (85 dB(G))

Measurements of operating wind turbines published by Epsilon and Associates (Epsilon) also show that infrasonic sound emissions from modern upwind-configured wind turbines are below audibility thresholds for even the more sensitive people at a distance of 1,000 feet. The results of the Epsilon analysis and field testing indicate that there is no audible infrasound either outside or inside homes at the any of the measurement sites – the closest site was approximately 900 feet from a wind farm. Wind farms at distances beyond 1,000 feet meet the ANSI (American National Standards Institute) standard for low frequency noise in bedrooms, classrooms, and hospitals, and there should be no window rattles or perceptible vibration of lightweight walls or ceilings within homes. In homes there may be slightly audible low frequency noise (depending on other sources of low frequency noise); however, the levels are below criteria and recommendations for low frequency noise within homes. [10] The wind turbine types measured by Epsilon include the GE 1.5sle and Siemens SWT 2.3-93.

[10] Epsilon Associates, A Study of Low Frequency Noise and Infrasound from Wind Turbines, May 2009.

Inaudible sound is not generally assessed in analyses of environmental noise (because it cannot be heard), and there is limited merit in discussing an appropriate metric for inaudible sound in the context of an assessment of environmental noise caused by wind turbines.

Low frequency noise can be problematic if it occurs at very high levels or levels higher than what occurs from wind turbines. Mechanics who work on military aircraft are one example of the subset of the general population who might be routinely exposed to very high levels of low frequency noise. Excessive exposure to infrasound and low frequency noise (ILFN), which is defined as all acoustical phenomena occurring at or below the frequency bands of 500 Hz has been associated with a condition termed vibro-acoustic disease (VAD).), a thickening of cardiovascular structures, such as cardiac muscle and blood vessels.[11] Other examples of environments where the ILFN may reach levels and exposures that could lead to VAD include:

- Military, applications of infrasound as a non-lethal weapon;
- Work carried out in connection with the Apollo space program (i.e. levels equivalent to exposure of astronauts during blast off);
- Echocardiography of aerospace workers (i.e. those working around ground running aero engines); and
- Noise risks in military operations.

Levels of infrasound due to all of the above will have significant effects above 125 dB (linear).[12] The infrasound levels due to all of the above bear no connection to the sound produced by wind turbines.[13]

In summary, there is clear, consistent, and objective evidence that modern wind turbines emit very low levels of infrasonic and low frequency noise. The evidence also shows that these emissions are below the internationally recognized threshold for perception of infrasound. Furthermore, the Chief Medical Officer of Heath from Ontario, Canada stated: “There is no evidence of adverse health effects from infrasound below the sound pressure level of 90dB (Leventhall 2003 and 2006).[14]”

The appropriate metric to measure and assess audible wind turbine sound is dictated by the context of the measurements. In this instance, the applicable sound limits are the context for this discussion. Section 6951 of the San Diego County Zoning Ordinance requires that sound level limits of Title 3, Division 6, Chapter 4 of the San Diego County Code (Noise Abatement and Control) shall apply to large wind turbine systems. San Diego County Code of Regulatory Ordinances Section 36.403 Sound Level Measurement specifies that sound level measurements

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[11] Castelo Branco NAA, Alves-Pereira M. (2004) Vibroacoustic disease. *Noise & Health* 2004; 6(23): 3-20.
[12] Kryter, Karl D. The Effects of Noise on Man, Second Edition. Florida: Academic Press Inc., 1985
[13] Direct testimony of Dr. Geoff Leventhall on behalf of Wisconsin Electric Power Company, before the Public Service Commission of Wisconsin, E-docket number 6630-CE-302
[14] Chief Medical Officer of Health, “The Potential Health Impact of Wind Turbines,” May 2010.

"[…]shall be measured with a sound level meter using A-weighting and a "slow" response time, as these terms are used in ANSI S1.1-1994 or its latest revision.

Additionally the San Diego County General Plan Part VIII Noise Element states:

> "The most appropriate basic unit of measure for community noise is the A-weighted sound level, abbreviated dBA. This unit gives a lower weight to low and high frequency sounds in a manner similar to the relative lower efficiency of the ear at low or high frequencies."[15]
>
> In San Diego County, the appropriate metric for measuring audible wind turbine generated sound is the A-weighted decibels. This is consistent with the County Noise Element, local sound level limits[16] and post-construction sound level measurement procedures.[17] The A-weighting scale simulates the frequency response of the human ear to both high, mid and low frequency sounds.

2. *Please provide an explanation of the general level and amount of low frequency noise generated by wind turbines and how it compares to other noise sources. Please also respond to the comment that low frequency sound increases as the distance from wind turbines increases.*

Response: Post-construction noise monitoring requirements for wind turbines are fairly new in the United States, and therefore there is not an abundance of noise monitoring data available. A recent field study performed by Epsilon Associates (*A Study of Low Frequency Noise and Infrasound from Wind Turbines, July 2009*) contains a detailed discussion of measured low-frequency noise from wind turbines. The study measured infrasound and low frequency sound associated with two modern turbines, the GE 1.5sle and the Siemens 2.3-93. Using existing ANSI criteria for the evaluation of interior sound levels, Epsilon Associates determined that noise generated by wind farms at distances beyond 1,000 feet were below the low frequency noise criteria for bedrooms, classrooms and hospitals. In addition to meeting ANSI background noise criteria the measured interior noise levels also demonstrate that wind turbine setbacks of 1,000 feet will not cause "more than minimal annoyance (if any) from low frequency noise, and there should be no wind rattles or perceptible vibration of light-weight walls or ceilings within homes."

The overall noise level and spectrum of the GE 1.5-sle turbine is similar to the noise emissions of the GE 1.5 XLE, one of the turbines being considered for use in the Tule Wind Project. The Siemens 2.3-93 turbine, also used in the Epsilon study, has similar sound emissions, within +/- 3 dB, to the 2.0 MW and 3.0 MW turbines being considered for use in the Tule Wind Project. Current setbacks for the Tule Wind Project are more than 1,500 feet from the nearest non-participating home. Based on the Epsilon noise study, low frequency noise at a distance of

[15] San Diego County General Plan Part VIII Noise Element. GPA 06-008. 2006 September 27. Pg. VIII-6.
[16] San Diego County Code of Regulatory Ordinances Section 36.404.
[17] San Diego County Code of Regulatory Ordinances Section 36.403.

1,500 feet will have no audible infrasound and will meet ANSI S12.2 criteria for acceptable indoor levels for low frequency sound.

Infrasound and low frequency sound exposure is part of the everyday sound exposure. Natural sources of low frequency and infrasound include wind and moving bodies of water such as rivers and waterfalls. Common anthropogenic sources of low frequency and infrasound include vehicular traffic, aircraft, rail traffic, HVAC equipment and other industrial sources. Household appliances and everyday activities such as washing machines, running, swinging on a swing set, and swimming also produce low frequency sound and infrasound.

Additionally the infrasonic and low-frequency noise emissions from wind turbines are often less than levels emitted by natural sources like ocean waves crashing on a beach (crashing ocean waves often produce a roar that has a distinct low-frequency tonal component that is much louder than the noise emitted by a wind turbine).

The notion that sound pressure levels in any frequency range increase with increasing distance from the noise source is not a factual statement. Sound levels in all frequencies including low frequencies do not increase with increasing distance from the noise source. Sound pressure waves travel in all directions, and therefore lose energy with increasing distance from the noise source. Sound levels diminish as the sound propagates outward along the path from the source to the receiver; this divergence is independent of frequency.[18,19] A simple analogy is an unshaded light bulb; the amount of light diminishes with increasing distance from the bulb.

There are instances in which sound levels in a particular location would experience a slight increase in sound levels due to the presence of reflective surfaces. This does not mean that the low frequency increases with distances, but that reflective surfaces may cause localized increases in sound of all frequencies. This would be similar to placing a light bulb over a mirror, as some of the light would reflect upwards and may appear brighter. But there would never be an increase in the amount of light or energy as you move away from the source.

3. *Please provide an explanation regarding how the existing ambient sound levels were calculated for the project, including the standards and measurement procedures adhered to in collecting this data. Please provide a discussion of how short term events or background wind noises were considered in calculating existing ambient sound levels.*

Response: Existing noise levels were not calculated, they were measured directly using precision logging sound level meters and microphones. Measurement durations were 24 hours long at each measurement location. Data were continuously recorded and logged in the memory of the sound level meter for later download and analysis. Existing sound levels were analyzed in terms of 1-hour intervals, consistent with many state and federal agency standards (i.e., Federal Highway Administration, Federal Transit Administration, Federal Railroad Administration, Minnesota Pollution Control Agency, Illinois Pollution Control Board, etc.), as well as common

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[18] Anderson Grant S and Kurze Ulrich J. Outdoor Sound Propagation. in Noise and Vibration Control Engineering: Principles and Applications. Edited by Leo L. Neranek and Istvan L. Ver. 1992.
[19] Harris, Cyril M. Handbook of Acoustical Measurements and Noise Control. Third Ed. Acoustical Society of America. 1998.

practice for environmental noise measurements. In regard to the San Diego County regulations, the 1-hour measurement interval was required to compare existing sound levels against future sound levels due to the project.

The intent of the sound measurement was to *characterize the existing ambient sound environment*. Therefore, standardized measurement methods were chosen which have scope and purpose that are compatible with this intent. The applicable standards from the ANSI and ASTM International (formerly known as the American Society for Testing and Materials) are listed Table 3-1 by their designation, title, and a paraphrase of the purpose and scope that is applicable to the existing ambient sound measurement.

Table 3-1. Applicable Sound Measurement Standards for Existing Ambient Sound

ANSI S1.13	*Measurement of Sound Pressure Levels in Air*
A fundamental standard providing a uniform procedure for measuring sound pressure levels at a single point in space; it is applicable to a wide range of measurements indoors or outdoors.	
ANSI S12.9/Part 2	*Measurement of Environmental Sound. Part 2: Measurement of Long-Term, Wide-Area Sound*
Procedures to measure environmental sound levels for several purposes, including, "Assessment of the general community noise environment and establishment of baseline environmental noise levels." It includes procedures for spatial and temporal sampling.	
ASTM E1 014	*Measurement of Outdoor A-Weighted Sound Levels*
Procedures to measure and document sound pressure levels outdoors for several purposes, including, "Documentation of sound levels before the introduction of a new sound source (for example, assessment of the impact due to a proposed use)."	

The measurement of existing ambient sound levels for the Tule Wind Project followed applicable portions of the above measurement standards.

The measurement procedures above consider short-term sound events an inherent feature of the sound measurement, and do not exclude these sounds from the measurement. There are other measurement methods which address the exclusion of short-term and transient sound events in the environment. They are listed in Table 3-2 by designation, title, and a paraphrase of the purpose and scope.

The standards above are *not* intended to characterize the existing ambient sound levels. They are intended to measure the sound from a specific source. It is therefore inappropriate to use these methods to document the existing (pre-construction) acoustic environment. The sound sources of interest – the wind turbines – do not yet exist.

Table 3-2. Applicable Sound Measurement Standards for Short-Term and Transient Sound

ANSI S12.9/Part 3	*Measurement of Environmental Sound. Part 3: Short-Term Measurements with an Observer Present*
Procedures to measure sound from a specific source and to effectively eliminate the influence of extraneous background sounds from the specific source.	
ANSI S12.18	*Outdoor Measurement of Sound Pressure Level*
Procedures to measure sound from a specific source or sources and to account for environmental conditions with the purpose of obtaining reproducible sound pressure levels of the same sound source in different environmental conditions.	
ASTM E1780	*Measuring Outdoor Sound Received from a Nearby Fixed Source*
Procedures to measure sound from a specific source at a location in the vicinity of that same source, primarily for the purpose of comparing to criteria or regulatory limits.	

The standards ANSI S12.9/Part 3 and ANSI S12.18 both have procedures to remove the influence of extraneous background sounds. When measuring a specific sound source, it is impossible to separate the sound of the specific source of interest from the rest of the sounds in the environment. Therefore it is necessary to perform two measurements: one of the total sound (the source of interest combined with the remaining sounds in the background environment), and one of just the background sound (the sounds in the environment without the source of interest). Once this is accomplished, it is possible to mathematically derive the sound level of the specific sound source on its own, without the background environment. This can be an intricate process, because the background sound must be nearly identical in both measurements. If short-term or transient noise events occur in either the total sound measurement or the background sound measurement, the calculation will yield incorrect results. Therefore short term or transient events are excluded when measuring a specific sound source.

Measuring the existing ambient sound environment for the Tule Wind Project did not follow procedures of ANSI S12.18 described above. Despite the existence of a clause therein which allows for measurement of ambient sound measurements, the introduction states the procedures are primarily focused on measurements of specific sound sources, and the scope clause specifically precludes use of ANSI S12.18 for environmental assessment or planning for compatible land uses.

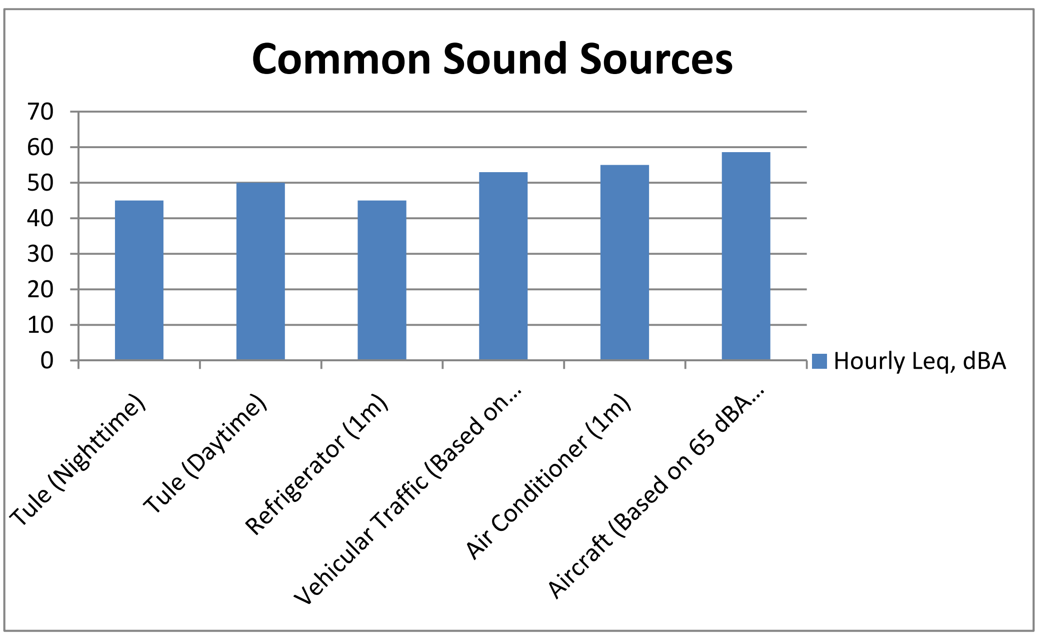
Short-term noise events that occurred during the measurement period are inherently integral to the existing ambient sound environment for the Tule Wind Project; therefore these sounds were included in the measurement results of the existing ambient sound environment, following applicable portions of standards ANSI S1.13 and ANSI S12.9/Part 2 and ASTM E1014. In other words, the analysis for the Tule Wind Project included short term events and background wind noises in its measurements of existing ambient sound levels.

4. *Please provide an explanation regarding the sound characteristics of wind turbine noise, including a discussion of how noise from wind turbines compares to noise generated from other sources at comparable sound levels (e.g. aircraft or road noise) and how noise from wind turbines compares to other sources in terms of annoyance. Please take into consideration the modulating character of wind turbine noise, the mix of tones from wind turbines and how they relate to the thresholds of perception, low frequency energy (both audible and inaudible) generated by wind turbines, and the effect of spacing between wind turbines.*

Response: Wind turbine sound is created by mechanical components and through aerodynamic generation. The dominant source of sound for modern turbines is the interaction of the rotating blades with the air called aerodynamic sound. Aerodynamic sound produced by wind turbines is broadband and contains: low and inaudible amounts of energy in the infrasonic range, low amounts of low frequency energy which may or may not be audible, and relatively higher levels of noise in the audible range of middle and high frequencies.[20]

Table 4-1 depicts various common noise sources in comparison to the sound design goals of the Tule Wind Project. As shown in Table 4-1, the sound design goals for the Tule Wind Project are 50 and 45 dBA, on an hourly Leq basis, for daytime and nighttime hours respectively. The sound level limits depicted apply to the property line of residential parcels. Sound levels of 45 and 50 dBA are comparable to common interior sound sources such as modern refrigerators.

Table 4-1. Common Noise Sources



[20] G.P. van den Berg. "The Beat is Getting Stronger: The Effect of Atmospheric Stability on Low Frequency Modulated Sound of Wind Turbines." Noise Notes Volume 4 Number 4.

In comparison to other exterior sound sources an hourly Leq of 45 dBA is relatively low. The San Diego County threshold of significance allows for a sound level exposure of up to 60 dBA CNEL or 53 dBA Leq for transportation related sources.[21] In comparison to the Tule Wind Project, vehicular traffic can be 3 to 8 dBA louder than wind turbine generated noise. Both vehicular traffic and aircraft overflight commonly approach or exceed 50 dBA Leq. Steady, low-volume traffic pass-by events exhibit a rhythmic rise and fall in volume. Ocean waves crashing on a beach also exhibit a rhythmic rise and fall in volume. In this manner noise from these events exhibits amplitude modulation, which by virtue of its nature is not intrinsically annoying or harmful to human health. Both traffic noise and ocean waves exhibit a mix of broadband, low frequency, and infrasonic noise emissions – which by virtue of its nature is also not intrinsically annoying or harmful to human health.

Wind turbines emit broad band noise. As the blades move closer and away from a stationary listener, the noise they emit gets louder and softer. This rhythmic increase and decrease in noise emissions is called amplitude modulation. The frequency content of amplitude modulated wind turbine noise typically occurs between 500 Hz and 1,000 Hz.[22]Certain persons believe that the amplitude modulated sound made by wind turbines makes their noise emissions more annoying than other environmental noises like highway traffic noise. However, as mentioned previously, noise which exhibits amplitude modulation is not considered to be annoying.

In fact, many people consider the rhythmic noise made by ocean waves to be desirable. Although noise from ocean waves is largely broadband, it also contains low-frequency noise and is a natural source of infrasound.

In one respect, differential spacing between wind turbines has the same effect as differential spacing between any other sound sources in that at certain distances the combination of lines of turbines will behave like a line-source. This effect is a matter of geometry, and these geometric attributes were included in the sound analysis for the Tule Wind Farm. In another respect, differential spacing between wind turbines may affect the amount of turbulence that downwind turbines may experience. Current state of the art acoustical analysis tools do not incorporate meteorological routines that would allow the assessment such inter-turbine turbulence. To ensure that the noise analysis does not understate the noise from the project due to the inability to account for such specific atmospheric effects, other, conservative assumptions were used in the noise analysis, including use of 100% acoustically reflective ground, modeling of the hot weather package (which includes additional noise from cooling equipment in the nacelle), continuously downwind conditions in all directions and the addition of 2 dBs to the manufacturer-stated sound emissions. Please refer to Response 7 of Data Request No. 14 for further details on inter-turbine turbulence.

[21] Estimated based on constant vehicular traffic
[22] Colby et al. Wind Turbine Sound and Health Effects – An Expert Panel Review. American Wind Energy Association. December 2009.

5. *Please provide an explanation of the relative level of annoyance resulting from low frequency sound as it compares to perceptible, audible sound. Please take into consideration the thresholds of perception for single pure tones as compared to tones generated by wind turbines and the relative sensitivity of individuals to audible and inaudible sound levels.*

Response: It is difficult to correlate inaudible sounds (in any frequency band) to perceptible, audible sounds because if a sound cannot be heard then its potential to annoy a person is very difficult to establish objectively. This is particularly true in the outdoor environment as opposed to in an audiology booth. We know that the low frequency and infrasonic energy in wind turbine noise has enough energy to impart a displacement upon a human skin of approximately ten microns (half the thickness of a strand of hair). We also know that heart beats, breathing, and normal movements displace the areas of the human body significantly more than ten microns.[23] In addition, the human body produces multiple sources of sound. Heart sounds are in the range of 27 to 35 dB at 20-40 Hz[24] and lung sounds are reported in the range of 5-35 dB at 150-600 Hz[25]. Therefore, it is difficult to accept the hypothesis that sound pressure levels from wind turbines in the inaudible portion of the acoustic spectrum have potential to annoy or impart adverse health effects in a direct exposure to outcome continuum.

The responses to question 1 established that low frequency and infrasonic content of wind turbine noise is below recognized thresholds of perception. There is anecdotal evidence that suggests that audible wind turbine noise is annoying to some people. However, the Chief Medical Officer of Health for Ontario Canada stated in a recent report, “The review concludes that while some people living near wind turbines report symptoms such as dizziness, headaches, and sleep disturbance, the scientific evidence available to date does not demonstrate a direct causal link between wind turbine noise and adverse health effects. The sound level from wind turbines at common residential setbacks is not sufficient to cause hearing impairment or other direct health effects, although some people may find it annoying”[26].

The suggestion that inaudible sound from wind turbines causes annoyance is largely unsupported by objective and factual data. There is no direct, causal link between inaudible sound from wind turbines and annoyance. Pure single tones, also referred to as prominent discrete tones, exhibit an increase of at least 5 dB from the adjacent octave bands. This makes them discernable as a tone, and they stand out from the overall acoustic environment and are by definition more distinctly audible. Common modern wind turbines do not emit prominent discrete tones[27,28,29].

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[23] Direct testimony of Dr. Geoff Leventhall on behalf of Wisconsin Electric Power Company, before the Public Service Commission of Wisconsin, E-docket number 6630-CE-302.
[24] Sakai, A., Feigen, L. P., and Luisada, A. A. (1971). Frequency distribution of the heart sounds in normal man. *Cardiovascular Research.* 5(3), (358 -363).
[25] Fiz, J. A., Gnitecki, J., Kraman, S. S., Wodicka, G. R., and Pasterkamp, H. (2008). Effect of body position on lung sounds in healthy young men. 133(3), (729 -736).
[26] Chief Medical Officer of Health, “The Potential Health Impact of Wind Turbines”, May 2010.
[27] Delta Test Report, “Measurement of Noise Emission from a Vestas V90 3 MW wind turbine “model 0””, December 10, 2009.
[28] General Electric, “Technical Documentation Wind Turbine Generator Systems GE 1.6xle - 50 Hz & 60 Hz”, 2009.

6. *Please provide an explanation of the methods used by HDR to measure sound generated by the wind turbines, including an explanation for the use of the dB(A) scale as a metric for determining noise impacts from wind turbines.*

Response: HDR has not measured sound emissions from wind turbines associated with the proposed project. The analysis results presented in the *Tule Wind Project – Draft Noise Analysis Report* represent calculated project-related sound levels. Project-related sound levels were calculated using Cadna-A, an acoustical analysis software package designed for evaluating environmental noise from stationary and mobile sources. Cadna-A is a three-dimensional noise model based on International Standards Organization (ISO) 9613, "Attenuation of Sound during Propagation Outdoors," adopted by the ISO in 1996. This standard provides a widely-accepted engineering method for the calculation of outdoor environmental noise levels from sources of known sound emission.

Several sound sources associated with project operations were modeled using Cadna-A including the project collector substation, wind turbine generators and a SODAR unit. The sound analysis evaluated noise impacts based on the maximum project build-out in terms of number of turbines. The maximum build-out for the project allows for up to 128 1.5 MW turbines. In the assessment of wind turbine-generated sound 128 Gamesa G87 2.0 MW turbines were modeled. If 2.0 MW turbines, such as the G87, were to be utilized, approximately 100 locations would be built versus the 128 locations modeled. Turbine locations and turbine types have not been finalized; therefore, all potential locations were analyzed. Actual noise impacts utilizing a 2.0 MW turbine would be less than modeled due to fewer turbines.

The sound analysis estimated project-related sound levels by incorporating a number of modeling techniques whose net effect conservatively over-estimated noise propagation in the project area. These techniques include assuming that the ground is 100% acoustically reflective, that the noise levels associated with the hot weather package (which includes additional noise from cooling equipment in the nacelle) were occurring all of the time, and other techniques as described in response to question 16 that conservatively over-estimate project related noise levels. Table 6-1 summarizes the conservative modeling assumptions and their effect on modeling results.

The net effect of these conservative assumptions shown in the table above is the over-estimation of project-related noise levels. As shown in Table 6-1, this noise analysis is reasonable, appropriate, and is more conservative than required by the standards of practice in the field of environmental acoustics.

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[29] Suzlon Energy A/S, "Sound Power Level S88-2.1MW", October 25, 2010.

Table 6-1. Modeling Assumptions and Influence on Calculated Sound Level

Modeling Assumption	Effect on Calculated Sound Level
Guaranteed sound level v. maximum manufacturer stated	+2 dB
Continuous use of hot weather package[1]	+ 2.6 dB
Reflective ground	+3 dB
Continuous downwind conditions for all directions[2]	≈ 0 to 2 dB
Use of 128 2.0 MW turbines vs. 128 1.5 MW turbines[3]	≈ 0 to 5 dB
Total effect on calculated sound level	7.6 to 14.6 dB

[1] Lower emission modes of the hot weather package would be used during nighttime hours as the mode modeled will only be used in temperature above 98° F.
[2] This results in the wind blowing in all directions continuously throughout an hour.
These are the most favorable propagation conditions (wind blows in all directions all the time).
[3]The Tule sound analysis modeled 2.0 MW turbines in a layout that is representative of maximum build-out with a 1.5 MW turbine (resulting in 28 additional turbines). If 1.5 MW turbines were modeled using the current layout, resulting sound levels would be up to 5 dB lower, based on the use of a GE 1.5 XLE turbine.

The A-weighting scale is a close approximation of the human response to different frequencies of sound and is in broad use across many disciplines which address noise. The A-weighting scale attenuates low-frequency noises in a manner that simulates how human ears attenuate low frequency noise at low levels (approximately 40 dB). The A-weighting scale is the most appropriate weighting scale for environmental acoustics analysis and to assess compliance with applicable noise limits. State and Federal agencies that regulate environmental noise throughout the United States rely on the A-weighted decibel, or dB(A) as the most appropriate metric for assessing human response to noise. Applicable noise rules in California also rely on the A-weighted decibel.

Section 6951 of the San Diego County Zoning Ordinance requires that sound level limits of Title 3, Division 6, Chapter 4 of the San Diego County Code (Noise Abatement and Control) shall apply to large wind turbine systems. San Diego County Code of Regulatory Ordinances Section 36.403 Sound Level Measurement specifies that sound level measurements "[…] shall be measured with a sound level meter using A-weighting and a "slow" response time, as these terms are used in ANSI S1.1-1994 or its latest revision.

Additionally the San Diego County General Plan Part VIII Noise Element states:

> "The most appropriate basic unit of measure for community noise is the A-weighted sound level, abbreviated dBA. This unit gives a lower weight to low and high frequency sounds in a manner similar to the relative lower efficiency of the ear at low or high frequencies."[30]

[30]San Diego County General Plan Part VIII Noise Element. GPA 06-008. 2006 September 27. Pg. VIII-6.

In San Diego County the appropriate metric for determining noise impacts from wind turbine generated sound is the A-weighted decibels. This is consistent with the County Noise Element, local sound level limits[31] and post-construction sound level measurement procedures.[32]

Please refer to Sections 1.3 and 3.1 of the *Tule Wind Project – Draft Noise Analysis Report* for further details concerning the modeling methodology and applicable regulations.

7. Please provide an explanation of how temperature inversion, uncharacteristic weather patterns, high wind shear above the boundary layer, periods of atmospheric turbulence (as it relates to turbines mounted on high locations with rough terrain), and inter-turbine turbulence resulting from inter-turbine spacing of less than 5 to 7 rotor diameters were addressed in the sound modeling.

Response: The noise analysis report prepared and submitted for this project explains the meteorological assumptions and features used in the Cadna-A noise model developed to calculate project-related noise. Events such as temperature inversions, uncharacteristic weather patterns, high wind shear above the boundary layer, periods of atmospheric turbulence, and inter-turbine turbulence typically last for short durations, sometimes very short durations. Current state of the art acoustical analysis tools do not incorporate meteorological routines that would allow the assessment of micro-climatology like inter-turbine turbulence, atmospheric turbulence and high wind shear above the boundary layer. Alternatively, conservative assumptions were used in the noise analysis, including use of 100% acoustically reflective ground, modeling of the hot weather package (which includes additional noise from cooling equipment in the nacelle), continuously downwind conditions in all directions and the addition of 2 decibels to the manufacturer-stated sound emissions. These assumptions ensure that the noise analysis does not understate noise from the project.

Temperature Inversions

Atmospheric conditions influence the propagation of sound; the main effect is refraction (a change in the direction of the sound waves) produced by vertical gradients of wind and temperature. Normally the temperature decreases steadily with increasing height above the ground. At night, the temperature sometimes decreases with decreasing height; this is called a temperature inversion. During an inversion, the sound waves that would normally travel upward and away from the noise source refracts (bends) downward. This causes noise levels at points away from the source to be louder than they would be under non-inversion conditions.[33]

[31] San Diego County Code of Regulatory Ordinances Section 36.404
[32] San Diego County Code of Regulatory Ordinances Section 36.403
[33] Page 3-12, “Handbook of Noise Control”, ed by Cyril M. Harris, second edition, 1979

The sound modeling performed for the Tule Wind Project represents sound levels that would be experienced under downwind propagation, or propagation under a "well-developed moderate ground-based temperature inversion, such as commonly occurs at night."[34]

Temperature inversions are most commonly caused by radiative cooling of the ground at night leading to cooling of the air in contact with the ground. Such conditions are especially prevalent on cloudless nights with little wind. If winds occurred at the ground level, the inversion layer would become mixed with the layers above it and the inversion would begin to disappear.

Temperature inversions occurring within the lowest 50 to 100 meters of atmosphere can affect noise levels measured on the ground. Such conditions may increase noise levels by focusing sound wave propagation paths at a single point. Conventional approaches to assessing noise propagation under temperature inversion conditions require knowledge of the temperature gradient and assume that the noise source is located below the temperature inversion, typically near the ground. In summary, when a layer of cool air is trapped at the ground surface (with a layer of warmer air above it) and the winds are still, the resulting temperature inversion is known to focus sound wave propagation paths (from noise sources operating in the layer of cold air, most often on the ground) at a single point on the ground.

The effect of temperature inversions on noise propagation from wind turbines is not typical of other sources. Wind turbines located on top of ridges are often located at elevations that are much higher than nearby receivers. In those circumstances it is unlikely that conventional temperature inversions in the lower 100 meters of the atmosphere would affect noise propagation from sources elevated as high as wind turbines on top of ridges. A further consideration must be that temperature inversion requires little to no wind in order to minimize atmospheric mixing and hence develop. During calm conditions the wind turbine generators are unlikely to operate, because the cut-in speed is approximately 3-4 m/s. [35]

In general, sound propagates best under stable conditions with a strong inversion, such as during a clear night with low winds. In those situations, sound levels from wind turbines would be at their lowest. Wind speeds under very stable conditions – Stability Class G – generally are too low to generate electricity, and thus, the wind turbines would produce little or no noise. As a result, worst-case conditions for wind turbines tend to be under more moderate nighttime inversions.[36]

Moderate nighttime inversions include periods when winds at the hub height are above the cut-in speed and ground-level winds are still, so that there is no masking noise from ground-level winds. These conditions are most likely to result in the highest levels of amplitude modulation, be most favorable to noise propagation, and therefore result in wind turbine noise being the most perceivable[37]. Post-construction noise measurements were performed during these conditions, at

[34] International Organization for Standardization (ISO). ISO 9613-2:1996. *Measurement of Environmental Sound. Part 2: Measurement of Long-Term, Wide-Area Sound.*
[35] Silverton Wind Farm Noise Impact Assessment, July 23, 2008, by Heggies Pty Ltd.
[36] Kenneth H. Kalinski, "Understanding Turbine Sound Impact Studies", North American Wind Power, May 2008.
[37] Resource Systems Engineering, "Response to Powers Trust Objection", November 3, 2009

both the Mars Hill and Stetson wind farms. Over 300 hours of measurement data was collected under these conditions. Analysis of that data confirmed that noise levels measured under these moderate nighttime inversion conditions were within 5 dBA of modeled noise levels[38].

Temperature inversions can be modeled using current acoustical software using conservative methods that overestimate noise levels (as was done for this project) and also more refined methods. A more refined method involves use of the CONCAWE routine in Cadna-A, which allows a modeler to simulate very specific meteorological conditions including individual stability classes and select wind speeds. Table 7-1 presents a comparison of analysis results of three different and increasingly stable temperature inversions. Using a single Gamesa G87 turbine, one of the proposed turbine types for the Tule Wind Project, a model was developed to compare the sound levels that may be experienced during a temperature inversion. A comparison of modeled sound levels using various atmospheric stability classes and the assumptions used in the Tule sound study is presented in Table 7-1 below.

Table 7-1. Comparison of Various Temperature Inversions

Receptor Distance	ISO 9613-2 (Model Used for Tule Sound Study)	CONCAWE[2,3]	
	No Wind Rose[1]	Stab. Class = E Wind = 4.5 m/s	Stab. Class = F Wind = 2.5 m/s
500 ft	58.1	53.0	44.2
1000 ft	52.2	49.0	40.2
1500 ft	48.4	46.0	37.2
2000 ft	45.6	43.6	34.8

[1]The Tule sound study utilized ISO 9613-2 with no wind rose. These parameters represent a “well-developed moderate ground-based temperature inversion, such as commonly occurs at night.”[39]
[2] meteorological corrections were applied to simulate inversions at various stability classes.
[3]Sound emissions used for CONCAWE calculations are relative to the operational wind speeds for each class. The turbine sound emissions in the CONCAWE models do not include 2.6 dB for warm-weather package noise. The periods in which these atmospheric stability classes are expected are cooler nighttime and early morning periods

Analysis results in Table 7-1 shows that the Tule noise analysis conservatively overestimates the project-related noise levels in a wide variety of atmospheric stability conditions, including strong inversions with low wind speeds. As shown in Table 7-1 the modeled results for ISO 9613-2 (that used for the Tule sound study) using no wind rose, are approximately 2 dB to 5 dB above the results for conditions consistent with stability class E, and approximately 11 dB to 16 dB above the results for conditions consistent with stability class F. This demonstrates that the modeling methods performed in the Tule noise analysis result in conservative over-estimates of project-related noise that are adequately representative of meteorological conditions that lead to

[38] Resource Systems Engineering, “Response to Powers Trust Objection”, November 3, 2009.
[39] International Organization for Standardization (ISO). ISO 9613-2:1996. *Measurement of Environmental Sound. Part 2: Measurement of Long-Term, Wide-Area Sound.*

the most efficient noise propagation. These conditions include strong temperature inversions with calm winds below the cut-in speed.

The noise analysis performed for the Tule Wind Project modeled a moderate inversion condition. The Tule noise analysis also added more than five decibels of conservatism. In this manner, the Tule noise analysis accounted for moderate inversions and conditions most favorable to noise propagation, when ground-level masking is at its lowest level, and turbine noise is most noticeable.

Uncharacteristic Weather Patterns

Uncharacteristic weather patterns means winds are blowing from a direction that they normally do not blow from. The primary effect of this condition is to reduce noise levels at upwind receivers and slightly increase noise levels at downwind receivers.[40] Even during these conditions, wind direction changes throughout each hour; therefore downwind noise levels will vary with fluctuations in wind direction. By comparison, the Tule noise analysis assumes that the wind blows in each direction for the entire duration of an hour. The result of this unrealistic meteorological condition is conservative over-estimates of project-related noise levels during uncharacteristic weather patterns.

High Wind Shear Above the Boundary Layer

Wind speeds generally increase with increasing height above the ground. Irregularities in features on the ground (buildings, terrain, trees and other vegetation) cause friction between the ground and winds closest to it. That friction slows down wind speeds in the atmospheric layer closest to the ground. Wind shear occurs where the lowest atmospheric layer meets a layer of the atmosphere above it that is not affected by surficial friction: wind shear is the boundary between the lower (slower) winds and the higher (faster) winds.

There is evidence that wind shear increases both the sound power emissions and the amplitude modulation from wind turbines. Wind shear is highest and exhibits the greatest difference between wind speeds at 10 meters and at 80 meters at low wind speeds. Wind shear reduces with increasing wind speed to the point where it is, on average, of a similar value as that used in IEC 61400-11 to define wind turbine sound power levels. The difference between wind speeds at 10 meters and 80 meters at low wind speeds is more predominant at night. Night time wind shear is, on average, higher than day time. There does not appear to be a large difference between average wind shear in summer and winter. The evidence suggests that shear in winter may be slightly higher but this may be due to the fact that there are longer nights when shear is higher. Wind shear on a flat site is significantly higher than that on a hilly site, even a hilly site with low rolling hills. The difference in wind speeds at 10 meters and 80 meters is also higher on a flat site. This is true at all times of day and all times of the year.[41]

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[40] Page 3-12, "Handbook of Noise Control", ed by Cyril M. Harris, second edition, 1979
[41] Dick Bowdler, "Wind Shear and its Effect on Noise Assessment", proceedings from the Third International Conference on Wind Turbine Noise, Aalborg, Denmark, June 2009.

While there is evidence to suggest that wind shear may increase the sound emissions, the effects are site specific and cannot be predicted with currently available data. Wind turbine sound emissions are measured using IEC 61400 Part 11. The wind turbine sound emission standard does not require the reporting of sound emissions under various wind shear conditions; therefore sound emissions for the proposed turbines, at various wind shear gradients is unavailable. Additionally it is infeasible to model noise results over all of the weather conditions and shear gradients that possibly could occur at a site. However, post-construction noise measurements performed at Mars Hill and Stetson indicate that when wind shear conditions exist, measured wind turbine noise levels are within five decibels of modeled results.[42] This reinforces the validity and conservatism of the Tule noise analysis.

There are also reports which claim that amplitude modulation may be affected by wind shear. Dr. Andy Moorhouse performed a study to determine the prevalence of amplitude modulation in wind farms in the UK and to identify the likely causes of amplitude modulation. Dr. Moorhouse summarizes his findings:

> *The literature review indicated that, although there has been much research into the general area of aerodynamic noise it is a highly complex field, and whilst general principles are understood there are still unanswered questions. Regarding the specific phenomenon of AM there has been little research and the causes are still the subject of debate. AM is not fully predictable at current state of the art. The survey of wind turbine manufacturers revealed that, although there was considerable interest, few have any experience of AM.*[43]

As stated by Dr. Moorehouse, there is no standard way to predict the occurrence of amplitude modulation, and there is no universally-agreed upon way to assess the potential for annoyance due to it. Therefore it is not possible to model it for the proposed Tule project. However, as demonstrated above, the Tule noise model conservatively over-estimates project-related noise levels.

Atmospheric Turbulence

Atmospheric turbulence causes inflow turbulent sound, meaning aeroacoustic noise is caused by the interaction of the atmosphere and the turbine blades. G.P. van den Berg defines inflow turbulent sound as being caused "Because of atmospheric turbulence there is a random movement of air superimposed on the average wind speed. The contribution of atmospheric turbulent to wind sound is named 'in-flow turbulence sound' and is broad band sound stretching over a wide frequency range."[44] A white paper prepared by the Renewable Energy Research

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[42] Resource Systems Engineering, "Response to Powers Trust Objection", November 3, 2009
[43] University of Salford. NANR233 "Research into aerodynamic modulation of wind turbine noise" Page 3 of 57, June 2007.
[44] G.P. van den Berg. "The Beat is Getting Stronger: The Effect of Atmospheric Stability on Low Frequency Modulated Sound of Wind Turbines." Noise Notes Volume 4 Number 4.

Laboratory cites that while inflow turbulence sound contributes to the broadband noise but is not yet fully quantified.[45] Therefore it is not possible to model it for the proposed Tule project.

The effects of atmospheric turbulence and the random micro-turbulence upon turbine blades will result in both increases and decreases in wind turbine noise emissions on a short-term, transient, instantaneous basis. Over a one-hour period, their net effect is unlikely to be dramatic. Atmospheric turbulence at the ground level will also create more masking noises at the ground level, making it harder to discern the turbine noise. The absence of atmospheric turbulence, and the random micro-turbulent winds that randomly interact with moving wind turbine blades is an ideal condition that does not occur in nature. These micro-turbulent winds occur whenever the wind blows; blades interact with these winds whenever they move through the air. On this basis it is reasonable to assume that reference sound power levels measured using IEC61400, and upon which the Tule sound analysis is based, already incorporate the influence of random micro-turbulent winds. As demonstrated above, the Tule noise model conservatively over-estimates project-related noise levels.

While atypical conditions such as those listed may temporarily increase sound levels, the sound analysis prepared for the Draft EIR/EIS prepared for the Tule Wind Project focused on conservatively over-estimating project-related sound levels that would be experienced on a daily basis.

The noise analyses performed for this project is consistent with the standards of practice in the field of environmental acoustics, and generally overstates the noise impacts. The analysis conservatively ignored ground absorption, and included an additional amount of conservatism added to the sound power level of each wind turbine. The analysis also conservatively assumed that the turbine was operating at its loudest rated sound power level condition for the entire duration of one hour. Additionally this analysis assumed that the most efficient propagation characteristics exist in all direction for the entire duration of one hour. These conservative measures are consistent with standard practice in the field of applied environmental acoustics and also help to ensure that wind turbine noise levels from the Project are not under-predicted.

Therefore, the noise analyses conducted for the Tule Wind Project meets the standard of practice in the field of environmental acoustics, provides a conservative assessment of the noise from the project, and adheres to the San Diego County Guidelines for Noise Impact Assessment.

Please refer to Responses 14, 15, and 16 of Data Request No. 14 for further details on wind turbine sound emission, amplitude modulation and noise modeling methodology.

8. It has been argued that the manufacturer's reported power levels for the wind turbines represents a standardized value assuming "typical" conditions of a neutral atmosphere with a moderate wind shear gradient; therefore, the manufacture's data does not represent worst-case conditions. Please respond.

[45] Rogers, et al. Wind Turbine Acoustic Noise. Renewable Energy Research Laboratory. January 2006.

Response: By virtue of their nature, sound power levels are intended to describe the sound emissions of a particular source in the absence of any specific environment; see Response 14 of Data Request No. 14 for further discussion on this. Based on over 300 hours of measurements performed by Epsilon Associates when wind turbine noise was most noticeable (when ground level winds were still and did not mask wind turbine noise), noise emissions from a modern 1.5 MW wind turbine are within ranges considered acceptable by state and federal agencies that regulate environmental noise. The analysis conducted by Epsilon Associates does represent "worst-case" conditions, such as when winds are still and noise from the wind turbine is not masked. It is infeasible to model noise results over all of the possible weather conditions and shear gradients that could occur. Additionally, the noise analysis included several conservative assumptions, including use of 100% acoustically reflective ground, modeling of the hot weather package (which includes additional noise from cooling equipment in the nacelle), continuously downwind conditions in all directions and the addition of 2 decibels to the manufacturer stated sound emissions. These assumptions ensure that the noise analysis does not understate noise from the project.

9. Please provide an explanation of the appropriate scale for measuring low frequency noise levels or infrasound, including a discussion of how using different scales (A-weighting, C-weighting, and Z-weighting) may affect the measurement of low frequency noise. Please provide an analysis of the low frequency noise generated by the wind turbines, using dB(C) weighted noise analysis. Also, please provide available sound power level data for frequencies below 63 Hz for the proposed wind turbines.

Response: This question exists in the context of an environmental noise analysis for a proposed wind turbine project. The sound analysis performed for the Tule Wind Project focuses on the potential effect of airborne sound and vibration on humans. Hence, the weighting scale used in the analysis, the A-weighting scale, is representative of human perception of sound. Existing requirements in San Diego County also rely on A-weighting for sound measurements and regulations. Please refer to Response 1 and 6 of Data Request No. 14 for further details on applicable regulations and use of the A-weighting scale. While there are weighting scales other than the A-weighting scale, which simulates human response to frequencies of sound, use of other weighting scales produces results that do not reflect how human ears respond to different frequencies of sound. Therefore they are not appropriate to use in the context of an environmental acoustics analysis performed to assess compliance with applicable noise limits. State, federal and local agencies that regulate environmental noise throughout the United States rely on the A-weighted decibel, or dB(A) as the most appropriate metric for assessing human response to noise. The San Diego County Noise Element also considers "the most appropriate basic unit of measure for community noise" to be the A-weighted sound level, abbreviated dBA. This unit gives a lower weight to low and high frequency sounds in a manner similar to the relative lower efficiency of the ear at low or high frequencies."[46]

The current sound study, *Tule Wind Project – Draft Noise Analysis Report*, dated February of 2011 provides an analysis of project related sound. The analysis includes an assessment of

[46]San Diego County General Plan Part VIII Noise Element. GPA 06-008. 2006 September 27. Pg. VIII-6.

project-related sound in comparison to existing noise requirements, on an A-weighted basis. Also included in the current sound analysis for informational purposes is the operational project-related sound level in dBC. Please refer to Tables 9 and 12 of the current sound study for additional details.

The A-weighting scale attenuates low-frequency noises in a manner that simulates how human ears attenuate low frequency noise. The C-weighting scale does not attenuate low frequencies as much as the A-weighting scale. The intent of the C-weighting scale is to simulate human perception at higher sound levels, in excess of 70 decibels. Use of C-weighting produce different sound analysis results than those already reported in units of A-weighted decibels. The difference between the A-weighted and C-weighted results are insignificant because it represents low level frequencies that humans do not hear well and the applicable noise limits are not expressed in C-weighted decibels.

Wind turbine sound emissions vary and are dependent on the rated power, turbine model, hub height, wind conditions, and other factors. The maximum sound emissions stated by the manufacturer for turbines considered for use on the Tule Wind Project vary from 104 dBA to 109 dBA. The Gamesa G87, the turbine with the greatest sound emissions, was used in the sound analysis to determine the potential for noise impact.

The sound power level used in the Tule Wind Project analysis is based on maximum operating conditions at 10 meters per second wind speeds, combined with noise from auxiliary fans to cool the nacelle in hot weather. Additionally, 2 decibels were added to each octave band to account for uncertainty. Table 9-1 presents the spectral sound power level data provided by Gamesa, the modeled turbine manufacturer, for frequencies 63 Hz and below.

Table 9-1. Spectral Noise Emissions Data – Gamesa G87

Sound Emissions	**Octave Bands, SWL (Hz)**	
	31.5	**63**
Manufacturer	81.8	90.2
Modeled	83.8	92.2

Please refer to Section 3.2 of the *Tule Wind Project – Draft Noise Analysis Report* for further details on sound emissions and modeling.

The Z-weighting scale is a linear scale that does not weight any of the frequencies: it is flat, linear, and unweighted. Low frequency sounds would appear relatively higher in Z-weighting than in A-weighting. In the context of an environmental noise assessment performed to assess the potential effect of airborne sound on humans and determine compliance with A-weighted noise limits, there is no merit to expressing project-related noise using Z-weighting. The

Z-weighting scale is not representative of the manner in which humans perceive low frequency sound; therefore it is inappropriate to use this scale to assess the potential effect of airborne sound on humans.

10. *Please provide a discussion of the sound and/or vibration effects that could result if two or more turbines are operating near each other, either "in sync" or "out of sync," including a discussion of the audible sound waves and low frequency sound waves that would be produced. Please also address the potential sound effects of the turbines in conjunction with proposed wind turbines in the area.*

Response: Combinations of sound waves "in sync" usually refers to what acousticians call coherent summation. This is applicable to sound only if the two sounds are received in perfect unison and are perfectly identical sound waves.[47] While important for engineering issues such as loudspeaker design, this is not applicable to environmental acoustics. First, the effects of coherent summation is very time and location specific. With a slight move a couple of feet over, or a small wind or temperature change, the coherent summation will become incoherent summation (out-of-sync). Furthermore the broadband sounds from two wind turbines are random noise created by turbulence[48] which *cannot* be summed coherently.[49] Therefore the Tule project is not anticipated to result in any exceedances of the applicable noise limits due to coherent summation effects.

11. *Please provide an explanation of how the American National Standards Institute's (ANSI) S12.9 and S12.18 procedures are applicable for measuring outdoor environmental sound in the case of the wind turbines as a ground based noise source and how they were considered in calculating sound levels resulting from the wind turbines. Please also comment on how these standards consider atypical operational conditions such as temperature inversion, uncharacteristic weather patterns, high wind shear above the boundary layer, and periods of atmospheric turbulence (as it relates to turbines mounted on high locations with rough terrain).*

Response: The standards in the ANSI S12.9 series are intended to provide guidance on measuring environmental sound sources and predicting community response based on sound exposure. The primary purpose of ANSI S12.18 is to measure environmental sound from a specific source and is most commonly used in compliance verification during post-construction. Neither standard provides guidance on calculating sound levels from wind turbines prior to construction; therefore neither standard was used to calculate sound levels resulting from project-related sound sources.

The noise measurements made for the Tule Wind Project were performed in accordance with recognized standards prior to construction measured the ambient acoustic environment before wind turbines were built and commenced operation. Therefore, the issue of ground-based noise sources lacks merit.

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[47] Kinsler, Lawrence E, et al. Fundamentals of Acoustics Fourth Ed. John Wiley and Sons, Inc. 2000.
[48] Thomas S. Brooks, Airfoil Self-noise and Prediction, NASA Reference Publication 1218 (1989) 15.
[49] Kinsler, Frey et. al. *Fundamentals of Acoustics.*

The intent of the sound measurement was to characterize the ambient sound environment. The results reflect all aspects of the existing ambient sound environment including the meteorological conditions present at the time of measurement. The measurement cannot characterize a sound source which isn't there, such as the proposed wind turbines.

The standardized measurement methods with scope and purpose clauses compatible with characterizing the ambient sound environment include ANSI S1.13, ANSI S12.9/Part 2, ASTM E1014, and ASTM E1503. The measurement methods employed for this assessment were consistent with these standards in whole or in part and were also consistent with several state and federal agency measurement methods and good engineering practice. For a discussion of calculated sound levels and uncharacteristic conditions, inversions, etc. please refer to the response to question 7. Please refer to response number 3 for further details on ANSI S12.9 and S12.18.

12. *Please provide an explanation of how the International Organization for Standardization (ISO) Standard 9613 (Part 2) is applicable for addressing the attenuation of outdoor environmental sound in the case of the wind turbines as a ground based noise source and how it was considered in calculating sound levels resulting from the wind turbines.*

Response: ISO 9613-2 (Attenuation of Sound during Propagation Outdoors) provides the internationally-recognized and accepted methods for calculating environmental noise levels including noise emissions from wind turbines. The Cadna-A software incorporates ISO 9613 in the propagation calculations. The ISO 9613 methods used by Cadna-A were endorsed by an independent working group of European acoustical consultants.[50] Additionally, post-construction studies performed by Andrew Bullmore[51] and Kenneth Kalinski[52] compared measured sound levels from wind farms with corresponding calculation models of the same wind farms. These comparisons showed that wind turbine sound levels modeled in CadnaA and utilizing the ISO 9613-2 calculation methods can achieve good correlation with the post-construction measurements, effectively validating the calculation for wind-turbine sound sources.

Please refer to Responses 13 and 16 of Data Request No. 14, as well as Section 1.3 and Appendix D of the *Tule Wind Project – Draft Noise Analysis Report* for further details on the modeling methodology and ISO 9613 Part 2.

13. *Please comment on the recently promoted algorithm by the Swedish EPA for modeling sound from wind turbines, which applies for both onshore and offshore turbines. The model apparently incorporates enhancements to the ISO Standard 9613 (Part 2) that addresses the specific characteristics of wind turbine sound emissions to propagate at a decay rate of 3dB per doubling of distance for distances of several hundred meters away from the turbine (as opposed to the 6dB decay rate in the ISO Standard).*

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[50] Bowdler et al., Prediction and Assessment of Wind Turbine Noise. Institute of Acoustics, *Acoustics Bulletin*. March / April 2009.
[51] Bullmore et al. "Wind Farm Noise Predictions and Comparison with Measurements". Third International Meeting on Wind Turbine Noise. June 2009.
[52] Kalinski, Kenneth and Eddie Duncan. "Propagation Modeling Parameters for Wind Power Projects". Sound & Vibration. December 2008.

Response: Sound is a physical phenomenon subject to the laws of physics. Therefore the Swedish EPA calculation for wind turbine sound levels is very similar to the calculation from ISO 9613-2. Several combined *attenuation* factors account for the "decay rate" as a function of distance: geometric divergence, atmospheric absorption, ground attenuation and meteorological effects. Both standards account for geometric divergence equally. Atmospheric absorption is accounted for in slightly different ways, but they will produce the same result for wind-turbine sound sources. The difference between the two standards is how they account for ground attenuation and meteorological effects.

Both standards, the ISO 9613-2 calculation and the Swedish calculation, are fundamentally based upon geometric divergence from a point source exhibiting a 6 dB "decay rate" per distance doubled. For atmospheric attenuation, the Swedish calculation makes a correction for atmospheric absorption. This correction is a device which mimics the atmospheric absorption calculation in ISO 9613-2 when calculating each octave-band frequency separately.

Ground attenuation and metrological effects are lumped into one calculation. This calculation for ISO 9613-2 is derived from empirical data, specifically field measurements of sound attenuation over soft ground. Where there is hard ground instead of soft ground, the ISO 9613-2 calculation institutes a broadband pressure doubling (which is approximately +3 dB). Ground attenuation and meteorological effects for the Swedish calculation assumes reflective ground, and also provides an adjustment for wind speed gradients using calculations from IEC 61400 Part 11. The effect of the ground attenuation and meteorological effects may increase or decrease sound levels from ISO 9613-2 to the Swedish calculation, depending upon the modeling parameters. Effects of different modeling parameters are far too variable to discuss in general terms.

For propagation over water the Swedish calculation uses another device to account for sound "skipping" over the water. After a certain distance it institutes a 3 dB decay rate with distance as opposed to the usual 6 dB rate. This is typically associated with sound propagation over water, and it is similar to certain underwater effects in the ocean due to temperature layers. This is only applicable to offshore wind-turbines, not the type of on shore turbines proposed for the Tule Wind Project.

Both standards, the ISO 9613-2 calculation and the Swedish calculation, will exhibit a 6 dB "decay rate" per distance doubled when calculating the geometric divergence for a single point source, such as a wind turbine. However, a number of point sources which span a large distance closely resemble a line source. So for certain areas a series of point sources will naturally exhibit the 3 dB decay rate of a line source. This will be true for any noise model which calculates the total sound due to all sources, including the Cadna-A model used for the noise analysis for the Tule Wind project.

Note that the Tule noise model decay rate (as a function of distance) was the result of geometric divergence, atmospheric attenuation, hard reflective ground, and the total sound due to all sources in the analysis, according to Cadna-A and the ISO 9613-2 calculations. Given the different modeling parameters, it is impossible to determine whether the results would have differed, either higher or lower, using the Swedish calculations. However, given the similarities in the models they would not be likely to be materially different. Furthermore there are several conservative assumptions built into the Tule noise model to avoid under-predicting noise levels, explained further in response 16, which are not part of the Swedish calculation. Therefore the calculated noise levels shown in HDR's noise report are conservatively high noise levels and the referenced Swedish standard is not relevant in the context of this analysis.

14. Please provide an explanation of how the International Electrotechnical Commission (IEC) Standard 614000 (Part 11) is applicable for measuring outdoor environmental sound in the case of the wind turbines as a ground based noise source and how it was considered in calculating sound levels resulting from the wind turbines. Please also comment on how this standard considers atypical operational conditions such as temperature inversion, uncharacteristic weather patterns, high wind shear above the boundary layer, and periods of atmospheric turbulence (as it relates to turbines mounted on high locations with rough terrain).

Response: The purpose of a sound power measurement is to quantify the noise emission characteristic of a sound source irrespective of its environment. This makes the resulting sound power level useful for predicting the effect of introducing the noise source into any environment. Using a forklift. as an arbitrary example of another sound source, the sound power measurement will enable an analyst to predict how introducing a new forklift will affect the sound level inside a warehouse. It also enables the analyst to predict how a new forklift will affect the sound levels in an outdoor truck yard, a distinctly different environment than an indoor warehouse. In the same respect, the IEC 61400 Part 11 measurement standard attempts to remove the influence of the particular environment so the results can be used to predict sound levels in other environments.

Wind turbines have different sound emission characteristics based upon its operating condition. For an example, a forklift has a different sound emission characteristic when driving than the sound emission characteristic when it is lifting. Therefore, the IEC 61400 Part 11 measurement standard states its results as a function of wind speed. Generally higher wind speeds cause the turbine to operate with higher noise emission levels; however, there is an upper limit to wind turbine noise emissions. At a certain wind speed, which is different for different turbines, the turbine will begin to regulate itself so it does not rotate any faster, there will be a maximum rotation speed even as wind speeds may increase. The results of the sound power measurement include all aspects of the wind turbine itself and are irrespective of uncharacteristic weather patterns, etc.

The noise analysis prepared for the EIR/EIS did not specifically simulate atypical operational conditions such as temperature inversions, uncharacteristic weather patterns, high wind shear above the boundary layer, and periods of atmospheric turbulence. The sound analysis conservatively estimated project-related sound levels that would be experienced on a daily basis and did not focus on the atypical operational conditions previously stated. Rather, the noise analysis incorporated a number of modeling techniques whose net effect conservatively over-estimated noise propagation in the project area. These techniques include assuming that the ground is 100% acoustically reflective, that the noise levels associated with the hot weather package, which includes additional noise from cooling equipment in the nacelle), were occurring all of the time, and other techniques as described in response to question 16 that conservatively over-estimate project related noise levels. Table 14-1 summarizes the conservative modeling assumptions and their effect on modeling results.

Table 14-1. Modeling Assumptions and Influence on Calculated Sound Level

Modeling Assumption	Effect on Calculated Sound Level
Guaranteed sound level v. maximum manufacturer stated	+2 dB
Continuous use of hot weather package[1]	+ 2.6 dB
Reflective ground	+3 dB
Continuous downwind conditions for all directions[2]	≈ 0 to 2 dB
Use of 128 2.0 MW turbines vs. 128 1.5 MW turbines[3]	≈ 0 to 5 dB
Total effect on calculated sound level	7.6 to 14.6 dB

[1] Lower emission modes of the hot weather package would be used during nighttime hours as the mode modeled will only be used in temperature above 98° F.
[2] This results in -the wind blowing in all directions continuously throughout an hour.
These are the most favorable propagation conditions (wind blows in all directions all the time).
[3]The Tule sound analysis modeled 2.0 MW turbines in a layout that is representative of maximum build-out with a 1.5 MW turbine (resulting in 28 additional turbines). If 1.5 MW turbines were modeled using the current layout, resulting sound levels would be up to 5 dB lower, based on the use of a GE 1.5 XLE turbine.

The net effect of these conservative assumptions show in the table above is the over-estimation of project-related noise levels. These over-estimates account for events like micrometeorological turbulence on the blades, turbine-to-turbine wake interaction, inversions, and other phenomena that potentially affects wind turbine noise generation and propagation. As shown in the table above, this noise analysis is reasonable, appropriate, and is more conservative than required by the standards of practice in the field of environmental acoustics.

Note that there are four cooling modes that may be utilized with the Gamesa G87 and Gamesa G90 turbine models. The cooling modes available with the hot weather package include two modes in which additional fans are operating allowing for use in hot weather climates. The relative increase in sound emissions for each cooling mode is summarized in Table 14-2 below, provided by Gamesa.

Table 14-2. Gamesa G87 and G90 Cooling Modes Sound Emission

Turbine Type	Increase in Sound Emission Level, dB			
	Mode 0	Mode 1	Mode 2	Mode 3
Gamesa G87	0	0	1.5	2.6
Gamesa G90	0	0	1.5	2.6

The operating mode is dependant of the ambient temperature and power generated conditions at a particular time. Mode 3 which provides the greatest sound emission was utilized in the sound analysis presented in the *Tule Wind Project – Draft Noise Analysis Report.* This mode represents a conservative operating assumption. The Tule noise model utilized the turbine operation mode with the highest noise emission characteristic provided by the manufacturer: the highest wind speed operation and the hot weather package. These conservative modeling decisions help ensure that the noise analysis does not under-predict project-related noise.

15. Please provide an explanation of the existence and potential effects of amplitude modulation (blade thumping) from wind turbines during periods of high turbulence or wind shear levels, both on outdoor and indoor sound levels in the vicinity of the turbines.

Response: Amplitude modulation refers to the rhythmic increase and decrease in wind turbine noise levels as the blades rotate closer to and away from a stationary listener. Blade thumping typically refers to amplitude modulation that occurs with a "greater than normal degree of regular fluctuation at blade passing frequency."[53] Several literature review and field studies concerning amplitude modulation have been performed but there is little consensus on the cause and prediction of amplitude modulation.

Dr. Andy Moorhouse performed a study to determine the prevalence of amplitude modulation in wind farms in the UK and to identify the likely causes of amplitude modulation. Dr. Moorhouse summarizes his findings:

> *"The literature review indicated that, although there has been much research into the general area of aerodynamic noise it is a highly complex field, and whilst general principles are understood there are still unanswered questions. Regarding the specific phenomenon of AM [amplitude modulation] there has been little research and the causes are still the subject of debate. AM [amplitude modulation] is not fully predictable at current state of the art."*[54]

While amplitude modulation in wind turbine sound can occur, it is not an issue at most locations. The study performed by Dr. Moorehouse determined that amplitude modulation was "considered to be a factor [in noise complaints] in four of the sites, and a possible factor in another eight [out of 127 wind farms surveyed]."[55] The results of the study show that very few wind farms in the UK had noise complaints resulting from amplitude modulation. Furthermore, the ability to predict the amount of amplitude modulation is still uncertain.

The sound of ocean waves on a beach also exhibit amplitude modulation as the waves travel through their cycle of approach, crashing on the beach, and receding. On that basis, amplitude

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[53] Moorhouse et al. "Research into Aerodynamic Modulation of Wind Turbine Noise: Final Report". July 2007. http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/files/file40570.pdf
[54] Moorhouse et al. "Research into Aerodynamic Modulation of Wind Turbine Noise: Final Report". July 2007. http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/files/file40570.pdf
[55] Moorhouse et al. "Research into Aerodynamic Modulation of Wind Turbine Noise: Final Report". July 2007. http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/files/file40570.pdf

modulation is not intrinsically harmful or unpleasant. During periods of high turbulence, amplitude modulation may be masked by the sound of turbulent winds. When ground-level winds are still and winds at the hub height are above cut-in speed (wind shear), amplitude modulation may be more noticeable to persons outdoors than when highly turbulent winds are present.

The results of Dr. Moorehouse's study of amplitude modulation from wind farms showed that "27 of the 133 wind farm sites operational across the UK at the time of the survey had attracted noise complaints at some point. An estimated total of 239 formal complaints have been received about UK wind farm sites since 1991, 152 of which were from a single site. The estimated total number of complainants is 81 over the same sixteen year period. This shows that in terms of the number of people affected, wind farm noise is a small-scale problem compared with other types of noise; for example the number of complaints about industrial noise exceeds those about wind farms by around three orders of magnitude. In only one case was the wind farm considered by the local authority to be causing a statutory nuisance. Again, this indicates that, despite press articles to the contrary, the incidence of wind farm noise and AM [amplitude modulation] in the UK is low. AM [amplitude modulation] was considered to be a factor in four of the sites, and a possible factor in another eight. Regarding the four sites, analysis of meteorological data suggests that the conditions for AM [amplitude modulation] would prevail between about 7% and 15% of the time. AM [amplitude modulation] would not therefore be present most days, although it could occur for several days running over some periods. Complaints have subsided for three out of these four sites, in one case as a result of remedial treatment in the form of a wind turbine control system. In the remaining case, which is a recent installation, investigations are ongoing. "

Studies and literature review done to date show that amplitude modulation can be reported in some noise complaints. There is no standard way to predict its occurrence, and there is no universally-agreed upon way to assess the potential for annoyance due to it. Therefore it is not possible and necessary to attempt to model it for the propose Tule project.

16. *Please provide an explanation of the tolerance assumed for instrumentation error. It has been argued that the HDR technical report included the 2 dB tolerance level associated with IEC Standard 614000 (Part 11) for measuring the sound power produced by wind turbines instead of the 3 dB tolerance applied by the ISO 9613-2 methodology. Please discuss the use of an appropriate tolerance and the potential effect of the calculation if the other method would have been used (if appropriate).*

Response: The sound power level used in the analysis is the manufacturer guaranteed sound emissions. The guaranteed sound emissions are based on IEC Standard 61400 Part 11 measurement methods. The guaranteed sound emissions, adds 2 dB to the manufacturer stated emission and is based on maximum operating conditions utilizing additional fans for hot weather conditions at 10 meters per second wind speeds. The use of guaranteed sound emissions is conservative, in that it assumes the wind turbines generate 2 dB more noise than manufacturer reports for the turbines.

A 3 dB correction to account for uncertainty in ISO 9613 Part 2 was accounted for through conservative assumptions concerning sound propagation utilized in other portions of the analysis. The use of conservative modeling assumptions results in more than 3 dB increase over less conservative methods; therefore, no additional corrections were applied. Table 16-1 summarizes the conservative modeling assumptions and their effect on modeling results.

Table 16-1. Modeling Assumptions and Influence on Calculated Sound Level

Modeling Assumption	Effect on Calculated Sound Level
Guaranteed sound level v. maximum manufacturer stated	+2 dB
Continuous use of hot weather package[1]	+ 2.6 dB
Reflective ground	+3 dB
Continuous downwind conditions for all directions[2]	≈ 0 to 2 dB
Use of 128 2.0 MW turbines vs. 128 1.5 MW turbines[3]	≈ 0 to 5 dB
Total effect on calculated sound level	7.6 to 14.6 dB

[1] Lower emission modes of the hot weather package would be used during nighttime hours as the mode modeled will only be used in temperature above 98° F.
[2] This results in -the wind blowing in all directions continuously throughout an hour.
These are the most favorable propagation conditions (wind blows in all directions all the time).
[3]The Tule sound analysis modeled 2.0 MW turbines in a layout that is representative of maximum build-out with a 1.5 MW turbine (resulting in 28 additional turbines). If 1.5 MW turbines were modeled using the current layout, resulting sound levels would be up to 5 dB lower, based on the use of a GE 1.5 XLE turbine.

For a detailed discussion of the hot weather package, meteorological assumptions and other modeling assumptions please refer to Responses 7 and 14 of Data Request No. 14.

Refer to Section 1.3 and Appendix D of the *Tule Wind Project – Draft Noise Analysis Report* for further details on the modeling methodology and ISO 9613 Part 2.

17. Please provide a detailed description of the noise controls that would be incorporated into the design of the proposed wind turbine facilities.

Response: Siting is the primary noise control method that is incorporated into the design of the proposed wind turbine facility. It is also important to note that modern turbines have made great strides in noise reduction technology from what was available in previous turbine generations. Technological advancements that have most contributed to reduced sound emissions from wind turbines include rotor placement, pitch-control rotors, low-noise gearboxes, use of insulated nacelles, vibration-isolated mechanical equipment and variable speed operation.

18. Please provide a graphic depicting the specific area(s) that would be impacted by nighttime construction noise.

Response: Nighttime construction is not currently planned therefore no impacts due to nighttime construction noise are anticipated. As discussed in Section B, Project Description, Tule Wind, LLC anticipates that construction activities would occur between 7 a.m. and 7 p.m., Monday through Saturday, but may involve extended hours as needed to complete certain construction activities. When construction would occur outside of the hours permitted by the County of San Diego, Tule Wind, LLC would follow established protocol and seek a variance from the County noise requirements consistent with County Code Section 36.423. Tule Wind, LLC would also provide advanced notice to property owners within 300 feet of planned activities. The advanced notice would include the start and completion dates of construction and the hours of construction. In addition, implementation of APM TULE NOI-4 would further minimize noise impacts associated with construction. If a variance from the construction hours of 7 a.m. to 7 p.m. cannot be obtained from the County, no construction will occur outside the normal hours of construction.

19. Please provide a graphic which identifies and labels the locations of the construction noise impacted boundary lines.

Response: Figures 3 and 4 (attached) depict the location of properties that would most likely be affected by sound from temporary roadway and transmission line construction activities if incorporation of BMPs and mitigation were not implemented. Underground utility construction, tower base construction, and batch plant operations are not anticipated to cause construction noise impacts at adjacent parcels; therefore, no graphic has been provided for these activities.

Roadway and transmission line construction activities have the potential to cause temporary impacts to six adjacent parcels. The adjacent property boundaries are in some instances as close as 18 feet from the construction buffer zone and will experience the highest noise levels from road construction and grading activities. However, with the incorporation of BMPs and mitigation measures identified in the noise report based on comments submitted to the CPUC incorporating the Modified Project Layout, construction sound levels at all adjacent property boundaries are anticipated to comply with Sections 36.409 and 36.410 of the San Diego County Noise Ordinance.

20. Please provide a graphic which identifies and labels the locations of the affected legally occupied properties and the locations where portable noise barriers would be required.

Response: Figures 3 and 4 (attached) depict the location of properties that would most likely be affected by sound from temporary roadway and transmission line construction activities if incorporation of BMPs and mitigation were not implemented. Mitigation will be provided at the highlighted parcels to will include a portable noise barrier. Exact height and length of each noise barrier will be determined upon final design. With the incorporation of BMPs and mitigation measures, the highest predicted construction noise level at an adjacent property boundary would be reduced from 94 dBA to 74 dBA Leq, one decibel below the sound level limit of 75 dBA Leq outlined in Section 36.409 of the San Diego County Noise Ordinance.

Field verification of legally occupied dwellings is pending; therefore it was conservatively assumed that all parcels are legal residential properties. Prior to construction, a noise report will be finalized to demonstrate compliance with the San Diego County Code of Regulatory Ordinances Section 36.409 and 36.410.

21. Please provide a noise evaluation for the proposed sonic detecting and ranging unit (SODAR). Provide quantitative data that determines whether this proposed noise generating unit complies with County Noise Ordinance, Section 36.404.

Response: The current sound study, *Tule Wind Project – Draft Noise Analysis Report*, dated February of 2011 provides an analysis of project related sound including the SODAR unit. The nearest residential property boundary is located approximately 4,500 feet from the proposed SODAR unit. The calculated noise contribution from the SODAR unit is less than 0 dBA on an hourly Leq basis at all residential property boundaries. This means that the sound levels from the SODAR experienced at residences are low enough that they fall below the reference pressure level used in calculating dB. Therefore, no noise impacts are predicted to occur due to SODAR noise.

Please refer to Section 3.2 and Appendix B of the draft sound study for additional details concerning the SODAR sound emissions and modeling.

22. Please provide a detailed response to the following comment received on the Draft EIR/EIS:

The concrete batch plant would be subject to the sound level limits within County Code Section 36.404 because it is not considered a temporary operation (e.g. it will operate for more than three months).

If the plant would be considered a potential long-term noise source, please provide an explanation of how this source would comply with County Noise Ordinance, Section 36.404.

Response: The concrete batch plant will only be used in the construction phase of the Tule Wind Project; therefore, is subject to sound level limits for construction activities as stated within County Code Section 36.409 and 36.410.

Please refer to Section 3.3 of the *Tule Wind Project – Draft Noise Analysis Report* for further details on batch plant operations.

23. *Please provide detailed responses to specific comments 1 through 19 as identified in the letter from Richard James of E-Coustic Solutions provided in Attachment B.*

23.1 E-Coustic Solutions Comment 1 (page 1)

Claim – Setbacks of less than 1.25 miles are inadequate

> *"First, setbacks, from property lines to the nearest turbine of less than 2 kilometers (1.25 miles) are clearly inadequate for most quiet rural communities. The presence of nearby will not mask or otherwise offset the noise from wind turbines."*

Response: E-Coustic Solution's comment that turbine setbacks less than 1.25 miles (6,600 feet) are inadequate is not supported by recognized scientific studies, sound modeling or measurement data. Additionally such claims conflict with current local wind turbine regulations. Section 6951 Part A of the San Diego County Zoning Ordinance requires setbacks of four times the height, or 1,968 feet, from property lines.[56]

A turbine setback distance does not guarantee a particular noise level at property lines. The level of project-related noise varies with the turbine layout, number of turbines, speed of the turbine blades, meteorological conditions, terrain and the distance of the listener from the turbine; therefore, a setback distance is inadequate to characterize the amount of project related noise at a property line. The San Diego County noise ordinance requires that operational noise comply with San Diego County Code of Regulatory Ordinances Section 36.404. Detailed noise modeling which accounts for turbine layout, number of total turbines and site specific terrain was performed for the Tule Wind Project in order to assess the project's noise emissions and compliance with San Diego County Code of Regulatory Ordinances Section 36.404.

E-Coustic Solution's comment that the presence of (nearby noise sources) will not mask or otherwise offset wind turbine noise is inconsistent with local noise assessment methods (masking occurs when noise from one source hides (or masks) the noise from a second source. In this context, wind-induced noise at ground level often has potential to mask or hide wind turbine noise). Current noise regulations in San Diego County including Significance Guideline 4.1.A and Section 36.404 of the San Diego County Code provide guidance on existing noise levels in relation to project related noise. When existing noise levels are below 60 dB CNEL, an increase of 10 dB over pre-existing conditions is allowed. In areas of greater noise exposure, an increase of 3 dB is allowed. The assessment methods utilized for the Tule Wind Project are consistent with current regulations in San Diego County. This means that the county guidelines already address circumstances where a proposed activity may introduce a new noise source into the acoustic environment; allowable incremental increases are identified. Background noise does not have to mask wind turbine noise the existing noise limits allow some new noise to be made.

Claim – Validity of submitted noise reports and documents

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[56] Calculation of minimum setback distance is based on a maximum turbine height of 492 feet. Actual setback distance is dependant on final turbine hub height and rotor diameter.

"The reports and documents submitted on behalf of the Project do not correctly or adequately describe the impact of the proposed project on the host community, or its residents whose homes and properties are close to the footprint of the project."

Response: Reports and documents submitted on behalf of the project applicant reflect measurements of modern upwind configured turbines and literature review of currently available scientific data. The measurement reports cited, including the Epsilon report, compare measurements of operating wind farms to established noise standards and metrics that are commonly accepted in the U.S. and that are designed to protect the environment.[57]

The white papers and other reports submitted, including "Wind Turbine Sound and Health Effects An Expert Panel Review." by the American Wind Energy Association (AWEA) and "The Potential Health Impact of Wind Turbines" from the Chief Medical Officer of Health, are based on literature reviews of scientific and medical databases.[58] Both AWEA and the Chief Medical Officer of Health cite current scientific and peer reviewed literature of wind turbine generated sound and low frequency sound. The cited reports all support the conclusion that there is no direct causal relationship between wind turbine sound and adverse health effects[59]as stated in the Tule Wind Project – Draft Noise Analysis Report.

Claim – Audible and inaudible wind turbine noise cause health effects

"People living at distance up to 1 mile from wind turbines on flat land and, for turbines located on ridges above the homes at distances of up to 2 miles are experiencing adverse health effects from sleep disturbance at night from audible turbine noise."

"Other aspects of wind turbine sound emissions, especially amplitude modulated infra and low frequency sounds that may not be reach the threshold of audibility are currently believed to be caused by vestibular disturbances from rapid modulations of the infra and low frequency sound."

Response: Several reviews of currently available scientific data have determined that there is no direct causal relationship between wind turbine generated sound and health effects. The Chief Medical Officer of Health of Ontario[60] recently performed a study focusing on the topic of wind turbine noise and health. The study concluded the following concerning wind turbines and health:

- While some people living near wind turbines report symptoms such as dizziness, headaches, and sleep disturbance, the scientific evidence available to date does not demonstrate a direct causal link between wind turbine noise and adverse health effects.

[57] Epsilon Associate, Inc. "A Study of Low Frequency Noise and Infrasound from Wind Turbines." July 2009.
[58] "Wind Turbine Sound and Health Effects An Expert Panel Review." American Wind Energy Association, Canadian Wind Energy Association. December 2009.
[59] "Wind Turbine Sound and Health Effects An Expert Panel Review." American Wind Energy Association, Canadian Wind Energy Association. December 2009.
[60] "The Potential Health Impact of Wind Turbines." Chief Medical Officer of Health Report. May 2010.

- The sound level from wind turbines at common residential setbacks is not sufficient to cause hearing impairment or other direct adverse health effects. However, some people might find it annoying. It has been suggested that annoyance may be a reaction to the characteristic “swishing” or fluctuating nature of wind turbine sound rather than to the intensity of sound.
- Low frequency sound and infrasound from current generation upwind model turbines are well below the pressure sound levels at which known health effects occur. Further, there is no scientific evidence to date that vibration from low frequency wind turbine noise causes adverse health effects.
- Community engagement at the outset of planning for wind turbines is important and may alleviate health concerns about wind farms.
- Concerns about fairness and equity may also influence attitudes towards wind farms and allegations about effects on health. These factors deserve greater attention in future developments.

23.2 E-Coustic Solutions Comment 2 (page 2)

Claim – Measurements used to collect background sound levels do not meet recognized standards.

Response: The E-Coustic Solutions comment reveals some confusion regarding when it is appropriate to use a background sound measurement and when to measure ambient sound. To clarify this issue, these two terms need to be defined. A discussion of when it is appropriate to exclude certain sounds from a measurement will follow.

San Diego County Code of Regulatory Ordinances Section 36.402, Clause (a) defines the ambient sound to be, “…the composite of existing noise from all sources at a given location and time.” This is a common definition of ambient noise or ambient sound[61], such as the definitions found in ANSI S1.1, ANSI S12.9, and ASTM C634. The same ordinance clause (in 36.402) continues, “Ambient noise is sometimes referred to as background noise.” This is sometimes a source of great confusion because background sound, in addition to often meaning ambient sound in casual conversation, also has its own precise meaning and use. Specifically, background sound includes all the *other* sounds which may interfere with the measurement of a *particular* individual sound source or group of sound sources. Background sound is defined in the same general standards ANSI S1.1, ANSI S12.9, and ASTM C634 as well as numerous national and international standards which deal with measurement of particular sound sources.

Background sound measurements normally occur during the course of measuring a particular sound source. It is impossible to separate the sound of the source of interest from the rest of the sounds in the environment. Therefore, it is necessary to perform two measurements: one of the total sound, and one of just the background sound. Once these two measurements are

[61] To add to the confusion, background sound is sometimes called background noise, and likewise ambient sound is sometimes called ambient noise. Noise is sound, there is no physical difference. Noise is just unwanted sound.

accomplished, it is possible to mathematically derive the sound level of the particular sound source on its own, effectively eliminating the influence of environmental and extraneous background sounds. This is a common definition of background sound, as defined in ANSI S1.1, ANSI S12.9, and ASTM C634, as well as numerous national and international standards which deal with measurement of particular sound sources. This can be a tricky process in uncontrolled outdoor environments, because the background sound must be nearly identical in both measurements. If short-term or transient noise events occur in either the total sound measurement or the background sound measurement, the calculation will yield incorrect results.

The E-Coustic Solutions comment suggests that the measurement should exclude or suppress certain short-term or transient sounds. While it is sometimes desirable and appropriate to suppress transient or short-term noise events in the context of measuring a particular sound source, measurements of the ambient noise environment to establish the environmental baseline should be all-inclusive of all sounds in the environment. In order to establish a valid baseline, the measurement should reflect the total sound exposure from the existing ambient environment.

The noise report for the project measured the actual sound of the existing ambient environment without artificially suppressing any sounds which occurred during the measurement period. The measurement method conformed to several ANSI and ASTM standards in whole or in part, as well as being consistent with many state and federal agency measurement methods, including the San Diego County noise regulations. Please refer to responses 2 and 11 of Data Request No. 14 for additional information.

23.3 E-Coustic Solutions Comment 3 (page 2)

Claim – Cadna-A model results understates impact

Response: Modeling methods used in the noise analysis for the Tule Wind Project are consistent with internationally-recognized and accepted methods for calculating environmental noise levels. The Cadna-A model developed for the Tule Wind Project utilizes modeling assumptions which best reflect measurements from operating wind farms. Post-construction studies performed by Andrew Bullmore[62] and Kenneth Kalinski[63] show that wind turbine sound levels modeled with ISO 9613:2 using no ground attenuation, or reflective ground, best fit or overstated monitored sound levels depending on the site and wind conditions. Please refer to responses 13 and 16 of Data Request No. 14 for additional information regarding ISO 9613 and the modeling assumptions.

Section 1.3 of the *Tule Wind Project – Draft Noise Analysis Report*, dated February 2011 also includes further details on the modeling methodology.

23.4 E-Coustic Solutions Comment 4 (page 2)

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[62] Bullmore et al. "Wind Farm Noise Predictions and Comparison with Measurements". Third International Meeting on Wind Turbine Noise. June 2009.
[63] Kalinski, Kenneth and Eddie Duncan. "Propagation Modeling Parameters for Wind Power Projects". Sound & Vibration. December 2008.

Claim – Information provided concerning health risks, infra and low frequency sound, noise limits, setbacks, background sound levels and computer modeling methods are incorrect, incomplete or otherwise misleading.

Response: Reports and documents submitted on behalf of the project applicant reflect measurements of modern upwind configured turbines and literature review of currently available scientific data. Please refer to response number 23.1 of Data Request No. 14 for further details on the materials cited in the *Tule Wind Project – Draft Noise Analysis Report,* dated February 2011.

23.5 E-Coustic Solutions Comment 5 (page 2)

Claim – Background sound study was inadequate

> *"Had the background studies met the procedural and protocol requirements of the American National Standards Institute's (ANSI)S 12.9 and S12.18 standards for measuring environmental sounds outdoors the study would have reported much lower background sound levels. The Project would have a 'significant impact' under CEQA Guidelines (Appendix G (VII))."*

Response: The measurement of the existing ambient noise environment conforms to the applicable portions of several standards and is consistent with the measurements associated with San Diego County noise regulations. Existing ambient noise measurement methods utilized in the noise analysis for the Tule Wind Project are consistent with several standards and practices including ANSI S1.13, ANSI S12.9/Part 2, ASTM E1014, ASTM E1503, several state and federal agency measurement methods, and good engineering practice. The study was adequate and appropriate, and consistent with the accepted industry standards.

Please refer to response number 23.2 of Data Request No. 14 for further information concerning the ambient noise measurement methods.

Claim – Had modeling properly addressed wind turbine emitted sound power predicted sound levels would have been higher.

Response: The noise analysis conducted for the Tule Wind Project used the best available data from wind turbine manufacturers to estimate project-related sound levels. Several conservative assumptions were utilized in the Tule sound model including the turbine operation mode with the highest noise emission characteristic, continuous downwind conditions, reflective ground coverage and the use of noise emissions representative of the hot weather package. The modeling was adequate and appropriate, and consistent with the accepted industry standards.

Please refer to responses 14 and 16 of Data Request No. 14 for further information concerning wind turbine noise emission measurement methods and the modeling methodology.

23.6 E-Coustic Solutions Comment 6 (pages 2-3)

Claim – Project noise levels would be in excess of standards and create a substantial permanent increase in ambient noise level if the background study and computer modeling had been performed according to the recommendation of E-Coustic Solutions

Response: E-Coustic Solution's proposed background noise study and modeling methods are inconsistent with current County regulations and best practices in the field of environmental acoustics. The measurement of the existing ambient noise environment conforms to applicable portions of several noise standards and is consistent with the measurements associated with San Diego County noise regulations. Existing ambient noise measurement methods utilized in the noise analysis for the Tule Wind Project are consistent with several standards and practices including ANSI S1.13, ANSI S12.9/Part 2, ASTM E1014, ASTM E1503, several state and federal agency measurement methods, and good engineering practice.

The San Diego County Code of Regulatory Ordinances Section 36.402, Clause (a) defines the ambient sound to be, "…the composite of existing noise from all sources at a given location and time." The same ordinance clause (in 36.402) continues, "Ambient noise is sometimes referred to as background noise." The measurement performed for the Tule Wind Project depicts ambient conditions including all existing sources. The use of a background sound level to represent existing conditions, as proposed by E-Coustic Solutions, is inconsistent with CEQA as the background sound level excludes existing noise sources that contribute to the ambient environment.

Furthermore the modeling methods used in the noise analysis for the Tule Wind Project are consistent with internationally-recognized and accepted methods for calculating environmental noise levels. The Cadna-A model developed for the Tule Wind Project utilizes modeling assumptions which best reflect measurements from operating wind farms. Please refer to Section 1.3 of the *Tule Wind Project – Draft Noise Analysis Report*, dated February 2011, for further details on the modeling methodology.

Please refer to response 23.2 of Data Request No. 14 for further details on the ambient noise measurement methodology and the background measurement proposed by E-Coustic Solutions, and to responses 13 and 16 for additional information regarding ISO 9613 and the modeling assumptions.

In summary, use of the methods advocated by E-Coustic Solutions would have resulted in different, inappropriate, and unrepresentative noise analysis results. Furthermore, the resulting inappropriate off-set distances would likely inhibit wind turbine developments in areas where high quality wind resources and access to transmission lines make wind turbine developments feasible.

23.7 E-Coustic Solutions Comment 7 (page 3)

Claim – Wind turbine noise will result in adverse health effects

Response: Several reviews of currently available scientific data have determined that there is no direct casual relationship between wind turbine generated sound and health effects. The sources cited by E-Coustic Solutions which support the claim that wind turbine noise will result in adverse health effects are not peer reviewed, do not support their claims with measurement data and do not qualify as valid epidemiological studies. Furthermore, Dr. Geoff Leventhall concluded that "a simple order of magnitude calculation, using basic physics of the level which will be known to a 16-year-old school pupil, shows that the movement of the diaphragm under the forces which might result from wind turbine noise is less than 10 microns. That is less than one hundredth of a millimeter or about one tenth of the average thickness of human hair. During normal breathing, the diaphragm moves several centimeters."[64] Clearly wind turbine noise would not cause adverse health effects to a human body.

Also, a review of the medical literature databases performed by Exponent, Inc. found no evidence of a causal link between exposure to wind turbine noise and adverse health effects. As of this review (by Exponent), there has not been a specific health condition documented in the peer reviewed published literature to be classified as a disease caused by exposure to sound levels and frequencies generated by the operation of wind turbines.[65] Please refer to responses 5, 23.1, and 24-26 of Data Request No. 14 for further information concerning wind turbine noise and health effects.

23.8 E-Coustic Solutions Comment 8 (page 3)

Claim – If the Project is approved as currently proposed there will be significant negative noise impacts.

> *"The result of these technical flaws along with an outdated understanding of how the human body responds to acoustical energy below the threshold of perception leads to a conclusion that if the Project, as proposed, is approved, it will, with a high degree of certainty, have negative noise impacts that are 'significant.'"*

Response: These specific claims are unsupported, and inconsistent with the norms of environmental acoustics and how noise is regulated as an environmental pollutant in the United States. In testimony during the Glacial Hills wind farm permit process, Dr. Geoff Leventhall testified that the forces on the human body resulting from exposure to low frequency and infrasonic noise produce a deflection of approximately 10 microns or about one tenth of the average thickness of human hair. Normal lung function (breathing) causes a deflection of more

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[64] Direct testimony of Dr. Geoff Leventhall on behalf of Wisconsin Electric Power Company, before the Public Service Commission of Wisconsin, E-docket number 6630-CE-302

[65] "Evaluation of the Scientific Literature on the Health Effects Associated with Wind Turbines and Low Frequency Sound", Exponent, Inc., October 20, 2009, and also in testimony by of Dr. Mark Roberts in Glacial Hills wind farm project in Wisconsin, Broad Mountain wind farm project in Pennsylvania, and Goodhue Wind project in Minnesota.

than a centimeter. Heart beats and normal body motions cause more deflection than ten microns and, therefore, the forces imparted upon a human body by exposure to wind turbine noise are meaningless.[66]

The *Tule Wind Project – Draft Noise Analysis Report* addressed all applicable noise considerations in relation to local regulation and CEQA including:

- Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of the other agencies.
- Exposure of persons to or generation of excessive ground borne vibration or ground borne noise levels.
- A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project.
- A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.

Upon final design, approval of project layout, and prior to construction, a sound study will be finalized to demonstrate compliance with the San Diego County Code of Regulatory Ordinances Section 36.409 and 36.410; therefore, no significant noise impacts due to operational noise are anticipated.

23.9 E-Coustic Solutions Comment 9 (page 3)

<u>Claim – Wind turbine utilities produce sound levels in excess of a 40 dBA limit provided by the World Health Organization for safe and healthful sleep.</u>

Response: E-Coustic Solutions comment does not recognize several important concepts associated with the World Health Organization's (WHO) nighttime noise recommended limit. First, the proposed project is subject to the noise limits enforced by the County; the WHO has no jurisdiction in California. Second, the referenced WHO noise limit is nothing more than a recommendation; it is not a regulatory limit; this concept is explicitly clear in the WHO document. Third, the referenced WHO noise limit is actually expressed as an annual average of all nighttime hours. In other words, it represents the hourly equivalent noise level (Leq) for each of the eight nighttime hours, averaged over all 365 days of the year. It is not, as E-Coustic Solutions erroneously implies, a one-hour noise limit. Therefore, statements that this proposed project will exceed the WHO nighttime exterior sound level recommendation are not factual.

E-Coustic Solution's claim that project-related sound levels will be in excess of WHO recommendations are not supported by modeling or site specific meteorological data. The modeling results presented in the *Tule Wind Project – Draft Noise Analysis Report* is representative of a single hour in which turbines operate at maximum noise emission. Project-

[66] Direct testimony of Dr. Geoff Leventhall on behalf of Wisconsin Electric Power Company, before the Public Service Commission of Wisconsin, E-docket number 6630-CE-302

related sound levels will be less than those shown in the noise analysis report during periods when wind speeds are below the cut-in speed. The proposed turbines do not operate at maximum noise emissions during all hours of every day and night in a year.

Claim – Project-related sound levels will result in "a high level of community complaints" stemming from sleeping disturbance and noise pollution.

Response: Annoyance is subjective and difficult to predict; therefore, it cannot be said with any degree of certainty that the project-related sound levels will result in a "high level of community complaints stemming from sleeping disturbance and noise pollution." Finding 33 of the San Diego County Noise Element discusses the topic of annoyance and the causes of annoyance:

> *"The degree of annoyance is closely related to both acoustical and non-acoustical factors. The former include the levels and durations and number of occurrences of identifiable noise events; the residual noise level; the variability of the noise levels; the time of day; and special factors related to the character of the information content of the noise. Non-acoustical factors include the particular activity disrupted, the attitude of those affected, and factors specific to particular sound sources, such as disagreements over barking dogs."*

As described in Finding 33 of the San Diego County Noise Element, aural sensitivity and attitudes toward a project or sound source will affect the level of annoyance experienced by an individual. Therefore, although it is possible that individuals may experience annoyance as a result of the Tule wind project, it is not a predictable outcome and the setbacks used for siting will serve to minimize the levels of noise as a source of potential annoyance.

Please refer to response to Data Request No. 14 response number 5 for additional information concerning annoyance.

Claim – Wind turbine sound will result in health effects

> *"In addition, there is mounting evidence that for the more sensitive members of the community, especially children under six, people with pre-existing medical conditions, particularly those with diseases of the vestibular system and other organs of balance and proprioception, and seniors with existing sleep problems will be likely to experience serious health risks."*

Response: Please refer to responses 5, 23.1, and 24-26 of Data Request No. 14 for further information concerning wind turbine noise and health effects.

23.10 E-Coustic Solutions Comment 10 (pages 6-7)

Response: ISO 9613-2 (Attenuation of Sound during Propagation Outdoors) provides the internationally-recognized and accepted methods for calculating environmental noise levels including noise emissions from wind turbines. The Cadna-A software incorporates ISO 9613 in the propagation calculations. The ISO 9613 methods used by Cadna-A were endorsed by an independent working group of European acoustical consultants.[67] Additionally, post-construction studies performed by Andrew Bullmore[68] and Kenneth Kalinski[69] compared measured sound levels from wind farms with corresponding calculation models of the same wind farms. These comparisons showed that wind turbine sound levels modeled in Cadna-A and utilizing the ISO 9613-2 calculation methods can achieve good correlation with the post-construction measurements, effectively validating the calculation for wind-turbine sound sources. See responses 12 and 23.3 of Data Request No. 14 for information regarding the ISO 9613-2 calculation method.

The comment from E-Coustic Solutions regarding blast waves is not applicable because blast waves are not sound waves; they exhibit some similar behaviors but they are fundamentally different and methods of calculating blast effects are likewise different. Wind turbine noise emissions are not comparable to blast waves.

See response 13 of Data Request No. 14 for information regarding the recent calculation method from the Swedish EPA. The E-Coustic Solutions comment is factually incorrect when it states that the calculation for sound propagation considers a decay rate of 3 dB per doubling of distance. Over land, propagation occurs at a decay rate of 6 dB per doubling of distance, just as the ISO 9613-2 calculation does. The Swedish method does implement a different propagation calculation for offshore wind turbines (that means wind turbine noise propagation over open water), which includes a device to propagate at 3 dB per doubling of distance, in addition to the standard propagation for point sources at 6 dB per doubling of distance. The installation of wind turbines in open water is not proposed as part of the Tule Wind Project. Therefore, the E-Coustic Solutions' reference to the Swedish EPA methods is incorrect, inapplicable, and inappropriate.

23.11 E-Coustic Solutions Comment 11 (pages 7-8)

<u>Claim – Using sound power levels measured according to the method in IEC 61400/Part 11 will under-predict sound levels during conditions of a nighttime stable atmosphere.</u>

Response: See response 14 of Data Request No. 14 for an explanation of the purpose and use of sound power levels. By virtue of their nature, sound power level data intentionally removed the effect of the listening environment to allow prediction of noise from the source under study in a variety of listening environments. The sound power data is intended to be irrespective of a particular environment, contrary to the suggestion of E-Coustic Solutions. This comment from E-Coustic Solutions is fundamentally misleading. The internationally-recognized way to establish a sound power level for a single wind turbine is through methods contained in IEC 61400. Use of a different measurement standard to establish the reference sound power level is inappropriate.

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[67] Bowdler et al., Prediction and Assessment of Wind Turbine Noise. Institute of Acoustics *Acoustics Bulletin*. March / April 2009.
[68] Bullmore et al. "Wind Farm Noise Predictions and Comparison with Measurements". Third International Meeting on Wind Turbine Noise. June 2009.
[69] Kalinski, Kenneth and Eddie Duncan. "Propagation Modeling Parameters for Wind Power Projects". Sound & Vibration. December 2008.

Use of that reference sound power level to assess wind turbine noise levels under different stability regimes is independent of the IEC 61400 method, because that is simply a measurement method and assessing wind turbine noise levels under different conditions requires modeling. That modeling should be based on ISO 9613. On this basis, this comment is misleading.

Furthermore, temperature inversions often form during stable nighttime conditions when ground-level wind speeds range from mild/calm to still (no wind). Normally, the temperature of the atmosphere gets colder as you move higher above the earth's surface. A temperature inversion is an atmospheric condition in which the atmospheric temperature increases with height above ground (cool air is trapped near the ground with warmer air above it). Temperature inversions are most commonly caused by radiative cooling of the ground at night leading to cooling of the air in contact with the ground. Such conditions are especially prevalent on cloudless nights with little wind. If winds occurred at the ground level, the inversion layer would become mixed with the layers above it and the inversion would begin to disappear.

During episodes of stable atmosphere, temperature inversions occurring within the lowest 50 to 100 meters of atmosphere can affect noise levels measured on the ground. Such conditions may increase noise levels by focusing sound wave propagation paths at a single point. Conventional approaches to assessing noise propagation under temperature inversion conditions require knowledge of the temperature gradient and assume that the noise source is located below the temperature inversion, typically near the ground. In summary, when a layer of cool air is trapped at the ground surface (with a layer of warmer air above it) and the winds are still, the resulting temperature inversion is known to focus sound wave propagation paths (from noise sources operating in the layer of cold air, most often on the ground) at a single point on the ground.

When the atmosphere is stable, the effect of temperature inversions on noise propagation from wind turbines is not typical of other sources. Wind turbines located on top of ridges are often located at elevations that are much higher than nearby receivers. In those circumstances it is unlikely that conventional temperature inversions in the lower 100 meters of the atmosphere would affect noise propagation from sources elevated as high as wind turbines on top of ridges. A further consideration must be that temperature inversions require little to no wind in order to minimize atmospheric mixing and hence develop. During calm conditions the wind turbine generators are unlikely to operate, because the cut-in speed is approximately 3-4 m/s. [70]

In general, sound propagates best under stable conditions with a strong inversion, such as during a clear night with low winds. In those situations, sound levels from wind turbines would be at their lowest. Wind speeds under very stable conditions—Stability Class G—generally are too low to generate electricity, and thus, the wind turbines would produce little or no noise because they would not be operating. As a result, worst-case conditions for wind turbines tend to be under more moderate nighttime inversions.[71]

Moderate nighttime inversions include periods when winds at the hub height are above the cut-in speed and ground-level winds are still; the still ground-level winds do not create any masking

[70] Silverton Wind Farm Noise Impact Assessment, July 23, 2008, by Heggies Pty Ltd.
[71] Kenneth H. Kalinski, "Understanding Turbine Sound Impact Studies", North American Wind Power, May 2008.

noise. These conditions are most likely to result in the highest levels of amplitude modulation, be most favorable to noise propagation, and wind turbine noise being the most perceivable[72]. Post-construction noise measurements were performed during these conditions, at both the Mars Hill and Stetson wind farms. Over 300 hours of measurement data was collected under these conditions. Analysis of that data confirmed that noise levels measured under these conditions were within 5 dBA of modeled noise levels[73]. The noise analysis performed for the Tule project modeled a moderate inversion condition. The Tule noise analysis also added more than 5 dBs of conservatism. In this manner, the Tule noise analysis accounted for moderate inversions and conditions most favorable to propagation, when ground-level masking is at its lowest level, and turbine noise is most noticeable.

Under an inversion there may be less wind-generated masking sound near the ground under the boundary layer. The noise levels are not necessarily louder during these environmental conditions, but they may be more perceivable in the absence of the masking effects of ground-level winds. Several other measures have been enacted in the sound propagation model to avoid under-predicting the sound levels. These are discussed in greater detail in response 16 of Data Request No. 14, and the *Tule Wind Project – Draft Noise Analysis Report*, dated February 2011 (Section 1.3 and Appendix D).

23.12 E-Coustic Solutions Comment 12 (pages 8-9)

<u>Claim – Modeling methods and assumptions should have included 3 dB to account for uncertainty in ISO 9613-2</u>

Response: Several measures of conservatism have been taken in the noise model to avoid under-predicting the sound levels at the receiver. A 3dB correction to account for uncertainty in ISO 9613 Part 2 was accounted for through other conservative assumptions used in the modeling. The use of conservative modeling assumptions results in more than 3 dB increase over less conservative methods; therefore, no additional corrections were applied.

Please refer to responses 7 and 16 of Data Request No. 14 for further details on the modeling methodology and assumptions.

23.13 E-Coustic Solutions Comment 13 (page 9)

<u>Claim – Predicted sound levels underestimate nighttime noise under stable atmospheric</u> conditions.

Response: E-Coustic Solutions does not support their claim with measurement data. As stated previously, during stable nighttime conditions, ground-level wind speeds range from mild/calm to still (no wind); often temperature inversions form. Normally, the temperature of the atmosphere gets colder as you move higher above the earth's surface. A temperature inversion is an atmospheric condition in which the atmospheric temperature increases with height above

[72] Resource Systems Engineering, "Response to Powers Trust Objection", November 3, 2009.
[73] Resource Systems Engineering, "Response to Powers Trust Objection", November 3, 2009.

ground (cool air is trapped near the ground with warmer air above it). Temperature inversions are most commonly caused by radiative cooling of the ground at night leading to cooling of the air in contact with the ground. Such conditions are especially prevalent on cloudless nights with little wind. If winds occurred at the ground level, the inversion layer would become mixed with the layers above it and the inversion would begin to disappear.

During episodes of stable atmosphere, temperature inversions occurring within the lowest 50 to 100 meters of atmosphere can affect noise levels measured on the ground. Such conditions may increase noise levels by focusing sound wave propagation paths at a single point. Conventional approaches to assessing noise propagation under temperature inversion conditions require knowledge of the temperature gradient and assume that the noise source is located below the temperature inversion, typically near the ground. In summary, when a layer of cool air is trapped at the ground surface (with a layer of warmer air above it) and the winds are still, the resulting temperature inversion is known to focus sound wave propagation paths (from noise sources operating in the layer of cold air, most often on the ground) at a single point on the ground.

When the atmosphere is stable, the effect of temperature inversions on noise propagation from wind turbines is not typical of other sources. Wind turbines located on top of ridges are often located at elevations that are much higher than nearby receivers. In those circumstances it is unlikely that conventional temperature inversions in the lower 100 meters of the atmosphere would affect noise propagation from sources elevated as high as wind turbines on top of ridges. A further consideration must be that temperature inversion require little to no wind in order to minimize atmospheric mixing and hence develop. During calm conditions the wind turbine generators are unlikely to operate, because the cut-in speed is approximately 3-4 m/s.[74]

In general, sound propagates best under stable conditions with a strong inversion, such as during a clear night with low winds. In those situations, sound levels from wind turbines would be at their lowest. Wind speeds under very stable conditions—Stability Class G—generally are too low to generate electricity, and thus, the wind turbines would produce little or no noise because they would not be operating. As a result, worst-case conditions for wind turbines tend to be under more moderate nighttime inversions.[75]

Moderate nighttime inversions include periods when winds at the hub height are above the cut-in speed and ground-level winds are still; the still ground-level winds do not create any masking noise. These conditions are most likely to result in the highest levels of amplitude modulation, be most favorable to noise propagation, and wind turbine noise being the most perceivable[76]. Post-construction noise measurements were performed during these conditions, at both the Mars Hill and Stetson wind farms. Over 300 hours of measurement data was collected under these conditions. Analysis of that data confirmed that noise levels measured under these conditions were within 5 dBA of modeled noise levels.[77] The noise analysis performed for the Tule project modeled a moderate inversion condition. The Tule noise analysis also added more than 5 dBs of

[74] Silverton Wind Farm Noise Impact Assessment, July 23, 2008, by Heggies Pty Ltd.
[75] Kenneth H. Kalinski, "Understanding Turbine Sound Impact Studies", North American Wind Power, May 2008.
[76] Resource Systems Engineering, "Response to Powers Trust Objection", November 3, 2009.
[77] Resource Systems Engineering, "Response to Powers Trust Objection", November 3, 2009.

conservatism. In this manner, the Tule noise analysis accounted for moderate inversions and conditions most favorable to propagation, when ground-level masking is at its lowest level, and turbine noise is most noticeable.

Please refer to responses 7 and 16 of Data Request No. 14 for further details on the modeling methodology and assumptions.

23.14 E-Coustic Solutions Comment 14 (page 9)

Response: The limits stated by E-Coustic Solutions for source heights mischaracterize the language that is actually in ISO 9613-2. Section 9 of the ISO Standard discusses the accuracy of calculations, and lists the accuracy according to certain geometric conditions in Table 5, therein. Table 5 from ISO 9613-2 is reproduced in the E-Coustic Solutions comment as Figure 12 on page 21. The data in Table 5 means that the standard can provide an estimate of accuracy within those heights based upon previous study, but that the standard does not provide an estimate of accuracy for heights and distances greater than listed in the table. The language in ISO 9613-2 *does not prohibit* using those calculations with source and receiver heights and distances greater than listed in the table. The calculations are based upon physical principles and are found in several standards and academic resources; they are not unique to this standard and its table of estimated accuracy.

Furthermore, E-Coustic Solutions seems to have misinterpreted the table of estimated accuracy by stating that it is limited to “noise sources that are no more than 30 meters above the receiving locations.” Actually, the height value is based upon a mean (average) of the source and receiver height, so for a receiver that is 2 meters high [6 feet] the table of accuracy values will still apply to sources that are 58 meters high [190 feet], because the mean height of the source and receiver is then 98 feet (30 meters). A wind turbine with a hub height of 80 meters will be far enough outside the parameters shown in the table to be unable to estimate the accuracy associated with the sound propagation, apart from saying that it will likely be greater than ±3 dB. But it is not as far outside the parameters as characterized by E-Coustic Solutions (the source height is about 35% higher than the table of estimated accuracy can account for, not 167% that E-Coustic Solutions stated).

For modeling wind turbines, the ISO 9613-2 methods used by Cadna-A were endorsed by an independent working group of European acoustical consultants.[78] Additionally, post-construction studies performed by Andrew Bullmore[79] and Kenneth Kalinski[80] compared measured sound levels from wind farms with corresponding calculation models of the same wind farms. These comparisons showed that wind turbine sound levels modeled in Cadna-A and utilizing the

[78] Bowdler et al., Prediction and Assessment of Wind Turbine Noise. Institute of Acoustics *Acoustics Bulletin*. March / April 2009.
[79] Bullmore et al. “Wind Farm Noise Predictions and Comparison with Measurements”. Third International Meeting on Wind Turbine Noise. June 2009.
[80] Kalinski, Kenneth and Eddie Duncan. “Propagation Modeling Parameters for Wind Power Projects”. Sound & Vibration. December 2008.

ISO 9613-2 calculation methods can achieve good correlation with the post-construction measurements when the modeling parameters are chosen appropriately.

In summary, the ISO 9613-2 standard can provide an estimate of accuracy for certain geometric parameters of the source and receiver (heights and distances). But it does not preclude the use of the calculations outside of these parameters. Wind turbines are outside these parameters and so may have a level of uncertainty greater than 3 dB, but wind turbines are not as far outside these parameters as E-Coustic Solutions implies. Additionally wind turbine models have been compared to field measurements with acceptable results as shown in the Kalinski study.[81]

Please refer to responses 12 and 23.3 of Data Request No. 14 for further details on the modeling methodology and post-construction monitoring.

The limits stated by E-Coustic Solutions for source heights and distances do not preclude the use of the calculations outside of these limits. The portions of the calculations used in the noise model for the Tule Wind Project are based upon physical principles and are found in several standards and academic resources. These limits are merely a statement of where there is a well-studied level of uncertainty, and these estimated levels of uncertainty may be applied when using all portions of the ISO 9613-2 calculations.

23.15 E-Coustic Solutions Comment 15 (pages 12-15)

Claim – Wind turbine sound causes annoyance at sound levels 10 dBA or more below the sound levels that would cause equivalent annoyance from other sources.

Response: Annoyance is subjective and influenced by aural sensitivity and attitudes toward a project. Please refer to response numbers 5 and 23.9 of Data Request No. 14 for additional information concerning annoyance.

Claim – IEC 61400-11 test procedures do not represent a "worst case" sound propagation condition.

Response: The noise study for the project used very conservative assumptions. This is discussed in greater detail in responses 7 and 8 of Data Request No. 14.

The sound power level measurement method described in IEC 61400-11 does not address propagation in any particular environment. The purpose of a sound power measurement is to quantify the noise emission characteristic of a sound source irrespective of its environment. This makes the resulting sound power level useful for predicting the effect of introducing the noise source into any environment. Sound propagation is addressed through the Cadna-A model.

The Cadna-A model developed for the Tule Wind Project utilizes modeling assumptions which best reflect measurements from operating wind farms. Post-construction studies show that wind

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[81] Kalinski, Kenneth and Eddie Duncan. "Propagation Modeling Parameters for Wind Power Projects". Sound & Vibration. December 2008.

turbine sound levels modeled with ISO 9613:2 using no ground attenuation best fit monitored sound levels. Additionally, conservative assumptions such as the use of the manufacturer guaranteed sound levels and modeling of the hot weather package were also used in the sound model developed for the Tule Wind Project. These modeling assumptions are all implemented with the goal to avoid under-predicting sound levels.

Please refer to response 14 of Data Request No. 14 for further details on IEC 61400-11.

<u>Claim – Amplitude modulated sound results in sound fluctuating 5 dBA or more</u>

Response: Wind turbines emit broad band noise with a spectral peak around 500 Hz. As the blades move closer and farther away from a stationary listener, the noise they emit gets louder and softer. This rhythmic increase and decrease in noise emissions is called amplitude modulation, and the amount of modulation varies according to proximity to the wind turbine. Sound from many sources exhibits amplitude modulation. Steady, low-volume traffic pass-by events exhibit a rhythmic rise and fall in volume. Ocean waves crashing on a beach also exhibit a rhythmic rise and fall in volume. In this manner noise from these events exhibit amplitude modulation, this by virtue of its nature is not intrinsically annoying or harmful to human health. In fact, many people consider the rhythmic noise made by ocean waves to be desirable.

Please refer to response number 4 of Data Request No. 14 for further details on the characteristics of wind turbine sound and amplitude modulation.

In addition, it should be noted that the E-Coustic study does not present site-specific data and does not appear to be based on any consideration of the Tule project's specific conditions. In fact, it appears to have been written for another project entirely (the Kent Breeze Project, which is mentioned on page 13 of the report).

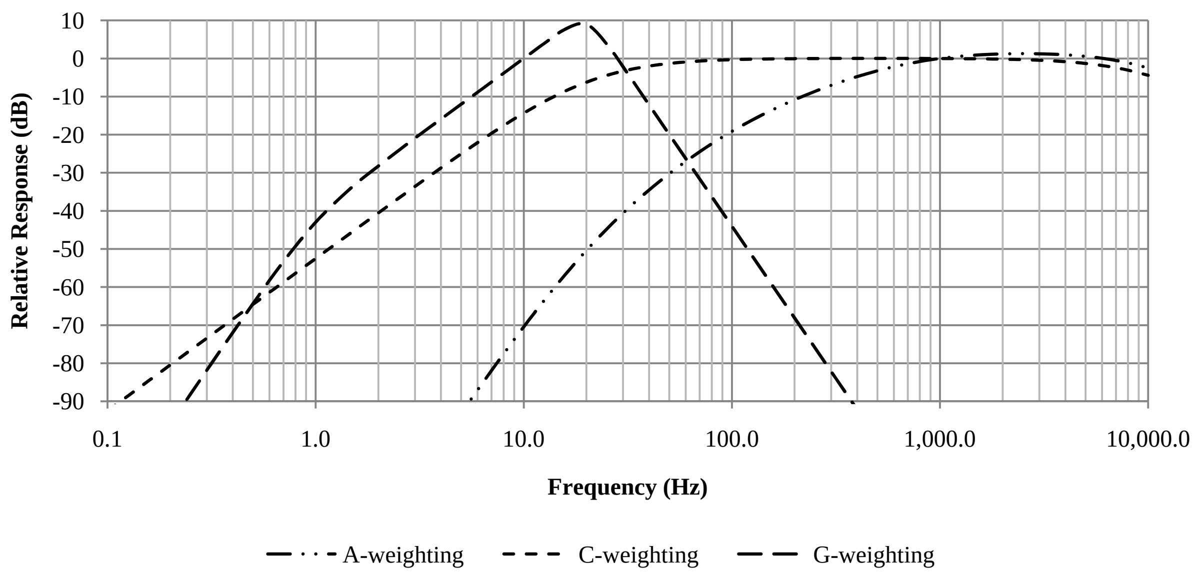
23.16 E-Coustic Solutions Comment 16 (pages 16-19)

<u>Claim – Low frequency sounds and infrasound should be measured using dBC and dBG, respectively</u>

Response: This question exists in the context of an environmental noise analysis for a proposed wind turbine project. Existing requirements in San Diego County rely on A-weighting for sound measurements and regulations. The A-weighting scale is a close approximation of the human response to different frequencies of sound and is in broad use across many disciplines which address noise. While there are weighting scales other than the A-weighting scale (which simulates human response to frequencies of sound), use of other weighting scales produces results that do not reflect how human ears respond to different frequencies of sound. Therefore, they are not appropriate to use in the context of an environmental acoustics analysis performed to assess compliance with applicable noise limits.

The A-weighting scale attenuates low-frequency noises in a manner that simulates how human ears attenuate low frequency noise at low levels (approximately 40 dB). The C-weighting scale does not attenuate low frequencies as much as the A-weighting scale because it simulates how humans perceive sound at higher levels (approximately 80 dB). Use of C-weighting produces different noise analysis results than those already reported in units of A-weighted dBs. The differences between the A-weighted and C-weighted results are not pertinent because sound levels at receptors will not reach levels as high as 80 dB due to the wind turbines.

The G-weighting scale emphasizes frequencies centered at 20 Hz; it begins to heavily discount the influence of frequencies above 40 Hz and below 5 Hz. A comparison of weighting scales is shown in the graph below.[82,83] In the context of an environmental noise assessment performed to assess compliance with A-weighted noise limits, there is no merit to expressing project-related noise using G-weighting.



Please refer to responses 1, 6 and 9 of Data Request No. 14 for further details on applicable regulations and use of the A-weighting scale.

<u>Claim – Infrasound from wind turbines will be audible for some people at levels lower than what is required for threshold of perception, based on a single pure tone</u>

Response: The science behind the perception of infrasound and minimum audible field for infrasound has been studied by the evaluation of pure tone and the presence of background noise. The threshold of perception found amongst studies is not consistent due to variability in study conditions and subjects. There is not consensus and very little data to evaluate the exact effect of background noise on the audibility of infrasound.

[82] ANSI S1.4-1983. American National Standard Specification for Sound Level Meters.
[83] ISO 7196:1995. Acoustics – Frequency-weighting characteristic for infrasound measurements.

This uncertainty is discussed by Moller and Pedersen below.

> *"Generally low-frequency and infrasonic sounds from everyday life are not pure tones alone, but rather combinations of different random noises and tonal components. It is however, impossible to make thresholds for all imaginable combinations of sounds that exist, and as seen above there is no final conclusion about possible higher or lower sensitivity to noise bands than to pure tones. Anyway, differences seem to be relatively modest, and the pure-tone threshold can with a reasonable approximation be used as a guideline for the thresholds also for nonsinusoidal sounds."*[84]

As stated by E-Coustic Solution the threshold for perception presented in the Watanbe and Pedersen study is based on pure tones; therefore, the threshold of audibility in the presence of other sounds will vary. The differences in the minimum audible field will be relatively modest and pure tone thresholds serve as a reasonable approximation.[85].

Measurements of operating wind turbines published by Epsilon and Associates[86] show that infrasonic sound emissions from modern upwind-configured wind turbines are below audibility thresholds for even the more sensitive people at a distance of 1,000 feet. Infrasound levels measured at a distance of 1,000 feet from GE 1.5 sle and Siemens SWT 2.3 wind turbine generators were more than 20 dBs below the median thresholds of hearing.

Please refer to responses 1 and 2 of Data Request No. 14 for further details on infrasound and low frequency sound.

<u>Claim – Statements that infrasound is not significant because it does not reach the amplitudes above the threshold of perception are mischaracterizing wind turbine infrasound</u>

Response: This is simply not true. The *Tule Wind Project – Draft Noise Analysis Report* addressed all applicable noise considerations and "significance" determinations in relation to local regulation and CEQA including:

- Exposure of person to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of the other agencies.
- Exposure of persons to or generation of excessive ground borne vibration or ground borne noise levels.
- A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project.
- A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.

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[84] Moller H. and Pedersen C.S. Hearing at low and infrasonic frequencies. Noise Health 2004;6:37-57.
[85] Moller H. and Pedersen C.S. Hearing at low and infrasonic frequencies. Noise Health 2004;6:37-57.
[86] Epsilon Associate, Inc. "A Study of Low Frequency Noise and Infrasound from Wind Turbines". July 2009.

Post-construction measurements show that the amount of low frequency sound and infrasound from wind turbines is modest and acceptable according to ANSI standards. Please refer to response 26 of Data Request No. 14 for further information on infrasound.

Claim – Infrasound and low frequency sound below the threshold of perception can cause health effects.

Response: Several reviews of currently available scientific data have determined that there is no direct casual relationship between wind turbine generated sound and health effects. A review of the medical literature databases performed by Exponent, Inc. found no evidence of a causal link between exposure to wind turbine noise and adverse health effects. As of this review (by Exponent), there has not been a specific health condition documented in the peer reviewed published literature to be classified as a disease caused by or associated with exposure to sound levels and frequencies generated by the operation of wind turbines.[87]

The Chief Medical Officer of Health of Ontario[88] recently performed a study focusing on the topic of wind turbine noise and health. The study also concluded the following concerning wind turbine and health:

- While some people living near wind turbines report symptoms such as dizziness, headaches, and sleep disturbance, the scientific evidence available to date does not demonstrate a direct causal link between wind turbine noise and adverse health effects.

- The sound level from wind turbines at common residential setbacks is not sufficient to cause hearing impairment or other direct adverse health effects. However, some people might find it annoying. It has been suggested that annoyance may be a reaction to the characteristic "swishing" or fluctuating nature of wind turbine sound rather than to the intensity of sound.

- Low frequency sound and infrasound from current generation upwind model turbines are well below the pressure sound levels at which known health effects occur. Further, there is no scientific evidence to date that vibration from low frequency wind turbine noise causes adverse health effects.

Please refer to responses 5, 23.1, 23.7, and 26 of Data Request No. 14 for further information concerning infrasound, low frequency sound, and health effects.

Claim – Dr. Nina Pierpont established a causal link between wind turbine infrasound and low frequency sound and medical pathologies

[87] "Evaluation of the Scientific Literature on the Health Effects Associated with Wind Turbines and Low Frequency Sound", Exponent, Inc., October 20, 2009, and also in testimony by of Dr. Mark Roberts in Glacial Hills wind farm project in Wisconsin, Broad Mountain wind farm project in Pennsylvania, and Goodhue Wind project in Minnesota.
[88] "The Potential Health Impact of Wind Turbines." Chief Medical Officer of Health Report. May 2010.

Response: While the work of Dr. Nina Pierpont intends to establish a causal link between wind turbine infrasound and low frequency sound and health effects, she fails to do so.

Association is not equal to causation. Researchers can find an association, also called a correlation, which is a relationship, negative or positive, between two or more variables. Often an association is identified through statistical inferences before a causal relationship is established. Historically, there have been careful clinical observations (e.g., case reports and series) that have stimulated a number of now-classic epidemiology research efforts that have identified important associations and ultimately the determinants of causal relationships. There have also been case reports identifying associations that did not hold up under epidemiological scrutiny, such as those associating blunt force trauma and cancer. For this reason, case studies cannot be used to determine causation. A causal association can only be established by the evaluation of well designed and executed epidemiologic studies.

A landmark discussion of the process of moving from a disease being associated with a risk factor to a point where the scientific community is comfortable attributing causation to a risk factor was put forth by Sir Austin Bradford Hill in 1965. It was during this time that a number of papers, including the Surgeon General Report issued in 1964, began to more formally delineate the scientific reasoning process that justifies a conclusion that observed associations between an exposure and a disease are the result of a causal relationship between the exposure and the disease. Key statements from scientists during that time include the following:

> "Disregarding then any such problem in semantics we have this situation. Our observations reveal *an association between two variables, perfectly clear-cut* and beyond what we would care to attribute to chance. What aspects of that association should we especially consider before deciding that the most likely interpretation of it is causation?" [italics added]. Hill's nine criteria for causation have been described in a number of ways. They are commonly referred to as strength, consistency, specificity, temporality, biological gradient, plausibility, coherence, experiment, and analogy[89].

Numerous reviews of Dr. Pierpont's research conclude that it fails to establish a causal link due to several reasons, including the fact that her samples were deliberately selected and their sizes were too small, as well as the fact that there was no control group[90]. Several reviews of currently available scientific data have determined that there is no direct casual relationship between wind turbine-generated sound and adverse health effects.

Please refer to responses 5, 23.1, 23.7, 23.16 and 26 of Data Request No. 14 for further information concerning infrasound, low frequency sound and health effects.

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[89] Hill AB. (1965). The Environment and Disease: Association or Causation? *Proc R Soc Med.* 58295 -300).
[90] Testimony of Dr. Mark Roberts to the Wisconsin Public Utilities Commission, docket number 6630-CE-302.

Claim – The research conducted by Dr. Nina Pierpont meets the standards of a peer reviewed epidemiological study.

> *"The type of epidemiological study conducted by Dr. Pierpont is termed a case-crossover study. […] Further the report was peer-reviewed by some of the top experts in the U.S. and Britain who have experience with vestibular disturbances and adverse health conditions."*

Response: The following components of the aforementioned comment are not true: "*epidemiological study conducted by Dr. Pierpont*" and *"the report was peer-reviewed"*. Dr. Pierpont's work was not an epidemiological study, but a series of case reports and it did not undergo the rigor of a peer review process which generally uses anonymity and employs a double-blind process whereby the authors and peer reviewers remain unknown or blinded to each other. Dr. Pierpont's peer review process appears to be among colleagues and friends and not a single- or double-blind process. She used nontraditional references such as newspaper articles and television interviews in support of her hypothesis. In rebuttal testimony to the Wisconsin Public Utilities Commission, Dr. Mark Roberts stated the following. "My assessment is that the material (Pierpont research) describing the phenomena does not appear to have been peer reviewed in a critical, blinded fashion in the same manner as the articles published in the leading medical journals. In addition, some of the references that I have seen cited are newspaper articles, TV interviews, and addresses before legislative bodies. Those are not traditional formats to present scientific data. It shortcuts the review process that is part of the scientific process of discovery."

Dr. Roberts also concluded the following:

1. "Wind Turbine Syndrome" is not a medical diagnosis supported by peer reviewed, published, scientific literature;

2. The materials presented to support "Wind Turbine Syndrome" are not of sufficient scientific quality nor have they received the rigorous scientific review and vetting that is customarily part of the peer review and publishing process;

3. The tried and true scientific method of developing a hypothesis, testing that hypothesis, publishing the results and having others attempt to repeat the research has not been done to test the existence of a health condition called "Wind Turbine Syndrome;"

4. An accumulation of anecdotal interviews with self-selected persons living near a wind turbine does not constitute an epidemiological study and is not sufficient to determine causation;

5. The bases for claimed adverse health effects due to wind turbines cited by Mr. James either cannot withstand scientific scrutiny or have nothing to do with wind turbines; and

6. Siting a wind turbine within view of a residence and the operation of that turbine could be a source of annoyance to those living in the residence[91]."

Claim – Health effects from wind turbine sound is plausible based on currently existing information

Response: Scientific evidence challenges the notion that adverse health effects from wind turbine sound is plausible. Dr. Pierpont claims that infrasound at 4-8 Hz enters the lungs and vibrates the diaphragm and its attached liver, passing confusing messages on to the visceral graviceptors. Dr. Pierpont gives no evidence to support this, but instead uses references to whole body vibration, applied to the feet or seat, which is a completely different excitation to that from sound. A simple order of magnitude calculation using basic physics, shows that the movement of the diaphragm under the forces which might result from wind turbine noise is less than 10 microns. That is less than one hundredth of a millimeter or about one tenth of the average thickness of human hair. During normal breathing, the diaphragm moves several centimeters.

Another part of Pierpont's hypothesis states that infrasound from wind turbines, at a frequency of 1-2 Hz, vibrates the chest, adding to the confusing signals which upset the balance system. However, there is already a strong source of infrasound inside the body. The human heart beats at 1-2 Hz, giving far greater magnitudes than might be produced by infrasound from wind turbines at these frequencies. The beating heart vibrates the surface of the body at a high enough level to be picked up by a stethoscope, or even the ear. The sound produced by wind turbines does not. [92]

Claim – Some people exposed to wind turbine sound are suffering psychological distress and other related harm which warrants the label "health effects" or "disease"

Response: There is not universal agreement that exposure to wind turbine sound causes adverse human health effects. The Chief Medical Officer of Ontario reviewed potential human health effects of wind turbines. The review concludes that while some people living near wind turbines report symptoms such as dizziness, headaches, and sleep disturbance, the scientific evidence available to date does not demonstrate a direct causal link between wind turbine noise and adverse health effects. Several reviews of currently available scientific data have determined that there is no direct casual relationship between wind turbine generated sound and health effects. Both Dr. Mark Roberts, MD, PhD and former State Epidemiologist for the Oklahoma State Department of Health[93] and Dr. Arlene King, the Chief Medical Officer for Ontario[94] concluded there is inadequate evidence to establish a causal link between exposure to wind turbine noise and adverse human health effects. Please refer to responses 5, 23.1, 23.7, 23.16, and 26 of Data Request No. 14 for further information concerning wind turbine generated sound and health effects.

[91] Testimony of Dr. Mark Roberts to the Wisconsin Public Utilities Commission, docket number 6630-CE-302.
[92] Testimony of Dr. Geoff Leventhall to the Wisconsin Public Utilities Commission, docket 6603-CE-302.
[93] Testimony of Dr. Mark Roberts to the Wisconsin Public Utilities Commission, docket number 6630-CE-302.
[94] "The Potential Health Impact of Wind Turbines." Chief Medical Officer of Health Report. May 2010.

Furthermore, a report, "Wind Turbine Sound and Health Effects: An Expert Panel Review", prepared by a multidisciplinary panel is of medical doctors, audiologists, and acoustical professionals from the United States, Canada, Denmark, and the United Kingdom stated that "there is no evidence that the audible or sub-audible sounds emitted by wind turbines have any direct adverse physiological effects". It was also determined that "the ground-borne vibrations from wind turbines are too weak to be detected by, or to affect, humans"[95]. The sound level from wind turbines at common residential setbacks is not sufficient to cause hearing impairment or other direct health effects, although some people may find it annoying. [96] This sentiment is echoed in the findings of an European Union financed study that released it final report, "WINDFARM perception: Visual and acoustic impact of wind turbine farms on residents" in 2008. It was stated that

> *"There is no indication that the sound from wind turbines had an effect on respondents' health, except for the interruption of sleep. At high levels of wind turbine sound (more than 45 dBA) interruption of sleep was more likely than at low levels. Higher levels of background sound from road traffic also increased the odds for interrupted sleep.*
>
> *Annoyance from wind turbine sound was related to difficulties with falling asleep and to higher stress scores. From this study it cannot be concluded whether these health effects are caused by annoyance or vice versa or whether both are related to another factor."*[97]

<u>Claim – "There is ample scientific evidence to conclude that wind turbines cause serious health problems for some people living nearby"</u>

Response: Several reviews of currently available scientific data have determined that there is no direct casual relationship between wind turbine generated sound and health effects. Please refer to responses 5, 23.1, 23.7, 23.16 and 26 of Data Request No. 14 for further information concerning wind turbine generated sound and health effects. Both Dr. Mark Roberts, MD, PhD and former State Epidemiologist for the Oklahoma State Department of Health[98] and Dr. Arlene King, the Chief Medical Officer for Ontario[99] concluded there is inadequate evidence to establish a causal link between exposure to wind turbine noise and adverse human health effects.

<u>Claim – "The reports that claim that there is no evidence of health effects are based on a very simplistic understanding of epidemiology and self-serving definitions of what does not count as evidence"</u>

Response: This statement is simply not true. Both Dr. Mark Roberts, MD, PhD and former State Epidemiologist for Oklahoma State Department of Health[100] and Dr. Arlene King, the

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[95] Wind Turbine Sound and Health Effects: An Expert Panel Review. Available at http://www.canwea.ca/pdf/talkwind/Wind_Turbine_Sound_and_Health_Effects.pdf.
[96] "The Potential Health Impact of Wind Turbines." Chief Medical Officer of Health Report. May 2010.
[97] WINDFARM perception: Visual and acoustic impact of wind turbine farms on residents. Available at http://www.windaction.org/?module=uploads&func=download&fileId=1615.
[98] Testimony of Dr. Mark Roberts to the Wisconsin Public Utilities Commission, docket number 6630-CE-302.
[99] "The Potential Health Impact of Wind Turbines." Chief Medical Officer of Health Report. May 2010.
[100] Testimony of Dr. Mark Roberts to the Wisconsin Public Utilities Commission, docket number 6630-CE-302.

Chief Medical Officer for Ontario[101] concluded there is inadequate evidence to establish a causal link between exposure to wind turbine noise and adverse human health effects[102].

Claim – Infrasound from wind turbines below the threshold of perception can affect the inner ear

Response: Several natural functions such as the heart beating, blood flowing, muscle vibrations and breathing cause infrasound and low frequency noise at low levels but do not cause adverse health effects and in fact are necessary to sustain human life. While evidence exists that infrasound below the threshold of perception can cause movement of the inner ear this does not establish a casual relationship between wind turbine sound and adverse health effects.

Claim – ASHRAE supports the claim that adverse health effects are related to inaudible low frequency and infrasound

Response: ASHRAE does concern itself with noise and vibration for indoor environments, primarily in regard to heating, ventilation and air-conditioning systems (HVAC). The design goals that ASHRAE recommends are aimed at providing comfort, speech privacy and speech intelligibility as appropriate to room uses. Studies of office noise such as the one cited by E-Coustic Solutions[103] are quite prevalent and many have found that audible sounds from poorly-designed HVAC systems affect the concentration, productivity and attitude of office workers. Furthermore, Geoff Leventhall had an opportunity to discuss the relevance of his research to wind turbines. That particular research of low-frequency “rumble” in HVAC noise was not applicable to wind turbines because the spectrum was dissimilar in frequency and in levels, and the findings indicated little effect due to low-frequency noise.[104]

The design goals that ASHRAE recommends are through either the RC Mark II rating system or the NC rating system. These rating systems consider high-frequency sounds, mid-frequency sounds and low-frequency sounds(the NC rating system was updated in 2008 to include low frequencies, contrary to the claim by E-Coustic Solutions[105]), but neither of these rating systems address infrasound. The recommended criteria, even for residential bedrooms, allow low-frequency noise at 60 dB or potentially higher in frequencies below 31.5 Hz.

Claim – Low-frequency components of wind turbine sound causes extraordinary effects inside buildings and causes effects upon an extraordinarily broad area.

Response: The specific effects of low-frequency sound which E-Coustic Solutions discusses are nothing more than phenomena that billions of people encounter every day in a built environment. These effects do not identify anything inherently problematic. The comment also mentions the

[101] “The Potential Health Impact of Wind Turbines.” Chief Medical Officer of Health Report. May 2010.
[102] Wind Turbine Sound and Health Effects: An Expert Panel Review. Available at http://www.canwea.ca/pdf/talkwind/Wind_Turbine_Sound_and_Health_Effects.pdf.
[103] K. Persson Waye, R. Rylander, S. Benton and H. G. Leventhall. Effects on performance and work quality due to low-frequency ventilation noise. Journal of Sound and Vibration, 1997.
[104] Testimony of Dr. Geoff Leventhall to the Wisconsin Public Utilities Commission, docket number 6630-CE-302.
[105] ANSI S12.2-2008 American National Standard Criteria for Evaluating Room Noise.

effect of distance upon sound levels (from a source which the author does not cite). The particular effect described seems to be once again a physical phenomenon that is not wind-turbine specific and is not inherently problematic. These statements of simple facts do not support any claim that wind turbine noise is intrinsically different than many other often-encountered noise sources.

23.18 E-Coustic Solutions Comment 18 (page 21)

Claim – Sound modeling should have included a 3 dB tolerance to account for the ISO-methodology

Response: A 3 dB correction to account for uncertainty in ISO 9613 Part 2 was implemented by applying conservative assumptions concerning sound propagation. The use of conservative modeling assumptions results in more than 3 dB increase over less conservative methods; therefore, no additional corrections were applied.

Please refer to responses 12 and16 of Data Request No. 14 for further details on ISO 9613-2, the modeling methodology and modeling assumptions.

Refer to Section 1.3 and Appendix D of the *Tule Wind Project – Draft Noise Analysis Report* (February 2011) for further details on the modeling methodology and ISO 9613 Part 2.

23.19 E-Coustic Solutions Comment 19 (page 21)

Response: E-Coustic Solutions' assertion that sound power levels are inappropriately used in this analysis is simply not true, and is potentially misleading. Sound power levels have been addressed in responses 14, 23.11 and 23.15 of Data Request No. 14. Standardized and repeatable measurements are desirable, not a deficiency.

PUBLIC HEALTH AND SAFETY

24. Please provide a discussion of the potential health effects resulting form two or more turbines operating near each other and causing repetitive, low frequency "periodic beats".

Response: G.P. van den Berg reported that often late in the afternoon or in the evening the turbine sound acquires a distinct 'beating' character, the rhythm of which is in agreement with the blade passing frequency.[106] He also notes that "It is not clear to what degree this fluctuating character determines the relatively high annoyance caused by wind turbine sound and to a deterioration of sleep quality." He continues to note that "wind turbine sound measurements are

[106] G.P. van den Berg, "The Beat is Getting Stronger: The Effect of Atmospheric Stability on Low Frequency Modulated Sound of Wind Turbines", in Noise Notes, volume 4, number 4.

easier when performed in a stable atmosphere, which agrees well with the night being the sensitive period for noise immission."[107]

However, post construction noise measurements performed at the Mars Hill and Stetson wind farms under the stable conditions that van den Berg recommends show that measured noise levels are within 5 dBA of modeled noise levels, and were also within acceptable ranges. The Tule noise analysis incorporated over 5 dBA of conservatism, and in that regard adequately assessed project-related noise levels. Furthermore, the actual force upon a body created by the infrasonic and low frequency noise emissions from operating wind turbines creates a displacement of approximately 10 microns, or one-tenth the thickness of the average human hair. Normal breathing, heart beats, and body motions produce larger displacements than 10 microns and do not cause adverse health effects[108]. For this reason, there is limited potential for adverse human health effects due to the operation of wind turbines.

25. *Please provide an explanation of the studies considered and addressed to evaluate potential health effects from low frequency noise.*

Response: Long-term exposure to very high levels of low frequency noise has been shown to have adverse effects on health. It has been demonstrated that high levels of low frequency noise can excite body vibrations, such as a chest resonance vibration that can occur at a frequency of 50 Hz to 80 Hz[109]. These chest wall and body hair vibrations have also been shown to occur at the infrasonic range[110,111]. However, in those instances, levels were significantly higher than the amounts of low frequency noise emitted by wind turbines. Studied health effects of low frequency sound include vibroacoustic disease which has been linked to prolonged exposure to high intensity low frequency noise, in excess of 110 dB, not low intensity low frequency noise[112,113,114]. Additionally studies have found that there is no evidence of adverse health effects related to low intensity low frequency noise, below 90 dB.[115] Low frequency sound and infrasound associated with wind turbines are well below 90 dB. Other studies have explored the effects of acoustic excitation by measuring the resulting vibration, non-aural effects and the perception of unpleasantness or annoyance among those exposed to low frequency noise including the following:

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[107] G.P. van den Berg, "The Beat is Getting Stronger: The Effect of Atmospheric Stability on Low Frequency Modulated Sound of Wind Turbines", in Noise Notes, volume 4, number 4.
[108] Testimony of Dr. Geoff Leventhall to the Wisconsin Public Utilities Commission, docket 6603-CE-302.
[109] Leventhall, G. (2007). What is infrasound? 93(1-3), (130 -137).
[110] Mohr G.C., Cole J.N., Guild E., and Gierke von, H. E. (1965). Effects of Low Frequency and Infrasonic Noises on Man. 36.817 -827).
[111] Schust, M. (2004). Effects of low frequency noise up to 100 Hz. *Noise and Health.* 6(23), (73 -85).
[112] Castelo Branco N.A.A. and Rodriguez E. (1999). The Vibroacoustic Disease - An Emerging Pathology. *Aviation Space & Environmental Medicine.* 70(3,Pt2), (A1 -A6).
[113] Takahashi, Y., Yonekawa, Y., and Kanada, K. (2001). A new approach to assess low frequency noise in the working environment. *Industrial Health.* 39(3), (281 -286).
[114] Maschke, C. (2004). Introduction to the special issue on low frequency noise. *Noise and Health.* 6(23), (1 -2).
[115] "Wind Turbine Noise Issues." Renewable Energy Research Laboratory; University of Massachusetts. 2006.

- Berglund, B., Hassmen, P., and Job, R. F. (1996). Sources and effects of low-frequency noise. *Journal of the Acoustical Society of America.* 99(5), (2985 -3002).
- Danielsson A. and Landstroem U. (1985). Blood Pressure Changes in Man During Infrasonic Exposure. *Acta Medica Scandinavica.* 217.531 -535).
- Inaba R. and Okada A. (1988). Study on the Effects of Infra- and Low Frequency Sound on the Sleep by EEG Recordings. *Journal of Low Frequency Noise, Vibration and Active Control.* 7.15 -19).
- Inukai Y., Taya H., Miyano H., and Kuriyama H. (1986). A Multidimensional Evaluation Method for the Psychological Effects of Pure Tones at Low and Infrasonic Frequencies. *Journal of Low Frequency Noise, Vibration and Active Control.* 5.104 -112).
- Inukai Y., Nakamura N., and Taya H. (2000). Unpleasantness and Acceptable Limits of Low Frequency Sound. *Journal of Low Frequency Noise, Vibration and Active Control.* 19.135 -140).
- Ising, H., Lange-Asschenfeldt, H., Moriske, H. J., Born, J., and Eilts, M. (2004). Low frequency noise and stress: bronchitis and cortisol in children exposed chronically to traffic noise and exhaust fumes. *Noise and Health.* 6(23), (21 -28).
- Ising, H. and Kruppa, B. (2004). Health effects caused by noise: evidence in the literature from the past 25 years. *Noise and Health.* 6(22), (5 -13).
- Karpova N.I., Alekseev S., Erokhin V.N., Kadyskina E.N., and Reutov O.V. (1970). Early Response of the Organism to Low Frequency Acoustical Oscillations. *Noise and Vibration Bulletin.* 11(65), (100 -103).
- Maschke, C. (2004). Introduction to the special issue on low frequency noise. *Noise and Health.* 6(23), (1 -2).
- Mohr G.C., Cole J.N., Guild E., and Gierke von, H. E. (1965). Effects of Low Frequency and Infrasonic Noises on Man. 36.817 -827).
- Pedersen, E. and Waye, K. P. (2004). Perception and annoyance due to wind turbine noise--a dose-response relationship. *Journal of the Acoustical Society of America.* 116(6), (3460 -3470).
- Pedersen, E. and Persson, Waye K. (2007). Wind turbine noise, annoyance and self-reported health and well-being in different living environments. 64(7), (480 -486).
- Pedersen, E. and Waye, K. P. (2008). Wind Turbines - Low Level Noise Sources Interfering With Restoration. *Environmental Research Letters.* 3.
- Persson Waye K. and Rylander R. (2001). The Extent of Annoyance and Long-Term Effects Among Persons Exposed to LFN in the Home Environment. 240.483 -497).
- Schust, M. (2004). Effects of low frequency noise up to 100 Hz. *Noise and Health.* 6(23), (73 -85).

- Takahashi, Y., Yonekawa, Y., Kanada, K., and Maeda, S. (1999). A pilot study on the human body vibration induced by low frequency noise. *Industrial Health.* 37(1), (28 -35).
- Takahashi, Y., Yonekawa, Y., and Kanada, K. (2001). A new approach to assess low frequency noise in the working environment. *Industrial Health.* 39(3), (281 -286).
- Takahashi, Y., Kanada, K., Yonekawa, Y., and Harada, N. (2005). A study on the relationship between subjective unpleasantness and body surface vibrations induced by high-level low-frequency pure tones. *Industrial Health.* 43(3), (580 -587).
- Tesarz M., Kjellberg A., Landstroem U., and Holmberg K. (1997). Subjective Response Patterns Related to Low Frequency Noise. *Journal of Low Frequency Noise, Vibration and Active Control.* 16(2), (145 -149).
- Waye K. (2004). Effects of Low-Frequency Noise on Sleep. *Noise and Health.* 6(23), (87-91).

In fact, wind turbines produce modest and acceptable amounts of low frequency noise, as shown by post-construction noise measurement data publicly available and reasonably obtainable on the internet. A field study performed by Epsilon Associates measured low frequency noise associated with two modern turbines, the GE 1.5sle and the Siemens 2.3-93.[116] Using existing ANSI criteria for the evaluation of interior noise levels, Epsilon Associates determined that noise generated by wind farms at distances beyond 1,000 feet were below the low frequency noise criteria for bedrooms, classrooms and hospitals. In addition to meeting ANSI background noise criteria the measured interior noise levels also demonstrate that wind turbine setbacks of 1,000 feet will not cause "more than minimal annoyance (if any) from low frequency noise, and there should be no wind rattles or perceptible vibration of light-weight walls or ceilings within homes."

The overall noise level and spectrum of the GE 1.5-sle turbine is similar to the noise emissions of the GE 1.5 XLE, one of the turbines being considered for use in the Tule Wind Project. The Siemens 2.3-93 turbine, also used in the Epsilon study, has similar sound emissions, within ±3 dB, to the 2.0 MW and 3.0 MW turbines being considered for use in the Tule Wind Project. Current setbacks for the Tule Wind Project are more than 1,500 feet from the nearest non-participating home. Based on the Epsilon noise study, low frequency noise at a distance of 1,500 feet will have no audible infrasound and will meet ANSI S12.2 criteria for acceptable indoor levels for low frequency sound.

Most of the concerns arising from the notion that wind turbines emit powerful amounts of low-frequency noise stem from E-Coustic Solutions' apparent reliance on outdated NASA reports that demonstrate that downwind-configured wind turbines produce high levels of low frequency noise. The same NASA report also very clearly states that modern upwind-configured wind turbines do not emit nearly as much low frequency noise as the older, out-of-production, downwind-configured wind turbines. The turbines proposed for the Tule wind project would be modern upwind-configured and, therefore, would emit the small amounts of low frequency noise

[116] Epsilon Associate, Inc. "A Study of Low Frequency Noise and Infrasound from Wind Turbines." July 2009.

that are documented in the sources discussed above. As discussed in response number 24 of Data Request No. 14, these levels are not harmful to the human body and in fact are produced by heartbeats and other natural functions. Therefore, no adverse health effects from low frequency noise are anticipated.

26. *Please provide an explanation of how the human body responds to extremely low levels of energy, such as inaudible low frequency sound and infrasound. Please also describe the potential health effects of infrasound and low frequency sound as compared to the effects of audible sound levels. Please take into consideration the auditory system's response to levels of low frequency sound and infrasound at pressures significantly lower than what is necessary to reach the threshold of audibility.*

Response: The turbines at the Tule Wind Project will emit limited levels of low frequency and infrasonic sound. Recently some concerns have been raised about possible health effects from these inaudible sound levels. One theory comes from Dr. Nina Pierpont who claims that health effects including dizziness, headache, visual blurring and tachycardia, or "Wind Turbine Syndrome", can occur as a result of exposure to wind turbine sound. Dr. Pierpont claims that "Wind Turbine Syndrome", a term she coined, results from a disturbance to the vestibular system by exposure to low levels of infrasound and low frequency sound emitted by wind turbines.

The topics of "Wind Turbine Syndrome", infrasound and low frequency sound below the threshold of hearing have been addressed by Dr. Geoff Leventhall in his testimony in the Glacial Hills wind farm project in Wisconsin. Dr. Leventhall, a former professor who founded an acoustics research program in England that specialized in low frequency and infrasonic research, is internationally recognized as having expertise in the topics of low frequency and infrasound. Dr. Leventhall stated:

> *Attempts to claim that illnesses result from inaudible wind turbine noise do not stand up to simple analyses of the very low forces and pressures produced by the sound from wind turbines. Additionally, the body is full of sound and vibration at infrasonic and low frequencies, originating in natural body processes. As an example, the beating heart is an obvious source of infrasound within the body. Other sources of background low frequency noise and vibration are blood flows, muscle vibrations, breathing, fluids in the gut and so on. The result is that any effect from wind turbine noise, or any other low level of noise, which might be produced within the body is 'lost' in the existing background noise and vibration.*[117]

Dr. Leventhall goes on to state that "the wide range of symptoms" which Dr. Pierpont associates with "Wind Turbine Syndrome" are "well known to others as the stress effects of audible noise, to which a small number of persons are susceptible."

[117] Testimony of Dr. Geoff Leventhall to the Wisconsin Public Utilities Commission, docket 6603-CE-302.

The work of Dr. Pierpont relied heavily on the research of Dr. Neil Todd from the Faculty of Life Science at University of Manchester, who recently reprimanded Pierpont for her misinterpretation and use of his research. Dr. Pierpont's "Wind Turbine Syndrome" theory has incorrectly sought to insert air-borne noise issues into a paper which is entirely about vibration through direct contact with the skull. Dr. Todd states the following concerning Pierpont's interpretation of his research:

> *Our research is being cited to support the case that 'wind turbine syndrome' is related to a disturbance of vestibular apparatus produced by low-frequency components of the acoustic radiations from wind turbines. Our work does not provide the direct evidence suggested. We described a sensitivity of the vestibular system to low-frequency vibration of the head (through direct physical contact), at about 100Hz, and not air-conducted sound.*[118]

Dr. Leventhall also quoted Dr. Todd, who states that:

> *At present I do not believe that there is any direct evidence to show that any of the above acoustico-physiological mechanisms (associated with wind turbine syndrome) are activated by the radiations from wind turbines. Even if the vestibular system were activated in a controlled acoustic environment, it is not necessarily the case that it would produce pathological effects. Until such evidence is available I have an open mind on "wind turbine syndrome.*[119]

Dr. Leventhall goes on to state:

> *Throughout Pierpont's work there is no clear indication of the excitation levels which she believes might cause a problem. While she must be aware of safe and unsafe doses of medication, she continues to close her mind to the concept of safe doses of sound, although "safe sound" is our everyday experience. Thus, Pierpont's hypothesis [related to "Wind Turbine Syndrome"] fails.*[120]

Dr. Leventhall summarizes additional technical portions of Pierpont's theory that infrasound causes health effects by stating:

> *Pierpont's second hypothesis is equally unfounded. She says that infrasound at 4 – 8Hz enters the lungs and vibrates the diaphragm and its attached liver, so passing confusing messages on to the visceral graviceptors. She gives no evidence*

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[118] Dr Neil Todd Faculty of Life Science University of Manchester (Todd, N., Rosengren, S. M., and Colebatch, J. G. (2008): Tuning and sensitivity of the human vestibular system to low frequency vibration. *Neuroscience Letters* 444, 36 - 41.) as cited in Levanthal testimony to the Wisconsin Public Utilities Commission, docket 6603-CE-302.

[119] Dr Neil Todd Faculty of Life Science University of Manchester (Todd, N., Rosengren, S. M., and Colebatch, J. G. (2008): Tuning and sensitivity of the human vestibular system to low frequency vibration. *Neuroscience Letters* 444, 36 - 41.) as cited in Levanthal testimony to the Wisconsin Public Utilities Commission, docket 6603-CE-302.

[120] Testimony of Dr. Geoff Leventhall to the Wisconsin Public Utilities Commission, docket 6603-CE-302.

> *to support this, but instead uses references to whole body vibration, applied to the feet or seat, which is a completely different excitation to that from sound. A simple order of magnitude calculation, using basic physics of the level which will be known to a 16-year-old school pupil, shows that the movement of the diaphragm under the forces which might result from wind turbine noise is less than 10 micron. That is less than one hundredth of a millimeter or about one tenth of the average thickness of human hair. During normal breathing, the diaphragm moves several centimeters.[…] Another part of Pierpont's second hypothesis states that infrasound from wind turbines, at a frequency of 1 – 2Hz, vibrates the chest, so adding to the confusing signals which upset the balance system. However, there is already a strong source of infrasound inside the body, beating at 1 –2 Hz, giving far greater magnitudes than might be produced by infrasound from wind turbines at these frequencies: the human heart. The beating heart vibrates the surface of the body at a high enough level to be picked up by a stethoscope, or even the ear. The sound produced by wind turbines does not.*[121]

Dr. Leventhall also commented on an issue raised by Mr. Richard James of E-Coustic Solutions:

> *James uses Dr. Neil Todd as an example to 'demonstrate that there is sufficient evidence to present a causal link between ILFN (infrasound and low frequency noise) and adverse health effects.' What Dr. Todd actually showed was that, for a vibration input through physical contact to the mastoid area at the back of the head, certain reflexes, indicative of a vestibular response, continue to about 15dB lower than the level at which the hearing mechanism of the inner ear ceases to respond to vibration in the skull. It takes only a little thinking to realize that all of the people who use bone conduction hearing aids are receiving vibration inputs to their vestibular system at levels well above the system's perception threshold. This does not affect them.*[122]

The testimony of Drs. Leventhall and Todd state that there are no scientifically valid peer reviewed studies showing any adverse health effects from infrasonic or low frequency noise emitted from turbines, and that there is no valid mechanism by which the infrasound produced by turbines could affect the human body any differently than other infrasound produced within the body. Therefore, no adverse health effects are anticipated from any infrasound produced by turbines associated with the Tule Wind Project.

27. Please provide justification for the noted 1,000 foot setback (from Epsilon Associates report) from wind turbines to residences and an explanation of the methodology used to determine this setback. Please comment on how the elevation of wind turbines as compared to residences, based on topography and terrain, was considered in determining setbacks. Please comment on the appropriateness of a 1.25-mile or 2-mile

[121] Testimony of Dr. Geoff Leventhall to the Wisconsin Public Utilities Commission, docket 6603-CE-302.
[122] Testimony of Dr. Geoff Leventhall to the Wisconsin Public Utilities Commission, docket 6603-CE-302.

setback from turbines to residences and sensitive receptors, including justification supporting the response.

Response: Through a series of measurements, Epsilon Associates determined that at a distance of 1,000 feet sound emissions from GE 1.5sle and Siemens 2.3-93 wind turbines conform to applicable ANSI standards, including ANSI/ASA S12.9 Part 4 and ANSI/ASA S12.2. Measurement data was collected through a series of interior and outdoor measurements performed at existing wind farms. Data collected in the field study consisted of outdoor measurements at various distances from the turbines and concurrent interior and exterior measurements at residences. Comparing measured sound levels with ANSI criteria for the evaluation of interior sound levels, Epsilon Associates determined that sound generated by wind farms at distances beyond 1,000 feet were below the low frequency noise criteria for bedrooms, classrooms and hospitals. In addition to meeting ANSI background noise criteria, the measured interior noise levels also demonstrate that wind turbine setbacks of 1,000 feet will not cause "more than minimal annoyance (if any) from low frequency noise, and there should be no wind rattles or perceptible vibration of light-weight walls or ceilings within homes."[123]

As previously noted, the distance of 1,000 feet is based on field measurements; therefore the elevation between the turbine and each monitoring location may vary. The exact height of the turbines was not noted in the report; therefore the elevation of the turbines in comparison to the residences cannot be determined. Setbacks for the Tule Wind Project are based on cumulative sound levels, not a single turbine setback, and account for site specific elevation and terrain. Setbacks of 1.25 miles and 2.0 miles, as suggested by E-Coustic Solutions, are not required, nor are they supported by measurement or modeling data. The San Diego County noise ordinance requires that operational noise comply with San Diego County Code of Regulatory Ordinances Section 36.404. HDR performed detailed noise modeling of project related sound to determine the compliance with the noise ordinance. The model created for the Tule Wind Project accounts for the current turbine layout, number of total turbines, elevation and site specific terrain.

Please refer to Response 2 of Data Request No. 14 for additional details on the Epsilon Associates field study and necessary setbacks.

28. Please provide an explanation of the potential for shadow flicker to occur, taking into consideration the proposed location of the wind turbines in relationship to nearby residences and other sensitive receptors.

Response: Shadow flicker is commonly defined as alternating changes in light intensity at a given stationary location. In order for shadow flicker to occur, three conditions must be met:

1. The sun must be shining with no clouds obscuring the sun.
2. The rotor blades must be spinning and be located between the receptor and the sun.
3. The receptor must be sufficiently close to the turbine to be able to distinguish a shadow created by the turbine

[123] Epsilon Associate, Inc. "A Study of Low Frequency Noise and Infrasound from Wind Turbines." July 2009.

The frequency of occurrence of shadow flicker at a given receptor tends to decrease with increasing distance between turbine and receptor. Additionally, the intensity of shadow flicker at a given receptor also decreases with increasing distance between turbine and receptor because the shadow cast by the rotor blade decreases in size as the distance from the turbine increases. The combination of these two factors means that even for receptors which are in a theoretical path of a shadow cast from a proposed turbine, a discernable shadow will not be realized due to the distance between many of these receptors and the proposed turbines.

For receptors which have the potential to experience shadow flicker from wind turbines, the number of experienced shadow flicker hours is generally small for a number of reasons, including the daily change in the sun's path and cloud cover, the fact that turbines do not operate 100 percent of the time over the course of the year, and typical setback requirements.

For the Tule Wind Project, the proposed location of the wind turbines in relationship to nearby residences and sensitive receptors (occupied house) is such that the vast majority of proposed turbines will be physically unable to cast a shadow in the direction of the vast majority of receptors, including the largest group of receptors south of Interstate 8 (I-8) near Old Highway 80 and several, though not all, receptors north of I-8. That is to say, a turbine which lies within approximately 60 degrees due north relative to a receptor at the Tule Wind Project's latitude, will never cast a shadow on that receptor. As discussed in greater detail below in Response 29, there are four sensitive receptors with the potential to experience shadow flicker from the Tule Wind Project. Please see Response 29 of Data Request No. 14 and the corresponding graphics for an analysis of the potential for sensitive receptors to experience shadow flicker as a result of the Tule Wind Project.

29. *Please provide a graphic depicting the exposure of shadows from the wind turbines on adjacent properties, particularly residences and other sensitive receptors, considering the proposed locations of the turbines, topography, and day/night lighting. Please also provide calculations of the anticipated shadow exposure on adjacent residences and other sensitive receptors and a table summarizing this information.*

While the vast majority of receptors near the project area will have no shadow flicker from the Tule Wind Project turbines, a limited shadow flicker model run was made to determine potential shadow flicker that could occur at several sensitive receptors. Receptors within 2,000 meters (6,562 feet) of any proposed turbine were considered. Beyond 2,000 meters, it is reasonable to assume that the human eye would not be able to discern a shadow cast from a wind turbine. Of the identified receptors within 2,000 meters of proposed turbines, four homes were included in the model run, while others were not included in the model run because it is physically impossible for any proposed turbine to cast a shadow on these receptors due to the fact these receptors lie within 60 degrees of due north from the receptors, outside of the sun's path at any point in the year. Attached are modeling results and corresponding graphics depicting the classic butterfly pattern associated with shadow flicker. The modeling was completed using many different inputs, including:

1. Real Data

- Actual coordinates of turbines
- Actual coordinates of receptors
- Actual topographic data

2. Conservative Assumptions

- Specifications of the turbines being considered with the highest hub height and longest rotor diameter
- 100 percent turbine operation
- No vegetative screening
- Receptors can be impacted from all directions (i.e., "greenhouse mode")

3. Realistic Features

- Actual wind data from a local meteorological tower to account for the percentage of time wind blows from each direction.
- National Weather Service sunshine probability data to approximate average cloud cover.

This combination of inputs results in conservative model results. As shown in Table 29-1 below, the home with the most shadow flicker as predicted by the model is on the northwest side of the project where an annual total of 17 hours, 36 minutes of shadow flicker was predicted.

Table 29-1. Tule Wind Project Shadow Flicker Impact by Receptor

Receptor ID	Receptor Location (UTM NAD83 Zone 11)[a]		Elevation	Shadow Hours per Year	Shadow Days Per Year	Max Shadow Hours per Day	Hours per Year
	X - Coordinate	Y - Coordinate	[m]	[HH:MM/Year][b] (Worst Case)	[Days/Year][c] (Worst Case)	[HH:MM/Day][d] (Worst Case)	[HH:MM/Yr][e] (Conservative)
Home_1	569,149.57	3,619,849.70	1133.9	24:15	78	0:27	14:11
Home_32	566,421.29	3,619,605.44	1111.4	13:40	82	0:13	9:14
Home_42	566,409.75	3,620,055.86	1121.5	9:55	59	0:14	6:20
Home_47	557,803.90	3,630,391.08	1429.7	32:32	151	0:29	17:36

[a] The coordinate system is the Universal Transverse Mercator (UTM) system, using North American Datum 1983 (NAD 83), Zone 11.
[b] Total hours per year of shadow flicker at this receptor under worst-case conditions.
[c] Days per year in which shadow flicker is possible at this receptor under worst-case conditions.
[d] The maximum daily hour and minutes of shadow flicker at this receptor, under worst-case conditions. This value is the single day maximum due to the combination of receptor and turbine locations, and sun path across the sky. All other days will be less than this maximum as the sun path changes throughout the year. All days will also be less than this maximum due to real world conditions such as cloud cover, changes in wind direction, and less than 100% wind turbine operation.
[e] Conservatively predicted hours of shadow flicker at this receptor, including sunshine probability and actual wind direction data. Actual hours should be less than this value due to less than 100% wind turbine operation, and other mitigating factors such as screening due to trees or structures.

Actual shadow flicker hours experienced are expected to be significantly less due to the conservative assumptions listed. To put this value in perspective, the total annual daylight hours in nearby Chula Vista (and equivalent latitudes) is approximately 4,444 hours; therefore this conservative amount represents less than 0.4 percent of the total possible sunlight hours in a year. As discussed in greater detail in Response 30 of Data Request No. 14, there is currently no published scientific evidence to positively link wind turbines with adverse health effects.

30. Please provide an analysis of the potential health effects on adjacent residences and sensitive receptors as a result of shadow flicker.

Shadow flicker from wind turbines does not cause seizures in persons with photosensitive epilepsy. Data from the Epilepsy Foundation indicates that although the frequency of flashing light that is most likely to cause seizures varies from person to person, generally, the frequency of flashing lights most likely to trigger seizures is between 5 and 30 Hertz[124] (Hz refers to flashes per second). The large modern three-bladed wind turbines under consideration for this project rotate at approximately 19 revolutions per minute (rpm) or less[125]. Even assuming a slightly faster rotation speed of 20 rpm, the blade passing frequency is approximately 1 Hz (20 rev/min * min/60 sec * 3 blades), is well below the critical frequency of 5 Hz[126]. There is currently no published scientific evidence to positively link wind turbines with adverse health effects[127].

The majority of documentation related to non-seizure health impacts due to shadow flicker consists of informal testimonials given by residents or drivers on roadways in proximity to a wind turbine. These testimonials cite headaches, vertigo, nausea, blinding effects, disorientation, loss of balance, and increased levels of stress and anxiety as symptoms directly related to wind turbine shadow flicker. These testimonials are primarily available on websites often cited by anti-wind advocates rather than formal medical literature. Some complaints regarding these symptoms do appear in more formal materials, but are merely reported and are not studied or discussed in any detail[128]. Several of these sources state that complaints of headaches and other similar symptoms are highly, but not perfectly, correlated with annoyance complaints. To date,

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[124] Epilepsy Foundation. (n.d.). Photosensitivity and Seizures. Retrieved June 2010, from http://www.epilepsyfoundation.org/about/photosensitivity/

[125] The Wind Power. Wind turbines and windfarms database, technical data. Retrieved April 2011, from http://www.thewindpower.net/wind-turbine-datasheet-technical-47-gamesa-g90-2000.php

[126] Burton, T., Sharpe, D., & Jenkins, N. (2001). Wind Energy Handbook. West Sussex, England: John Wiley & Sons, Ltd.

[127] National Health and Medical Research Council. (2010, July). Wind Turbines and Health. Retrieved August 2010, from: http://www.nhmrc.gov.au/_files_nhmrc/file/publications/synopses/public_statement_wind_turbines_and_health.pdf

[128] Michigan Public Service Commission. (2010, January). Report on the Impact of Setback Requirements and Noise Limitations in Wind Zones in Michigan. Retrieved August 2010, from http://www.michigan.gov/documents/mpsc/werzb_rpt_01-2010_309001_7.pdf, North Dakota Legislative Council. (2009, October). Allocation of Wind Rights – Background Memorandum. Retrieved August 2010, from http://www.legis.nd.gov/assembly/61-2009/docs/pdf/19041.pdf, Minnesota Department of Health. (2009). Public Health Impacts of Wind. Retrieved June 2010, from http://energyfacilities.puc.state.mn.us/documents/Public%20Health%20Impacts%20of%20Wind%20Turbines,%205.22.09%20Revised.pdf

the available published, peer-reviewed literature states that no studies or scientific evidence links shadow flicker to adverse health impacts[129] [130].

31. Please provide an explanation of the safety concerns or hazards (e.g., vehicle driver distraction) that may occur as a result of shadow flicker.

Response: A concern that is occasionally raised is that shadow flicker occurring on a roadway could distract drivers and cause accidents. In order to obtain a driver's license, motorists are generally evaluated through a road test on their ability to react appropriately to the various situations they encounter. Shadows on the road way or road side distractions are a common occurrence. A whole segment of the advertising industry has been developed that takes advantage of the passing motorist attention. Numerous cities now have massive "big screen TVs" erected beside major highways, yet there is no data showing these entities cause accidents. Wind turbines or their fleeting shadows do not have these attention demanding qualities.

Shadows on roadways can be caused by nearby trees or buildings, or the earth's terrain itself. A car passing through shadows caused by anything can experience shadow flicker at very high frequencies dependent on vehicle speed and the object(s) causing the shadow. Moving shadows on roadways can be caused by wind turbines, a single passing cloud, or an airplane. Regardless of the source of the shadow or any other potential change that a driver notices gradually or suddenly, it is generally the responsibility of the motorist to maintain control of their vehicle in the face of any situation they encounter. A moving car would pass quickly through any shadow on a road caused by a turbine associated with the Tule Wind Project, and therefore any potential for distraction would be remote. Because vehicles on roadways are not stationary objects, it is not appropriate to include roadways as part of a shadow flicker analysis, as shadow flicker is commonly defined as alternating changes in light intensity at a given *stationary* location.

Current research involving motor vehicle accidents have highlighted the increased risk of driver activities that focus on attention diverting activities such as cell phone use, map reading, etc and have not identified shadow flicker or shadows in general as a source of driver distraction sufficient to increase the risk of accidents[131].

32. Please provide a response to a comment that suggests that shadow flicker setbacks for current wind turbine designs should be 10 rotational diameters (approximately 1000 meters); flash frequency should not exceed three per second; and the shadows cast by one turbine on another should not have a cumulative flash rate exceeding three per second.

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[129] National Health and Medical Research Council. (2010, July). Wind Turbines and Health. Retrieved August 2010, from: http://www.nhmrc.gov.au/_files_nhmrc/file/publications/synopses/public_statement_wind_turbines_and_health.pdf

[130] Ohio Department of Health. (2008, March). Retrieved August 2010, from http://www.odh.ohio.gov/ASSETS/C43A4CD6C24B4F8493CB32D525FB7C27/Wind%20Turbine%20SUMMARY%20REPORT.pdf

[131] Driver Distraction in Commercial Vehicle Operations (Doc. No. FMCSA-RRR-09-042), U.S. Department of Transportation, Federal Motor Carrier Safety Administration, Office of Analysis, Research and Technology, September 2009.

The frequency of occurrence and intensity of shadow flicker at a given receptor tends to decrease with increasing distance between turbine and receptor. However, to our knowledge, there is no mathematic or scientific method or empirical observation that supports the specific value of 10 rotor diameters as an appropriate setback or as an appropriate distance to include as part of a regulatory approach to shadow flicker. Additionally, while rotor diameter impacts the area affected by shadow flicker, the width of the blade is the more important parameter in creating a distinct flicker over a long distance, and therefore, it is illogical to base setbacks on a rotor diameter basis for purposes of controlling shadow flicker.

Concerns related to flash frequency generally are rooted in a concern about triggers for photosensitive epilepsy. Assuming this, and as discussed in the response to item number 30, shadow flicker from wind turbines does not cause seizures in persons with photosensitive epilepsy. Generally, the frequency of flashing lights most likely to trigger seizures is between 5 and 30 Hz (flashes per second)[132], rather than the 3 flashes per second noted here. The rotation speed of modern wind turbines is much less than 5 Hz, or the lowest frequency of concern as cited by the Epilepsy Foundation.

The cumulative flash rate comment also appears to be rooted in a concern about triggers for photosensitive epilepsy. Assuming a rotor speed of 20 revolutions per minute, which equates to a flash frequency of approximately 1 Hz, five turbines (1 Hz * 5 = 5 Hz) would have to be aligned between the receptor and the sun to increase the frequency to something close to the 5 Hz identified by the Epilepsy Foundation as a level of interest for photosensitive epilepsy. Given that the proposed turbines are generally aligned on a north-south line for the majority of the proposed project, and given that the vast majority of the turbines lie to the north of receptors, the occurrence of five or more turbines aligning between the receptor and sun would be virtually impossible. If five or more turbines did align, the spacing between the turbines themselves combined with the setback distance between receptor and turbines would create a situation where a shadow cast from the fifth turbine in a line would not be discernable at the receptor in a line with all five (or more) turbines. Therefore, cumulative flash rates are not an anticipated public health concern for the Tule Wind Project.

33. *Please provide an explanation of the potential for ice throw to occur from wind turbine blades, as well as the associated potential safety hazard to people or passing vehicles.*

Response: Rime ice or glace ice can form on a wind turbine given the right combination of temperature and moisture. Rime ice will occur when objects such as trees or wind turbines are exposed to low temperatures in combination with fog. Depending on the duration of the ice conditions, significant amounts of rime ice can collect on the turbines and increase static and dynamic loads. Glace ice can occur when a warm front drifts above cold air. The falling rain can get cooled down to temperatures below the freezing point without actually freezing into solid ice. If the super-cooled rain hits the surface or objects with temperatures below 32 degrees Fahrenheit, it will instantly turn to a layer of solid ice. Both types of ice would only occur when the temperature is below freezing (32 degrees Fahrenheit). In the project area, the average low

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[132] American Epilepsy Foundation: http://www.epilepsyfoundation.org/about/photosensitivity/

temperature is above freezing throughout the year, with the exception of December, which has an average low temperature of 32 degrees Fahrenheit. In general, the potential for ice would be limited to winter (late November-February), when overnight temperatures can dip into the 20s and lower 30s.

With a non-operating turbine (stationary rotor), the ice will accumulate and eventually fall to the ground below the turbine in a pattern generally the width of the rotor diameter and downwind of the turbine. The lightest ice particles generally will be carried the farthest downwind, and the heavier pieces generally will fall straight down, thus posing a potential hazard to objects and personnel in a relatively small area beneath the turbine[133].

With an operating turbine, ice will also accumulate and eventually be shed subject to the gravity forces (as with stationary turbines) and be thrown horizontally some distance from the turbine due to the centrifugal force developed by the rotating rotor. Ice thrown from operating turbines is anticipated to have the potential to travel greater distances, as opposed to ice shed from turbines in a stationary position[134,135].

Potential safety hazards associated with the Tule Wind Project could therefore occur from ice throw during the infrequent nights in the winter when the temperature and weather conditions are conducive to icing and the turbines are in motion. Industry professionals have recognized and analyzed these risks and through various studies have developed siting setback recommendations which mitigate the risk to personnel and property. The recommendation provided in the literature and by specific turbine manufacturers indicates that the empirically derived most conservative setback distance for the turbine is 1.5 times (hub height + rotor diameter). This is a distance which can effectively be regarded as a "safe" distance[136,137,138], beyond which there is negligible risk of injury from ice throw. For the proposed turbines (100 meter hub height and 100 meter rotor) the most conservative safe distance would then be 300 meters (~984 feet). The 984 feet should be considered a conservative distance for discussions of health and safety related to ice throw for the Tule Wind Project. The nearest occupied home to a turbine under the current layout is 2,407 feet; the nearest turbines to the Cottonwood and Lark Canyon campgrounds are at least 2,356 feet and 1,123 feet away, respectively. The likelihood of members of the public occupying the campgrounds during freezing conditions is very low. Therefore there is little anticipated risk from ice throw at residences or campgrounds.

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[133] Recommendation for Risk Assessments of Ice Throw and Blade Failure in Ontario Prepared by Garrad Hassan for the Canadian Wind Association; 31 May 2007.

[134] Recommendation for Risk Assessments of Ice Throw and Blade Failure in Ontario Prepared by Garrad Hassan for the Canadian Wind Association; 31 May 2007.

[135] Risk Analysis of Ice Throw from Wind Turbines, Henry Seifert, Annette Westerhellweg, Jurgen Kroning, Paper presented at BOREAS 6,9 to 11 April 2003, Pyha, Finland.

[136] Setback Considerations for Wind Turbine Siting, GE Wind; Dated 2009.

[137] Ice Shedding and Ice Throw – Risk and Mitigation, GE Energy/ GER-4262 (04/06); Dated 2006.

[138] Risk Analysis of Ice Throw from Wind Turbines, Henry Seifert, Annette Westerhellweg, Jurgen Kroning, Paper presented at BOREAS 6,9 to 11 April 2003, Pyha, Finland.

There are points along McCain Valley Road (the only public road in the vicinity of proposed turbines) that are located within 984 feet from the closest turbines (the closest location is approximately 496 feet).

For areas within 984 feet of the turbines, there would be limited risk of potential safety hazards to people or passing vehicles from ice throw. The likelihood of members of the public being within this area (either on McCain Valley Road or elsewhere in public areas) during potential ice throw events is extremely low, since the temperatures are only conducive to icing intermittently during winter nights (which would have low use of both the roads and the public areas), and the turbines would not necessarily be in operation during every potential ice event, thereby limiting the possibility for ice to be thrown any distance beyond the blade length.

The following measures would further minimize and mitigate the potential for adverse effects to the general public from ice throw:

- The fences and warning signs that will be installed under the direction of the BLM will serve to keep members of the public away from areas directly under turbines, thereby reducing the risk of injury.
- If the blades become iced, it is likely they will become unbalanced and the vibration sensor will stop the turbine, or the wind measuring instruments will freeze over and cause an automatic shutdown, reducing the potential for ice throw.

If operations and maintenance personnel must enter the turbine area when there is an ice accumulation, standard safety precautions and safety protocols would be followed including but not be limited to[139,140]:

- Remotely shutting down the turbine,
- Yawing the turbine to position the rotor on the side opposite from the tower door.
- Parking vehicles at a safe distance from the tower.
- Restarting the turbine remotely when work is complete and personnel are clear.
- Wearing standard personnel protective gear, such as hard hats.

Based on the low frequency and the anticipated low likelihood of icing conditions, the distance between the closest occupied residence to the proposed turbines (2,407 feet), and standard safety precautions and safety protocols, the risk to public health and safety from ice throw is anticipated to be insignificant.

34. Please comment on the structural integrity of the wind turbines in regard to withstanding extremely cold temperatures.

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[139] Ice Shedding and Ice Throw – Risk and Mitigation, GE Energy/ GER-4262 (04/06); Dated 2006.
[140] Risk Analysis of Ice Throw from Wind Turbines, Henry Seifert, Annette Westerhellweg, Jurgen Kroning, Paper presented at BOREAS 6,9 to 11 April 2003, Pyha, Finland.

Response: Turbines sold in North America are generally adaptable to the extreme cold as accounted for in the design and certification process. Wind turbines are regularly found in northern climes of the US and in Canada and function in extreme cold.

The International Standard IEC 61400-1[141] indicates that the extreme temperature range for the standard wind turbine is -20C to+50C (-4Fto +122F). Based on historical weather data for the Jacumba area[142], record lows in the winter have been recorded at 20F and record highs in the summer have been recorded at 120F, within the standard wind turbine temperature range. Therefore, no cold weather structurally related problems are anticipated for the Tule project.

Furthermore, all turbines will be inspected by an independent engineering company (e.g., Germanischer Lloyd, DNV or other appropriate independent engineer) prior to commissioning of the project. This will require each turbine to have a statement of Compliance for Design Assessment that the turbine is in compliance with the IEC 61400-1 rules for safe design, including their ability to withstand the temperature range for the project area.

35. Please provide an explanation of the potential health effects of electromagnetic energy resulting from the wind turbines, also referred to as "dirty electricity".

Response: Electromagnetic energy and "dirty electricity" refer to different phenomena. As described in Draft EIR/EIS Section D.10.8.1, an Electromagnetic Field (EMF) is a physical field produced by electrically charged objects, when a current passes through a wire. Dirty electricity, on the other hand, is poor power quality. This poor power quality could create a ground current that will lead to an unbalance circuit problem on the system, which in turn might cause stray voltage.

Wind turbines create electromagnetic fields from the power facilities that are a part of the turbine makeup. As described in the Draft EIR/EIS Section D.10.8.1, electric and magnetic fields attenuate rapidly with distance from the source. The electrical wiring of the wind turbine generator is also surrounded by an electrically-conductive metal cover, so any EMF levels outside of the wind turbine would be very low. In addition, given the large distances between the proposed turbines and homes (2,407 feet or greater) and the Cottonwood and Lark Canyon campgrounds (2,356 feet and 1,123 feet or greater, respectively), the turbines are not anticipated to result in measurable levels in EMF at residences or campgrounds. Finally, as discussed in Section D.10.8.6 of the Draft EIR/EIS, there is inadequate or no evidence of health effects at low exposure levels.

Stray voltage could occur if the electrical equipment in the turbines is not maintained properly. Induced current or stray voltage has the potential for adverse health effects if not properly grounded. As part of the commissioning of the project, turbines will be examined to confirm that they are properly grounded, as discussed in Project Design Feature (PDF) 17 of the San Diego Rural Fire Protection District (SDRFPD) approved Fire Protection Plan, dated November 3,

[141] International Standard IEC 61400-1.
[142] A History of Significant Weather Events in Southern California. Updated February 2010. Accessed April 11, 2011. National Weather Services Forecast Office, San Diego, CA.

2010. Regular operations and maintenance measures will similarly confirm that there are no stray voltage issues through the life of the project. Therefore, no health effects would be anticipated to occur from stray voltage.

36. Please provide detailed responses to comments 1, 7, 9, and 16 related to public health and safety, as identified in the letter from Richard James of E-Coustic Solutions provided in Attachment B.

Please see Responses 23.1, 23.7, 23.9, and 23.16 of Data Request No. 14 for detailed responses to comments identified in the letter from E-Coustic Solutions.

37. Please provide detailed responses to comments 1 and 2 related to shadow flicker and "dirty electricity", as identified in the letter and exhibit from Stephan Volker provided in Attachment B.

The concerns identified by Mr. Volker are largely addressed in Responses 28 through 32 (shadow flicker) and Response 35 ("dirty electricity") of Data Request No. 14. Shadow flicker, indeed, has been reported through informal testimonies as being an annoyance, but have not been independently verified as a health concern in published scientific literature. See Response 30 of Data Request No. 14 above for more details.

The National Highway Traffic Safety Administration (NHTSA) describes driver distraction as something that could present a serious and potentially deadly danger, and identifies various forms of distracted driving, including cell phone use, texting, eating, drinking, talking with passengers, and using in-vehicle technologies and portable electronic devices, along with less obvious forms of distractions including daydreaming or dealing with strong emotions. See Response 31 of Data Request No. 14 for more details.

As mentioned in Response 28 above, the vast majority of receptors near the project area will have no shadow flicker from the Tule Wind Project turbines. A few receptors could experience shadow flicker throughout the year. See Response 29 above for more details.

VISUAL RESOURCES

38. Please provide the Tule Wind viewshed map (EIR/EIS Figure D.3-2) that reflects the "Modified Project Layout".

Response: Revised viewshed map is provided as part of this response letter (attached).

WATER (APRIL 8, 2011)

39. In addition to the water availability letters provided by Jacumba Community Services District and Live Oak Springs Water Company in August 2010, please provide additional documentation verifying the source and availability of water and/or will serve letters from well water providers as well as water purveyors to meet the proposed use of approximately 19 million gallons of water during construction of the Tule Wind Project.

Response: Tule Wind, LLC (Tule Wind) will rely on groundwater wells on Rough Acres Ranch and on Ewiiaapaayp Band of Kumeyaay Indians tribal land to supply construction water demands for the Tule Wind Project. Attached to this response is a letter from John Gibson of Hamann Companies which confirms the availability of groundwater from Rough Acres Ranch. We are also working with the Ewiiaapaayp Band of Kumeyaay Indians to obtain a similar letter of water availability. This information is forthcoming.

In addition, attached to this response are two (2) reports from Geo-Logic Associates, which collectively confirm that groundwater resources on Rough Acres Ranch and on Ewiiaapaayp tribal land will be sufficient to supply both peak water use (124 gallons per minute (gpm)) and total water use (estimated 19 million gallons) required to build the Tule Wind Project.

The Geo-Logic Associates *Estimate of Available Groundwater* (September 7, 2010) indicates that the conservative peak water use rate required for construction of the Tule Wind Project would require groundwater pumping at a rate of 124 gallons per minute (gpm). Based on groundwater sufficiency tests conducted by Geo-Logic Associates on Rough Acres Ranch and Ewiiaapaayp tribal land, Geo-Logic concluded in the *Groundwater Investigation Report* (December 10, 2010) that combined groundwater resources between these two groundwater sources could easily supply 130 gpm, if not more, thereby demonstrating sufficient peak use supply.

Furthermore, the Geo-Logic *Groundwater Investigation Report* also demonstrates that both sources also are sufficient to supply the estimated 19 million gallons necessary to construct the Tule Wind Project. These conclusions are discussed in more detail below.

Rough Acres Ranch Wells – Based on the well test plan that was approved by the County of San Diego, Geo-Logic conducted a step test followed by a 72-hour, 50 gallons per minute (gpm), constant rate aquifer pumping test at Well No. 6a on Rough Acres Ranch. Based on the lack of significant drawdown in the nearest observation well (36 feet away), and no evidence of an effect in more distant observation wells, Geo-Logic concluded that there is significant groundwater resources within this water production area. In fact, during testing Geo-Logic observed no drawdown in wells located within one-third and one-half mile of the pumping well. Accordingly, Geo-Logic concluded that interference with the nearest off-site wells, approximately one half mile from the pumping well, is not anticipated at the 50 gpm level proposed during construction of the Tule Wind Project.

Although Tule Wind does not anticipate the need to do so, the Geo-Logic *Groundwater Investigation Report* concluded that it is possible to double the pumping rate at the Rough Acres Ranch well to 100 gpm “without well interference or significant groundwater depletion.” At a 50 gpm rate, the *Groundwater Investigation Report* concludes that the maximum drawdown rate over a nine-month period would be 66 acre-feet, and at 100 gpm, the maximum drawdown rate would be 136 acre-feet. Until pumping is increased by eight (8) times the 50 gpm rate (8x50=400 gpm) to 54 acre-feet per month (nearly 486 acre-feet per year) would the groundwater basin approach the 50% depletion level of 500 acre-feet within the basin. To put this water supply in perspective, the total estimated construction water supply necessary for the Tule Wind Project is approximately a little more than 58 acre-feet of water (19 million / 326,000 gallons per acre foot). Accordingly, the *Groundwater Investigation Report* concludes that there is a more than sufficient water supply available at Rough Acres Ranch.

Ewiiaapaayp Tribal Wells - In addition, as discussed in the *Groundwater Investigation Report*, although there are no requirements for analysis of groundwater use on tribal lands, the aquifer pumping test and analyses for two wells within Thing Valley (Ewiiaapaayp Tribal lands) indicate that there is sufficient storage for use of groundwater within Thing Valley and no significant impacts to groundwater storage are anticipated. Based on existing records, the South well is reported to produce water at a rate of 30 gpm and the North well is reported to produce water at a rate of 90 gpm.

GIS INFORMATION (April 8, 2011)

40. Please provide pole numbering for the revised transmission line route, to be added to the modified Tule Wind Project graphics in the Final EIR/EIS.

Response: GIS meta data for transmission line pole numbering for the Modified Project Layout is provided as part of this response letter (CD attached).

Exponent
185 Hansen Court
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Wood Dale, IL 60191

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April 29, 2011

Mr. Iain Fisher
Energy Division
California Public Utilities Commission
505 Van Ness Avenue
San Francisco, California 94102-3298

Subject: Data Request No. 14
Tule Wind Power Project
Exponent Project No. 1103183.000

Dear Mr. Fisher:

I am a Principal Scientist and Director of the Center for Occupational and Environmental Health in the Chicago office of Exponent, a scientific research and consulting company headquartered in Menlo Park, California. I have worked at Exponent since November, 2003. Prior to working at Exponent, I held a series of positions with advancing responsibility in the areas of public health, occupational medicine, and academia. I was employed at the Oklahoma State Department of Health from 1972 to 1990 and held a series of positions culminating in my appointment as the State Epidemiologist, a post that I held from 1979 to 1982, followed by the position of Consulting Medical/Environmental Epidemiologist from 1983 to 1990. In both of these capacities, I directed epidemiologic investigations of a broad range of health concerns, from food-borne outbreaks to cancer clusters. I was a faculty member of the Department of Preventive Medicine at the Medical College of Wisconsin, Milwaukee, from 1990 to 1997, and I completed my tenure as Associate Professor and Acting Chairman of the Department. While on faculty at the Medical College, I was a part-time Medical Director for Wisconsin Centrifugal, a foundry in Waukesha, Wisconsin, and Miller Brewery, Milwaukee, Wisconsin. In this role, I supervised the health monitoring programs, both company-mandated and OSHA-required, in addition to the day-to-day clinical aspects of the employee health service. My responsibilities included biological surveillance of employee population as well as worksite reviews and inspections. I have also served as Corporate Medical Director for several global companies prior to joining Exponent.

I earned a Master's degree in Education in 1972, an M.P.H. in Epidemiology and Biostatistics in 1974, and a Ph.D. in Epidemiology and Biostatistics in 1979. I completed medical school in 1986, an internship in Family Medicine in 1987, and a residency/fellowship in Occupational and Environmental Medicine in 1990. I am a Fellow of the American College of Occupational and Environmental Medicine. I have unrestricted licenses to practice medicine in Oklahoma, Wisconsin, and Illinois. In addition to my employment experience, I am a past member (2000–2007 and 2008–2011) of the Board of Directors for the American College of Occupational and Environmental Medicine in Arlington Heights, Illinois. I have been a member of the Board of Directors of Vysis, Inc. in Downers Grove, Illinois and the Board of Scientific Counselors for the Agency for Toxic Substances and Disease

Registry in Atlanta, Georgia. In addition, I have served as an active participant on numerous state and national professional committees and board of directors.

I was asked by Iberdrola Renewables, Inc. to review and comment on the health aspects of the response to the "Data Request No. 14: Tule Wind Project." My review consisted of an evaluation of draft responses for clinical and epidemiological consistency with current peer-reviewed, published literature. The responses adequately reflect the content of the scientific literature and are consistent with major reviews by academic and industry groups.

While I am not an acoustical engineer, acoustician, or noise modeler, I did review and was able to follow the processes described in the response to a level with which I am professionally comfortable and was able to utilize the data to address questions regarding health effects relative to the Tule wind farm project. The assumptions made regarding the modeling are generally consistent with other modeling efforts concerning other wind farm projects with which I have been involved.

A number of the questions included in the response involve lay concerns unsupported in the peer-reviewed literature, but reflect concerns of sufficient magnitude such that they should be addressed. A prime example of these concerns is "dirty electricity." While conjuring up visions of unhealthy consequences, "dirty electricity" actually appears to be a repackaging of "stray voltage" or possibly "EMF." Each of these terms periodically has been linked with power generation, transmission or use, yet there are no scientifically founded health effects associated with those entities or indications that these entities are associated with wind-generated power. These lay observations should not detract from the fact that there are no scientific, peer-reviewed studies that link wind turbines to specific diseases or health conditions.

It is my opinion that the following specific responses to the "Data Request No. 14: Tule Wind Project" is scientifically based and can be relied upon in the review of the proposed wind farm:

Items#: 1, 3, 5, 9, 10, 11, 13, 14, 15, 17, 18, 91, 20, 21, 23, 24, 25, 26, 29, 30, 31, 32, 33, 35, 37.

Best regards,

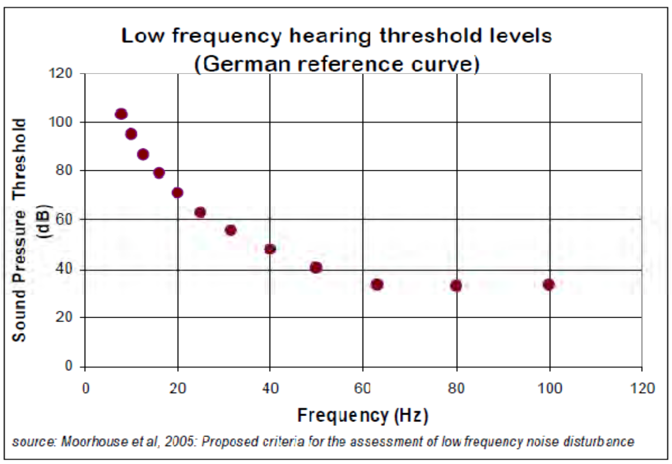
Mark A. Roberts, M.D., Ph.D.
Principal Scientist
Director for the Center of Occupational and Environmental Health

NOISE

1. *Please explain the characteristics of audible and inaudible sound as they relate to wind turbines, as well as a discussion regarding the appropriate metric for measuring both.*

Response: Wind turbine sound is created by mechanical components in the nacelle and through aerodynamic generation. The dominant source of sound for modern turbines is the interaction of the rotating blades with the air, called aerodynamic sound. Modern upwind-configured wind turbines produce noise throughout the range of infrasonic, low, midrange, and high frequencies. These broadband sound emissions typically exhibit peak spectral emissions around 500 Hz[1] to 1 kHz. The noise emitted by modern upwind-configured wind turbines contains very low amounts of energy in the infrasonic range, low amounts of low frequency energy, and relatively more energy in the audible range. Modern up-wind configured wind turbines are recognized as emitting less low-frequency noise than older down-wind configured wind turbines[2], illustrated in Figure 1-1.

Figure 1-1. Low Frequency Hearing Threshold Levels



Sound is perceived and recognized by its loudness (pressure) and pitch (frequency). Human hearing of sound loudness ranges between 0 dB (threshold of sound for humans) and 140 dB (very loud and painful sound for most humans)[3,4]. Not all sound pressures are perceived as being equally loud by the human ear due to the fact that the human ear does not respond equally to all

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1 The frequency of sound is expressed in Hertz (Hz) which is equal to 1 cycle per second.

2 Anthony L. Rogers, Ph.D., James F. Manwell, Ph.D., Sally Wright, M.S., PE, " Wind Turbine Acoustic Noise" prepared by the Renewable Energy Research Laboratory, Department of Mechanical and Industrial Engineering, University of Massachusetts at Amherst, January 2006.

3 NASD.National Agricultural Safety Database. Noise: The Invisible Hazard. (1993), Available at http://www.nasdonline.org/docs/d000801-d000900/d000882/d000882.html.

4 NMCPHC. Navy and Marine Corps Public Health Center. Physics of Sound. (4-15-2009), Available at http://www-nmcphc.med.navy.mil/downloads/occmed/toolbox/PHYSICSOFSOUND.ppt.

frequencies. The frequency range of human hearing has been found to be between 20 Hz and 20,000 Hz for young individuals with a declining upper frequency range correlating with increasing age[5]. The sound perception, "hearing," for humans is less sensitive to lower frequency (low pitch) and higher frequency (high pitch) sounds. As a result, the human ear can most easily recognize sounds in the middle of the audible spectrum, which is ideally between 1 kHz to 4 kHz (1,000 to 4,000 vibrations per second)[6]. Figure 1-2 from Rogers, et al. shows the hearing threshold for the human ear for low frequency noise expressed as sound pressure. The figure shows that humans do not hear sounds below 20 Hz very well.

Figure 1-2. Spectral Content of Vestas V80 Noise Showing Infrasonic and Low Frequency

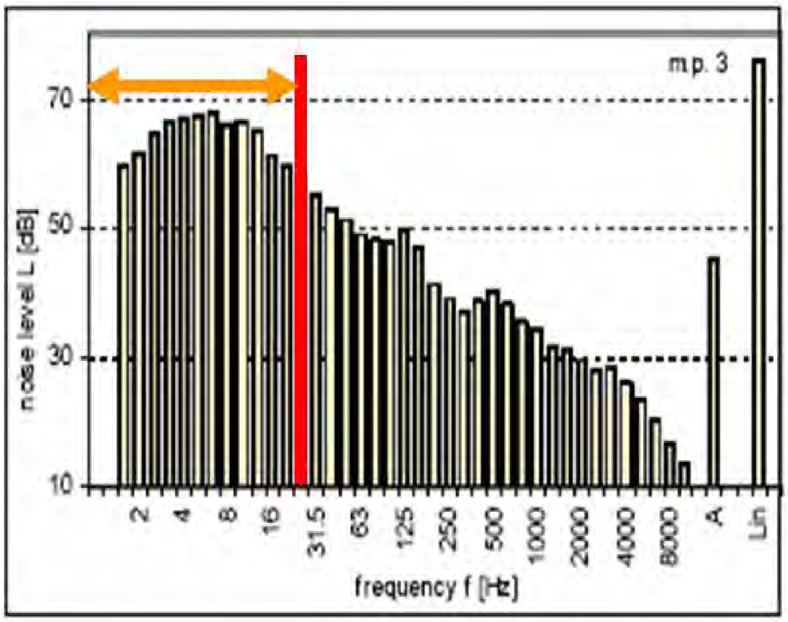
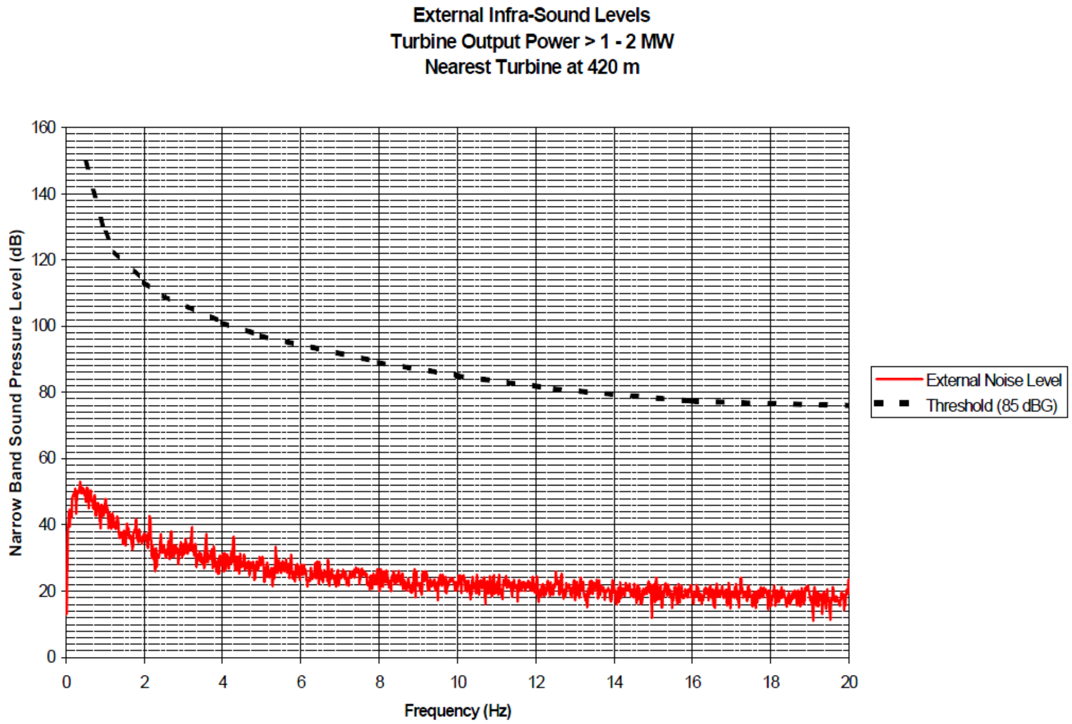


Figure 1-2 from Rogers, et. al shows noise levels downwind of a Vestas V80. When compared with the threshold shown in the figure above, the figure below shows that the infrasonic and low frequency content of the Vestas noise emissions are below the hearing human perception threshold.

The data in Figure 1-2 are supported by data reported in "InfraSound, Low Frequency Noise & Vibration from Wind Turbines"[7] by Dr. Andy McKenzie of the Hayes McKenzie Partnership Ltd, as shown in Figure 1-3 below.

[5] Berglund, B., Hassmen, P., and Job, R. F. (1996). Sources and effects of low-frequency noise. *Journal of the Acoustical Society of America.* 99(5), (2985 -3002).
[6] UNSW.The University of New South Wales. dB: What is a decibel? (2005), Available at http://www.phys.unsw.edu.au/jw/dB.html.
[7] Available at http://www.envis.sk/storage/25McKenzie.pdf

Figure 1-3. Wind Turbine Noise Measurement Data



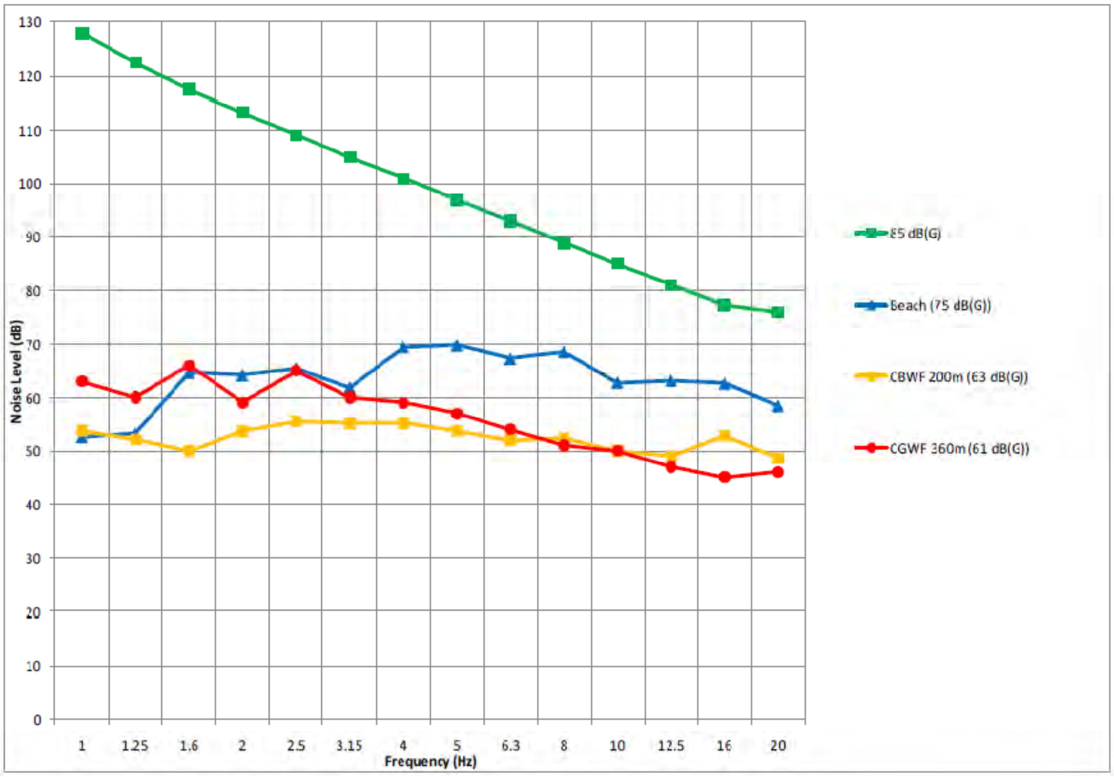
Data in Figure 1-3 above shows that infrasound from a 1-2 MW (megawatt) wind turbine operating approximately 420 m away from the receiver are well below the threshold for perception of infrasound.

Additionally these data are supported by measurement data reported in Australia by the consulting firm Sonus Pty, Ltd[8]. The graph (Figure 1-4) below by Sonus compares infrasound measurements at two operating wind farms, Clements Gap (CGWF – 61 dBG) and Cape Bridgewater) (CBWF – 63 dBG), with data measured at a beach in the absence of wind turbine noise. These three data sets are compared with the internationally recognized audibility threshold for infrasonic noise.

The Sonus measurement results indicate that the levels of infrasound in the vicinity of the two Australian wind farms are well below the audibility threshold of 85 dB(G) established by international research.[9] The measurement results are of the same order as that measured from a range of sources including a beach.

[8] Sonus Pty, Ltd. in "INFRASOUND MEASUREMENTS FROM WIND FARMS AND OTHER SOURCES" prepared for Pacific Hydro Pty Ltd, November 2010.
[9] Sonus Pty, Ltd. in "INFRASOUND MEASUREMENTS FROM WIND FARMS AND OTHER SOURCES" prepared for Pacific Hydro Pty Ltd, November 2010.

Figure 1-4. Infrasound Summary Results from Two Australian Wind Farms



Summary Graph – Infrasound measurement results from two Australian wind farms (Clements Gap at 61 dB(G) and Cape Bridgewater at 63 dB(G)) compared against measurement results at a beach (measured at 75 dB(G)) and the internationally recognised Audibility Threshold (85 dB(G))

Measurements of operating wind turbines published by Epsilon and Associates (Epsilon) also show that infrasonic sound emissions from modern upwind-configured wind turbines are below audibility thresholds for even the more sensitive people at a distance of 1,000 feet. The results of the Epsilon analysis and field testing indicate that there is no audible infrasound either outside or inside homes at the any of the measurement sites – the closest site was approximately 900 feet from a wind farm. Wind farms at distances beyond 1,000 feet meet the ANSI (American National Standards Institute) standard for low frequency noise in bedrooms, classrooms, and hospitals, and there should be no window rattles or perceptible vibration of lightweight walls or ceilings within homes. In homes there may be slightly audible low frequency noise (depending on other sources of low frequency noise); however, the levels are below criteria and recommendations for low frequency noise within homes. [10] The wind turbine types measured by Epsilon include the GE 1.5sle and Siemens SWT 2.3-93.

[10] Epsilon Associates, A Study of Low Frequency Noise and Infrasound from Wind Turbines, May 2009.

Inaudible sound is not generally assessed in analyses of environmental noise (because it cannot be heard), and there is limited merit in discussing an appropriate metric for inaudible sound in the context of an assessment of environmental noise caused by wind turbines.

Low frequency noise can be problematic if it occurs at very high levels or levels higher than what occurs from wind turbines. Mechanics who work on military aircraft are one example of the subset of the general population who might be routinely exposed to very high levels of low frequency noise. Excessive exposure to infrasound and low frequency noise (ILFN), which is defined as all acoustical phenomena occurring at or below the frequency bands of 500 Hz has been associated with a condition termed vibro-acoustic disease (VAD).), a thickening of cardiovascular structures, such as cardiac muscle and blood vessels.[11] Other examples of environments where the ILFN may reach levels and exposures that could lead to VAD include:

- Military, applications of infrasound as a non-lethal weapon;
- Work carried out in connection with the Apollo space program (i.e. levels equivalent to exposure of astronauts during blast off);
- Echocardiography of aerospace workers (i.e. those working around ground running aero engines); and
- Noise risks in military operations.

Levels of infrasound due to all of the above will have significant effects above 125 dB (linear).[12] The infrasound levels due to all of the above bear no connection to the sound produced by wind turbines.[13]

In summary, there is clear, consistent, and objective evidence that modern wind turbines emit very low levels of infrasonic and low frequency noise. The evidence also shows that these emissions are below the internationally recognized threshold for perception of infrasound. Furthermore, the Chief Medical Officer of Heath from Ontario, Canada stated: “There is no evidence of adverse health effects from infrasound below the sound pressure level of 90dB (Leventhall 2003 and 2006).[14]”

The appropriate metric to measure and assess audible wind turbine sound is dictated by the context of the measurements. In this instance, the applicable sound limits are the context for this discussion. Section 6951 of the San Diego County Zoning Ordinance requires that sound level limits of Title 3, Division 6, Chapter 4 of the San Diego County Code (Noise Abatement and Control) shall apply to large wind turbine systems. San Diego County Code of Regulatory Ordinances Section 36.403 Sound Level Measurement specifies that sound level measurements

[11] Castelo Branco NAA, Alves-Pereira M. (2004) Vibroacoustic disease. *Noise & Health* 2004; 6(23): 3-20.
[12] Kryter, Karl D. The Effects of Noise on Man, Second Edition. Florida: Academic Press Inc., 1985
[13] Direct testimony of Dr. Geoff Leventhall on behalf of Wisconsin Electric Power Company, before the Public Service Commission of Wisconsin, E-docket number 6630-CE-302
[14] Chief Medical Officer of Health, “The Potential Health Impact of Wind Turbines,” May 2010.

"[…]shall be measured with a sound level meter using A-weighting and a "slow" response time, as these terms are used in ANSI S1.1-1994 or its latest revision.

Additionally the San Diego County General Plan Part VIII Noise Element states:

> "The most appropriate basic unit of measure for community noise is the A-weighted sound level, abbreviated dBA. This unit gives a lower weight to low and high frequency sounds in a manner similar to the relative lower efficiency of the ear at low or high frequencies."[15]
>
> In San Diego County, the appropriate metric for measuring audible wind turbine generated sound is the A-weighted decibels. This is consistent with the County Noise Element, local sound level limits[16] and post-construction sound level measurement procedures.[17] The A-weighting scale simulates the frequency response of the human ear to both high, mid and low frequency sounds.

2. *Please provide an explanation of the general level and amount of low frequency noise generated by wind turbines and how it compares to other noise sources. Please also respond to the comment that low frequency sound increases as the distance from wind turbines increases.*

Response: Post-construction noise monitoring requirements for wind turbines are fairly new in the United States, and therefore there is not an abundance of noise monitoring data available. A recent field study performed by Epsilon Associates (*A Study of Low Frequency Noise and Infrasound from Wind Turbines, July 2009*) contains a detailed discussion of measured low-frequency noise from wind turbines. The study measured infrasound and low frequency sound associated with two modern turbines, the GE 1.5sle and the Siemens 2.3-93. Using existing ANSI criteria for the evaluation of interior sound levels, Epsilon Associates determined that noise generated by wind farms at distances beyond 1,000 feet were below the low frequency noise criteria for bedrooms, classrooms and hospitals. In addition to meeting ANSI background noise criteria the measured interior noise levels also demonstrate that wind turbine setbacks of 1,000 feet will not cause "more than minimal annoyance (if any) from low frequency noise, and there should be no wind rattles or perceptible vibration of light-weight walls or ceilings within homes."

The overall noise level and spectrum of the GE 1.5-sle turbine is similar to the noise emissions of the GE 1.5 XLE, one of the turbines being considered for use in the Tule Wind Project. The Siemens 2.3-93 turbine, also used in the Epsilon study, has similar sound emissions, within +/- 3 dB, to the 2.0 MW and 3.0 MW turbines being considered for use in the Tule Wind Project. Current setbacks for the Tule Wind Project are more than 1,500 feet from the nearest non-participating home. Based on the Epsilon noise study, low frequency noise at a distance of

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[15] San Diego County General Plan Part VIII Noise Element. GPA 06-008. 2006 September 27. Pg. VIII-6.
[16] San Diego County Code of Regulatory Ordinances Section 36.404.
[17] San Diego County Code of Regulatory Ordinances Section 36.403.

1,500 feet will have no audible infrasound and will meet ANSI S12.2 criteria for acceptable indoor levels for low frequency sound.

Infrasound and low frequency sound exposure is part of the everyday sound exposure. Natural sources of low frequency and infrasound include wind and moving bodies of water such as rivers and waterfalls. Common anthropogenic sources of low frequency and infrasound include vehicular traffic, aircraft, rail traffic, HVAC equipment and other industrial sources. Household appliances and everyday activities such as washing machines, running, swinging on a swing set, and swimming also produce low frequency sound and infrasound.

Additionally the infrasonic and low-frequency noise emissions from wind turbines are often less than levels emitted by natural sources like ocean waves crashing on a beach (crashing ocean waves often produce a roar that has a distinct low-frequency tonal component that is much louder than the noise emitted by a wind turbine).

The notion that sound pressure levels in any frequency range increase with increasing distance from the noise source is not a factual statement. Sound levels in all frequencies including low frequencies do not increase with increasing distance from the noise source. Sound pressure waves travel in all directions, and therefore lose energy with increasing distance from the noise source. Sound levels diminish as the sound propagates outward along the path from the source to the receiver; this divergence is independent of frequency.[18,19] A simple analogy is an unshaded light bulb; the amount of light diminishes with increasing distance from the bulb.

There are instances in which sound levels in a particular location would experience a slight increase in sound levels due to the presence of reflective surfaces. This does not mean that the low frequency increases with distances, but that reflective surfaces may cause localized increases in sound of all frequencies. This would be similar to placing a light bulb over a mirror, as some of the light would reflect upwards and may appear brighter. But there would never be an increase in the amount of light or energy as you move away from the source.

3. *Please provide an explanation regarding how the existing ambient sound levels were calculated for the project, including the standards and measurement procedures adhered to in collecting this data. Please provide a discussion of how short term events or background wind noises were considered in calculating existing ambient sound levels.*

Response: Existing noise levels were not calculated, they were measured directly using precision logging sound level meters and microphones. Measurement durations were 24 hours long at each measurement location. Data were continuously recorded and logged in the memory of the sound level meter for later download and analysis. Existing sound levels were analyzed in terms of 1-hour intervals, consistent with many state and federal agency standards (i.e., Federal Highway Administration, Federal Transit Administration, Federal Railroad Administration, Minnesota Pollution Control Agency, Illinois Pollution Control Board, etc.), as well as common

[18] Anderson Grant S and Kurze Ulrich J. Outdoor Sound Propagation. in Noise and Vibration Control Engineering: Principles and Applications. Edited by Leo L. Neranek and Istvan L. Ver. 1992.
[19] Harris, Cyril M. Handbook of Acoustical Measurements and Noise Control. Third Ed. Acoustical Society of America. 1998.

practice for environmental noise measurements. In regard to the San Diego County regulations, the 1-hour measurement interval was required to compare existing sound levels against future sound levels due to the project.

The intent of the sound measurement was to *characterize the existing ambient sound environment*. Therefore, standardized measurement methods were chosen which have scope and purpose that are compatible with this intent. The applicable standards from the ANSI and ASTM International (formerly known as the American Society for Testing and Materials) are listed Table 3-1 by their designation, title, and a paraphrase of the purpose and scope that is applicable to the existing ambient sound measurement.

Table 3-1. Applicable Sound Measurement Standards for Existing Ambient Sound

ANSI S1.13	*Measurement of Sound Pressure Levels in Air*
A fundamental standard providing a uniform procedure for measuring sound pressure levels at a single point in space; it is applicable to a wide range of measurements indoors or outdoors.	
ANSI S12.9/Part 2	*Measurement of Environmental Sound. Part 2: Measurement of Long-Term, Wide-Area Sound*
Procedures to measure environmental sound levels for several purposes, including, "Assessment of the general community noise environment and establishment of baseline environmental noise levels." It includes procedures for spatial and temporal sampling.	
ASTM E1 014	*Measurement of Outdoor A-Weighted Sound Levels*
Procedures to measure and document sound pressure levels outdoors for several purposes, including, "Documentation of sound levels before the introduction of a new sound source (for example, assessment of the impact due to a proposed use)."	

The measurement of existing ambient sound levels for the Tule Wind Project followed applicable portions of the above measurement standards.

The measurement procedures above consider short-term sound events an inherent feature of the sound measurement, and do not exclude these sounds from the measurement. There are other measurement methods which address the exclusion of short-term and transient sound events in the environment. They are listed in Table 3-2 by designation, title, and a paraphrase of the purpose and scope.

The standards above are *not* intended to characterize the existing ambient sound levels. They are intended to measure the sound from a specific source. It is therefore inappropriate to use these methods to document the existing (pre-construction) acoustic environment. The sound sources of interest – the wind turbines – do not yet exist.

Table 3-2. Applicable Sound Measurement Standards for Short-Term and Transient Sound

ANSI S12.9/Part 3	*Measurement of Environmental Sound. Part 3: Short-Term Measurements with an Observer Present*
Procedures to measure sound from a specific source and to effectively eliminate the influence of extraneous background sounds from the specific source.	
ANSI S12.18	*Outdoor Measurement of Sound Pressure Level*
Procedures to measure sound from a specific source or sources and to account for environmental conditions with the purpose of obtaining reproducible sound pressure levels of the same sound source in different environmental conditions.	
ASTM E1780	*Measuring Outdoor Sound Received from a Nearby Fixed Source*
Procedures to measure sound from a specific source at a location in the vicinity of that same source, primarily for the purpose of comparing to criteria or regulatory limits.	

The standards ANSI S12.9/Part 3 and ANSI S12.18 both have procedures to remove the influence of extraneous background sounds. When measuring a specific sound source, it is impossible to separate the sound of the specific source of interest from the rest of the sounds in the environment. Therefore it is necessary to perform two measurements: one of the total sound (the source of interest combined with the remaining sounds in the background environment), and one of just the background sound (the sounds in the environment without the source of interest). Once this is accomplished, it is possible to mathematically derive the sound level of the specific sound source on its own, without the background environment. This can be an intricate process, because the background sound must be nearly identical in both measurements. If short-term or transient noise events occur in either the total sound measurement or the background sound measurement, the calculation will yield incorrect results. Therefore short term or transient events are excluded when measuring a specific sound source.

Measuring the existing ambient sound environment for the Tule Wind Project did not follow procedures of ANSI S12.18 described above. Despite the existence of a clause therein which allows for measurement of ambient sound measurements, the introduction states the procedures are primarily focused on measurements of specific sound sources, and the scope clause specifically precludes use of ANSI S12.18 for environmental assessment or planning for compatible land uses.

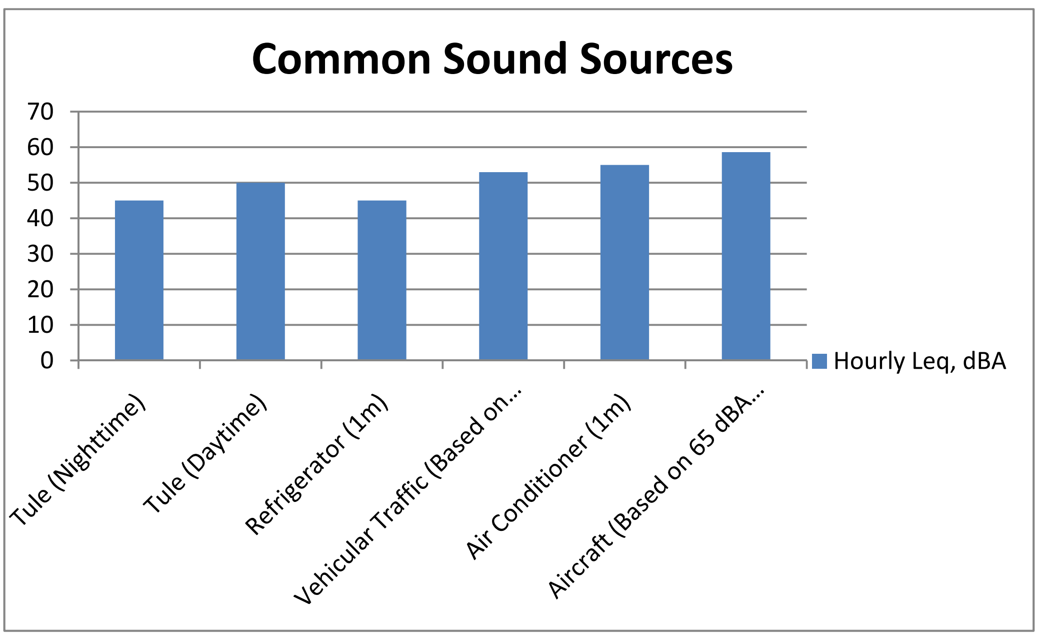
Short-term noise events that occurred during the measurement period are inherently integral to the existing ambient sound environment for the Tule Wind Project; therefore these sounds were included in the measurement results of the existing ambient sound environment, following applicable portions of standards ANSI S1.13 and ANSI S12.9/Part 2 and ASTM E1014. In other words, the analysis for the Tule Wind Project included short term events and background wind noises in its measurements of existing ambient sound levels.

4. *Please provide an explanation regarding the sound characteristics of wind turbine noise, including a discussion of how noise from wind turbines compares to noise generated from other sources at comparable sound levels (e.g. aircraft or road noise) and how noise from wind turbines compares to other sources in terms of annoyance. Please take into consideration the modulating character of wind turbine noise, the mix of tones from wind turbines and how they relate to the thresholds of perception, low frequency energy (both audible and inaudible) generated by wind turbines, and the effect of spacing between wind turbines.*

Response: Wind turbine sound is created by mechanical components and through aerodynamic generation. The dominant source of sound for modern turbines is the interaction of the rotating blades with the air called aerodynamic sound. Aerodynamic sound produced by wind turbines is broadband and contains: low and inaudible amounts of energy in the infrasonic range, low amounts of low frequency energy which may or may not be audible, and relatively higher levels of noise in the audible range of middle and high frequencies.[20]

Table 4-1 depicts various common noise sources in comparison to the sound design goals of the Tule Wind Project. As shown in Table 4-1, the sound design goals for the Tule Wind Project are 50 and 45 dBA, on an hourly Leq basis, for daytime and nighttime hours respectively. The sound level limits depicted apply to the property line of residential parcels. Sound levels of 45 and 50 dBA are comparable to common interior sound sources such as modern refrigerators.

Table 4-1. Common Noise Sources



[20] G.P. van den Berg. "The Beat is Getting Stronger: The Effect of Atmospheric Stability on Low Frequency Modulated Sound of Wind Turbines." Noise Notes Volume 4 Number 4.

In comparison to other exterior sound sources an hourly Leq of 45 dBA is relatively low. The San Diego County threshold of significance allows for a sound level exposure of up to 60 dBA CNEL or 53 dBA Leq for transportation related sources.[21] In comparison to the Tule Wind Project, vehicular traffic can be 3 to 8 dBA louder than wind turbine generated noise. Both vehicular traffic and aircraft overflight commonly approach or exceed 50 dBA Leq. Steady, low-volume traffic pass-by events exhibit a rhythmic rise and fall in volume. Ocean waves crashing on a beach also exhibit a rhythmic rise and fall in volume. In this manner noise from these events exhibits amplitude modulation, which by virtue of its nature is not intrinsically annoying or harmful to human health. Both traffic noise and ocean waves exhibit a mix of broadband, low frequency, and infrasonic noise emissions – which by virtue of its nature is also not intrinsically annoying or harmful to human health.

Wind turbines emit broad band noise. As the blades move closer and away from a stationary listener, the noise they emit gets louder and softer. This rhythmic increase and decrease in noise emissions is called amplitude modulation. The frequency content of amplitude modulated wind turbine noise typically occurs between 500 Hz and 1,000 Hz.[22]Certain persons believe that the amplitude modulated sound made by wind turbines makes their noise emissions more annoying than other environmental noises like highway traffic noise. However, as mentioned previously, noise which exhibits amplitude modulation is not considered to be annoying.

In fact, many people consider the rhythmic noise made by ocean waves to be desirable. Although noise from ocean waves is largely broadband, it also contains low-frequency noise and is a natural source of infrasound.

In one respect, differential spacing between wind turbines has the same effect as differential spacing between any other sound sources in that at certain distances the combination of lines of turbines will behave like a line-source. This effect is a matter of geometry, and these geometric attributes were included in the sound analysis for the Tule Wind Farm. In another respect, differential spacing between wind turbines may affect the amount of turbulence that downwind turbines may experience. Current state of the art acoustical analysis tools do not incorporate meteorological routines that would allow the assessment such inter-turbine turbulence. To ensure that the noise analysis does not understate the noise from the project due to the inability to account for such specific atmospheric effects, other, conservative assumptions were used in the noise analysis, including use of 100% acoustically reflective ground, modeling of the hot weather package (which includes additional noise from cooling equipment in the nacelle), continuously downwind conditions in all directions and the addition of 2 dBs to the manufacturer-stated sound emissions. Please refer to Response 7 of Data Request No. 14 for further details on inter-turbine turbulence.

[21] Estimated based on constant vehicular traffic
[22] Colby et al. Wind Turbine Sound and Health Effects – An Expert Panel Review. American Wind Energy Association. December 2009.

5. *Please provide an explanation of the relative level of annoyance resulting from low frequency sound as it compares to perceptible, audible sound. Please take into consideration the thresholds of perception for single pure tones as compared to tones generated by wind turbines and the relative sensitivity of individuals to audible and inaudible sound levels.*

Response: It is difficult to correlate inaudible sounds (in any frequency band) to perceptible, audible sounds because if a sound cannot be heard then its potential to annoy a person is very difficult to establish objectively. This is particularly true in the outdoor environment as opposed to in an audiology booth. We know that the low frequency and infrasonic energy in wind turbine noise has enough energy to impart a displacement upon a human skin of approximately ten microns (half the thickness of a strand of hair). We also know that heart beats, breathing, and normal movements displace the areas of the human body significantly more than ten microns.[23] In addition, the human body produces multiple sources of sound. Heart sounds are in the range of 27 to 35 dB at 20-40 Hz[24] and lung sounds are reported in the range of 5-35 dB at 150-600 Hz[25]. Therefore, it is difficult to accept the hypothesis that sound pressure levels from wind turbines in the inaudible portion of the acoustic spectrum have potential to annoy or impart adverse health effects in a direct exposure to outcome continuum.

The responses to question 1 established that low frequency and infrasonic content of wind turbine noise is below recognized thresholds of perception. There is anecdotal evidence that suggests that audible wind turbine noise is annoying to some people. However, the Chief Medical Officer of Health for Ontario Canada stated in a recent report, “The review concludes that while some people living near wind turbines report symptoms such as dizziness, headaches, and sleep disturbance, the scientific evidence available to date does not demonstrate a direct causal link between wind turbine noise and adverse health effects. The sound level from wind turbines at common residential setbacks is not sufficient to cause hearing impairment or other direct health effects, although some people may find it annoying”[26].

The suggestion that inaudible sound from wind turbines causes annoyance is largely unsupported by objective and factual data. There is no direct, causal link between inaudible sound from wind turbines and annoyance. Pure single tones, also referred to as prominent discrete tones, exhibit an increase of at least 5 dB from the adjacent octave bands. This makes them discernable as a tone, and they stand out from the overall acoustic environment and are by definition more distinctly audible. Common modern wind turbines do not emit prominent discrete tones[27,28,29].

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[23] Direct testimony of Dr. Geoff Leventhall on behalf of Wisconsin Electric Power Company, before the Public Service Commission of Wisconsin, E-docket number 6630-CE-302.
[24] Sakai, A., Feigen, L. P., and Luisada, A. A. (1971). Frequency distribution of the heart sounds in normal man. *Cardiovascular Research.* 5(3), (358 -363).
[25] Fiz, J. A., Gnitecki, J., Kraman, S. S., Wodicka, G. R., and Pasterkamp, H. (2008). Effect of body position on lung sounds in healthy young men. 133(3), (729 -736).
[26] Chief Medical Officer of Health, “The Potential Health Impact of Wind Turbines”, May 2010.
[27] Delta Test Report, “Measurement of Noise Emission from a Vestas V90 3 MW wind turbine “model 0””, December 10, 2009.
[28] General Electric, “Technical Documentation Wind Turbine Generator Systems GE 1.6xle - 50 Hz & 60 Hz”, 2009.

6. *Please provide an explanation of the methods used by HDR to measure sound generated by the wind turbines, including an explanation for the use of the dB(A) scale as a metric for determining noise impacts from wind turbines.*

Response: HDR has not measured sound emissions from wind turbines associated with the proposed project. The analysis results presented in the *Tule Wind Project – Draft Noise Analysis Report* represent calculated project-related sound levels. Project-related sound levels were calculated using Cadna-A, an acoustical analysis software package designed for evaluating environmental noise from stationary and mobile sources. Cadna-A is a three-dimensional noise model based on International Standards Organization (ISO) 9613, “Attenuation of Sound during Propagation Outdoors,” adopted by the ISO in 1996. This standard provides a widely-accepted engineering method for the calculation of outdoor environmental noise levels from sources of known sound emission.

Several sound sources associated with project operations were modeled using Cadna-A including the project collector substation, wind turbine generators and a SODAR unit. The sound analysis evaluated noise impacts based on the maximum project build-out in terms of number of turbines. The maximum build-out for the project allows for up to 128 1.5 MW turbines. In the assessment of wind turbine-generated sound 128 Gamesa G87 2.0 MW turbines were modeled. If 2.0 MW turbines, such as the G87, were to be utilized, approximately 100 locations would be built versus the 128 locations modeled. Turbine locations and turbine types have not been finalized; therefore, all potential locations were analyzed. Actual noise impacts utilizing a 2.0 MW turbine would be less than modeled due to fewer turbines.

The sound analysis estimated project-related sound levels by incorporating a number of modeling techniques whose net effect conservatively over-estimated noise propagation in the project area. These techniques include assuming that the ground is 100% acoustically reflective, that the noise levels associated with the hot weather package (which includes additional noise from cooling equipment in the nacelle) were occurring all of the time, and other techniques as described in response to question 16 that conservatively over-estimate project related noise levels. Table 6-1 summarizes the conservative modeling assumptions and their effect on modeling results.

The net effect of these conservative assumptions shown in the table above is the over-estimation of project-related noise levels. As shown in Table 6-1, this noise analysis is reasonable, appropriate, and is more conservative than required by the standards of practice in the field of environmental acoustics.

[29] Suzlon Energy A/S, “Sound Power Level S88-2.1MW”, October 25, 2010.

Table 6-1. Modeling Assumptions and Influence on Calculated Sound Level

Modeling Assumption	Effect on Calculated Sound Level
Guaranteed sound level v. maximum manufacturer stated	+2 dB
Continuous use of hot weather package[1]	+ 2.6 dB
Reflective ground	+3 dB
Continuous downwind conditions for all directions[2]	≈ 0 to 2 dB
Use of 128 2.0 MW turbines vs. 128 1.5 MW turbines[3]	≈ 0 to 5 dB
Total effect on calculated sound level	7.6 to 14.6 dB

[1] Lower emission modes of the hot weather package would be used during nighttime hours as the mode modeled will only be used in temperature above 98° F.
[2] This results in the wind blowing in all directions continuously throughout an hour.
These are the most favorable propagation conditions (wind blows in all directions all the time).
[3]The Tule sound analysis modeled 2.0 MW turbines in a layout that is representative of maximum build-out with a 1.5 MW turbine (resulting in 28 additional turbines). If 1.5 MW turbines were modeled using the current layout, resulting sound levels would be up to 5 dB lower, based on the use of a GE 1.5 XLE turbine.

The A-weighting scale is a close approximation of the human response to different frequencies of sound and is in broad use across many disciplines which address noise. The A-weighting scale attenuates low-frequency noises in a manner that simulates how human ears attenuate low frequency noise at low levels (approximately 40 dB). The A-weighting scale is the most appropriate weighting scale for environmental acoustics analysis and to assess compliance with applicable noise limits. State and Federal agencies that regulate environmental noise throughout the United States rely on the A-weighted decibel, or dB(A) as the most appropriate metric for assessing human response to noise. Applicable noise rules in California also rely on the A-weighted decibel.

Section 6951 of the San Diego County Zoning Ordinance requires that sound level limits of Title 3, Division 6, Chapter 4 of the San Diego County Code (Noise Abatement and Control) shall apply to large wind turbine systems. San Diego County Code of Regulatory Ordinances Section 36.403 Sound Level Measurement specifies that sound level measurements "[…] shall be measured with a sound level meter using A-weighting and a "slow" response time, as these terms are used in ANSI S1.1-1994 or its latest revision.

Additionally the San Diego County General Plan Part VIII Noise Element states:

> "The most appropriate basic unit of measure for community noise is the A-weighted sound level, abbreviated dBA. This unit gives a lower weight to low and high frequency sounds in a manner similar to the relative lower efficiency of the ear at low or high frequencies."[30]

[30]San Diego County General Plan Part VIII Noise Element. GPA 06-008. 2006 September 27. Pg. VIII-6.

In San Diego County the appropriate metric for determining noise impacts from wind turbine generated sound is the A-weighted decibels. This is consistent with the County Noise Element, local sound level limits[31] and post-construction sound level measurement procedures.[32]

Please refer to Sections 1.3 and 3.1 of the *Tule Wind Project – Draft Noise Analysis Report* for further details concerning the modeling methodology and applicable regulations.

7. *Please provide an explanation of how temperature inversion, uncharacteristic weather patterns, high wind shear above the boundary layer, periods of atmospheric turbulence (as it relates to turbines mounted on high locations with rough terrain), and inter-turbine turbulence resulting from inter-turbine spacing of less than 5 to 7 rotor diameters were addressed in the sound modeling.*

Response: The noise analysis report prepared and submitted for this project explains the meteorological assumptions and features used in the Cadna-A noise model developed to calculate project-related noise. Events such as temperature inversions, uncharacteristic weather patterns, high wind shear above the boundary layer, periods of atmospheric turbulence, and inter-turbine turbulence typically last for short durations, sometimes very short durations. Current state of the art acoustical analysis tools do not incorporate meteorological routines that would allow the assessment of micro-climatology like inter-turbine turbulence, atmospheric turbulence and high wind shear above the boundary layer. Alternatively, conservative assumptions were used in the noise analysis, including use of 100% acoustically reflective ground, modeling of the hot weather package (which includes additional noise from cooling equipment in the nacelle), continuously downwind conditions in all directions and the addition of 2 decibels to the manufacturer-stated sound emissions. These assumptions ensure that the noise analysis does not understate noise from the project.

Temperature Inversions

Atmospheric conditions influence the propagation of sound; the main effect is refraction (a change in the direction of the sound waves) produced by vertical gradients of wind and temperature. Normally the temperature decreases steadily with increasing height above the ground. At night, the temperature sometimes decreases with decreasing height; this is called a temperature inversion. During an inversion, the sound waves that would normally travel upward and away from the noise source refracts (bends) downward. This causes noise levels at points away from the source to be louder than they would be under non-inversion conditions.[33]

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[31] San Diego County Code of Regulatory Ordinances Section 36.404
[32] San Diego County Code of Regulatory Ordinances Section 36.403
[33] Page 3-12, "Handbook of Noise Control", ed by Cyril M. Harris, second edition, 1979

The sound modeling performed for the Tule Wind Project represents sound levels that would be experienced under downwind propagation, or propagation under a "well-developed moderate ground-based temperature inversion, such as commonly occurs at night."[34]

Temperature inversions are most commonly caused by radiative cooling of the ground at night leading to cooling of the air in contact with the ground. Such conditions are especially prevalent on cloudless nights with little wind. If winds occurred at the ground level, the inversion layer would become mixed with the layers above it and the inversion would begin to disappear.

Temperature inversions occurring within the lowest 50 to 100 meters of atmosphere can affect noise levels measured on the ground. Such conditions may increase noise levels by focusing sound wave propagation paths at a single point. Conventional approaches to assessing noise propagation under temperature inversion conditions require knowledge of the temperature gradient and assume that the noise source is located below the temperature inversion, typically near the ground. In summary, when a layer of cool air is trapped at the ground surface (with a layer of warmer air above it) and the winds are still, the resulting temperature inversion is known to focus sound wave propagation paths (from noise sources operating in the layer of cold air, most often on the ground) at a single point on the ground.

The effect of temperature inversions on noise propagation from wind turbines is not typical of other sources. Wind turbines located on top of ridges are often located at elevations that are much higher than nearby receivers. In those circumstances it is unlikely that conventional temperature inversions in the lower 100 meters of the atmosphere would affect noise propagation from sources elevated as high as wind turbines on top of ridges. A further consideration must be that temperature inversion requires little to no wind in order to minimize atmospheric mixing and hence develop. During calm conditions the wind turbine generators are unlikely to operate, because the cut-in speed is approximately 3-4 m/s. [35]

In general, sound propagates best under stable conditions with a strong inversion, such as during a clear night with low winds. In those situations, sound levels from wind turbines would be at their lowest. Wind speeds under very stable conditions – Stability Class G – generally are too low to generate electricity, and thus, the wind turbines would produce little or no noise. As a result, worst-case conditions for wind turbines tend to be under more moderate nighttime inversions.[36]

Moderate nighttime inversions include periods when winds at the hub height are above the cut-in speed and ground-level winds are still, so that there is no masking noise from ground-level winds. These conditions are most likely to result in the highest levels of amplitude modulation, be most favorable to noise propagation, and therefore result in wind turbine noise being the most perceivable[37]. Post-construction noise measurements were performed during these conditions, at

[34] International Organization for Standardization (ISO). ISO 9613-2:1996. *Measurement of Environmental Sound. Part 2: Measurement of Long-Term, Wide-Area Sound.*
[35] Silverton Wind Farm Noise Impact Assessment, July 23, 2008, by Heggies Pty Ltd.
[36] Kenneth H. Kalinski, "Understanding Turbine Sound Impact Studies", North American Wind Power, May 2008.
[37] Resource Systems Engineering, "Response to Powers Trust Objection", November 3, 2009

both the Mars Hill and Stetson wind farms. Over 300 hours of measurement data was collected under these conditions. Analysis of that data confirmed that noise levels measured under these moderate nighttime inversion conditions were within 5 dBA of modeled noise levels[38].

Temperature inversions can be modeled using current acoustical software using conservative methods that overestimate noise levels (as was done for this project) and also more refined methods. A more refined method involves use of the CONCAWE routine in Cadna-A, which allows a modeler to simulate very specific meteorological conditions including individual stability classes and select wind speeds. Table 7-1 presents a comparison of analysis results of three different and increasingly stable temperature inversions. Using a single Gamesa G87 turbine, one of the proposed turbine types for the Tule Wind Project, a model was developed to compare the sound levels that may be experienced during a temperature inversion. A comparison of modeled sound levels using various atmospheric stability classes and the assumptions used in the Tule sound study is presented in Table 7-1 below.

Table 7-1. Comparison of Various Temperature Inversions

Receptor Distance	ISO 9613-2 (Model Used for Tule Sound Study)	CONCAWE[2,3]	
	No Wind Rose[1]	Stab. Class = E Wind = 4.5 m/s	Stab. Class = F Wind = 2.5 m/s
500 ft	58.1	53.0	44.2
1000 ft	52.2	49.0	40.2
1500 ft	48.4	46.0	37.2
2000 ft	45.6	43.6	34.8

[1]The Tule sound study utilized ISO 9613-2 with no wind rose. These parameters represent a "well-developed moderate ground-based temperature inversion, such as commonly occurs at night."[39]
[2] meteorological corrections were applied to simulate inversions at various stability classes.
[3]Sound emissions used for CONCAWE calculations are relative to the operational wind speeds for each class. The turbine sound emissions in the CONCAWE models do not include 2.6 dB for warm-weather package noise. The periods in which these atmospheric stability classes are expected are cooler nighttime and early morning periods

Analysis results in Table 7-1 shows that the Tule noise analysis conservatively overestimates the project-related noise levels in a wide variety of atmospheric stability conditions, including strong inversions with low wind speeds. As shown in Table 7-1 the modeled results for ISO 9613-2 (that used for the Tule sound study) using no wind rose, are approximately 2 dB to 5 dB above the results for conditions consistent with stability class E, and approximately 11 dB to 16 dB above the results for conditions consistent with stability class F. This demonstrates that the modeling methods performed in the Tule noise analysis result in conservative over-estimates of project-related noise that are adequately representative of meteorological conditions that lead to

[38] Resource Systems Engineering, "Response to Powers Trust Objection", November 3, 2009.
[39] International Organization for Standardization (ISO). ISO 9613-2:1996. *Measurement of Environmental Sound. Part 2: Measurement of Long-Term, Wide-Area Sound.*

the most efficient noise propagation. These conditions include strong temperature inversions with calm winds below the cut-in speed.

The noise analysis performed for the Tule Wind Project modeled a moderate inversion condition. The Tule noise analysis also added more than five decibels of conservatism. In this manner, the Tule noise analysis accounted for moderate inversions and conditions most favorable to noise propagation, when ground-level masking is at its lowest level, and turbine noise is most noticeable.

Uncharacteristic Weather Patterns

Uncharacteristic weather patterns means winds are blowing from a direction that they normally do not blow from. The primary effect of this condition is to reduce noise levels at upwind receivers and slightly increase noise levels at downwind receivers.[40] Even during these conditions, wind direction changes throughout each hour; therefore downwind noise levels will vary with fluctuations in wind direction. By comparison, the Tule noise analysis assumes that the wind blows in each direction for the entire duration of an hour. The result of this unrealistic meteorological condition is conservative over-estimates of project-related noise levels during uncharacteristic weather patterns.

High Wind Shear Above the Boundary Layer

Wind speeds generally increase with increasing height above the ground. Irregularities in features on the ground (buildings, terrain, trees and other vegetation) cause friction between the ground and winds closest to it. That friction slows down wind speeds in the atmospheric layer closest to the ground. Wind shear occurs where the lowest atmospheric layer meets a layer of the atmosphere above it that is not affected by surficial friction: wind shear is the boundary between the lower (slower) winds and the higher (faster) winds.

There is evidence that wind shear increases both the sound power emissions and the amplitude modulation from wind turbines. Wind shear is highest and exhibits the greatest difference between wind speeds at 10 meters and at 80 meters at low wind speeds. Wind shear reduces with increasing wind speed to the point where it is, on average, of a similar value as that used in IEC 61400-11 to define wind turbine sound power levels. The difference between wind speeds at 10 meters and 80 meters at low wind speeds is more predominant at night. Night time wind shear is, on average, higher than day time. There does not appear to be a large difference between average wind shear in summer and winter. The evidence suggests that shear in winter may be slightly higher but this may be due to the fact that there are longer nights when shear is higher. Wind shear on a flat site is significantly higher than that on a hilly site, even a hilly site with low rolling hills. The difference in wind speeds at 10 meters and 80 meters is also higher on a flat site. This is true at all times of day and all times of the year.[41]

[40] Page 3-12, "Handbook of Noise Control", ed by Cyril M. Harris, second edition, 1979
[41] Dick Bowdler, "Wind Shear and its Effect on Noise Assessment", proceedings from the Third International Conference on Wind Turbine Noise, Aalborg, Denmark, June 2009.

While there is evidence to suggest that wind shear may increase the sound emissions, the effects are site specific and cannot be predicted with currently available data. Wind turbine sound emissions are measured using IEC 61400 Part 11. The wind turbine sound emission standard does not require the reporting of sound emissions under various wind shear conditions; therefore sound emissions for the proposed turbines, at various wind shear gradients is unavailable. Additionally it is infeasible to model noise results over all of the weather conditions and shear gradients that possibly could occur at a site. However, post-construction noise measurements performed at Mars Hill and Stetson indicate that when wind shear conditions exist, measured wind turbine noise levels are within five decibels of modeled results.[42] This reinforces the validity and conservatism of the Tule noise analysis.

There are also reports which claim that amplitude modulation may be affected by wind shear. Dr. Andy Moorhouse performed a study to determine the prevalence of amplitude modulation in wind farms in the UK and to identify the likely causes of amplitude modulation. Dr. Moorhouse summarizes his findings:

> *The literature review indicated that, although there has been much research into the general area of aerodynamic noise it is a highly complex field, and whilst general principles are understood there are still unanswered questions. Regarding the specific phenomenon of AM there has been little research and the causes are still the subject of debate. AM is not fully predictable at current state of the art. The survey of wind turbine manufacturers revealed that, although there was considerable interest, few have any experience of AM.*[43]

As stated by Dr. Moorehouse, there is no standard way to predict the occurrence of amplitude modulation, and there is no universally-agreed upon way to assess the potential for annoyance due to it. Therefore it is not possible to model it for the proposed Tule project. However, as demonstrated above, the Tule noise model conservatively over-estimates project-related noise levels.

Atmospheric Turbulence

Atmospheric turbulence causes inflow turbulent sound, meaning aeroacoustic noise is caused by the interaction of the atmosphere and the turbine blades. G.P. van den Berg defines inflow turbulent sound as being caused "Because of atmospheric turbulence there is a random movement of air superimposed on the average wind speed. The contribution of atmospheric turbulent to wind sound is named 'in-flow turbulence sound' and is broad band sound stretching over a wide frequency range."[44] A white paper prepared by the Renewable Energy Research

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[42] Resource Systems Engineering, "Response to Powers Trust Objection", November 3, 2009
[43] University of Salford. NANR233 "Research into aerodynamic modulation of wind turbine noise" Page 3 of 57, June 2007.
[44] G.P. van den Berg. "The Beat is Getting Stronger: The Effect of Atmospheric Stability on Low Frequency Modulated Sound of Wind Turbines." Noise Notes Volume 4 Number 4.

Laboratory cites that while inflow turbulence sound contributes to the broadband noise but is not yet fully quantified.[45] Therefore it is not possible to model it for the proposed Tule project.

The effects of atmospheric turbulence and the random micro-turbulence upon turbine blades will result in both increases and decreases in wind turbine noise emissions on a short-term, transient, instantaneous basis. Over a one-hour period, their net effect is unlikely to be dramatic. Atmospheric turbulence at the ground level will also create more masking noises at the ground level, making it harder to discern the turbine noise. The absence of atmospheric turbulence, and the random micro-turbulent winds that randomly interact with moving wind turbine blades is an ideal condition that does not occur in nature. These micro-turbulent winds occur whenever the wind blows; blades interact with these winds whenever they move through the air. On this basis it is reasonable to assume that reference sound power levels measured using IEC61400, and upon which the Tule sound analysis is based, already incorporate the influence of random micro-turbulent winds. As demonstrated above, the Tule noise model conservatively over-estimates project-related noise levels.

While atypical conditions such as those listed may temporarily increase sound levels, the sound analysis prepared for the Draft EIR/EIS prepared for the Tule Wind Project focused on conservatively over-estimating project-related sound levels that would be experienced on a daily basis.

The noise analyses performed for this project is consistent with the standards of practice in the field of environmental acoustics, and generally overstates the noise impacts. The analysis conservatively ignored ground absorption, and included an additional amount of conservatism added to the sound power level of each wind turbine. The analysis also conservatively assumed that the turbine was operating at its loudest rated sound power level condition for the entire duration of one hour. Additionally this analysis assumed that the most efficient propagation characteristics exist in all direction for the entire duration of one hour. These conservative measures are consistent with standard practice in the field of applied environmental acoustics and also help to ensure that wind turbine noise levels from the Project are not under-predicted.

Therefore, the noise analyses conducted for the Tule Wind Project meets the standard of practice in the field of environmental acoustics, provides a conservative assessment of the noise from the project, and adheres to the San Diego County Guidelines for Noise Impact Assessment.

Please refer to Responses 14, 15, and 16 of Data Request No. 14 for further details on wind turbine sound emission, amplitude modulation and noise modeling methodology.

8. It has been argued that the manufacturer's reported power levels for the wind turbines represents a standardized value assuming "typical" conditions of a neutral atmosphere with a moderate wind shear gradient; therefore, the manufacture's data does not represent worst-case conditions. Please respond.

[45] Rogers, et al. Wind Turbine Acoustic Noise. Renewable Energy Research Laboratory. January 2006.

Response: By virtue of their nature, sound power levels are intended to describe the sound emissions of a particular source in the absence of any specific environment; see Response 14 of Data Request No. 14 for further discussion on this. Based on over 300 hours of measurements performed by Epsilon Associates when wind turbine noise was most noticeable (when ground level winds were still and did not mask wind turbine noise), noise emissions from a modern 1.5 MW wind turbine are within ranges considered acceptable by state and federal agencies that regulate environmental noise. The analysis conducted by Epsilon Associates does represent "worst-case" conditions, such as when winds are still and noise from the wind turbine is not masked. It is infeasible to model noise results over all of the possible weather conditions and shear gradients that could occur. Additionally, the noise analysis included several conservative assumptions, including use of 100% acoustically reflective ground, modeling of the hot weather package (which includes additional noise from cooling equipment in the nacelle), continuously downwind conditions in all directions and the addition of 2 decibels to the manufacturer stated sound emissions. These assumptions ensure that the noise analysis does not understate noise from the project.

9. Please provide an explanation of the appropriate scale for measuring low frequency noise levels or infrasound, including a discussion of how using different scales (A-weighting, C-weighting, and Z-weighting) may affect the measurement of low frequency noise. Please provide an analysis of the low frequency noise generated by the wind turbines, using dB(C) weighted noise analysis. Also, please provide available sound power level data for frequencies below 63 Hz for the proposed wind turbines.

Response: This question exists in the context of an environmental noise analysis for a proposed wind turbine project. The sound analysis performed for the Tule Wind Project focuses on the potential effect of airborne sound and vibration on humans. Hence, the weighting scale used in the analysis, the A-weighting scale, is representative of human perception of sound. Existing requirements in San Diego County also rely on A-weighting for sound measurements and regulations. Please refer to Response 1 and 6 of Data Request No. 14 for further details on applicable regulations and use of the A-weighting scale. While there are weighting scales other than the A-weighting scale, which simulates human response to frequencies of sound, use of other weighting scales produces results that do not reflect how human ears respond to different frequencies of sound. Therefore they are not appropriate to use in the context of an environmental acoustics analysis performed to assess compliance with applicable noise limits. State, federal and local agencies that regulate environmental noise throughout the United States rely on the A-weighted decibel, or dB(A) as the most appropriate metric for assessing human response to noise. The San Diego County Noise Element also considers "the most appropriate basic unit of measure for community noise" to be the A-weighted sound level, abbreviated dBA. This unit gives a lower weight to low and high frequency sounds in a manner similar to the relative lower efficiency of the ear at low or high frequencies."[46]

The current sound study, *Tule Wind Project – Draft Noise Analysis Report*, dated February of 2011 provides an analysis of project related sound. The analysis includes an assessment of

[46]San Diego County General Plan Part VIII Noise Element. GPA 06-008. 2006 September 27. Pg. VIII-6.

project-related sound in comparison to existing noise requirements, on an A-weighted basis. Also included in the current sound analysis for informational purposes is the operational project-related sound level in dBC. Please refer to Tables 9 and 12 of the current sound study for additional details.

The A-weighting scale attenuates low-frequency noises in a manner that simulates how human ears attenuate low frequency noise. The C-weighting scale does not attenuate low frequencies as much as the A-weighting scale. The intent of the C-weighting scale is to simulate human perception at higher sound levels, in excess of 70 decibels. Use of C-weighting produce different sound analysis results than those already reported in units of A-weighted decibels. The difference between the A-weighted and C-weighted results are insignificant because it represents low level frequencies that humans do not hear well and the applicable noise limits are not expressed in C-weighted decibels.

Wind turbine sound emissions vary and are dependent on the rated power, turbine model, hub height, wind conditions, and other factors. The maximum sound emissions stated by the manufacturer for turbines considered for use on the Tule Wind Project vary from 104 dBA to 109 dBA. The Gamesa G87, the turbine with the greatest sound emissions, was used in the sound analysis to determine the potential for noise impact.

The sound power level used in the Tule Wind Project analysis is based on maximum operating conditions at 10 meters per second wind speeds, combined with noise from auxiliary fans to cool the nacelle in hot weather. Additionally, 2 decibels were added to each octave band to account for uncertainty. Table 9-1 presents the spectral sound power level data provided by Gamesa, the modeled turbine manufacturer, for frequencies 63 Hz and below.

Table 9-1. Spectral Noise Emissions Data – Gamesa G87

Sound Emissions	**Octave Bands, SWL (Hz)**	
	31.5	**63**
Manufacturer	81.8	90.2
Modeled	83.8	92.2

Please refer to Section 3.2 of the *Tule Wind Project – Draft Noise Analysis Report* for further details on sound emissions and modeling.

The Z-weighting scale is a linear scale that does not weight any of the frequencies: it is flat, linear, and unweighted. Low frequency sounds would appear relatively higher in Z-weighting than in A-weighting. In the context of an environmental noise assessment performed to assess the potential effect of airborne sound on humans and determine compliance with A-weighted noise limits, there is no merit to expressing project-related noise using Z-weighting. The

Z-weighting scale is not representative of the manner in which humans perceive low frequency sound; therefore it is inappropriate to use this scale to assess the potential effect of airborne sound on humans.

10. Please provide a discussion of the sound and/or vibration effects that could result if two or more turbines are operating near each other, either "in sync" or "out of sync," including a discussion of the audible sound waves and low frequency sound waves that would be produced. Please also address the potential sound effects of the turbines in conjunction with proposed wind turbines in the area.

Response: Combinations of sound waves "in sync" usually refers to what acousticians call coherent summation. This is applicable to sound only if the two sounds are received in perfect unison and are perfectly identical sound waves.[47] While important for engineering issues such as loudspeaker design, this is not applicable to environmental acoustics. First, the effects of coherent summation is very time and location specific. With a slight move a couple of feet over, or a small wind or temperature change, the coherent summation will become incoherent summation (out-of-sync). Furthermore the broadband sounds from two wind turbines are random noise created by turbulence[48] which *cannot* be summed coherently.[49] Therefore the Tule project is not anticipated to result in any exceedances of the applicable noise limits due to coherent summation effects.

11. Please provide an explanation of how the American National Standards Institute's (ANSI) S12.9 and S12.18 procedures are applicable for measuring outdoor environmental sound in the case of the wind turbines as a ground based noise source and how they were considered in calculating sound levels resulting from the wind turbines. Please also comment on how these standards consider atypical operational conditions such as temperature inversion, uncharacteristic weather patterns, high wind shear above the boundary layer, and periods of atmospheric turbulence (as it relates to turbines mounted on high locations with rough terrain).

Response: The standards in the ANSI S12.9 series are intended to provide guidance on measuring environmental sound sources and predicting community response based on sound exposure. The primary purpose of ANSI S12.18 is to measure environmental sound from a specific source and is most commonly used in compliance verification during post-construction. Neither standard provides guidance on calculating sound levels from wind turbines prior to construction; therefore neither standard was used to calculate sound levels resulting from project-related sound sources.

The noise measurements made for the Tule Wind Project were performed in accordance with recognized standards prior to construction measured the ambient acoustic environment before wind turbines were built and commenced operation. Therefore, the issue of ground-based noise sources lacks merit.

[47] Kinsler, Lawrence E, et al. Fundamentals of Acoustics Fourth Ed. John Wiley and Sons, Inc. 2000.
[48] Thomas S. Brooks, Airfoil Self-noise and Prediction, NASA Reference Publication 1218 (1989) 15.
[49] Kinsler, Frey et. al. *Fundamentals of Acoustics.*

The intent of the sound measurement was to characterize the ambient sound environment. The results reflect all aspects of the existing ambient sound environment including the meteorological conditions present at the time of measurement. The measurement cannot characterize a sound source which isn't there, such as the proposed wind turbines.

The standardized measurement methods with scope and purpose clauses compatible with characterizing the ambient sound environment include ANSI S1.13, ANSI S12.9/Part 2, ASTM E1014, and ASTM E1503. The measurement methods employed for this assessment were consistent with these standards in whole or in part and were also consistent with several state and federal agency measurement methods and good engineering practice. For a discussion of calculated sound levels and uncharacteristic conditions, inversions, etc. please refer to the response to question 7. Please refer to response number 3 for further details on ANSI S12.9 and S12.18.

12. *Please provide an explanation of how the International Organization for Standardization (ISO) Standard 9613 (Part 2) is applicable for addressing the attenuation of outdoor environmental sound in the case of the wind turbines as a ground based noise source and how it was considered in calculating sound levels resulting from the wind turbines.*

Response: ISO 9613-2 (Attenuation of Sound during Propagation Outdoors) provides the internationally-recognized and accepted methods for calculating environmental noise levels including noise emissions from wind turbines. The Cadna-A software incorporates ISO 9613 in the propagation calculations. The ISO 9613 methods used by Cadna-A were endorsed by an independent working group of European acoustical consultants.[50] Additionally, post-construction studies performed by Andrew Bullmore[51] and Kenneth Kalinski[52] compared measured sound levels from wind farms with corresponding calculation models of the same wind farms. These comparisons showed that wind turbine sound levels modeled in CadnaA and utilizing the ISO 9613-2 calculation methods can achieve good correlation with the post-construction measurements, effectively validating the calculation for wind-turbine sound sources.

Please refer to Responses 13 and 16 of Data Request No. 14, as well as Section 1.3 and Appendix D of the *Tule Wind Project – Draft Noise Analysis Report* for further details on the modeling methodology and ISO 9613 Part 2.

13. *Please comment on the recently promoted algorithm by the Swedish EPA for modeling sound from wind turbines, which applies for both onshore and offshore turbines. The model apparently incorporates enhancements to the ISO Standard 9613 (Part 2) that addresses the specific characteristics of wind turbine sound emissions to propagate at a decay rate of 3dB per doubling of distance for distances of several hundred meters away from the turbine (as opposed to the 6dB decay rate in the ISO Standard).*

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[50] Bowdler et al., Prediction and Assessment of Wind Turbine Noise. Institute of Acoustics, *Acoustics Bulletin*. March / April 2009.
[51] Bullmore et al. "Wind Farm Noise Predictions and Comparison with Measurements". Third International Meeting on Wind Turbine Noise. June 2009.
[52] Kalinski, Kenneth and Eddie Duncan. "Propagation Modeling Parameters for Wind Power Projects". Sound & Vibration. December 2008.

Response: Sound is a physical phenomenon subject to the laws of physics. Therefore the Swedish EPA calculation for wind turbine sound levels is very similar to the calculation from ISO 9613-2. Several combined *attenuation* factors account for the "decay rate" as a function of distance: geometric divergence, atmospheric absorption, ground attenuation and meteorological effects. Both standards account for geometric divergence equally. Atmospheric absorption is accounted for in slightly different ways, but they will produce the same result for wind-turbine sound sources. The difference between the two standards is how they account for ground attenuation and meteorological effects.

Both standards, the ISO 9613-2 calculation and the Swedish calculation, are fundamentally based upon geometric divergence from a point source exhibiting a 6 dB "decay rate" per distance doubled. For atmospheric attenuation, the Swedish calculation makes a correction for atmospheric absorption. This correction is a device which mimics the atmospheric absorption calculation in ISO 9613-2 when calculating each octave-band frequency separately.

Ground attenuation and metrological effects are lumped into one calculation. This calculation for ISO 9613-2 is derived from empirical data, specifically field measurements of sound attenuation over soft ground. Where there is hard ground instead of soft ground, the ISO 9613-2 calculation institutes a broadband pressure doubling (which is approximately +3 dB). Ground attenuation and meteorological effects for the Swedish calculation assumes reflective ground, and also provides an adjustment for wind speed gradients using calculations from IEC 61400 Part 11. The effect of the ground attenuation and meteorological effects may increase or decrease sound levels from ISO 9613-2 to the Swedish calculation, depending upon the modeling parameters. Effects of different modeling parameters are far too variable to discuss in general terms.

For propagation over water the Swedish calculation uses another device to account for sound "skipping" over the water. After a certain distance it institutes a 3 dB decay rate with distance as opposed to the usual 6 dB rate. This is typically associated with sound propagation over water, and it is similar to certain underwater effects in the ocean due to temperature layers. This is only applicable to offshore wind-turbines, not the type of on shore turbines proposed for the Tule Wind Project.

Both standards, the ISO 9613-2 calculation and the Swedish calculation, will exhibit a 6 dB "decay rate" per distance doubled when calculating the geometric divergence for a single point source, such as a wind turbine. However, a number of point sources which span a large distance closely resemble a line source. So for certain areas a series of point sources will naturally exhibit the 3 dB decay rate of a line source. This will be true for any noise model which calculates the total sound due to all sources, including the Cadna-A model used for the noise analysis for the Tule Wind project.

Note that the Tule noise model decay rate (as a function of distance) was the result of geometric divergence, atmospheric attenuation, hard reflective ground, and the total sound due to all sources in the analysis, according to Cadna-A and the ISO 9613-2 calculations. Given the different modeling parameters, it is impossible to determine whether the results would have differed, either higher or lower, using the Swedish calculations. However, given the similarities in the models they would not be likely to be materially different. Furthermore there are several conservative assumptions built into the Tule noise model to avoid under-predicting noise levels, explained further in response 16, which are not part of the Swedish calculation. Therefore the calculated noise levels shown in HDR's noise report are conservatively high noise levels and the referenced Swedish standard is not relevant in the context of this analysis.

14. Please provide an explanation of how the International Electrotechnical Commission (IEC) Standard 614000 (Part 11) is applicable for measuring outdoor environmental sound in the case of the wind turbines as a ground based noise source and how it was considered in calculating sound levels resulting from the wind turbines. Please also comment on how this standard considers atypical operational conditions such as temperature inversion, uncharacteristic weather patterns, high wind shear above the boundary layer, and periods of atmospheric turbulence (as it relates to turbines mounted on high locations with rough terrain).

Response: The purpose of a sound power measurement is to quantify the noise emission characteristic of a sound source irrespective of its environment. This makes the resulting sound power level useful for predicting the effect of introducing the noise source into any environment. Using a forklift. as an arbitrary example of another sound source, the sound power measurement will enable an analyst to predict how introducing a new forklift will affect the sound level inside a warehouse. It also enables the analyst to predict how a new forklift will affect the sound levels in an outdoor truck yard, a distinctly different environment than an indoor warehouse. In the same respect, the IEC 61400 Part 11 measurement standard attempts to remove the influence of the particular environment so the results can be used to predict sound levels in other environments.

Wind turbines have different sound emission characteristics based upon its operating condition. For an example, a forklift has a different sound emission characteristic when driving than the sound emission characteristic when it is lifting. Therefore, the IEC 61400 Part 11 measurement standard states its results as a function of wind speed. Generally higher wind speeds cause the turbine to operate with higher noise emission levels; however, there is an upper limit to wind turbine noise emissions. At a certain wind speed, which is different for different turbines, the turbine will begin to regulate itself so it does not rotate any faster, there will be a maximum rotation speed even as wind speeds may increase. The results of the sound power measurement include all aspects of the wind turbine itself and are irrespective of uncharacteristic weather patterns, etc.

The noise analysis prepared for the EIR/EIS did not specifically simulate atypical operational conditions such as temperature inversions, uncharacteristic weather patterns, high wind shear above the boundary layer, and periods of atmospheric turbulence. The sound analysis conservatively estimated project-related sound levels that would be experienced on a daily basis and did not focus on the atypical operational conditions previously stated. Rather, the noise analysis incorporated a number of modeling techniques whose net effect conservatively over-estimated noise propagation in the project area. These techniques include assuming that the ground is 100% acoustically reflective, that the noise levels associated with the hot weather package, which includes additional noise from cooling equipment in the nacelle), were occurring all of the time, and other techniques as described in response to question 16 that conservatively over-estimate project related noise levels. Table 14-1 summarizes the conservative modeling assumptions and their effect on modeling results.

Table 14-1. Modeling Assumptions and Influence on Calculated Sound Level

Modeling Assumption	Effect on Calculated Sound Level
Guaranteed sound level v. maximum manufacturer stated	+2 dB
Continuous use of hot weather package[1]	+ 2.6 dB
Reflective ground	+3 dB
Continuous downwind conditions for all directions[2]	≈ 0 to 2 dB
Use of 128 2.0 MW turbines vs. 128 1.5 MW turbines[3]	≈ 0 to 5 dB
Total effect on calculated sound level	7.6 to 14.6 dB

[1] Lower emission modes of the hot weather package would be used during nighttime hours as the mode modeled will only be used in temperature above 98° F.
[2] This results in -the wind blowing in all directions continuously throughout an hour.
These are the most favorable propagation conditions (wind blows in all directions all the time).
[3]The Tule sound analysis modeled 2.0 MW turbines in a layout that is representative of maximum build-out with a 1.5 MW turbine (resulting in 28 additional turbines). If 1.5 MW turbines were modeled using the current layout, resulting sound levels would be up to 5 dB lower, based on the use of a GE 1.5 XLE turbine.

The net effect of these conservative assumptions show in the table above is the over-estimation of project-related noise levels. These over-estimates account for events like micrometeorological turbulence on the blades, turbine-to-turbine wake interaction, inversions, and other phenomena that potentially affects wind turbine noise generation and propagation. As shown in the table above, this noise analysis is reasonable, appropriate, and is more conservative than required by the standards of practice in the field of environmental acoustics.

Note that there are four cooling modes that may be utilized with the Gamesa G87 and Gamesa G90 turbine models. The cooling modes available with the hot weather package include two modes in which additional fans are operating allowing for use in hot weather climates. The relative increase in sound emissions for each cooling mode is summarized in Table 14-2 below, provided by Gamesa.

Table 14-2. Gamesa G87 and G90 Cooling Modes Sound Emission

Turbine Type	Increase in Sound Emission Level, dB			
	Mode 0	Mode 1	Mode 2	Mode 3
Gamesa G87	0	0	1.5	2.6
Gamesa G90	0	0	1.5	2.6

The operating mode is dependant of the ambient temperature and power generated conditions at a particular time. Mode 3 which provides the greatest sound emission was utilized in the sound analysis presented in the *Tule Wind Project – Draft Noise Analysis Report.* This mode represents a conservative operating assumption. The Tule noise model utilized the turbine operation mode with the highest noise emission characteristic provided by the manufacturer: the highest wind speed operation and the hot weather package. These conservative modeling decisions help ensure that the noise analysis does not under-predict project-related noise.

15. Please provide an explanation of the existence and potential effects of amplitude modulation (blade thumping) from wind turbines during periods of high turbulence or wind shear levels, both on outdoor and indoor sound levels in the vicinity of the turbines.

Response: Amplitude modulation refers to the rhythmic increase and decrease in wind turbine noise levels as the blades rotate closer to and away from a stationary listener. Blade thumping typically refers to amplitude modulation that occurs with a "greater than normal degree of regular fluctuation at blade passing frequency."[53] Several literature review and field studies concerning amplitude modulation have been performed but there is little consensus on the cause and prediction of amplitude modulation.

Dr. Andy Moorhouse performed a study to determine the prevalence of amplitude modulation in wind farms in the UK and to identify the likely causes of amplitude modulation. Dr. Moorhouse summarizes his findings:

> *"The literature review indicated that, although there has been much research into the general area of aerodynamic noise it is a highly complex field, and whilst general principles are understood there are still unanswered questions. Regarding the specific phenomenon of AM [amplitude modulation] there has been little research and the causes are still the subject of debate. AM [amplitude modulation] is not fully predictable at current state of the art."*[54]

While amplitude modulation in wind turbine sound can occur, it is not an issue at most locations. The study performed by Dr. Moorehouse determined that amplitude modulation was "considered to be a factor [in noise complaints] in four of the sites, and a possible factor in another eight [out of 127 wind farms surveyed]."[55] The results of the study show that very few wind farms in the UK had noise complaints resulting from amplitude modulation. Furthermore, the ability to predict the amount of amplitude modulation is still uncertain.

The sound of ocean waves on a beach also exhibit amplitude modulation as the waves travel through their cycle of approach, crashing on the beach, and receding. On that basis, amplitude

[53] Moorhouse et al. "Research into Aerodynamic Modulation of Wind Turbine Noise: Final Report". July 2007. http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/files/file40570.pdf
[54] Moorhouse et al. "Research into Aerodynamic Modulation of Wind Turbine Noise: Final Report". July 2007. http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/files/file40570.pdf
[55] Moorhouse et al. "Research into Aerodynamic Modulation of Wind Turbine Noise: Final Report". July 2007. http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/files/file40570.pdf

modulation is not intrinsically harmful or unpleasant. During periods of high turbulence, amplitude modulation may be masked by the sound of turbulent winds. When ground-level winds are still and winds at the hub height are above cut-in speed (wind shear), amplitude modulation may be more noticeable to persons outdoors than when highly turbulent winds are present.

The results of Dr. Moorehouse's study of amplitude modulation from wind farms showed that "27 of the 133 wind farm sites operational across the UK at the time of the survey had attracted noise complaints at some point. An estimated total of 239 formal complaints have been received about UK wind farm sites since 1991, 152 of which were from a single site. The estimated total number of complainants is 81 over the same sixteen year period. This shows that in terms of the number of people affected, wind farm noise is a small-scale problem compared with other types of noise; for example the number of complaints about industrial noise exceeds those about wind farms by around three orders of magnitude. In only one case was the wind farm considered by the local authority to be causing a statutory nuisance. Again, this indicates that, despite press articles to the contrary, the incidence of wind farm noise and AM [amplitude modulation] in the UK is low. AM [amplitude modulation] was considered to be a factor in four of the sites, and a possible factor in another eight. Regarding the four sites, analysis of meteorological data suggests that the conditions for AM [amplitude modulation] would prevail between about 7% and 15% of the time. AM [amplitude modulation] would not therefore be present most days, although it could occur for several days running over some periods. Complaints have subsided for three out of these four sites, in one case as a result of remedial treatment in the form of a wind turbine control system. In the remaining case, which is a recent installation, investigations are ongoing. "

Studies and literature review done to date show that amplitude modulation can be reported in some noise complaints. There is no standard way to predict its occurrence, and there is no universally-agreed upon way to assess the potential for annoyance due to it. Therefore it is not possible and necessary to attempt to model it for the propose Tule project.

16. Please provide an explanation of the tolerance assumed for instrumentation error. It has been argued that the HDR technical report included the 2 dB tolerance level associated with IEC Standard 614000 (Part 11) for measuring the sound power produced by wind turbines instead of the 3 dB tolerance applied by the ISO 9613-2 methodology. Please discuss the use of an appropriate tolerance and the potential effect of the calculation if the other method would have been used (if appropriate).

Response: The sound power level used in the analysis is the manufacturer guaranteed sound emissions. The guaranteed sound emissions are based on IEC Standard 61400 Part 11 measurement methods. The guaranteed sound emissions, adds 2 dB to the manufacturer stated emission and is based on maximum operating conditions utilizing additional fans for hot weather conditions at 10 meters per second wind speeds. The use of guaranteed sound emissions is conservative, in that it assumes the wind turbines generate 2 dB more noise than manufacturer reports for the turbines.

A 3 dB correction to account for uncertainty in ISO 9613 Part 2 was accounted for through conservative assumptions concerning sound propagation utilized in other portions of the analysis. The use of conservative modeling assumptions results in more than 3 dB increase over less conservative methods; therefore, no additional corrections were applied. Table 16-1 summarizes the conservative modeling assumptions and their effect on modeling results.

Table 16-1. Modeling Assumptions and Influence on Calculated Sound Level

Effect on Calculated	Effect on Calculated Sound Level
Guaranteed sound level v. maximum manufacturer stated	+2 dB
Continuous use of hot weather package[1]	+ 2.6 dB
Reflective ground	+3 dB
Continuous downwind conditions for all directions[2]	≈ 0 to 2 dB
Use of 128 2.0 MW turbines vs. 128 1.5 MW turbines[3]	≈ 0 to 5 dB
Total effect on calculated sound level	7.6 to 14.6 dB

[1] Lower emission modes of the hot weather package would be used during nighttime hours as the mode modeled will only be used in temperature above 98° F.
[2] This results in -the wind blowing in all directions continuously throughout an hour.
These are the most favorable propagation conditions (wind blows in all directions all the time).
[3]The Tule sound analysis modeled 2.0 MW turbines in a layout that is representative of maximum build-out with a 1.5 MW turbine (resulting in 28 additional turbines). If 1.5 MW turbines were modeled using the current layout, resulting sound levels would be up to 5 dB lower, based on the use of a GE 1.5 XLE turbine.

For a detailed discussion of the hot weather package, meteorological assumptions and other modeling assumptions please refer to Responses 7 and 14 of Data Request No. 14.

Refer to Section 1.3 and Appendix D of the *Tule Wind Project – Draft Noise Analysis Report* for further details on the modeling methodology and ISO 9613 Part 2.

17. Please provide a detailed description of the noise controls that would be incorporated into the design of the proposed wind turbine facilities.

Response: Siting is the primary noise control method that is incorporated into the design of the proposed wind turbine facility. It is also important to note that modern turbines have made great strides in noise reduction technology from what was available in previous turbine generations. Technological advancements that have most contributed to reduced sound emissions from wind turbines include rotor placement, pitch-control rotors, low-noise gearboxes, use of insulated nacelles, vibration-isolated mechanical equipment and variable speed operation.

18. Please provide a graphic depicting the specific area(s) that would be impacted by nighttime construction noise.

Response: Nighttime construction is not currently planned therefore no impacts due to nighttime construction noise are anticipated. As discussed in Section B, Project Description, Tule Wind, LLC anticipates that construction activities would occur between 7 a.m. and 7 p.m., Monday through Saturday, but may involve extended hours as needed to complete certain construction activities. When construction would occur outside of the hours permitted by the County of San Diego, Tule Wind, LLC would follow established protocol and seek a variance from the County noise requirements consistent with County Code Section 36.423. Tule Wind, LLC would also provide advanced notice to property owners within 300 feet of planned activities. The advanced notice would include the start and completion dates of construction and the hours of construction. In addition, implementation of APM TULE NOI-4 would further minimize noise impacts associated with construction. If a variance from the construction hours of 7 a.m. to 7 p.m. cannot be obtained from the County, no construction will occur outside the normal hours of construction.

19. *Please provide a graphic which identifies and labels the locations of the construction noise impacted boundary lines.*

Response: Figures 3 and 4 (attached) depict the location of properties that would most likely be affected by sound from temporary roadway and transmission line construction activities if incorporation of BMPs and mitigation were not implemented. Underground utility construction, tower base construction, and batch plant operations are not anticipated to cause construction noise impacts at adjacent parcels; therefore, no graphic has been provided for these activities.

Roadway and transmission line construction activities have the potential to cause temporary impacts to six adjacent parcels. The adjacent property boundaries are in some instances as close as 18 feet from the construction buffer zone and will experience the highest noise levels from road construction and grading activities. However, with the incorporation of BMPs and mitigation measures identified in the noise report based on comments submitted to the CPUC incorporating the Modified Project Layout, construction sound levels at all adjacent property boundaries are anticipated to comply with Sections 36.409 and 36.410 of the San Diego County Noise Ordinance.

20. *Please provide a graphic which identifies and labels the locations of the affected legally occupied properties and the locations where portable noise barriers would be required.*

Response: Figures 3 and 4 (attached) depict the location of properties that would most likely be affected by sound from temporary roadway and transmission line construction activities if incorporation of BMPs and mitigation were not implemented. Mitigation will be provided at the highlighted parcels to will include a portable noise barrier. Exact height and length of each noise barrier will be determined upon final design. With the incorporation of BMPs and mitigation measures, the highest predicted construction noise level at an adjacent property boundary would be reduced from 94 dBA to 74 dBA Leq, one decibel below the sound level limit of 75 dBA Leq outlined in Section 36.409 of the San Diego County Noise Ordinance.

Field verification of legally occupied dwellings is pending; therefore it was conservatively assumed that all parcels are legal residential properties. Prior to construction, a noise report will be finalized to demonstrate compliance with the San Diego County Code of Regulatory Ordinances Section 36.409 and 36.410.

21. Please provide a noise evaluation for the proposed sonic detecting and ranging unit (SODAR). Provide quantitative data that determines whether this proposed noise generating unit complies with County Noise Ordinance, Section 36.404.

Response: The current sound study, *Tule Wind Project – Draft Noise Analysis Report*, dated February of 2011 provides an analysis of project related sound including the SODAR unit. The nearest residential property boundary is located approximately 4,500 feet from the proposed SODAR unit. The calculated noise contribution from the SODAR unit is less than 0 dBA on an hourly Leq basis at all residential property boundaries. This means that the sound levels from the SODAR experienced at residences are low enough that they fall below the reference pressure level used in calculating dB. Therefore, no noise impacts are predicted to occur due to SODAR noise.

Please refer to Section 3.2 and Appendix B of the draft sound study for additional details concerning the SODAR sound emissions and modeling.

22. Please provide a detailed response to the following comment received on the Draft EIR/EIS:

The concrete batch plant would be subject to the sound level limits within County Code Section 36.404 because it is not considered a temporary operation (e.g. it will operate for more than three months).

If the plant would be considered a potential long-term noise source, please provide an explanation of how this source would comply with County Noise Ordinance, Section 36.404.

Response: The concrete batch plant will only be used in the construction phase of the Tule Wind Project; therefore, is subject to sound level limits for construction activities as stated within County Code Section 36.409 and 36.410.

Please refer to Section 3.3 of the *Tule Wind Project – Draft Noise Analysis Report* for further details on batch plant operations.

23. *Please provide detailed responses to specific comments 1 through 19 as identified in the letter from Richard James of E-Coustic Solutions provided in Attachment B.*

23.1 E-Coustic Solutions Comment 1 (page 1)

Claim – Setbacks of less than 1.25 miles are inadequate

> *"First, setbacks, from property lines to the nearest turbine of less than 2 kilometers (1.25 miles) are clearly inadequate for most quiet rural communities. The presence of nearby will not mask or otherwise offset the noise from wind turbines."*

Response: E-Coustic Solution's comment that turbine setbacks less than 1.25 miles (6,600 feet) are inadequate is not supported by recognized scientific studies, sound modeling or measurement data. Additionally such claims conflict with current local wind turbine regulations. Section 6951 Part A of the San Diego County Zoning Ordinance requires setbacks of four times the height, or 1,968 feet, from property lines.[56]

A turbine setback distance does not guarantee a particular noise level at property lines. The level of project-related noise varies with the turbine layout, number of turbines, speed of the turbine blades, meteorological conditions, terrain and the distance of the listener from the turbine; therefore, a setback distance is inadequate to characterize the amount of project related noise at a property line. The San Diego County noise ordinance requires that operational noise comply with San Diego County Code of Regulatory Ordinances Section 36.404. Detailed noise modeling which accounts for turbine layout, number of total turbines and site specific terrain was performed for the Tule Wind Project in order to assess the project's noise emissions and compliance with San Diego County Code of Regulatory Ordinances Section 36.404.

E-Coustic Solution's comment that the presence of (nearby noise sources) will not mask or otherwise offset wind turbine noise is inconsistent with local noise assessment methods (masking occurs when noise from one source hides (or masks) the noise from a second source. In this context, wind-induced noise at ground level often has potential to mask or hide wind turbine noise). Current noise regulations in San Diego County including Significance Guideline 4.1.A and Section 36.404 of the San Diego County Code provide guidance on existing noise levels in relation to project related noise. When existing noise levels are below 60 dB CNEL, an increase of 10 dB over pre-existing conditions is allowed. In areas of greater noise exposure, an increase of 3 dB is allowed. The assessment methods utilized for the Tule Wind Project are consistent with current regulations in San Diego County. This means that the county guidelines already address circumstances where a proposed activity may introduce a new noise source into the acoustic environment; allowable incremental increases are identified. Background noise does not have to mask wind turbine noise the existing noise limits allow some new noise to be made.

Claim – Validity of submitted noise reports and documents

[56] Calculation of minimum setback distance is based on a maximum turbine height of 492 feet. Actual setback distance is dependant on final turbine hub height and rotor diameter.

> *"The reports and documents submitted on behalf of the Project do not correctly or adequately describe the impact of the proposed project on the host community, or its residents whose homes and properties are close to the footprint of the project."*

Response: Reports and documents submitted on behalf of the project applicant reflect measurements of modern upwind configured turbines and literature review of currently available scientific data. The measurement reports cited, including the Epsilon report, compare measurements of operating wind farms to established noise standards and metrics that are commonly accepted in the U.S. and that are designed to protect the environment.[57]

The white papers and other reports submitted, including "Wind Turbine Sound and Health Effects An Expert Panel Review." by the American Wind Energy Association (AWEA) and "The Potential Health Impact of Wind Turbines" from the Chief Medical Officer of Health, are based on literature reviews of scientific and medical databases.[58] Both AWEA and the Chief Medical Officer of Health cite current scientific and peer reviewed literature of wind turbine generated sound and low frequency sound. The cited reports all support the conclusion that there is no direct causal relationship between wind turbine sound and adverse health effects[59]as stated in the Tule Wind Project – Draft Noise Analysis Report.

Claim – Audible and inaudible wind turbine noise cause health effects

> *"People living at distance up to 1 mile from wind turbines on flat land and, for turbines located on ridges above the homes at distances of up to 2 miles are experiencing adverse health effects from sleep disturbance at night from audible turbine noise."*

> *"Other aspects of wind turbine sound emissions, especially amplitude modulated infra and low frequency sounds that may not be reach the threshold of audibility are currently believed to be caused by vestibular disturbances from rapid modulations of the infra and low frequency sound."*

Response: Several reviews of currently available scientific data have determined that there is no direct causal relationship between wind turbine generated sound and health effects. The Chief Medical Officer of Health of Ontario[60] recently performed a study focusing on the topic of wind turbine noise and health. The study concluded the following concerning wind turbines and health:

- While some people living near wind turbines report symptoms such as dizziness, headaches, and sleep disturbance, the scientific evidence available to date does not demonstrate a direct causal link between wind turbine noise and adverse health effects.

[57] Epsilon Associate, Inc. "A Study of Low Frequency Noise and Infrasound from Wind Turbines." July 2009.
[58] "Wind Turbine Sound and Health Effects An Expert Panel Review." American Wind Energy Association, Canadian Wind Energy Association. December 2009.
[59] "Wind Turbine Sound and Health Effects An Expert Panel Review." American Wind Energy Association, Canadian Wind Energy Association. December 2009.
[60] "The Potential Health Impact of Wind Turbines." Chief Medical Officer of Health Report. May 2010.

- The sound level from wind turbines at common residential setbacks is not sufficient to cause hearing impairment or other direct adverse health effects. However, some people might find it annoying. It has been suggested that annoyance may be a reaction to the characteristic "swishing" or fluctuating nature of wind turbine sound rather than to the intensity of sound.
- Low frequency sound and infrasound from current generation upwind model turbines are well below the pressure sound levels at which known health effects occur. Further, there is no scientific evidence to date that vibration from low frequency wind turbine noise causes adverse health effects.
- Community engagement at the outset of planning for wind turbines is important and may alleviate health concerns about wind farms.
- Concerns about fairness and equity may also influence attitudes towards wind farms and allegations about effects on health. These factors deserve greater attention in future developments.

23.2 E-Coustic Solutions Comment 2 (page 2)

Claim – Measurements used to collect background sound levels do not meet recognized standards.

Response: The E-Coustic Solutions comment reveals some confusion regarding when it is appropriate to use a background sound measurement and when to measure ambient sound. To clarify this issue, these two terms need to be defined. A discussion of when it is appropriate to exclude certain sounds from a measurement will follow.

San Diego County Code of Regulatory Ordinances Section 36.402, Clause (a) defines the ambient sound to be, "…the composite of existing noise from all sources at a given location and time." This is a common definition of ambient noise or ambient sound[61], such as the definitions found in ANSI S1.1, ANSI S12.9, and ASTM C634. The same ordinance clause (in 36.402) continues, "Ambient noise is sometimes referred to as background noise." This is sometimes a source of great confusion because background sound, in addition to often meaning ambient sound in casual conversation, also has its own precise meaning and use. Specifically, background sound includes all the *other* sounds which may interfere with the measurement of a *particular* individual sound source or group of sound sources. Background sound is defined in the same general standards ANSI S1.1, ANSI S12.9, and ASTM C634 as well as numerous national and international standards which deal with measurement of particular sound sources.

Background sound measurements normally occur during the course of measuring a particular sound source. It is impossible to separate the sound of the source of interest from the rest of the sounds in the environment. Therefore, it is necessary to perform two measurements: one of the total sound, and one of just the background sound. Once these two measurements are

[61] To add to the confusion, background sound is sometimes called background noise, and likewise ambient sound is sometimes called ambient noise. Noise is sound, there is no physical difference. Noise is just unwanted sound.

accomplished, it is possible to mathematically derive the sound level of the particular sound source on its own, effectively eliminating the influence of environmental and extraneous background sounds. This is a common definition of background sound, as defined in ANSI S1.1, ANSI S12.9, and ASTM C634, as well as numerous national and international standards which deal with measurement of particular sound sources. This can be a tricky process in uncontrolled outdoor environments, because the background sound must be nearly identical in both measurements. If short-term or transient noise events occur in either the total sound measurement or the background sound measurement, the calculation will yield incorrect results.

The E-Coustic Solutions comment suggests that the measurement should exclude or suppress certain short-term or transient sounds. While it is sometimes desirable and appropriate to suppress transient or short-term noise events in the context of measuring a particular sound source, measurements of the ambient noise environment to establish the environmental baseline should be all-inclusive of all sounds in the environment. In order to establish a valid baseline, the measurement should reflect the total sound exposure from the existing ambient environment.

The noise report for the project measured the actual sound of the existing ambient environment without artificially suppressing any sounds which occurred during the measurement period. The measurement method conformed to several ANSI and ASTM standards in whole or in part, as well as being consistent with many state and federal agency measurement methods, including the San Diego County noise regulations. Please refer to responses 2 and 11 of Data Request No. 14 for additional information.

23.3 E-Coustic Solutions Comment 3 (page 2)

Claim – Cadna-A model results understates impact

Response: Modeling methods used in the noise analysis for the Tule Wind Project are consistent with internationally-recognized and accepted methods for calculating environmental noise levels. The Cadna-A model developed for the Tule Wind Project utilizes modeling assumptions which best reflect measurements from operating wind farms. Post-construction studies performed by Andrew Bullmore[62] and Kenneth Kalinski[63] show that wind turbine sound levels modeled with ISO 9613:2 using no ground attenuation, or reflective ground, best fit or overstated monitored sound levels depending on the site and wind conditions. Please refer to responses 13 and 16 of Data Request No. 14 for additional information regarding ISO 9613 and the modeling assumptions.

Section 1.3 of the *Tule Wind Project – Draft Noise Analysis Report*, dated February 2011 also includes further details on the modeling methodology.

23.4 E-Coustic Solutions Comment 4 (page 2)

[62] Bullmore et al. "Wind Farm Noise Predictions and Comparison with Measurements". Third International Meeting on Wind Turbine Noise. June 2009.
[63] Kalinski, Kenneth and Eddie Duncan. "Propagation Modeling Parameters for Wind Power Projects". Sound & Vibration. December 2008.

Claim – Information provided concerning health risks, infra and low frequency sound, noise limits, setbacks, background sound levels and computer modeling methods are incorrect, incomplete or otherwise misleading.

Response: Reports and documents submitted on behalf of the project applicant reflect measurements of modern upwind configured turbines and literature review of currently available scientific data. Please refer to response number 23.1 of Data Request No. 14 for further details on the materials cited in the *Tule Wind Project – Draft Noise Analysis Report,* dated February 2011.

23.5 E-Coustic Solutions Comment 5 (page 2)

Claim – Background sound study was inadequate

> *"Had the background studies met the procedural and protocol requirements of the American National Standards Institute's (ANSI)S 12.9 and S12.18 standards for measuring environmental sounds outdoors the study would have reported much lower background sound levels. The Project would have a 'significant impact' under CEQA Guidelines (Appendix G (VII))."*

Response: The measurement of the existing ambient noise environment conforms to the applicable portions of several standards and is consistent with the measurements associated with San Diego County noise regulations. Existing ambient noise measurement methods utilized in the noise analysis for the Tule Wind Project are consistent with several standards and practices including ANSI S1.13, ANSI S12.9/Part 2, ASTM E1014, ASTM E1503, several state and federal agency measurement methods, and good engineering practice. The study was adequate and appropriate, and consistent with the accepted industry standards.

Please refer to response number 23.2 of Data Request No. 14 for further information concerning the ambient noise measurement methods.

Claim – Had modeling properly addressed wind turbine emitted sound power predicted sound levels would have been higher.

Response: The noise analysis conducted for the Tule Wind Project used the best available data from wind turbine manufacturers to estimate project-related sound levels. Several conservative assumptions were utilized in the Tule sound model including the turbine operation mode with the highest noise emission characteristic, continuous downwind conditions, reflective ground coverage and the use of noise emissions representative of the hot weather package. The modeling was adequate and appropriate, and consistent with the accepted industry standards.

Please refer to responses 14 and 16 of Data Request No. 14 for further information concerning wind turbine noise emission measurement methods and the modeling methodology.

23.6 E-Coustic Solutions Comment 6 (pages 2-3)

Claim – Project noise levels would be in excess of standards and create a substantial permanent increase in ambient noise level if the background study and computer modeling had been performed according to the recommendation of E-Coustic Solutions

Response: E-Coustic Solution's proposed background noise study and modeling methods are inconsistent with current County regulations and best practices in the field of environmental acoustics. The measurement of the existing ambient noise environment conforms to applicable portions of several noise standards and is consistent with the measurements associated with San Diego County noise regulations. Existing ambient noise measurement methods utilized in the noise analysis for the Tule Wind Project are consistent with several standards and practices including ANSI S1.13, ANSI S12.9/Part 2, ASTM E1014, ASTM E1503, several state and federal agency measurement methods, and good engineering practice.

The San Diego County Code of Regulatory Ordinances Section 36.402, Clause (a) defines the ambient sound to be, "…the composite of existing noise from all sources at a given location and time." The same ordinance clause (in 36.402) continues, "Ambient noise is sometimes referred to as background noise." The measurement performed for the Tule Wind Project depicts ambient conditions including all existing sources. The use of a background sound level to represent existing conditions, as proposed by E-Coustic Solutions, is inconsistent with CEQA as the background sound level excludes existing noise sources that contribute to the ambient environment.

Furthermore the modeling methods used in the noise analysis for the Tule Wind Project are consistent with internationally-recognized and accepted methods for calculating environmental noise levels. The Cadna-A model developed for the Tule Wind Project utilizes modeling assumptions which best reflect measurements from operating wind farms. Please refer to Section 1.3 of the *Tule Wind Project – Draft Noise Analysis Report*, dated February 2011, for further details on the modeling methodology.

Please refer to response 23.2 of Data Request No. 14 for further details on the ambient noise measurement methodology and the background measurement proposed by E-Coustic Solutions, and to responses 13 and 16 for additional information regarding ISO 9613 and the modeling assumptions.

In summary, use of the methods advocated by E-Coustic Solutions would have resulted in different, inappropriate, and unrepresentative noise analysis results. Furthermore, the resulting inappropriate off-set distances would likely inhibit wind turbine developments in areas where high quality wind resources and access to transmission lines make wind turbine developments feasible.

23.7 E-Coustic Solutions Comment 7 (page 3)

Claim – Wind turbine noise will result in adverse health effects

Response: Several reviews of currently available scientific data have determined that there is no direct casual relationship between wind turbine generated sound and health effects. The sources cited by E-Coustic Solutions which support the claim that wind turbine noise will result in adverse health effects are not peer reviewed, do not support their claims with measurement data and do not qualify as valid epidemiological studies. Furthermore, Dr. Geoff Leventhall concluded that "a simple order of magnitude calculation, using basic physics of the level which will be known to a 16-year-old school pupil, shows that the movement of the diaphragm under the forces which might result from wind turbine noise is less than 10 microns. That is less than one hundredth of a millimeter or about one tenth of the average thickness of human hair. During normal breathing, the diaphragm moves several centimeters."[64] Clearly wind turbine noise would not cause adverse health effects to a human body.

Also, a review of the medical literature databases performed by Exponent, Inc. found no evidence of a causal link between exposure to wind turbine noise and adverse health effects. As of this review (by Exponent), there has not been a specific health condition documented in the peer reviewed published literature to be classified as a disease caused by exposure to sound levels and frequencies generated by the operation of wind turbines.[65] Please refer to responses 5, 23.1, and 24-26 of Data Request No. 14 for further information concerning wind turbine noise and health effects.

23.8 E-Coustic Solutions Comment 8 (page 3)

Claim – If the Project is approved as currently proposed there will be significant negative noise impacts.

> *"The result of these technical flaws along with an outdated understanding of how the human body responds to acoustical energy below the threshold of perception leads to a conclusion that if the Project, as proposed, is approved, it will, with a high degree of certainty, have negative noise impacts that are 'significant.'"*

Response: These specific claims are unsupported, and inconsistent with the norms of environmental acoustics and how noise is regulated as an environmental pollutant in the United States. In testimony during the Glacial Hills wind farm permit process, Dr. Geoff Leventhall testified that the forces on the human body resulting from exposure to low frequency and infrasonic noise produce a deflection of approximately 10 microns or about one tenth of the average thickness of human hair. Normal lung function (breathing) causes a deflection of more

[64] Direct testimony of Dr. Geoff Leventhall on behalf of Wisconsin Electric Power Company, before the Public Service Commission of Wisconsin, E-docket number 6630-CE-302

[65] "Evaluation of the Scientific Literature on the Health Effects Associated with Wind Turbines and Low Frequency Sound", Exponent, Inc., October 20, 2009, and also in testimony by of Dr. Mark Roberts in Glacial Hills wind farm project in Wisconsin, Broad Mountain wind farm project in Pennsylvania, and Goodhue Wind project in Minnesota.

than a centimeter. Heart beats and normal body motions cause more deflection than ten microns and, therefore, the forces imparted upon a human body by exposure to wind turbine noise are meaningless.[66]

The *Tule Wind Project – Draft Noise Analysis Report* addressed all applicable noise considerations in relation to local regulation and CEQA including:

- Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of the other agencies.
- Exposure of persons to or generation of excessive ground borne vibration or ground borne noise levels.
- A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project.
- A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.

Upon final design, approval of project layout, and prior to construction, a sound study will be finalized to demonstrate compliance with the San Diego County Code of Regulatory Ordinances Section 36.409 and 36.410; therefore, no significant noise impacts due to operational noise are anticipated.

23.9 E-Coustic Solutions Comment 9 (page 3)

<u>Claim – Wind turbine utilities produce sound levels in excess of a 40 dBA limit provided by the World Health Organization for safe and healthful sleep.</u>

Response: E-Coustic Solutions comment does not recognize several important concepts associated with the World Health Organization's (WHO) nighttime noise recommended limit. First, the proposed project is subject to the noise limits enforced by the County; the WHO has no jurisdiction in California. Second, the referenced WHO noise limit is nothing more than a recommendation; it is not a regulatory limit; this concept is explicitly clear in the WHO document. Third, the referenced WHO noise limit is actually expressed as an annual average of all nighttime hours. In other words, it represents the hourly equivalent noise level (Leq) for each of the eight nighttime hours, averaged over all 365 days of the year. It is not, as E-Coustic Solutions erroneously implies, a one-hour noise limit. Therefore, statements that this proposed project will exceed the WHO nighttime exterior sound level recommendation are not factual.

E-Coustic Solution's claim that project-related sound levels will be in excess of WHO recommendations are not supported by modeling or site specific meteorological data. The modeling results presented in the *Tule Wind Project – Draft Noise Analysis Report* is representative of a single hour in which turbines operate at maximum noise emission. Project-

[66] Direct testimony of Dr. Geoff Leventhall on behalf of Wisconsin Electric Power Company, before the Public Service Commission of Wisconsin, E-docket number 6630-CE-302

related sound levels will be less than those shown in the noise analysis report during periods when wind speeds are below the cut-in speed. The proposed turbines do not operate at maximum noise emissions during all hours of every day and night in a year.

Claim – Project-related sound levels will result in "a high level of community complaints" stemming from sleeping disturbance and noise pollution.

Response: Annoyance is subjective and difficult to predict; therefore, it cannot be said with any degree of certainty that the project-related sound levels will result in a "high level of community complaints stemming from sleeping disturbance and noise pollution." Finding 33 of the San Diego County Noise Element discusses the topic of annoyance and the causes of annoyance:

> *"The degree of annoyance is closely related to both acoustical and non-acoustical factors. The former include the levels and durations and number of occurrences of identifiable noise events; the residual noise level; the variability of the noise levels; the time of day; and special factors related to the character of the information content of the noise. Non-acoustical factors include the particular activity disrupted, the attitude of those affected, and factors specific to particular sound sources, such as disagreements over barking dogs."*

As described in Finding 33 of the San Diego County Noise Element, aural sensitivity and attitudes toward a project or sound source will affect the level of annoyance experienced by an individual. Therefore, although it is possible that individuals may experience annoyance as a result of the Tule wind project, it is not a predictable outcome and the setbacks used for siting will serve to minimize the levels of noise as a source of potential annoyance.

Please refer to response to Data Request No. 14 response number 5 for additional information concerning annoyance.

Claim – Wind turbine sound will result in health effects

> *"In addition, there is mounting evidence that for the more sensitive members of the community, especially children under six, people with pre-existing medical conditions, particularly those with diseases of the vestibular system and other organs of balance and proprioception, and seniors with existing sleep problems will be likely to experience serious health risks."*

Response: Please refer to responses 5, 23.1, and 24-26 of Data Request No. 14 for further information concerning wind turbine noise and health effects.

23.10 E-Coustic Solutions Comment 10 (pages 6-7)

Response: ISO 9613-2 (Attenuation of Sound during Propagation Outdoors) provides the internationally-recognized and accepted methods for calculating environmental noise levels including noise emissions from wind turbines. The Cadna-A software incorporates ISO 9613 in the propagation calculations. The ISO 9613 methods used by Cadna-A were endorsed by an independent working group of European acoustical consultants.[67] Additionally, post-construction studies performed by Andrew Bullmore[68] and Kenneth Kalinski[69] compared measured sound levels from wind farms with corresponding calculation models of the same wind farms. These comparisons showed that wind turbine sound levels modeled in Cadna-A and utilizing the ISO 9613-2 calculation methods can achieve good correlation with the post-construction measurements, effectively validating the calculation for wind-turbine sound sources. See responses 12 and 23.3 of Data Request No. 14 for information regarding the ISO 9613-2 calculation method.

The comment from E-Coustic Solutions regarding blast waves is not applicable because blast waves are not sound waves; they exhibit some similar behaviors but they are fundamentally different and methods of calculating blast effects are likewise different. Wind turbine noise emissions are not comparable to blast waves.

See response 13 of Data Request No. 14 for information regarding the recent calculation method from the Swedish EPA. The E-Coustic Solutions comment is factually incorrect when it states that the calculation for sound propagation considers a decay rate of 3 dB per doubling of distance. Over land, propagation occurs at a decay rate of 6 dB per doubling of distance, just as the ISO 9613-2 calculation does. The Swedish method does implement a different propagation calculation for offshore wind turbines (that means wind turbine noise propagation over open water), which includes a device to propagate at 3 dB per doubling of distance, in addition to the standard propagation for point sources at 6 dB per doubling of distance. The installation of wind turbines in open water is not proposed as part of the Tule Wind Project. Therefore, the E-Coustic Solutions' reference to the Swedish EPA methods is incorrect, inapplicable, and inappropriate.

23.11 E-Coustic Solutions Comment 11 (pages 7-8)

<u>Claim – Using sound power levels measured according to the method in IEC 61400/Part 11 will under-predict sound levels during conditions of a nighttime stable atmosphere.</u>

Response: See response 14 of Data Request No. 14 for an explanation of the purpose and use of sound power levels. By virtue of their nature, sound power level data intentionally removed the effect of the listening environment to allow prediction of noise from the source under study in a variety of listening environments. The sound power data is intended to be irrespective of a particular environment, contrary to the suggestion of E-Coustic Solutions. This comment from E-Coustic Solutions is fundamentally misleading. The internationally-recognized way to establish a sound power level for a single wind turbine is through methods contained in IEC 61400. Use of a different measurement standard to establish the reference sound power level is inappropriate.

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[67] Bowdler et al., Prediction and Assessment of Wind Turbine Noise. Institute of Acoustics *Acoustics Bulletin*. March / April 2009.

[68] Bullmore et al. "Wind Farm Noise Predictions and Comparison with Measurements". Third International Meeting on Wind Turbine Noise. June 2009.

[69] Kalinski, Kenneth and Eddie Duncan. "Propagation Modeling Parameters for Wind Power Projects". Sound & Vibration. December 2008.

Use of that reference sound power level to assess wind turbine noise levels under different stability regimes is independent of the IEC 61400 method, because that is simply a measurement method and assessing wind turbine noise levels under different conditions requires modeling. That modeling should be based on ISO 9613. On this basis, this comment is misleading.

Furthermore, temperature inversions often form during stable nighttime conditions when ground-level wind speeds range from mild/calm to still (no wind). Normally, the temperature of the atmosphere gets colder as you move higher above the earth's surface. A temperature inversion is an atmospheric condition in which the atmospheric temperature increases with height above ground (cool air is trapped near the ground with warmer air above it). Temperature inversions are most commonly caused by radiative cooling of the ground at night leading to cooling of the air in contact with the ground. Such conditions are especially prevalent on cloudless nights with little wind. If winds occurred at the ground level, the inversion layer would become mixed with the layers above it and the inversion would begin to disappear.

During episodes of stable atmosphere, temperature inversions occurring within the lowest 50 to 100 meters of atmosphere can affect noise levels measured on the ground. Such conditions may increase noise levels by focusing sound wave propagation paths at a single point. Conventional approaches to assessing noise propagation under temperature inversion conditions require knowledge of the temperature gradient and assume that the noise source is located below the temperature inversion, typically near the ground. In summary, when a layer of cool air is trapped at the ground surface (with a layer of warmer air above it) and the winds are still, the resulting temperature inversion is known to focus sound wave propagation paths (from noise sources operating in the layer of cold air, most often on the ground) at a single point on the ground.

When the atmosphere is stable, the effect of temperature inversions on noise propagation from wind turbines is not typical of other sources. Wind turbines located on top of ridges are often located at elevations that are much higher than nearby receivers. In those circumstances it is unlikely that conventional temperature inversions in the lower 100 meters of the atmosphere would affect noise propagation from sources elevated as high as wind turbines on top of ridges. A further consideration must be that temperature inversions require little to no wind in order to minimize atmospheric mixing and hence develop. During calm conditions the wind turbine generators are unlikely to operate, because the cut-in speed is approximately 3-4 m/s. [70]

In general, sound propagates best under stable conditions with a strong inversion, such as during a clear night with low winds. In those situations, sound levels from wind turbines would be at their lowest. Wind speeds under very stable conditions—Stability Class G—generally are too low to generate electricity, and thus, the wind turbines would produce little or no noise because they would not be operating. As a result, worst-case conditions for wind turbines tend to be under more moderate nighttime inversions.[71]

Moderate nighttime inversions include periods when winds at the hub height are above the cut-in speed and ground-level winds are still; the still ground-level winds do not create any masking

[70] Silverton Wind Farm Noise Impact Assessment, July 23, 2008, by Heggies Pty Ltd.
[71] Kenneth H. Kalinski, "Understanding Turbine Sound Impact Studies", North American Wind Power, May 2008.

noise. These conditions are most likely to result in the highest levels of amplitude modulation, be most favorable to noise propagation, and wind turbine noise being the most perceivable[72]. Post-construction noise measurements were performed during these conditions, at both the Mars Hill and Stetson wind farms. Over 300 hours of measurement data was collected under these conditions. Analysis of that data confirmed that noise levels measured under these conditions were within 5 dBA of modeled noise levels[73]. The noise analysis performed for the Tule project modeled a moderate inversion condition. The Tule noise analysis also added more than 5 dBs of conservatism. In this manner, the Tule noise analysis accounted for moderate inversions and conditions most favorable to propagation, when ground-level masking is at its lowest level, and turbine noise is most noticeable.

Under an inversion there may be less wind-generated masking sound near the ground under the boundary layer. The noise levels are not necessarily louder during these environmental conditions, but they may be more perceivable in the absence of the masking effects of ground-level winds. Several other measures have been enacted in the sound propagation model to avoid under-predicting the sound levels. These are discussed in greater detail in response 16 of Data Request No. 14, and the *Tule Wind Project – Draft Noise Analysis Report,* dated February 2011 (Section 1.3 and Appendix D).

23.12 E-Coustic Solutions Comment 12 (pages 8-9)

<u>Claim – Modeling methods and assumptions should have included 3 dB to account for uncertainty in ISO 9613-2</u>

Response: Several measures of conservatism have been taken in the noise model to avoid under-predicting the sound levels at the receiver. A 3dB correction to account for uncertainty in ISO 9613 Part 2 was accounted for through other conservative assumptions used in the modeling. The use of conservative modeling assumptions results in more than 3 dB increase over less conservative methods; therefore, no additional corrections were applied.

Please refer to responses 7 and 16 of Data Request No. 14 for further details on the modeling methodology and assumptions.

23.13 E-Coustic Solutions Comment 13 (page 9)

<u>Claim – Predicted sound levels underestimate nighttime noise under stable atmospheric</u> conditions.

Response: E-Coustic Solutions does not support their claim with measurement data. As stated previously, during stable nighttime conditions, ground-level wind speeds range from mild/calm to still (no wind); often temperature inversions form. Normally, the temperature of the atmosphere gets colder as you move higher above the earth's surface. A temperature inversion is an atmospheric condition in which the atmospheric temperature increases with height above

[72] Resource Systems Engineering, "Response to Powers Trust Objection", November 3, 2009.
[73] Resource Systems Engineering, "Response to Powers Trust Objection", November 3, 2009.

ground (cool air is trapped near the ground with warmer air above it). Temperature inversions are most commonly caused by radiative cooling of the ground at night leading to cooling of the air in contact with the ground. Such conditions are especially prevalent on cloudless nights with little wind. If winds occurred at the ground level, the inversion layer would become mixed with the layers above it and the inversion would begin to disappear.

During episodes of stable atmosphere, temperature inversions occurring within the lowest 50 to 100 meters of atmosphere can affect noise levels measured on the ground. Such conditions may increase noise levels by focusing sound wave propagation paths at a single point. Conventional approaches to assessing noise propagation under temperature inversion conditions require knowledge of the temperature gradient and assume that the noise source is located below the temperature inversion, typically near the ground. In summary, when a layer of cool air is trapped at the ground surface (with a layer of warmer air above it) and the winds are still, the resulting temperature inversion is known to focus sound wave propagation paths (from noise sources operating in the layer of cold air, most often on the ground) at a single point on the ground.

When the atmosphere is stable, the effect of temperature inversions on noise propagation from wind turbines is not typical of other sources. Wind turbines located on top of ridges are often located at elevations that are much higher than nearby receivers. In those circumstances it is unlikely that conventional temperature inversions in the lower 100 meters of the atmosphere would affect noise propagation from sources elevated as high as wind turbines on top of ridges. A further consideration must be that temperature inversion require little to no wind in order to minimize atmospheric mixing and hence develop. During calm conditions the wind turbine generators are unlikely to operate, because the cut-in speed is approximately 3-4 m/s.[74]

In general, sound propagates best under stable conditions with a strong inversion, such as during a clear night with low winds. In those situations, sound levels from wind turbines would be at their lowest. Wind speeds under very stable conditions—Stability Class G—generally are too low to generate electricity, and thus, the wind turbines would produce little or no noise because they would not be operating. As a result, worst-case conditions for wind turbines tend to be under more moderate nighttime inversions.[75]

Moderate nighttime inversions include periods when winds at the hub height are above the cut-in speed and ground-level winds are still; the still ground-level winds do not create any masking noise. These conditions are most likely to result in the highest levels of amplitude modulation, be most favorable to noise propagation, and wind turbine noise being the most perceivable[76]. Post-construction noise measurements were performed during these conditions, at both the Mars Hill and Stetson wind farms. Over 300 hours of measurement data was collected under these conditions. Analysis of that data confirmed that noise levels measured under these conditions were within 5 dBA of modeled noise levels.[77] The noise analysis performed for the Tule project modeled a moderate inversion condition. The Tule noise analysis also added more than 5 dBs of

[74] Silverton Wind Farm Noise Impact Assessment, July 23, 2008, by Heggies Pty Ltd.
[75] Kenneth H. Kalinski, "Understanding Turbine Sound Impact Studies", North American Wind Power, May 2008.
[76] Resource Systems Engineering, "Response to Powers Trust Objection", November 3, 2009.
[77] Resource Systems Engineering, "Response to Powers Trust Objection", November 3, 2009.

conservatism. In this manner, the Tule noise analysis accounted for moderate inversions and conditions most favorable to propagation, when ground-level masking is at its lowest level, and turbine noise is most noticeable.

Please refer to responses 7 and 16 of Data Request No. 14 for further details on the modeling methodology and assumptions.

23.14 E-Coustic Solutions Comment 14 (page 9)

Response: The limits stated by E-Coustic Solutions for source heights mischaracterize the language that is actually in ISO 9613-2. Section 9 of the ISO Standard discusses the accuracy of calculations, and lists the accuracy according to certain geometric conditions in Table 5, therein. Table 5 from ISO 9613-2 is reproduced in the E-Coustic Solutions comment as Figure 12 on page 21. The data in Table 5 means that the standard can provide an estimate of accuracy within those heights based upon previous study, but that the standard does not provide an estimate of accuracy for heights and distances greater than listed in the table. The language in ISO 9613-2 *does not prohibit* using those calculations with source and receiver heights and distances greater than listed in the table. The calculations are based upon physical principles and are found in several standards and academic resources; they are not unique to this standard and its table of estimated accuracy.

Furthermore, E-Coustic Solutions seems to have misinterpreted the table of estimated accuracy by stating that it is limited to "noise sources that are no more than 30 meters above the receiving locations." Actually, the height value is based upon a mean (average) of the source and receiver height, so for a receiver that is 2 meters high [6 feet] the table of accuracy values will still apply to sources that are 58 meters high [190 feet], because the mean height of the source and receiver is then 98 feet (30 meters). A wind turbine with a hub height of 80 meters will be far enough outside the parameters shown in the table to be unable to estimate the accuracy associated with the sound propagation, apart from saying that it will likely be greater than ±3 dB. But it is not as far outside the parameters as characterized by E-Coustic Solutions (the source height is about 35% higher than the table of estimated accuracy can account for, not 167% that E-Coustic Solutions stated).

For modeling wind turbines, the ISO 9613-2 methods used by Cadna-A were endorsed by an independent working group of European acoustical consultants.[78] Additionally, post-construction studies performed by Andrew Bullmore[79] and Kenneth Kalinski[80] compared measured sound levels from wind farms with corresponding calculation models of the same wind farms. These comparisons showed that wind turbine sound levels modeled in Cadna-A and utilizing the

[78] Bowdler et al., Prediction and Assessment of Wind Turbine Noise. Institute of Acoustics *Acoustics Bulletin*. March / April 2009.
[79] Bullmore et al. "Wind Farm Noise Predictions and Comparison with Measurements". Third International Meeting on Wind Turbine Noise. June 2009.
[80] Kalinski, Kenneth and Eddie Duncan. "Propagation Modeling Parameters for Wind Power Projects". Sound & Vibration. December 2008.

ISO 9613-2 calculation methods can achieve good correlation with the post-construction measurements when the modeling parameters are chosen appropriately.

In summary, the ISO 9613-2 standard can provide an estimate of accuracy for certain geometric parameters of the source and receiver (heights and distances). But it does not preclude the use of the calculations outside of these parameters. Wind turbines are outside these parameters and so may have a level of uncertainty greater than 3 dB, but wind turbines are not as far outside these parameters as E-Coustic Solutions implies. Additionally wind turbine models have been compared to field measurements with acceptable results as shown in the Kalinski study.[81]

Please refer to responses 12 and 23.3 of Data Request No. 14 for further details on the modeling methodology and post-construction monitoring.

The limits stated by E-Coustic Solutions for source heights and distances do not preclude the use of the calculations outside of these limits. The portions of the calculations used in the noise model for the Tule Wind Project are based upon physical principles and are found in several standards and academic resources. These limits are merely a statement of where there is a well-studied level of uncertainty, and these estimated levels of uncertainty may be applied when using all portions of the ISO 9613-2 calculations.

23.15 E-Coustic Solutions Comment 15 (pages 12-15)

Claim – Wind turbine sound causes annoyance at sound levels 10 dBA or more below the sound levels that would cause equivalent annoyance from other sources.

Response: Annoyance is subjective and influenced by aural sensitivity and attitudes toward a project. Please refer to response numbers 5 and 23.9 of Data Request No. 14 for additional information concerning annoyance.

Claim – IEC 61400-11 test procedures do not represent a “worst case” sound propagation condition.

Response: The noise study for the project used very conservative assumptions. This is discussed in greater detail in responses 7 and 8 of Data Request No. 14.

The sound power level measurement method described in IEC 61400-11 does not address propagation in any particular environment. The purpose of a sound power measurement is to quantify the noise emission characteristic of a sound source irrespective of its environment. This makes the resulting sound power level useful for predicting the effect of introducing the noise source into any environment. Sound propagation is addressed through the Cadna-A model.

The Cadna-A model developed for the Tule Wind Project utilizes modeling assumptions which best reflect measurements from operating wind farms. Post-construction studies show that wind

[81] Kalinski, Kenneth and Eddie Duncan. “Propagation Modeling Parameters for Wind Power Projects”. Sound & Vibration. December 2008.

turbine sound levels modeled with ISO 9613:2 using no ground attenuation best fit monitored sound levels. Additionally, conservative assumptions such as the use of the manufacturer guaranteed sound levels and modeling of the hot weather package were also used in the sound model developed for the Tule Wind Project. These modeling assumptions are all implemented with the goal to avoid under-predicting sound levels.

Please refer to response 14 of Data Request No. 14 for further details on IEC 61400-11.

Claim – Amplitude modulated sound results in sound fluctuating 5 dBA or more

Response: Wind turbines emit broad band noise with a spectral peak around 500 Hz. As the blades move closer and farther away from a stationary listener, the noise they emit gets louder and softer. This rhythmic increase and decrease in noise emissions is called amplitude modulation, and the amount of modulation varies according to proximity to the wind turbine. Sound from many sources exhibits amplitude modulation. Steady, low-volume traffic pass-by events exhibit a rhythmic rise and fall in volume. Ocean waves crashing on a beach also exhibit a rhythmic rise and fall in volume. In this manner noise from these events exhibit amplitude modulation, this by virtue of its nature is not intrinsically annoying or harmful to human health. In fact, many people consider the rhythmic noise made by ocean waves to be desirable.

Please refer to response number 4 of Data Request No. 14 for further details on the characteristics of wind turbine sound and amplitude modulation.

In addition, it should be noted that the E-Coustic study does not present site-specific data and does not appear to be based on any consideration of the Tule project's specific conditions. In fact, it appears to have been written for another project entirely (the Kent Breeze Project, which is mentioned on page 13 of the report).

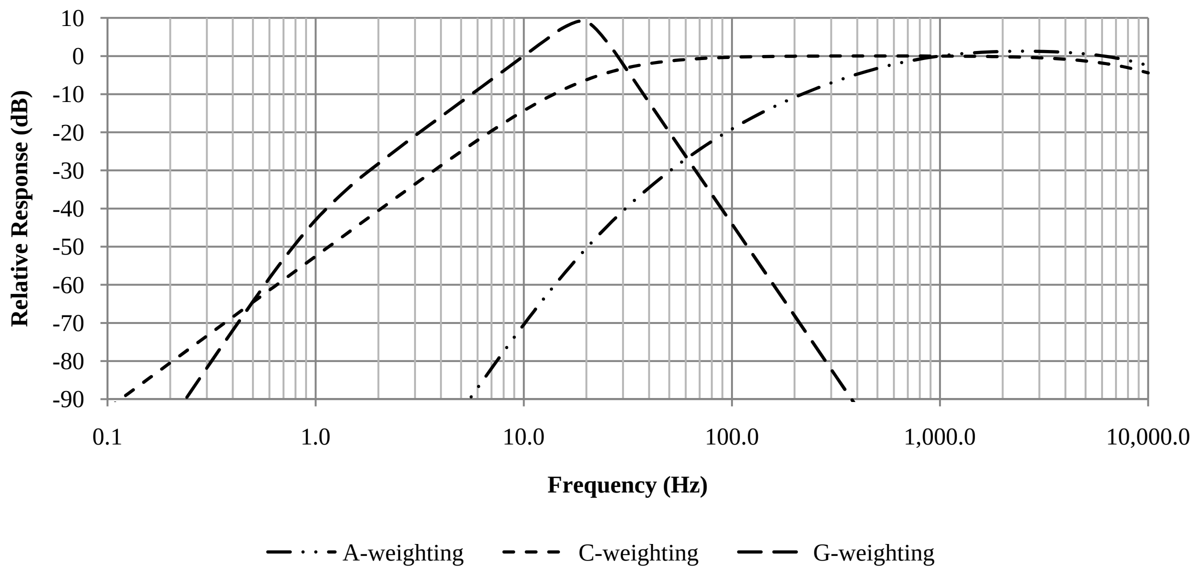
23.16 E-Coustic Solutions Comment 16 (pages 16-19)

Claim – Low frequency sounds and infrasound should be measured using dBC and dBG, respectively

Response: This question exists in the context of an environmental noise analysis for a proposed wind turbine project. Existing requirements in San Diego County rely on A-weighting for sound measurements and regulations. The A-weighting scale is a close approximation of the human response to different frequencies of sound and is in broad use across many disciplines which address noise. While there are weighting scales other than the A-weighting scale (which simulates human response to frequencies of sound), use of other weighting scales produces results that do not reflect how human ears respond to different frequencies of sound. Therefore, they are not appropriate to use in the context of an environmental acoustics analysis performed to assess compliance with applicable noise limits.

The A-weighting scale attenuates low-frequency noises in a manner that simulates how human ears attenuate low frequency noise at low levels (approximately 40 dB). The C-weighting scale does not attenuate low frequencies as much as the A-weighting scale because it simulates how humans perceive sound at higher levels (approximately 80 dB). Use of C-weighting produces different noise analysis results than those already reported in units of A-weighted dBs. The differences between the A-weighted and C-weighted results are not pertinent because sound levels at receptors will not reach levels as high as 80 dB due to the wind turbines.

The G-weighting scale emphasizes frequencies centered at 20 Hz; it begins to heavily discount the influence of frequencies above 40 Hz and below 5 Hz. A comparison of weighting scales is shown in the graph below.[82,83] In the context of an environmental noise assessment performed to assess compliance with A-weighted noise limits, there is no merit to expressing project-related noise using G-weighting.



Please refer to responses 1, 6 and 9 of Data Request No. 14 for further details on applicable regulations and use of the A-weighting scale.

<u>Claim – Infrasound from wind turbines will be audible for some people at levels lower than what is required for threshold of perception, based on a single pure tone</u>

Response: The science behind the perception of infrasound and minimum audible field for infrasound has been studied by the evaluation of pure tone and the presence of background noise. The threshold of perception found amongst studies is not consistent due to variability in study conditions and subjects. There is not consensus and very little data to evaluate the exact effect of background noise on the audibility of infrasound.

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[82] ANSI S1.4-1983. American National Standard Specification for Sound Level Meters.
[83] ISO 7196:1995. Acoustics – Frequency-weighting characteristic for infrasound measurements.

This uncertainty is discussed by Moller and Pedersen below.

> *"Generally low-frequency and infrasonic sounds from everyday life are not pure tones alone, but rather combinations of different random noises and tonal components. It is however, impossible to make thresholds for all imaginable combinations of sounds that exist, and as seen above there is no final conclusion about possible higher or lower sensitivity to noise bands than to pure tones. Anyway, differences seem to be relatively modest, and the pure-tone threshold can with a reasonable approximation be used as a guideline for the thresholds also for nonsinusoidal sounds."*[84]

As stated by E-Coustic Solution the threshold for perception presented in the Watanbe and Pedersen study is based on pure tones; therefore, the threshold of audibility in the presence of other sounds will vary. The differences in the minimum audible field will be relatively modest and pure tone thresholds serve as a reasonable approximation.[85].

Measurements of operating wind turbines published by Epsilon and Associates[86] show that infrasonic sound emissions from modern upwind-configured wind turbines are below audibility thresholds for even the more sensitive people at a distance of 1,000 feet. Infrasound levels measured at a distance of 1,000 feet from GE 1.5 sle and Siemens SWT 2.3 wind turbine generators were more than 20 dBs below the median thresholds of hearing.

Please refer to responses 1 and 2 of Data Request No. 14 for further details on infrasound and low frequency sound.

<u>Claim – Statements that infrasound is not significant because it does not reach the amplitudes above the threshold of perception are mischaracterizing wind turbine infrasound</u>

Response: This is simply not true. The *Tule Wind Project – Draft Noise Analysis Report* addressed all applicable noise considerations and "significance" determinations in relation to local regulation and CEQA including:

- Exposure of person to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of the other agencies.
- Exposure of persons to or generation of excessive ground borne vibration or ground borne noise levels.
- A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project.
- A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.

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[84] Moller H. and Pedersen C.S. Hearing at low and infrasonic frequencies. Noise Health 2004;6:37-57.
[85] Moller H. and Pedersen C.S. Hearing at low and infrasonic frequencies. Noise Health 2004;6:37-57.
[86] Epsilon Associate, Inc. "A Study of Low Frequency Noise and Infrasound from Wind Turbines". July 2009.

Post-construction measurements show that the amount of low frequency sound and infrasound from wind turbines is modest and acceptable according to ANSI standards. Please refer to response 26 of Data Request No. 14 for further information on infrasound.

Claim – Infrasound and low frequency sound below the threshold of perception can cause health effects.

Response: Several reviews of currently available scientific data have determined that there is no direct casual relationship between wind turbine generated sound and health effects. A review of the medical literature databases performed by Exponent, Inc. found no evidence of a causal link between exposure to wind turbine noise and adverse health effects. As of this review (by Exponent), there has not been a specific health condition documented in the peer reviewed published literature to be classified as a disease caused by or associated with exposure to sound levels and frequencies generated by the operation of wind turbines.[87]

The Chief Medical Officer of Health of Ontario[88] recently performed a study focusing on the topic of wind turbine noise and health. The study also concluded the following concerning wind turbine and health:

- While some people living near wind turbines report symptoms such as dizziness, headaches, and sleep disturbance, the scientific evidence available to date does not demonstrate a direct causal link between wind turbine noise and adverse health effects.

- The sound level from wind turbines at common residential setbacks is not sufficient to cause hearing impairment or other direct adverse health effects. However, some people might find it annoying. It has been suggested that annoyance may be a reaction to the characteristic “swishing” or fluctuating nature of wind turbine sound rather than to the intensity of sound.

- Low frequency sound and infrasound from current generation upwind model turbines are well below the pressure sound levels at which known health effects occur. Further, there is no scientific evidence to date that vibration from low frequency wind turbine noise causes adverse health effects.

Please refer to responses 5, 23.1, 23.7, and 26 of Data Request No. 14 for further information concerning infrasound, low frequency sound, and health effects.

Claim – Dr. Nina Pierpont established a causal link between wind turbine infrasound and low frequency sound and medical pathologies

[87] “Evaluation of the Scientific Literature on the Health Effects Associated with Wind Turbines and Low Frequency Sound”, Exponent, Inc., October 20, 2009, and also in testimony by of Dr. Mark Roberts in Glacial Hills wind farm project in Wisconsin, Broad Mountain wind farm project in Pennsylvania, and Goodhue Wind project in Minnesota.
[88] “The Potential Health Impact of Wind Turbines.” Chief Medical Officer of Health Report. May 2010.

Response: While the work of Dr. Nina Pierpont intends to establish a causal link between wind turbine infrasound and low frequency sound and health effects, she fails to do so.

Association is not equal to causation. Researchers can find an association, also called a correlation, which is a relationship, negative or positive, between two or more variables. Often an association is identified through statistical inferences before a causal relationship is established. Historically, there have been careful clinical observations (e.g., case reports and series) that have stimulated a number of now-classic epidemiology research efforts that have identified important associations and ultimately the determinants of causal relationships. There have also been case reports identifying associations that did not hold up under epidemiological scrutiny, such as those associating blunt force trauma and cancer. For this reason, case studies cannot be used to determine causation. A causal association can only be established by the evaluation of well designed and executed epidemiologic studies.

A landmark discussion of the process of moving from a disease being associated with a risk factor to a point where the scientific community is comfortable attributing causation to a risk factor was put forth by Sir Austin Bradford Hill in 1965. It was during this time that a number of papers, including the Surgeon General Report issued in 1964, began to more formally delineate the scientific reasoning process that justifies a conclusion that observed associations between an exposure and a disease are the result of a causal relationship between the exposure and the disease. Key statements from scientists during that time include the following:

> "Disregarding then any such problem in semantics we have this situation. Our observations reveal *an association between two variables, perfectly clear-cut* and beyond what we would care to attribute to chance. What aspects of that association should we especially consider before deciding that the most likely interpretation of it is causation?" [italics added]. Hill's nine criteria for causation have been described in a number of ways. They are commonly referred to as strength, consistency, specificity, temporality, biological gradient, plausibility, coherence, experiment, and analogy[89].

Numerous reviews of Dr. Pierpont's research conclude that it fails to establish a causal link due to several reasons, including the fact that her samples were deliberately selected and their sizes were too small, as well as the fact that there was no control group[90]. Several reviews of currently available scientific data have determined that there is no direct casual relationship between wind turbine-generated sound and adverse health effects.

Please refer to responses 5, 23.1, 23.7, 23.16 and 26 of Data Request No. 14 for further information concerning infrasound, low frequency sound and health effects.

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[89] Hill AB. (1965). The Environment and Disease: Association or Causation? *Proc R Soc Med.* 58295 -300).
[90] Testimony of Dr. Mark Roberts to the Wisconsin Public Utilities Commission, docket number 6630-CE-302.

Claim – The research conducted by Dr. Nina Pierpont meets the standards of a peer reviewed epidemiological study.

> *"The type of epidemiological study conducted by Dr. Pierpont is termed a case-crossover study. […] Further the report was peer-reviewed by some of the top experts in the U.S. and Britain who have experience with vestibular disturbances and adverse health conditions."*

Response: The following components of the aforementioned comment are not true: "*epidemiological study conducted by Dr. Pierpont*" and *"the report was peer-reviewed"*. Dr. Pierpont's work was not an epidemiological study, but a series of case reports and it did not undergo the rigor of a peer review process which generally uses anonymity and employs a double-blind process whereby the authors and peer reviewers remain unknown or blinded to each other. Dr. Pierpont's peer review process appears to be among colleagues and friends and not a single- or double-blind process. She used nontraditional references such as newspaper articles and television interviews in support of her hypothesis. In rebuttal testimony to the Wisconsin Public Utilities Commission, Dr. Mark Roberts stated the following. "My assessment is that the material (Pierpont research) describing the phenomena does not appear to have been peer reviewed in a critical, blinded fashion in the same manner as the articles published in the leading medical journals. In addition, some of the references that I have seen cited are newspaper articles, TV interviews, and addresses before legislative bodies. Those are not traditional formats to present scientific data. It shortcuts the review process that is part of the scientific process of discovery."

Dr. Roberts also concluded the following:

1. "Wind Turbine Syndrome" is not a medical diagnosis supported by peer reviewed, published, scientific literature;

2. The materials presented to support "Wind Turbine Syndrome" are not of sufficient scientific quality nor have they received the rigorous scientific review and vetting that is customarily part of the peer review and publishing process;

3. The tried and true scientific method of developing a hypothesis, testing that hypothesis, publishing the results and having others attempt to repeat the research has not been done to test the existence of a health condition called "Wind Turbine Syndrome;"

4. An accumulation of anecdotal interviews with self-selected persons living near a wind turbine does not constitute an epidemiological study and is not sufficient to determine causation;

5. The bases for claimed adverse health effects due to wind turbines cited by Mr. James either cannot withstand scientific scrutiny or have nothing to do with wind turbines; and

6. Siting a wind turbine within view of a residence and the operation of that turbine could be a source of annoyance to those living in the residence[91]."

Claim – Health effects from wind turbine sound is plausible based on currently existing information

Response: Scientific evidence challenges the notion that adverse health effects from wind turbine sound is plausible. Dr. Pierpont claims that infrasound at 4-8 Hz enters the lungs and vibrates the diaphragm and its attached liver, passing confusing messages on to the visceral graviceptors. Dr. Pierpont gives no evidence to support this, but instead uses references to whole body vibration, applied to the feet or seat, which is a completely different excitation to that from sound. A simple order of magnitude calculation using basic physics, shows that the movement of the diaphragm under the forces which might result from wind turbine noise is less than 10 microns. That is less than one hundredth of a millimeter or about one tenth of the average thickness of human hair. During normal breathing, the diaphragm moves several centimeters.

Another part of Pierpont's hypothesis states that infrasound from wind turbines, at a frequency of 1-2 Hz, vibrates the chest, adding to the confusing signals which upset the balance system. However, there is already a strong source of infrasound inside the body. The human heart beats at 1-2 Hz, giving far greater magnitudes than might be produced by infrasound from wind turbines at these frequencies. The beating heart vibrates the surface of the body at a high enough level to be picked up by a stethoscope, or even the ear. The sound produced by wind turbines does not. [92]

Claim – Some people exposed to wind turbine sound are suffering psychological distress and other related harm which warrants the label "health effects" or "disease"

Response: There is not universal agreement that exposure to wind turbine sound causes adverse human health effects. The Chief Medical Officer of Ontario reviewed potential human health effects of wind turbines. The review concludes that while some people living near wind turbines report symptoms such as dizziness, headaches, and sleep disturbance, the scientific evidence available to date does not demonstrate a direct causal link between wind turbine noise and adverse health effects. Several reviews of currently available scientific data have determined that there is no direct casual relationship between wind turbine generated sound and health effects. Both Dr. Mark Roberts, MD, PhD and former State Epidemiologist for the Oklahoma State Department of Health[93] and Dr. Arlene King, the Chief Medical Officer for Ontario[94] concluded there is inadequate evidence to establish a causal link between exposure to wind turbine noise and adverse human health effects. Please refer to responses 5, 23.1, 23.7, 23.16, and 26 of Data Request No. 14 for further information concerning wind turbine generated sound and health effects.

[91] Testimony of Dr. Mark Roberts to the Wisconsin Public Utilities Commission, docket number 6630-CE-302.
[92] Testimony of Dr. Geoff Leventhall to the Wisconsin Public Utilities Commission, docket 6603-CE-302.
[93] Testimony of Dr. Mark Roberts to the Wisconsin Public Utilities Commission, docket number 6630-CE-302.
[94] "The Potential Health Impact of Wind Turbines." Chief Medical Officer of Health Report. May 2010.

Furthermore, a report, "Wind Turbine Sound and Health Effects: An Expert Panel Review", prepared by a multidisciplinary panel is of medical doctors, audiologists, and acoustical professionals from the United States, Canada, Denmark, and the United Kingdom stated that "there is no evidence that the audible or sub-audible sounds emitted by wind turbines have any direct adverse physiological effects". It was also determined that "the ground-borne vibrations from wind turbines are too weak to be detected by, or to affect, humans"[95]. The sound level from wind turbines at common residential setbacks is not sufficient to cause hearing impairment or other direct health effects, although some people may find it annoying. [96] This sentiment is echoed in the findings of an European Union financed study that released it final report, "WINDFARM perception: Visual and acoustic impact of wind turbine farms on residents" in 2008. It was stated that

> *"There is no indication that the sound from wind turbines had an effect on respondents' health, except for the interruption of sleep. At high levels of wind turbine sound (more than 45 dBA) interruption of sleep was more likely than at low levels. Higher levels of background sound from road traffic also increased the odds for interrupted sleep.*
>
> *Annoyance from wind turbine sound was related to difficulties with falling asleep and to higher stress scores. From this study it cannot be concluded whether these health effects are caused by annoyance or vice versa or whether both are related to another factor."*[97]

<u>Claim – "There is ample scientific evidence to conclude that wind turbines cause serious health problems for some people living nearby"</u>

Response: Several reviews of currently available scientific data have determined that there is no direct casual relationship between wind turbine generated sound and health effects. Please refer to responses 5, 23.1, 23.7, 23.16 and 26 of Data Request No. 14 for further information concerning wind turbine generated sound and health effects. Both Dr. Mark Roberts, MD, PhD and former State Epidemiologist for the Oklahoma State Department of Health[98] and Dr. Arlene King, the Chief Medical Officer for Ontario[99] concluded there is inadequate evidence to establish a causal link between exposure to wind turbine noise and adverse human health effects.

<u>Claim – "The reports that claim that there is no evidence of health effects are based on a very simplistic understanding of epidemiology and self-serving definitions of what does not count as evidence"</u>

Response: This statement is simply not true. Both Dr. Mark Roberts, MD, PhD and former State Epidemiologist for Oklahoma State Department of Health[100] and Dr. Arlene King, the

[95] Wind Turbine Sound and Health Effects: An Expert Panel Review. Available at http://www.canwea.ca/pdf/talkwind/Wind_Turbine_Sound_and_Health_Effects.pdf.
[96] "The Potential Health Impact of Wind Turbines." Chief Medical Officer of Health Report. May 2010.
[97] WINDFARM perception: Visual and acoustic impact of wind turbine farms on residents. Available at http://www.windaction.org/?module=uploads&func=download&fileId=1615.
[98] Testimony of Dr. Mark Roberts to the Wisconsin Public Utilities Commission, docket number 6630-CE-302.
[99] "The Potential Health Impact of Wind Turbines." Chief Medical Officer of Health Report. May 2010.
[100] Testimony of Dr. Mark Roberts to the Wisconsin Public Utilities Commission, docket number 6630-CE-302.

Chief Medical Officer for Ontario[101] concluded there is inadequate evidence to establish a causal link between exposure to wind turbine noise and adverse human health effects[102].

Claim – Infrasound from wind turbines below the threshold of perception can affect the inner ear

Response: Several natural functions such as the heart beating, blood flowing, muscle vibrations and breathing cause infrasound and low frequency noise at low levels but do not cause adverse health effects and in fact are necessary to sustain human life. While evidence exists that infrasound below the threshold of perception can cause movement of the inner ear this does not establish a casual relationship between wind turbine sound and adverse health effects.

Claim – ASHRAE supports the claim that adverse health effects are related to inaudible low frequency and infrasound

Response: ASHRAE does concern itself with noise and vibration for indoor environments, primarily in regard to heating, ventilation and air-conditioning systems (HVAC). The design goals that ASHRAE recommends are aimed at providing comfort, speech privacy and speech intelligibility as appropriate to room uses. Studies of office noise such as the one cited by E-Coustic Solutions[103] are quite prevalent and many have found that audible sounds from poorly-designed HVAC systems affect the concentration, productivity and attitude of office workers. Furthermore, Geoff Leventhall had an opportunity to discuss the relevance of his research to wind turbines. That particular research of low-frequency “rumble” in HVAC noise was not applicable to wind turbines because the spectrum was dissimilar in frequency and in levels, and the findings indicated little effect due to low-frequency noise.[104]

The design goals that ASHRAE recommends are through either the RC Mark II rating system or the NC rating system. These rating systems consider high-frequency sounds, mid-frequency sounds and low-frequency sounds(the NC rating system was updated in 2008 to include low frequencies, contrary to the claim by E-Coustic Solutions[105]), but neither of these rating systems address infrasound. The recommended criteria, even for residential bedrooms, allow low-frequency noise at 60 dB or potentially higher in frequencies below 31.5 Hz.

Claim – Low-frequency components of wind turbine sound causes extraordinary effects inside buildings and causes effects upon an extraordinarily broad area.

Response: The specific effects of low-frequency sound which E-Coustic Solutions discusses are nothing more than phenomena that billions of people encounter every day in a built environment. These effects do not identify anything inherently problematic. The comment also mentions the

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[101] “The Potential Health Impact of Wind Turbines.” Chief Medical Officer of Health Report. May 2010.
[102] Wind Turbine Sound and Health Effects: An Expert Panel Review. Available at http://www.canwea.ca/pdf/talkwind/Wind_Turbine_Sound_and_Health_Effects.pdf.
[103] K. Persson Waye, R. Rylander, S. Benton and H. G. Leventhall. Effects on performance and work quality due to low-frequency ventilation noise. Journal of Sound and Vibration, 1997.
[104] Testimony of Dr. Geoff Leventhall to the Wisconsin Public Utilities Commission, docket number 6630-CE-302.
[105] ANSI S12.2-2008 American National Standard Criteria for Evaluating Room Noise.

effect of distance upon sound levels (from a source which the author does not cite). The particular effect described seems to be once again a physical phenomenon that is not wind-turbine specific and is not inherently problematic. These statements of simple facts do not support any claim that wind turbine noise is intrinsically different than many other often-encountered noise sources.

23.18 E-Coustic Solutions Comment 18 (page 21)

Claim – Sound modeling should have included a 3 dB tolerance to account for the ISO-methodology

Response: A 3 dB correction to account for uncertainty in ISO 9613 Part 2 was implemented by applying conservative assumptions concerning sound propagation. The use of conservative modeling assumptions results in more than 3 dB increase over less conservative methods; therefore, no additional corrections were applied.

Please refer to responses 12 and16 of Data Request No. 14 for further details on ISO 9613-2, the modeling methodology and modeling assumptions.

Refer to Section 1.3 and Appendix D of the *Tule Wind Project – Draft Noise Analysis Report* (February 2011) for further details on the modeling methodology and ISO 9613 Part 2.

23.19 E-Coustic Solutions Comment 19 (page 21)

Response: E-Coustic Solutions' assertion that sound power levels are inappropriately used in this analysis is simply not true, and is potentially misleading. Sound power levels have been addressed in responses 14, 23.11 and 23.15 of Data Request No. 14. Standardized and repeatable measurements are desirable, not a deficiency.

PUBLIC HEALTH AND SAFETY

24. Please provide a discussion of the potential health effects resulting form two or more turbines operating near each other and causing repetitive, low frequency "periodic beats".

Response: G.P. van den Berg reported that often late in the afternoon or in the evening the turbine sound acquires a distinct 'beating' character, the rhythm of which is in agreement with the blade passing frequency.[106] He also notes that "It is not clear to what degree this fluctuating character determines the relatively high annoyance caused by wind turbine sound and to a deterioration of sleep quality." He continues to note that "wind turbine sound measurements are

[106] G.P. van den Berg, "The Beat is Getting Stronger: The Effect of Atmospheric Stability on Low Frequency Modulated Sound of Wind Turbines", in Noise Notes, volume 4, number 4.

easier when performed in a stable atmosphere, which agrees well with the night being the sensitive period for noise immission."[107]

However, post construction noise measurements performed at the Mars Hill and Stetson wind farms under the stable conditions that van den Berg recommends show that measured noise levels are within 5 dBA of modeled noise levels, and were also within acceptable ranges. The Tule noise analysis incorporated over 5 dBA of conservatism, and in that regard adequately assessed project-related noise levels. Furthermore, the actual force upon a body created by the infrasonic and low frequency noise emissions from operating wind turbines creates a displacement of approximately 10 microns, or one-tenth the thickness of the average human hair. Normal breathing, heart beats, and body motions produce larger displacements than 10 microns and do not cause adverse health effects[108]. For this reason, there is limited potential for adverse human health effects due to the operation of wind turbines.

25. Please provide an explanation of the studies considered and addressed to evaluate potential health effects from low frequency noise.

Response: Long-term exposure to very high levels of low frequency noise has been shown to have adverse effects on health. It has been demonstrated that high levels of low frequency noise can excite body vibrations, such as a chest resonance vibration that can occur at a frequency of 50 Hz to 80 Hz[109]. These chest wall and body hair vibrations have also been shown to occur at the infrasonic range[110,111]. However, in those instances, levels were significantly higher than the amounts of low frequency noise emitted by wind turbines. Studied health effects of low frequency sound include vibroacoustic disease which has been linked to prolonged exposure to high intensity low frequency noise, in excess of 110 dB, not low intensity low frequency noise[112,113,114]. Additionally studies have found that there is no evidence of adverse health effects related to low intensity low frequency noise, below 90 dB.[115] Low frequency sound and infrasound associated with wind turbines are well below 90 dB. Other studies have explored the effects of acoustic excitation by measuring the resulting vibration, non-aural effects and the perception of unpleasantness or annoyance among those exposed to low frequency noise including the following:

[107] G.P. van den Berg, "The Beat is Getting Stronger: The Effect of Atmospheric Stability on Low Frequency Modulated Sound of Wind Turbines", in Noise Notes, volume 4, number 4.
[108] Testimony of Dr. Geoff Leventhall to the Wisconsin Public Utilities Commission, docket 6603-CE-302.
[109] Leventhall, G. (2007). What is infrasound? 93(1-3), (130 -137).
[110] Mohr G.C., Cole J.N., Guild E., and Gierke von, H. E. (1965). Effects of Low Frequency and Infrasonic Noises on Man. 36.817 -827).
[111] Schust, M. (2004). Effects of low frequency noise up to 100 Hz. *Noise and Health.* 6(23), (73 -85).
[112] Castelo Branco N.A.A. and Rodriguez E. (1999). The Vibroacoustic Disease - An Emerging Pathology. *Aviation Space & Environmental Medicine.* 70(3,Pt2), (A1 -A6).
[113] Takahashi, Y., Yonekawa, Y., and Kanada, K. (2001). A new approach to assess low frequency noise in the working environment. *Industrial Health.* 39(3), (281 -286).
[114] Maschke, C. (2004). Introduction to the special issue on low frequency noise. *Noise and Health.* 6(23), (1 -2).
[115] "Wind Turbine Noise Issues." Renewable Energy Research Laboratory; University of Massachusetts. 2006.

- Berglund, B., Hassmen, P., and Job, R. F. (1996). Sources and effects of low-frequency noise. *Journal of the Acoustical Society of America.* 99(5), (2985 -3002).
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- Inukai Y., Nakamura N., and Taya H. (2000). Unpleasantness and Acceptable Limits of Low Frequency Sound. *Journal of Low Frequency Noise, Vibration and Active Control.* 19.135 -140).
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- Karpova N.I., Alekseev S., Erokhin V.N., Kadyskina E.N., and Reutov O.V. (1970). Early Response of the Organism to Low Frequency Acoustical Oscillations. *Noise and Vibration Bulletin.* 11(65), (100 -103).
- Maschke, C. (2004). Introduction to the special issue on low frequency noise. *Noise and Health.* 6(23), (1 -2).
- Mohr G.C., Cole J.N., Guild E., and Gierke von, H. E. (1965). Effects of Low Frequency and Infrasonic Noises on Man. 36.817 -827).
- Pedersen, E. and Waye, K. P. (2004). Perception and annoyance due to wind turbine noise--a dose-response relationship. *Journal of the Acoustical Society of America.* 116(6), (3460 -3470).
- Pedersen, E. and Persson, Waye K. (2007). Wind turbine noise, annoyance and self-reported health and well-being in different living environments. 64(7), (480 -486).
- Pedersen, E. and Waye, K. P. (2008). Wind Turbines - Low Level Noise Sources Interfering With Restoration. *Environmental Research Letters.* 3.
- Persson Waye K. and Rylander R. (2001). The Extent of Annoyance and Long-Term Effects Among Persons Exposed to LFN in the Home Environment. 240.483 -497).
- Schust, M. (2004). Effects of low frequency noise up to 100 Hz. *Noise and Health.* 6(23), (73 -85).

- Takahashi, Y., Yonekawa, Y., Kanada, K., and Maeda, S. (1999). A pilot study on the human body vibration induced by low frequency noise. *Industrial Health.* 37(1), (28 -35).
- Takahashi, Y., Yonekawa, Y., and Kanada, K. (2001). A new approach to assess low frequency noise in the working environment. *Industrial Health.* 39(3), (281 -286).
- Takahashi, Y., Kanada, K., Yonekawa, Y., and Harada, N. (2005). A study on the relationship between subjective unpleasantness and body surface vibrations induced by high-level low-frequency pure tones. *Industrial Health.* 43(3), (580 -587).
- Tesarz M., Kjellberg A., Landstroem U., and Holmberg K. (1997). Subjective Response Patterns Related to Low Frequency Noise. *Journal of Low Frequency Noise, Vibration and Active Control.* 16(2), (145 -149).
- Waye K. (2004). Effects of Low-Frequency Noise on Sleep. *Noise and Health.* 6(23), (87-91).

In fact, wind turbines produce modest and acceptable amounts of low frequency noise, as shown by post-construction noise measurement data publicly available and reasonably obtainable on the internet. A field study performed by Epsilon Associates measured low frequency noise associated with two modern turbines, the GE 1.5sle and the Siemens 2.3-93.[116] Using existing ANSI criteria for the evaluation of interior noise levels, Epsilon Associates determined that noise generated by wind farms at distances beyond 1,000 feet were below the low frequency noise criteria for bedrooms, classrooms and hospitals. In addition to meeting ANSI background noise criteria the measured interior noise levels also demonstrate that wind turbine setbacks of 1,000 feet will not cause "more than minimal annoyance (if any) from low frequency noise, and there should be no wind rattles or perceptible vibration of light-weight walls or ceilings within homes."

The overall noise level and spectrum of the GE 1.5-sle turbine is similar to the noise emissions of the GE 1.5 XLE, one of the turbines being considered for use in the Tule Wind Project. The Siemens 2.3-93 turbine, also used in the Epsilon study, has similar sound emissions, within ±3 dB, to the 2.0 MW and 3.0 MW turbines being considered for use in the Tule Wind Project. Current setbacks for the Tule Wind Project are more than 1,500 feet from the nearest non-participating home. Based on the Epsilon noise study, low frequency noise at a distance of 1,500 feet will have no audible infrasound and will meet ANSI S12.2 criteria for acceptable indoor levels for low frequency sound.

Most of the concerns arising from the notion that wind turbines emit powerful amounts of low-frequency noise stem from E-Coustic Solutions' apparent reliance on outdated NASA reports that demonstrate that downwind-configured wind turbines produce high levels of low frequency noise. The same NASA report also very clearly states that modern upwind-configured wind turbines do not emit nearly as much low frequency noise as the older, out-of-production, downwind-configured wind turbines. The turbines proposed for the Tule wind project would be modern upwind-configured and, therefore, would emit the small amounts of low frequency noise

[116] Epsilon Associate, Inc. "A Study of Low Frequency Noise and Infrasound from Wind Turbines." July 2009.

that are documented in the sources discussed above. As discussed in response number 24 of Data Request No. 14, these levels are not harmful to the human body and in fact are produced by heartbeats and other natural functions. Therefore, no adverse health effects from low frequency noise are anticipated.

26. Please provide an explanation of how the human body responds to extremely low levels of energy, such as inaudible low frequency sound and infrasound. Please also describe the potential health effects of infrasound and low frequency sound as compared to the effects of audible sound levels. Please take into consideration the auditory system's response to levels of low frequency sound and infrasound at pressures significantly lower than what is necessary to reach the threshold of audibility.

Response: The turbines at the Tule Wind Project will emit limited levels of low frequency and infrasonic sound. Recently some concerns have been raised about possible health effects from these inaudible sound levels. One theory comes from Dr. Nina Pierpont who claims that health effects including dizziness, headache, visual blurring and tachycardia, or "Wind Turbine Syndrome", can occur as a result of exposure to wind turbine sound. Dr. Pierpont claims that "Wind Turbine Syndrome", a term she coined, results from a disturbance to the vestibular system by exposure to low levels of infrasound and low frequency sound emitted by wind turbines.

The topics of "Wind Turbine Syndrome", infrasound and low frequency sound below the threshold of hearing have been addressed by Dr. Geoff Leventhall in his testimony in the Glacial Hills wind farm project in Wisconsin. Dr. Leventhall, a former professor who founded an acoustics research program in England that specialized in low frequency and infrasonic research, is internationally recognized as having expertise in the topics of low frequency and infrasound. Dr. Leventhall stated:

> *Attempts to claim that illnesses result from inaudible wind turbine noise do not stand up to simple analyses of the very low forces and pressures produced by the sound from wind turbines. Additionally, the body is full of sound and vibration at infrasonic and low frequencies, originating in natural body processes. As an example, the beating heart is an obvious source of infrasound within the body. Other sources of background low frequency noise and vibration are blood flows, muscle vibrations, breathing, fluids in the gut and so on. The result is that any effect from wind turbine noise, or any other low level of noise, which might be produced within the body is 'lost' in the existing background noise and vibration.* [117]

Dr. Leventhall goes on to state that "the wide range of symptoms" which Dr. Pierpont associates with "Wind Turbine Syndrome" are "well known to others as the stress effects of audible noise, to which a small number of persons are susceptible."

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[117] Testimony of Dr. Geoff Leventhall to the Wisconsin Public Utilities Commission, docket 6603-CE-302.

The work of Dr. Pierpont relied heavily on the research of Dr. Neil Todd from the Faculty of Life Science at University of Manchester, who recently reprimanded Pierpont for her misinterpretation and use of his research. Dr. Pierpont's "Wind Turbine Syndrome" theory has incorrectly sought to insert air-borne noise issues into a paper which is entirely about vibration through direct contact with the skull. Dr. Todd states the following concerning Pierpont's interpretation of his research:

> *Our research is being cited to support the case that 'wind turbine syndrome' is related to a disturbance of vestibular apparatus produced by low-frequency components of the acoustic radiations from wind turbines. Our work does not provide the direct evidence suggested. We described a sensitivity of the vestibular system to low-frequency vibration of the head (through direct physical contact), at about 100Hz, and not air-conducted sound.*[118]

Dr. Leventhall also quoted Dr. Todd, who states that:

> *At present I do not believe that there is any direct evidence to show that any of the above acoustico-physiological mechanisms (associated with wind turbine syndrome) are activated by the radiations from wind turbines. Even if the vestibular system were activated in a controlled acoustic environment, it is not necessarily the case that it would produce pathological effects. Until such evidence is available I have an open mind on "wind turbine syndrome.*[119]

Dr. Leventhall goes on to state:

> *Throughout Pierpont's work there is no clear indication of the excitation levels which she believes might cause a problem. While she must be aware of safe and unsafe doses of medication, she continues to close her mind to the concept of safe doses of sound, although "safe sound" is our everyday experience. Thus, Pierpont's hypothesis [related to "Wind Turbine Syndrome"] fails.*[120]

Dr. Leventhall summarizes additional technical portions of Pierpont's theory that infrasound causes health effects by stating:

> *Pierpont's second hypothesis is equally unfounded. She says that infrasound at 4 – 8Hz enters the lungs and vibrates the diaphragm and its attached liver, so passing confusing messages on to the visceral graviceptors. She gives no evidence*

[118] Dr Neil Todd Faculty of Life Science University of Manchester (Todd, N., Rosengren, S. M., and Colebatch, J. G. (2008): Tuning and sensitivity of the human vestibular system to low frequency vibration. *Neuroscience Letters* 444, 36 - 41.) as cited in Levanthal testimony to the Wisconsin Public Utilities Commission, docket 6603-CE-302.

[119] Dr Neil Todd Faculty of Life Science University of Manchester (Todd, N., Rosengren, S. M., and Colebatch, J. G. (2008): Tuning and sensitivity of the human vestibular system to low frequency vibration. *Neuroscience Letters* 444, 36 - 41.) as cited in Levanthal testimony to the Wisconsin Public Utilities Commission, docket 6603-CE-302.

[120] Testimony of Dr. Geoff Leventhall to the Wisconsin Public Utilities Commission, docket 6603-CE-302.

> *to support this, but instead uses references to whole body vibration, applied to the feet or seat, which is a completely different excitation to that from sound. A simple order of magnitude calculation, using basic physics of the level which will be known to a 16-year-old school pupil, shows that the movement of the diaphragm under the forces which might result from wind turbine noise is less than 10 micron. That is less than one hundredth of a millimeter or about one tenth of the average thickness of human hair. During normal breathing, the diaphragm moves several centimeters.[…] Another part of Pierpont's second hypothesis states that infrasound from wind turbines, at a frequency of 1 – 2Hz, vibrates the chest, so adding to the confusing signals which upset the balance system. However, there is already a strong source of infrasound inside the body, beating at 1 –2 Hz, giving far greater magnitudes than might be produced by infrasound from wind turbines at these frequencies: the human heart. The beating heart vibrates the surface of the body at a high enough level to be picked up by a stethoscope, or even the ear. The sound produced by wind turbines does not.*[121]

Dr. Leventhall also commented on an issue raised by Mr. Richard James of E-Coustic Solutions:

> *James uses Dr. Neil Todd as an example to 'demonstrate that there is sufficient evidence to present a causal link between ILFN (infrasound and low frequency noise) and adverse health effects.' What Dr. Todd actually showed was that, for a vibration input through physical contact to the mastoid area at the back of the head, certain reflexes, indicative of a vestibular response, continue to about 15dB lower than the level at which the hearing mechanism of the inner ear ceases to respond to vibration in the skull. It takes only a little thinking to realize that all of the people who use bone conduction hearing aids are receiving vibration inputs to their vestibular system at levels well above the system's perception threshold. This does not affect them.*[122]

The testimony of Drs. Leventhall and Todd state that there are no scientifically valid peer reviewed studies showing any adverse health effects from infrasonic or low frequency noise emitted from turbines, and that there is no valid mechanism by which the infrasound produced by turbines could affect the human body any differently than other infrasound produced within the body. Therefore, no adverse health effects are anticipated from any infrasound produced by turbines associated with the Tule Wind Project.

27. Please provide justification for the noted 1,000 foot setback (from Epsilon Associates report) from wind turbines to residences and an explanation of the methodology used to determine this setback. Please comment on how the elevation of wind turbines as compared to residences, based on topography and terrain, was considered in determining setbacks. Please comment on the appropriateness of a 1.25-mile or 2-mile

[121] Testimony of Dr. Geoff Leventhall to the Wisconsin Public Utilities Commission, docket 6603-CE-302.
[122] Testimony of Dr. Geoff Leventhall to the Wisconsin Public Utilities Commission, docket 6603-CE-302.

setback from turbines to residences and sensitive receptors, including justification supporting the response.

Response: Through a series of measurements, Epsilon Associates determined that at a distance of 1,000 feet sound emissions from GE 1.5sle and Siemens 2.3-93 wind turbines conform to applicable ANSI standards, including ANSI/ASA S12.9 Part 4 and ANSI/ASA S12.2. Measurement data was collected through a series of interior and outdoor measurements performed at existing wind farms. Data collected in the field study consisted of outdoor measurements at various distances from the turbines and concurrent interior and exterior measurements at residences. Comparing measured sound levels with ANSI criteria for the evaluation of interior sound levels, Epsilon Associates determined that sound generated by wind farms at distances beyond 1,000 feet were below the low frequency noise criteria for bedrooms, classrooms and hospitals. In addition to meeting ANSI background noise criteria, the measured interior noise levels also demonstrate that wind turbine setbacks of 1,000 feet will not cause "more than minimal annoyance (if any) from low frequency noise, and there should be no wind rattles or perceptible vibration of light-weight walls or ceilings within homes."[123]

As previously noted, the distance of 1,000 feet is based on field measurements; therefore the elevation between the turbine and each monitoring location may vary. The exact height of the turbines was not noted in the report; therefore the elevation of the turbines in comparison to the residences cannot be determined. Setbacks for the Tule Wind Project are based on cumulative sound levels, not a single turbine setback, and account for site specific elevation and terrain. Setbacks of 1.25 miles and 2.0 miles, as suggested by E-Coustic Solutions, are not required, nor are they supported by measurement or modeling data. The San Diego County noise ordinance requires that operational noise comply with San Diego County Code of Regulatory Ordinances Section 36.404. HDR performed detailed noise modeling of project related sound to determine the compliance with the noise ordinance. The model created for the Tule Wind Project accounts for the current turbine layout, number of total turbines, elevation and site specific terrain.

Please refer to Response 2 of Data Request No. 14 for additional details on the Epsilon Associates field study and necessary setbacks.

28. Please provide an explanation of the potential for shadow flicker to occur, taking into consideration the proposed location of the wind turbines in relationship to nearby residences and other sensitive receptors.

Response: Shadow flicker is commonly defined as alternating changes in light intensity at a given stationary location. In order for shadow flicker to occur, three conditions must be met:

1. The sun must be shining with no clouds obscuring the sun.
2. The rotor blades must be spinning and be located between the receptor and the sun.
3. The receptor must be sufficiently close to the turbine to be able to distinguish a shadow created by the turbine

[123] Epsilon Associate, Inc. "A Study of Low Frequency Noise and Infrasound from Wind Turbines." July 2009.

The frequency of occurrence of shadow flicker at a given receptor tends to decrease with increasing distance between turbine and receptor. Additionally, the intensity of shadow flicker at a given receptor also decreases with increasing distance between turbine and receptor because the shadow cast by the rotor blade decreases in size as the distance from the turbine increases. The combination of these two factors means that even for receptors which are in a theoretical path of a shadow cast from a proposed turbine, a discernable shadow will not be realized due to the distance between many of these receptors and the proposed turbines.

For receptors which have the potential to experience shadow flicker from wind turbines, the number of experienced shadow flicker hours is generally small for a number of reasons, including the daily change in the sun's path and cloud cover, the fact that turbines do not operate 100 percent of the time over the course of the year, and typical setback requirements.

For the Tule Wind Project, the proposed location of the wind turbines in relationship to nearby residences and sensitive receptors (occupied house) is such that the vast majority of proposed turbines will be physically unable to cast a shadow in the direction of the vast majority of receptors, including the largest group of receptors south of Interstate 8 (I-8) near Old Highway 80 and several, though not all, receptors north of I-8. That is to say, a turbine which lies within approximately 60 degrees due north relative to a receptor at the Tule Wind Project's latitude, will never cast a shadow on that receptor. As discussed in greater detail below in Response 29, there are four sensitive receptors with the potential to experience shadow flicker from the Tule Wind Project. Please see Response 29 of Data Request No. 14 and the corresponding graphics for an analysis of the potential for sensitive receptors to experience shadow flicker as a result of the Tule Wind Project.

29. Please provide a graphic depicting the exposure of shadows from the wind turbines on adjacent properties, particularly residences and other sensitive receptors, considering the proposed locations of the turbines, topography, and day/night lighting. Please also provide calculations of the anticipated shadow exposure on adjacent residences and other sensitive receptors and a table summarizing this information.

While the vast majority of receptors near the project area will have no shadow flicker from the Tule Wind Project turbines, a limited shadow flicker model run was made to determine potential shadow flicker that could occur at several sensitive receptors. Receptors within 2,000 meters (6,562 feet) of any proposed turbine were considered. Beyond 2,000 meters, it is reasonable to assume that the human eye would not be able to discern a shadow cast from a wind turbine. Of the identified receptors within 2,000 meters of proposed turbines, four homes were included in the model run, while others were not included in the model run because it is physically impossible for any proposed turbine to cast a shadow on these receptors due to the fact these receptors lie within 60 degrees of due north from the receptors, outside of the sun's path at any point in the year. Attached are modeling results and corresponding graphics depicting the classic butterfly pattern associated with shadow flicker. The modeling was completed using many different inputs, including:

1. Real Data

- Actual coordinates of turbines
- Actual coordinates of receptors
- Actual topographic data

2. Conservative Assumptions

- Specifications of the turbines being considered with the highest hub height and longest rotor diameter
- 100 percent turbine operation
- No vegetative screening
- Receptors can be impacted from all directions (i.e., "greenhouse mode")

3. Realistic Features

- Actual wind data from a local meteorological tower to account for the percentage of time wind blows from each direction.
- National Weather Service sunshine probability data to approximate average cloud cover.

This combination of inputs results in conservative model results. As shown in Table 29-1 below, the home with the most shadow flicker as predicted by the model is on the northwest side of the project where an annual total of 17 hours, 36 minutes of shadow flicker was predicted.

Table 29-1. Tule Wind Project Shadow Flicker Impact by Receptor

Receptor ID	Receptor Location (UTM NAD83 Zone 11)[a]		Elevation	Shadow Hours per Year	Shadow Days Per Year	Max Shadow Hours per Day	Hours per Year
	X - Coordinate	Y - Coordinate	[m]	[HH:MM/Year][b] (Worst Case)	[Days/Year][c] (Worst Case)	[HH:MM/Day][d] (Worst Case)	[HH:MM/Yr][e] (Conservative)
Home_1	569,149.57	3,619,849.70	1133.9	24:15	78	0:27	14:11
Home_32	566,421.29	3,619,605.44	1111.4	13:40	82	0:13	9:14
Home_42	566,409.75	3,620,055.86	1121.5	9:55	59	0:14	6:20
Home_47	557,803.90	3,630,391.08	1429.7	32:32	151	0:29	17:36

[a] The coordinate system is the Universal Transverse Mercator (UTM) system, using North American Datum 1983 (NAD 83), Zone 11.
[b] Total hours per year of shadow flicker at this receptor under worst-case conditions.
[c] Days per year in which shadow flicker is possible at this receptor under worst-case conditions.
[d] The maximum daily hour and minutes of shadow flicker at this receptor, under worst-case conditions. This value is the single day maximum due to the combination of receptor and turbine locations, and sun path across the sky. All other days will be less than this maximum as the sun path changes throughout the year. All days will also be less than this maximum due to real world conditions such as cloud cover, changes in wind direction, and less than 100% wind turbine operation.
[e] Conservatively predicted hours of shadow flicker at this receptor, including sunshine probability and actual wind direction data. Actual hours should be less than this value due to less than 100% wind turbine operation, and other mitigating factors such as screening due to trees or structures.

Actual shadow flicker hours experienced are expected to be significantly less due to the conservative assumptions listed. To put this value in perspective, the total annual daylight hours in nearby Chula Vista (and equivalent latitudes) is approximately 4,444 hours; therefore this conservative amount represents less than 0.4 percent of the total possible sunlight hours in a year. As discussed in greater detail in Response 30 of Data Request No. 14, there is currently no published scientific evidence to positively link wind turbines with adverse health effects.

30. Please provide an analysis of the potential health effects on adjacent residences and sensitive receptors as a result of shadow flicker.

Shadow flicker from wind turbines does not cause seizures in persons with photosensitive epilepsy. Data from the Epilepsy Foundation indicates that although the frequency of flashing light that is most likely to cause seizures varies from person to person, generally, the frequency of flashing lights most likely to trigger seizures is between 5 and 30 Hertz[124] (Hz refers to flashes per second). The large modern three-bladed wind turbines under consideration for this project rotate at approximately 19 revolutions per minute (rpm) or less[125]. Even assuming a slightly faster rotation speed of 20 rpm, the blade passing frequency is approximately 1 Hz (20 rev/min * min/60 sec * 3 blades), is well below the critical frequency of 5 Hz[126]. There is currently no published scientific evidence to positively link wind turbines with adverse health effects[127].

The majority of documentation related to non-seizure health impacts due to shadow flicker consists of informal testimonials given by residents or drivers on roadways in proximity to a wind turbine. These testimonials cite headaches, vertigo, nausea, blinding effects, disorientation, loss of balance, and increased levels of stress and anxiety as symptoms directly related to wind turbine shadow flicker. These testimonials are primarily available on websites often cited by anti-wind advocates rather than formal medical literature. Some complaints regarding these symptoms do appear in more formal materials, but are merely reported and are not studied or discussed in any detail[128]. Several of these sources state that complaints of headaches and other similar symptoms are highly, but not perfectly, correlated with annoyance complaints. To date,

[124] Epilepsy Foundation. (n.d.). Photosensitivity and Seizures. Retrieved June 2010, from http://www.epilepsyfoundation.org/about/photosensitivity/

[125] The Wind Power. Wind turbines and windfarms database, technical data. Retrieved April 2011, from http://www.thewindpower.net/wind-turbine-datasheet-technical-47-gamesa-g90-2000.php

[126] Burton, T., Sharpe, D., & Jenkins, N. (2001). Wind Energy Handbook. West Sussex, England: John Wiley & Sons, Ltd.

[127] National Health and Medical Research Council. (2010, July). Wind Turbines and Health. Retrieved August 2010, from: http://www.nhmrc.gov.au/_files_nhmrc/file/publications/synopses/public_statement_wind_turbines_and_health.pdf

[128] Michigan Public Service Commission. (2010, January). Report on the Impact of Setback Requirements and Noise Limitations in Wind Zones in Michigan. Retrieved August 2010, from http://www.michigan.gov/documents/mpsc/werzb_rpt_01-2010_309001_7.pdf, North Dakota Legislative Council. (2009, October). Allocation of Wind Rights – Background Memorandum. Retrieved August 2010, from http://www.legis.nd.gov/assembly/61-2009/docs/pdf/19041.pdf, Minnesota Department of Health. (2009). Public Health Impacts of Wind. Retrieved June 2010, from http://energyfacilities.puc.state.mn.us/documents/Public%20Health%20Impacts%20of%20Wind%20Turbines,%205.22.09%20Revised.pdf

the available published, peer-reviewed literature states that no studies or scientific evidence links shadow flicker to adverse health impacts[129] [130].

31. Please provide an explanation of the safety concerns or hazards (e.g., vehicle driver distraction) that may occur as a result of shadow flicker.

Response: A concern that is occasionally raised is that shadow flicker occurring on a roadway could distract drivers and cause accidents. In order to obtain a driver's license, motorists are generally evaluated through a road test on their ability to react appropriately to the various situations they encounter. Shadows on the road way or road side distractions are a common occurrence. A whole segment of the advertising industry has been developed that takes advantage of the passing motorist attention. Numerous cities now have massive "big screen TVs" erected beside major highways, yet there is no data showing these entities cause accidents. Wind turbines or their fleeting shadows do not have these attention demanding qualities.

Shadows on roadways can be caused by nearby trees or buildings, or the earth's terrain itself. A car passing through shadows caused by anything can experience shadow flicker at very high frequencies dependent on vehicle speed and the object(s) causing the shadow. Moving shadows on roadways can be caused by wind turbines, a single passing cloud, or an airplane. Regardless of the source of the shadow or any other potential change that a driver notices gradually or suddenly, it is generally the responsibility of the motorist to maintain control of their vehicle in the face of any situation they encounter. A moving car would pass quickly through any shadow on a road caused by a turbine associated with the Tule Wind Project, and therefore any potential for distraction would be remote. Because vehicles on roadways are not stationary objects, it is not appropriate to include roadways as part of a shadow flicker analysis, as shadow flicker is commonly defined as alternating changes in light intensity at a given *stationary* location.

Current research involving motor vehicle accidents have highlighted the increased risk of driver activities that focus on attention diverting activities such as cell phone use, map reading, etc and have not identified shadow flicker or shadows in general as a source of driver distraction sufficient to increase the risk of accidents[131].

32. Please provide a response to a comment that suggests that shadow flicker setbacks for current wind turbine designs should be 10 rotational diameters (approximately 1000 meters); flash frequency should not exceed three per second; and the shadows cast by one turbine on another should not have a cumulative flash rate exceeding three per second.

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[129] National Health and Medical Research Council. (2010, July). Wind Turbines and Health. Retrieved August 2010, from:
http://www.nhmrc.gov.au/_files_nhmrc/file/publications/synopses/public_statement_wind_turbines_and_health.pdf

[130] Ohio Department of Health. (2008, March). Retrieved August 2010, from
http://www.odh.ohio.gov/ASSETS/C43A4CD6C24B4F8493CB32D525FB7C27/Wind%20Turbine%20SUMMARY%20REPORT.pdf

[131] Driver Distraction in Commercial Vehicle Operations (Doc. No. FMCSA-RRR-09-042), U.S. Department of Transportation, Federal Motor Carrier Safety Administration, Office of Analysis, Research and Technology, September 2009.

The frequency of occurrence and intensity of shadow flicker at a given receptor tends to decrease with increasing distance between turbine and receptor. However, to our knowledge, there is no mathematic or scientific method or empirical observation that supports the specific value of 10 rotor diameters as an appropriate setback or as an appropriate distance to include as part of a regulatory approach to shadow flicker. Additionally, while rotor diameter impacts the area affected by shadow flicker, the width of the blade is the more important parameter in creating a distinct flicker over a long distance, and therefore, it is illogical to base setbacks on a rotor diameter basis for purposes of controlling shadow flicker.

Concerns related to flash frequency generally are rooted in a concern about triggers for photosensitive epilepsy. Assuming this, and as discussed in the response to item number 30, shadow flicker from wind turbines does not cause seizures in persons with photosensitive epilepsy. Generally, the frequency of flashing lights most likely to trigger seizures is between 5 and 30 Hz (flashes per second)[132], rather than the 3 flashes per second noted here. The rotation speed of modern wind turbines is much less than 5 Hz, or the lowest frequency of concern as cited by the Epilepsy Foundation.

The cumulative flash rate comment also appears to be rooted in a concern about triggers for photosensitive epilepsy. Assuming a rotor speed of 20 revolutions per minute, which equates to a flash frequency of approximately 1 Hz, five turbines (1 Hz * 5 = 5 Hz) would have to be aligned between the receptor and the sun to increase the frequency to something close to the 5 Hz identified by the Epilepsy Foundation as a level of interest for photosensitive epilepsy. Given that the proposed turbines are generally aligned on a north-south line for the majority of the proposed project, and given that the vast majority of the turbines lie to the north of receptors, the occurrence of five or more turbines aligning between the receptor and sun would be virtually impossible. If five or more turbines did align, the spacing between the turbines themselves combined with the setback distance between receptor and turbines would create a situation where a shadow cast from the fifth turbine in a line would not be discernable at the receptor in a line with all five (or more) turbines. Therefore, cumulative flash rates are not an anticipated public health concern for the Tule Wind Project.

33. Please provide an explanation of the potential for ice throw to occur from wind turbine blades, as well as the associated potential safety hazard to people or passing vehicles.

Response: Rime ice or glace ice can form on a wind turbine given the right combination of temperature and moisture. Rime ice will occur when objects such as trees or wind turbines are exposed to low temperatures in combination with fog. Depending on the duration of the ice conditions, significant amounts of rime ice can collect on the turbines and increase static and dynamic loads. Glace ice can occur when a warm front drifts above cold air. The falling rain can get cooled down to temperatures below the freezing point without actually freezing into solid ice. If the super-cooled rain hits the surface or objects with temperatures below 32 degrees Fahrenheit, it will instantly turn to a layer of solid ice. Both types of ice would only occur when the temperature is below freezing (32 degrees Fahrenheit). In the project area, the average low

[132] American Epilepsy Foundation: http://www.epilepsyfoundation.org/about/photosensitivity/

temperature is above freezing throughout the year, with the exception of December, which has an average low temperature of 32 degrees Fahrenheit. In general, the potential for ice would be limited to winter (late November-February), when overnight temperatures can dip into the 20s and lower 30s.

With a non-operating turbine (stationary rotor), the ice will accumulate and eventually fall to the ground below the turbine in a pattern generally the width of the rotor diameter and downwind of the turbine. The lightest ice particles generally will be carried the farthest downwind, and the heavier pieces generally will fall straight down, thus posing a potential hazard to objects and personnel in a relatively small area beneath the turbine[133].

With an operating turbine, ice will also accumulate and eventually be shed subject to the gravity forces (as with stationary turbines) and be thrown horizontally some distance from the turbine due to the centrifugal force developed by the rotating rotor. Ice thrown from operating turbines is anticipated to have the potential to travel greater distances, as opposed to ice shed from turbines in a stationary position[134,135].

Potential safety hazards associated with the Tule Wind Project could therefore occur from ice throw during the infrequent nights in the winter when the temperature and weather conditions are conducive to icing and the turbines are in motion. Industry professionals have recognized and analyzed these risks and through various studies have developed siting setback recommendations which mitigate the risk to personnel and property. The recommendation provided in the literature and by specific turbine manufacturers indicates that the empirically derived most conservative setback distance for the turbine is 1.5 times (hub height + rotor diameter). This is a distance which can effectively be regarded as a "safe" distance[136,137,138], beyond which there is negligible risk of injury from ice throw. For the proposed turbines (100 meter hub height and 100 meter rotor) the most conservative safe distance would then be 300 meters (~984 feet). The 984 feet should be considered a conservative distance for discussions of health and safety related to ice throw for the Tule Wind Project. The nearest occupied home to a turbine under the current layout is 2,407 feet; the nearest turbines to the Cottonwood and Lark Canyon campgrounds are at least 2,356 feet and 1,123 feet away, respectively. The likelihood of members of the public occupying the campgrounds during freezing conditions is very low. Therefore there is little anticipated risk from ice throw at residences or campgrounds.

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[133] Recommendation for Risk Assessments of Ice Throw and Blade Failure in Ontario Prepared by Garrad Hassan for the Canadian Wind Association; 31 May 2007.

[134] Recommendation for Risk Assessments of Ice Throw and Blade Failure in Ontario Prepared by Garrad Hassan for the Canadian Wind Association; 31 May 2007.

[135] Risk Analysis of Ice Throw from Wind Turbines, Henry Seifert, Annette Westerhellweg, Jurgen Kroning, Paper presented at BOREAS 6,9 to 11 April 2003, Pyha, Finland.

[136] Setback Considerations for Wind Turbine Siting, GE Wind; Dated 2009.

[137] Ice Shedding and Ice Throw – Risk and Mitigation, GE Energy/ GER-4262 (04/06); Dated 2006.

[138] Risk Analysis of Ice Throw from Wind Turbines, Henry Seifert, Annette Westerhellweg, Jurgen Kroning, Paper presented at BOREAS 6,9 to 11 April 2003, Pyha, Finland.

There are points along McCain Valley Road (the only public road in the vicinity of proposed turbines) that are located within 984 feet from the closest turbines (the closest location is approximately 496 feet).

For areas within 984 feet of the turbines, there would be limited risk of potential safety hazards to people or passing vehicles from ice throw. The likelihood of members of the public being within this area (either on McCain Valley Road or elsewhere in public areas) during potential ice throw events is extremely low, since the temperatures are only conducive to icing intermittently during winter nights (which would have low use of both the roads and the public areas), and the turbines would not necessarily be in operation during every potential ice event, thereby limiting the possibility for ice to be thrown any distance beyond the blade length.

The following measures would further minimize and mitigate the potential for adverse effects to the general public from ice throw:

- The fences and warning signs that will be installed under the direction of the BLM will serve to keep members of the public away from areas directly under turbines, thereby reducing the risk of injury.
- If the blades become iced, it is likely they will become unbalanced and the vibration sensor will stop the turbine, or the wind measuring instruments will freeze over and cause an automatic shutdown, reducing the potential for ice throw.

If operations and maintenance personnel must enter the turbine area when there is an ice accumulation, standard safety precautions and safety protocols would be followed including but not be limited to[139,140]:

- Remotely shutting down the turbine,
- Yawing the turbine to position the rotor on the side opposite from the tower door.
- Parking vehicles at a safe distance from the tower.
- Restarting the turbine remotely when work is complete and personnel are clear.
- Wearing standard personnel protective gear, such as hard hats.

Based on the low frequency and the anticipated low likelihood of icing conditions, the distance between the closest occupied residence to the proposed turbines (2,407 feet), and standard safety precautions and safety protocols, the risk to public health and safety from ice throw is anticipated to be insignificant.

34. Please comment on the structural integrity of the wind turbines in regard to withstanding extremely cold temperatures.

[139] Ice Shedding and Ice Throw – Risk and Mitigation, GE Energy/ GER-4262 (04/06); Dated 2006.
[140] Risk Analysis of Ice Throw from Wind Turbines, Henry Seifert, Annette Westerhellweg, Jurgen Kroning, Paper presented at BOREAS 6,9 to 11 April 2003, Pyha, Finland.

Response: Turbines sold in North America are generally adaptable to the extreme cold as accounted for in the design and certification process. Wind turbines are regularly found in northern climes of the US and in Canada and function in extreme cold.

The International Standard IEC 61400-1[141] indicates that the extreme temperature range for the standard wind turbine is -20C to+50C (-4Fto +122F). Based on historical weather data for the Jacumba area[142], record lows in the winter have been recorded at 20F and record highs in the summer have been recorded at 120F, within the standard wind turbine temperature range. Therefore, no cold weather structurally related problems are anticipated for the Tule project.

Furthermore, all turbines will be inspected by an independent engineering company (e.g., Germanischer Lloyd, DNV or other appropriate independent engineer) prior to commissioning of the project. This will require each turbine to have a statement of Compliance for Design Assessment that the turbine is in compliance with the IEC 61400-1 rules for safe design, including their ability to withstand the temperature range for the project area.

35. Please provide an explanation of the potential health effects of electromagnetic energy resulting from the wind turbines, also referred to as "dirty electricity".

Response: Electromagnetic energy and "dirty electricity" refer to different phenomena. As described in Draft EIR/EIS Section D.10.8.1, an Electromagnetic Field (EMF) is a physical field produced by electrically charged objects, when a current passes through a wire. Dirty electricity, on the other hand, is poor power quality. This poor power quality could create a ground current that will lead to an unbalance circuit problem on the system, which in turn might cause stray voltage.

Wind turbines create electromagnetic fields from the power facilities that are a part of the turbine makeup. As described in the Draft EIR/EIS Section D.10.8.1, electric and magnetic fields attenuate rapidly with distance from the source. The electrical wiring of the wind turbine generator is also surrounded by an electrically-conductive metal cover, so any EMF levels outside of the wind turbine would be very low. In addition, given the large distances between the proposed turbines and homes (2,407 feet or greater) and the Cottonwood and Lark Canyon campgrounds (2,356 feet and 1,123 feet or greater, respectively), the turbines are not anticipated to result in measurable levels in EMF at residences or campgrounds. Finally, as discussed in Section D.10.8.6 of the Draft EIR/EIS, there is inadequate or no evidence of health effects at low exposure levels.

Stray voltage could occur if the electrical equipment in the turbines is not maintained properly. Induced current or stray voltage has the potential for adverse health effects if not properly grounded. As part of the commissioning of the project, turbines will be examined to confirm that they are properly grounded, as discussed in Project Design Feature (PDF) 17 of the San Diego Rural Fire Protection District (SDRFPD) approved Fire Protection Plan, dated November 3,

[141] International Standard IEC 61400-1.
[142] A History of Significant Weather Events in Southern California. Updated February 2010. Accessed April 11, 2011. National Weather Services Forecast Office, San Diego, CA.

2010. Regular operations and maintenance measures will similarly confirm that there are no stray voltage issues through the life of the project. Therefore, no health effects would be anticipated to occur from stray voltage.

36. Please provide detailed responses to comments 1, 7, 9, and 16 related to public health and safety, as identified in the letter from Richard James of E-Coustic Solutions provided in Attachment B.

Please see Responses 23.1, 23.7, 23.9, and 23.16 of Data Request No. 14 for detailed responses to comments identified in the letter from E-Coustic Solutions.

37. Please provide detailed responses to comments 1 and 2 related to shadow flicker and "dirty electricity", as identified in the letter and exhibit from Stephan Volker provided in Attachment B.

The concerns identified by Mr. Volker are largely addressed in Responses 28 through 32 (shadow flicker) and Response 35 ("dirty electricity") of Data Request No. 14. Shadow flicker, indeed, has been reported through informal testimonies as being an annoyance, but have not been independently verified as a health concern in published scientific literature. See Response 30 of Data Request No. 14 above for more details.

The National Highway Traffic Safety Administration (NHTSA) describes driver distraction as something that could present a serious and potentially deadly danger, and identifies various forms of distracted driving, including cell phone use, texting, eating, drinking, talking with passengers, and using in-vehicle technologies and portable electronic devices, along with less obvious forms of distractions including daydreaming or dealing with strong emotions. See Response 31 of Data Request No. 14 for more details.

As mentioned in Response 28 above, the vast majority of receptors near the project area will have no shadow flicker from the Tule Wind Project turbines. A few receptors could experience shadow flicker throughout the year. See Response 29 above for more details.

VISUAL RESOURCES

38. Please provide the Tule Wind viewshed map (EIR/EIS Figure D.3-2) that reflects the "Modified Project Layout".

Response: Revised viewshed map is provided as part of this response letter (attached).

WATER (APRIL 8, 2011)

39. In addition to the water availability letters provided by Jacumba Community Services District and Live Oak Springs Water Company in August 2010, please provide additional documentation verifying the source and availability of water and/or will serve letters from well water providers as well as water purveyors to meet the proposed use of approximately 19 million gallons of water during construction of the Tule Wind Project.

Response: Tule Wind, LLC (Tule Wind) will rely on groundwater wells on Rough Acres Ranch and on Ewiiaapaayp Band of Kumeyaay Indians tribal land to supply construction water demands for the Tule Wind Project. Attached to this response is a letter from John Gibson of Hamann Companies which confirms the availability of groundwater from Rough Acres Ranch. We are also working with the Ewiiaapaayp Band of Kumeyaay Indians to obtain a similar letter of water availability. This information is forthcoming.

In addition, attached to this response are two (2) reports from Geo-Logic Associates, which collectively confirm that groundwater resources on Rough Acres Ranch and on Ewiiaapaayp tribal land will be sufficient to supply both peak water use (124 gallons per minute (gpm)) and total water use (estimated 19 million gallons) required to build the Tule Wind Project.

The Geo-Logic Associates *Estimate of Available Groundwater* (September 7, 2010) indicates that the conservative peak water use rate required for construction of the Tule Wind Project would require groundwater pumping at a rate of 124 gallons per minute (gpm). Based on groundwater sufficiency tests conducted by Geo-Logic Associates on Rough Acres Ranch and Ewiiaapaayp tribal land, Geo-Logic concluded in the *Groundwater Investigation Report* (December 10, 2010) that combined groundwater resources between these two groundwater sources could easily supply 130 gpm, if not more, thereby demonstrating sufficient peak use supply.

Furthermore, the Geo-Logic *Groundwater Investigation Report* also demonstrates that both sources also are sufficient to supply the estimated 19 million gallons necessary to construct the Tule Wind Project. These conclusions are discussed in more detail below.

Rough Acres Ranch Wells – Based on the well test plan that was approved by the County of San Diego, Geo-Logic conducted a step test followed by a 72-hour, 50 gallons per minute (gpm), constant rate aquifer pumping test at Well No. 6a on Rough Acres Ranch. Based on the lack of significant drawdown in the nearest observation well (36 feet away), and no evidence of an effect in more distant observation wells, Geo-Logic concluded that there is significant groundwater resources within this water production area. In fact, during testing Geo-Logic observed no drawdown in wells located within one-third and one-half mile of the pumping well. Accordingly, Geo-Logic concluded that interference with the nearest off-site wells, approximately one half mile from the pumping well, is not anticipated at the 50 gpm level proposed during construction of the Tule Wind Project.

Although Tule Wind does not anticipate the need to do so, the Geo-Logic *Groundwater Investigation Report* concluded that it is possible to double the pumping rate at the Rough Acres Ranch well to 100 gpm "without well interference or significant groundwater depletion." At a 50 gpm rate, the *Groundwater Investigation Report* concludes that the maximum drawdown rate over a nine-month period would be 66 acre-feet, and at 100 gpm, the maximum drawdown rate would be 136 acre-feet. Until pumping is increased by eight (8) times the 50 gpm rate (8x50=400 gpm) to 54 acre-feet per month (nearly 486 acre-feet per year) would the groundwater basin approach the 50% depletion level of 500 acre-feet within the basin. To put this water supply in perspective, the total estimated construction water supply necessary for the Tule Wind Project is approximately a little more than 58 acre-feet of water (19 million / 326,000 gallons per acre foot). Accordingly, the *Groundwater Investigation Report* concludes that there is a more than sufficient water supply available at Rough Acres Ranch.

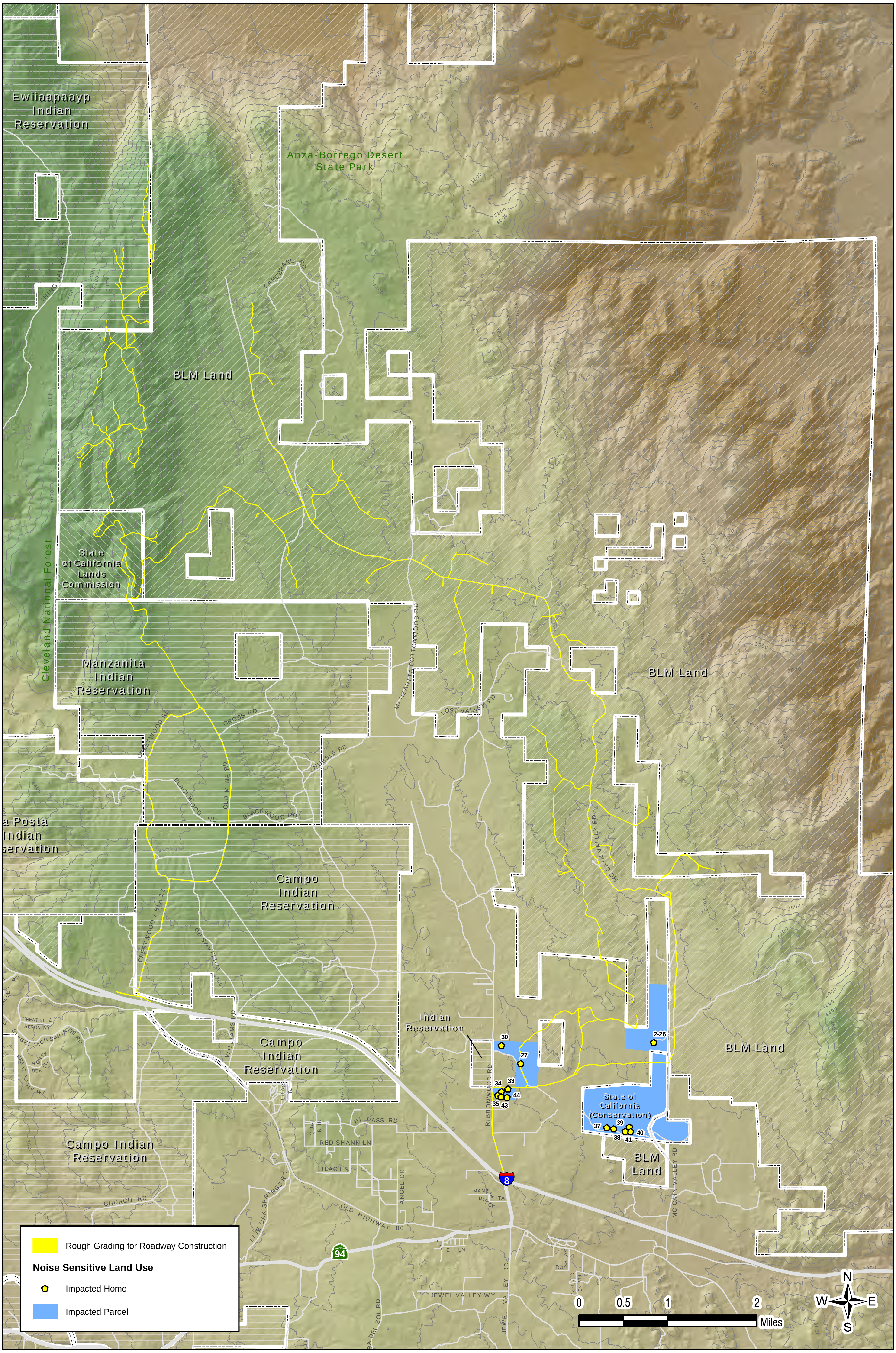
Ewiiaapaayp Tribal Wells - In addition, as discussed in the *Groundwater Investigation Report*, although there are no requirements for analysis of groundwater use on tribal lands, the aquifer pumping test and analyses for two wells within Thing Valley (Ewiiaapaayp Tribal lands) indicate that there is sufficient storage for use of groundwater within Thing Valley and no significant impacts to groundwater storage are anticipated. Based on existing records, the South well is reported to produce water at a rate of 30 gpm and the North well is reported to produce water at a rate of 90 gpm.

GIS INFORMATION (April 8, 2011)

40. Please provide pole numbering for the revised transmission line route, to be added to the modified Tule Wind Project graphics in the Final EIR/EIS.

Response: GIS meta data for transmission line pole numbering for the Modified Project Layout is provided as part of this response letter (CD attached).

Attachments

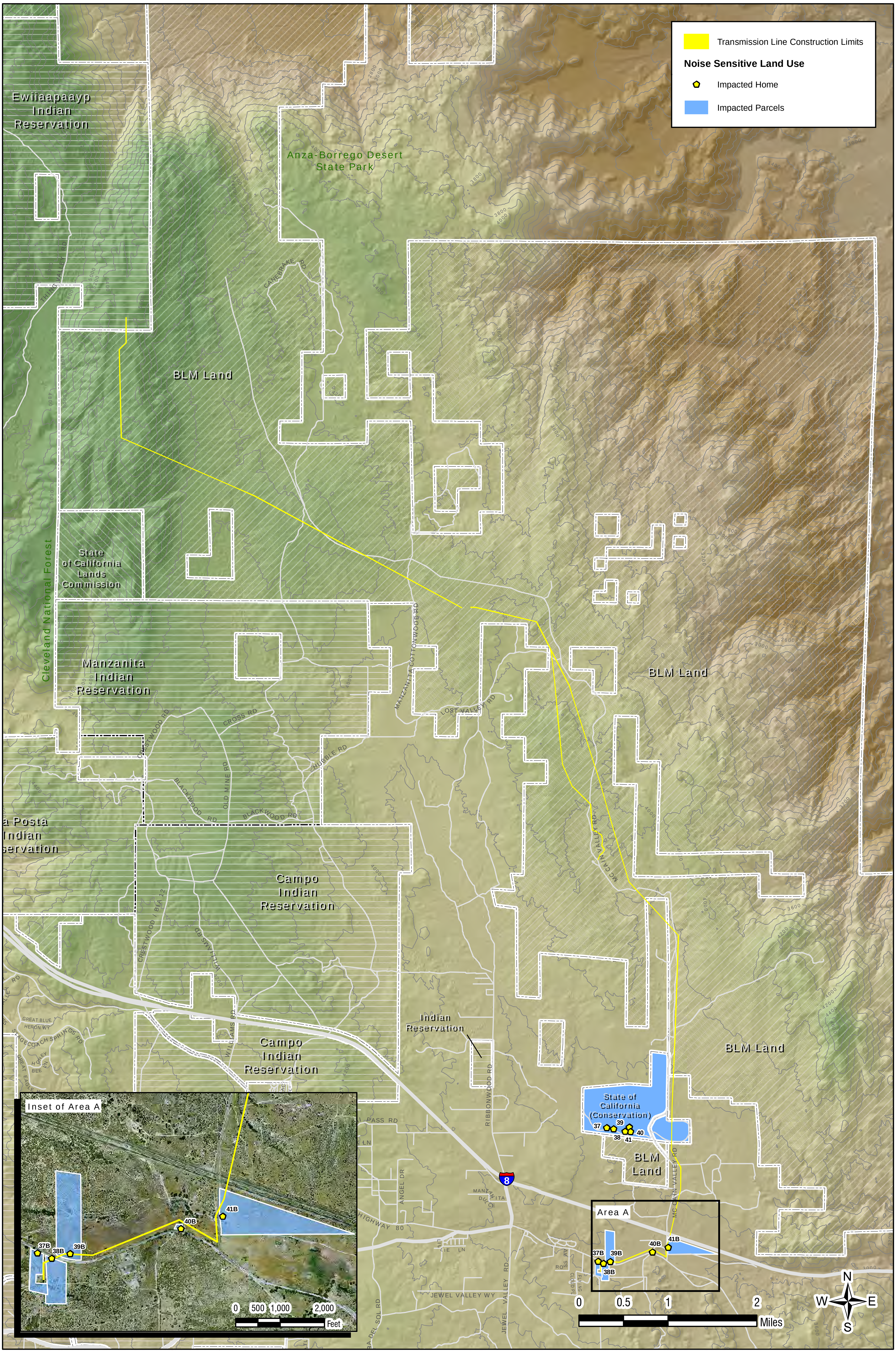


Roadway Construction Temporary Noise Impacts

FIGURE 3

Tule, LLC | Tule Wind Project | Noise Analysis

HDR ONE COMPANY | *Many Solutions*™

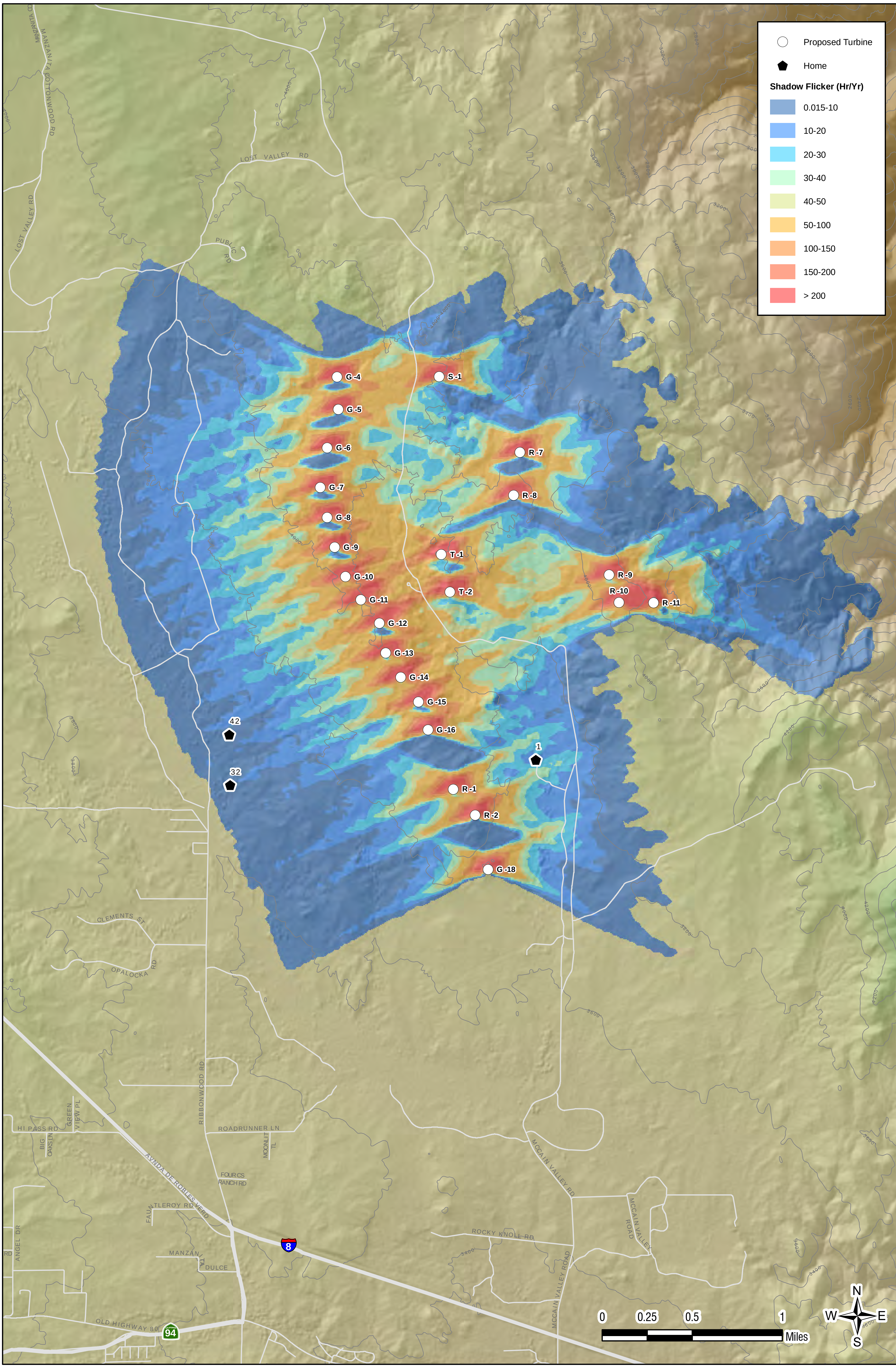


Transmission Line Construction Temporary Noise Impacts

FIGURE 4

Tule, LLC | Tule Wind Project | Noise Analysis

HDR ONE COMPANY | *Many Solutions*

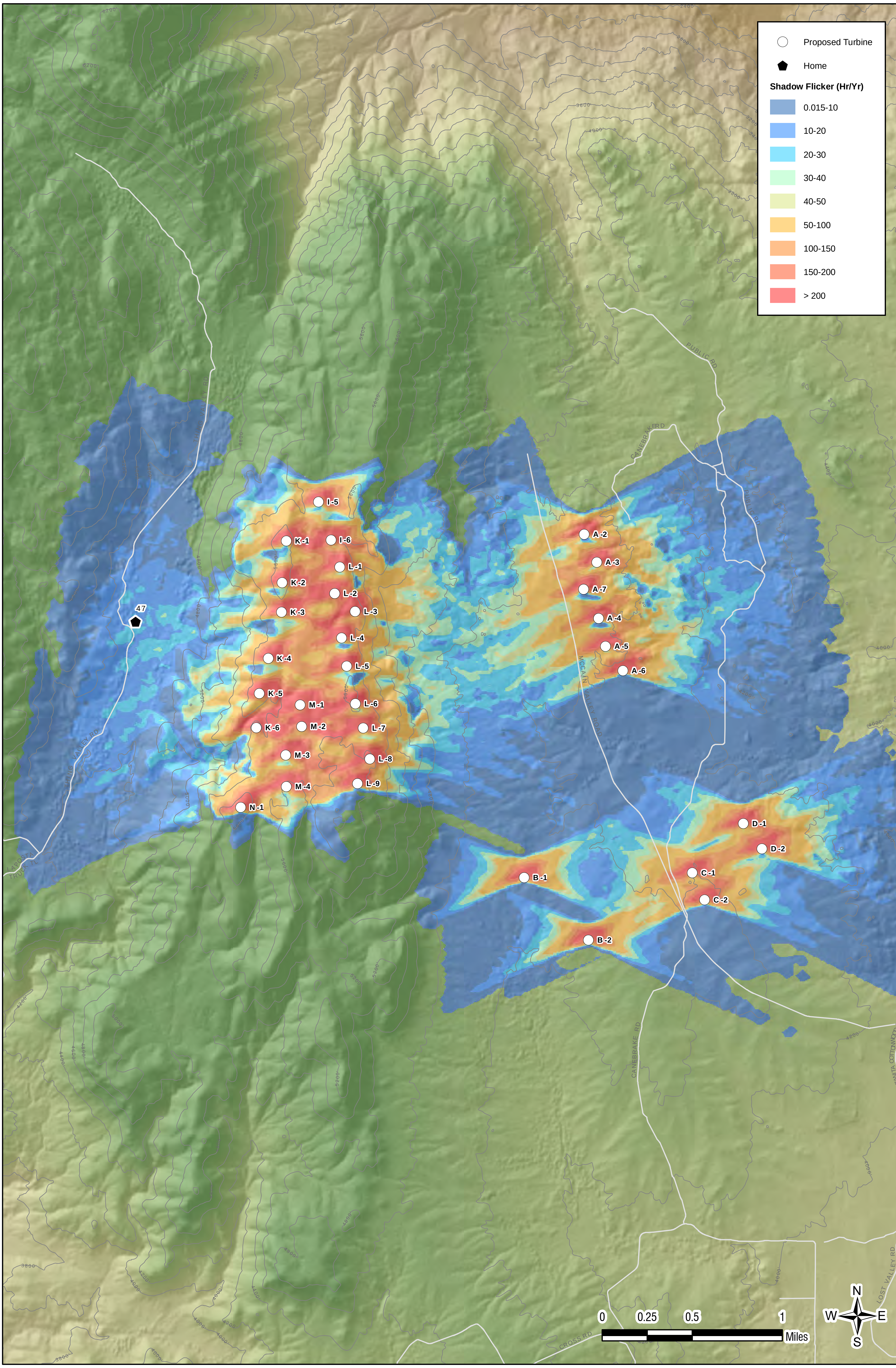


Shadow Flicker Model Result

FIGURE 1 of 2

Tule Wind, LLC | Tule Wind Project | Shadow Flicker Analysis

HDR
ONE COMPANY | *Many Solutions*



Shadow Flicker Model Result

FIGURE 2 of 2

Tule Wind, LLC | Tule Wind Project | Shadow Flicker Analysis

HDR ONE COMPANY | *Many Solutions*™

Project:
Tule_SF_ver3_20110415

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Licensed user:
HDR
701 Xenia Av. So. Suite 600
US-MINNEAPOLI MN 55416

Anjali Malhotra / Anjali.Malhotra@hdrinc.com
Calculated:
4/27/2011 12:42 PM/2.7.486

SHADOW - Main Result

Calculation: Tule_ver5_20110427

Assumptions for shadow calculations

Maximum distance for influence	2,000 m
Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

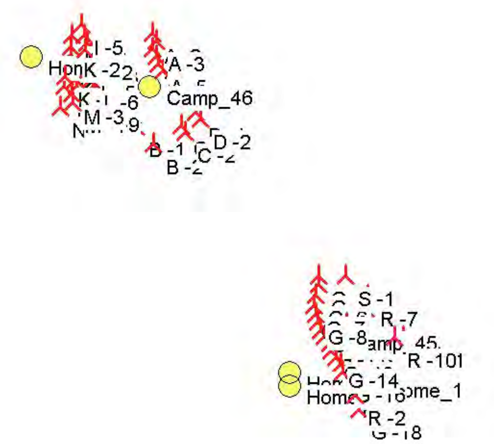
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.84	0.87	0.90	0.94	0.95	0.97	0.91	0.91	0.93	0.92	0.87	0.82

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
908	1,296	509	545	228	67	389	582	1,418	2,220	378	220	8,760

Idle start wind speed: Cut in wind speed from power curve

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:
Height contours used: Height Contours: cnte_meter_clp_windpro2.wpo (5)
Obstacles used in calculation
Eye height: 1.5 m
Grid resolution: 10 m



Scale 1:250,000
New WTG
Shadow receptor

WTGs

	UTM NAD83 Zone: 11 East	North	Z [m]	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	RPM [RPM]
A -2	561,804.09	3,631,201.77	1,377.7	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
A -3	561,917.94	3,630,952.68	1,377.7	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
A -4	561,937.73	3,630,452.20	1,364.5	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
A -5	562,002.45	3,630,201.98	1,353.3	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
A -6	562,158.29	3,629,984.81	1,339.9	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
A -7	561,802.03	3,630,710.09	1,384.5	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
B -1	561,289.75	3,628,131.76	1,377.7	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
B -2	561,868.64	3,627,578.30	1,366.1	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
C -1	562,790.65	3,628,185.17	1,341.1	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
C -2	562,903.04	3,627,944.03	1,353.3	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
D -1	563,244.02	3,628,629.42	1,316.7	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
D -2	563,412.87	3,628,403.90	1,319.7	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
G -10	567,438.77	3,621,473.50	1,219.2	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
G -11	567,575.86	3,621,267.02	1,219.2	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
G -12	567,744.21	3,621,058.98	1,219.2	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
G -13	567,802.86	3,620,795.53	1,213.7	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
G -14	567,938.48	3,620,579.14	1,201.5	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
G -15	568,097.18	3,620,360.00	1,207.0	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
G -16	568,183.19	3,620,112.40	1,207.0	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
G -18	568,728.19	3,618,869.03	1,158.2	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
G -4	567,350.19	3,623,255.86	1,253.1	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
G -5	567,361.37	3,622,967.50	1,255.8	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
G -6	567,266.06	3,622,623.30	1,260.1	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
G -7	567,207.74	3,622,267.96	1,255.5	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
G -8	567,270.07	3,622,000.26	1,243.6	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
G -9	567,338.61	3,621,734.47	1,233.2	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
I -5	559,429.81	3,631,473.34	1,682.5	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	67.0	16.7
I -6	559,543.42	3,631,133.13	1,670.3	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	67.0	16.7
K -1	559,144.24	3,631,122.37	1,719.1	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	67.0	16.7
K -2	559,111.38	3,630,750.68	1,730.1	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	67.0	16.7
K -3	559,106.52	3,630,487.43	1,694.7	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	67.0	16.7

To be continued on next page...

Project:
Tule_SF_ver3_20110415

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HDR
701 Xenia Av. So. Suite 600
US-MINNEAPOLI MN 55416

Anjali Malhotra / Anjali.Malhotra@hdrinc.com
Calculated:
4/27/2011 12:42 PM/2.7.486

SHADOW - Main Result

Calculation: Tule_ver5_20110427

...continued from previous page

	UTM NAD83 Zone: 11				WTG type						
	East	North	Z	Row data/Description	Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	RPM
	UTM NAD83 Zone: 11		[m]					[kW]	[m]	[m]	[RPM]
K -4	558,990.58	3,630,073.55	1,694.7	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	67.0	16.7
K -5	558,914.30	3,629,758.58	1,670.3	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	67.0	16.7
K -6	558,888.83	3,629,452.77	1,658.1	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	67.0	16.7
L -1	559,624.18	3,630,894.11	1,694.7	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	67.0	16.7
L -2	559,580.77	3,630,657.60	1,682.5	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	67.0	16.7
L -3	559,763.88	3,630,497.11	1,670.3	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	67.0	16.7
L -4	559,645.85	3,630,259.85	1,694.7	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	67.0	16.7
L -5	559,692.55	3,630,009.01	1,694.7	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	67.0	16.7
L -6	559,772.75	3,629,674.77	1,706.9	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	67.0	16.7
L -7	559,843.38	3,629,457.53	1,694.7	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	67.0	16.7
L -8	559,905.82	3,629,182.17	1,706.9	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	67.0	16.7
L -9	559,796.22	3,628,959.98	1,736.8	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	67.0	16.7
M -1	559,279.09	3,629,660.47	1,682.5	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	67.0	16.7
M -2	559,294.62	3,629,466.37	1,692.9	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	67.0	16.7
M -3	559,153.94	3,629,211.21	1,694.7	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	67.0	16.7
M -4	559,160.96	3,628,928.50	1,719.1	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	67.0	16.7
N -1	558,753.82	3,628,742.19	1,731.3	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	67.0	16.7
R -1	568,413.18	3,619,583.43	1,194.8	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
R -10	569,882.81	3,621,261.12	1,226.1	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
R -11	570,190.51	3,621,259.66	1,219.2	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
R -2	568,610.26	3,619,352.40	1,182.6	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
R -7	568,988.30	3,622,595.05	1,207.0	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
R -8	568,933.80	3,622,211.49	1,231.4	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
R -9	569,791.12	3,621,506.35	1,231.4	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
S -1	568,261.71	3,623,266.45	1,219.2	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
T -1	568,290.86	3,621,677.98	1,219.2	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7
T -2	568,372.54	3,621,344.84	1,207.0	GAMESA G90/2000 2000 90...	Yes	GAMESA	G90/2000-2,000	2,000	90.0	78.0	16.7

Shadow receptor-Input

No.	UTM NAD83 Zone: 11 East	North	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
			[m]	[m]	[m]	[m]	[°]	[°]	
Camp_45	567,895.53	3,621,389.12	1,189.6	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
Camp_46	561,712.05	3,629,422.31	1,328.8	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
Home_1	569,149.57	3,619,849.70	1,133.9	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
Home_32	566,421.29	3,619,605.44	1,111.4	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
Home_42	566,409.75	3,620,055.86	1,121.5	1.0	1.0	1.0	-180.0	90.0	"Green house mode"
Home_47	557,803.90	3,630,391.08	1,429.7	1.0	1.0	1.0	-180.0	90.0	"Green house mode"

Calculation Results

Shadow receptor

	Shadow, worst case			Shadow, expected values
No.	Shadow hours per year	Shadow days per year	Max shadow hours per day	Shadow hours per year
	[h/year]	[days/year]	[h/day]	[h/year]
Camp_45	137:46	193	1:20	82:19
Camp_46	9:00	78	0:11	5:14
Home_1	24:15	78	0:27	14:11
Home_32	13:40	82	0:13	9:14
Home_42	9:55	59	0:14	6:20
Home_47	32:32	151	0:29	17:36

Licensed user:
HDR
701 Xenia Av. So. Suite 600
US-MINNEAPOLI MN 55416

Anjali Malhotra / Anjali.Malhotra@hdrinc.com

Calculated:
4/27/2011 12:42 PM/2.7.486

SHADOW - Main Result

Calculation: Tule_ver5_20110427

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
A -2	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (9)	0:00	0:00
A -3	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (20)	0:00	0:00
A -4	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (11)	0:00	0:00
A -5	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (18)	0:00	0:00
A -6	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (32)	0:00	0:00
A -7	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (23)	0:00	0:00
B -1	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (34)	0:00	0:00
B -2	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (33)	0:00	0:00
C -1	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (31)	0:00	0:00
C -2	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (19)	0:00	0:00
D -1	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (30)	0:52	0:24
D -2	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (66)	0:00	0:00
G -10	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (25)	46:54	25:31
G -11	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (15)	57:40	37:14
G -12	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (16)	0:00	0:00
G -13	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (47)	0:00	0:00
G -14	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (50)	4:43	3:07
G -15	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (60)	11:38	7:59
G -16	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (57)	16:52	9:18
G -18	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (48)	0:00	0:00
G -4	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (29)	0:00	0:00
G -5	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (64)	0:00	0:00
G -6	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (65)	0:00	0:00
G -7	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (55)	0:00	0:00
G -8	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (52)	0:00	0:00
G -9	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (63)	0:00	0:00
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K -4	GAMESA G90/2000 2000 90.0 !O! hub: 67.0 m (39)	4:25	2:13
K -5	GAMESA G90/2000 2000 90.0 !O! hub: 67.0 m (49)	5:46	2:42
K -6	GAMESA G90/2000 2000 90.0 !O! hub: 67.0 m (21)	0:00	0:00
L -1	GAMESA G90/2000 2000 90.0 !O! hub: 67.0 m (40)	0:00	0:00
L -2	GAMESA G90/2000 2000 90.0 !O! hub: 67.0 m (67)	0:00	0:00
L -3	GAMESA G90/2000 2000 90.0 !O! hub: 67.0 m (35)	0:00	0:00
L -4	GAMESA G90/2000 2000 90.0 !O! hub: 67.0 m (10)	2:03	1:10
L -5	GAMESA G90/2000 2000 90.0 !O! hub: 67.0 m (41)	0:00	0:00
L -6	GAMESA G90/2000 2000 90.0 !O! hub: 67.0 m (45)	2:16	1:16
L -7	GAMESA G90/2000 2000 90.0 !O! hub: 67.0 m (14)	2:05	1:14
L -8	GAMESA G90/2000 2000 90.0 !O! hub: 67.0 m (12)	2:02	1:15
L -9	GAMESA G90/2000 2000 90.0 !O! hub: 67.0 m (46)	1:42	1:03
M -1	GAMESA G90/2000 2000 90.0 !O! hub: 67.0 m (7)	3:24	1:36
M -2	GAMESA G90/2000 2000 90.0 !O! hub: 67.0 m (8)	4:13	1:55
M -3	GAMESA G90/2000 2000 90.0 !O! hub: 67.0 m (44)	0:00	0:00
M -4	GAMESA G90/2000 2000 90.0 !O! hub: 67.0 m (42)	0:00	0:00
N -1	GAMESA G90/2000 2000 90.0 !O! hub: 67.0 m (13)	0:00	0:00
R -1	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (17)	14:36	9:18
R -10	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (51)	1:09	0:42
R -11	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (59)	0:00	0:00
R -2	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (56)	0:00	0:00
R -7	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (24)	0:00	0:00
R -8	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (27)	0:00	0:00
R -9	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (28)	1:34	0:54
S -1	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (58)	0:00	0:00

To be continued on next page...

Licensed user:
HDR
701 Xenia Av. So. Suite 600
US-MINNEAPOLI MN 55416

Anjali Malhotra / Anjali.Malhotra@hdrinc.com

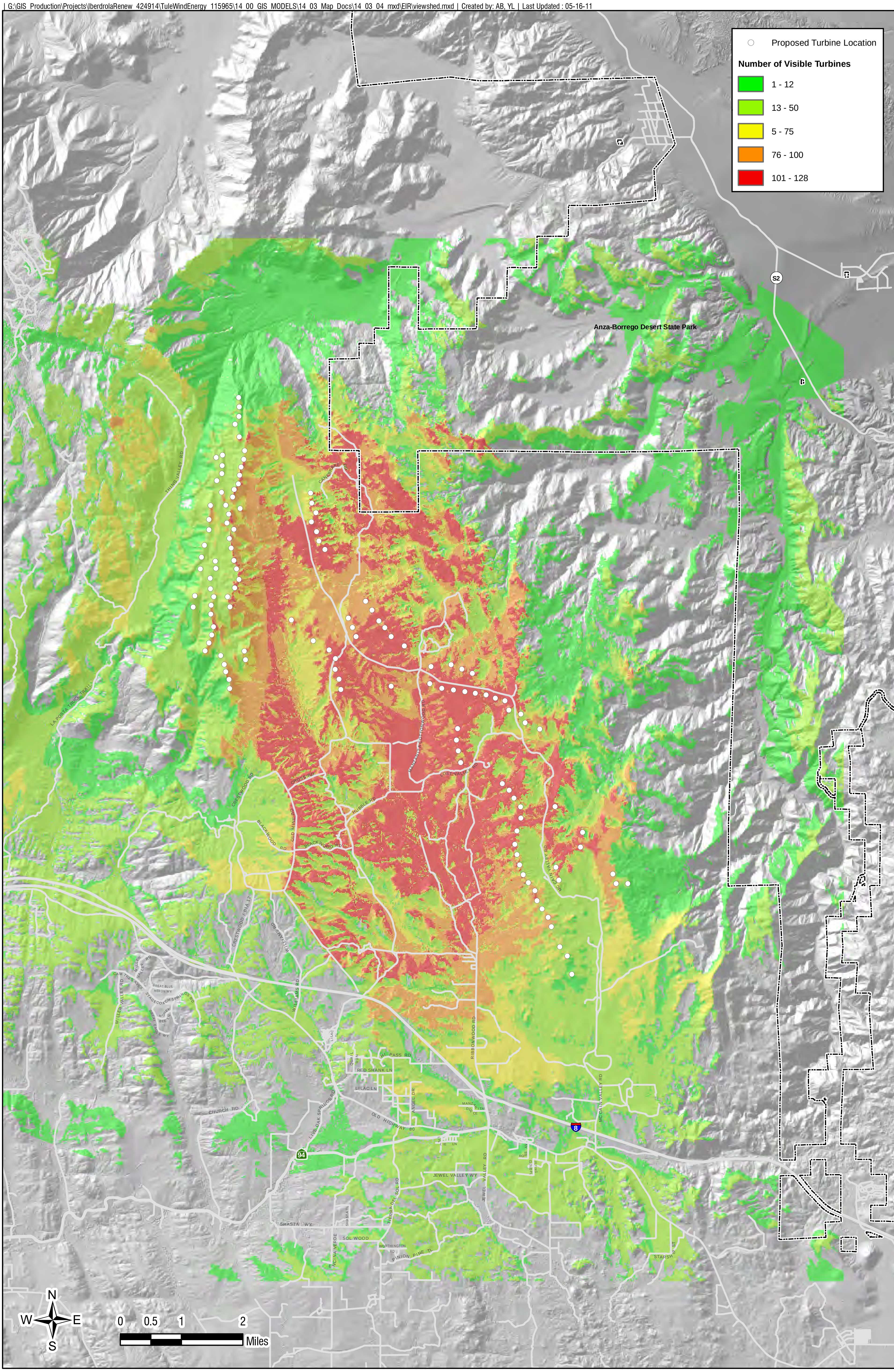
Calculated:
4/27/2011 12:42 PM/2.7.486

SHADOW - Main Result

Calculation: Tule_ver5_20110427

...continued from previous page

No.	Name	Worst case [h/year]	Expected [h/year]
T -1	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (61)	0:00	0:00
T -2	GAMESA G90/2000 2000 90.0 !O! hub: 78.0 m (26)	30:28	17:50



Viewshed

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IBERDROLA
RENEWABLES

April 6, 2010

Mr. John Gibson
Hamann Companies
1000 Pioneer Way
El Cajon, Ca 92020

Re: Tule Wind Project – Groundwater Availability Confirmation Request

Dear Mr. Gibson:

As part of the Draft EIR/EIS process, Tule Wind, LLC (Tule Wind) has been requested by the California Public Utilities Commission (CPUC) to provide additional documentation verifying its construction water sources and their availability from the well water providers that will supply construction water for the Tule Wind Project. As you know, Tule Wind intends to pump groundwater from wells located on Rough Acres Ranch (specifically Well No. 6a) to supply a portion of its water needs for the construction of the Tule Wind Project.

As you may remember, groundwater testing based on County of San Diego Guidelines was conducted on Rough Acres Ranch with approval from Hamann Companies in the summer of 2010 by Geo-Logic Associates on behalf of Tule Wind. The results of the testing were presented in the Groundwater Investigation prepared by Geo-Logic Associates (December 2010).

Based on the well test plan that was approved by the County of San Diego, Geo-Logic conducted a step test, followed by a 72-hour, 50 gallons per minute, constant rate aquifer pumping test at Well No. 6a on Rough Acres Ranch. Based on the lack of significant drawdown in the nearest observation well (36 feet away), and no evidence of an effect in more distant observation wells, Geo-Logic concluded that there is significant groundwater resources within this water production area. In fact, during testing Geo-Logic observed no drawdown in wells located within one third and one half mile of the pumping well. Accordingly, Geo-Logic concluded that interference with the nearest off-site wells, approximately one half mile from the pumping well, is not anticipated at the level proposed during construction of the Tule Wind Project. Furthermore, although Tule Wind does not anticipate the need to do so, the Geo-Logic Groundwater Investigation concluded that it is possible to double the expected pumping rate at the Rough Acres Ranch well to 100 gallons per minute "without well interference or significant groundwater depletion."

Since the Geo-Logic Groundwater Investigation was performed in December 2010, Tule Wind has voluntarily modified the Tule Wind Project to reduce the proposed number of wind turbines from 134 turbines to 128 turbines. Accordingly, Geo-Logic prepared a Modified Construction Water Supply Memo (February 28, 2011) to determine the amount of water that would be saved through Tule Wind's voluntary modifications to the Tule Wind Project. The table below estimates groundwater demand to construct the proposed modified project layout, comparod to the previous project layout.

	Project Components	Daily Rate (gpd)	Days	Gallons
134 Turbines	Road Construction	120,000	72	8,640,000
	Turbines	15,000	67	1,005,000
	Dust Suppression During Foundation Construction	100,000	67	6,700,000
	Dust Suppression During Turbine Erection	50,000	60	3,000,000
	Fire Protection-one-time filling of four (4) 10,000 gallon tanks		1	40,000
	Total			***19,385,000***
	128 Turbines	**Daily Rate (gpd)**	**Days**	**Gallons**
128 Turbines	Road Construction	120,000	72	8,640,000
	Turbines	15,000	64	960,000
	Dust Suppression During Turbine Erection	100,000	64	6,400,000
	Dust Suppression During Turbine Erection	50,000	58	2,900,000
	Fire Protection- one-time filling of four (4) 10,000 gallon tanks		1	40,000
	Total			***18,940,000***

Source: Geo-Logic Associates Modified Construction Water Supply Evaluation Memo (February 28, 2011).

As demonstrated in the table, Tule Wind's voluntary project modification would slightly reduce the total water demand for the construction of the Tule Wind Project. Based on this fact, Geo-Logic concluded in its Modified Construction Water Supply Evaluation Memo (February 2011) that its analysis in the Groundwater Investigation (December 2010), which evaluated a higher water demand for the Tule Wind Project, remained valid and that there would be a sufficient water supply to serve the Tule Wind Project as modified by Tule Wind.

As confirmation of Hamann Companies' commitment to provide construction water from groundwater resources on Rough Acres Ranch and acknowledgement that this water has not been committed to other entities for use during the construction of the Tule Wind project, Tule Wind respectfully requests your signature below to confirm your participation as a source of construction water for the Tule Wind Project.

Please return this signed letter to me at your earliest convenience, so that I can convey it to the CPUC by April 8, 2011, the date the CPUC has requested that Tule Wind confirm the availability of the Rough Acres Ranch construction water source.

Thank you for your cooperation and your continued support of the Tule Wind Project. Please do not hesitate to call me at 760-445-3081 or email me at Harley.McDonald@iberdrolaren.com with any questions or concerns.

Sincerely,

Harley McDonald
Business Developer

Attached: Geo-Logic Associates, Groundwater Investigation Report (December 2010)
Geo-Logic Associates Modified Construction Water Supply Evaluation Memo (February 28, 2011)

On behalf of Hamann Companies, I confirm that Tule Wind, LLC has permission to withdraw groundwater from wells located on Rough Acres Ranch for construction of the Tule Wind Project. I also confirm that these groundwater resources have not been committed to any other entities during the period that they will be required for the construction of the Tule Wind Project, and that they are reserved for construction of the Tule Wind Project.

Date: April 6, 2011

John Gibson
Property Acquisition
Hamann Companies

IBERDROLA RENEWABLES

April 8, 2010

Mr. William Micklin
Chief Executive Officer
Ewiiaapaayp Band of Kumeyyay Indians
4054 Willows Road
Alpine, CA 91901

Re: Tule Wind Project – Groundwater Availability Confirmation Request

Dear Mr. Micklin:

As part of the Draft EIR/EIS process, Tule Wind, LLC (Tule Wind) has been requested by the California Public Utilities Commission (CPUC) to provide additional documentation verifying its construction water sources from the well water providers that will supply construction water for the Tule Wind Project. As you know, Tule Wind intends to pump groundwater from wells located on Ewiiaapaayp Tribal land to supply a portion of its water needs for the construction of the Tule Wind Project.

As you know, there are two groundwater production wells located on the Ewiiaapaayp tribal lands (North and South wells).

North Well. Based on tribal approval, Geo-Logic Associates on behalf of Tule Wind conducted groundwater testing on the North well in the summer of 2010. The North well is capable of producing groundwater at up to 90 gallons per minute (gpm). The North well was constructed to provide water to a commercial water bottling facility constructed adjacent to the tribal fire station, though the bottling facility never opened and the North well remains idle.

South Well. According to a report provided by the Ewiiaapaayp Tribe, the South well has the potential to produce water at a rate of about 30 gpm. It is used to provide water to a storage tank that supplies water to tribal members at the residences and the fire station. Since there are no permanent residents on tribal lands, the South well only pumps occasionally to maintain the water level in the tank.

As reported in the Groundwater Investigation Report, the aquifer pumping test and analyses indicate that there is sufficient storage for use of groundwater within Thing Valley and no significant impacts to groundwater storage are anticipated. However, the pumping test data and the noted boundary condition identified during the test after 1700 minutes suggests that to support the project water needs, it may be necessary to pump at a lesser rate or lesser frequency at the aquifer pumping test well, and supplement water from this well with water from another well within Thing Valley such as the observation well. Based on the groundwater testing conducted at the North well and reports provided for the South well, groundwater water resources are available at a combined (North and South wells) rate of 120 gpm.

As confirmation of Ewiiaapaayps' commitment to provide construction water from groundwater resources on tribal land and acknowledgement that this water has not been committed to other entities for use during the construction of the Tule Wind project, Tule Wind respectively requests your signature below to confirm your participation as a source of construction water for the Tule Wind Project.

Please return this signed letter to me at your earliest convenience, so that I can convey it to the CPUC by April 8, 2011, the date the CPUC has requested that Tule Wind confirm the availability of the Ewiiaapaayp Tribe's groundwater for use during construction.

Thank you for your cooperation and your continued support of the Tule Wind Project. Please do not hesitate to call me at 760-445-3081 or email me at Harley.McDonald@iberdrolaren.com with any questions or concerns.

Sincerely,

Harley McDonald
Business Developer

Attached: Geo-Logic Associates, Groundwater Investigation Report (December 2010)
Geo-Logic Associates Modified Construction Water Supply Evaluation Memo (February 28, 2011)

On behalf of Ewiiaapaayp Band of Kumeyyay Indians, I confirm that Tule Wind, LLC has permission to withdraw groundwater from wells located on Ewiiaapaayp Tribal land at mutually agreed upon terms for construction of the Tule Wind Project. I also confirm that these groundwater resources have not been committed to any other entities during the period they will be required for the construction of the Tule Wind Project, and that they are reserved for construction of the Tule Wind Project.

Date: _April 8, 2011_________________

Robert Pinto Sr.

Robert Pinto Sr.
Tribal Chairman
Ewwiiaapaayp Band of Kumeyyay Indians

GROUNDWATER INVESTIGATION REPORT

TULE WIND FARM
EAST SAN DIEGO COUNTY, CALIFORNIA

Project Proponent:
Jeffrey Durocher, Wind Permitting Manager
Iberdrola Resources
1125 NW Couch Street, Suite 700
Portland, Oregon 97209
Case No. 3300-09-019
ER No. 09-21-001

Prepared for:
HDR, Inc.
8690 Balboa Avenue, Suite 200
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and

County of San Diego
Department of Planning and Land Use
5201 Ruffin Road, Suite B
San Diego, CA 92123

Prepared By:

Sarah J. Battelle, CHG 619

Geo-Logic Associates
16885 W. Bernardo Drive, Suite 305
San Diego, CA 92127

JN:2010-0005

DECEMBER 2010

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GLOSSARY OF TERMS, ACRONYMS, AND ABBREVIATIONS

af	Acre feet
APN	Assessor's Parcel Number
CIMIS	California Irrigation Management Information System
DWR	Department of Water Resources
ETo	Evapotranspiration
Ft	Feet
gpd	Gallons per day
gpm	gallons per minute
msl	mean sea level
SCS	Soil Conservation Survey
t/t'	Time since pumping started divided by time since pumping stopped

EXECUTIVE SUMMARY

A groundwater investigation was conducted to evaluate the groundwater resources within Thing Valley on the Ewiiaapaayp Reservation and Rough Acres Ranch in McCain Valley. The purpose of the investigation was to assess the availability of groundwater as a resource in support of the Tule Wind Farm construction project, which proposes to be extracted at these locations over a nine-month construction period. The groundwater investigation included long-term 72-hour constant rate pumping tests and subsequent analysis of the data to assess the hydraulic properties of the aquifer at each of these locations.

Results of the groundwater investigation suggest that both locations provide viable groundwater resources in support of project construction. Although groundwater resources on Tribal land are not within the jurisdiction of the County, pumping test results indicate that the Reservation well appears to be somewhat limited at the test pumping rate of 80 gallons per minute (gpm). Based on a boundary condition identified during the course of the aquifer pumping test, it is recommended that a reduced pumping rate and a reduced frequency be used at this well. However, pumping from other Reservation wells may be used to supplement pumping from the test well.

At the Rough Acres Ranch, pumping at 50 gpm showed no evidence of well interference, or significant depletion of the groundwater in storage within the pumping well. In fact, analysis of the data suggests that pumping could be doubled without any significant impact. Based on the results of the aquifer test, no significant impacts to this groundwater resource are anticipated associated with pumping at the Rough Acres Ranch test well.

1.0 INTRODUCTION

1.1 Purpose of the Report

This groundwater investigation report describes field conditions, and presents the results of field and analytical procedures used to evaluate groundwater resource availability within the Thing Valley area of the Ewiiaapaayp Reservation and the Rough Acres Ranch area of McCain Valley to support construction of the proposed Tule Wind Project. The Tule Wind Project will include the construction of 134 wind turbines, and associated service roads, transmission lines and ancillary structures over a period of approximately nine months during which time groundwater will be extracted from the underlying aquifers to support construction activities. This investigation also addresses the sustainability of groundwater withdrawal from the aquifers with respect to the existing and proposed future uses. Construction is slated to begin in the third quarter 2011, and the wind turbine facility is scheduled to come on line in the fourth quarter 2012.

Engineering estimates indicate that construction, and associated groundwater extraction, is expected to last approximately nine months. According to the project developer, groundwater demand for the project is expected to occur in four phases. Initially the project will require approximately 120,000 gallons of water per day (gpd) during road building (60 gallons per minute [gpm]), increasing to 250,000 gpd (equivalent to a constant rate of 124 gpm) while both road and turbine foundation construction and construction-related dust suppression. Water demand will then decrease to approximately 130,000 gpd (a constant rate of 65 gpm) following completion of the 72-day road construction portion of the project, while turbine foundation construction continues, and finally decrease to 100,000 gpd (50 gpm) for dust control during the remainder of the project. Subsequent site work is not expected to require additional groundwater supply. The total volume of extracted groundwater to support the project is anticipated to be approximately 65 to 125 acre-feet.

When the Tule Wind Project turbines become operational, only a limited quantity of water will be required, estimated at 2,500 gallons per day to supply the operations and maintenance building services and support staff.

1.2 Project Location and Description

The Tule Wind Farm will be developed on 15,350 acres in eastern San Diego County. The project area is located approximately one mile north in Interstate 8 (I-8), generally between La Posta Truck Trail on the west and McCain Valley Road on the east (Figure 1). Given the large size of the project area and the need for water throughout, two sites were identified for water production: Thing Valley and McCain Valley (Rough Acres Ranch). These areas are described in more detail in the following sections.

1.2.1 Thing Valley Water Production Area

The Thing Valley Water Production Area is located approximately 10 miles north of I-8 off La Posta Truck Trail/Thing Valley Road on the Ewiiaapaayp Reservation (Figure 2A). The reservation is located in an isolated, triangular-shaped, southeasterly-draining valley near the headwaters of La Posta Creek. Ground surface elevations range from 5000 to 5100 feet on the valley floor, but rise to over 6200 feet along the surrounding ridgelines. Reservation structures dot the valley floor, and include a fire station, an abandoned water bottling facility, and several abandoned, vacant, or partially-occupied residential structures. Two groundwater production wells ("north well" and "south well") were constructed in August 1980 near the center of the valley. The "south well" is connected to a series of solar panels that power an electric submersible pump. This well pumps water to a storage tank at the northwestern end of the valley, and the stored water supplies the Reservation. The "north well" is located approximately 60 feet northeast of the "south well". It is equipped with an electric submersible pump, but it is not currently used for water production. According to personal communications with the tribal representative and review of the tribal website, there are no permanent inhabitants within the valley, through tribal members visit the location periodically. The nearest residence is approximately 4 miles south of the subject valley in the larger Thing Valley. The "north well" and "south well" occupy Assessor's Parcel Number (APN) 4130800300, and the remainder of the valley spans APNs 4131503000, 4130800100, and 4130800200. The "far field" observation well is located within APN 4131503200.

1.2.2 Rough Acres Ranch Water Production Area

The Rough Acres Ranch Water Production Area is located approximately one mile north of I-8 between Ribbonwood Road on the west and McCain Valley Road on the east (Figure 2B). This site occupies the broad alluviated, southeasterly-draining McCain Valley that, within the project area, is bounded on the north and south by low-relief granitic hills. Ground surface elevations in the valley range from approximately 3600 feet above mean sea level at the northwestern corner of the project area and along the northern bounding hills to about 3450 feet above mean sea level at the southeastern corner of the project area. Within the project area, Rough Acres Ranch is surrounded by scattered residences on the west and south, a low-security detention facility and landing strip on the east, and open space on the north. The valley floor is used for livestock grazing. The Rough Acres Ranch property is crossed by a series of graded dirt roads, and contains a number of active and idle groundwater production wells that are used for domestic and agricultural supply. The area of the aquifer test spans APNs 6110600300, 6110700100, 6110900200, 6110900300, 6110900400, 6110901800, and 6111100100.

1.2.3 Project Description

The Tule Wind Farm project will include the construction of up to 134 wind turbines and associated roads, transmission lines and support facilities. Based on information provided by the project developer, IBR, the following water requirements have been estimated for the project construction (all work is anticipated to be performed over five-day work weeks):

1. Road Construction – Up to 120,000 gallons per work day will be required over a 72-day construction period. This translates to an average pumping rate of approximately 60 gpm assuming sufficient storage is available to allow for pumping seven days a week (83 gpm if the pumps are only active during work days).

2. Turbine Foundation Concrete Mixing – Turbine foundation construction is estimated to require 7,500 to 15,000 gallons of water per foundation. With 134 foundations to build, water demand will be approximately 15,000 and 30,000 gpd (assuming that two foundations are constructed each day in accordance with the 72-day work schedule). This much water use equals an average maximum pumping rate of approximately 15 gpm. The maximum continuous pumping rate (24-hours per day, seven days per week), required to support concrete mixing for three turbine foundations per day (45,000 gallons) is equivalent to 31 gpm.

3. Dust Control – During subsequent construction activities, approximately 50,000 to 100,000 gallons of water per working day will be required for dust control on project roads. The average continuous pumping rate required during these activities would be 50 gpm for an estimated nine-month construction period.

The pumping rates stipulated above are based on the assumption that there will be sufficient storage space to allow for groundwater extraction 24 hours per day, seven days per week. If there is insufficient water storage capacity to allow for continuous pump operation, higher incremental pumping rates would be required. Based on the aquifer testing performed for this report, the wells may not be able to pump at higher incremental pumping rates for peak demand.

1.3 Applicable Groundwater Regulations

Groundwater utilization for projects within the County of San Diego must address the requirements in the *County of San Diego Groundwater Ordinance No. 9826*, which stipulates that development and utilization of groundwater will not affect those who are dependent upon groundwater unless it can be demonstrated that there is an adequate supply to provide both the project and the existing users. In addition, since the project is proposing to use more than 20,000 gallons per day, it is considered a water intensive project according to the Groundwater Ordinance, and requires an evaluation of the cumulative groundwater impacts. The Ordinance provides for methods of analysis to determine potential impacts to the groundwater resource, and this investigation endeavors to address those potential impacts following the Ordinance-prescribed guidelines.

This project will result in groundwater extraction and utilization that may affect the local environment, a unique resource, and groundwater-dependent habitats. As a result, the California Environmental Quality Act (CEQA) requires an evaluation of environmental impacts associated with groundwater extraction, as well as other components of the project.

2.0 EXISTING CONDITIONS

This section of the water investigation report describes the existing conditions of the project areas, including topography, climate, geology and hydrogeology, surrounding land use, hydrology, and water quality.

2.1 Topographic Setting

2.1.1 Thing Valley Water Production Area

The Thing Valley Production area is situated in a triangular shaped valley near the headwaters of La Posta Creek. Ground surface elevations range from approximately 5100 feet above mean sea level (amsl) at the north end of the valley floor to about 5000 feet amsl at the south end of the valley floor (Figures 3A). Bounding ridgelines rise to over 6300 feet amsl. The watershed for the production area is approximately 2310 acres, draining the area to the northwest that includes the eastern flanks of the Laguna Mountains to the west and the southwestern flanks of the Sawtooth Mountains to the northeast.

2.1.2 Rough Acres Ranch Water Production Area

The Rough Acres Ranch Water Production Area is situated in McCain Valley, a broad south- to southeasterly trending valley that is generally bounded by the eastern flanks of the Laguna Mountains to the west and the In-Ko-Pah Mountains to the north and east. The valley is over 13 miles long, extending from the In-Ko-Pah Mountains to the north, and draining into Tule Canyon and Carrizo Gorge at the southeast. McCain Valley includes a large number of tributaries, including Tule Creek that passes through the Rough Acres Ranch study area as a dry wash at most times of the year. Because of the vast expanse of the drainage area, for purposes of this investigation and following guidance from the County Hydrogeologist, the watershed area is defined as an area of one-half mile radius surrounding the proposed production well (Figure 3B).

2.2 Climate

For purposes of this water supply study, the climate factors of most concern include precipitation and evapotranspiration. Data provided in this section comes from the County of San Diego Department of Planning and Land Use General Plan Update – Groundwater Study, State of California Department of Water Resources, and the California Irrigation Management System (CIMIS) databases.

2.2.1 Climate of the Thing Valley Water Production Area

At elevations of over 5000 feet, the Thing Valley WPA has a relatively mild climate. The site is located just east of the Laguna Mountains, and as a result, it sits in the rain shadow of these mountains. Historical climate data from the Campo area were used to conservatively represent conditions at this site. Based on information available from the California Department of Water Resources, the area receives an average of 15.6 inches of rainfall per year, with 80 percent of the rainfall occurring between November and March of each year. According to the State of California Reference Evapotranspiration Map developed by CIMIS, the site is located in Evapotranspiration Zone 16, with an average of 62.5 inches of evapotranspiration per year.

2.2.2 Climate of the Rough Acres Ranch Water Production Area

While 2000 feet lower in elevation, and about 10 miles east of the Thing Valley WPA, the Rough Acres Ranch WPA has similar values for rainfall and evapotranspiration. Using historical precipitation records from a monitoring station in Boulevard, California (approximately 2 miles south of the site), the average annual precipitation for the area is approximately 15.8 inches. The Rough Acres and Thing Valley WPAs are located in the same Evapotranspiration Zone, which indicates an average annual evapotranspiration of 62.5 inches.

2.3 Land Use

2.3.1 Land Use Surrounding the Thing Valley WPA

The Thing Valley WPA is located within the Ewiiaapaayp Reservation. According to the San Diego County General Plan, the site is located within the Mountain Area Community Planning Area with a land use designation as Indian Reservation. The highlands of the watershed area are located within the Cleveland National Forest, and the San Diego County General Plan identifies this area as the Central Mountain Community Planning Area, with an open space forest designation.

There are no full-time residents or industries within the Reservation limits, though the Reservation includes several abandoned structures and structures that are used periodically, as well as a fire station and a structure that was to be used as a water bottling plant. Aside from these structures, the surrounding land is undeveloped mountain and valley terrain. The nearest residents are located approximately 3 miles south of the WPA at Thing Valley Ranch.

2.3.2 Land Use Surrounding the Rough Acres Ranch WPA

The Rough Acres Ranch WPA is located in a sparsely populated region of the county. According to the San Diego County General Plan, the site is located within the Mountain Area Community Planning Area and has a land use designation as general agricultural. Properties surrounding the site are designated as general rural, and one parcel to the east is designated as National Forest/State Parks.

Consistent with the designated land uses, the Rough Acres Ranch is used for livestock grazing, and this property is surrounded by large lot residences to the west and south, a low-security detention center and rural air field to the east, and high desert open space to the north and east.

2.4 Water Demand

Because there are no residents or uses for groundwater within the Thing Valley WPA, and the County has no jurisdiction over groundwater use on tribal lands, there is no requirement to evaluate water demands in this area.

For the Rough Acres Ranch WPA, a conservative approach was used to ensure that the proposed project would not affect adjacent groundwater users. It is assumed that all groundwater for this project will be derived from the Rough Acres Ranch WPA even though the project will also utilize water from the Thing Valley WPA.

As recommended by the County Groundwater Geologist, the water production area was restricted to a one-half mile radius surrounding the production wells (the estimated maximum area of interference from the pumping well). However, to evaluate other groundwater uses, the evaluation radius was extended in some instances to about three quarters of a mile. Within this evaluation area, seven single family residences were identified, including one residence that operates an apparent poultry farm. In addition to the residences, the Rough Acres Ranch property is utilized for free-range livestock grazing, with an estimated head count of 100 animals. Using residential water demand values provided by the County's Guidelines for Determining Significance and published values for livestock water usage, the groundwater demand for the project is estimated in the following table:

Water Use	Demand (Acre-Feet per Year)	Demand (Acre-Feet per Month)
Proposed Project Construction (9 month duration)	60	6.7
Post-Project Maintenance	2.8	0.23
Residential Water Use (7 residential properties; 0.5 acre-feet per year per residence)	3.5	0.29
Livestock Grazing (100 head; 19 gallons per day per animal)	2.13	0.18
Poultry Raising (500 birds; 770 liters per 1000 birds per day)	0.11	0.01
Totals:	**65.74**	**7.18**

2.5 Geology and Soils

The Thing Valley and Rough Acres Ranch WPAs are situated within batholithic rocks of the Peninsular Ranges Geomorphic Province. Batholithic rocks were generally emplaced in the late Mesozoic to early Cenozoic eras. Post-emplacement uplift, weathering, and erosion has resulted in formation of surficial soils and alluvial deposits that mantle the crystalline bedrock. Due to the remote locations and paucity of mineral resources, neither site has been studied in detail, and most of the available geologic information comes from regional geologic studies, including the "Preliminary Geologic Map of the 30' x 60' El Cajon Quadrangle" (Todd, 2004) and "Mineral Resources of the Sawtooth Mountains and Carrizo Gorge/Eastern McCain Valley Wilderness Study Areas (Todd, et al., 1987). Soils information is provided by the United Sates Department of Agriculture - Soil Conservation Service and Forest Service. Geologic and soils conditions specific to each WPA and its watershed are described below.

2.5.1 Geology and Soils of the Thing Valley WPA

The Thing Valley WPA is flanked by the Laguna Mountains to the west and the Sawtooth Mountains to the north and east. Based on the available geologic information, in the vicinity of the WPA, the two mountain ranges are geologically similar, and are composed of the early Cretaceous-age Las Bancas Tonalite, an assemblage of lightly foliated tonalite, granodiorite, and quartz diorite. In addition, at the northernmost portion of the watershed, the Sawtooth Mountains are also underlain by a variety of Triassic and Jurassic-age metasedimentary rock units.

Along the valley floor, the crystalline bedrock is overlain by recent alluvium. Based on the logs of the groundwater production wells, the thickness of alluvium is estimated to be approximately 30 to 50 feet.

Based on maps prepared by the Soil Conservation Service (now Natural Resources Conservation Service), and presented on Figure 4A the following table presents the soil types and their properties within the Thing Valley WPA watershed area:

Soil Type	Moisture Holding Capacity (in)	Runoff Potential	Maximum Runoff Percentage	Area (acres)
Acid Igneous Rock Land (AcG)	0.10	Rapid	100%	250
Bancas Stony Loam (BbG)	3-5.5	Rapid to Very Rapid	81%	1000
Crouch Coarse Sandy Loam (CtE)	4.5-7	Medium	71%	50
Crouch Coarse Sandy Loam (CtF)	4-6	Rapid	74%	40
Crouch Rocky Coarse Sandy Loam (CuE)	3.5-5	Medium	78%	30
Crouch Rocky Coarse Sandy Loam (CuG)	3.5-5	Rapid to Very Rapid	78%	100
Mottsville Loamy Coarse Sand (MvC)	4-5	Slow to medium	74%	40
Mottsville Loamy Coarse Sand (MvD)	4-5	Medium	74%	30
Sheephead Rocky Fine Sandy Loam (SpG2)	2-3	Rapid to Very Rapid	87%	750
Steep Gullied Land (StG)	Not Available	Rapid	100%	10

2.5.2 Geology and Soils of the Rough Acres Ranch WPA

The Rough Acres Ranch WPA is located at the eastern edge of the Peninsular Ranges. Available geologic information in the vicinity of the WPA indicates that the area is underlain by the early to late Cretaceous era La Posta Tonalite, an assemblage of horneblende-biotite trondhjemite and granodiorite that is exposed on the low-relief highlands surrounding and within McCain Valley. Along the valley floor, the crystalline bedrock is overlain by recent alluvium. Based on the logs of the groundwater production wells in the valley, the thickness of alluvium is estimated to be 30 and 70 feet.

Based on maps prepared by the Soil Conservation Service (now Natural Resources Conservation Service), presented on Figure 4B, the following table presents the soil types and their properties within the Rough Acres Ranch WPA watershed area:

Soil Type	Moisture Holding Capacity (in)	Runoff Potential	Maximum Runoff Percentage	Area (acres)
Acid Igneous Rock Land (AcG)	0.1	Rapid	100%	10
Calpine Coarse Sandy Loam (CaC)	4.5-6.5	Slow to medium	72%	5
La Posta Loamy Coarse Sand (LaE2)	2-3	Medium	87%	60
La Posta Rocky Loamy Coarse Sand (LcE2)	1-2	Medium	94%	150
Loamy Alluvial Land (Lu)	6-9	Slow	62%	120
Mottsville Loamy Coarse Sand (MvC)	4-5	Slow to medium	75%	110
Tollhouse Rocky Coarse Sandy Loam (ToE2)	1-2	Medium to rapid	94%	50

2.6 Hydrogeologic Units

This section of the water investigation report describes the water-bearing units at each site and their general hydraulic properties.

2.6.1 Hydrogeologic Units of the Thing Valley WPA

The hydrogeologic units of the Thing Valley WPA include the recent alluvial soils and the underlying fractured Las Bancas Tonalite. The alluvium is restricted to the lowest portion of the valley floor; based on available geologic maps and Soil Conservation Service surveys, it underlies less than 10 percent of the watershed. In contrast, the Las Bancas Tonalite underlies the entire watershed area, either directly or beneath the alluvium.

A California State Department of Water Resources well completion report (no. 058539) is available for the "south" well that was used as the observation well for the aquifer testing in this study. Drilling logs for the "north" aquifer pumping test well and far-field observation wells were not available. Based on the log for the south well, the alluvium at this location is approximately 12 feet thick. Relatively weathered "granitic" bedrock extends from 12 to 50 feet below ground surface, and relatively unweathered "granitic" rock was encountered from 50 feet to the bottom of the hole at 400 feet. The geologic conditions at the north and far-field wells would be expected to be generally similar based on inspection of the surface geology.

A static water level was measured at each of the three test wells prior to the start of the step-drawdown test (Section 2.7). The static water levels in each well were sufficiently deep, and is likely below the base of alluvium. This suggests that alluvium groundwater is ephemeral, and does not contribute significantly to the available groundwater resource at this site.

The fractured Las Bancas Tonalite appears to be the most significant aquifer within the Thing Valley WPA. Using the recommendations from the County Groundwater

Geologist, a specific yield of 0.1 percent has been established for this unit. Figure 6 presents a conceptual hydrogeologic cross section through the Thing Valley WPA.

2.6.2 Hydrogeologic Units of the Rough Acres Ranch WPA

The hydrogeologic units of the Rough Acres Ranch WPA include the recent alluvial soils and the underlying weathered and fractured La Posta Tonalite. As shown on Figure 7, the alluvium covers the broad valley floor, and based on available geologic maps and Soil Conservation Service surveys (Figure 4B), it underlies approximately 50 to 60 percent of the watershed. The alluvium is directly underlain by the Las Bancas Tonalite, which is also exposed as outcroppings throughout the watershed. Figure 8 depicts a conceptual hydrogeologic cross section through this WPA.

While seven wells were used for the aquifer test in this study area, only the pumping well and two observation wells are within the prescribed one-half mile radius watershed. A California State Department of Water Resources well completion report (no. 1089956) is available for the pumping well. Geologic information suggests that the alluvium in the center of the valley is approximately 70 to 80 feet thick. Weathered bedrock extends to a depth of about 230 feet, and below that depth to the total depth of boring (420 feet), the crystalline rock is relatively unweathered. Static water levels measured in the pumping and observation well suggest that the lower 45 to 50 feet of alluvium is saturated. Little alluvium is noted on the logs for other observation wells in the test area, and well depths typically range from 400 to 900 feet, indicating that the fractured La Posta Tonalite is the primary source of groundwater for production wells in the area.

The fractured La Posta Tonalite appears to be the most significant aquifer within the Rough Acres Ranch WPA, with the alluvium providing at least seasonal recharge to the subjacent bedrock aquifer. Using the recommendations from the County Groundwater Geologist, a specific yield of 0.1 percent has been established for this bedrock aquifer. Published specific yield values for mixed sand and gravel aquifers (Driscoll, 1986) indicate a range of 10 to 25 percent.

2.7 Hydrologic Inventory and Groundwater Levels

2.7.1 Thing Valley WPA Hydrologic Inventory

As described in Section 2.6.1, two groundwater production wells are located within the Thing Valley WPA watershed. The wells are owned by the Ewiiaapaayp Tribe. The "south" well is currently used for as-needed water supply and pumps water to a storage tank. The "north" well was constructed to supply water to a proposed water bottling facility, but it is not currently used. Outside of the project watershed area, approximately one mile south of the north and south wells, is the "Thing Valley" observation well that is located near the confluence of La Posta Creek and an unnamed tributary. No other wells are known to exist within the watershed area. Well construction information and static water levels are provided in the following table.

Well Name	Total Depth (ft)	Seal Depth (ft)	Production Rate (gpm)	Water Level – August 2010 (feet below top of casing)
"North" Well	400	22	Idle	54.81
"South" Well	Unknown	Unknown	Up to 30 gpm	49.34
"Thing Valley" Well	Unknown	Unknown	Idle – No Pump	77.62

Locations for these wells are shown on Figure 5. The locations and elevations of these wells are not surveyed; however, using approximate ground surface elevations to establish an approximate groundwater elevation, a hydraulic gradient of 0.05 feet per foot is estimated. The approximated groundwater elevations suggest a southeasterly flow direction down Thing Valley.

According to a report provided by the Ewiiaapaayp Tribe, the "South" well has the potential to produce water at a rate of about 30 gpm. It is used to provide water to a storage tank that supplies water to tribal members at the residences and the fire station. Since there are no permanent residents in the reservation, the south well only pumps occasionally to maintain the water level in the tank.

The North well is capable of producing groundwater at up to 90 gpm, and a pumping test conducted on the well following its construction indicates a specific yield of 55 gpm. The North well was constructed to provide water to a commercial water bottling facility constructed adjacent to the tribal fire station, though the bottling facility never opened and the North well remains idle.

The Thing Valley well is located approximately one mile south of the north and south wells and is not equipped with a pump or power. The well has no cap, and is open to the atmosphere and needs to be secured to be in compliance with California State Well Standards (Bulletin 74-90).

Surface water bodies within the Thing Valley WPA watershed include the ephemeral La Posta Creek and its unnamed, ephemeral tributaries. La Posta Creek passes within approximately 400 feet to the west of the south well. There are no reservoirs or ponds within the watershed, and no springs have been mapped in the area.

2.7.2 Rough Acres Ranch WPA Hydrologic Inventory

While only two wells (Wells 6 and 6a) are located within the prescribed 502-acre watershed area, seven wells surrounding the project area were evaluated during this project. Of these, four are equipped with pumps and are actively used for municipal water supply or to provide water to livestock. The remaining three well are either equipped with pumps and are not currently used, or have not been equipped with pumps. Well construction, current estimated production, and static water levels are provided on the following table.

Well Name	Total Depth (ft)	Seal Depth (ft)	Production Rate (gpm)	Water Level – August 2010 (feet below top of casing)
Well No. 6a "North" Well	385	75	1	28.0
Well No. 6 "South" Well	Unknown	Unknown	1	27.80
Walker Residence Well	Unknown	Unknown	<0.5	54.78
Well No. 9 Livestock Supply Well	Unknown	Unknown	<0.5	29.45
Well No. 2	185	24	No Power	23.92
Well No. 4	185	91	No Pump	10.98
Well No. 8	970	50	Pump	17.95

Locations for these wells are shown on Figure 7. The locations and elevations of these wells are not surveyed; however, using approximate ground surface elevations to establish an approximate groundwater elevation, a hydraulic gradient of 0.01 feet per foot is estimated. The approximated groundwater elevations suggest convergent flow toward McCain Valley, with a general southeasterly flow within the valley.

Based on aquifer testing conducted as part of this investigation and well testing conducted during construction, Well No. 6 and No. 6a are capable of producing groundwater at 50 to 60 gpm. The well test conducted on well No. 6a after construction indicates a specific yield of 60 gpm. Currently these wells are principally used to supply water to grazing livestock, and are estimated to provide water at a rate of about 1500 gallons per day, or 1.05 gpm on average.

Well logs were not available for the Walker residence well, which provides potable water for a single-family residence. Using recommendations provided by the County Groundwater Geologist for a typical residential well, it is estimated that this well produces about one-half acre-foot per year, or about 0.5 gpm on average.

Well logs were also not available for the "Livestock" Well No. 9 located between the Walker residential well and Wells No. 6 and No. 6a. This well provides water for grazing livestock in troughs located throughout the ranch. It is estimated that this well produces water at a rate of about 500 gallons per day, or about one third of a gpm on average.

Well No. 2 is located approximately one mile northeast of Wells No. 6 and No. 6a. First groundwater was encountered at a depth of 70 feet below ground surface in "black and white rock" interpreted to be the La Posta tonalite. Well tests conducted during construction indicate a specific yield of 10 gpm over a three hour test period. Currently, the well is idle.

Well No. 4 is located approximately one mile north of Wells No. 6 and No. 6a. First groundwater was encountered at a depth of 35 feet in "decomposed granite". Well tests conducted during construction indicate a specific yield of 15 gpm over a one hour test period. There is no pump in this well.

Well No. 8 is located about 3 miles east of Wells No. 6 and No. 6a, just east of McCain Valley Road. First groundwater was encountered at a depth of 30 feet in "weathered granitic rock". A specific yield was not achieved during the post-construction well test, which pumped the well at 50 gpm for 8 hours and recorded 800 feet of drawdown.

In addition to the wells within the prescribed watershed and those used as observation wells during the aquifer testing conducted as part of this study, there are seven residences within three-quarters of a mile of the project site, and each has its own water supply well. It is estimated that each of the seven additional residences utilizes about one-half acre-foot of water per year, and one of the residences has a small poultry farm with an estimated 500 birds that utilizes an additional 0.11 acre-foot of water per year. In total, the additional water use in the vicinity of the site is estimated to be about 3.61 acre-feet per year, or about 2.25 gpm on average.

Surface water bodies within the Rough Acres Ranch WPA watershed include the ephemeral Tule Creek. Although the USGS topographic map of the area identifies a small reservoir near the northwestern portion of the watershed, that feature was not observed within the study area. Rough Acres Ranch discharges water from Wells No. 6 and No. 6a to a small livestock watering reservoir about 2000 feet north of these wells. The reservoir is not lined, and as a result, water infiltrates rapidly into the ground. A groundwater spring was observed on the canyon wall adjacent to Well No. 4. The estimated flow rate from the spring is less than 1 gpm. No other surface water bodies are present within the watershed or surrounding study area.

2.8 Water Quality

Because this water development project is intended to provide water for construction rather than for potable use, no water quality evaluation has been conducted.

3.0 WATER QUANTITY IMPACT ANALYSIS

Water quantity impact analyses were performed in accordance with the County of San Diego *Groundwater Ordinance*, the County's *Guidelines for Determining Significance and Report Format and Content Requirements – Groundwater Resources* and the approved Groundwater Investigation Workplan and Well Test Plan developed for the Tule Wind Project. Based on the County guidelines for determining significance and correspondence with the County, the water quantity analysis section must address well interference, and 50 percent reduction of groundwater in storage associated with groundwater extraction for construction. In addition, in accordance with the County's Groundwater Ordinance, because it is anticipated that groundwater extraction will exceed 20,000 gpd, which is considered a water intensive use, a cumulative groundwater evaluation is required.

This section provides an analysis of the groundwater conditions and a determination of significant impacts to the groundwater resources, based on CEQA guidelines. It should be noted however that the County does not have jurisdiction over water use on tribal lands, including the wells in Thing Valley on the Ewiiaapaayp Reservation. Aquifer testing on the Reservation was performed to assess available water for the project construction and a summary of these results is included herein.

Because the Thing Valley WPA is located within the Ewiiaapaayp Reservation, there is no regional authority governing the use of this water. As a result, the water quantity impact analysis has been limited to performance of a 72-hour aquifer pumping test from the North Well at a rate of 80 gpm followed by measurements of recovery back to static conditions. Over the test, the water level was drawn down approximately 80 feet in the pumping well, and about 17 feet in the nearest observation well, and less than one quarter of a foot in the Thing Valley observation well about one mile downgradient of the pumping well. Analysis of the test data as presented in Appendix A.

Thing Valley Water Quantity Impact Analysis. Thing Valley test data were recorded by Solinst Levelogger Gold pressure transducer data loggers placed in the pumping well and two observation wells. The aquifer transmissivity (the capacity of the well to transmit water) was calculated by a variety of methods using AquiferTest Pro, Version 3.5, numerical modeling software (Röhrich and Waterloo Hydrogeologic, 2002) and ranges from about 100 to 835 ft^2/day depending on the data (early, middle, late portions of the test) obtained during pumping and recovery; the average transmissivity was calculated to be 393 ft^2/day. A summary of the calculated transmissivity values and additional calculated values from the pumping test are provided in Appendix A.

A plot of time versus drawdown was developed from the aquifer pumping test data. Based on the data, a projected total drawdown in the pumping well of 190 feet is expected. A negative boundary condition occurs after 1700 minutes (about 28 hours) and pumping of 136,000 gallons of water. During the intial 1700 minutes of the pumping test, the drawdown cone around the pumping well was likely pulling water from the portion of the fractured rock within Thing Valley. As the cone developed further, the cone is interpreted to have intercepted less fractured bedrock (most likely along the canyon walls) resulting in diminished production (the negative boundary effect).

Considering that the pump has been inoperable for some time prior to the aquifer pumping test, it may be beneficial to remove the pump and conduct an inspection of the well casing and pump for corrosion damage and encrustation to ensure that the well(s) are optimally operable for the duration of the construction program.

3.1 Guidelines for Determination of Significance

For groundwater extraction projects in this fractured rock basin such as the Tule Wind Project, the County Guidelines state:

> "groundwater impacts will be considered significant if a soil moisture balance, or equivalent analysis, conducted using a minimum of 30 years of precipitation data, including drought periods, concludes that at any time groundwater in storage is reduced to a level of 50 percent or less as a result of groundwater extraction. Groundwater impacts are considered significant if a soil moisture balance or equivalent analysis conducted using a minimum of 30 years of precipitation data,

> including drought periods, concludes that at any time groundwater in storage is reduced to a level of 50 percent or less as a result of the project groundwater demands."

The Guidelines also state:

> "As an initial screening tool, offsite well interference will be considered a significant impact if after a five year projection of drawdown, the results indicate a decrease in water level of 20 feet or more in the offsite wells. If site-specific data indicates water bearing fractures exist which substantiate an interval of more than 400 feet between the static water level in each offsite well and the deepest major water bearing fracture in the well(s), a decrease in saturated thickness of 5% or more in the offsite wells would be considered a significant impact."

In addition, based on conversations with the County Groundwater Geologist, a basin-wide cumulative analysis is not required because the project's groundwater extraction period is limited to approximately 9 months. For purposes of the cumulative analysis, with the approval of the County Groundwater Geologist, the Rough Acres Ranch Water Production Area boundary has been defined as an area with a one-half mile radius surrounding the projected ranch groundwater extraction well No. 6a.

3.2 Methodology

In accordance with the approved well test plan for the Tule Wind Project, a step test followed by a 72-hour constant rate aquifer pumping test was conducted at Well No. 6a at the Rough Acres Ranch to evaluate hydraulic characteristics in this proposed construction supply well. Prior to initiating the pumping test, area residents were contacted to request their participation in the test. In order to participate, the resident was asked to discontinue pumping and allow measurement of changes in water levels in their supply well over the testing period. The following residents listed with their Assessor's Parcel Number (APN) were contacted:

Resident	APN	Response
Dave and Linda Shannon	611-091-14	No domestic water storage on site
Dennis and Celeste Wilson	611-091-15	No domestic water storage on site
York Heimerdinger	611-091-02	Has storage but refused the test
Jeff and Peggy Garber	611-090-15	Has storage but refused the test
Lynn Wilson	611-050-24	No domestic water storage on site
Wayne and Frankie Thibodeau	611-091-07	No return call

As presented in this table, none of the surrounding residents agreed to participate in the test. However, because the well pumping test was being performed on the Rough Acres Ranch, most of the available wells on the ranch were made available for monitoring. In addition, the Ranch Manager, Mr. Walker, made his residential supply well available for the duration of the test. A Solinst Levelogger Gold data logger was placed in each of the available ranch wells prior to the long-term constant rate pumping test. These well locations are presented on Figure 7.

The 72-hour aquifer pumping test was conducted between August 24, and 27, 2010, followed by measurement of well recovery to static conditions. Direct water level measurements could not be performed in 4-inch diameter cased pumping well No. 6a, because of limited access through the well head, with only sufficient room to place the levelogger pressure transducer into the well to a depth of 114 feet below the water level for measurements of the water level in this well. Because of limited access through the wellhead at Well No. 6, located approximately 36 feet from the pumping well, water levels in this observation well were measured manually with an electric water level meter. Flow from the pumping well (at about 50 gpm) was measured with an in-line flow meter and water was discharged to a stock pond location approximately 2000 feet northeast of the pumping well. In addition, barometric pressure was measured with the Solinst Barologger Gold transducer, placed in the pumping well pump house adjacent to the pumping well. The pumping well static water level at the start of the test was about 28 feet below ground surface (bgs) and the pump depth was reportedly positioned at an estimated depth of 350 feet, though the pump depth could not be verified. During the pumping test, the maximum drawdown in the pumping well was 77.5 feet. In the nearest observation Well No. 6, the water level was drawn down a maximum of 3.7 feet. An estimated 216,000 gallons of water was pumped to the stock pond.

Results of the pumping and recover tests were plotted on semilog plots to evaluate the data. County Guidelines were reviewed and incorporated into the analysis. In addition, the long-term aquifer test data were analyzed using AquiferTest Pro, Version 3.5, numerical modeling software (Röhrich and Waterloo Hydrogeologic, 2002) to calculate aquifer hydraulic properties.

3.3 Well Test Results

As required by the County Guidelines, a plot of the pumping test time versus drawdown curve in the pumping well was used to estimate the drawdown in the pumping well after five years (2,600,000 minutes) of pumping at an average of 50 gpm as performed during the pumping test. From the graphed pumping data, the projected draw down is 87 feet after five years (Figure 3; Appendix B). Recognizing the project water requirements are needed over an estimated 9-month construction period, 84 feet of drawdown is predicted. In the event that during the construction, a higher pumping rate is needed, using proportions, doubling the pumping rate to 100 gpm would produce a drawdown of 174 feet after five years.

Using the plot of the drawdown plotted against time presented logarithmically since pumping started (Figure 3; Appendix B), aquifer transmissivity can be calculated using the Cooper-Jacobs approximation to the Theis equation:

$$T = \frac{2.3Q}{4\pi\Delta s}$$

where,

T = transmissivity in square feet per day
Q = average pumping rate in ft^3 / day (e.g., 50 gpm multiplied by 193 = 9650 ft^3 / day)
π = 3.14
Δs = change in drawdown over one logarithm of time (3.13 ft. from Appendix B, Figure 3)

Based on this equation, a transmissivity of 563 square feet per day is calculated from the pumping data. Using Aquifer Test Pro numerical modeling software, curve matching methods were used on the time versus drawdown plots to calculate transmissivity, hydraulic conductivity, and storativity by different methods. The transmissivity values obtained from the pumping well ranged from between 26.9 and 630 square feet per day. The analytical results show higher transmissivity (and hydraulic conductivity values) for curves matched to the observation well No. 6 and range from 0.375 to 3750 square feet per day. It is believed that the relatively thick alluvial section in this area of McCain Valley acts as a reservoir recharging the underlying fractured bedrock system. If the fractures in the bedrock are limited, the actual volume of groundwater available may be controlled by these thicker sections of alluvium and the more highly fractured bedrock. A summary of the calculated hydraulic properties from the aquifer tests, are presented in Table 1 included in Appendix B.

The recovery data were evaluated to assess long-term affects on the groundwater aquifer. The plot of residual drawdown versus t/t' (the ratio of time to time since pumping stopped) plotted on a logarithmic scale was used to evaluate aquifer storage. At t/t' equal to 1, a residual drawdown would indicate permanent dewatering of the aquifer and greater than 2 feet of residual drawdown would indicate a failed pumping test. As shown on Figure 4 in Appendix B, when the resultant recovery curve is projected back to t/t' equals 1, a residual drawdown of 0.33 feet is obtained indicating a successful test.

Based on the lack of significant drawdown (3.7 feet) in the nearest observation well 36 feet away, and no evidence of an effect in more distal observation wells suggests that the there is significant water within this water production area. Interference with the nearest off-site wells approximately one half mile from the pumping well are not anticipated from the level of pumping proposed during project construction.

3.4 Cumulative Impacts Analysis

Because the project water needs exceed 20,000 gallons of water per day, a cumulative basin analysis is required. To address these cumulative requires, GLA worked directly with the County's Groundwater Geologist, Mr. Jim Bennett, to develop a reasonable approach. Because the McCain Valley is an extensive groundwater basin and pumping is proposed from a limited area of the basin, it was agreed that the cumulative analysis would be limited to a ½ mile radius about the pumping Well No. 6A. The cumulative analysis was performed using spreadsheets and calculations initially developed by Mr. Bennett.

Initially, project groundwater extraction at 50 gpm (72,000 gpd) and area residential and operational water demands were evaluated against monthly groundwater recharge during a drought condition to determine if project extraction will exceed 50 percent of the total storage capacity within an effective area of McCain Valley defined as approximately within one half mile of the proposed pumping Well No. 6a. A second analysis was performed with double the pumping (100 gpm) to further evaluate increased water utilization at this well. Using drought year precipitation data from the Boulevard gauging station (July 1998 through June 2005), when groundwater recharge is minimal and water is extracted from storage, a conservative assessment of possible groundwater impacts was developed.

3.4.1 Groundwater Recharge

In the spreadsheet, groundwater recharge was estimated from available precipitation data for the Boulevard gauging station over a seven year drought period from July 1998 through June 2005, provided by the County Groundwater Geologist. The recharge area was considered to be an area encompassing the ½-mile radius surrounding the pumping well, equivalent to 502 acres. The groundwater recharge also accounts for evapotranspiration based on an average of 62.5 inches per month as established by California Reference CIMIS ETo map, Zone 16.

3.4.2 Groundwater Demand

For the groundwater demand, the project water needs were incorporated with standard assumptions of water needs for other known potential groundwater users including residents, livestock, and other users identified within approximately ½ of the pumping well. To be conservative some land uses within ¾ mile of the pumping well were included into the overall area groundwater demand calculations. The groundwater demand calculation assumed that there were seven residents using 0.5 acre feet of water per year in accordance with County Guidelines. From literature (The Ohio State University Extension, 2002), an estimated 100 head of cattle graze on the Rough Acres Ranch, would require an estimated daily intake of 19 gallons per animal per day (the maximum estimated daily water intake required for a bull in 90 degree temperatures), equivalent to 2.13 acre feet of water. It should be noted that slightly lower water consumption values (up to 15 gallons per day) are estimated for various classes of horses that may also be grazing on the Ranch lands. A poultry farm, estimated to include 500 poultry, is located to the south of Rough Acres Ranch and based on available literature from Pennsylvania State University (2002), a conservative estimate of 100 gallons per day or 0.11 acre feet of water consumption each year is assumed to support these animals.

These water quantities in combination with the estimated 9-month construction schedule of water demand from the pumping well on Rough Acres Ranch of 50 gpm resulted in an overall groundwater demand of 7.18 acre-feet per month, or 65.74 acre-feet per year. The groundwater demand would increase to 13.88 acre-feet per month and 125.74 acre-feet per year with a corresponding doubling of the production from the pumping well to 100 gpm.

3.4.3 Groundwater in Storage

The groundwater storage capacity was calculated using conservative estimated of the saturated thickness of each of the hydrogeologic units underlying the water production area as observed in boring logs within the McCain Valley. For this analysis, it is assumed that the saturated thicknesses include 20 feet of alluvium, 10 feet of residuum, and 500 feet of fractured bedrock. Assuming that these materials are continuous over the 502 acre water production area, conservative estimates of the specific yield for each unit was obtained from the County. As summarized in Table 1 in Appendix C, the greatest specific yield is associated with the alluvium at 10%, the specific yield for the residuum is 5%, and because the fractured bedrock yields water only within the fractures, the specific yield for this unit is 0.10%.

By multiplying the 502 acres by the specific yield and by the saturated thickness for each hydrogeologic unit, the total groundwater in storage within the ½-mile water production area is 1002 acre feet of water.

3.4.4 Long-Term Groundwater Availability

Based on the proposed 9-month construction period and the project groundwater demand along with adjacent water users, subtracted from the existing groundwater in storage, in combination with the anticipated groundwater recharge generated over a seven year drought cycle, there will be no long-term groundwater requirements in support of the project. As shown on Table 2 in Appendix C, the maximum drawdown within the subject area is about 66 acre-feet, well above the 50% basin depletion level of 500 acre-feet. Even if project pumping were to be increased to 100 gpm, a maximum of 136 acre-feet of drawdown is calculated within the basin (Table 3; Appendix C). In fact, until pumping is increased by eight times to 54 acre-feet per month or nearly 486 acre-feet per year would the basin approach the 50% depletion level of 500 acre-feet (Table 4; Appendix C).

Based on these analyses, the long-term result of pumping at 50 gpm reduces the groundwater in storage to 94% and a maximum reduction to 92% of the total groundwater in storage during the 7-year drought period. Under an increased (100 gpm) pumping scenario, the groundwater in storage is reduced to 86% of the total with an average of 89%.

Following the project construction phase, the estimated water demand for the project site is estimated to be 2500 gallons per business day or about 2 acre-feet per year, associated with the operations and maintenance facility for the wind turbines. Based on the calculations of groundwater availability this level of use would have no significant impact on the groundwater in storage within McCain Valley.

3.5 Significance of Impacts Prior to Mitigation

Based on the results of the aquifer pumping test at the Rough Acres Ranch well No. 6a, the criteria for well interference and 50% depletion of groundwater in storage associated with the proposed project will not be met. No significant impacts to groundwater are anticipated associated with the project.

3.6 Mitigation Measures and Design Considerations

Based on the lack of significant impacts to groundwater associated with the proposed project, no groundwater mitigation measures are proposed for the project.

3.7 Conclusions

Based upon the analyses performed, well interference is not anticipated to be a significant impact for the Tule Wind Farm construction project. During the pumping test, a maximum of 3.7 feet of drawdown was observed in the nearest observation well 36 feet away from the pumping well. No observed drawdown was identified in wells located within one third and one half mile of the pumping well.

The potential for depletion of groundwater in storage within the McCain Valley is not anticipated. Results of the groundwater demand during a drought period indicate that eight times the anticipated groundwater pumping would be required to drawn groundwater to the 50% depletion level.

4.0 SUMMARY OF PROJECT IMPACTS AND MITIGATION

Based on the results of pumping tests and analysis of the data, there is sufficient groundwater to meet the project demands. Review of cumulative analyses performed within a ½ mile radial area of McCain Valley about the aquifer pumping test well indicates based on the available groundwater storage within McCain Valley, it is possible to increase pumping at the Rough Acres Ranch aquifer test well significantly without well interference or significant groundwater depletion.

Although there are no requirements for analysis of groundwater use on tribal lands, the aquifer pumping test and analyses indicate that there is sufficient storage for use of groundwater within Thing Valley and no significant impacts to groundwater storage are anticipated. However, the pumping test data and the noted boundary condition identified during the test after 1700 minutes suggests that to support the project water needs, it may be necessary to pump at a lesser rate or lesser frequency at the aquifer pumping test well, and supplement the water from this well with water from another well within Thing Valley such as the observation well. In addition, because the well has been inoperable for some time, it is recommended that this well and pump be inspected and rehabilitated as necessary to ensure that the well operates optimally for the duration of the construction project.

5.0 CLOSURE

This report was prepared in general accordance with acceptable professional geotechnical and hydrogeologic principles and practices. This report makes no other warranties, either expressed or implied as to the professional advice or information included herein. Although the groundwater investigation performed included constant rate pumping over a 72-hour period, it is not possible to fully anticipate an aquifer's behavior over the proposed 9-month construction period. It is understood that the project intends to obtain will serve letters to purchase water from off-site vendors if it is needed. The use of off-site water suppliers is recommended in the event that groundwater supplies are not fully supportive of the project. Our firm should be notified of any pertinent change in the project, or if conditions are found to differ from those described herein, because this may require a reevaluation of the conclusions. This report has not been prepared for use by parties or projects other than those named or described herein. It may not contain sufficient information for other parties or purposes.

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7.0 LIST OF PREPARERS AND PERSONS AND ORGANIZATIONS CONTACTED

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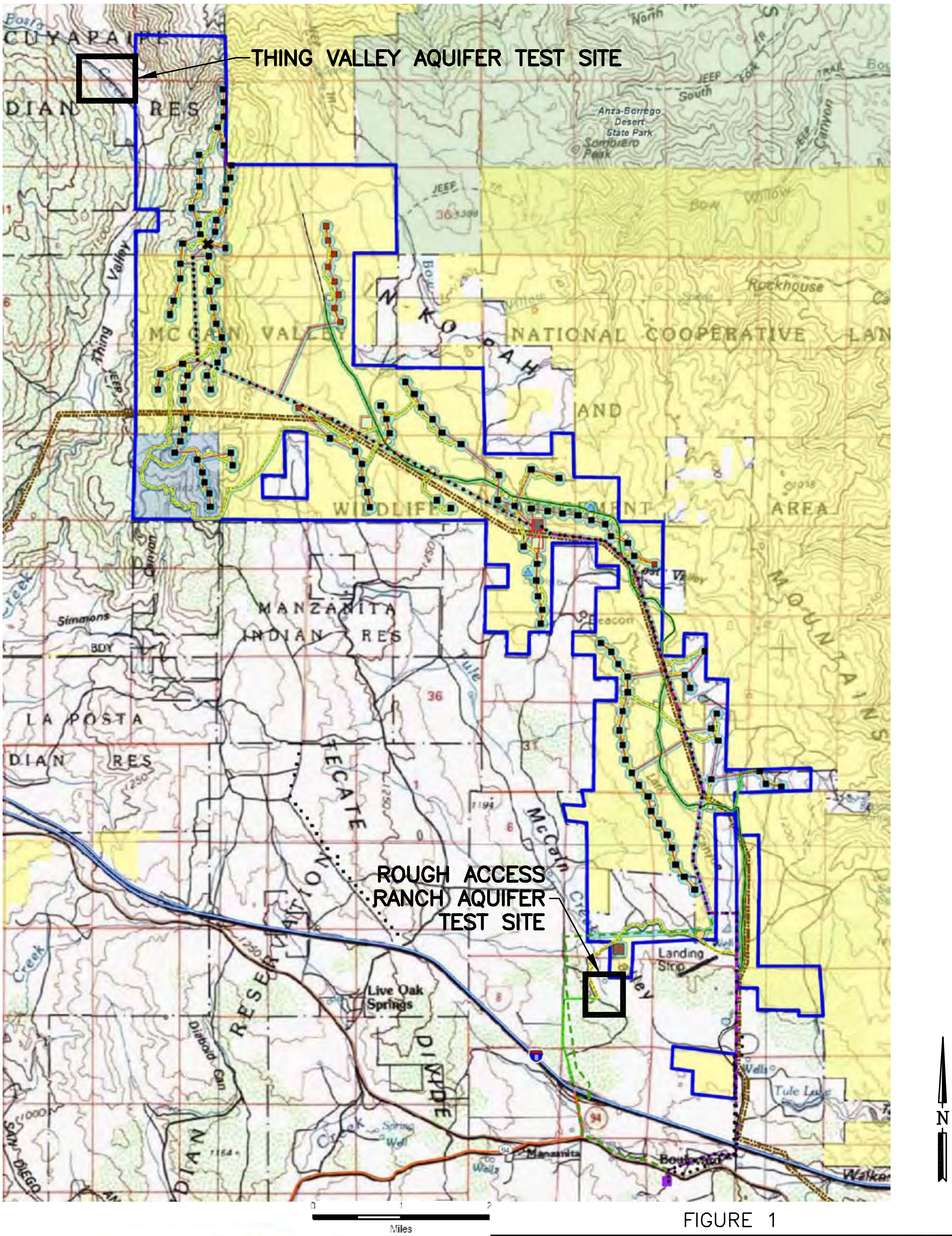
Mr. Robert Walker
Rough Acres Ranch Manager

Desi Vela
Field Technician, Ewiiaapaayp Band of Kumeyaay Indian

FIGURES



Legend

- Proposed Turbine
- Alternate Turbine
- Proposed Met Tower
- Proposed Junction Box
- Proposed Overhead Structure
- Preferred 138-kV Transmission Line
- Alternate 138-kV Transmission Line
- Proposed Underground 34.5-kV Line
- Proposed Overhead 34.5-kV Line
- Existing Road - Improvements Needed
- Proposed New Access Road
- Freeway
- Highway
- Major Road
- McCain Valley Road
- Proposed 10-acre Parking Area
- Proposed 2-acre Lay Down Area
- Proposed Batch Plant
- Preferred O&M and Substation
- Alternate O&M and Substation
- Existing Substation
- Proposed Sunrise Powerlink Transmission ROW
- Development Corridor
- Project Area
- CA State Lands Commission
- BLM Land

REFERENCE:
IBERDROLA RENEWABLES, 2009

FIGURE 1

PROJECT LOCATION MAP

TULE WIND PROJECT
SAN DIEGO COUNTY, CA

Geo-Logic
ASSOCIATES

DRAWN BY: VL	DATE: NOVEMBER 2010	JOB NO. 2010-005

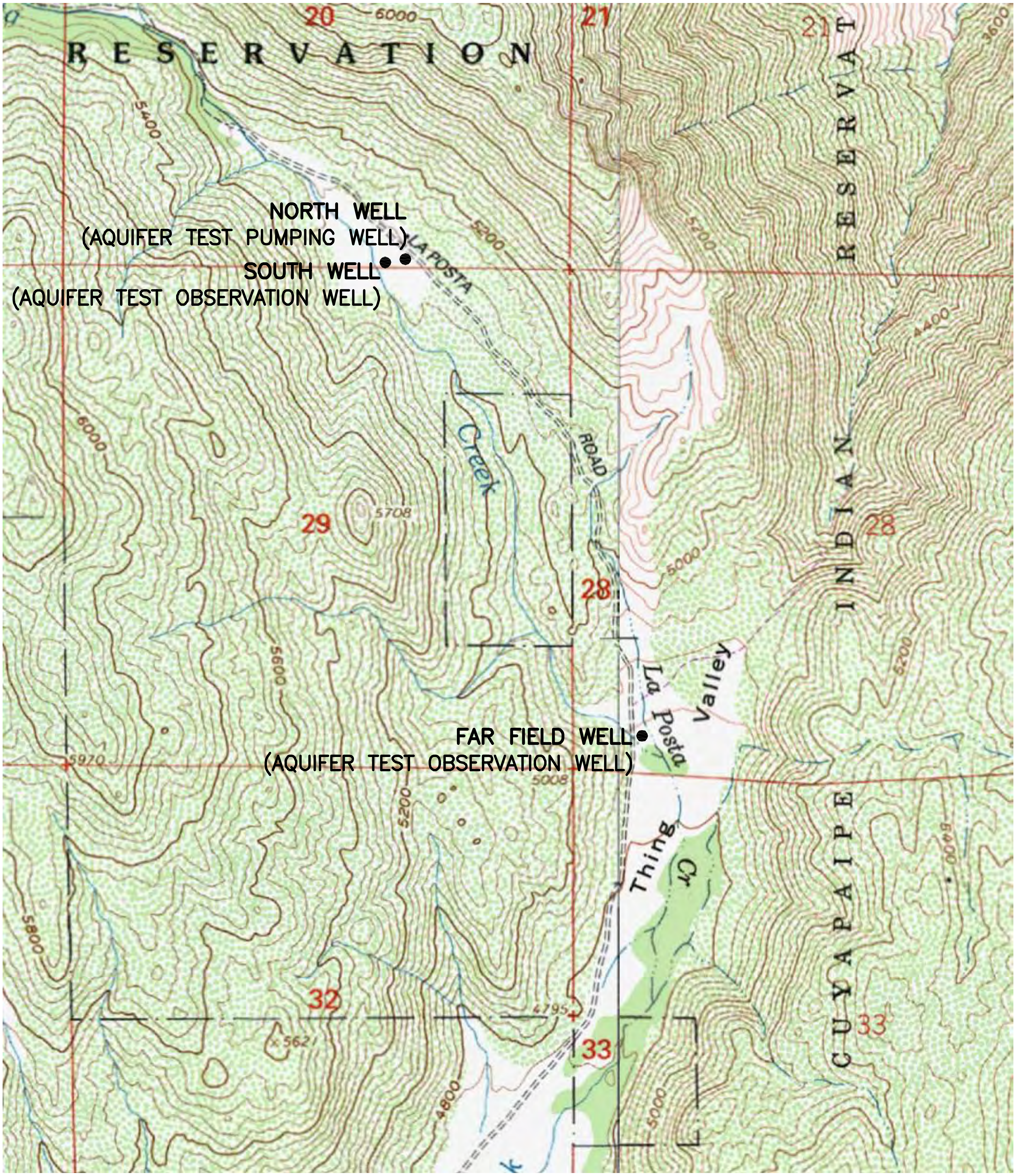


FIGURE 2A

GRAPHIC SCALE

750 0 375 750 1500

(in feet)

1 inch = 1500 ft.

N

REFERENCE: 7.5 MINUTE SERIES (TOPOGRAPHIC) MOUNT LAGUNA (1997) AND SOMBRERO PEAK (1975) CALIFORNIA QUADRANGLES

WELL LOCATION MAP THING VALLEY AQUIFER TEST SITE		
TULE WIND PROJECT SAN DIEGO COUNTY, CA		
Geo-Logic ASSOCIATES		
DRAWN BY: VL	DATE: NOVEMBER 2010	JOB NO. 2010-005

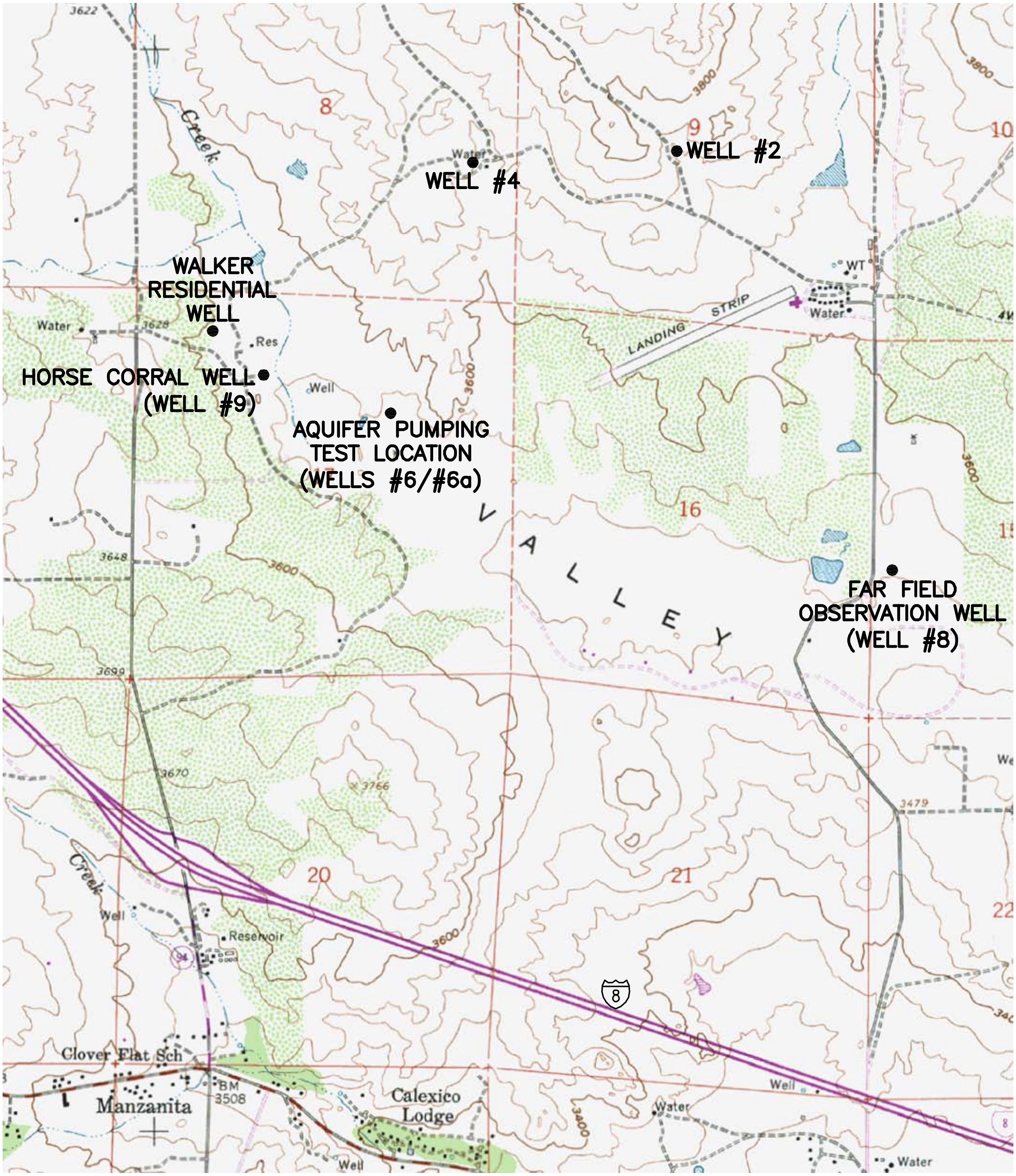


FIGURE 2B

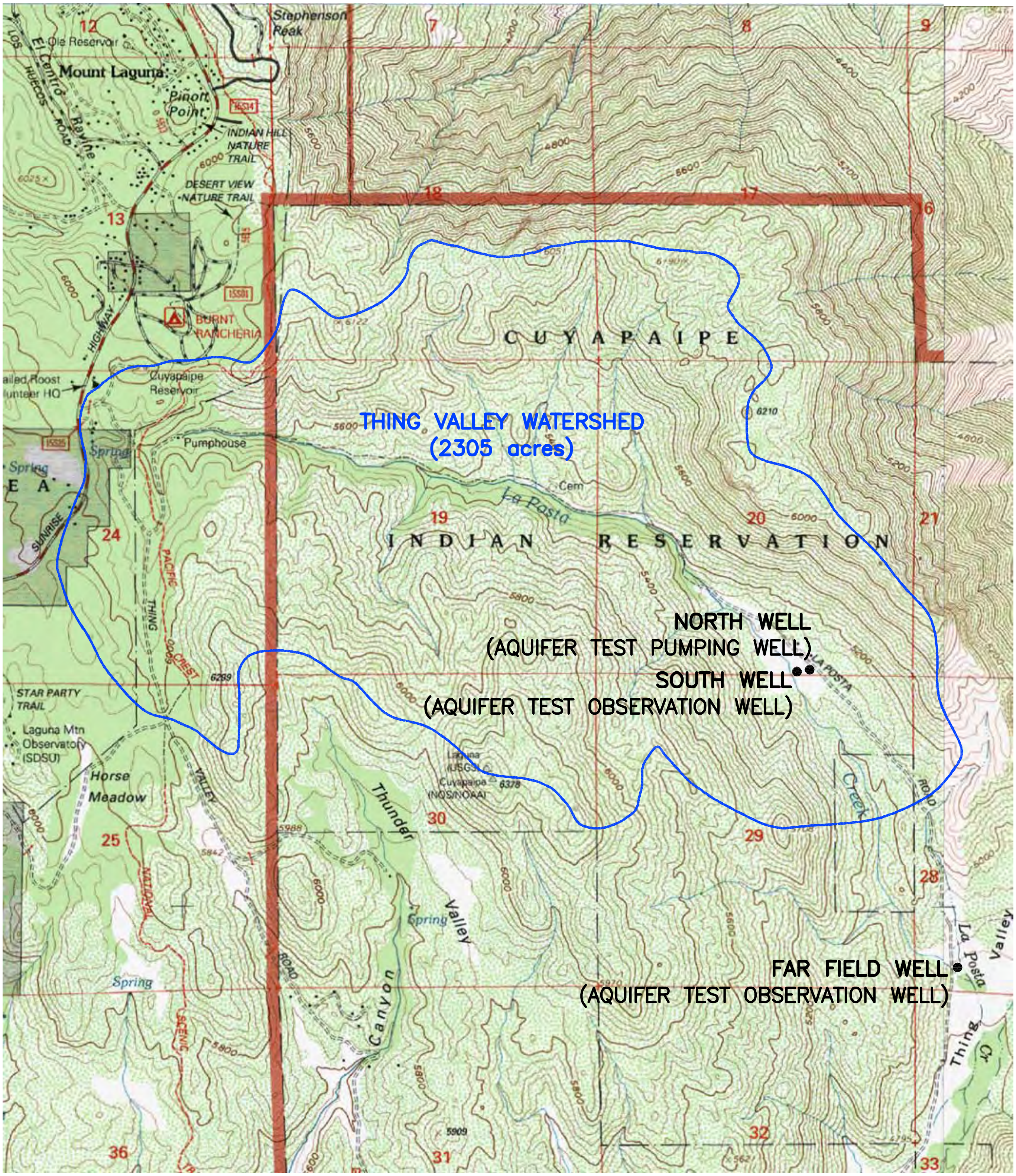
WELL LOCATION MAP
ROUGH ACRES RANCH AQUIFER TEST SITE

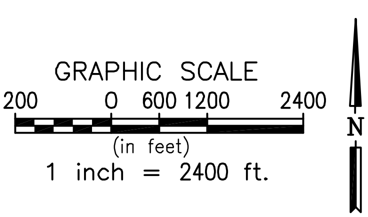
TULE WIND PROJECT
SAN DIEGO COUNTY, CA

Geo-Logic ASSOCIATES

REFERENCE: 7.5 MINUTE SERIES (TOPOGRAPHIC) LIVE OAK SPRINGS (1975) CALIFORNIA QUADRANGLE

DRAWN BY: VL	DATE: NOVEMBER 2010	JOB NO. 2010-005





REFERENCE: 7.5 MINUTE SERIES (TOPOGRAPHIC) MOUNT LAGUNA (1997) AND SOMBRERO PEAK (1975) CALIFORNIA QUADRANGLES

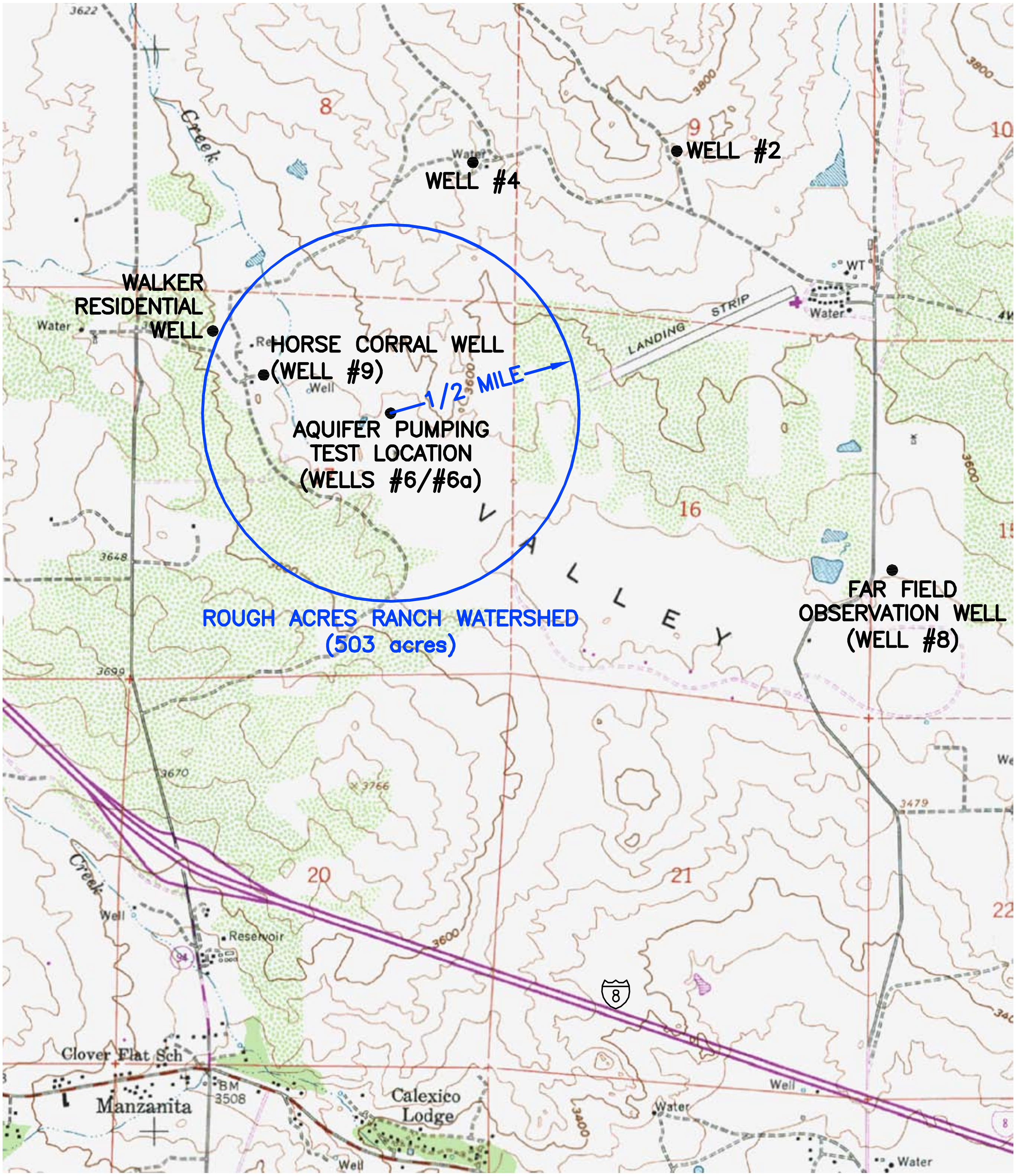
FIGURE 3A

WATERSHED MAP
THING VALLEY AQUIFER TEST SITE

TULE WIND PROJECT
SAN DIEGO COUNTY, CA

Geo-Logic ASSOCIATES

DRAWN BY: VL	DATE: NOVEMBER 2010	JOB NO. 2010-005



GRAPHIC SCALE

1000 0 500 1000 2000

(in feet)

1 inch = 2000 ft.

N

REFERENCE: 7.5 MINUTE SERIES (TOPOGRAPHIC) LIVE OAK SPRINGS (1975) CALIFORNIA QUADRANGLE

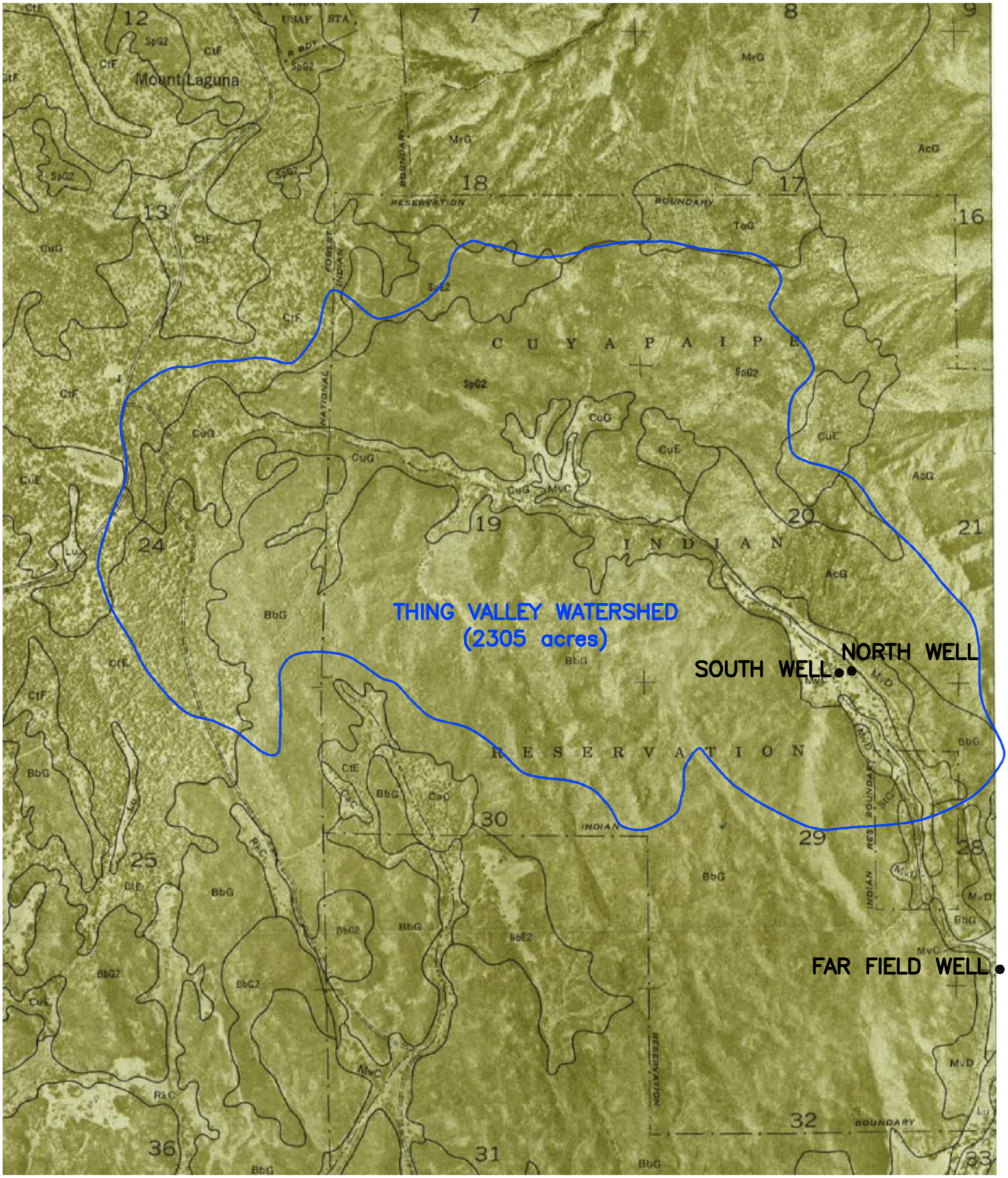
FIGURE 3B

WATERSHED MAP
ROUGH ACRES RANCH AQUIFER TEST SITE

TULE WIND PROJECT
SAN DIEGO COUNTY, CA

Geo-Logic ASSOCIATES

DRAWN BY: VL	DATE: NOVEMBER 2010	JOB NO. 2010-005



GRAPHIC SCALE
1200 0 600 1200 2400
(in feet)
1 inch = 2400 ft.

N

REFERENCE: SOIL SURVEY, SAN DIEGO AREA SOIL CONSERVATION SERVICE, 1973 (SEE TEXT SECTION 2.5 FOR EXPLANATION)

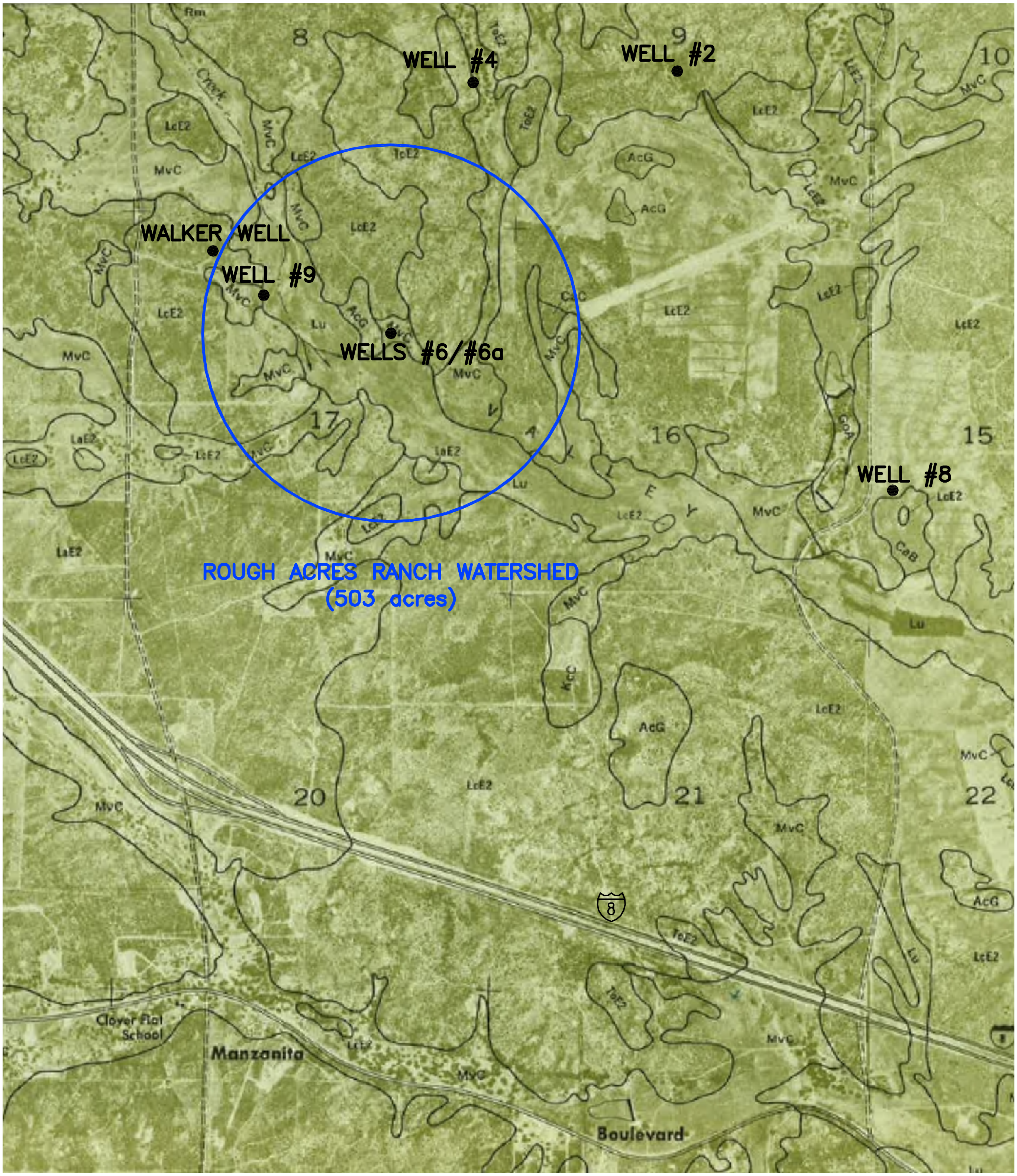
FIGURE 4A

SOILS MAP
THING VALLEY AQUIFER TEST SITE

TULE WIND PROJECT
SAN DIEGO COUNTY, CA

Geo-Logic
ASSOCIATES

DRAWN BY: VL	DATE: NOVEMBER 2010	JOB NO. 2010-005



GRAPHIC SCALE

1000 0 500 1000 2000

(in feet)

1 inch = 2000 ft.

N

FIGURE 4B

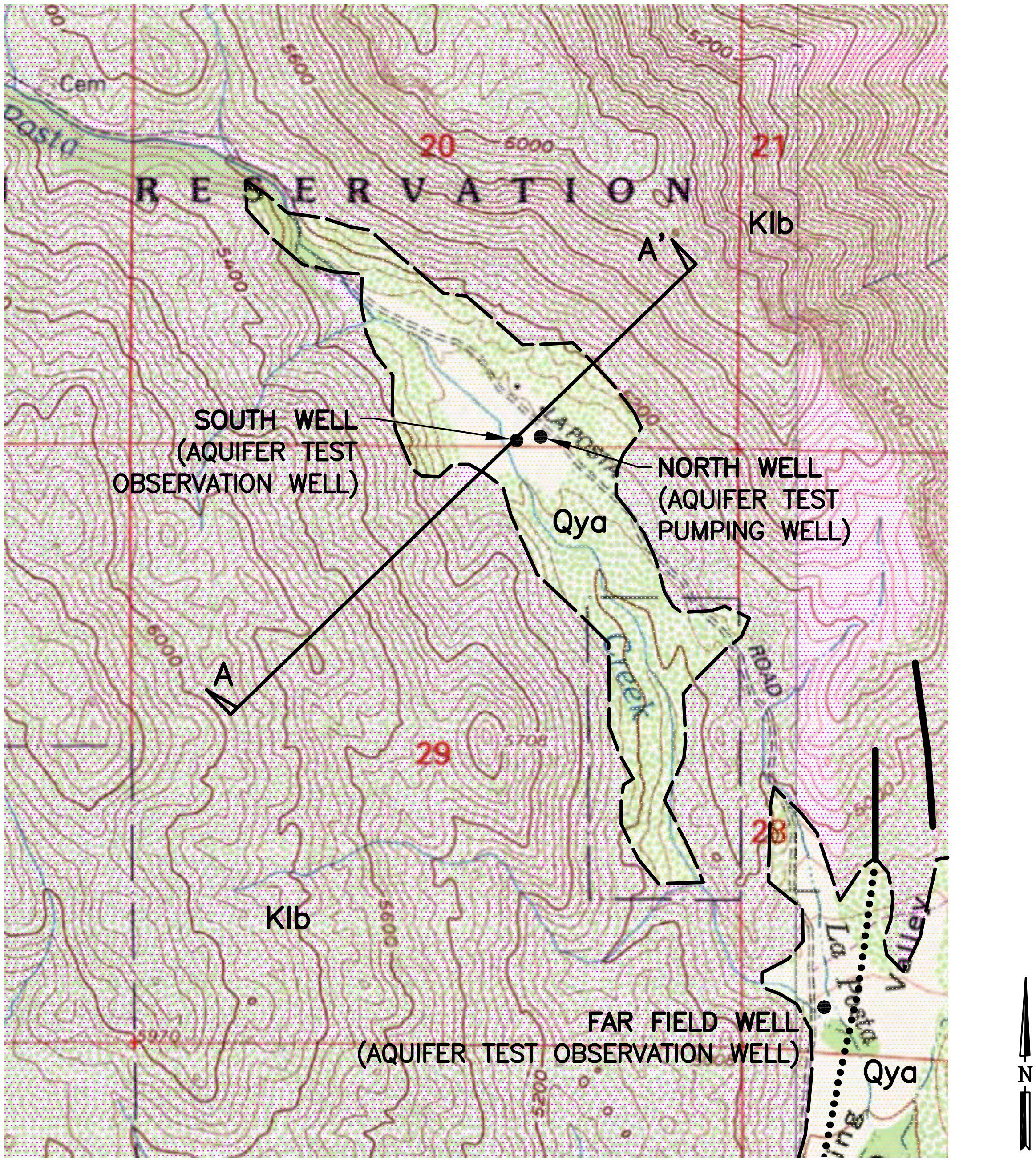
SOILS MAP
ROUGH ACRES RANCH AQUIFER TEST SITE

TULE WIND PROJECT
SAN DIEGO COUNTY, CA

Geo-Logic
ASSOCIATES

DRAWN BY: VL	DATE: NOVEMBER 2010	JOB NO. 2010-005

REFERENCE: SOIL SURVEY, SAN DIEGO AREA SOIL CONSERVATION SERVICE, 1973 (SEE TEXT SECTION 2.5 FOR EXPLANATION)



EXPLANATION:

Qya	YOUNG ALLUVIUM (HOLOCENE)
Klb	TONALITE OF LAS BANCAS (EARLY CRETACEOUS)
— — — —	APPROXIMATE GEOLOGIC CONTACT
———••••	FAULT, DOTTED WHERE CONCEALED
A A'	CROSS–SECTION LOCATION

GRAPHIC SCALE

750 0 375 750 1500

(in feet)

1 inch = 1500 ft.

REFERENCE: PRELIMINARY GEOLOGIC MAP OF EL CAJON 30' x 60' QUADRANGLE, SOUTHERN CALIFORNIA, V. R. TODD, 2004

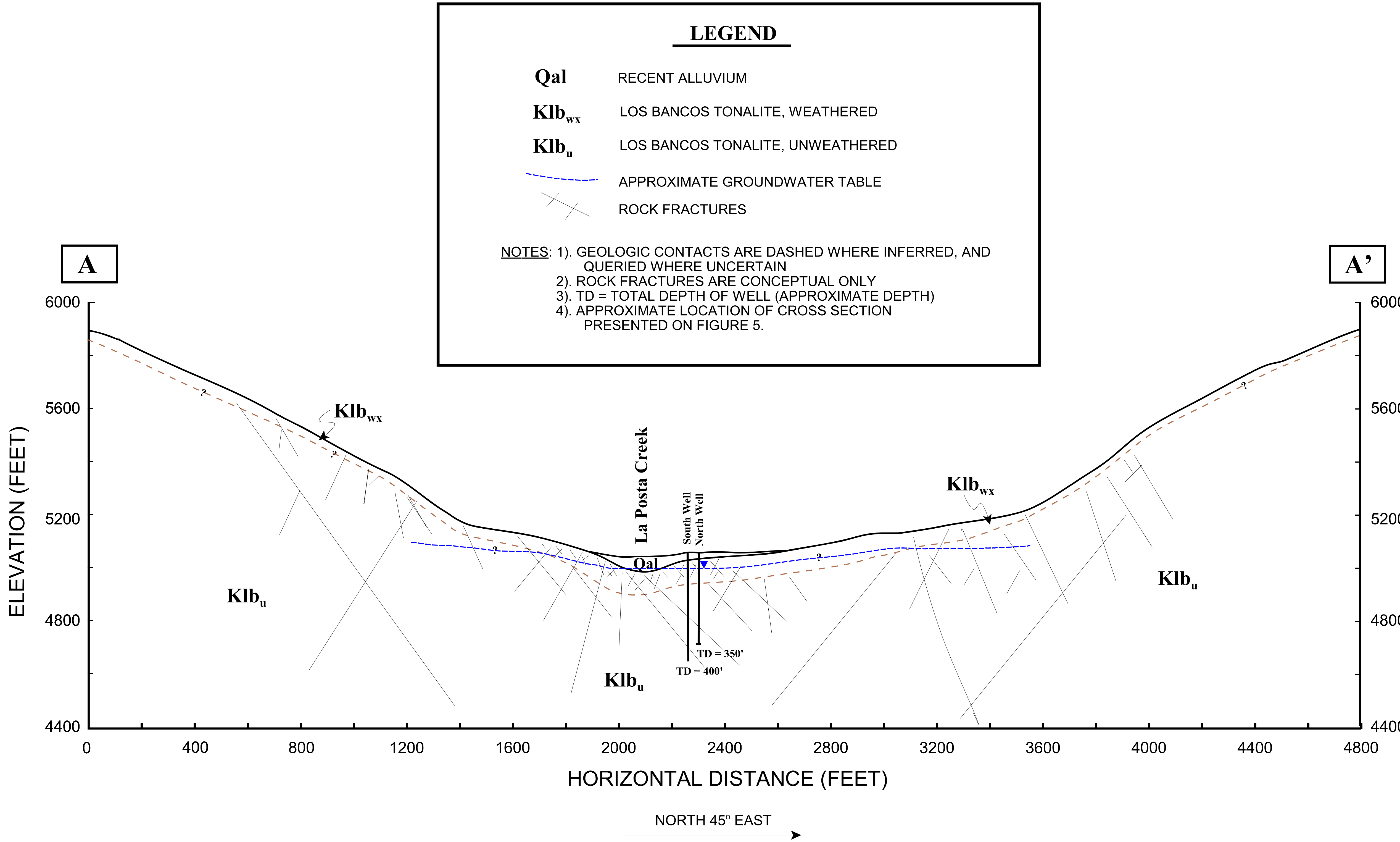
FIGURE 5

GEOLOGIC MAP
THING VALLEY AQUIFER TEST SITE

TULE WIND PROJECT
SAN DIEGO COUNTY, CA

Geo-Logic ASSOCIATES

DRAWN BY: VL	DATE: NOVEMBER 2010	JOB NO. 2010–005

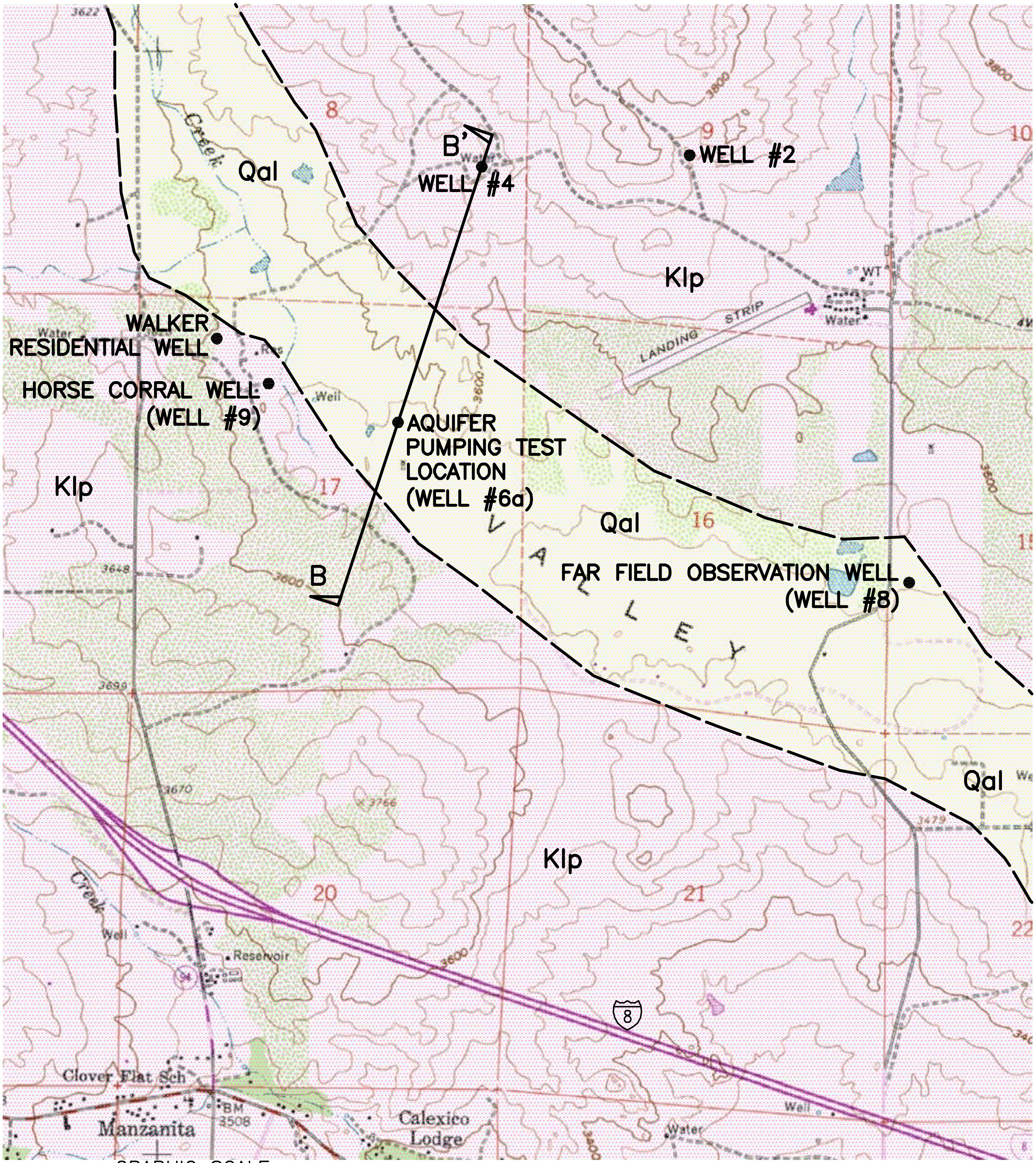


HORIZONTAL SCALE: 1 INCH = 400 FEET
VERTICAL SCALE: 1 INCH = 400 FEET
(11 X 17 INCH FORMAT ONLY)

FIGURE 6

CONCEPTUAL HYDROGEOLOGIC CROSS SECTION		
THING VALLEY STUDY AREA SAN DIEGO COUNTY, CALIFORNIA		
Geo-Logic ASSOCIATES		
Draft JGF	Date OCT 2010	Project No. 2010-0005

References: USGS, 1997, 7.5' Mount Laguna and USGS, 1975, 7.5' Sombrero Peak, CA Quadrangles.



GRAPHIC SCALE

1000 0 500 1000 2000

(in feet)

1 inch = 2000 ft.

N

REFERENCE: PRELIMINARY GEOLOGIC MAP OF EL CAJON 30' x 60' QUADRANGLE, SOUTHERN CALIFORNIA, V. R. TODD, 2004

EXPLANATION:

Qal	ALLUVIUM
Klp	TONALITE OF LA POSTA (EARLY AND LATE CRETACEOUS)
— — —	APPROXIMATE GEOLOGIC CONTACT
B B'	CROSS–SECTION LOCATION

FIGURE 7

GEOLOGIC MAP
ROUGH ACRES RANCH AQUIFER TEST SITE

TULE WIND PROJECT
SAN DIEGO COUNTY, CA

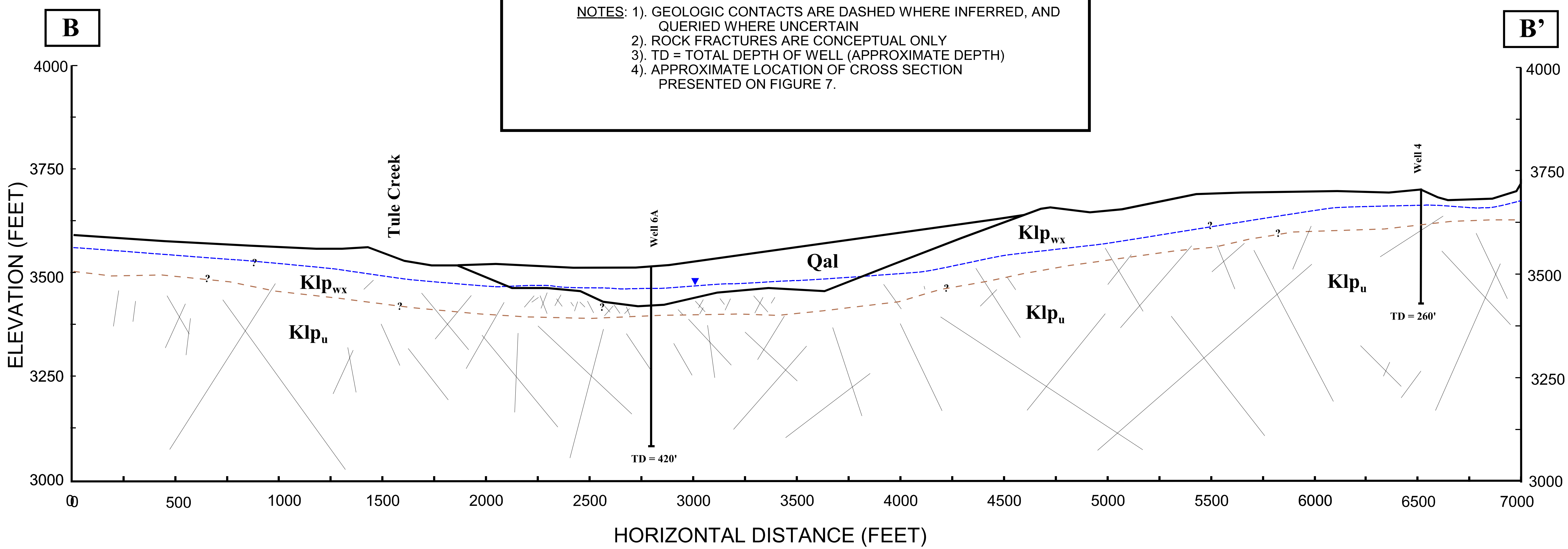
Geo-Logic ASSOCIATES

DRAWN BY: VL	DATE: NOVEMBER 2010	JOB NO. 2010–005

LEGEND

Qal	RECENT ALLUVIUM
Klp_{wx}	LA POSTA TONALITE, WEATHERED
Klb_{u}	LA POSTA TONALITE, UNWEATHERED
(blue dashed line)	APPROXIMATE GROUNDWATER TABLE
(crossing lines)	ROCK FRACTURES (SCHEMATIC ONLY)

NOTES: 1). GEOLOGIC CONTACTS ARE DASHED WHERE INFERRED, AND QUERIED WHERE UNCERTAIN
2). ROCK FRACTURES ARE CONCEPTUAL ONLY
3). TD = TOTAL DEPTH OF WELL (APPROXIMATE DEPTH)
4). APPROXIMATE LOCATION OF CROSS SECTION PRESENTED ON FIGURE 7.



NORTH 18° EAST →

HORIZONTAL SCALE: 1 INCH = 500 FEET
VERTICAL SCALE: 1 INCH = 250 FEET
2x VERTICAL EXAGGERATION
(11 X 17 INCH FORMAT ONLY)

References: USGS, 1975, 7.5' Live Oak Springs, CA Quadrangle.

FIGURE 8

CONCEPTUAL HYDROGEOLOGIC CROSS SECTION

ROUGH ACRES STUDY AREA
SAN DIEGO COUNTY, CALIFORNIA

Geo-Logic ASSOCIATES

Draft	Date	Project No.
JGF	OCT 2010	2010-0005

APPENDIX A

OBSERVATIONS AND ANALYSIS OF AQUIFER CHARACERISTICS

EWIIAAPAAYP RESERVATION

THING VALLEY, EAST SAN DIEGO COUNTY, CALIFORNIA

Geo-Logic
ASSOCIATES
Geologists, Hydrogeologists and Engineers

Date: November 8, 2010
Project No.: 2010-0005

To: John Hower, CEG
Sarah Battelle, CHG

From: Mark Vincent, CHG

Regarding: **Observations and Analyses of Aquifer Characteristics**
Thing Valley, San Diego County, California

INTRODUCTION

This memo presents a summary of observations and analyses made following a stepped and a constant rate aquifer pumping and recovery test in wells located in Thing Valley located approximately 10 miles north of I-8 off La Posta Truck Trail/Thing Valley Road in the Ewiiaapaayp Reservation, in eastern San Diego County, California. The tests were performed to determine whether sufficient volumes of water are available for the Tule Wind Farm construction projects. Analyses performed included calculation of transmissivity, hydraulic conductivity, and storativity for a pumping well and observation wells.

WELL AND AQUIFER CONDITIONS

A well labeled as South Well was used as the pumping well for this test. Another well labeled as North Well is located 61.5 feet to the west of the pumping well and was monitored and analyzed as an observation well. A third well identified as Thing Valley Well is located approximately 5,517 feet south-southeast of the pumping well and was also used as an observation well (Figure 1).

Records for drilling and construction of the wells used for these pumping tests are incomplete or nonexistent. A well identified on Department of Water Resources (DWR) records as the "Cuyapaipe Community Well" (identified as Form No. 058539) is believed to be the log for South Well. No records are available for North Well or Thing Valley Well.

Although DWR records indicate that slotted well casing was installed to a depth of 122 feet, they do not indicate whether or not casing exists below that depth or if the casing was installed prior to drilling the well to a total depth of 400 feet. The North and South Wells used in this pumping test have existing electric submersible pumps installed in them. Based on the production rates achieved during the tests performed, the wells are likely to be outfitted with four-inch diameter electric submersible pumps. Based on the depth and pressure head on the transducers installed in the wells for the test, it was assumed that all of the boreholes are 400 feet deep and are 10-inches in diameter. It was further assumed that the wells were constructed with 6-inch diameter well casing and that they are perforated or screened over the entire saturated thickness. Details of well construction could not be verified in the field because of the presence of pumps, discharge pipes, electrical wires, and surface sanitary seals.

The area immediately around North Well and South Well is underlain by alluvium comprised of poorly sorted sand, gravel, and silt derived from the crystalline basement rock exposed on the adjacent canyon sidewalls. The crystalline basement rocks are classified as tonalite and yield groundwater from fractures. The well log reportedly recorded for South Well indicates that there are about 12 to 15 feet of alluvium overlying the tonalite. An alternative interpretation of the log is that some of the materials described in the log to a depth of 50 feet could also be coarse-grained alluvium locally derived from the surrounding tonalite. Groundwater was measured at a depth of 54.81 feet below the top of sanitary seal on North Well (approximately 8-inches above ground surface) and was measured at a depth of 49.34 feet below the sanitary seal in South Well (also about 8-inches above ground surface). Groundwater was measure at a depth of 77.62 feet below the top of the conductor casing on Thing Valley Well (the conductor casing extends approximately 6-inches above ground surface).

TEST METHODS

Observations of groundwater elevation were recorded in a pumping well and two observation wells in Thing Valley. Data was collected using pressure transducers connected to data loggers. Barometric pressure changes were recorded during the test and corrections were made to the pressure head data collected during the tests.

A stepped aquifer pumping test was performed using North Well to determine the optimum pumping rate for a longer duration test. The pressure transducers were deployed and began recording data on August 12, 2010 to perform the stepped pumping test. The stepped pumping test was performed at pumping rates of 72 gallons per minute (gpm), 88 gpm, and 90 gpm. The pump could not be throttled down below 72 gpm without water exiting a by-pass / check valve and had a maximum yield of 90 gpm. A semi-logarithmic plot of elapsed time versus drawdown for the stepped pumping test is shown on Figure 2.

The constant rate pumping and recovery test was performed from August 16 through 19, 2010. The pump was powered-down on August 19, 2010 and allowed to recover until August 23, 2010 when the pressure transducers were removed from the wells. South Well was initially pumped at an average rate of 88 gpm and was corrected to 80 gpm during a period from about 1 to 2 hours into the test. Recovery tests were performed by turning off the pumps and recording the increasing head levels over time.

DATA ANALYSIS

Changes in groundwater level data recorded during this test were corrected for barometric pressure changes and used to generate a file containing tabulated time and changes in pressure head. The data was used to generate time-drawdown graphs for the pumping and observation wells and imported into computer software used to calculate the transmissivity and storativity of the fractured tonalite.

The stepped pump test analysis consists of plotting the drawdown versus time for each pumping rate on a time versus drawdown plot with time plotted on a logarithmic scale. Forward projections of each segment representing a different pumping rate can be used to predict the likely drawdown for the pumping well during for the selected duration of the test. A pumping rate of 80 gpm was selected as the target pumping rate because it would allow for ample drawdown without the well running dry during the test.

The method of Schafer (1978) was employed to determine how much of the data set for North Well was impacted by casing storage effects. The method is a simplification of the method first developed by Papadopulos and Cooper (1967) but does not require prior knowledge of the transmissivity or well efficiency. The point at which casing storage effects are overcome was calculated to occur approximately 12 to 14 minutes into the test based on the assumptions about well construction practices, pumping rates, and drawdown. Very early pumping data was ignored in the analyses described below due to casing storage effects and the non-uniform drawdown curve caused by the change in the pumping rate from 88 to 80 gpm.

Time versus drawdown plots were prepared for the pumping and observation wells for the pumping and recovery portions of the test. The plots are shown with the time axis plotted on a logarithmic scale and drawdown on a linear scale.

Figure 3 shows the time-drawdown plot for North Well during pumping. The first 12 to 14 minutes of the test show the effects of attempting to establish a constant pumping rate and casing storage effects. A slight recovery in the drawdown is noted from around 14 minutes to approximately 33 minutes due to a reduction in the pumping rate from 88 to 80 gpm. The North Well drawdown plots as a straight line on the time-drawdown chart representing constant aquifer properties during that portion of the drawdown cone development. A sudden change in the drawdown curve starts at approximately 1,700 minutes and changes again at approximately 3,000 minutes. The steepening of the time drawdown curve noted at approximately 1,700 and 3,000 minutes likely indicates a negative boundary effect.

A residual drawdown plot for the North Well is shown on Figure 4. The plot shows the change in drawdown versus the ratio of the time since the pump test started divided by the time since the recovery portion of the test started (t/t`). An inflection point is noted at approximately t/t`=100 possibly due to some type of boundary effect. The residual drawdown at a t/t` ratio of 1 extends through the origin and there is no discernable change in storage noted in the pumping well over the course of the pumping and recovery portions of the aquifer stress test.

A time-drawdown plot of South Well located 61.5 feet away from the pumping well shows a sharp decrease in drawdown from approximately 51 minutes to approximately 65 minutes which is considered to be the result of the decrease in pumping rate from 88 to 80 gpm (Figure 5). The South Well plot shows a slight increasing slope to the semi-logarithmic plot but shows a very strong inflection point at approximately 1,700 minutes into the test. This is interpreted to be the result of a negative boundary effect similar to that observed on the time-drawdown plot from North Well (compare Figures 3 and 5).

The South Well recovery portion of the test is plotted as the residual drawdown versus t/t` shows a concave upwards curvature to the semi-logarithmic plot (Figure 6) indicative of changing aquifer conditions from a t/t` ratio of about 10 to 200 into the recovery test period. The line segment from a t/t` ratio of 200 the end of the test is a straight line plot indicative of constant aquifer conditions. The residual drawdown value measured for a t/t' ratio of 1 is about -3.5 feet. Though this value is not within about one half of a foot as would be expected from a successful test, it may not be especially significant for an observation well when the pumping well shows no changes in storage effect.

The Thing Valley Well located approximately 5,517 feet south of the pumping well was monitored for changes in head. A possible cumulative drawdown of approximately 0.25 feet was observed from approximately 400 minutes until the end of the test (Figure 7). The recovery portion of the well is shown on Figure 8 and is shows a large sudden change in measured head near the end of the monitoring period. This is interpreted as a slippage of the transducer cable and is probably not a valid recovery curve.

Water level drawdown data were evaluated using the computer software program AquiferTest version 3.5 (Waterloo Hydrogeologic, 2002). The program performs curve matching of the time drawdown data to calculate transmissivity, hydraulic conductivity, and storativity using different methods. The methods employed included Cooper-Jacob (1946), Moench (1993), Neuman (1975), and Theis (1935).

DISCUSSION

As shown on Table 1, the calculated hydraulic conductivity values for all of the analytical methods employed ranged from a low of 0.285 feet/day for data collected from North Well using Neuman's method for the data collected from the end of the data set to a high of 2.39 feet/day for the early time recovery phase of South Well using the Theis Recovery method. An average conductivity of 1.122 feet/day was calculated from all methods from both South Well and North Well. The Storativity values range from a low of 3.33E-09 for North Well middle to late time data and a high of 4.19E+01 for a match to the very late time data recorded in South Well.

All of the analytical results show a higher transmissivity and hydraulic conductivity value for matches to the early time drawdown data and show lower values for matches to late time drawdown data. This is most likely the result of a higher degree of fracturing in the rock around the wells. North Well and South Well are located in a portion of Thing Valley which is entirely covered in up to 50 feet of alluvium (Figure 9). Inspection of aerial photographs from Google Earth show the local canyons and drainages are controlled by large scale joint sets. Areas of maximum fracturing will have higher transmissivity and hydraulic conductivity associated with them and also will be more prone to erosion.

During the pumping test, a cone of depression developed radially around the well until the cone intercepted lower transmissivity/less fractured rock at the canyon side walls (the negative boundary effect observed approximately 1,700 minutes into the test). After that time, the majority of the water entering the wells is coming from directly up and down canyon. A later stage negative boundary effect near the 3,000 minute mark observed in North Well may be a secondary negative boundary effect associated with translation of the cone of depression outside the portions of the canyon overlain by alluvium. Although the alluvium was not thought to be saturated during the test it is likely to act like a sponge slowing the downgradient flow of groundwater.

Because the fractures in the bedrock appear to be of aerially limited extent, the actual volume of groundwater available may be limited with larger volumes of groundwater available within the canyon areas where fracturing may be most prevalent.

CLOSURE

This summary of observations and analyses has been prepared in general accordance with accepted professional geotechnical and hydrogeologic principles and practices. This report makes no other warranties, either expressed or implied as to the professional advice or information included in it. Our firm should be notified of any pertinent change in the project, or if conditions are found to differ from those described herein, because this may require a reevaluation of the conclusions. This report has not been prepared for use by parties or projects other than those named or described herein. It may not contain sufficient information for other parties or purposes.

Geo-**L**ogic **A**ssociates

Mark W Vincent

Mark W. Vincent, PG 5767, CEG 1873, CHg 865
Senior Geologist

Attachments: Table 1 - Aquifer Stress Test Results
Figure 1 - Well Location Plan
Figure 2 - Step Test Time Drawdown Plot
Figure 3 - North Well Time Drawdown Plot Pumping
Figure 4 - North Well Time Drawdown Plot Recovery
Figure 5 - South Well Time Drawdown Plot Pumping
Figure 6 - South Well Time Drawdown Plot Recovery
Figure 7 - Thing Valley Well Time Drawdown Pumping
Figure 8 - Thing Valley Well Time Drawdown Recovery
Figure 9 - Geologic Map
Appendix A - Analytical Results from Aquifer Test Program

REFERENCES

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Table 1
Aquifer Stress Test Results
Thing Valley

Well Designation	Condition	Distance From Pumping Well (feet)	Groundwater Depth from TOC (feet)	Groundwater Depth from Ground Surface (feet)	Assumed Aquifer Thickness (feet)	Average Pumping Rate (gpm)	Analytical Method	Transmissivity (feet^2/day)	Conductivity (feet/day)	Storativity	Comments
North Well	Pumping	1	54.81	54.14	350	81	Cooper-Jacob	488	1.390	3.33E-09	Match to mid-late data.
North Well	Pumping	1	54.81	54.14	350	81	Cooper-Jacob	176	0.502	3.05E-02	Match to late data.
North Well	Pumping	1	54.81	54.14	350	81	Moench	261	0.741	4.45E-04	Match to late data.
North Well	Pumping	1	54.81	54.14	350	81	Neuman	**99.8 Minimum**	**0.285 Minimum**	3.82E-04	Match to late data.
North Well	Pumping	1	54.81	54.14	350	81	Theis	256	0.733	3.57E-04	Match to late data.
North Well	Pumping	1	54.81	54.14	350	81	Walton	115	0.327	2.41E-02	Match to late data.
North Well	Recovery	1	54.81	54.14	350	81	Theis Recovery	669	1.910	NA	Match to early data.
North Well	Recovery	1	54.81	54.14	350	81	Theis Recovery	473	1.350	NA	Match to middle data.
North Well	Recovery	1	54.81	54.14	350	81	Theis Recovery	337	0.963	NA	Match to late data.
South Well	Pumping	61.5	49.34	48.67	350	81	Cooper-Jacob	513	1.470	8.29E+00	Match to late data.
South Well	Pumping	61.5	49.34	48.67	350	81	Cooper-Jacob	294	0.841	4.19E+01	Match to very late data.
South Well	Pumping	61.5	49.34	48.67	350	81	Moench	467	1.330	1.35E-05	Match to late data.
South Well	Pumping	61.5	49.34	48.67	350	81	Neuman	469	1.340	9.12E-04	Match to late data.
South Well	Pumping	61.5	49.34	48.67	350	81	Theis	477	1.360	2.10E-03	Match to late data.
South Well	Pumping	61.5	49.34	48.67	350	81	Walton	477	1.360	8.76E+00	Match to late data.
South Well	Recovery	61.5	49.34	48.67	350	81	Theis Recovery	**835 Maximum**	**2.39 Maximum**	NA	Match to early data.
South Well	Recovery	61.5	49.34	48.67	350	81	Theis Recovery	508	1.450	NA	Match to middle data.
South Well	Recovery	61.5	49.34	48.67	350	81	Theis Recovery	311	0.888	NA	Match to late data.
							Average Values	**393**	**1.122**	**3.88E-03**	

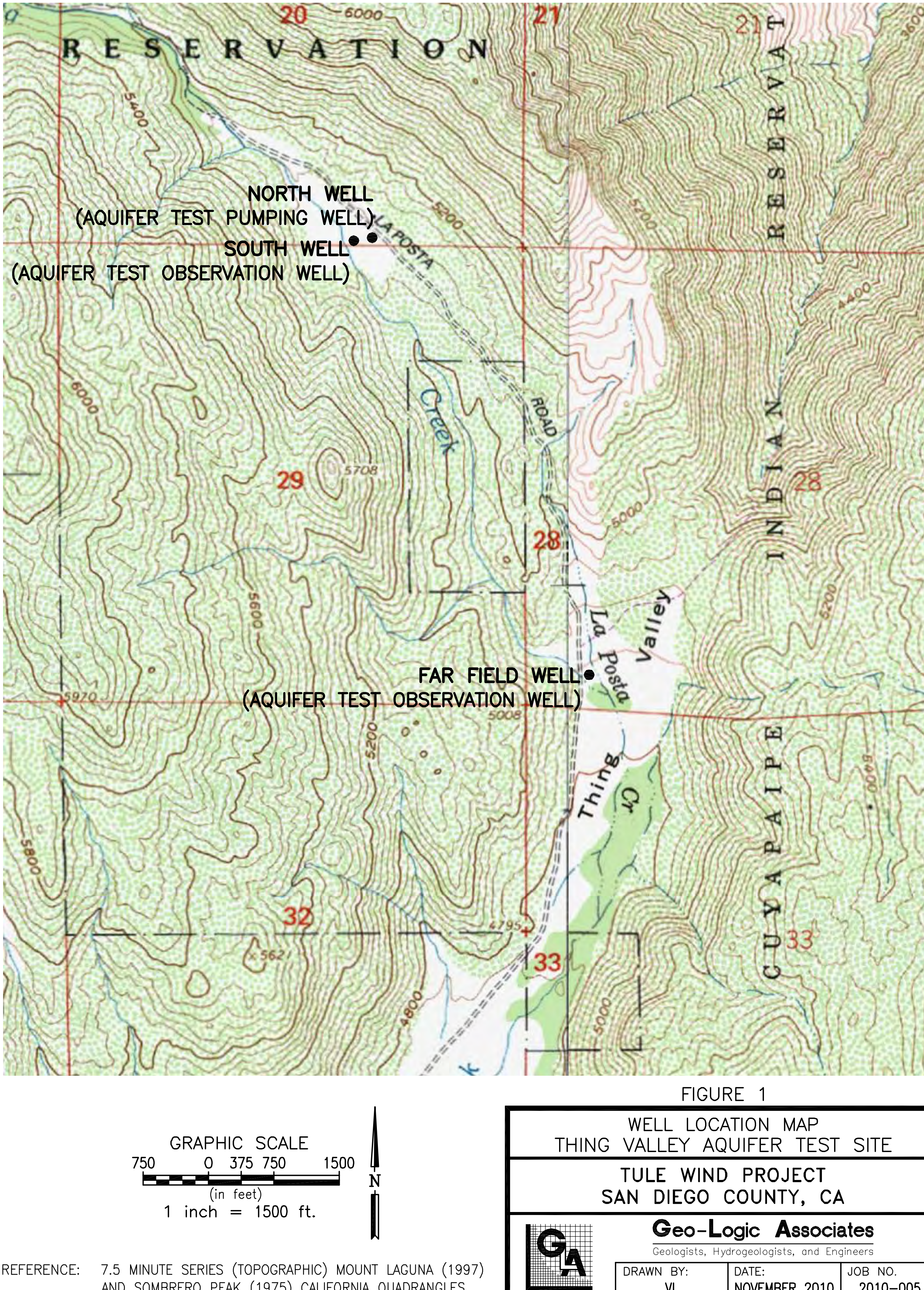


FIGURE 1

WELL LOCATION MAP
THING VALLEY AQUIFER TEST SITE

TULE WIND PROJECT
SAN DIEGO COUNTY, CA

Geo-Logic Associates
Geologists, Hydrogeologists, and Engineers

DRAWN BY:	DATE:	JOB NO.
VL	NOVEMBER 2010	2010-005

REFERENCE: 7.5 MINUTE SERIES (TOPOGRAPHIC) MOUNT LAGUNA (1997) AND SOMBRERO PEAK (1975) CALIFORNIA QUADRANGLES

Figure 2
North Well
(Pumping Well)
Time Drawdown Plot for Stepped Pump Test

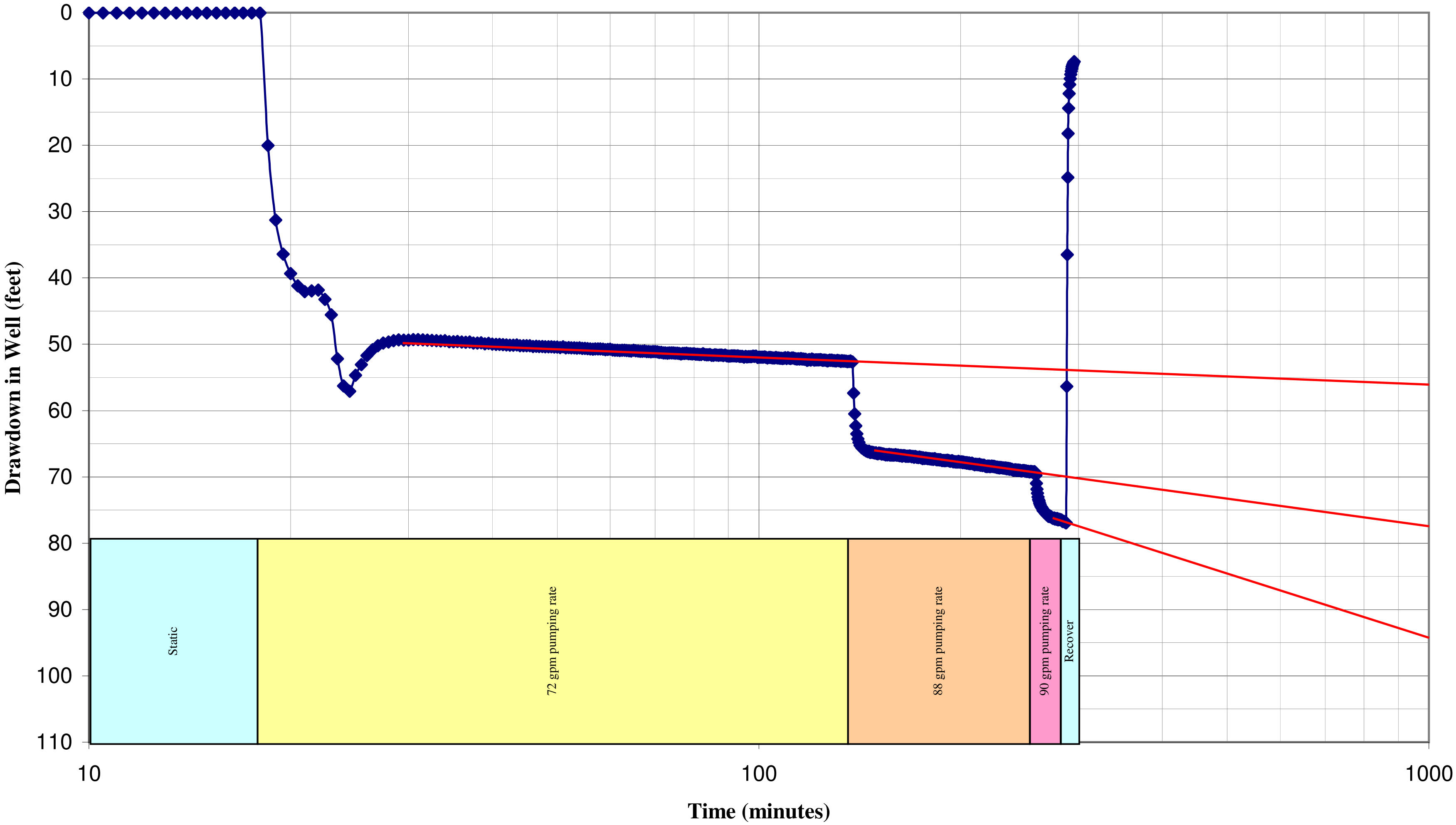


Figure 3
North Well
(Pumping Well)
Time-Drawdown Plot

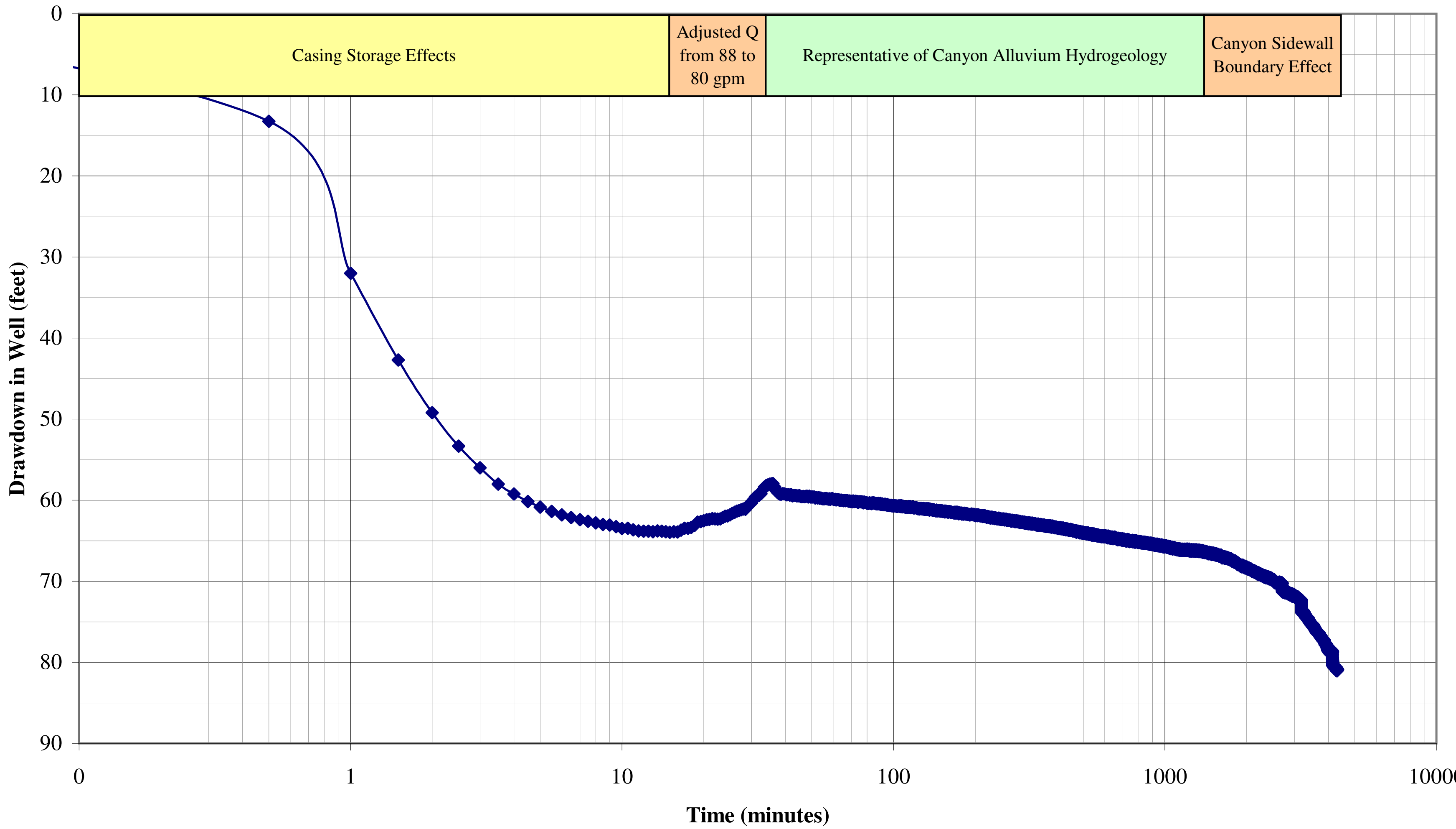


Figure 4
North Well
Recovery
Time-Drawdown Plot

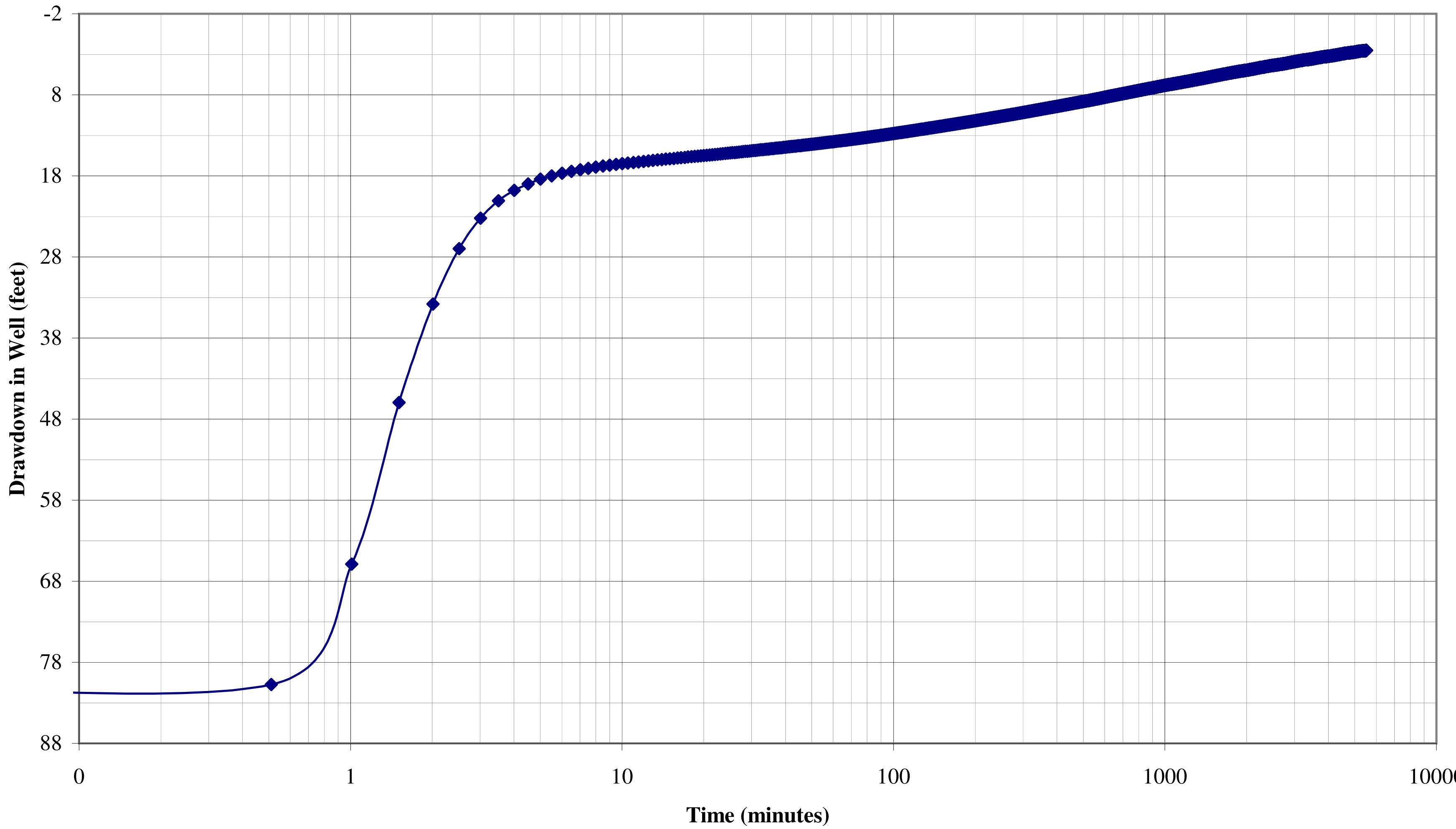


Figure 5
South Well
(Observation Well)
Time-Drawdown Plot

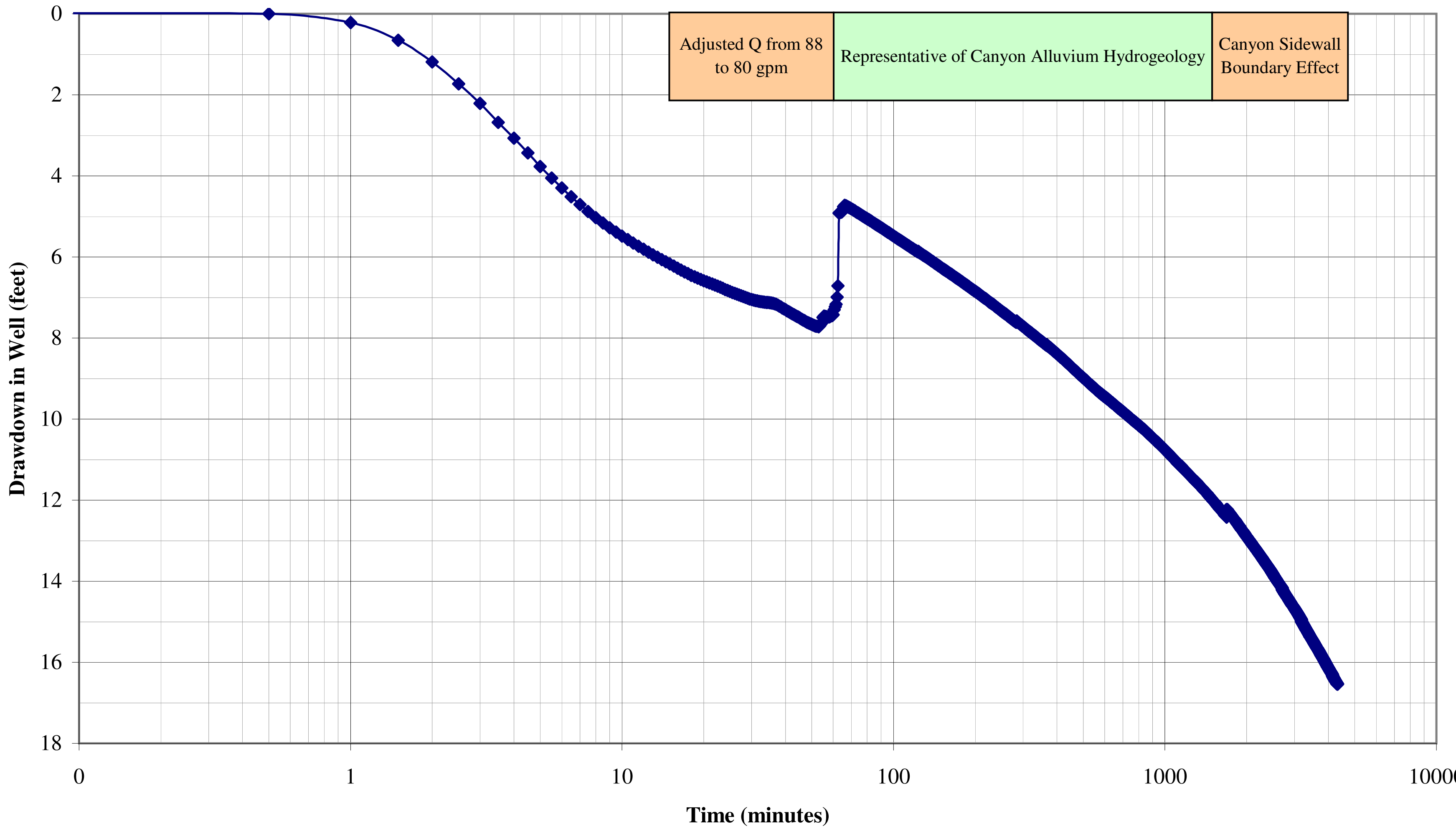


Figure 6
South Well
(Observation Well)
Recovery Time-Drawdown Plot

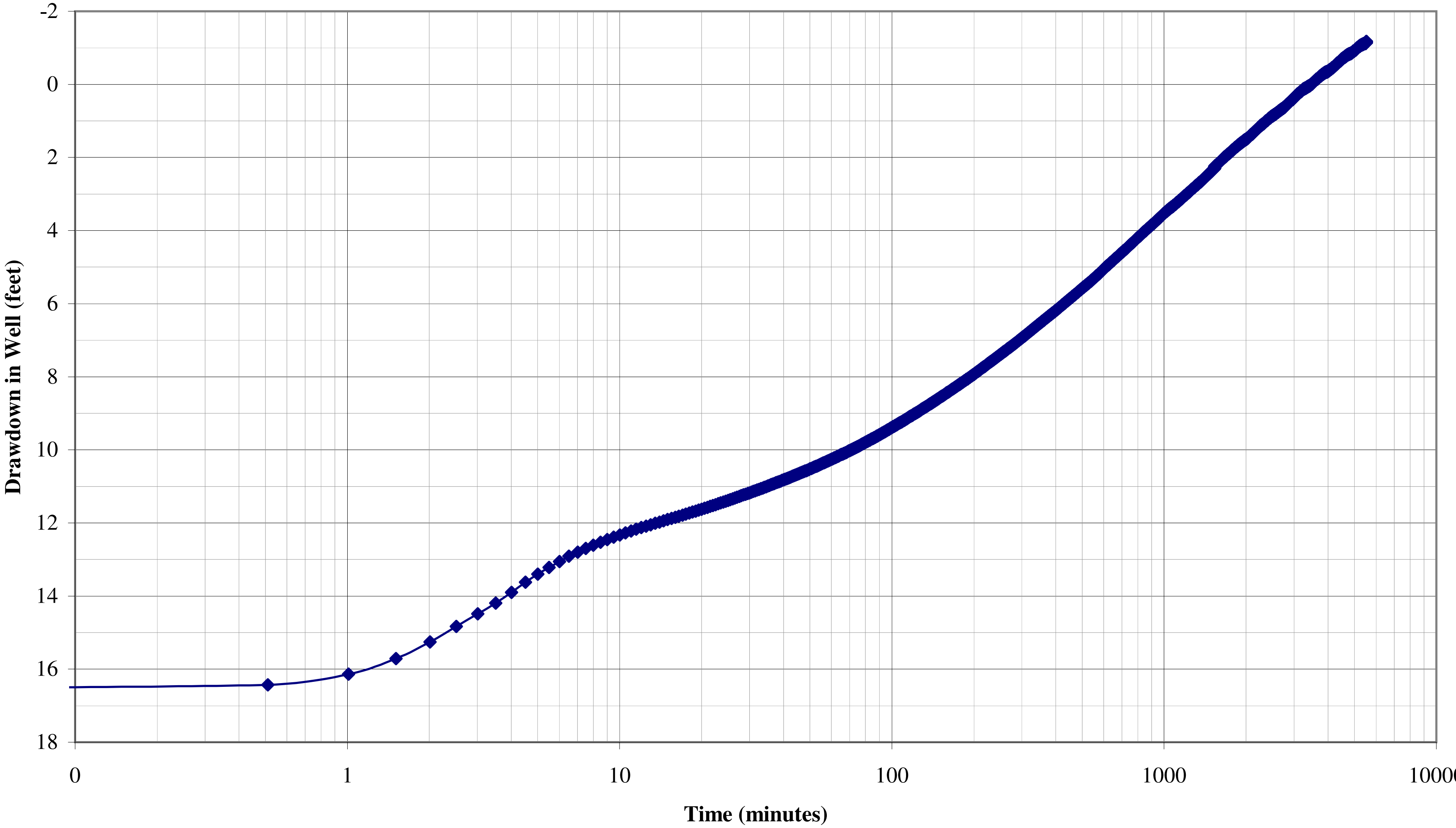


Figure 7
Thing Valley Well
(Observation Well)
Time-Drawdown Plot

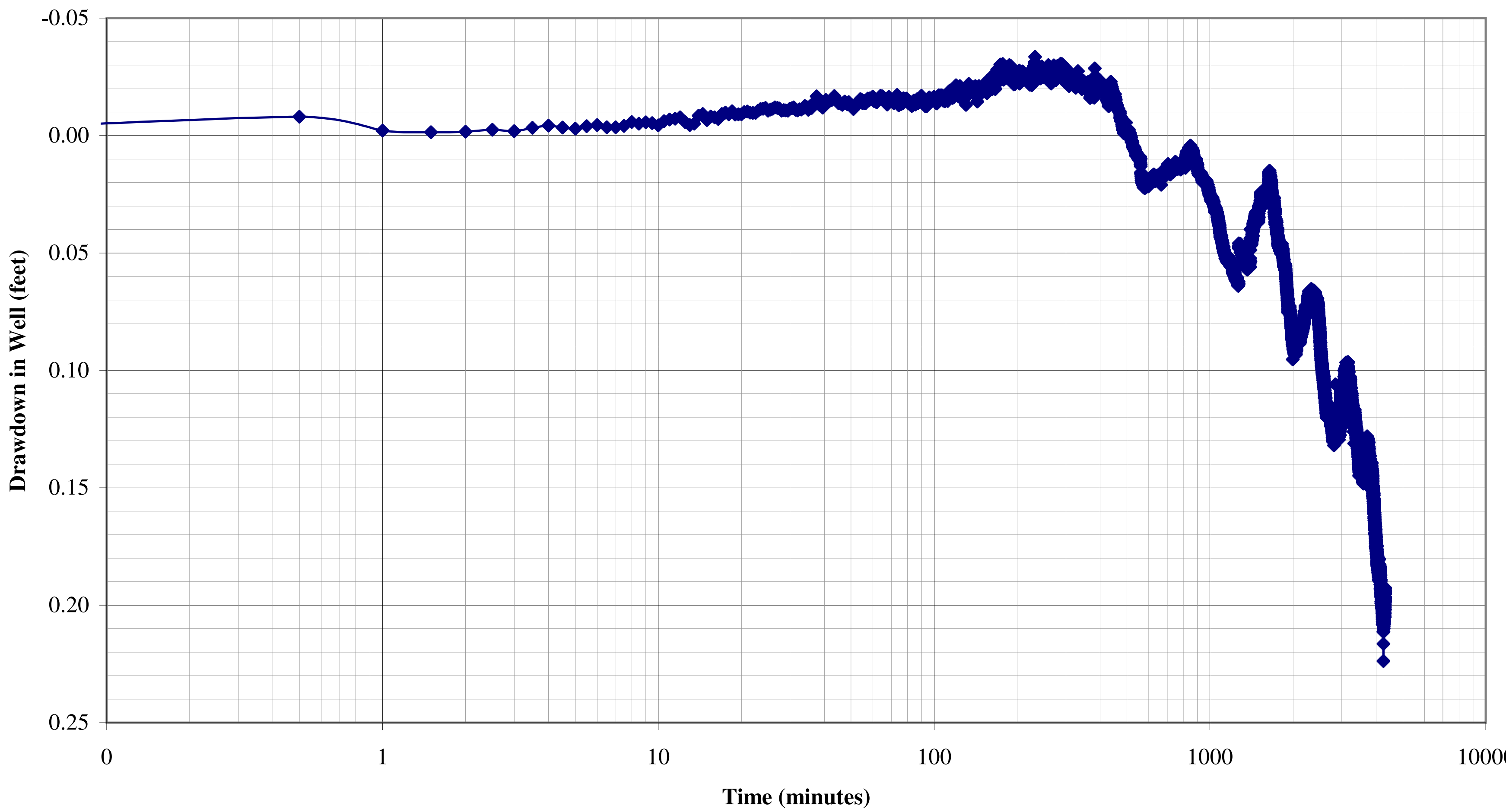
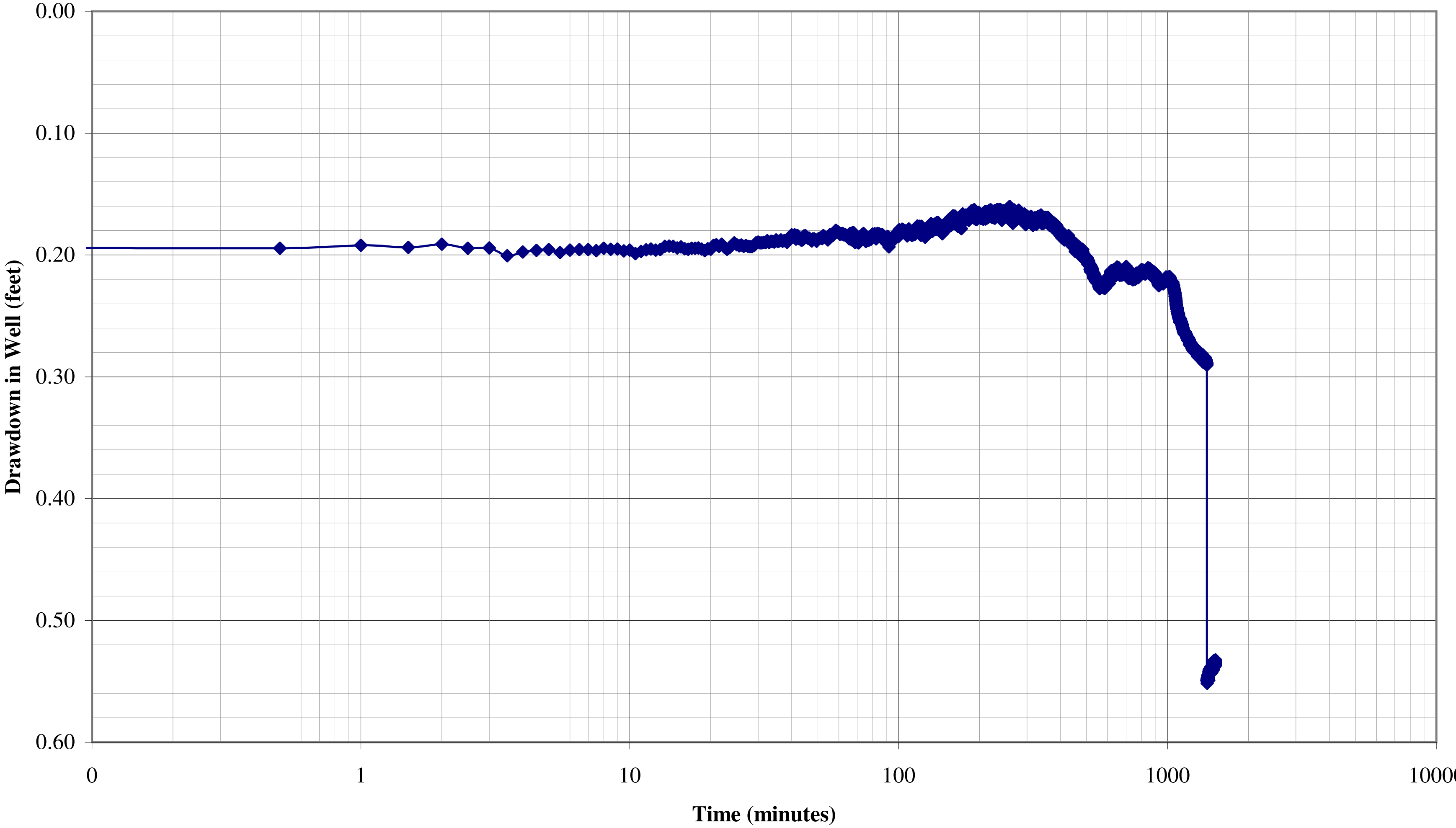
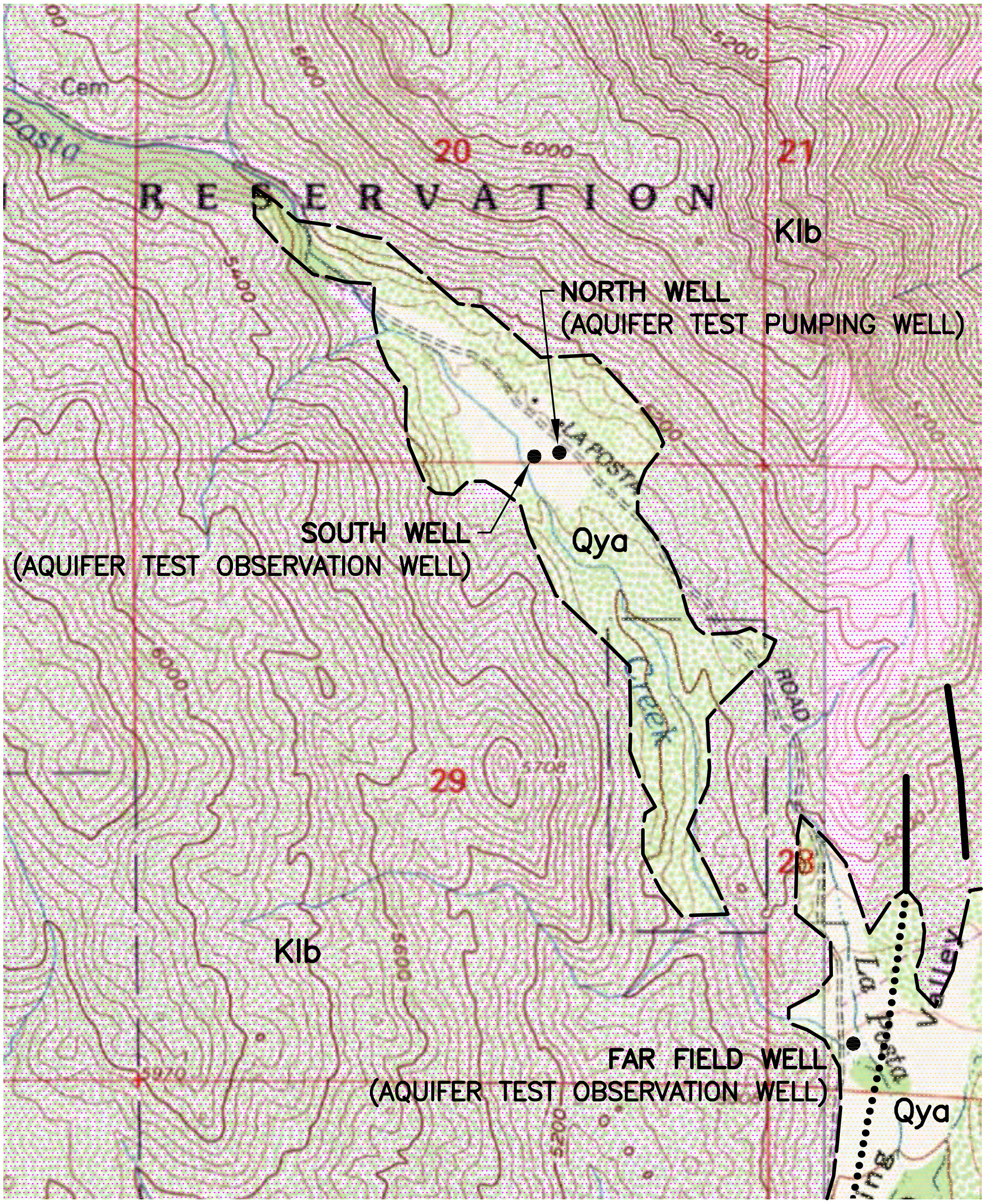


Figure 8
Thing Valley Well
Recovery
Time-Drawdown Plot





N

EXPLANATION:

Qya	YOUNG ALLUVIUM (HOLOCENE)
Klb	TONALITE OF LAS BANCAS (EARLY CRETACEOUS)
— — — —	APPROXIMATE GEOLOGIC CONTACT
———·····	FAULT, DOTTED WHERE CONCEALED

GRAPHIC SCALE
750 0 375 750 1500
(in feet)
1 inch = 1500 ft.

REFERENCE: PRELIMINARY GEOLOGIC MAP OF EL CAJON 30' x 60' QUADRANGLE, SOUTHERN CALIFORNIA, V. R. TODD, 2004

FIGURE 9

GEOLOGIC MAP
THING VALLEY AQUIFER TEST SITE

TULE WIND PROJECT
SAN DIEGO COUNTY, CA

Geo-Logic Associates
Geologists, Hydrogeologists, and Engineers

DRAWN BY:	DATE:	JOB NO.
VL	NOVEMBER 2010	2010-005

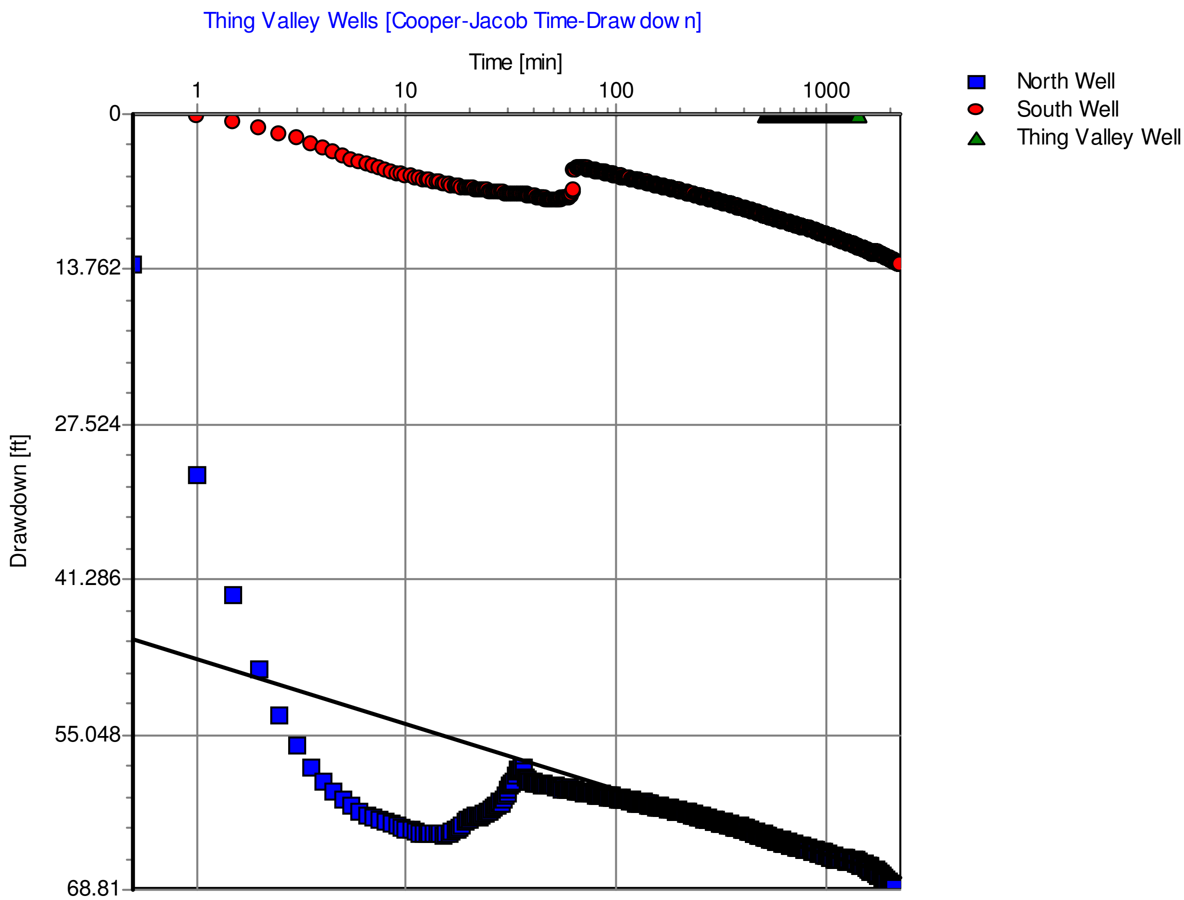
Waterloo Hydrogeologic, Inc.
460 Philip Street - Suite 101
Waterloo, Ontario, Canada
Phone: +1 519 746 1798

Pumping Test Analysis Report

Project: Thing Valley

Number: 2010-0005

Client:



Pumping Test: **Thing Valley Wells**

Analysis Method: **Cooper-Jacob Time-Drawdown**

Analysis Results:	Transmissivity:	4.88E+2 [ft²/d]	Conductivity:	1.39E+0 [ft/d]
	Storativity:	3.33E-9		

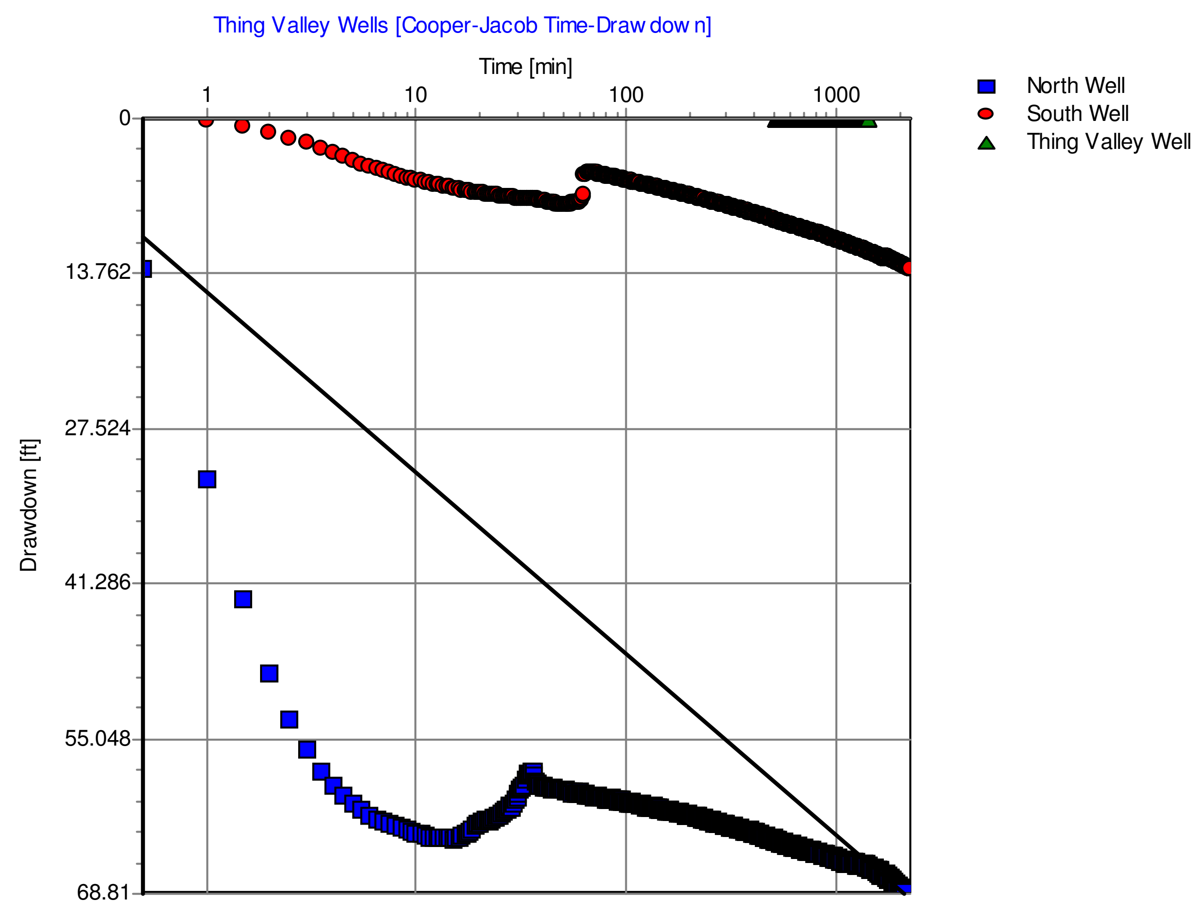
Test parameters:	Pumping Well:	Pumping Well	Aquifer Thickness:	350 [ft]
	Casing radius:	0.25 [ft]	Confined Aquifer	
	Screen length:	350 [ft]		
	Boring radius:	0.42 [ft]		
	Discharge Rate:	80.111574 [U.S. gal/min]		

Comments: North Well Match to mid-late data.

Evaluated by: MWV

Evaluation Date: 10/29/2010

Waterloo Hydrogeologic, Inc. 460 Philip Street - Suite 101 Waterloo, Ontario, Canada Phone: +1 519 746 1798	**Pumping Test Analysis Report** Project: Thing Valley Number: 2010-0005 Client:



Pumping Test: **Thing Valley Wells**

Analysis Method: **Cooper-Jacob Time-Drawdown**

Analysis Results:	Transmissivity:	1.76E+2 [ft²/d]	Conductivity:	5.02E-1 [ft/d]
	Storativity:	3.05E-2		

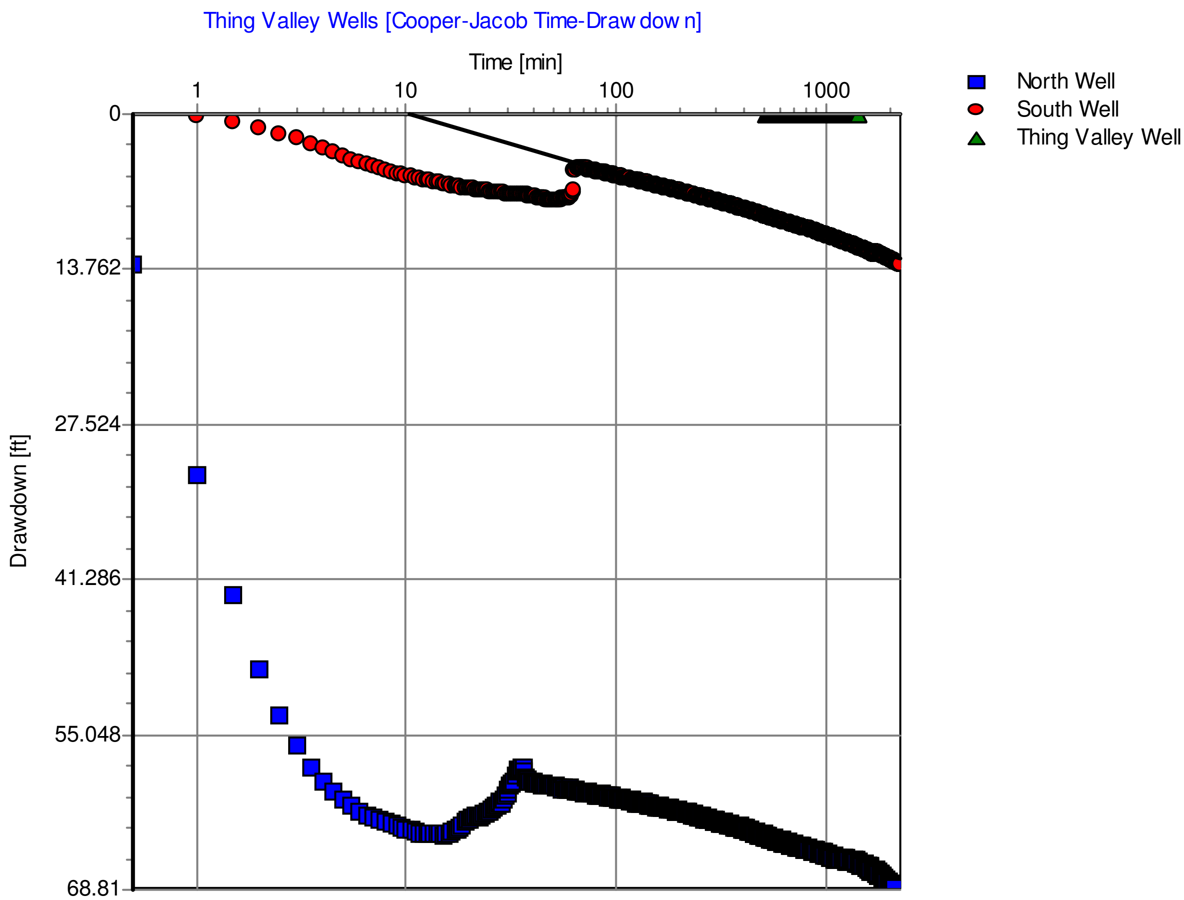
Test parameters:	Pumping Well:	Pumping Well	Aquifer Thickness:	350 [ft]
	Casing radius:	0.25 [ft]	Confined Aquifer	
	Screen length:	350 [ft]		
	Boring radius:	0.42 [ft]		
	Discharge Rate:	80.111574 [U.S. gal/min]		

Comments: North Well match to late data.

Evaluated by: MWV

Evaluation Date: 10/29/2010

Waterloo Hydrogeologic, Inc.	Pumping Test Analysis Report
460 Philip Street - Suite 101	Project: Thing Valley
Waterloo, Ontario, Canada	Number: 2010-0005
Phone: +1 519 746 1798	Client:



Pumping Test: **Thing Valley Wells**

Analysis Method: **Cooper-Jacob Time-Drawdown**

Analysis Results:				
	Transmissivity:	5.13E+2 [ft²/d]	Conductivity:	1.47E+0 [ft/d]
	Storativity:	8.29E+0		

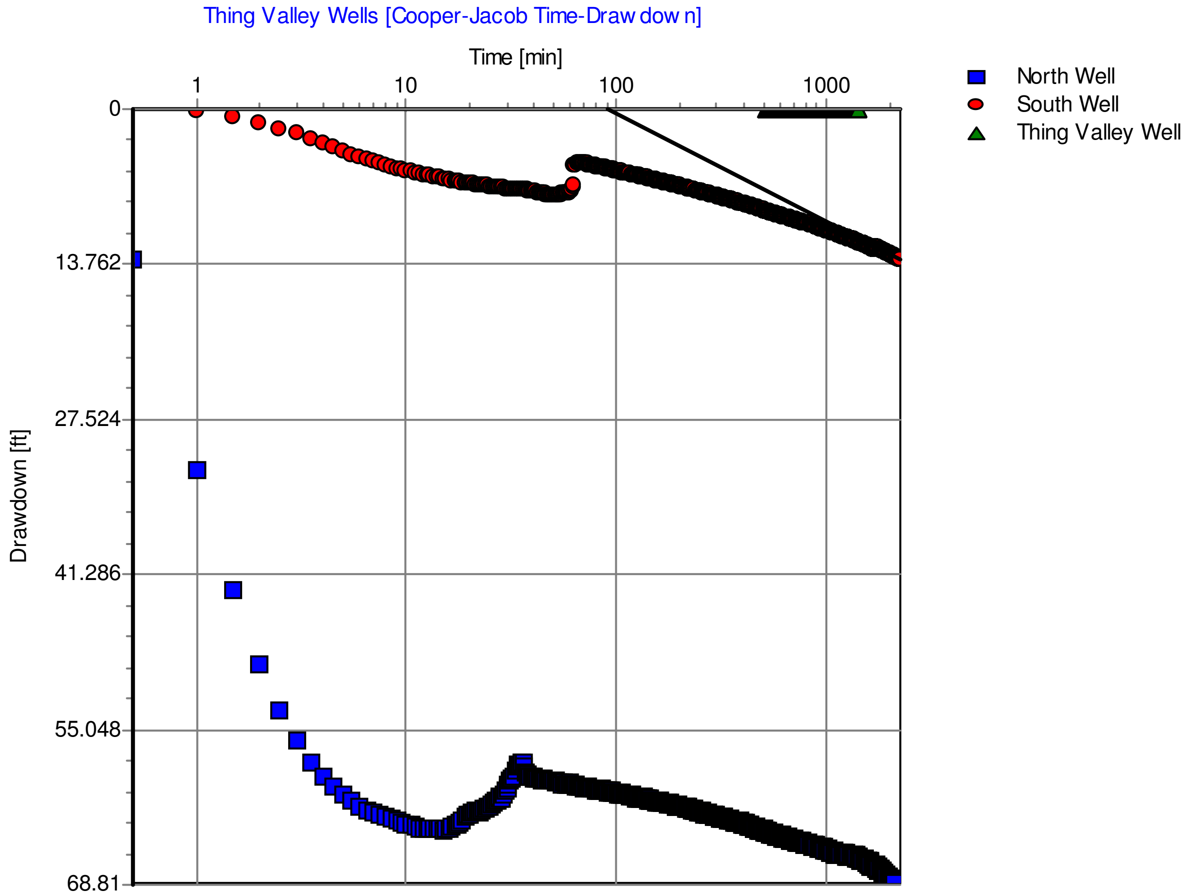
Test parameters:				
	Pumping Well:	Pumping Well	Aquifer Thickness:	350 [ft]
	Casing radius:	0.25 [ft]	Confined Aquifer	
	Screen length:	350 [ft]		
	Boring radius:	0.42 [ft]		
	Discharge Rate:	80.111574 [U.S. gal/min]		

Comments: South Well match to late data.

Evaluated by: MWV

Evaluation Date: 10/29/2010

Waterloo Hydrogeologic, Inc. 460 Philip Street - Suite 101 Waterloo, Ontario, Canada Phone: +1 519 746 1798	**Pumping Test Analysis Report** Project: Thing Valley Number: 2010-0005 Client:



Pumping Test: **Thing Valley Wells**

Analysis Method: **Cooper-Jacob Time-Drawdown**

Analysis Results:	Transmissivity:	2.94E+2 [ft²/d]	Conductivity:	8.41E-1 [ft/d]
	Storativity:	4.19E+1		

Test parameters:	Pumping Well:	Pumping Well	Aquifer Thickness:	350 [ft]
	Casing radius:	0.25 [ft]	Confined Aquifer	
	Screen length:	350 [ft]		
	Boring radius:	0.42 [ft]		
	Discharge Rate:	80.111574 [U.S. gal/min]		

Comments: South Well match to very late data.

Evaluated by: MWV

Evaluation Date: 10/29/2010

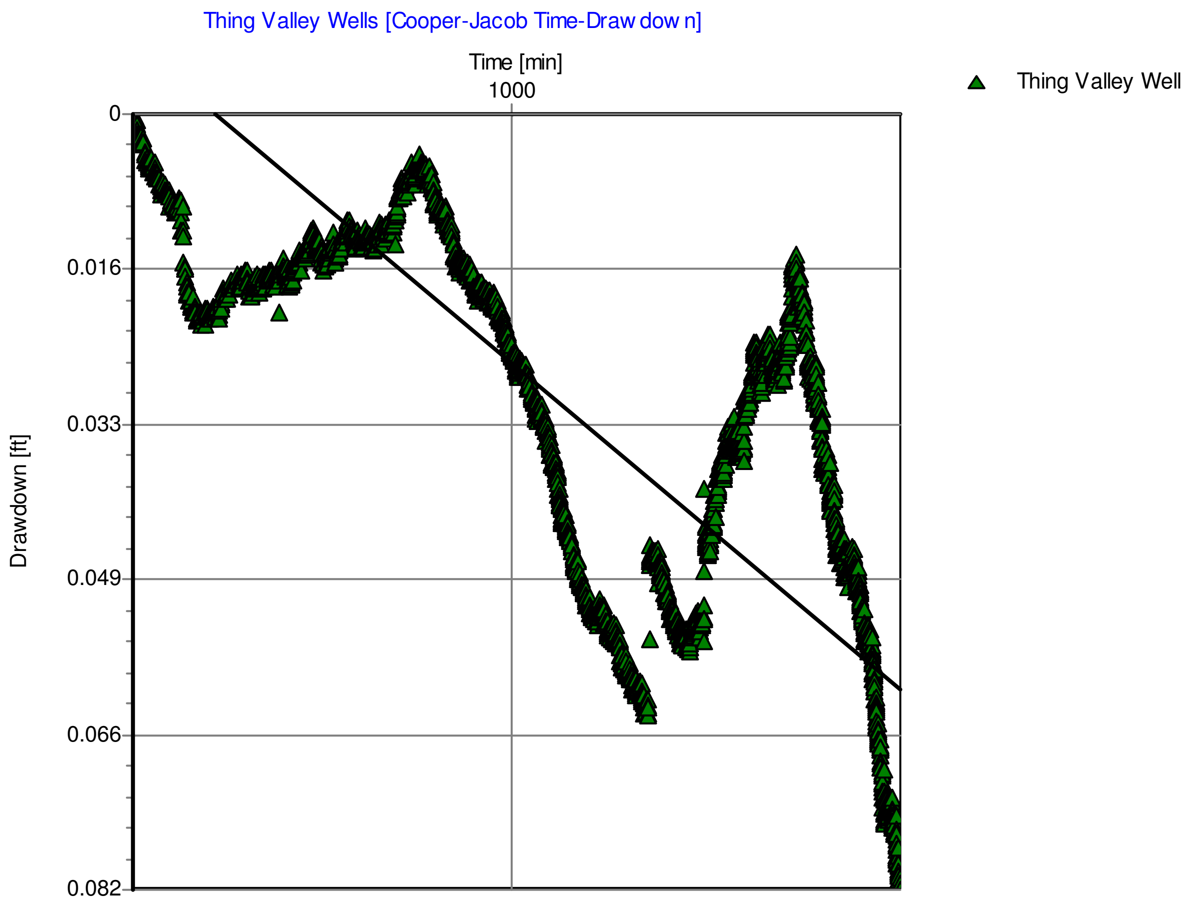
Waterloo Hydrogeologic, Inc.
460 Philip Street - Suite 101
Waterloo, Ontario, Canada
Phone: +1 519 746 1798

Pumping Test Analysis Report

Project: Thing Valley

Number: 2010-0005

Client:



Pumping Test: **Thing Valley Wells**

Analysis Method: **Cooper-Jacob Time-Drawdown**

Analysis Results:	Transmissivity:	2.41E+4 [ft²/d]	Conductivity:	6.88E+1 [ft/d]
	Storativity:	7.34E-4		
Test parameters:	Pumping Well:	Pumping Well	Aquifer Thickness:	350 [ft]
	Casing radius:	0.25 [ft]	Confined Aquifer	
	Screen length:	350 [ft]		
	Boring radius:	0.42 [ft]		
	Discharge Rate:	80.111574 [U.S. gal/min]		

Comments: Thing Valley program best fit match.

Evaluated by: MWV

Evaluation Date: 11/4/2010

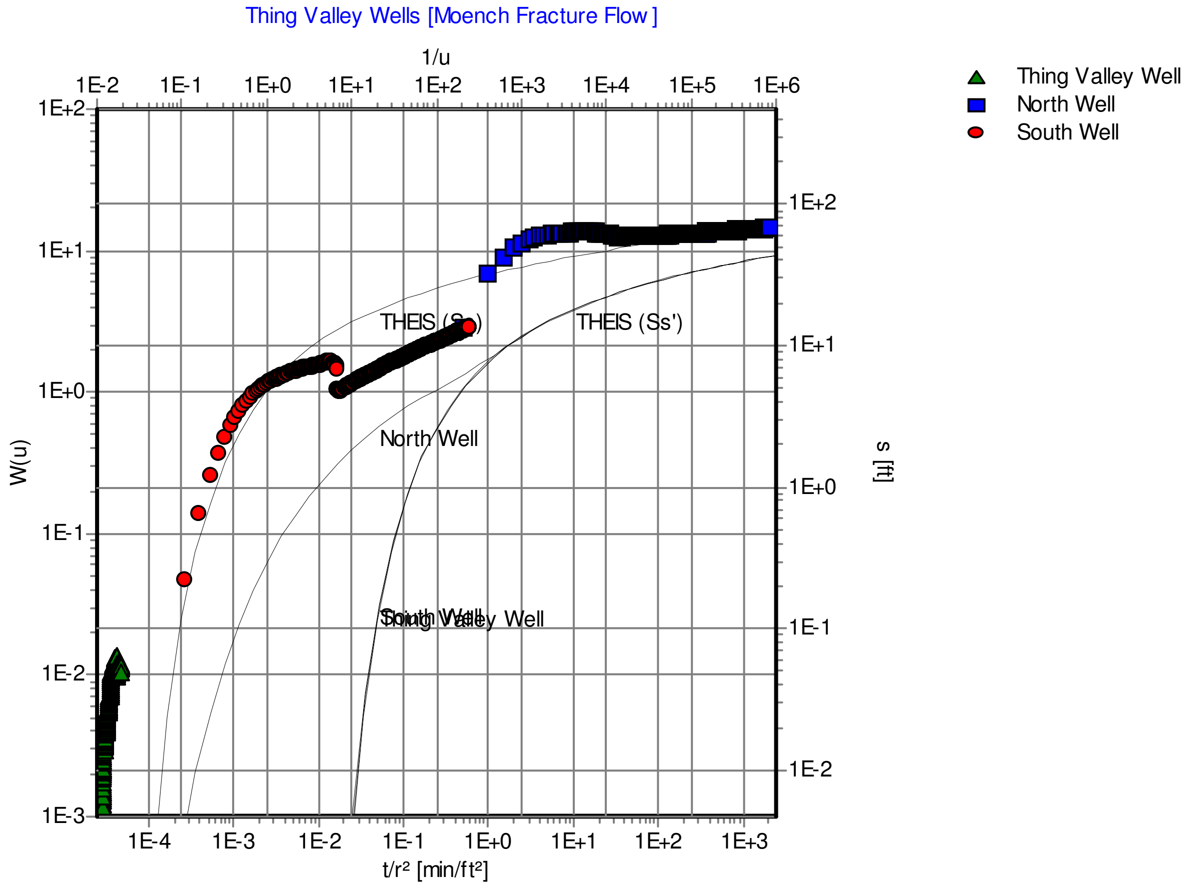
Waterloo Hydrogeologic, Inc.
460 Philip Street - Suite 101
Waterloo, Ontario, Canada
Phone: +1 519 746 1798

Pumping Test Analysis Report

Project: Thing Valley

Number: 2010-0005

Client:



Pumping Test: **Thing Valley Wells**

Analysis Method: **Moench Fracture Flow**

Analysis Results:				
	Transmissivity:	2.61E+2 [ft²/d]	Conductivity:	7.47E-1 [ft/d]
	Storativity:	4.45E-4		

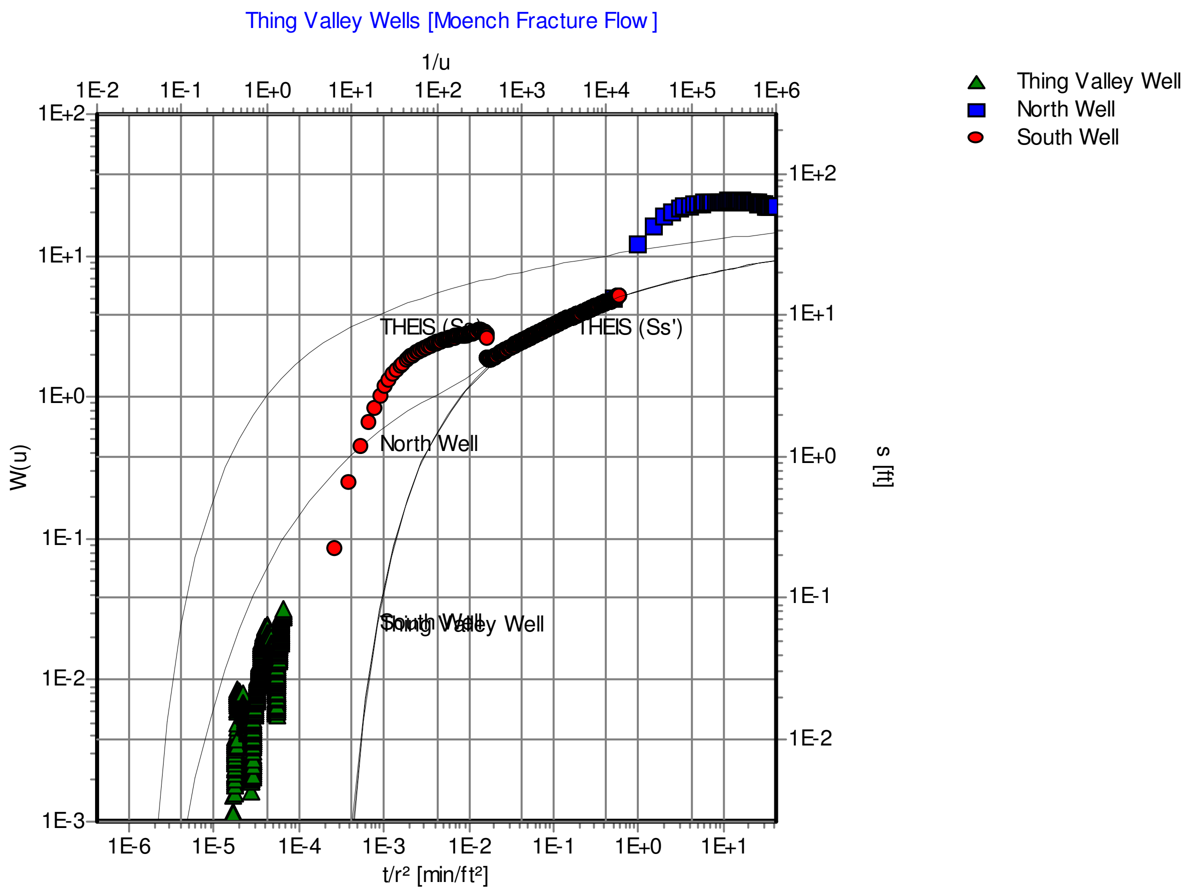
Test parameters:				
	Pumping Well:	Pumping Well	Aquifer Thickness:	350 [ft]
	Casing radius:	0.25 [ft]	b:	350 [ft]
	Screen length:	350 [ft]	Kv/Kh:	0.1
	Boring radius:	0.42 [ft]	C:	0.554
	Discharge Rate:	80.111574 [U.S. gal/mi	K(block)/K(Skin):	0.1
	Ss(blk)/Ss(fract):	200	K(block)/K(fracture):	0.1

Comments: North Well match to late data.

Evaluated by: MWV

Evaluation Date: 10/29/2010

	Waterloo Hydrogeologic, Inc.	**Pumping Test Analysis Report**
	460 Philip Street - Suite 101	Project: Thing Valley
	Waterloo, Ontario, Canada	Number: 2010-0005
	Phone: +1 519 746 1798	Client:



Pumping Test:	**Thing Valley Wells**			
Analysis Method:	**Moench Fracture Flow**			
Analysis Results:	Transmissivity:	4.67E+2 [ft²/d]	Conductivity:	1.33E+0 [ft/d]
	Storativity:	1.35E-5		
Test parameters:	Pumping Well:	Pumping Well	Aquifer Thickness:	350 [ft]
	Casing radius:	0.25 [ft]	b:	350 [ft]
	Screen length:	350 [ft]	Kv/Kh:	0.1
	Boring radius:	0.42 [ft]	C:	0.554
	Discharge Rate:	80.111574 [U.S. gal/mi	K(block)/K(Skin):	0.1
	Ss(blk)/Ss(fract):	200	K(block)/K(fracture):	0.1
Comments:	South Well match to late data.			

Evaluated by: MWV

Evaluation Date: 11/1/2010

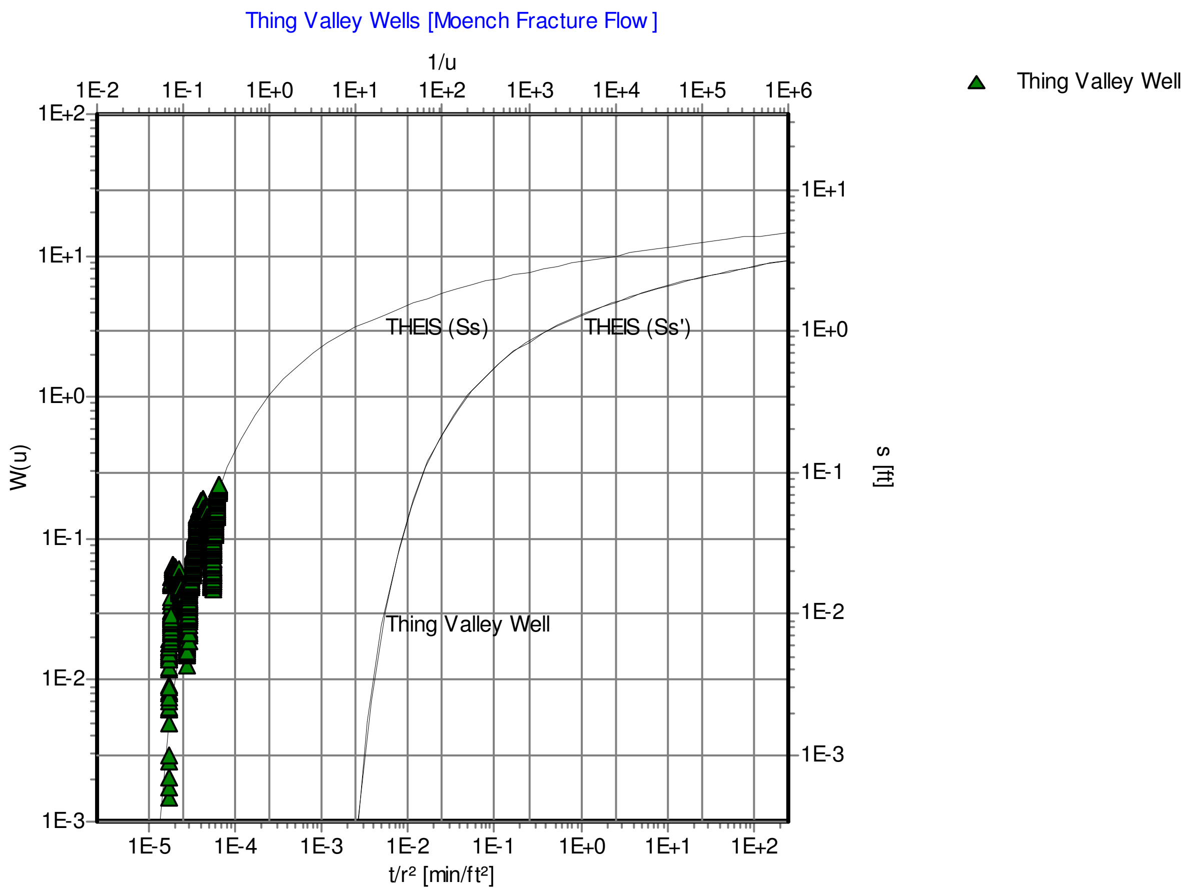
Waterloo Hydrogeologic, Inc.
460 Philip Street - Suite 101
Waterloo, Ontario, Canada
Phone: +1 519 746 1798

Pumping Test Analysis Report

Project: Thing Valley

Number: 2010-0005

Client:



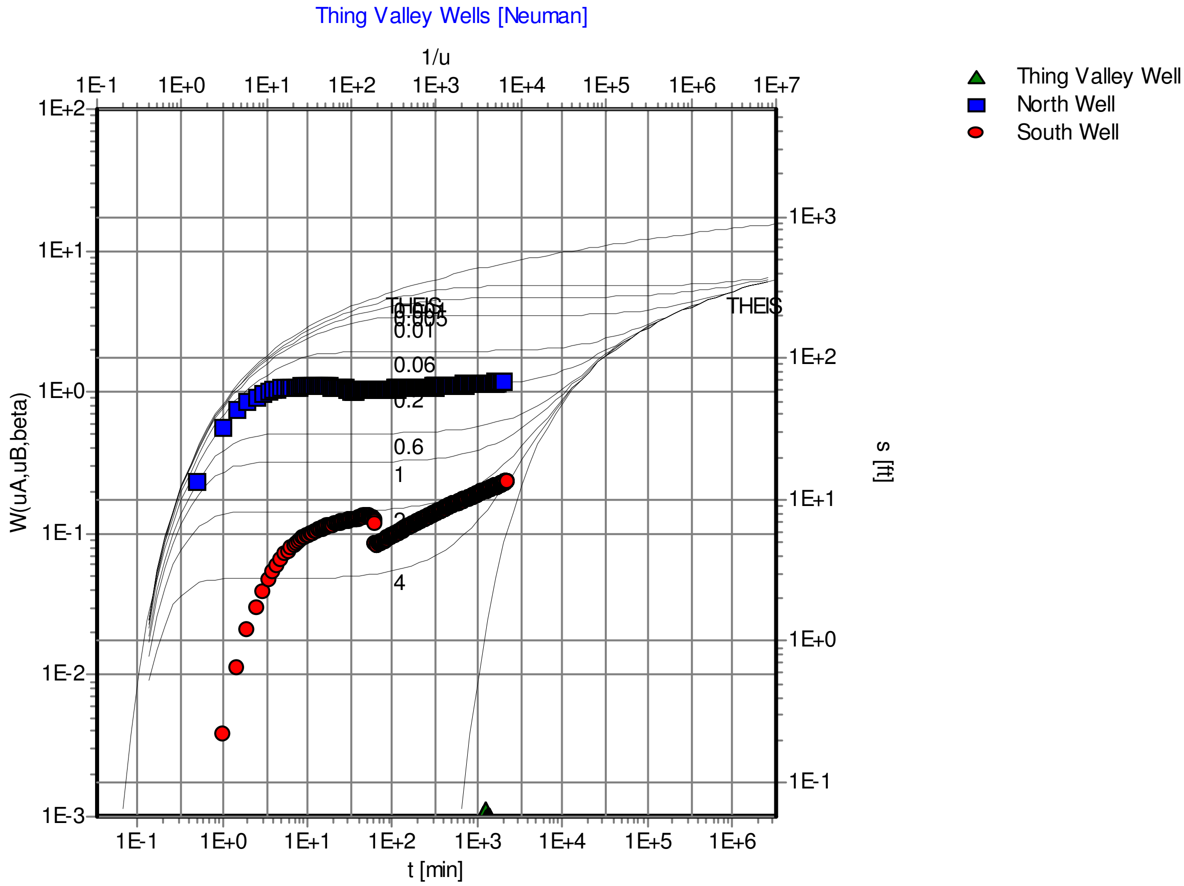
Pumping Test:	**Thing Valley Wells**			
Analysis Method:	**Moench Fracture Flow**			
Analysis Results:	Transmissivity:	3.61E+3 [ft²/d]	Conductivity:	1.03E+1 [ft/d]
	Storativity:	6.28E-4		
Test parameters:	Pumping Well:	Pumping Well	Aquifer Thickness:	350 [ft]
	Casing radius:	0.25 [ft]	b:	350 [ft]
	Screen length:	350 [ft]	Kv/Kh:	0.1
	Boring radius:	0.42 [ft]	C:	0.554
	Discharge Rate:	80.111574 [U.S. gal/mi	K(block)/K(Skin):	0.1
	Ss(blk)/Ss(fract):	200	K(block)/K(fracture):	0.1

Comments: Moench match to Thing Valley Well data.

Evaluated by: MWV

Evaluation Date: 11/4/2010

Waterloo Hydrogeologic, Inc. 460 Philip Street - Suite 101 Waterloo, Ontario, Canada Phone: +1 519 746 1798	**Pumping Test Analysis Report** Project: Thing Valley Number: 2010-0005 Client:



Pumping Test: **Thing Valley Wells**

Analysis Method: **Neuman**

Analysis Results:	Transmissivity:	2.13E+1 [ft²/d]	Conductivity:	6.09E-2 [ft/d]
	Storativity:	1.96E-2	Specific Yield:	1.96E+2

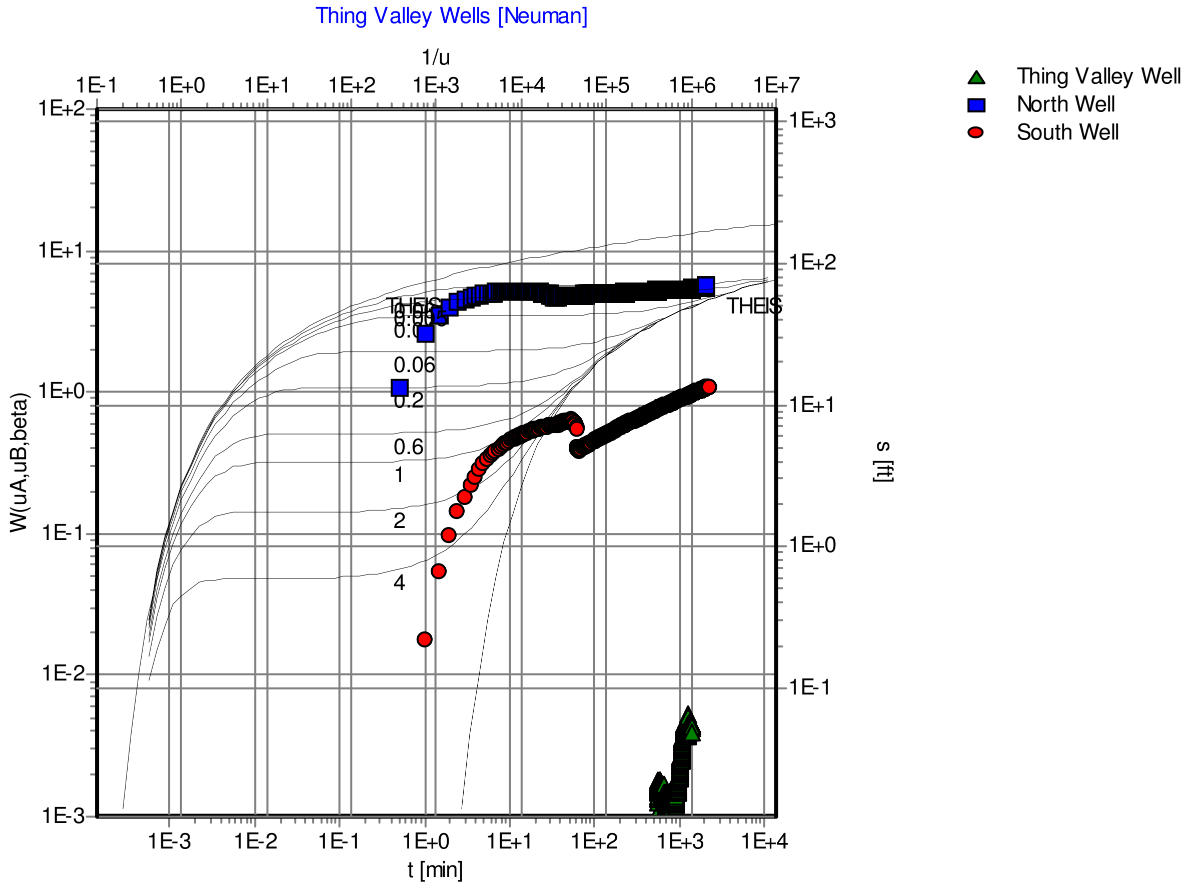
Test parameters:	Pumping Well:	Pumping Well	Aquifer Thickness:	350 [ft]
	Casing radius:	0.25 [ft]	Beta:	0.005
	Screen length:	350 [ft]		
	Boring radius:	0.42 [ft]		
	Discharge Rate:	80.111574 [U.S. gal/min]		
	LOG(Sy/S):	4		

Comments: North Well match to all data.

Evaluated by: MWV

Evaluation Date: 10/29/2010

Waterloo Hydrogeologic, Inc.	**Pumping Test Analysis Report**
460 Philip Street - Suite 101	Project: Thing Valley
Waterloo, Ontario, Canada	Number: 2010-0005
Phone: +1 519 746 1798	Client:

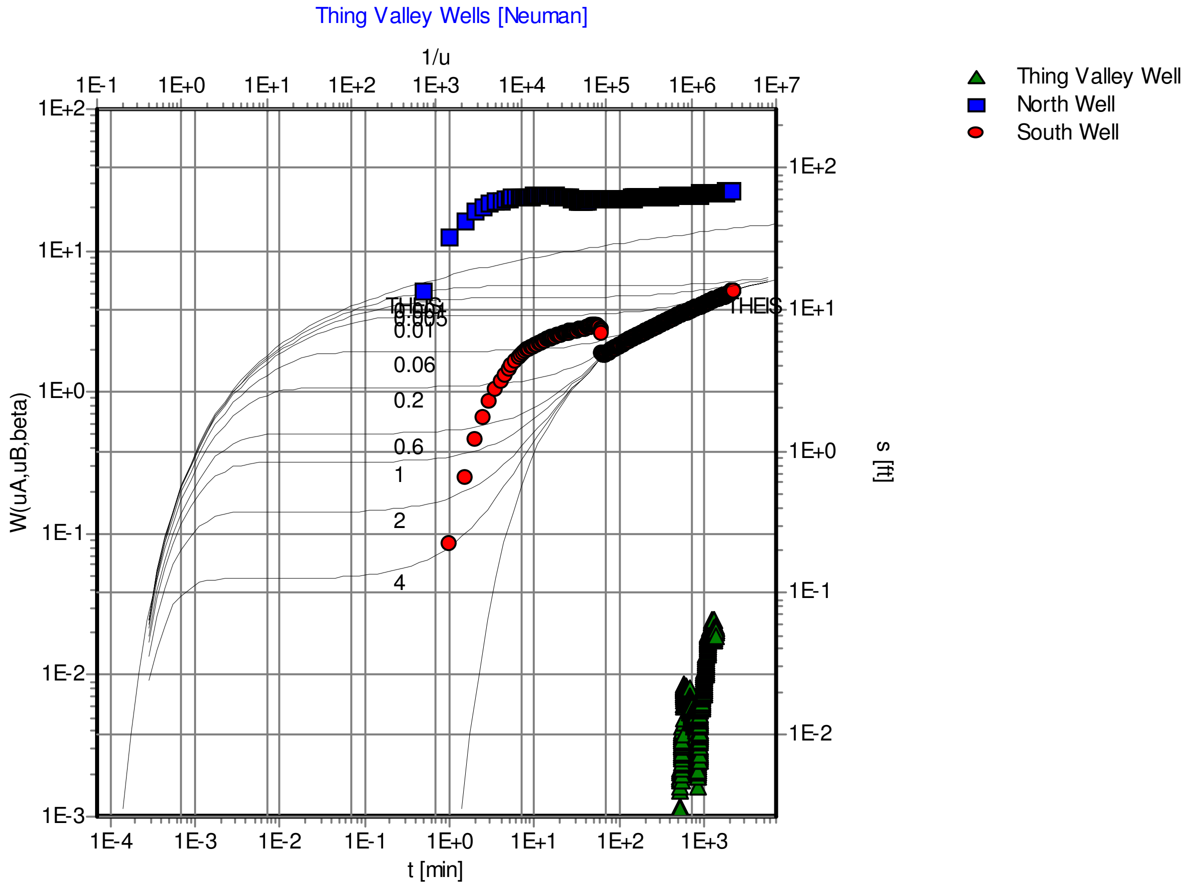


Pumping Test:	**Thing Valley Wells**			
Analysis Method:	**Neuman**			
Analysis Results:	Transmissivity:	9.98E+1 [ft²/d]	Conductivity:	2.85E-1 [ft/d]
	Storativity:	3.82E-4	Specific Yield:	3.82E+0
Test parameters:	Pumping Well:	Pumping Well	Aquifer Thickness:	350 [ft]
	Casing radius:	0.25 [ft]	Beta:	0.005
	Screen length:	350 [ft]		
	Boring radius:	0.42 [ft]		
	Discharge Rate:	80.111574 [U.S. gal/min]		
	LOG(Sy/S):	4		
Comments:	North Well match to late data.			

Evaluated by: MWV

Evaluation Date: 10/29/2010

Waterloo Hydrogeologic, Inc.	Pumping Test Analysis Report
460 Philip Street - Suite 101	Project: Thing Valley
Waterloo, Ontario, Canada	Number: 2010-0005
Phone: +1 519 746 1798	Client:



Pumping Test: **Thing Valley Wells**

Analysis Method: **Neuman**

Analysis Results:	Transmissivity:	4.69E+2 [ft²/d]	Conductivity:	1.34E+0 [ft/d]
	Storativity:	9.12E-4	Specific Yield:	9.12E+0

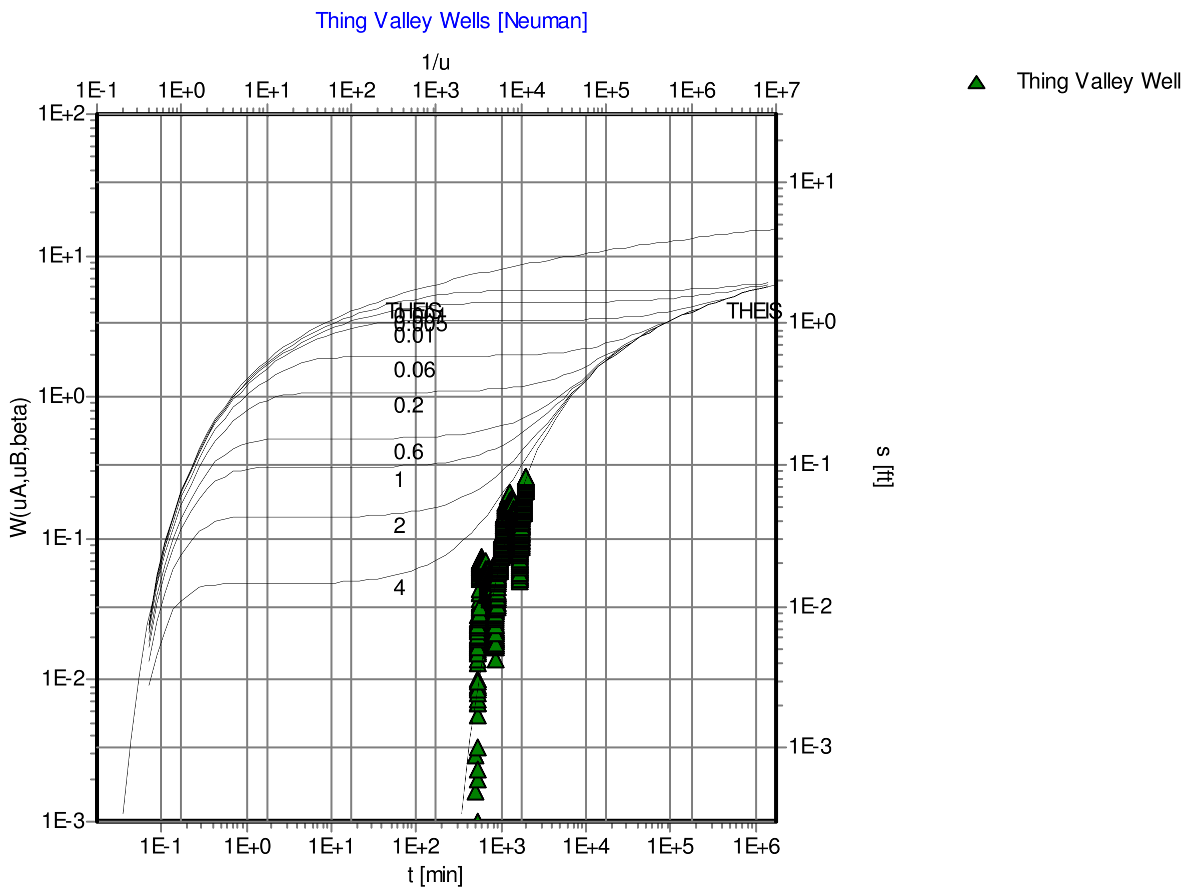
Test parameters:	Pumping Well:	Pumping Well	Aquifer Thickness:	350 [ft]
	Casing radius:	0.25 [ft]	Beta:	0.005
	Screen length:	350 [ft]		
	Boring radius:	0.42 [ft]		
	Discharge Rate:	80.111574 [U.S. gal/min]		
	LOG(Sy/S):	4		

Comments: South Well match to late data.

Evaluated by: MWV

Evaluation Date: 10/29/2010

Waterloo Hydrogeologic, Inc.	**Pumping Test Analysis Report**
460 Philip Street - Suite 101	Project: Thing Valley
Waterloo, Ontario, Canada	Number: 2010-0005
Phone: +1 519 746 1798	Client:



Pumping Test: **Thing Valley Wells**

Analysis Method: **Neuman**

Analysis Results:	Transmissivity:	4.06E+3 [ft²/d]	Conductivity:	1.16E+1 [ft/d]

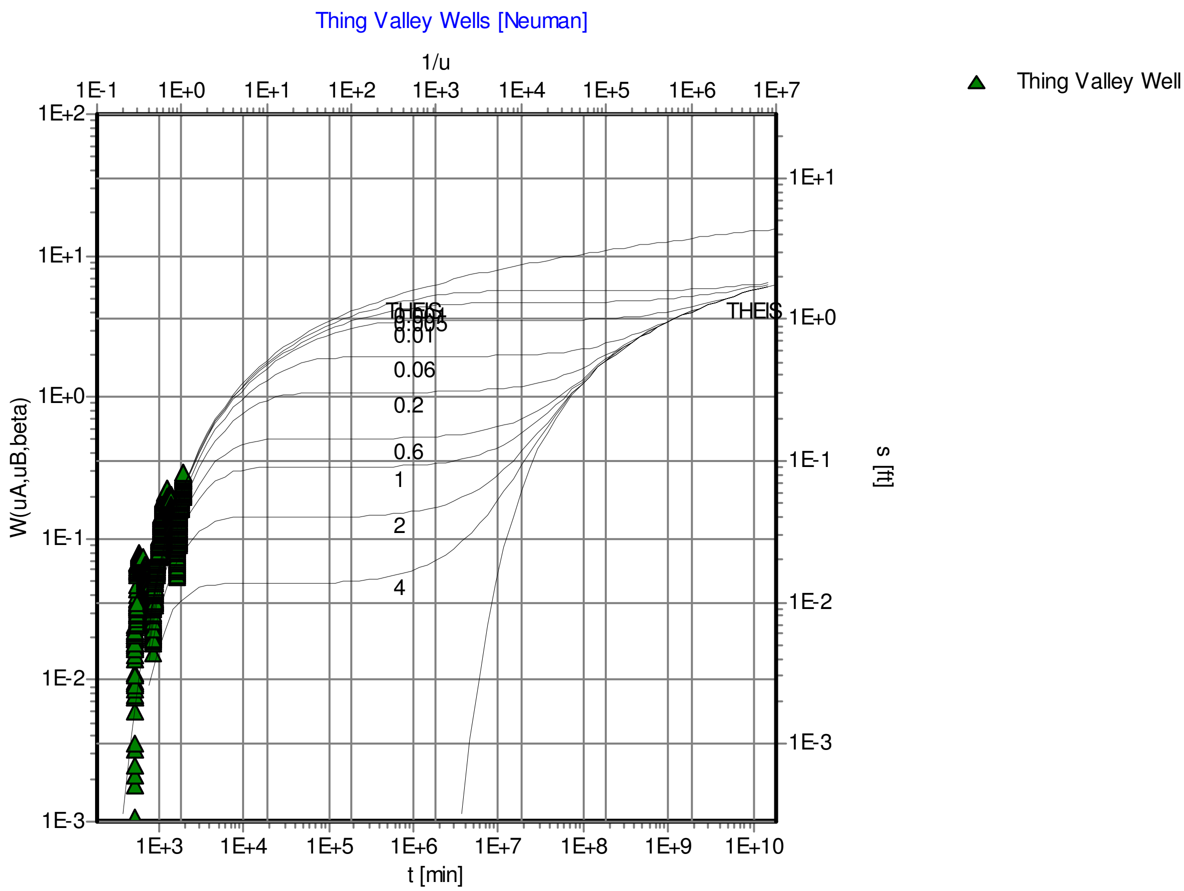
Test parameters:	Pumping Well:	Pumping Well	Aquifer Thickness:	350 [ft]
	Casing radius:	0.25 [ft]	Beta:	0.005
	Screen length:	350 [ft]		
	Boring radius:	0.42 [ft]		
	Discharge Rate:	80.111574 [U.S. gal/min]		
	LOG(Sy/S):	4		

Comments: Thing Valley data

Evaluated by: MWV

Evaluation Date: 11/4/2010

Waterloo Hydrogeologic, Inc.	**Pumping Test Analysis Report**
460 Philip Street - Suite 101	Project: Thing Valley
Waterloo, Ontario, Canada	Number: 2010-0005
Phone: +1 519 746 1798	Client:



Pumping Test: **Thing Valley Wells**

Analysis Method: **Neuman**

Analysis Results:	Transmissivity:	4.35E+3 [ft²/d]	Conductivity:	1.24E+1 [ft/d]
Test parameters:	Pumping Well:	Pumping Well	Aquifer Thickness:	350 [ft]
	Casing radius:	0.25 [ft]	Beta:	0.005
	Screen length:	350 [ft]		
	Boring radius:	0.42 [ft]		
	Discharge Rate:	80.111574 [U.S. gal/min]		
	LOG(Sy/S):	4		

Comments: Thing Valley data

Evaluated by: MWV

Evaluation Date: 11/4/2010

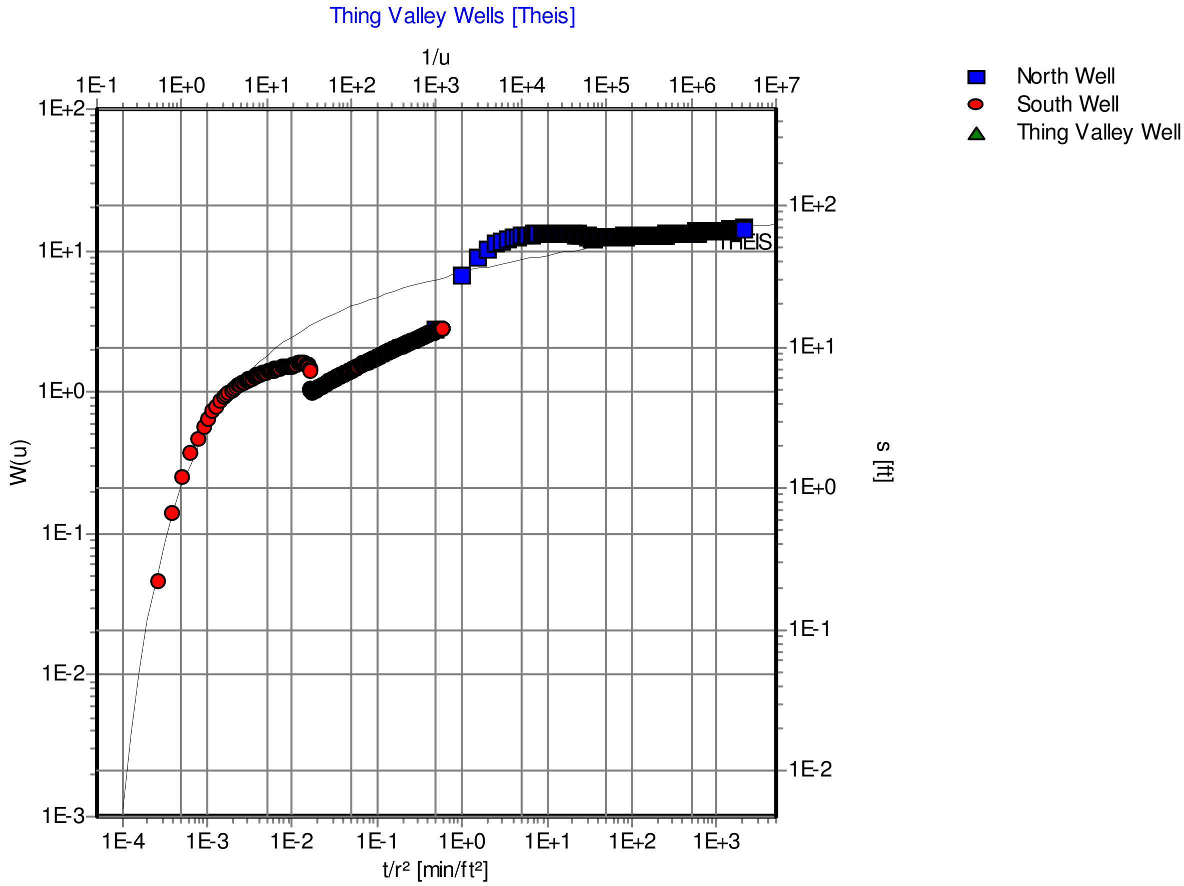
Waterloo Hydrogeologic, Inc.
460 Philip Street - Suite 101
Waterloo, Ontario, Canada
Phone: +1 519 746 1798

Pumping Test Analysis Report

Project: Thing Valley

Number: 2010-0005

Client:



Pumping Test: **Thing Valley Wells**

Analysis Method: **Theis**

Analysis Results:	Transmissivity:	2.56E+2 [ft²/d]	Conductivity:	7.33E-1 [ft/d]
	Storativity:	3.57E-4		

Test parameters:	Pumping Well:	Pumping Well	Aquifer Thickness:	350 [ft]
	Casing radius:	0.25 [ft]	Confined Aquifer	
	Screen length:	350 [ft]		
	Boring radius:	0.42 [ft]		
	Discharge Rate:	80.111574 [U.S. gal/min]		

Comments: North Well match to late data.
South Well match to early data.

Evaluated by: MWV

Evaluation Date: 10/29/2010

Waterloo Hydrogeologic, Inc.
460 Philip Street - Suite 101
Waterloo, Ontario, Canada
Phone: +1 519 746 1798

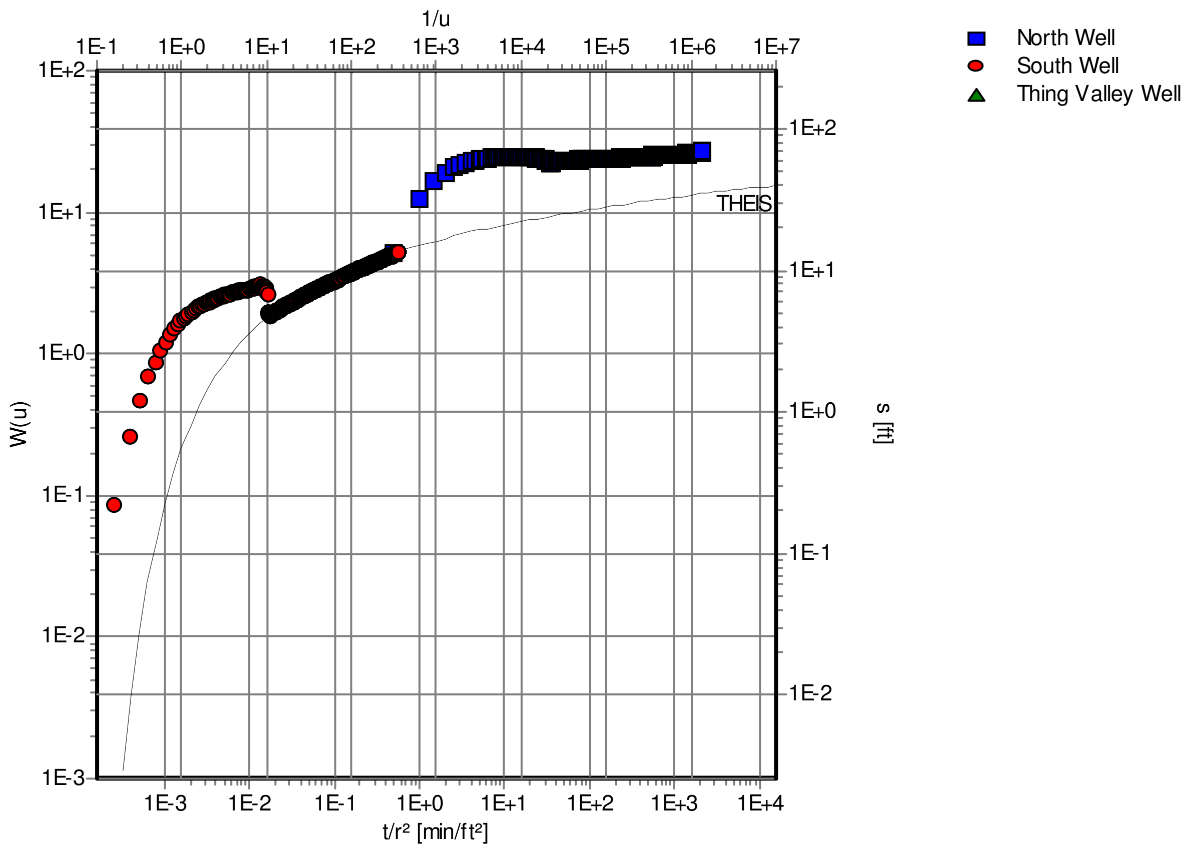
Pumping Test Analysis Report

Project: Thing Valley

Number: 2010-0005

Client:

Thing Valley Wells [Theis]



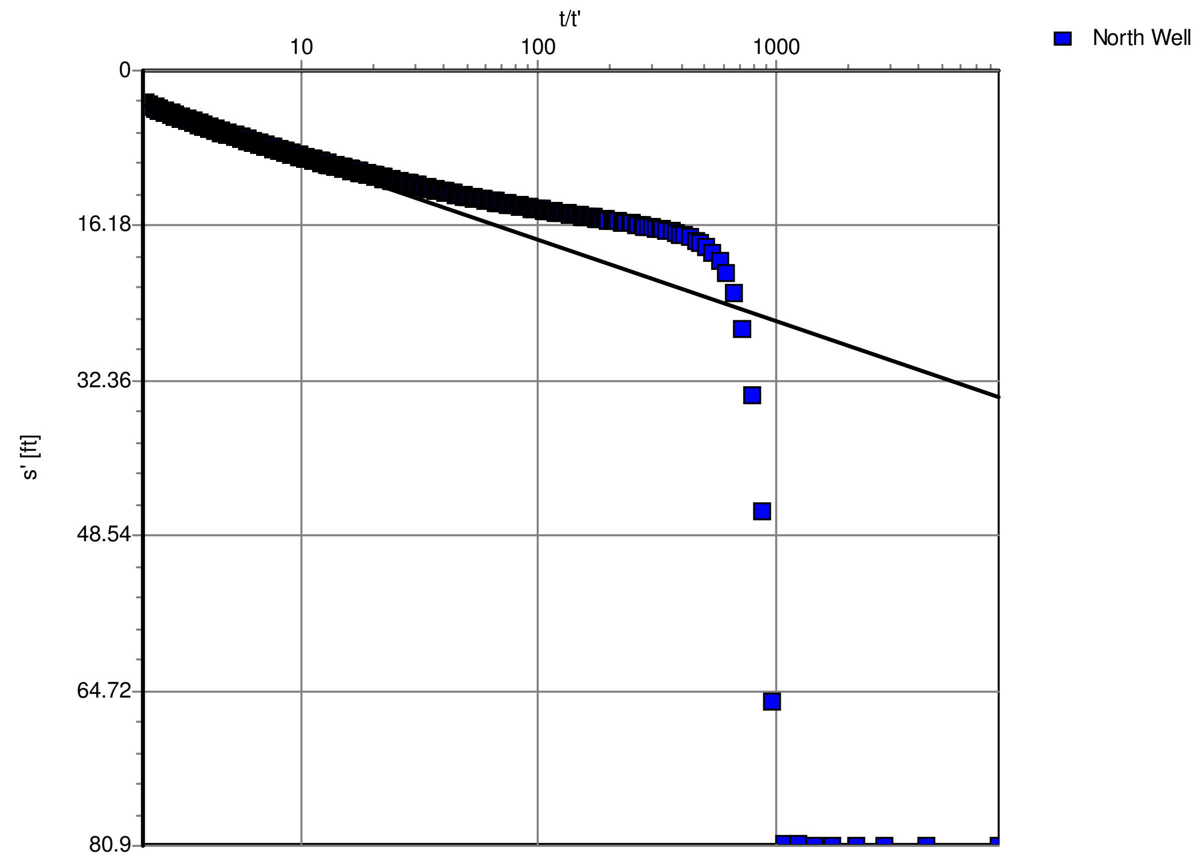
Pumping Test:	**Thing Valley Wells**			
Analysis Method:	**Theis**			
Analysis Results:	Transmissivity:	4.77E+2 [ft²/d]	Conductivity:	1.36E+0 [ft/d]
	Storativity:	2.10E-3		
Test parameters:	Pumping Well:	Pumping Well	Aquifer Thickness:	350 [ft]
	Casing radius:	0.25 [ft]	Confined Aquifer	
	Screen length:	350 [ft]		
	Boring radius:	0.42 [ft]		
	Discharge Rate:	80.111574 [U.S. gal/min]		
Comments:	Match to South Well late data.			

Evaluated by: MWV

Evaluation Date: 10/29/2010

Waterloo Hydrogeologic, Inc. 460 Philip Street - Suite 101 Waterloo, Ontario, Canada Phone: +1 519 746 1798	**Pumping Test Analysis Report** Project: Thing Valley Number: 2010-0005 Client:

Recovery Test [Theis Recovery]



Pumping Test: **Recovery Test**

Analysis Method: **Theis Recovery**

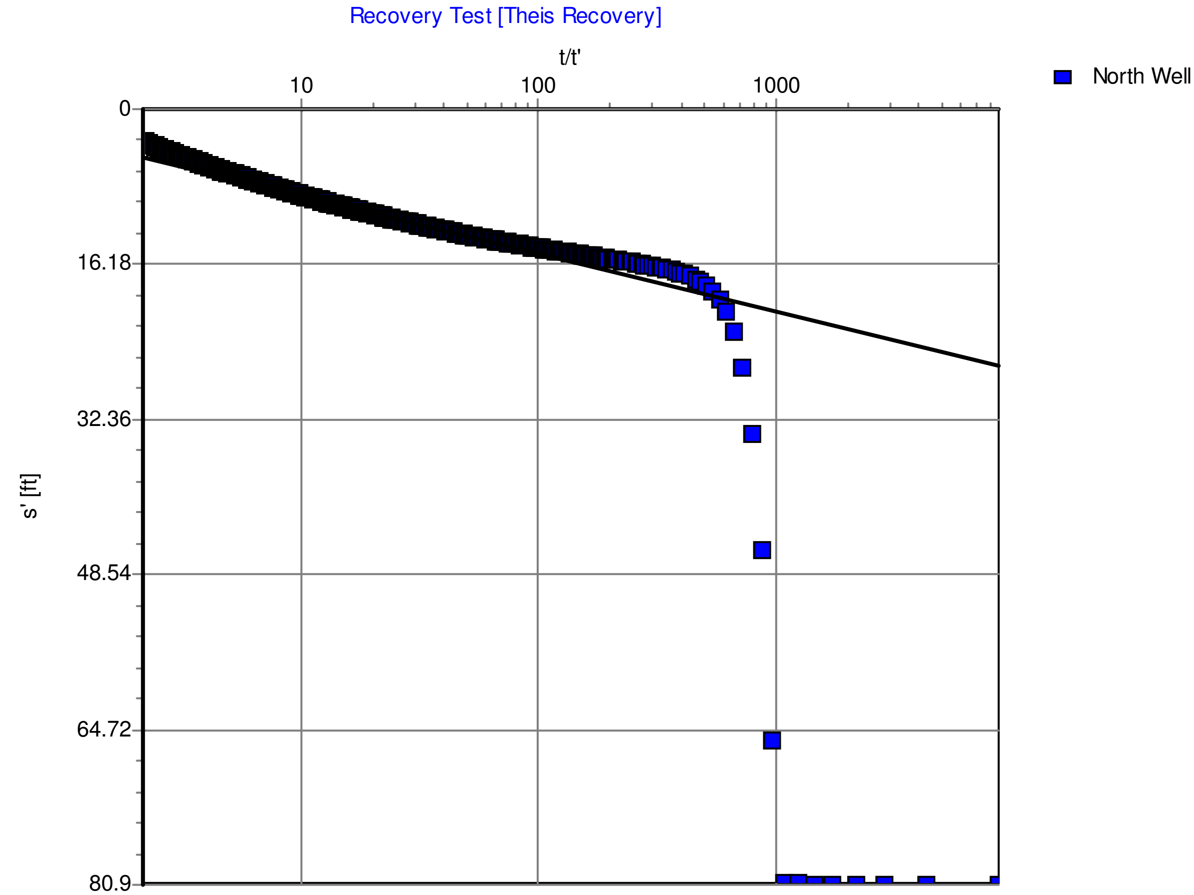
Analysis Results:	Transmissivity:	3.37E+2 [ft²/d]	Conductivity:	9.63E-1 [ft/d]
Test parameters:	Pumping Well:	Pumping Well	Aquifer Thickness:	350 [ft]
	Casing radius:	0.25 [ft]	Confined Aquifer	
	Screen length:	350 [ft]		
	Boring radius:	0.42 [ft]		
	Discharge Rate:	81 [U.S. gal/min]		
	Pumping Time	4320 [min]		

Comments: North Well recovery match to late data.

Evaluated by: MWV

Evaluation Date: 11/2/2010

	Waterloo Hydrogeologic, Inc. 460 Philip Street - Suite 101 Waterloo, Ontario, Canada Phone: +1 519 746 1798	**Pumping Test Analysis Report**
		Project: Thing Valley
		Number: 2010-0005
		Client:



Pumping Test: **Recovery Test**

Analysis Method: **Theis Recovery**

Analysis Results:	Transmissivity:	4.73E+2 [ft²/d]	Conductivity:	1.35E+0 [ft/d]

Test parameters:	Pumping Well:	Pumping Well	Aquifer Thickness:	350 [ft]
	Casing radius:	0.25 [ft]	Confined Aquifer	
	Screen length:	350 [ft]		
	Boring radius:	0.42 [ft]		
	Discharge Rate:	81 [U.S. gal/min]		
	Pumping Time	4320 [min]		

Comments:

Evaluated by:

Evaluation Date: 11/2/2010

Waterloo Hydrogeologic, Inc.
460 Philip Street - Suite 101
Waterloo, Ontario, Canada
Phone: +1 519 746 1798

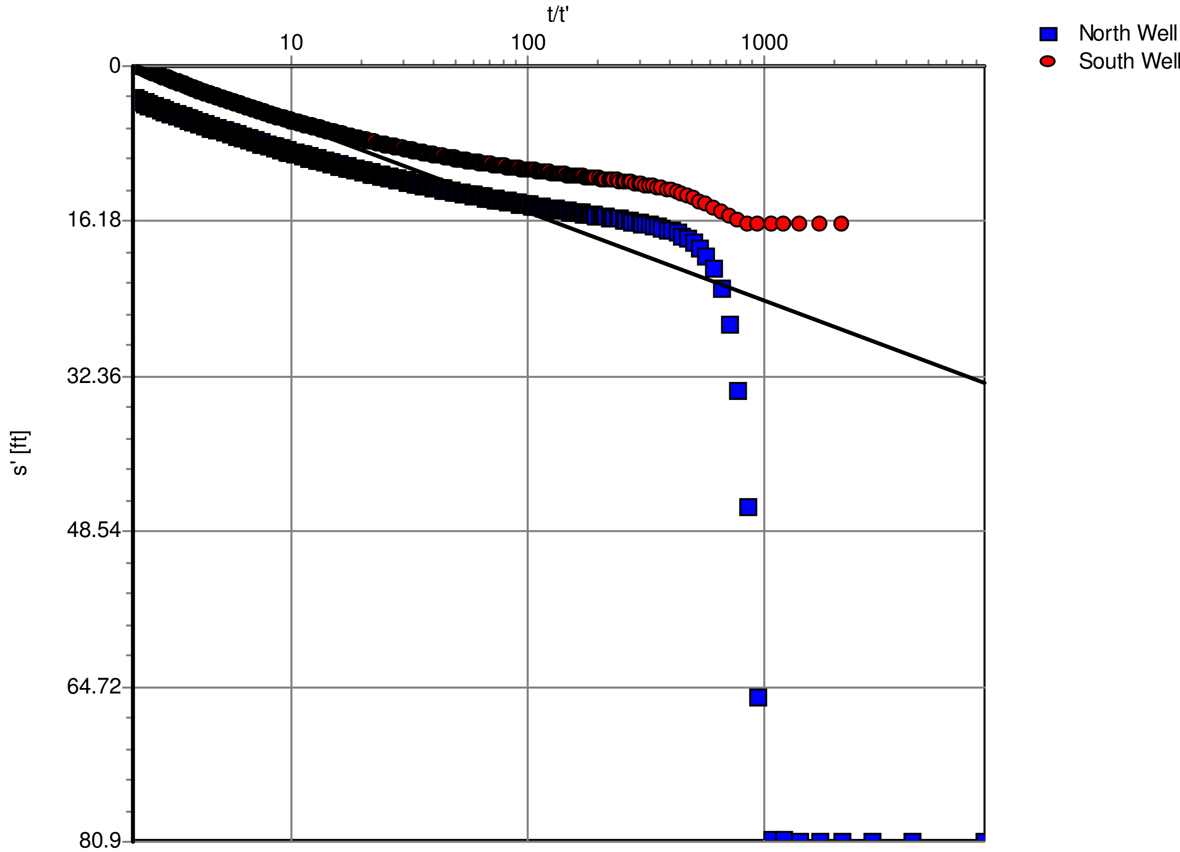
Pumping Test Analysis Report

Project: Thing Valley

Number: 2010-0005

Client:

Recovery Test [Theis Recovery]



Pumping Test: **Recovery Test**

Analysis Method: **Theis Recovery**

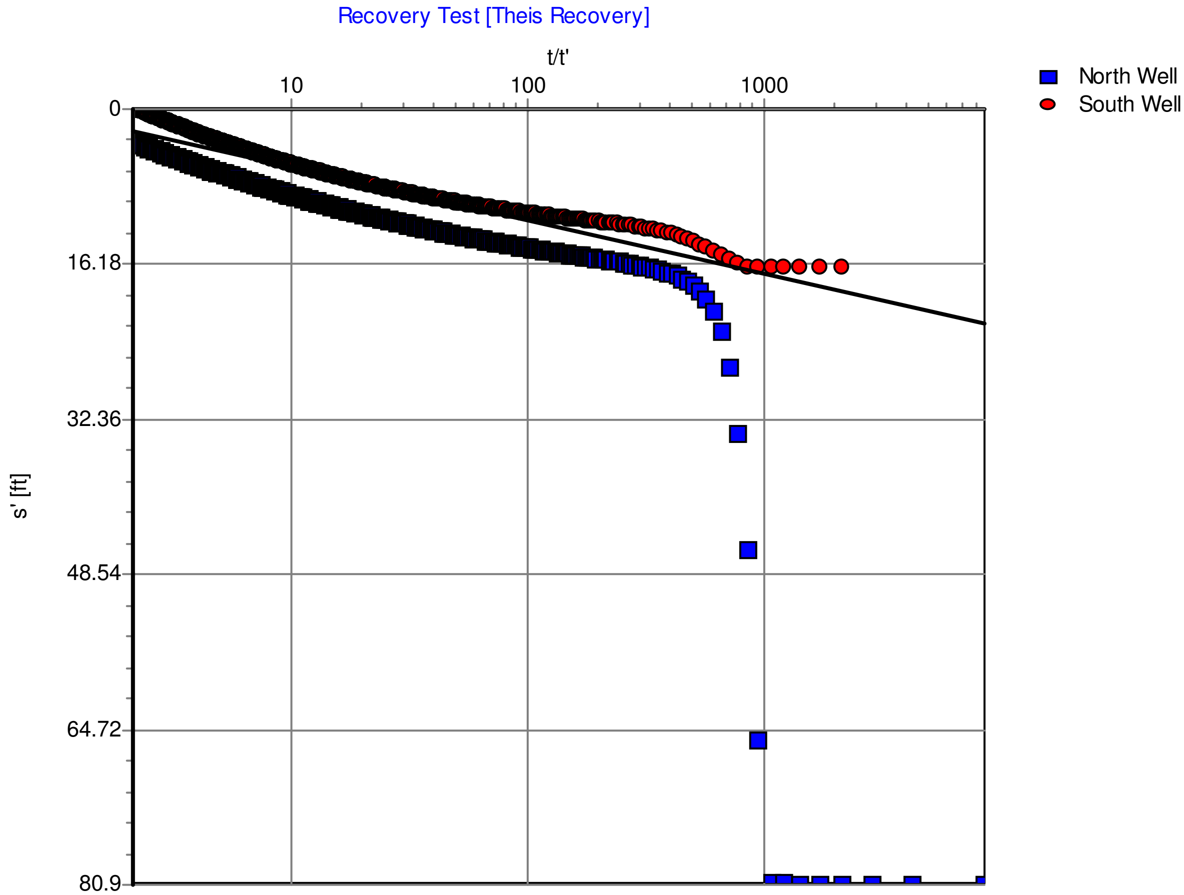
Analysis Results:	Transmissivity:	3.11E+2 [ft²/d]	Conductivity:	8.88E-1 [ft/d]
Test parameters:	Pumping Well:	Pumping Well	Aquifer Thickness:	350 [ft]
	Casing radius:	0.25 [ft]	Confined Aquifer	
	Screen length:	350 [ft]		
	Boring radius:	0.42 [ft]		
	Discharge Rate:	81 [U.S. gal/min]		
	Pumping Time	4320 [min]		

Comments: South Well Recovery match to late data.

Evaluated by: MWV

Evaluation Date: 11/2/2010

Waterloo Hydrogeologic, Inc. 460 Philip Street - Suite 101 Waterloo, Ontario, Canada Phone: +1 519 746 1798	**Pumping Test Analysis Report** Project: Thing Valley Number: 2010-0005 Client:



Pumping Test: **Recovery Test**

Analysis Method: **Theis Recovery**

Analysis Results:	Transmissivity:	5.08E+2 [ft²/d]	Conductivity:	1.45E+0 [ft/d]
Test parameters:	Pumping Well:	Pumping Well	Aquifer Thickness:	350 [ft]
	Casing radius:	0.25 [ft]	Confined Aquifer	
	Screen length:	350 [ft]		
	Boring radius:	0.42 [ft]		
	Discharge Rate:	81 [U.S. gal/min]		
	Pumping Time	4320 [min]		

Comments: South Well Recovery match to middle data.

Evaluated by: MWV

Evaluation Date: 11/2/2010

1

ABANDONED/DESTROYED

TOO CLOSE TO
SEPTIC TANK

2

PUMP IN WELL
NO POWER

PUMPED THIS W/
GENERATOR WORKED
FINE

JUST EAST OF
WATER STORAGE
TANK

COUNTY OF SAN DIEGO

DEPARTMENT OF ENVIRONMENTAL HEALTH
1255 Imperial Ave
San Diego, CA 92101
619-338-2222

WELL #2

INVOICE

ERMIT TYPE & NUMBER: LWEL 16225 **INVOICE DATE:** 16 SEP 2004

ERMIT OWNER: **CONTACT:**

IANOS DRILLING & PUMP
6052 LAWSON VALLEY RD.

AMUL CA 91935

APPLICANT:
FADEM ROBERT S&MARY O TRUST B1

PN: ~~611-070-02-00~~ 611-060-03 611-070-01

ITE ADDRESS: ~~2750~~ MCCAIN VALLEY RD

OCATION DESCRIPTION: ~~2750~~ MCCAIN VALLEY RD ~~JACUMBA 92036~~ BOULEVARD 91905 --

ROJECT DESCRIPTION/SCOPE

Number of Wells on Permit Application: 1
Description of Work: well drilling
Type of Use for Each Well: domestic

EE/DEPOSIT DETAILS

FEE CODE	DESCRIPTION	TIME ACCT.	ACCT. CODE	AMOUNT
6LE01--EHO	WATER WELL PERMIT	429E01	9773-773	390.00
			TOTAL AMOUNT DUE	$390.00

1-11? R 75 Sec 9

COUNTY OF SAN DIEGO
DEPARTMENT OF ENVIRONMENTAL HEALTH
WELL PERMIT APPLICATION

Parcel #2 120 acres

DEH USE ONLY
PERMIT # W 16225
WELL COMPUTER #
FEE:
WATER DIST:

1. Property Owner: Hamann Companies Phone: [illegible]-7124
[illegible] Mailing Address — El Cajon (City) — 92020 (Zip)

2. Well Location - Assessors Parcel Number ~~[illegible]-070-03~~ 611-060-03 611-070-01
McCain Hwy (Site Address) — ~~[illegible]~~ Boulevard (City) — Zip

3. Well Contractor - Well Driller Jim Mann [illegible] Company Name: Jim Mann Drilling
[illegible] (Mailing Address) — Jamul (City) — 91935 (Zip)

Phone#: [illegible] 1926 C-57#: [illegible] ☑ Cash Deposit ☐ Bond Posted

4. Use: ☐ Private ☐ Public ☐ Industrial ☐ Cathodic ☐ Other ______

5. Type of Work: ☑ New ☐ Reconstruction ☐ Destruction Time Extension: ☐ 1st ☐ 2nd

6. Type of Equipment: Air Rotary

7. Depth of Well: Proposed: 300 Existing: 0

8. Proposed:

Casing	Conductor Casing	Filter/Filler Material	Perforations
Type: Steel	☐ Yes ☐ No	☐ Yes ☐ No	From: ____ To: ____
Depth: 150	Depth: ____ ft.	From: ____ To: ____	From: ____ To: ____
Diameter 7 in.	Diameter ____ in.	Type: ____	From: ____ To: ____
Wall/Gauge: [illegible]	Wall/Gauge: ____	Wall/Gauge: ____	

9. Annular Seal: Depth: 50 ft. Sealing Material: Cement
Borehole diameter: 11 in. Conductor diameter: ____ in. Annular Thickness 2 in.

10. Date of Work: Start: [illegible] Complete: [illegible]

On sites served by public water, contact the local water agency for meter protection requirements.

I hereby agree to comply with all regulations of the Department of Environmental Health, and with all ordinances and laws of the County of San Diego and the State of California pertaining to well construction, repair, modification and destruction. Immediately upon completion of work, I will furnish the Department of Environmental Health with a complete and accurate log of the well. I accept responsibility for all work done as part of this permit and all work will be performed under my direct supervision.

Contractor's Signature: Jim Mann Date: 9-16-04

DISPOSITION OF APPLICATION (Department of Environmental Health Use only)

☒ **Approved** ☐ **Denied** Special Conditions: Grading and clearing associated with access to, or the construction, maintenance or destruction of water wells, may require additional permits from the County of San Diego and/or other agencies.

Specialist: [illegible signature] Date: 9/16/04

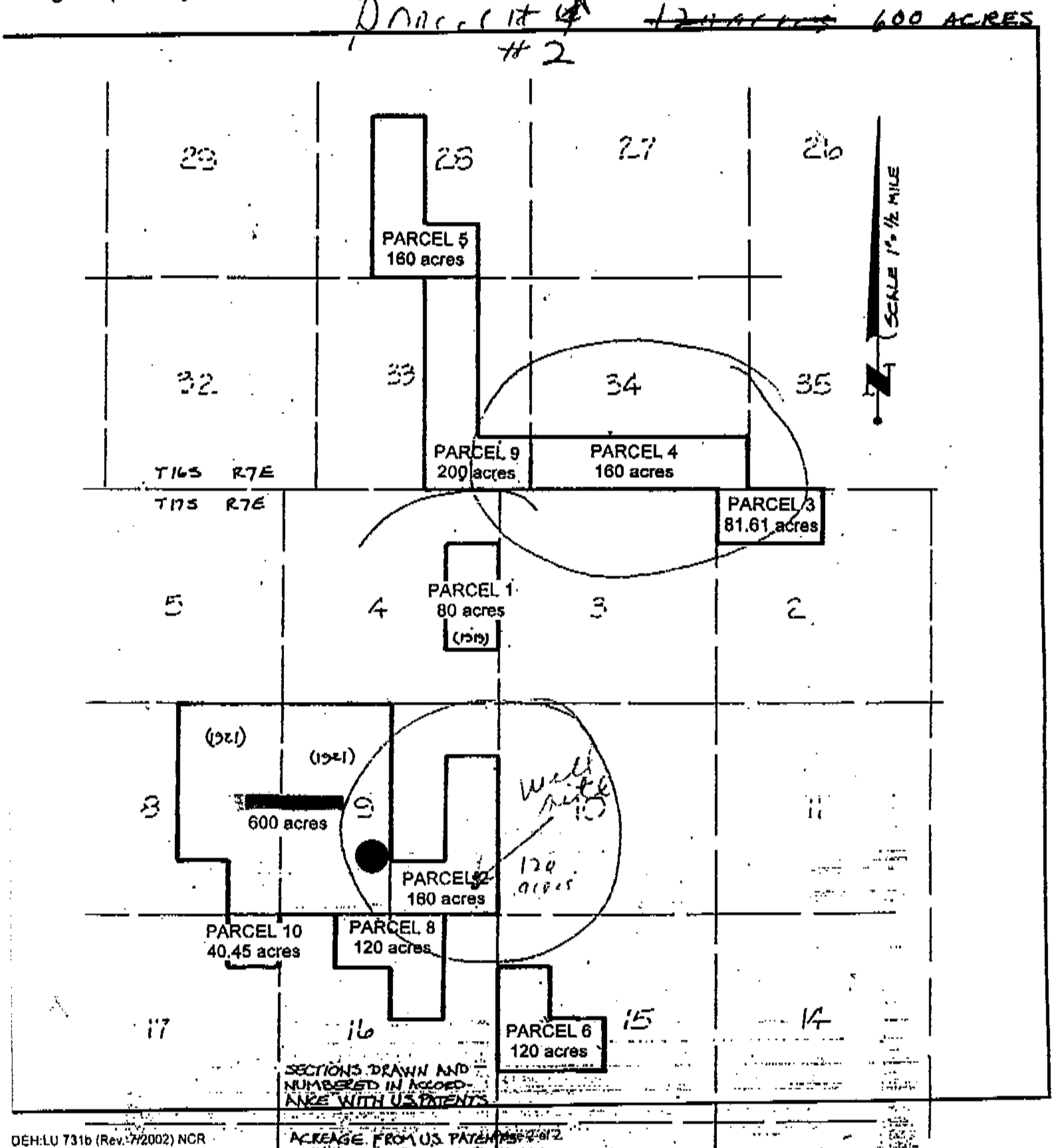
No public water to site

COUNTY OF SAN DIEGO
DEPARTMENT OF ENVIRONMENTAL HEALTH

Control #:
Assessor's Parcel Number:
611-060-03
611-070-01

LOCATION

Indicate below the vicinity and exact location of well with respect to the following items: Property lines, water bodies or water courses, drainage pattern, easements, roads, existing wells, sewers and private sewage disposal systems and other potential contamination sources, including dimensions.



County Mail Station — A-21

FIRST CARBON COPY

11 200 pump 160'

ASSESSORS PARCEL NUMBER:

COUNTY OF SAN DIEGO
DEPARTMENT OF HEALTH SERVICES
1700 PACIFIC HIGHWAY, SAN DIEGO, CA 92101-2417

WATER WELL DRILLERS REPORT
(INSERT under ORIGINAL PAGE w/carbon of State Form)

Notice of Intent No.
Local Permit No. or Date
State Well No.
Other Well No.

(1) OWNER: Name John Gibson #6
Address
City
Zip

(2) LOCATION OF WELL (See instructions):
County
Owner's Well Number
Well address if different from above
Township
Range
Section
Distance from cities, roads, railroads, fences, etc.

DEPARTMENT USE ONLY
Completed Well Construction:
Date
Date Inspected
Comments
Water Sample Taken?
Sanitarian's Approval:
6/4

(3) TYPE OF WORK:
New Well ☐ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in item (12)

(4) PROPOSED USE:
Domestic ☒
Irrigation ☒
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other ☐

(5) Equipment:
Rotary ☒ Reverse ☐
Cable ☐ Air ☒
Other ☐ Bucket ☐

(6) Gravel Pack: NEEAS
Yes ☐ No ☒ Size
Diameter of above
Packed from ___ to ___ ft.

(7) Casing Installed:
Steel ☒ Plastic ☐ Concrete ☐

(8) Perforations:
Type of perforation or size of screen

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot Size
0	24'	7"	156			

(9) WELL SEAL:
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth ___ ft.
Were strata sealed against pollution? Yes ☐ No ☒ Interval ___ ft.
Method of sealing BENTONITE-CEMENT

(10) WATER LEVELS:
Depth of first water, if known 70' ft.
Standing level after well completion 45' ft.

(11) WELL TESTS:
Was well test made? Yes ☒ No ☐ If yes, by whom? DRILLER
Type of test Pump ☐ Bailer ☐ Air lift ☒
Depth to water at start of test — ft. At end of test — ft.
Discharge 10 gal/min after 3 hours Water temperature Cool
Chemical analysis made? Yes ☐ No ☒ If yes, by whom?
Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

(12) WELL LOG: Total depth 600 ft. Depth of completed well 185? ft.
from ft. to ft. Formation (Describe by color, character, size or material)

0-2 - LOOSE SOIL
2-15 - D.G. GRAY
15-70 - BLACK' WHITE ROCK
70-71 - SOFTER (2 GPM)
71-90 - BLACK' WHITE ROCK
90-92 - SOFTER, ORANGE (2 GPM)
92-168 - BLACK' WHITE ROCK, SOME SOFT AREAS
168-178 - VERY SOFT (6 GPM)

Work Started 19 Completed 19

WELL DRILLERS STATEMENT: I hereby declare under penalty of perjury that the information provided in this report is true. This water well was installed in compliance with San Diego County Code and State of California, Department of Water Resources, Bulletin No. 74.

SIGNED [signature]
(Well Driller)

NAME
(Person, firm, or Corporation) (Type or Print)

ADDRESS

CITY ZIP

LICENSE NO. DATE THIS REPORT

DUPLICATE
Driller's Copy

Page 1 of 1

Owner's Well No. 2

Date Work Began 10-1-04, Ended 10-4-04

Local Permit Agency San Diego E.H.S.

Permit No. LWEL16225 Permit Date 9-16-04

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 0909404

DWR USE ONLY — DO NOT FILL IN
STATE WELL NO./STATION NO.
LATITUDE / LONGITUDE
APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) x VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD rotary FLUID air

DEPTH FROM SURFACE Ft. to Ft.	DESCRIPTION Describe material, grain size, color, etc.
0 – 2	loose soil
2 – 15	dg, gray
15 – 70	black & white rock
70 – 71	softer
71 – 90	black & white rock
90 – 92	softer, orange
92 – 168	black & white rock
	some softer areas
168 – 178	very soft

TOTAL DEPTH OF BORING 600 (Feet)

TOTAL DEPTH OF COMPLETED WELL 185 (Feet)

WELL OWNER

Name Hamann Companies

Mailing Address 1000 Pioneer Way

El Cajon, Ca 92020

CITY STATE ZIP

WELL LOCATION

Address McCain Valley

City Jacumba

County San Diego

APN Book 611 Page 070 Parcel 02

Township 17 Range 7E Section 9

Lat ___ DEG. MIN. SEC. N Long ___ DEG. MIN. SEC. W

LOCATION SKETCH

NORTH / WEST / EAST / SOUTH

See attached

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. ***PLEASE BE ACCURATE & COMPLETE.***

ACTIVITY (✓)

x NEW WELL

MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)

___ DESTROY (*Describe Procedures and Materials Under "GEOLOGIC LOG"*)

USES (✓)

WATER SUPPLY
x Domestic ___ Public
___ Irrigation ___ Industrial

MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 70 (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 45 (Ft.) & DATE MEASURED 10-4-04

ESTIMATED YIELD * 10 (GPM) & TEST TYPE airlift

TEST LENGTH 3 (Hrs.) TOTAL DRAWDOWN — (Ft.)

** May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft. to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0 – 24	11	x				steel	6 5/8	.188	

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft. to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0 – 24	x	x		

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
✓ Other ___

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME JIM MANOS DRILLING & PUMP
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

15052 LAWSON VLY RD, JAMUL, CA 91935
ADDRESS CITY STATE ZIP

Signed [signature] C-57 LICENSED WATER WELL CONTRACTOR — 3-1-06 DATE SIGNED — 360723 C-57 LICENSE NUMBER

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

#3

NO PUMP
NO POWER

WELL IS CAPPED

LOW GPM

COUNTY OF SAN DIEGO

DEPARTMENT OF ENVIRONMENTAL HEALTH
1255 Imperial Ave
San Diego, CA 92101
619-338-2222

#3

INVOICE

PERMIT TYPE & NUMBER: LWEL 16223
INVOICE DATE: 16 SEP 2004

PERMIT OWNER:
MANOS DRILLING & PUMP
16052 LAWSON VALLEY RD.

JAMUL CA 91935

CONTACT:

APN: ~~529-150-01-00~~ 611-060-03 611-070-01

APPLICANT:
FADEM ROBERT S&MARY O TRUST B1

SITE ADDRESS: ~~0057~~ MCCAIN VALLEY RD BOULEVARD 91905

LOCATION DESCRIPTION: ~~3057~~ MCCAIN VALLEY RD. ~~EL CAJON 02020~~

PROJECT DESCRIPTION/SCOPE

Number of Wells on Permit Application: 1
Description of Work: well drilling
Type of Use for Each Well: domestic

FEE/DEPOSIT DETAILS

FEE CODE	DESCRIPTION	TIME ACCT.	ACCT. CODE	AMOUNT
6LE01--EHO	WATER WELL PERMIT	429E01	9773-773	390.00
			09-16-04 1128 9773 773 429E01 CHECK	
			TOTAL AMOUNT DUE	$390.00

T-16S
R 7E
Sec. 34

COUNTY OF SAN DIEGO
DEPARTMENT OF ENVIRONMENTAL HEALTH
WELL PERMIT APPLICATION

Parcel 1 ~~4 160 acres~~ 600 ACRES

DEH USE ONLY
PERMIT # WEL16223
WELL COMPUTER #:
FEE:
WATER DIST:

1. Property Owner: Hamann Companies Phone: 440-7424
   1000 Pioneer Way — Mailing Address; El Cajon — City; 92020 — Zip
2. Well Location - Assessors Parcel Number: ~~COD~~ ~~529-150-34~~ 611-060-03 611-070-01
   McCain Valley — Site Address; ~~[illegible]~~ BOULEVARD — City; 91905 — Zip
3. Well Contractor - Well Driller: Van Adams Company Name: Van Adams Drilling
   11052 Lawson Way — Mailing Address; Jamul — City; 91935 — Zip
   Phone#: 445-1926 C-57#: 360722 ☒ Cash Deposit ☐ Bond Posted
4. Use: ☒ Private ☐ Public ☐ Industrial ☐ Cathodic ☐ Other ________
5. Type of Work: ☒ New ☐ Reconstruction ☐ Destruction Time Extension: ☐ 1st ☐ 2nd
6. Type of Equipment: Air Rotary
7. Depth of Well: Proposed: 300 Existing: Ø
8. Proposed:

Casing	Conductor Casing	Filter/Filler Material	Perforations
Type: Steel	☐ Yes ☐ No	☐ Yes ☐ No	From: ____ To: ____
Depth: 20	Depth: ____ ft.	From: ____ To: ____	From: ____ To: ____
Diameter 7 in.	Diameter ____ in.	Type: ____	From: ____ To: ____
Wall/Gauge: .188	Wall/Gauge: ____	Wall/Gauge: ____	

9. Annular Seal: Depth: 20 ft. Sealing Material: Bentonite Cement
   Borehole diameter: 11 in. Conductor diameter: ____ in. Annular Thickness 2 in.
10. Date of Work: Start: 9-27-04 Complete: 9-30-04

On sites served by public water, contact the local water agency for meter protection requirements.

I hereby agree to comply with all regulations of the Department of Environmental Health, and with all ordinances and laws of the County of San Diego and the State of California pertaining to well construction, repair, modification and destruction. Immediately upon completion of work, I will furnish the Department of Environmental Health with a complete and accurate log of the well. I accept responsibility for all work done as part of this permit and all work will be performed under my direct supervision.

Contractor's Signature: Van Adams Date: 9-16-04

DISPOSITION OF APPLICATION (Department of Environmental Health Use only)

☒ **Approved** ☐ **Denied** Special Conditions: Grading and clearing associated with access to, or the construction, maintenance or destruction of water wells, may require additional permits from the County of San Diego and/or other agencies.

Specialist: Danny O'Calla Date: 9/16/04

DEH-LU-731a (Rev. 4/02) NCR

No public water to site

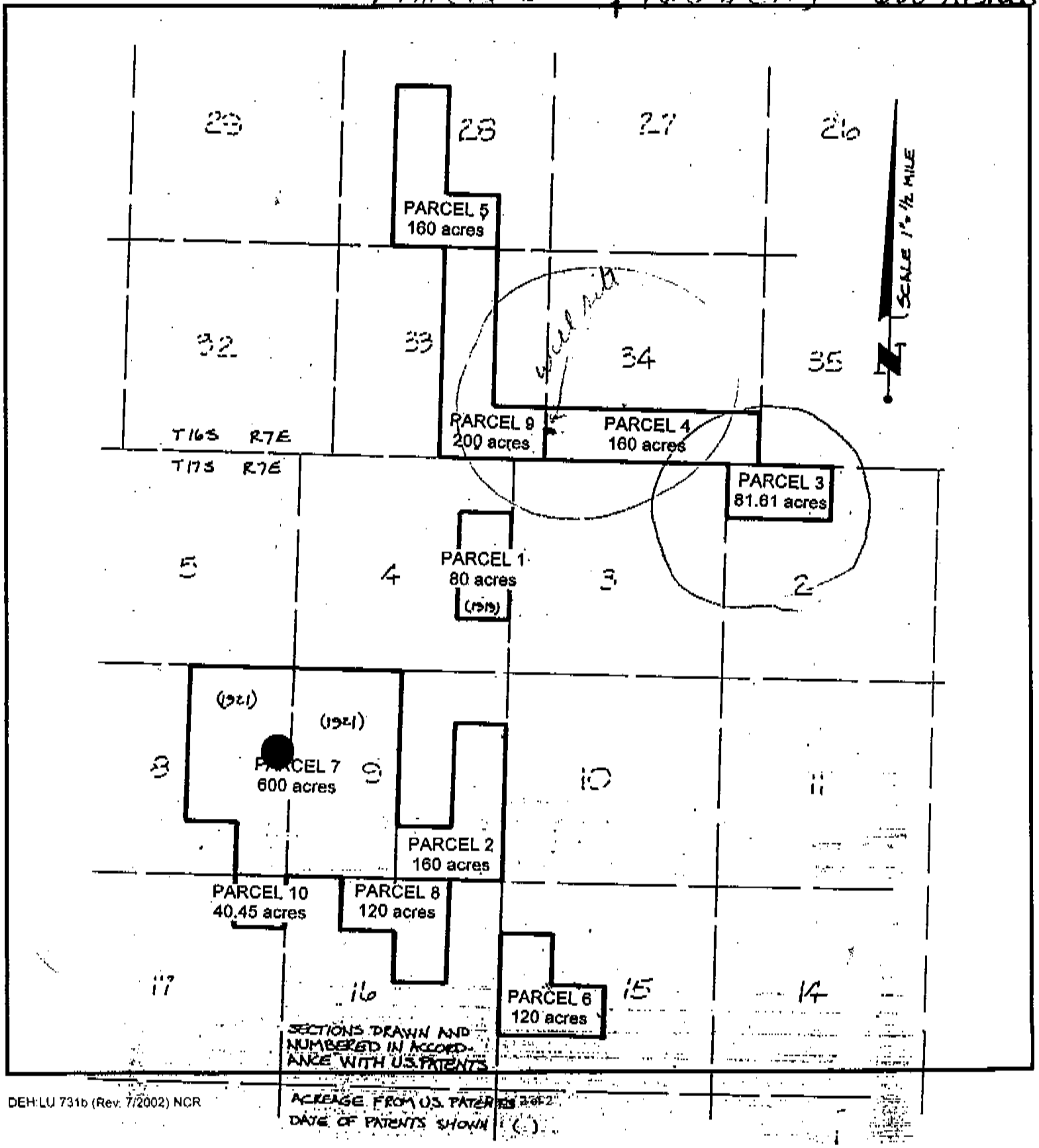
COUNTY OF SAN DIEGO
DEPARTMENT OF ENVIRONMENTAL HEALTH

Control #: LWEL 16223
Assessor's Parcel Number: ~~529-150-~~
611-060-03
611-070-01

LOCATION

Indicate below the vicinity and exact location of well with respect to the following items: Property lines, water bodies or water courses, drainage pattern, easements, roads, existing wells, sewers and private sewage disposal systems and other potential contamination sources, including dimensions.

Parcel # ~~4 160 acres~~ 600 Acres



#3

County Mail Station — A-21

ASSESSORS PARCEL NUMBER:

FIRST CARBON COPY

COUNTY OF SAN DIEGO
DEPARTMENT OF HEALTH SERVICES
1700 PACIFIC HIGHWAY, SAN DIEGO, CA 92101-2417

WATER WELL DRILLERS REPORT
(INSERT under ORIGINAL PAGE w/carbon of State Form)

Notice of Intent No. ______
Local Permit No. or Date ______

State Well No. ______
Other Well No. ______

(1) OWNER: Name John Gibson #5
Address McLAIN VALLEY
City ______ Zip ______

(2) LOCATION OF WELL (See instructions):
County ______ Owner's Well Number ______
Well address if different from above ______
Township ______ Range ______ Section ______
Distance from cities, roads, railroads, fences, etc. ______

DEPARTMENT USE ONLY
Completed Well Construction:
Date ______
Date Inspected ______
Comments ______
Water Sample Taken? ______
Sanitarian's Approval: ______

5 3/4

(3) TYPE OF WORK:
New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item (12)

(4) PROPOSED USE:
Domestic ☒
Irrigation ☒
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other ☐

(12) WELL LOG: Total depth 900 ft. Depth of completed well 900 ft.
from ft. to ft. Formation (Describe by color, character, size or material)

0 - 2 - SANDY TOPSOIL
2 - 102 - BLACK & WHITE & ORANGE, WEATHERED AREAS, LOOSE ROCKS, SAND (DRIP)
102 - 110 - BLACK & WHITE ROCK
110 - 112 - SOFTER (2 GPM) SAND
112 - 348 - BLACK & WHITE ROCK
348 - 349 - SOFTER (1/2 GPM)
349 - 900 - BLACK & WHITE ROCK SOME SOFTER AREAS

(5) Equipment:
Rotary ☒ Reverse ☐
Cable ☐ Air ☒
Other ☐ Bucket ☐

(6) Gravel Pack: NEEDS
Yes ☐ No ☒ Size ______
Diameter of above ______
Packed from ______ to ______ ft.

(7) Casing Installed:
Steel ☒ Plastic ☐ Concrete ☐

(8) Perforations:
Type of perforation or size of screen ______

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot Size
0	209	6 5/8	.188			

Work Started ______ 19__ Completed ______ 19__

(9) WELL SEAL:
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth ______ ft.
Were strata sealed against pollution? Yes ☐ No ☐ Interval ______ ft.
Method of sealing BENTONITE - CEMENT

(10) WATER LEVELS:
Depth of first water, if known 50' ft.
Standing level after well completion 35' ft.

(11) WELL TESTS:
Was well test made? Yes ☒ No ☐ If yes, by whom? DRILLER
Type of test Pump ☐ Bailer ☐ Air lift ☒
Depth to water at start of test — ft. At end of test — ft.
Discharge 2 gal/min after 2 hours Water temperature COOL
Chemical analysis made? Yes ☐ No ☒ If yes, by whom?
Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

WELL DRILLERS STATEMENT: I hereby declare under penalty of perjury that the information provided in this report is true. This water well was installed in compliance with San Diego County Code and State of California, Department of Water Resources, Bulletin No. 74.

SIGNED [signature]
(Well Driller)

NAME ______
(Person, firm, or Corporation) (Type or Print)

ADDRESS ______

CITY ______ ZIP ______

LICENSE NO. ______ DATE THIS REPORT ______

DHS:EHP-732 (83) CONFIDENTIAL — NOT FOR PUBLIC USE — WATER CODE SEC. 13752

DUPLICATE
Driller's Copy

Page 1 of 1
Owner's Well No. 3
Date Work Began 9-27-04, Ended 9-30-04
Local Permit Agency San Diego E.H.S.
Permit No. LWEL16223 Permit Date 9-16-04

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

No. 0909443

DWR USE ONLY — DO NOT FILL IN
STATE WELL NO./STATION NO.
LATITUDE / LONGITUDE
APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD rotary FLUID air

DEPTH FROM SURFACE Ft. to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
0 – 2	sandy topsoil
2 – 102	black, white, orange, very soft areas, loose rocks & sand
102 – 110	black & white rock
110 – 112	softer
112 – 348	black & white rock
349 – 349	soft
349 – 900	black & white rock, some softer areas

TOTAL DEPTH OF BORING 900 (Feet)
TOTAL DEPTH OF COMPLETED WELL 900 (Feet)

WELL OWNER

Name Hamann Companies
Mailing Address 1000 Pioneer Way
El Cajon, Ca 92020
CITY STATE ZIP

WELL LOCATION

Address 3057 McCain Valley Rd
City Jacumba
County San Diego
APN Book 529 Page 150 Parcel 01
Township 17 Range 7E Section 34
Lat ___ DEG. MIN. SEC. N Long ___ DEG. MIN. SEC. W

LOCATION SKETCH

NORTH / WEST / EAST / SOUTH

See Attached

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

X NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)

___ DESTROY (*Describe Procedures and Materials Under "GEOLOGIC LOG"*)

USES (✓)

WATER SUPPLY
X Domestic ___ Public
___ Irrigation ___ Industrial
MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 50 (Ft.) BELOW SURFACE
DEPTH OF STATIC WATER LEVEL 35 (Ft.) & DATE MEASURED 9-30-04
ESTIMATED YIELD * 2 (GPM) & TEST TYPE airlift
TEST LENGTH 2 (Hrs.) TOTAL DRAWDOWN — (Ft.)
** May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft. to Ft.	BORE-HOLE DIA. (Inches)	TYPE: BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0 – 209	11	x				steel	6 5/8	.188	

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft. to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0 – 209	x	x		

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
✓ Soil/Water Chemical Analyses
✓ Other ___

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME JIM MANOS DRILLING & PUMP
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

16052 LAWSON VLY RD, JAMUL, CA 91935
ADDRESS CITY STATE ZIP

Signed [signature] C-57 LICENSED WATER WELL CONTRACTOR
3-6-06 DATE SIGNED
360722 C-57 LICENSE NUMBER

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

#4

Power at well

NO pump

Across road from Bathrooms in West Canyon

water was discolored & hence quit using

COUNTY OF SAN DIEGO
DEPARTMENT OF ENVIRONMENTAL HEALTH
1255 Imperial Ave
San Diego, CA 92101
619-338-2222

#4

INVOICE

ERMIT TYPE & NUMBER: LWEL 16226 INVOICE DATE: 16 SEP 2004

ERMIT OWNER: CONTACT:
ADEM ROBERT S&MARY O TRUST B1
353 OCEAN ST

92008

611-060-03
PN: ~~611-110-01-00~~ 611-070-01

APPLICANT:
FADEM ROBERT S&MARY O TRUST B1

ITE ADDRESS: ~~2533~~ MCCAIN VALLEY RD
OCATION DESCRIPTION: ~~2533~~ MCCAIN VALLEY RD,

ROJECT DESCRIPTION/SCOPE
umber of Wells on Permit Application:1
escription of Work:new
ype of Use for Each Well:private

EE/DEPOSIT DETAILS

FEE CODE	DESCRIPTION	TIME ACCT.	ACCT. CODE	AMOUNT
6LE01--EHO	WATER WELL PERMIT	429E01	9773-773	390.00
			09-16-04 11:30 9773 773 429E01 CHECK	[illegible] $390.00
			TOTAL AMOUNT DUE	$390.00

276
6.15

COUNTY OF SAN DIEGO
DEPARTMENT OF ENVIRONMENTAL HEALTH
WELL PERMIT APPLICATION

Parcel 14 67 600

DEH USE ONLY
PERMIT # W LWCL162
WELL COMPUTER #
FEE:
WATER DIST:

1. Property Owner: Hamann Companies Phone: 440-7424
1000 Pioneer Way Mailing Address — El Cajon City — 92020 Zip
2. Well Location - Assessors Parcel Number ~~611-110-01~~ 611-060-03 611-070-01 BOULEVARD 91905
Site Address — City — Zip
3. Well Contractor - Well Driller Jim Mayes Company Name:
Mailing Address — City — Zip
Phone#: 445-1926 C-57#: 722 ☐ Cash Deposit ☐ Bond Posted
4. Use: ☒ Private ☐ Public ☐ Industrial ☐ Cathodic ☐ Other
5. Type of Work: ☐ New ☐ Reconstruction ☐ Destruction Time Extension: ☐ 1st ☐ 2nd
6. Type of Equipment: Air Rotary
7. Depth of Well: Proposed: 300 Existing:
8. Proposed:

Casing		Conductor Casing		Filter/Filler Material		Perforations	
Type:	Steel	☐ Yes ☐ No		☐ Yes ☐ No		From:	To:
Depth:	20	Depth:	ft.	From:	To:	From:	To:
Diameter	7 in.	Diameter	in.	Type:		From:	To:
Wall/Gauge:		Wall/Gauge:		Wall/Gauge:			

9. Annular Seal: Depth: ___ ft. Sealing Material: ___
Borehole diameter: ___ in. Conductor diameter: ___ in. Annular Thickness ___ in.
10. Date of Work: Start: ___ Complete: 7-27-04

On sites served by public water, contact the local water agency for meter protection requirements.

I hereby agree to comply with all regulations of the Department of Environmental Health, and with all ordinances and laws of the County of San Diego and the State of California pertaining to well construction, repair, modification and destruction. Immediately upon completion of work, I will furnish the Department of Environmental Health with a complete and accurate log of the well. I accept responsibility for all work done as part of this permit and all work will be performed under my direct supervision.

Contractor's Signature: [signature] Date:

DISPOSITION OF APPLICATION (Department of Environmental Health Use only)

☒ Approved ☐ Denied Special Conditions: Grading and clearing associated with access to, or the construction, maintenance or destruction of water wells, may require additional permits from the County of San Diego and/or other agencies.

Specialist: [signature] Date: 9/16/04

DEH-LU-731a (Rev. 4/02) NCR

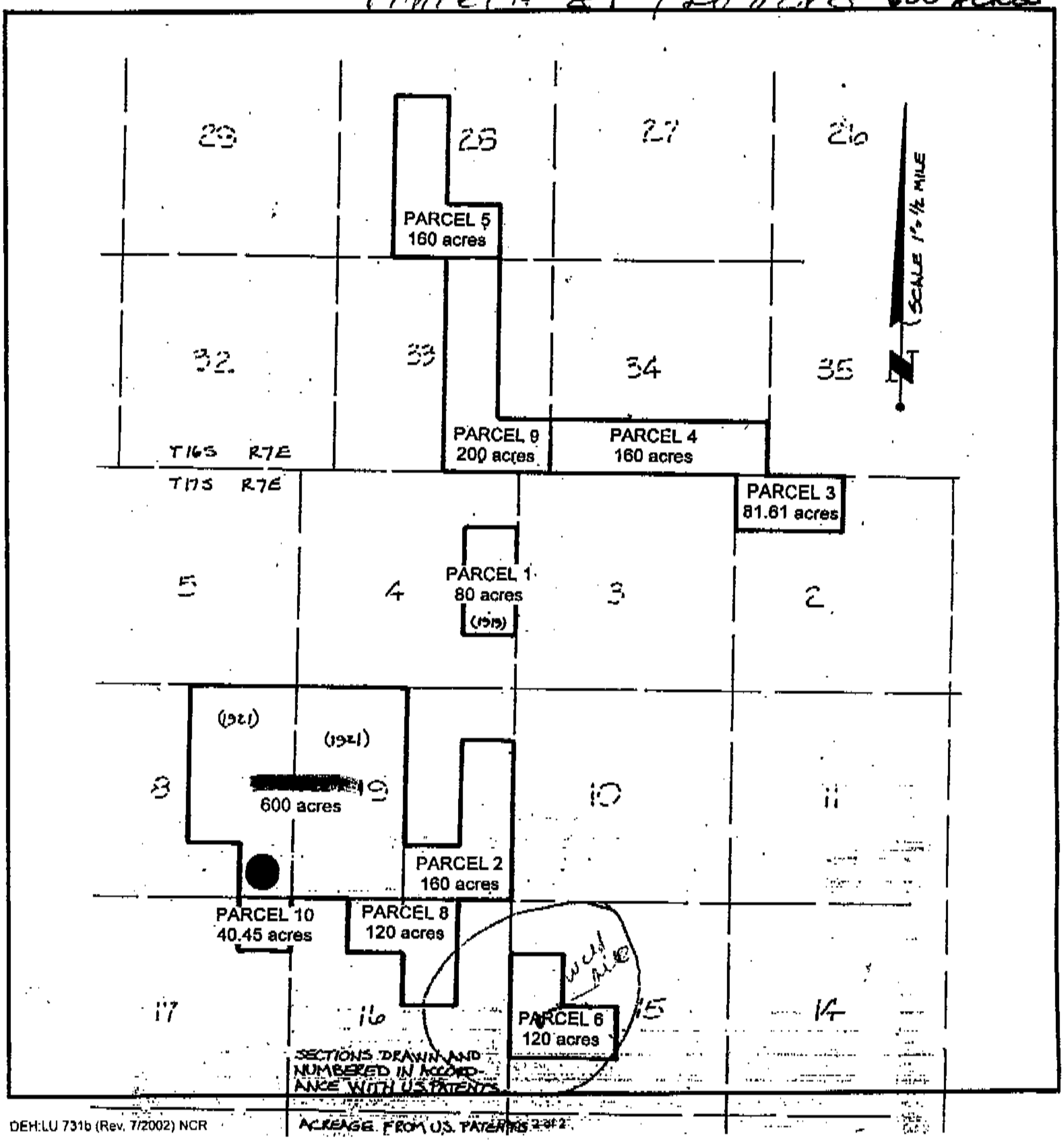
COUNTY OF SAN DIEGO
DEPARTMENT OF ENVIRONMENTAL HEALTH

Control #: LWCL 16226
Assessor's Parcel Number: ~~611-110-07~~
611-060-03
611-070-01

LOCATION

Indicate below the vicinity and exact location of well with respect to the following items: Property lines, water bodies or water courses, drainage pattern, easements, roads, existing wells, sewers and private sewage disposal systems and other potential contamination sources, including dimensions.

Parcel # ~~6~~ 7 ~~1200 acres~~ 600 ACRES



County Mail Station — A-21

FIRST CARBON COPY

ASSESSORS PARCEL NUMBER:

COUNTY OF SAN DIEGO
DEPARTMENT OF HEALTH SERVICES
1700 PACIFIC HIGHWAY, SAN DIEGO, CA 92101-2417

WATER WELL DRILLERS REPORT
(INSERT under ORIGINAL PAGE w/carbon of State Form)

Notice of Intent No. ______
Local Permit No. or Date ______

State Well No. ______
Other Well No. ______

(1) OWNER: Name JOHN WELL NO 2
Address ROYAL ACRES
City ______ Zip ______

(2) LOCATION OF WELL (See Instructions):
County ______ Owner's Well Number ______
Well address if different from above ______
Township ______ Range ______ Section ______
Distance from cities, roads, railroads, fences, etc. ______

(12) WELL LOG: Total depth 260 ft. Depth of completed well 195 ft.
from ft. to ft. Formation (Describe by color, character, size or material)

0-91 — SANDY, D.G.
91-130 — SOFT, ORANGE, WHITE & BROWN
130-132 — GRAY SOFT (5 GPM)
133-185 — SOFT ORANGE, WHITE, BLACK
185-190 — LOOSE ROCKS (20 GPM)
190-260 — SOFT & HARD

DEPARTMENT USE ONLY

Completed Well Construction:
Date ______
Date Inspected ______
Comments ______
Water Sample Taken? ______
Sanitarian's Approval: ______

Jeffrey #8

(3) TYPE OF WORK:
New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item (12)

(4) PROPOSED USE:
Domestic ☒
Irrigation ☒
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other ☐

(5) Equipment:
Rotary ☒ Reverse ☐
Cable ☐ Air ☒
Other ☐ Bucket ☐

(6) Gravel Pack:
Yes ☒ No ☐ Size 3/8ths
Diameter of above 4"
Packed from 0 to 185 ft.

(7) Casing Installed:
Steel ☒ Plastic ☐ Concrete ☐

(8) Perforations:
Type of perforation or size of screen

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot Size
0	91	6 5/8	185	0	185	3/32ths

(9) WELL SEAL:
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 91' ft.
Were strata sealed against pollution? Yes ☐ No ☒ Interval ______ ft.
Method of sealing BENTONITE - CEMENT

(10) WATER LEVELS:
Depth of first water, if known 130' ft.
Standing level after well completion 85 ft.

(11) WELL TESTS:
Was well test made? Yes ☒ No ☐ If yes, by whom? DRILLER
Type of test Pump ☐ Bailer ☐ Air lift ☐
Depth to water at start of test — ft. At end of test — ft.
Discharge 15 gal/min after 1 hours Water temperature COOL
Chemical analysis made? Yes ☐ No ☒ If yes, by whom?
Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

Work Started 19 Completed 19

WELL DRILLERS STATEMENT: I hereby declare under penalty of perjury that the information provided in this report is true. This water well was installed in compliance with San Diego County Code and State of California, Department of Water Resources, Bulletin No. 74.

SIGNED [signature]
(Well Driller)

NAME ______
(Person, firm, or Corporation) (Type or Print)

ADDRESS ______

CITY ______ ZIP ______

LICENSE NO. ______ DATE THIS REPORT ______

DHS:EHP-732 (83) CONFIDENTIAL — NOT FOR PUBLIC USE — WATER CODE SEC. 13752

DUPLICATE
Driller's Copy

Page 1 of 1

Owner's Well No. # 4

Date Work Began 9-25-04, Ended 9-27-04

Local Permit Agency San Diego E.H.S.

Permit No. LWEL16226 Permit Date 9-16-04

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 0909442

DWR USE ONLY — DO NOT FILL IN

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) x VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD rotary FLUID air

DEPTH FROM SURFACE Ft. to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
0 – 91	sandy, dg
91 – 130	soft, orange, white & brown
130 – 133	very soft
133 – 185	soft, orange, white & black
185 – 190	loose rocks
190 – 260	soft & hard

TOTAL DEPTH OF BORING 260 (Feet)

TOTAL DEPTH OF COMPLETED WELL 185 (Feet)

WELL OWNER

Name Hamann Companies

Mailing Address 1000 Pioneer Way

El Cajon, Ca. 92020

CITY STATE ZIP

WELL LOCATION

Address McCain Valley Rd

City Jacumba

County San Diego

APN Book 611 Page 110 Parcel 01

Township 17 Range 7E Section 15

Lat ___ DEG. MIN. SEC. N Long ___ DEG. MIN. SEC. W

LOCATION SKETCH

NORTH

WEST — See attached — EAST

SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

x NEW WELL

MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)

___ DESTROY (*Describe Procedures and Materials Under "GEOLOGIC LOG"*)

USES (✓)

WATER SUPPLY
x Domestic ___ Public
___ Irrigation ___ Industrial

MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 130 (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 35 (Ft.) & DATE MEASURED 9-27-04

ESTIMATED YIELD * 15 (GPM) & TEST TYPE airlift

TEST LENGTH 1 (Hrs.) TOTAL DRAWDOWN -- (Ft.)

* *May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft. to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0 – 91	11	x				steel	5 5/8	.188	
0 – 185	6½		x			pvc	4	sch 40	

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft. to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0 – 91	x	x		
0 – 185			x	5/16 pea gravel

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other ___

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME JIM MANOS DRILLING & PUMP
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

16052 LAWSON VLY RD, JAMUL, CA 91935
ADDRESS CITY STATE ZIP

Signed [signature] 2-6-06 360722
C-57 LICENSED WATER WELL CONTRACTOR DATE SIGNED C-57 LICENSE NUMBER

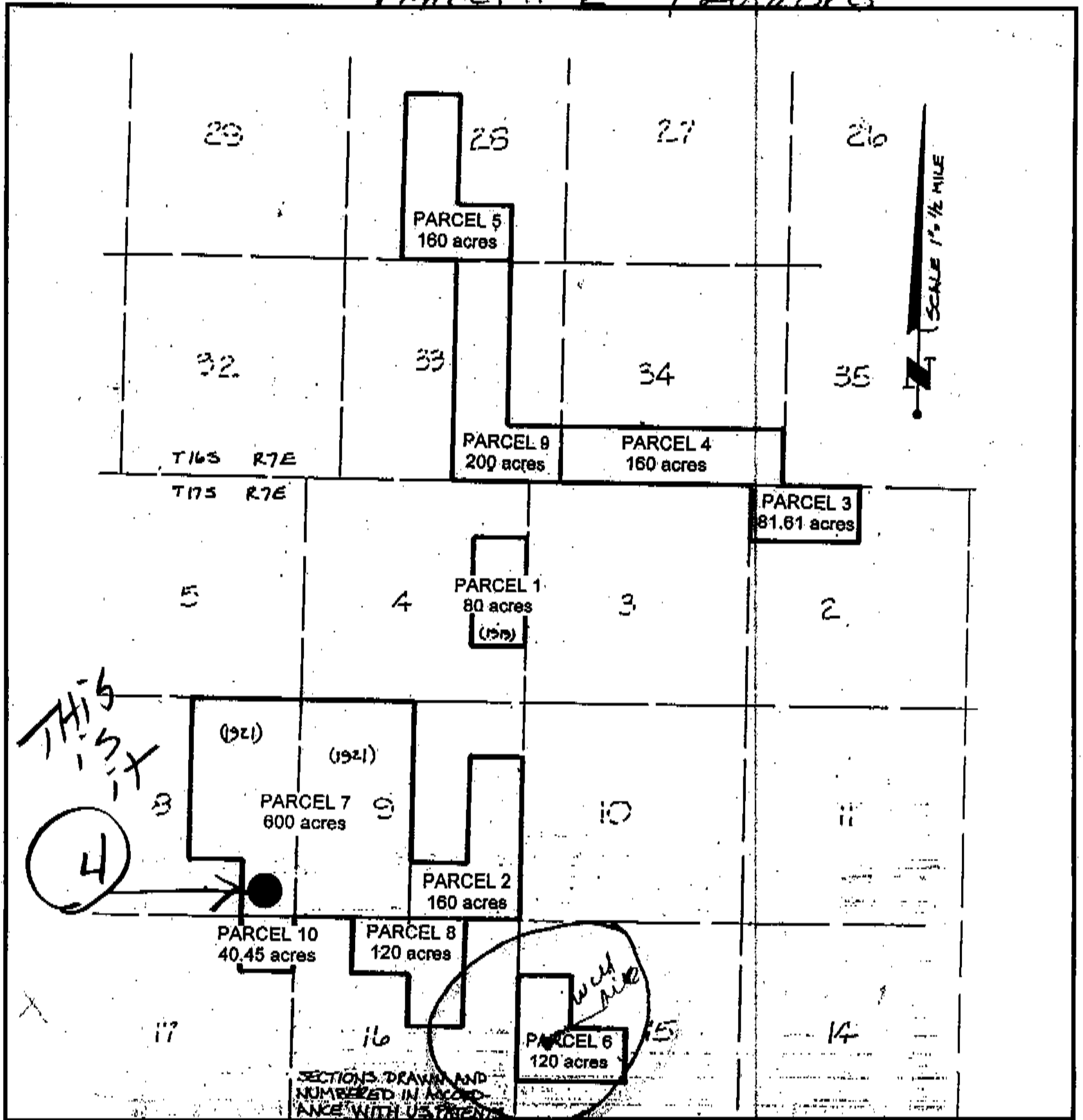
COUNTY OF SAN DIEGO
DEPARTMENT OF ENVIRONMENTAL HEALTH

Control #: LWCL 16226
Assessor's Parcel Number: 611-110-01

LOCATION

Indicate below the vicinity and exact location of well with respect to the following items: Property lines, water bodies or water courses, drainage pattern, easements, roads, existing wells, sewers and private sewage disposal systems and other potential contamination sources, including dimensions.

Parcel # 6 120 acres



5

Pump & power
to well

Have never
used this well

COUNTY OF SAN DIEGO
DEPARTMENT OF ENVIRONMENTAL HEALTH
1255 Imperial Ave
San Diego, CA 92101
619-338-2222

H5

INVOICE

PERMIT TYPE & NUMBER: LWEL 16224 **INVOICE DATE:** 16 SEP 2004

PERMIT OWNER: **CONTACT:**
MANOS DRILLING & PUMP
16052 LAWSON VALLEY RD.

JAMUL CA 91935

APPLICANT:
HAMANN ROBERT D FAMILY TRUST 04

APN: 611-030-01-00

SITE ADDRESS: 3041 MCCAIN VALLEY RD

LOCATION DESCRIPTION: 3041 MCCAIN VALLEY RD. JACUMBA 91935

PROJECT DESCRIPTION/SCOPE
Number of Wells on Permit Application: 1
Description of Work: well drilling
Type of Use for Each Well: domestic

FEE/DEPOSIT DETAILS

FEE CODE	DESCRIPTION	TIME ACCT.	ACCT. CODE	AMOUNT
6LE01--EHO	WATER WELL PERMIT	429E01	9773-773	390.00
			09-16-04 11:32 9773 773 429E01 CHECK	390.00
			TOTAL AMOUNT DUE	$390.00

R-
Sec 4

COUNTY OF SAN DIEGO
DEPARTMENT OF ENVIRONMENTAL HEALTH
WELL PERMIT APPLICATION

Parcel #1 80 Acres

DEH USE ONLY
PERMIT: LWEL 16224
WELL COMPUTER #
FEE:
WATER DIST:

1. Property Owner: Homann Company Phone: 7424
   1000 ... Mailing Address — City — Zip

2. Well Location - Assessors Parcel Number 611-030-081
   McClain ... Site Address — City — Zip

3. Well Contractor - Well Driller Jim Manos Company Name: ... Drilling
   Mailing Address — City — Zip

   Phone#: 445-1926 C-57#: 361722 ☒ Cash Deposit ☐ Bond Posted

4. Use: ☐ Private ☐ Public ☐ Industrial ☐ Cathodic ☐ Other
5. Type of Work: ☐ New ☐ Reconstruction ☐ Destruction Time Extension: ☐ 1st ☐ 2nd
6. Type of Equipment:
7. Depth of Well: Proposed: 300 Existing: —
8. Proposed:

Casing	Conductor Casing	Filter/Filler Material	Perforations
Type: Steel	☐ Yes ☐ No	☐ Yes ☐ No	From: To:
Depth:	Depth: ft.	From: To:	From: To:
Diameter in.	Diameter in.	Type:	From: To:
Wall/Gauge:	Wall/Gauge:	Wall/Gauge:	

9. Annular Seal: Depth: ft. Sealing Material:
   Borehole diameter: in. Conductor diameter: in. Annular Thickness in.

10. Date of Work: Start: Complete:

On sites served by public water, contact the local water agency for meter protection requirements.

I hereby agree to comply with all regulations of the Department of Environmental Health, and with all ordinances and laws of the County of San Diego and the State of California pertaining to well construction, repair, modification and destruction. Immediately upon completion of work, I will furnish the Department of Environmental Health with a complete and accurate log of the well. I accept responsibility for all work done as part of this permit and all work will be performed under my direct supervision.

Contractor's Signature: [signature] Date: 9-16-04

DISPOSITION OF APPLICATION (Department of Environmental Health Use only)

☒ **Approved** ☐ **Denied** Special Conditions: Grading and clearing associated with access to, or the construction, maintenance or destruction of water wells, may require additional permits from the County of San Diego and/or other agencies.

Specialist: [signature] Date: 9/16/04

DEH-LU-731a (Rev. 4/02) NCR

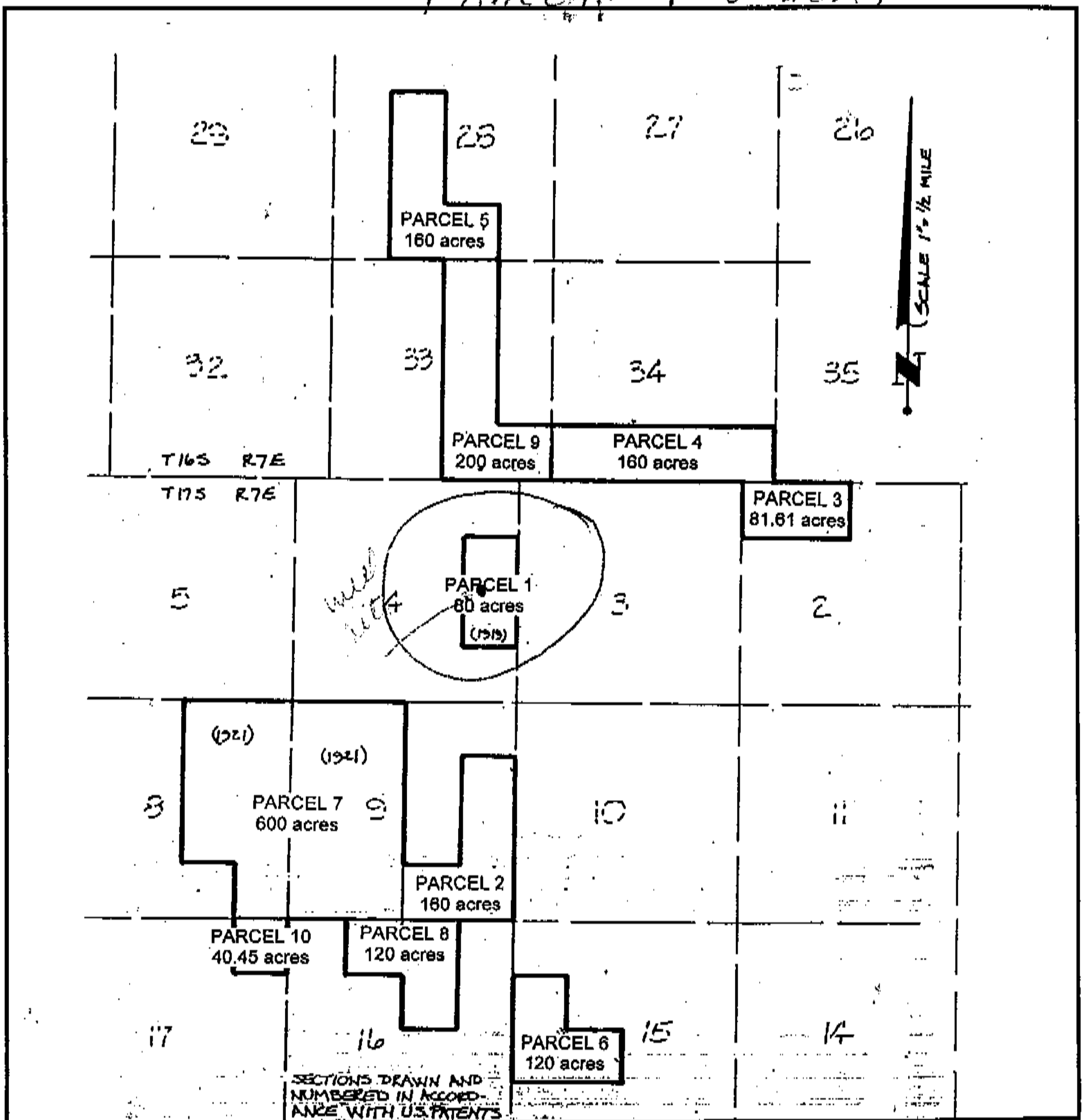
COUNTY OF SAN DIEGO
DEPARTMENT OF ENVIRONMENTAL HEALTH

Control #: LWEL 16274
Assessor's Parcel Number: 611-030-08

LOCATION

Indicate below the vicinity and exact location of well with respect to the following items: Property lines, water bodies or water courses, drainage pattern, easements, roads, existing wells, sewers and private sewage disposal systems and other potential contamination sources, including dimensions.

Parcel # 1 80 acres



ACREAGE FROM U.S. PATENTS
DATE OF PATENTS SHOWN ( )

County Mail Station — A-21

FIRST CARBON COPY

O.K. well

#5

ASSESSORS PARCEL NUMBER: ______ ______ ______

COUNTY OF SAN DIEGO
DEPARTMENT OF HEALTH SERVICES
1700 PACIFIC HIGHWAY, SAN DIEGO, CA 92101-2417

Notice of Intent No. ______
Local Permit No. or Date ______

WATER WELL DRILLERS REPORT
(INSERT under ORIGINAL PAGE w/carbon of State Form)

State Well No. ______
Other Well No. ______

(1) OWNER: Name JOHN WELL #3
Address ______
City ______ Zip ______

(2) LOCATION OF WELL (See instructions):
County ______ Owner's Well Number ______
Well address if different from above ______
Township ______ Range ______ Section ______
Distance from cities, roads, railroads, fences, etc. ______

DEPARTMENT USE ONLY
Completed Well Construction:
Date ______
Date Inspected ______
Comments ______
Water Sample Taken? ______
Sanitarian's Approval:

6/A

(3) TYPE OF WORK:
New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item (12)

(4) PROPOSED USE:
Domestic ☒
Irrigation ☒
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other ☐

(5) Equipment:
Rotary ☒ Reverse ☐
Cable ☐ Air ☒
Other ☐ Bucket ☐

(6) Gravel Pack:
Yes ☐ No ☒ Size ______
Diameter of above ______
Packed from ______ to ______ ft.

(7) Casing Installed:
Steel ☒ Plastic ☐ Concrete ☐

(8) Perforations:
Type of perforation or size of screen

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot Size
0	21	7"	.188			

(9) WELL SEAL:
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 20' ft.
Were strata sealed against pollution? Yes ☐ No ☒ Interval ______ ft.
Method of sealing BENTONITE - CEMENT

(10) WATER LEVELS:
Depth of first water, if known 50' ft.
Standing level after well completion 45' ft.

(11) WELL TESTS:
Was well test made? Yes ☒ No ☐ If yes, by whom? DRILLER
Type of test Pump ☐ Bailer ☐ Air lift ☒
Depth to water at start of test — ft. At end of test ______ ft.
Discharge 7 gal/min after 1 hours Water temperature COOL
Chemical analysis made? Yes ☐ No ☒ If yes, by whom?
Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

(12) WELL LOG: Total depth 800 ft. Depth of completed well 800 ft.
from ft. to ft. Formation (Describe by color, character, size or material)

0 - 15 TOPSOIL
15 - 50 - BLACK/WHITE ROCK
50 - 51 - (5 GPM)
51 - 110 - BLACK/WHITE ROCK
110 - 112 - SOFTER, ORANGE (1 GPM)
112 - 726 - BLACK/WHITE ROCK
726 - 727 - (5½ GPM)
727 - 800 - BLACK/WHITE ROCK

Work Started 19 Completed 19

WELL DRILLERS STATEMENT: I hereby declare under penalty of perjury that the information provided in this report is true. This water well was installed in compliance with San Diego County Code and State of California, Department of Water Resources, Bulletin No. 74.

SIGNED [signature] (Well Driller)

NAME ______ (Person, firm, or Corporation) (Type or Print)

ADDRESS ______

CITY ______ ZIP ______

LICENSE NO. ______ DATE THIS REPORT ______

CONFIDENTIAL — NOT FOR PUBLIC USE — WATER CODE SEC. 13752

DUPLICATE
Driller's Copy

Page 1 of 1

Owner's Well No. 5

Date Work Began 9-21-04, Ended 9-25-04

Local Permit Agency San Diego E.H.S.

Permit No. LWEL16224 Permit Date 9-16-04

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 0909441

DWR USE ONLY — DO NOT FILL IN

STATE WELL NO./STATION NO.

LATITUDE | LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) x VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD rotary FLUID air

DEPTH FROM SURFACE Ft. to Ft.	DESCRIPTION Describe material, grain size, color, etc.
0 – 1½	topsoil
1½ – 50	black & white rock
50 – 51	crack
51 – 110	black & white rock
110 – 112	softer, orange
112 – 726	black & white rock
726 – 727	crack
727 – 800	black & white rock

TOTAL DEPTH OF BORING 800 (Feet)

TOTAL DEPTH OF COMPLETED WELL 800 (Feet)

WELL OWNER

Name Hamann Companies

Mailing Address 1000 Pioneer Way

El Cajon, Ca 92020

CITY STATE ZIP

WELL LOCATION

Address 3041 McCain Valley Rd

City Jacumba

County San Diego

APN Book 611 Page 030 Parcel 01

Township 017 Range 7E Section 4

Lat ___ N DEG. MIN. SEC. Long ___ W DEG. MIN. SEC.

LOCATION SKETCH

NORTH

WEST — EAST

See attached

SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. ***PLEASE BE ACCURATE & COMPLETE.***

ACTIVITY (✓)

x NEW WELL

MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)

___ DESTROY (*Describe Procedures and Materials Under "GEOLOGIC LOG"*)

USES (✓)

WATER SUPPLY
x Domestic ___ Public
___ Irrigation ___ Industrial

MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 50 (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 45 (Ft.) & DATE MEASURED 9-25-04

ESTIMATED YIELD * 7 (GPM) & TEST TYPE airlift

TEST LENGTH 1 (Hrs.) TOTAL DRAWDOWN - (Ft.)

** May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft. to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0 – 21	11	x				steel	6 5/8	.188	

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft. to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0 – 21	x	x		

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
✓ Other ___

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME JIM MANOS DRILLING & PUMP
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

16052 LAWSON VLY RD, JAMUL, CA 91935
ADDRESS CITY STATE ZIP

Signed [signature] 3-6-06 360722
C-57 LICENSED WATER WELL CONTRACTOR DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 05-03

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

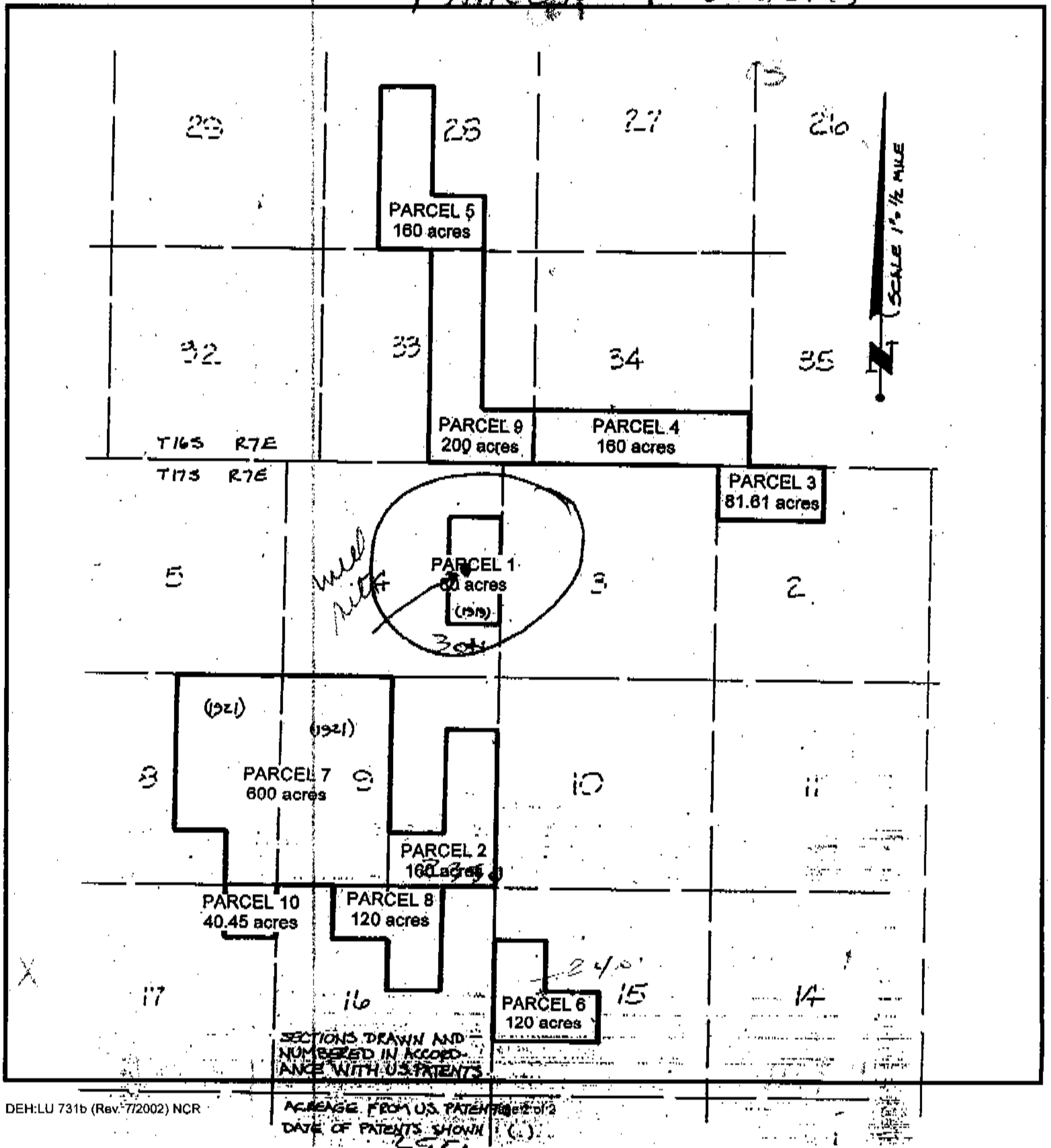
COUNTY OF SAN DIEGO
DEPARTMENT OF ENVIRONMENTAL HEALTH

Control #: LWEL 16224
Assessor's Parcel Number: 611-030-08

LOCATION

Indicate below the vicinity and exact location of well with respect to the following items: Property lines, water bodies or water courses, drainage pattern, easements, roads, existing wells, sewers and private sewage disposal systems and other potential contamination sources, including dimensions.

Parcel #1 80 acres



Fully operational

#6 no Logs
Available

origional
well on
Ranch

6A NEW
Public
Well

Fully operational

QUADRUPLICATE FEB 09 2010
For Local Requirements
County of San Diego
Dept. of Environmental Health
Land & Water Quality Div.

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 1089956

Page 1 of 1
Owner's Well No. 1
Date Work Began 11-4-09, Ended 11-10-09
Local Permit Agency San Diego C.H.S.
Permit No. LWC620420 Permit Date 11-13-09

DWR USE ONLY — DO NOT FILL IN
STATE WELL NO./STATION NO.
LATITUDE | LONGITUDE
APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD ROTARY FLUID AIR

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION Describe material, grain size, color, etc.
0	10	sandy-rocks
10	30	sandy-slightly firm
30	32	soft
32	70	sandy
70	85	harder
85	87	cracks
87	230	black & white rock, softer areas
230	233	softer, orange
233	330	black, white & orange
330	332	softer, orange
332	395	black & white rock, softer areas
395	395	sand
395	420	black & white rock

Completed Well Construction
Date 2/9/10
Date inspected
Comments KIVA entered on this date.
Water Sample Taken? [illegible]
Inspected By

TOTAL DEPTH OF BORING 420 (Feet)
TOTAL DEPTH OF COMPLETED WELL 385 (Feet)

CONFIDENTIAL NOT FOR PUBLIC USE WATER CODE SEC 13752

WELL OWNER

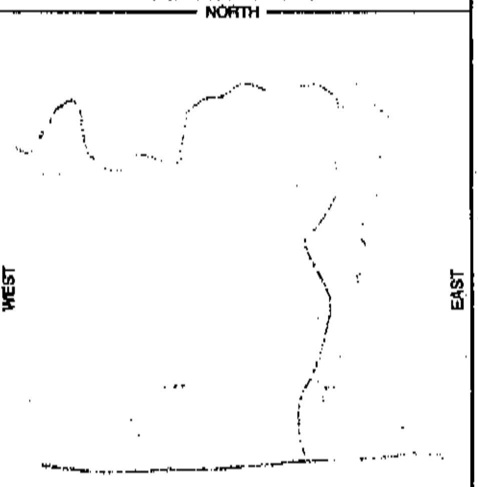
Name Harmony Grove Partners
Mailing Address 1000 Pioneer Way
El Cajon, Ca 92020 CITY STATE ZIP

WELL LOCATION

Address Mc Daniel Valley Road
City Jamul, Ca
County San Diego
APN Book 511 Page 090 Parcel 04
Township 17 S Range 2 E Section 17
Lat ___ N DEG. MIN. SEC. Long ___ W DEG. MIN. SEC.

LOCATION SKETCH

NORTH



Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

X NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (*Describe Procedures and Materials Under "GEOLOGIC LOG"*)

USES (✓)
WATER SUPPLY
___ Domestic ___ Public
___ Irrigation X Industrial
MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 30 (Ft.) BELOW SURFACE
DEPTH OF STATIC WATER LEVEL 30 (Ft.) & DATE MEASURED 11-10-09
ESTIMATED YIELD * 60 (GPM) & TEST TYPE airlift
TEST LENGTH 2 (Hrs.) TOTAL DRAWDOWN -- (Ft.)
** May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	56	12	x				steel		.188	
0	75		x				steel	6 5/8	.188	
0	385	6½		x			pvc	4	CL200	

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	56	x			(cement was pumped)
0	75		x		
0	385			x	5/16 pea gravel

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other [illegible]

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME JIM MANOS DRILLING & PUMP
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

16052 LAWSON VALLEY ROAD, JAMUL, CA 91935
ADDRESS CITY STATE ZIP

Signed [signature] 1/1/10 360?
C-57 LICENSED WATER WELL CONTRACTOR DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 05-03

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

#7 unstable hole
not much
water
well destroyed

Fain Drilling & Pump Co. Inc.
12029 Old Castle Rd.
Valley Center, CA 92082
Phone (760) 749-0701
Fax (760) 749-6380

Invoice

Bad hole Destroyed

#7

Date	Invoice #
2/15/2005	8049

Bill To

HAMANN COMPANIES
1000 PIONEER WAY
EL CAJON, CA 92020

P.O. No.	Terms	Project
	Due on receipt	

Description	Qty	Rate	Amount
WELL DRILLING (TEST HOLE) APN 611 090 03			
PARCEL # 10 40.45 ACRES			
MOVE IN AND SET UP 1ST. TIME	1	500.00	500.00
DRILLING 6.5" DIA HOLE	400	12.00	4,800.00
BACKFILL TEST HOLE AND CEMENT TOP	1	400.00	400.00
MOVE BACK TO TEST HOLE AND SET UP 2ND TIME	1	500.00	500.00
DRILL OUT AND CLEAN OUT EXISTING 400 FT.	1	400.00	400.00
DRILLING FROM 400-850 FT. 6.5" DIA HOLE	450	14.00	6,300.00
BACKFILL AND DESTROY TEST HOLE	1	400.00	400.00
WELL PERMIT AND FILING FEES	1	490.00	490.00

Total	$13,790.00
Payments/Credits	$0.00
Balance Due	$13,790.00

TRIPLICATE
Owner's Copy
Page 1 of 1

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet
No. 0909548

DWR USE ONLY — DO NOT FILL IN
STATE WELL NO./STATION NO.
LATITUDE | LONGITUDE
APN/TRS/OTHER

Owner's Well No. Test Well Par 10
Date Work Began 2/4/05, Ended 2/14/05
Local Permit Agency DEH
Permit No. 16457 Permit Date 2/7/05

GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD Rotary FLUID Air

DEPTH FROM SURFACE Ft. to	Ft.	DESCRIPTION Describe material, grain size, color, etc.
0	6	Slope wash - sand and silt brown color
6	62	Weathered, decomposed rock
62		1st water - seepage
62	112	quartz diorite
112	114	Fracture - seepage of water
114	274	Quartz diorite, soft weathered
274		Fracture - water
275	654	Quartz diorite, soft weathered
654		Fracture - seepage of water
654	720	Quartz diorite
720		Seepage of water
720	850	Quartz diorite
		Backfill and destroy bore hole

TOTAL DEPTH OF BORING 850 (Feet)
TOTAL DEPTH OF COMPLETED WELL 0 (Feet)

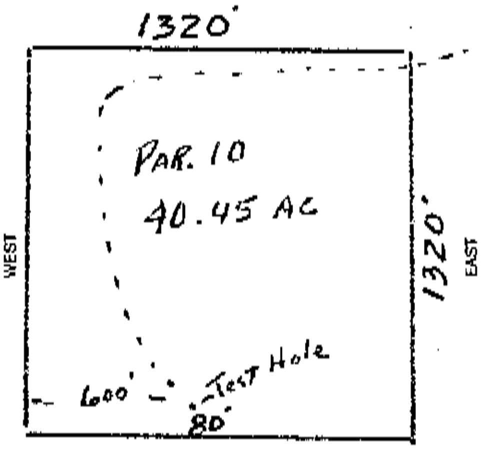
WELL OWNER

Name Hamann Companies
Mailing Address 1000 Pioneer Way
CITY El Cajon, STATE Ca ZIP 92020

WELL LOCATION

Address Mc Cain Valley Rd.
City Boulevard
County San Diego
APN Book 611 Page 090 Parcel 03
Township 17 S Range 7 E Section 17
Lat 32° 41' 735" N (DEG. MIN. SEC.) Long 116° 16' 613" W (DEG. MIN. SEC.)

LOCATION SKETCH



Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

___ NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

USES (✓)
WATER SUPPLY
___ Domestic ___ Public
___ Irrigation ___ Industrial
MONITORING ___
TEST WELL ✓
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 62 (Ft.) BELOW SURFACE
DEPTH OF STATIC WATER LEVEL 28 (Ft.) & DATE MEASURED 2/14/05
ESTIMATED YIELD * 10 (GPM) & TEST TYPE Airlift
TEST LENGTH 4 (Hrs.) TOTAL DRAWDOWN 500 (Ft.)
* *May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft. to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
NONE									

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	5			X	
5	25	X			
25	850			X	

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
✓ Other site map

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Fain Drilling & Pump Co Inc
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

12029 Old Castle Rd. Valley Center, Ca 92082
ADDRESS CITY STATE ZIP

Signed [signature] C-57 LICENSED WATER WELL CONTRACTOR
2-14-05 DATE SIGNED
328287 C-57 LICENSE NUMBER

DWR 188 REV. 05-03 IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

8

This WELL HAS no pump or power NEEDS to be relocated EAST outside of Transmission Line power EASEMENT

Fain Drilling & Pump Co. Inc.
12029 Old Castle Rd.
Valley Center, CA 92082
Phone (760) 749-0701
Fax (760) 749-6380

Invoice

#8

Date	Invoice #
2/11/2005	8048

Bill To
THE HAMANN COMPANIES 1000 PIONEER WAY EL CAJON, CA 92020

P.O. No.	Terms	Project
	Due on receipt	

Description	Qty	Rate	Amount
DRILLING 970 FT DEEP WELL APN 611 110 01			
PARCEL 6 120 AC			
EQUIPMENT SET UP	1	500.00	500.00
DRILLING 6.5" DIA HOLE	400	12.00	4,800.00
DRILLING 400-800' 6.5" DIA HOLE	400	14.00	5,600.00
DRILLING 800 - 970' 6.5" DIA HOLE	170	16.00	2,720.00
REAMING 6" TO 10" DIA HOLE	226	12.00	2,712.00
FURNISH AND INSTALL 6" WELL CASING	228	13.00	2,964.00
INSTALL 50 FT. SURFACE SEAL	1	1,500.00	1,500.00
WELL PERMIT AND FILING FEES	1	490.00	490.00

Total	$21,286.00
Payments/Credits	$0.00
Balance Due	$21,286.00

TRIPLICATE
Owner's Copy
Page 1 of 1

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 0909549

DWR USE ONLY — DO NOT FILL IN	
STATE WELL NO./STATION NO.	
LATITUDE	LONGITUDE
APN/TRS/OTHER	

Owner's Well No. Par. 6 -120

Date Work Began 2/1/05 , Ended 2/9/05

Local Permit Agency DEH

Permit No. 16456 Permit Date 2/1/05

GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD Rotary FLUID Air

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
0	12	Slope wash - sandy decomposed granite - brown color
12	212	Weathered Granitic Rock
212	226	Broken Rock
226	310	Weathered granitic rock mostly white quartz
310		Water 8 gpm
310	961	Granitic rock large crystals of white quartz
961		Water 40+ gpm
961	970	Fractured granitic rock large quartz crystals

TOTAL DEPTH OF BORING 970 (Feet)

TOTAL DEPTH OF COMPLETED WELL 970 (Feet)

WELL OWNER

Name The Hamann Companies

Mailing Address 1000 Pioneer Way

El Cajon Ca 92020

CITY STATE ZIP

WELL LOCATION

Address Rough Acres Ranch McCain Valley Rd.

City Boulevard

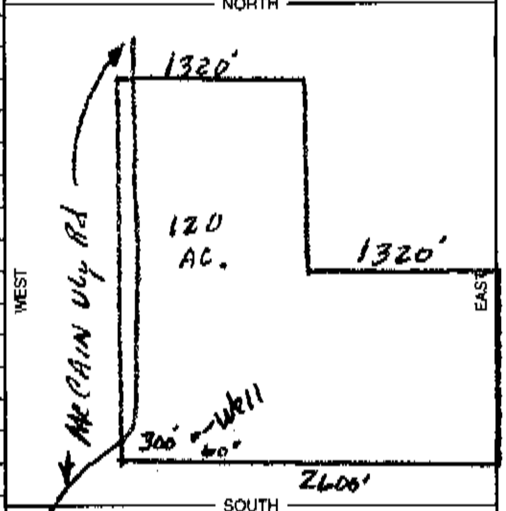
County San Diego

APN Book 611 Page 110 Parcel 01

Township 17S Range 7E Section 15

Lat 36 16 772 N Long 115 69 465 W
DEG. MIN. SEC. DEG. MIN. SEC.

LOCATION SKETCH



Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. ***PLEASE BE ACCURATE & COMPLETE.***

ACTIVITY (✓)

X NEW WELL

MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)

___ DESTROY *(Describe Procedures and Materials Under "GEOLOGIC LOG")*

USES (✓)

WATER SUPPLY
X Domestic ___ Public
___ Irrigation ___ Industrial

MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 30 (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 18 (Ft.) & DATE MEASURED ___

ESTIMATED YIELD * 50 (GPM) & TEST TYPE airlift

TEST LENGTH 8 (Hrs.) TOTAL DRAWDOWN 800 (Ft.)

** May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	226	10	X				Steel	6	.188	

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	50	X			
50	226			X	

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other ___

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

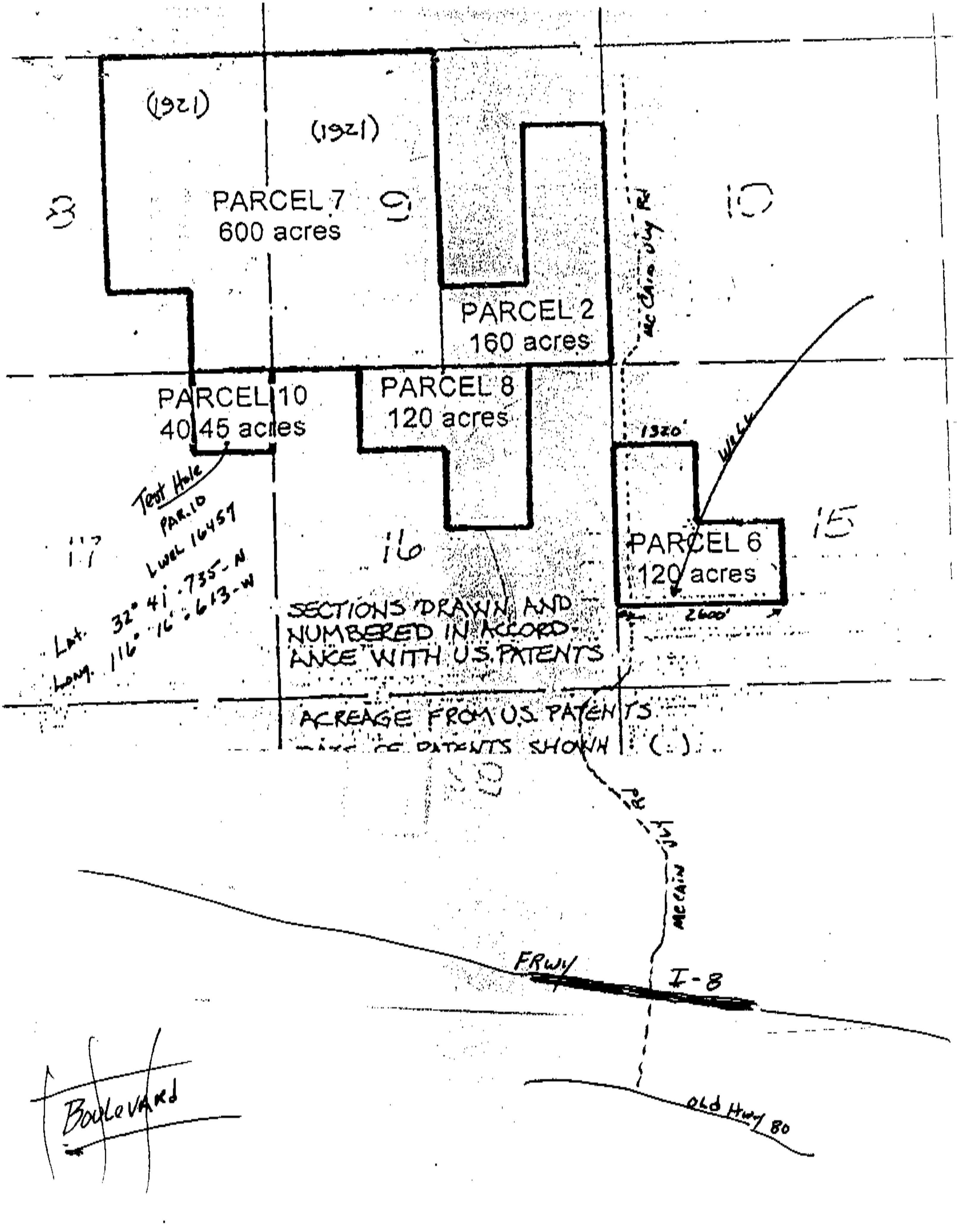
NAME Fain Drilling & Pump Co. Inc.
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

12029 Old Castle Rd. Valley Center, Ca 92082
ADDRESS CITY STATE ZIP

Signed [signature] 2/11/05 328287
C-57 LICENSED WATER WELL CONTRACTOR DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 05-03

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM


(1921)
(1921)
PARCEL 7
600 acres
8
9
10
McCain Vly Rd
PARCEL 2
160 acres
PARCEL 10
40 45 acres
PARCEL 8
120 acres
1320'
WELL
Test Hole
PAR. 10
LWEL 16457
17
16
15
PARCEL 6
120 acres
2600'
Lat. 32° 41' .735' N
Long. 116° 16' .613' W
SECTIONS DRAWN AND NUMBERED IN ACCORDANCE WITH U.S. PATENTS
ACREAGE FROM U.S. PATENTS
McCain Vly Rd
FRWY
I-8
Boulevard
Old Hwy 80

9

Fully operational
old well
No info
probably 5-10 GPM
& shallow

APPENDIX B

OBSERVATIONS AND ANALYSIS OF AQUIFER CHARACERISTICS

ROUGH ACRES RANCH

MCCAIN VALLEY, EAST SAN DIEGO COUNTY, CALIFORNIA

Geo-Logic ASSOCIATES
Geologists, Hydrogeologists and Engineers

Date: December 1, 2010
Project No.: 2010-0005

To: John Hower, CEG
Sarah Battelle, CHG

From: Mark Vincent, CHG

Regarding: **Observations and Analyses of Aquifer Characteristics Rough Acres Ranch, San Diego County, California**

INTRODUCTION

This memo presents a summary of observations and analyses made following a stepped and a constant rate aquifer pumping and recovery test in wells located at Rough Acres Ranch located approximately in McCain Valley in eastern San Diego County, California. The tests were performed to determine whether sufficient volumes of water are available for the Tule Wind Farm construction projects. Analyses performed included calculation of transmissivity, hydraulic conductivity, and storativity for a pumping well and observation wells.

WELL AND AQUIFER CONDITIONS

A well labeled as Well #6a was used as the pumping well for this test. Another well labeled as Well #6 (also referred to as South Well) is located 36 feet away from the pumping well and was monitored and analyzed as an observation well. More distant observation wells were monitored including Well #9 (Horse Corral Well), Walker Residence Well, Well #4 (RV Well), Well #2, and Well #8 (Far Field Well) (Figure 1).

Records for drilling and construction of the wells used for these pumping tests are incomplete or nonexistent. A well identified on Department of Water Resources (DWR) records as being owned by Harmony Grove Partners (identified as Form No. 1089956) is believed to be the log for Well #6a. Logs for Well #4 (RV Well) and Well #8 (Far Field Well) were also obtained. No records are available for Well #6 (South Well), The Walker Residence Well, Well #9 (Horse Corral Well), or Well #2.

Although DWR records indicate the borehole for Well #6a was drilled to a total depth of 420 feet, the bottom of the well is recorded to be at a depth of 385 feet below ground surface. Records are incomplete but it was assumed that the well screen extends from a depth of 75 to 385 feet below ground surface. A cement sanitary seal is reported to extend from ground surface to a depth of 56 feet. Wells #6 and #6a used in this pumping test have existing electric submersible pumps installed in them. Based on the production rates achieved during the tests performed, the wells are likely to be outfitted with four-inch diameter electric submersible pumps. Based on the depth and pressure head on the transducers installed in the wells for the test, it was assumed that both of the boreholes are 385 feet deep and are 6.5-inches in diameter. It was further assumed that the wells were constructed with 4-inch diameter well casing and that they are perforated or screened from a depth of 75 feet below ground surface. Details of well construction could not be verified in the field because of the presence of pumps, discharge pipes, electrical wires, and surface sanitary seals. Available well logs are included at the back of this document.

The area immediately around Well #6 and #6a is underlain by alluvium comprised of poorly sorted sand, gravel, and silt derived from the crystalline basement rock exposed on the adjacent canyon sidewalls. The crystalline basement rocks are classified as tonalite and yield groundwater from fractures. The well log reportedly recorded for Well #6a indicates that there is about 70 to 85 feet of alluvium overlying the tonalite. Groundwater was measured at a depth of 27.81 feet below the top of sanitary seal on Well #6a.

TEST METHODS

Observations of groundwater elevation were recorded in a pumping well and six observation wells in McCain Valley. Data was collected using pressure transducers connected to data loggers. Barometric pressure changes were recorded during the test and corrections were made to the pressure head data collected during the tests.

A stepped aquifer pumping test was performed using Well #6a to determine the optimum pumping rate for a longer duration test. The pressure transducers were deployed and began recording data on August 20, 2010 to perform the stepped pumping test. The stepped pumping test was performed at pumping rates of 28 gallons per minute (gpm), 38 gpm, 55 gpm and 60 gpm. A semi-logarithmic plot of elapsed time versus drawdown for the stepped pumping test is shown on Figure 2.

The constant rate pumping and recovery test was performed from August 24 through 27, 2010. The pump was powered-down on August 27, 2010 and allowed to recover for 10 hours when the pressure transducers were removed from the wells. A recovery test was performed by turning off the pumps and recording the increasing head levels over time.

DATA ANALYSIS

Changes in groundwater level data recorded during this test were corrected for barometric pressure changes and used to generate a file containing tabulated time and changes in pressure head. The data was used to generate time-drawdown graphs for the pumping and observation wells and imported into computer software used to calculate the transmissivity and storativity of the fractured tonalite.

The stepped pump test analysis consists of plotting the drawdown versus time for each pumping rate on a time versus drawdown plot with time plotted on a logarithmic scale. Forward projections of each segment representing a different pumping rate can be used to predict the likely drawdown for the pumping well during for the selected duration of the test. A pumping rate of 50 gpm was selected as the target pumping rate because it would allow for ample drawdown without the well running dry during the test.

The method of Schafer (1978) was employed to determine how much of the data set for Well #6a was impacted by casing storage effects. The method is a simplification of the method first developed by Papadopulos and Cooper (1967) but does not require prior knowledge of the transmissivity or well efficiency. The point at which casing storage effects are overcome was calculated to occur approximately 23 to 25 minutes into the test based on the assumptions about well construction practices, pumping rates, and drawdown. Very early pumping data was ignored in the analyses described below due to casing storage effects.

Time versus drawdown plots were prepared for the pumping and observation wells for the pumping and recovery portions of the test. The plots are shown with the time axis plotted on a logarithmic scale and drawdown on a linear scale.

Figure 3 shows the time-drawdown plot for Well #6a during pumping. The first 23 to 25 minutes of the test show the casing storage effects. Well #6a drawdown plots as a straight line on the time-drawdown chart representing constant aquifer properties during that portion of the drawdown cone development. A sudden change in the drawdown curve starts at approximately 11 or 12 minutes; which may reflect leakage from the alluvium above the fractured bedrock.

A residual drawdown plot for Well #6a is shown on Figure 4. The plot shows the change in drawdown versus the ratio of the time since the pump test started divided by the time since the recovery portion of the test started (t/t`). The residual drawdown at a t/t` ratio of 1 is shown to be about 0.33 feet (a less than significant change in storage noted in the pumping well over the course of the pumping and recovery portions of the aquifer stress test).

A time-drawdown plot of Well #6 (the observation well also referred to as South Well) located 36 feet away from the pumping well shows a decrease in drawdown from approximately 30 minutes to approximately 400 minutes which may result from leakage from the alluvium above the fractured bedrock (Figure 5). The Well #6 plot shows even less drawdown versus time after 400 minutes possibly reflecting the fractured bedrock aquifer.

The Well #6 recovery portion of the test is plotted as the residual drawdown versus t/t` shows a flat line on the semi-logarithmic plot (Figure 6) indicative of uniform aquifer conditions from a t/t` ratio of about 8 to 110 into the recovery test period. The residual drawdown value measured for a t/t' ratio of 1 is about -0.22 feet. It is not regarded to be significant compared to the County standard maximum change of 0.5 feet.

The Well #9 (Horse Corral Well) was monitored and the time-drawdown plot reflects that the well pump cycled on and off five times during the test (Figure 7). No analyses were performed for this well because the changes in drawdown versus time due to the pump activating are far greater than any drawdown likely to be induced by the pumping test at Well #6a.

Well #2 (Pond Well) and Well #9 (Far Field Well) were monitored for changes in head during the pumping test. Figure 8 and 9 show the time-drawdown plots for Wells #2 and #9. Both plots show similar small, cyclic, barometric changes in head but are not likely to have resulted from the pumping test. No analyses were performed using the data from these wells.

Water level drawdown data were evaluated using the computer software program AquiferTest version 3.5 (Waterloo Hydrogeologic, 2002). The program performs curve matching of the time drawdown data to calculate transmissivity, hydraulic conductivity, and storativity using different methods. The methods employed included Cooper-Jacob (1946), Moench (1993), Neuman (1975), and Theis (1935).

DISCUSSION

As shown on Table 1, the calculated hydraulic conductivity values for all of the analytical methods employed ranged from a low of 7.50E-04 feet/day for data collected from Well #6 (South Well) using the Theis method for the data collected from the end of the recovery test to a high of 7.50E+00 feet/day using the Cooper Jacob method with late time data for Well #6 (South Well). An average conductivity of 1.85 feet/day was calculated from all methods from both Well #6 and #6a. The Storativity values range from a low of 4.48E-06 for Well #6 late time data calculated using the Moench Fracture Flow method and a high of 7.87E-01 for a match to the late time data recorded in Well #6 using the Moench method with the vertical hydraulic conductivity set at one-tenth the horizontal hydraulic conductivity.

All of the analytical results show a higher transmissivity and hydraulic conductivity value for matches to the observation Well #6. The pumping well and observation well used for these analyses are located in a portion of McCain Valley which is entirely covered in up to 75 to 80 feet of alluvium (Figure 10). Based on the measured depth to groundwater in Well #6 and #6a, approximately 47 to 52 of saturated alluvium overlies the fractured bedrock at the test site (Figure 11). The saturated alluvium is likely to act like a reservoir recharging the fractures in the bedrock. The aerial extent of the fractured bedrock aquifer and the amount of storage in the fractures is likely controlled in part by the presence of the alluvial aquifer. Because the fractures in the bedrock appear to be of aerially limited extent, the actual volume of groundwater available may be limited with larger volumes of groundwater available within the canyon areas where fracturing may be most prevalent and alluvium is saturated.

CLOSURE

This summary of observations and analyses has been prepared in general accordance with accepted professional geotechnical and hydrogeologic principles and practices. This report makes no other warranties, either expressed or implied as to the professional advice or information included in it. Our firm should be notified of any pertinent change in the project, or if conditions are found to differ from those described herein, because this may require a reevaluation of the conclusions. This report has not been prepared for use by parties or projects other than those named or described herein. It may not contain sufficient information for other parties or purposes.

Geo-**L**ogic **A**ssociates

Mark W. Vincent

Mark W. Vincent, PG 5767, CEG 1873, CHg 865
Senior Geologist

Attachments: Table 1 - Aquifer Stress Test Results
Figure 1 - Well Location Plan
Figure 2 - Step Test Time Drawdown Plot
Figure 3 - North Well Time Drawdown Plot Pumping
Figure 4 - North Well Time Drawdown Plot Recovery
Figure 5 - South Well Time Drawdown Plot Pumping
Figure 6 - South Well Time Drawdown Plot Recovery
Figure 7 - Thing Valley Well Time Drawdown Pumping
Figure 8 - Thing Valley Well Time Drawdown Recovery
Figure 9 - Geologic Map
Appendix A - Analytical Results from Aquifer Test Program
Appendix B - Department of Water Resources Well Completion Reports

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Cooper, H.H., Jr. and Jacob, C.E., 1946, A Generalized Graphical Method for Evaluating Formation Constants and Summarizing Well Field History, *Transactions, American Geophysical Union*, Vol. 27, No. 4.

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Waterloo Hydrogeologic (co-developed with Thomas Roerich), 2002, AquiferTest version 3.5, Advanced Pumping Test and Slug Test Analytical Software.

Table 1

Aquifer Stress Test Results

Rough Acres Ranch - McCain Valley

Well Designation	Condition	Distance From Pumping Well (feet)	Groundwater Depth from Ground Surface (feet)	Assumed Aquifer Thickness (feet)	Average Pumping Rate (gpm)	Analytical Method	Transmissivity (feet^2/day)	Conductivity (feet/day)	Storativity	Comments
Well #6a	Pumping	1	28	500	50	Cooper-Jacob	6.30E+02	1.26E+00	NA	Match to late data.
Well #6a	Pumping	1	28	500	50	Moench Fracture Flow	1.12E+02	2.25E-01	2.70E-04	Match to late data.
Well #6a	Pumping	1	28	500	50	Moench	1.21E+02	2.43E-01	1.72E-01	Match to late data.
Well #6a	Pumping	1	28	500	50	Neuman	5.69E+01	1.14E-01	1.62E-02	Spec Yld. = 1.62E+02
Well #6a	Pumping	1	28	500	50	Theis	2.69E+01	5.39E-02	1.64E-01	Match to early data.
Well #6a	Pumping	1	28	500	50	Theis	1.51E+02	3.03E-01	3.19E-05	Match to late data.
Well #6a	Pumping	1	28	500	50	Walton	1.11E+02	2.21E-01	7.08E-04	Match to late data.
Well #6a	Recovery	1	28	500	0	Theis Recovery	2.17E-02	4.35E-05	NA	Match to early data.
Well #6a	Recovery	1	28	500	0	Theis Recovery	7.27E+00	1.45E-02	NA	Match to late data.
South Well #6	Pumping	36	27.81	500	50	Cooper-Jacob	2.14E+03	4.28E+00	NA	Match to middle data.
South Well #6	Pumping	36	27.81	500	50	Cooper-Jacob	3.75E+03	7.50E+00	NA	Match to late data.
South Well #7	Pumping	36	27.81	500	50	Moench Fracture Flow	2.95E+03	5.91E+00	4.48E-06	Match to late data.
South Well #6	Pumping	36	27.81	500	50	Moench	1.30E+03	2.60E+00	7.87E-01	Kv=1/10 Kh
South Well #6	Pumping	36	27.81	500	50	Neuman	9.67E+02	1.93E+00	NA	Match to all data.
South Well #6	Pumping	36	27.81	500	50	Theis	3.18E+03	6.36E+00	3.29E-06	Match to late data.
South Well #6	Pumping	36	27.81	500	50	Walton	1.13E+03	2.26E+00	1.47E-03	Match to early data.
South Well #6	Recovery	36	27.81	500	0	Theis Recovery	3.75E-01	7.50E-04	NA	Match to early data.
South Well #6	Recovery	36	27.81	500	0	Theis Recovery	2.23E+00	4.47E-03	NA	Match to late data.
						Average Values	**9.24E+02**	**1.85E+00**	**1.14E-01**	

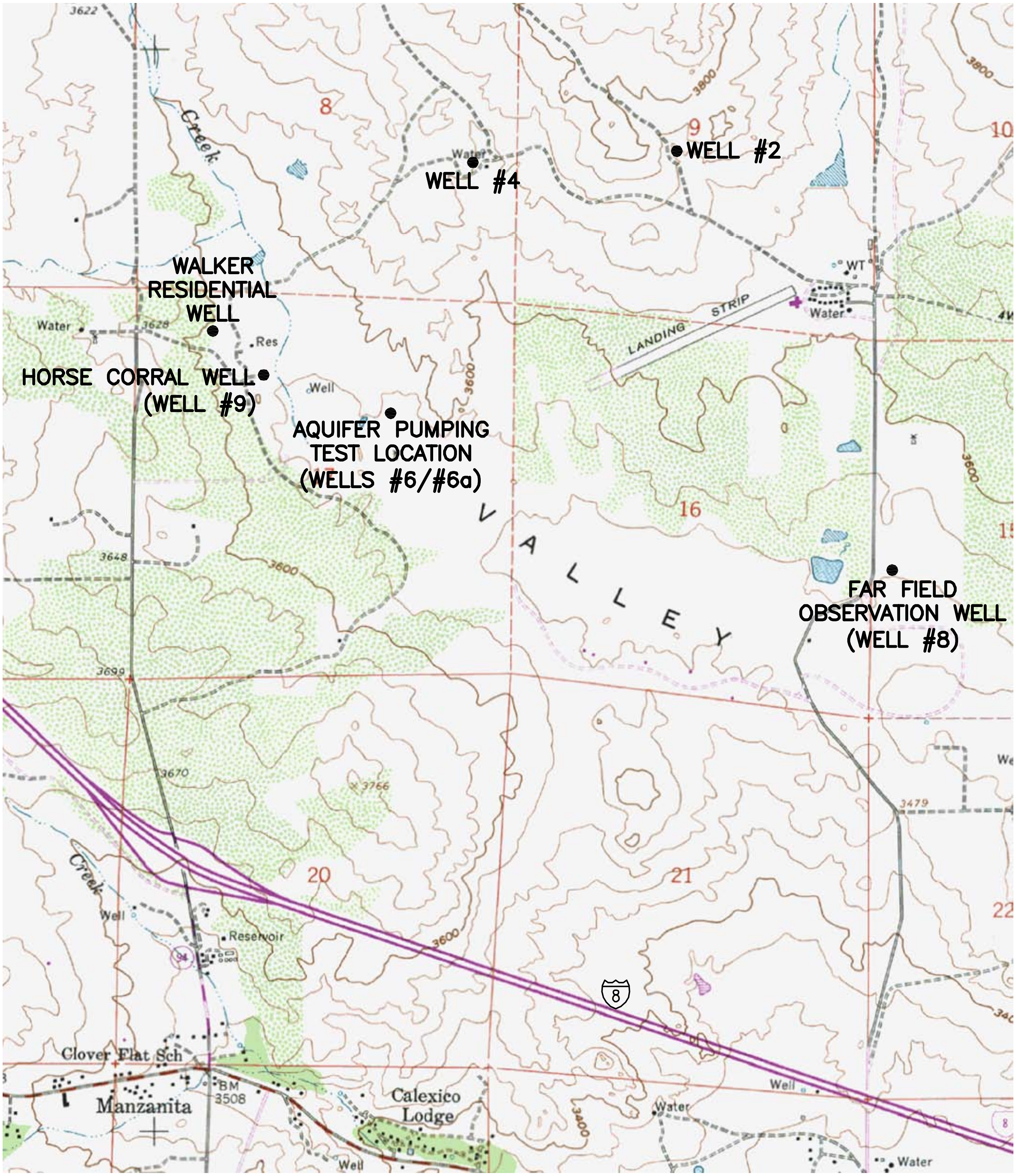


FIGURE 2B

WELL LOCATION MAP
ROUGH ACRES RANCH AQUIFER TEST SITE

TULE WIND PROJECT
SAN DIEGO COUNTY, CA

Geo-Logic ASSOCIATES

REFERENCE: 7.5 MINUTE SERIES (TOPOGRAPHIC) LIVE OAK SPRINGS (1975) CALIFORNIA QUADRANGLE

DRAWN BY: VL	DATE: NOVEMBER 2010	JOB NO. 2010-005

Figure 2
Step Drawdown Test
Well #6a - Pumping Well
Rough Acres Ranch, McCain Valley

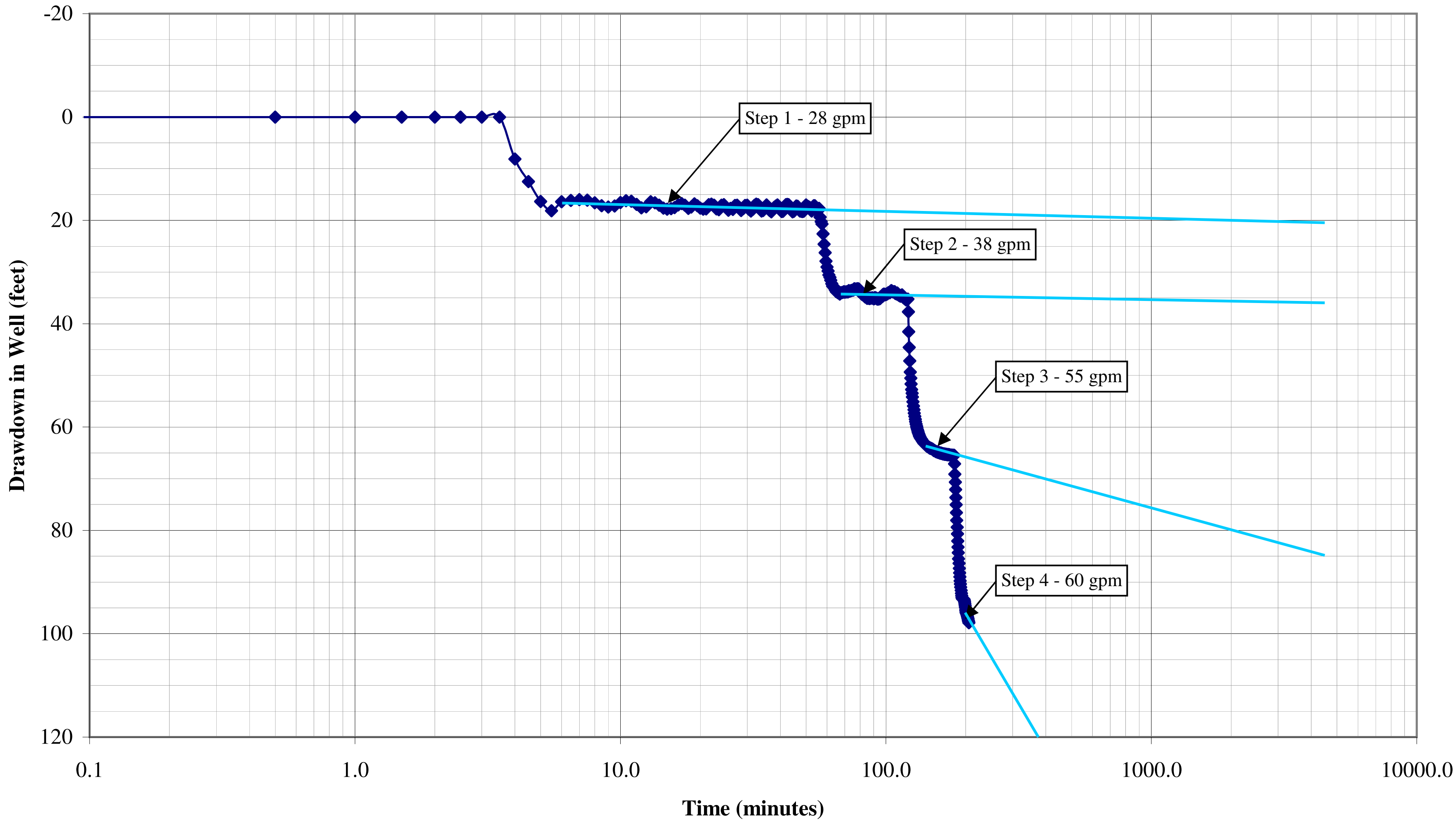


Figure 3
Drawdown in Pumping Well during 72-hour Pumping Test at 50 gpm
North Well at Rough Acres Ranch

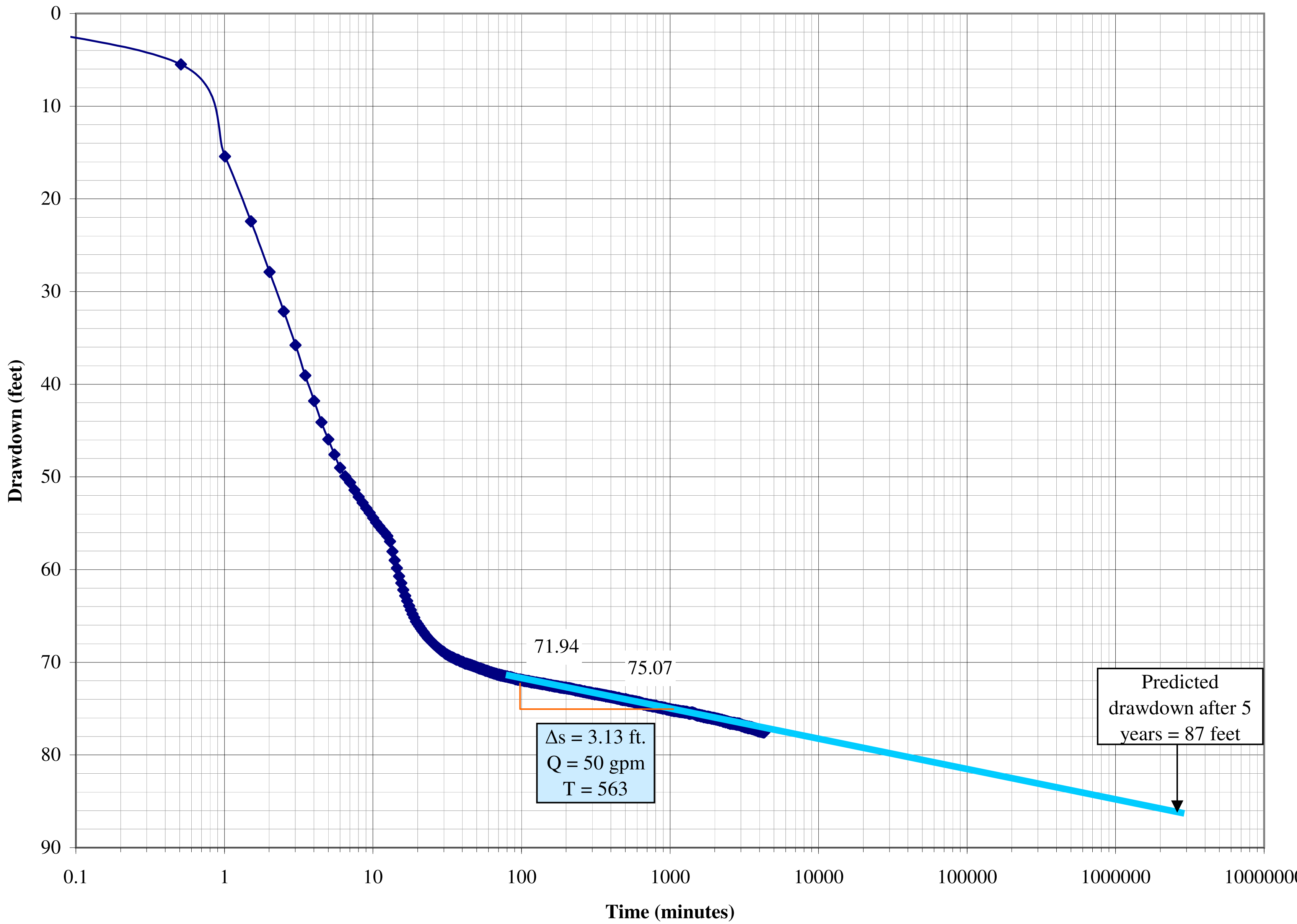


Figure 4
Residual Drawdown Plot
Pumping Well #6a

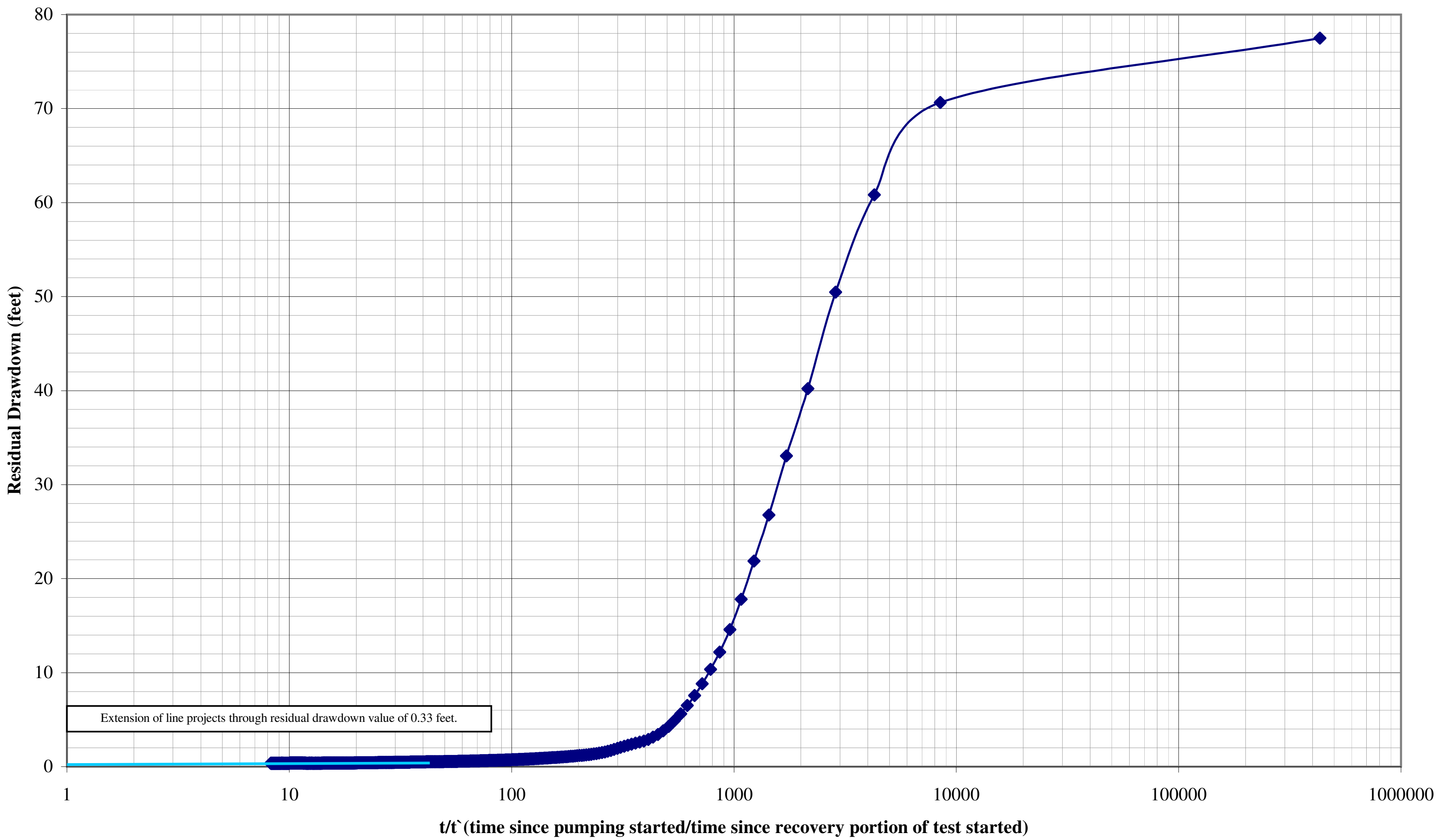


Figure 5
Well #6 - Observation Well
Time-Drawdown Plot
Rough Acres Ranch

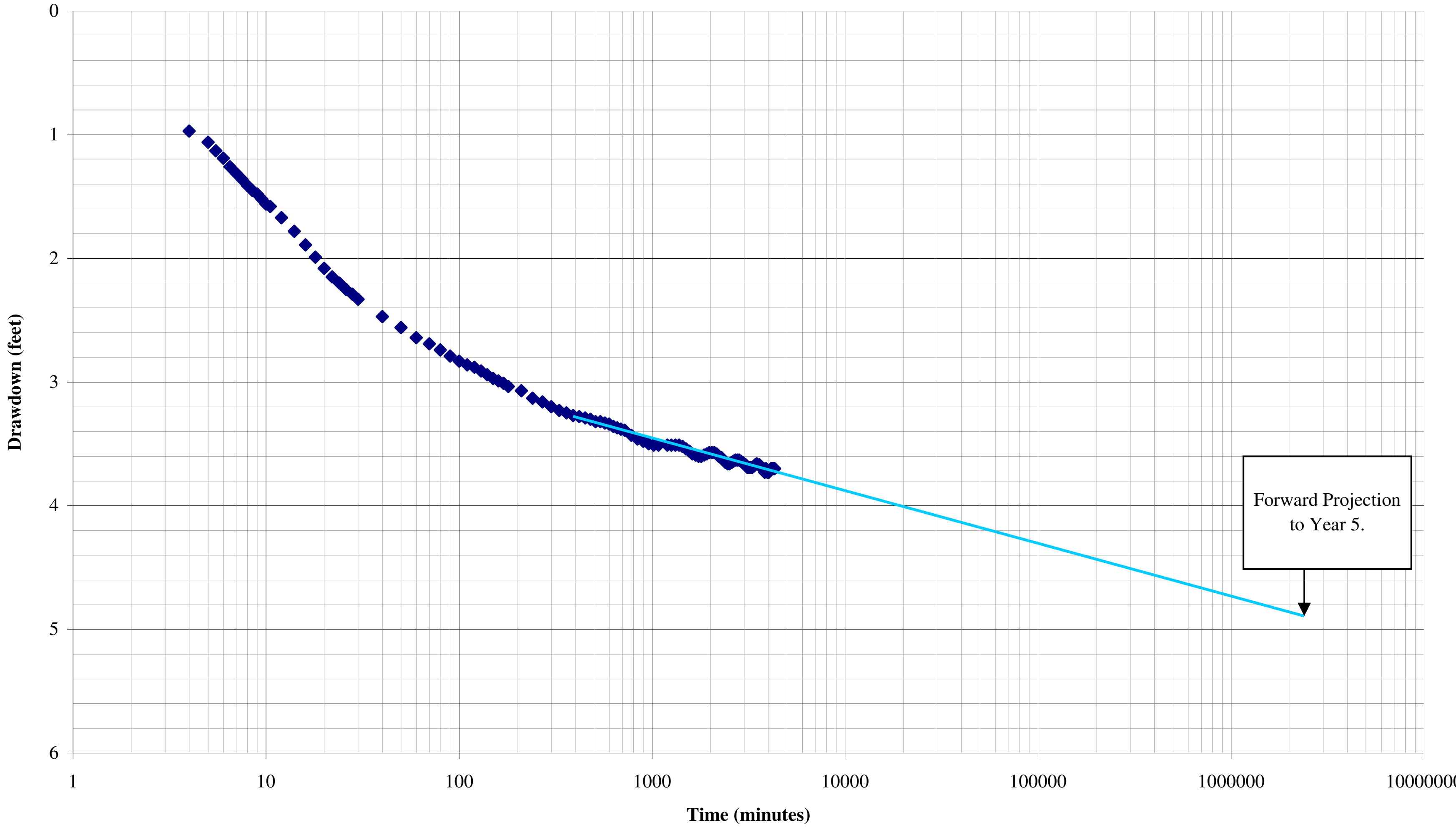


Figure 6
South Well - Observation Well
Residual Drawdown Plot
Rough Acres Ranch

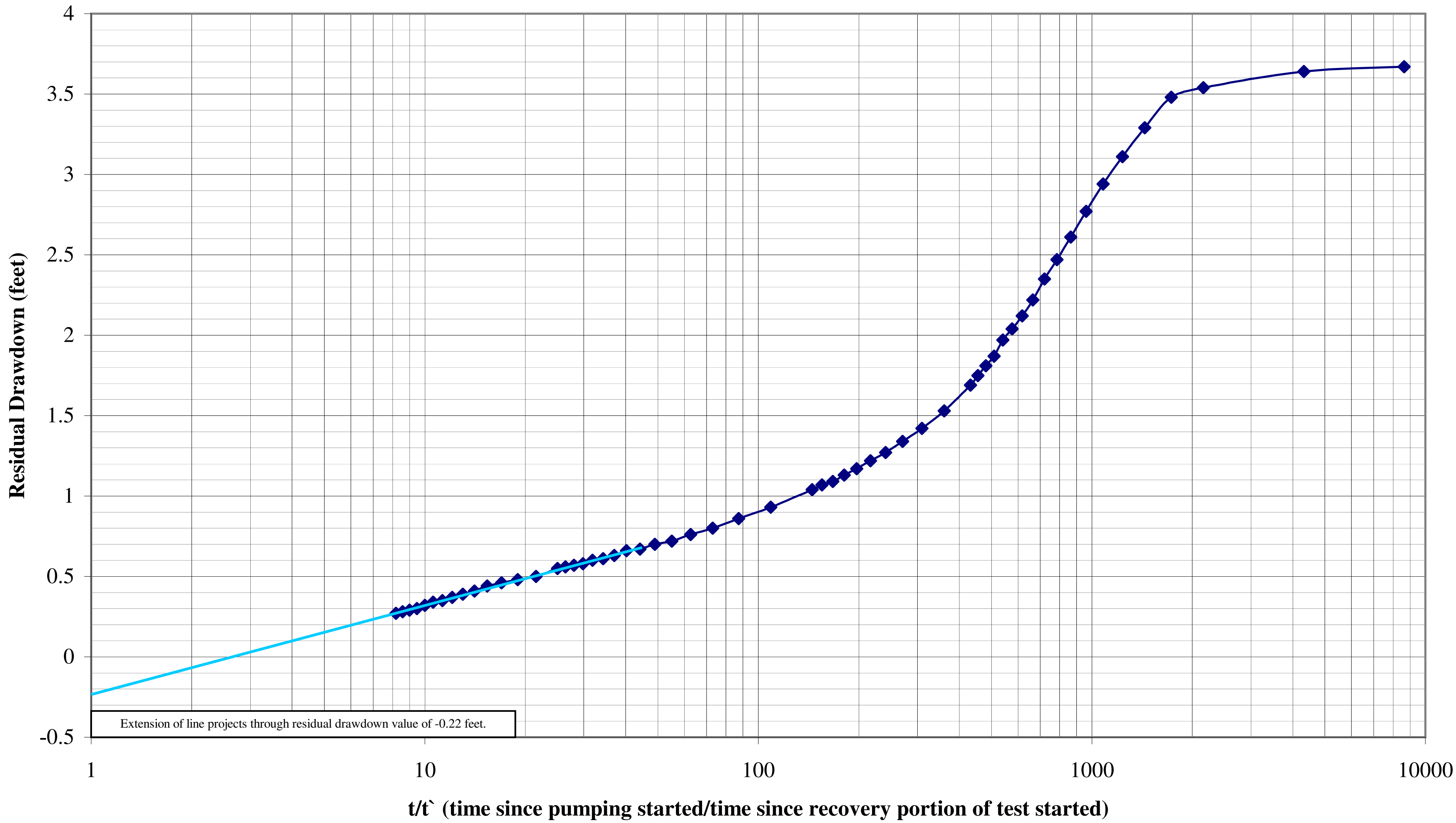


Figure 7
Horse Corral Well
(Observation Well)
Time-Drawdown Plot

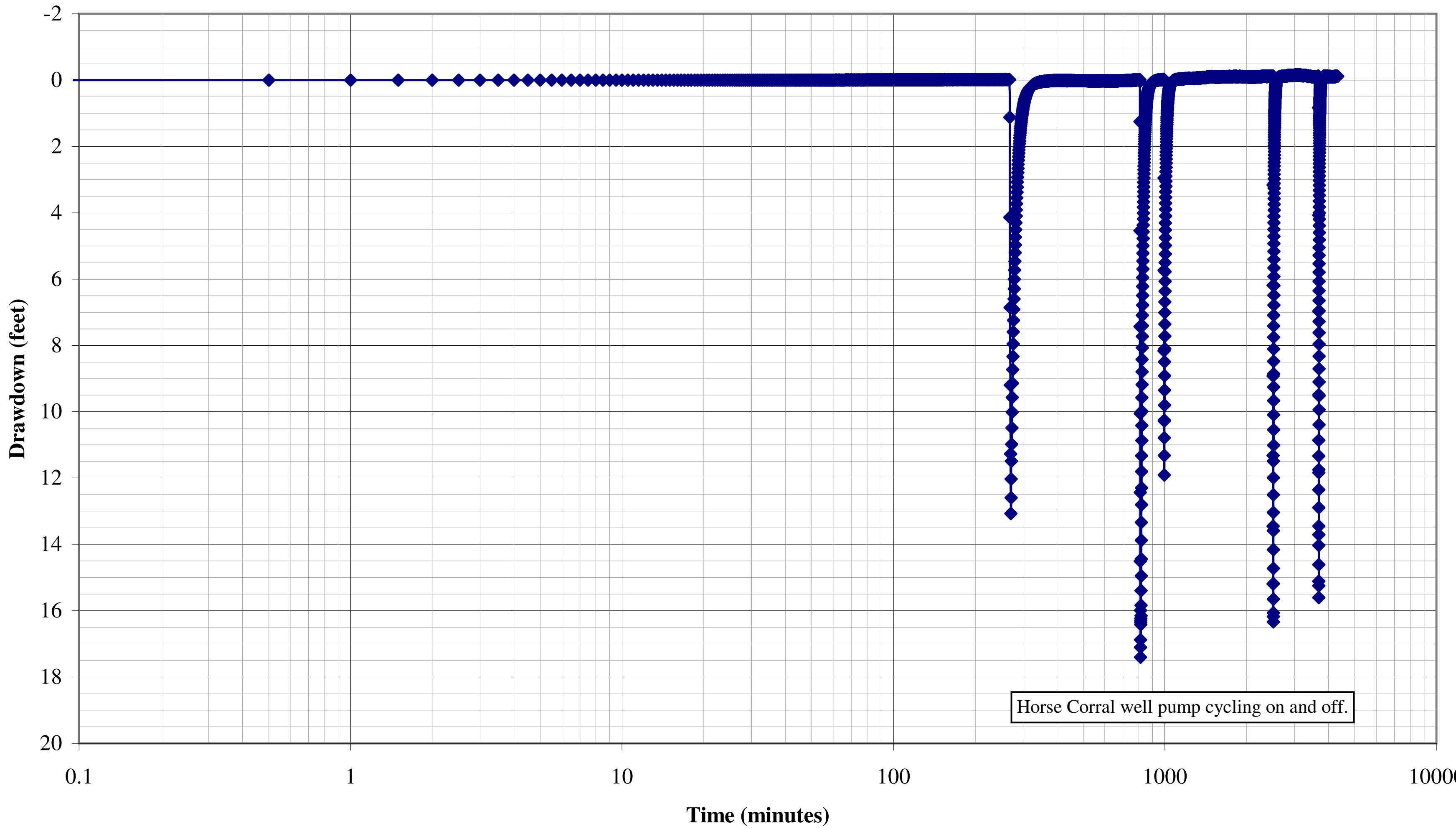


Figure 8
Well #2 - Observation Well
Distance-Drawdown Plot
Rough Acres Ranch

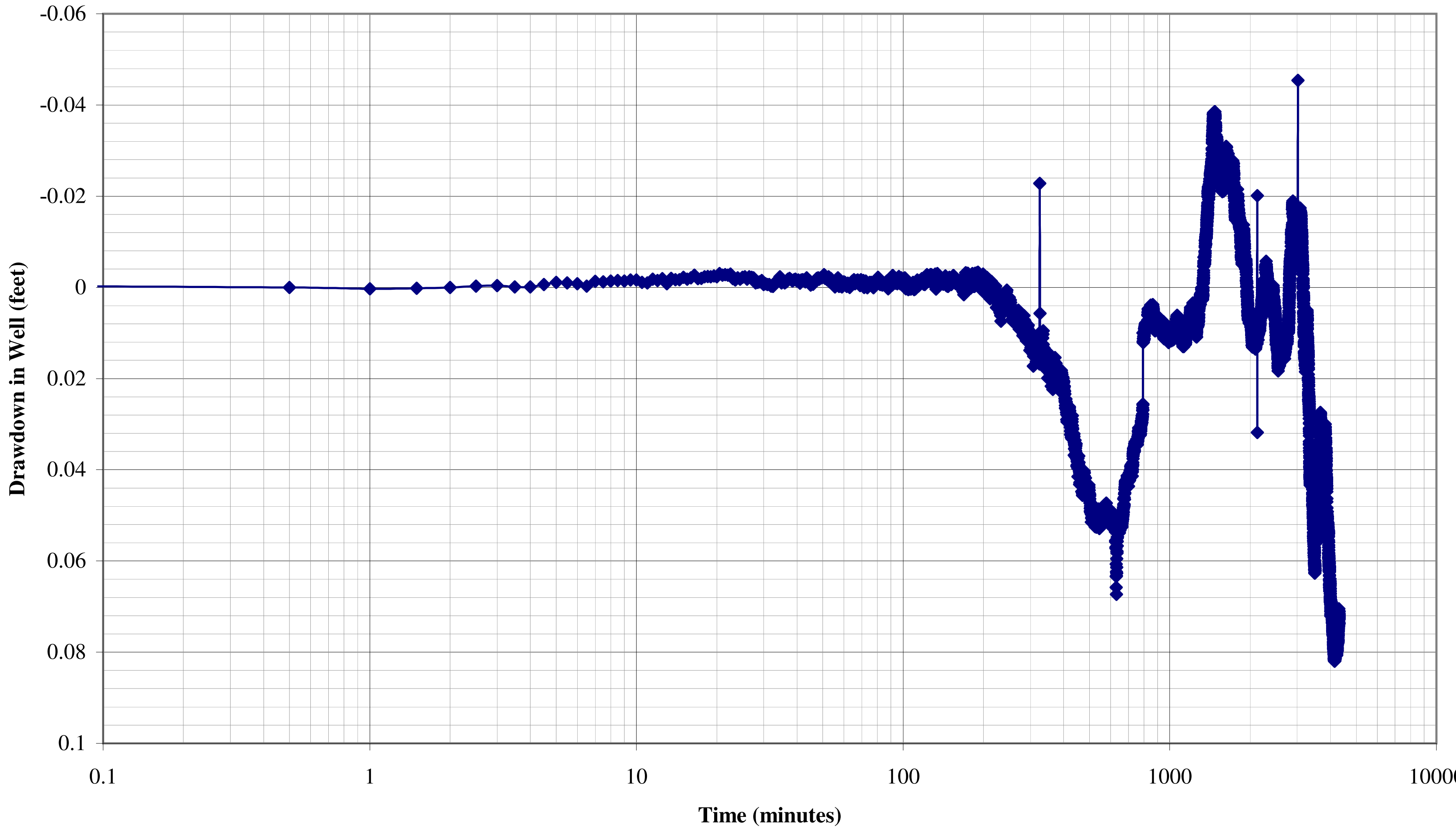
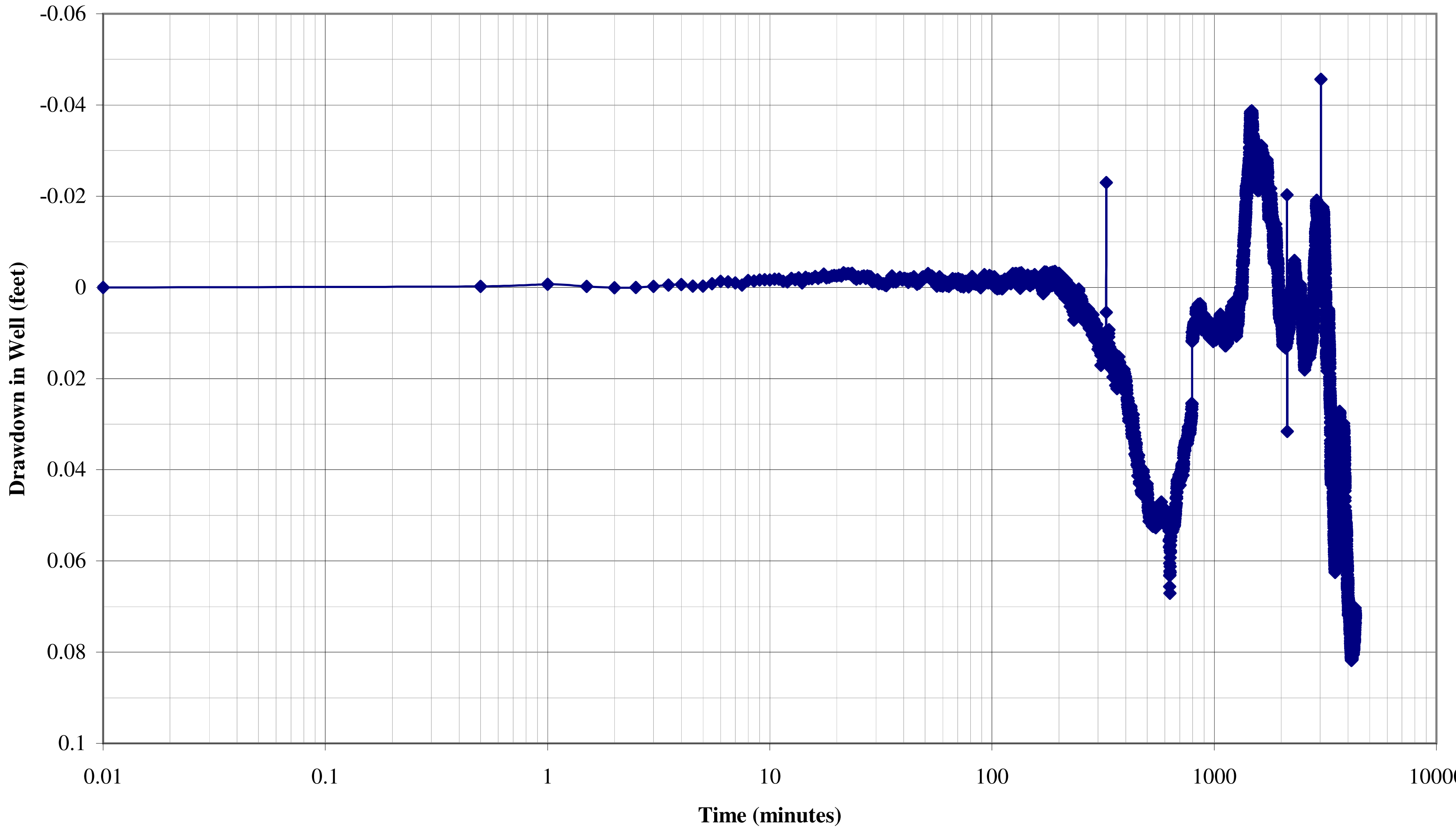
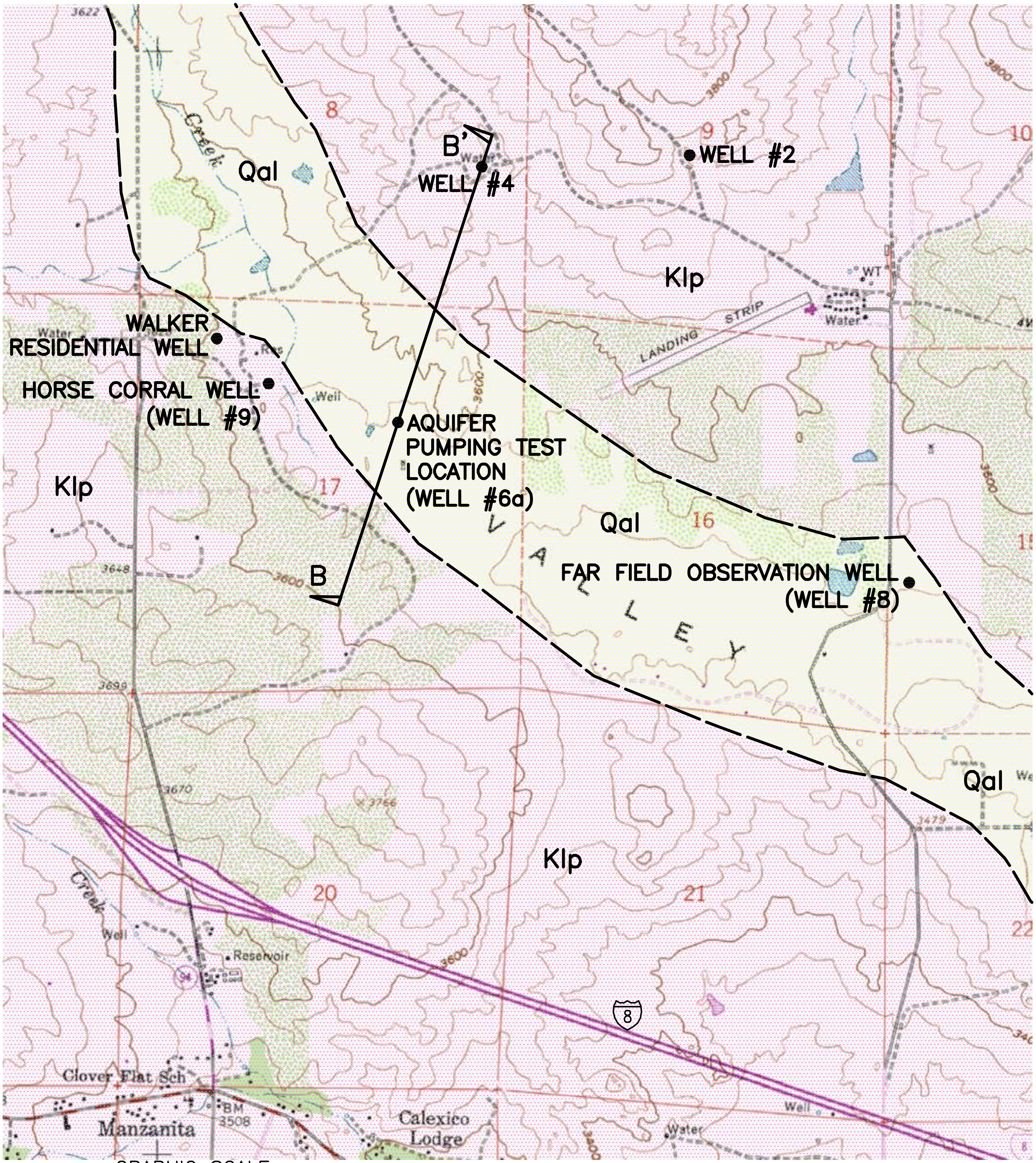


Figure 9
Well #8 Far Field - Observation Well
Time-Drawdown Plot
Rough Acres Ranch





GRAPHIC SCALE

1000 0 500 1000 2000

(in feet)

1 inch = 2000 ft.

N

REFERENCE: PRELIMINARY GEOLOGIC MAP OF EL CAJON 30' x 60' QUADRANGLE, SOUTHERN CALIFORNIA, V. R. TODD, 2004

EXPLANATION:

Qal ALLUVIUM

Klp TONALITE OF LA POSTA (EARLY AND LATE CRETACEOUS)

— — — APPROXIMATE GEOLOGIC CONTACT

B B' CROSS–SECTION LOCATION

FIGURE 7

GEOLOGIC MAP
ROUGH ACRES RANCH AQUIFER TEST SITE

TULE WIND PROJECT
SAN DIEGO COUNTY, CA

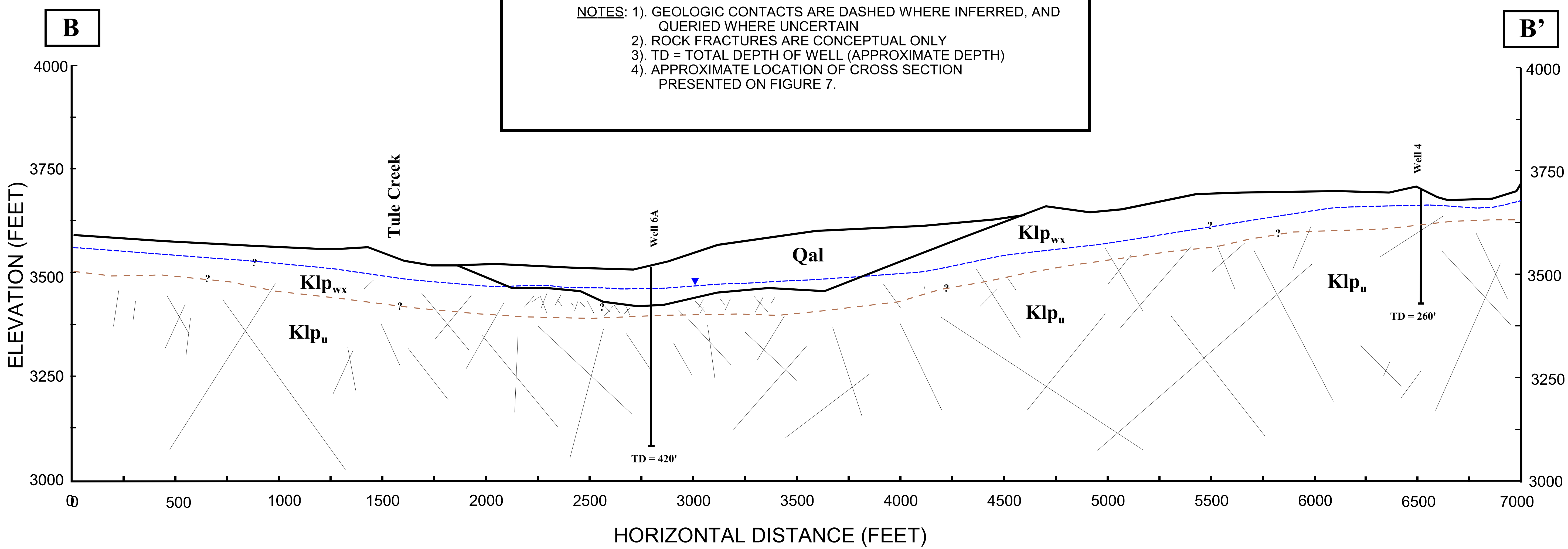
Geo-Logic ASSOCIATES

DRAWN BY: VL	DATE: NOVEMBER 2010	JOB NO. 2010–005

LEGEND

Qal	RECENT ALLUVIUM
Klp$_{wx}$	LA POSTA TONALITE, WEATHERED
Klb$_{u}$	LA POSTA TONALITE, UNWEATHERED
(blue dashed line)	APPROXIMATE GROUNDWATER TABLE
(thin lines)	ROCK FRACTURES (SCHEMATIC ONLY)

NOTES: 1). GEOLOGIC CONTACTS ARE DASHED WHERE INFERRED, AND QUERIED WHERE UNCERTAIN
2). ROCK FRACTURES ARE CONCEPTUAL ONLY
3). TD = TOTAL DEPTH OF WELL (APPROXIMATE DEPTH)
4). APPROXIMATE LOCATION OF CROSS SECTION PRESENTED ON FIGURE 7.



NORTH 18° EAST →

HORIZONTAL SCALE: 1 INCH = 500 FEET
VERTICAL SCALE: 1 INCH = 250 FEET
2x VERTICAL EXAGGERATION
(11 X 17 INCH FORMAT ONLY)

FIGURE 8

CONCEPTUAL HYDROGEOLOGIC CROSS SECTION

ROUGH ACRES STUDY AREA
SAN DIEGO COUNTY, CALIFORNIA

Geo-Logic ASSOCIATES

Draft	Date	Project No.
JGF	OCT 2010	2010-0005

References: USGS, 1975, 7.5' Live Oak Springs, CA Quadrangle.

Appendix A
Analytical Results from Aquifer Test Program

Waterloo Hydrogeologic, Inc.
460 Philip Street - Suite 101
Waterloo, Ontario, Canada
Phone: +1 519 746 1798

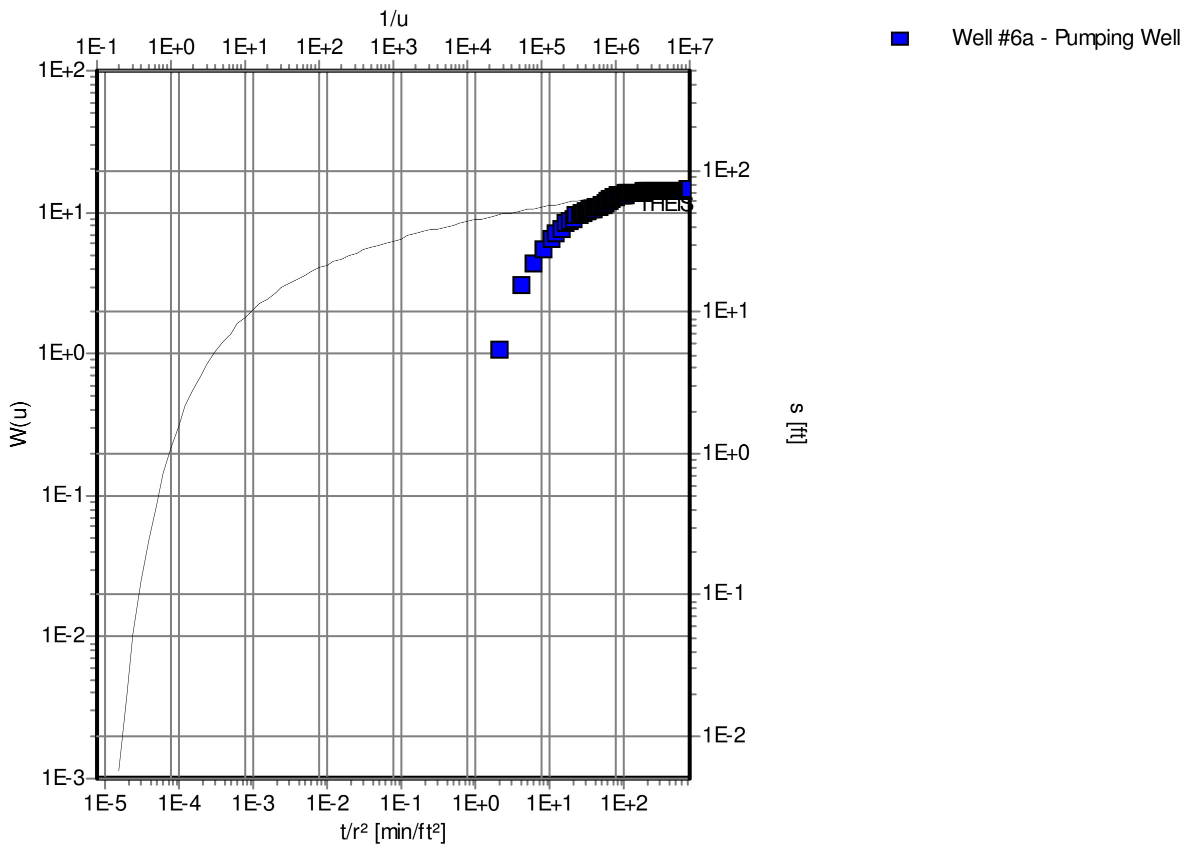
Pumping Test Analysis Report

Project: Rough Acres

Number:

Client:

Pumping Test Name [Theis]



Pumping Test:	**Pumping Test Name**			
Analysis Method:	**Theis**			
Analysis Results:	Transmissivity:	1.51E+2 [ft²/d]	Conductivity:	3.03E-1 [ft/d]
	Storativity:	3.19E-5		
Test parameters:	Pumping Well:	Well #6a	Aquifer Thickness:	500 [ft]
	Casing radius:	0.167 [ft]	Confined Aquifer	
	Screen length:	310 [ft]		
	Boring radius:	0.271 [ft]		
	Discharge Rate:	50 [U.S. gal/min]		

Comments: Match to late time data. Pumping Well.

Evaluated by: MWV

Evaluation Date: 11/18/2010

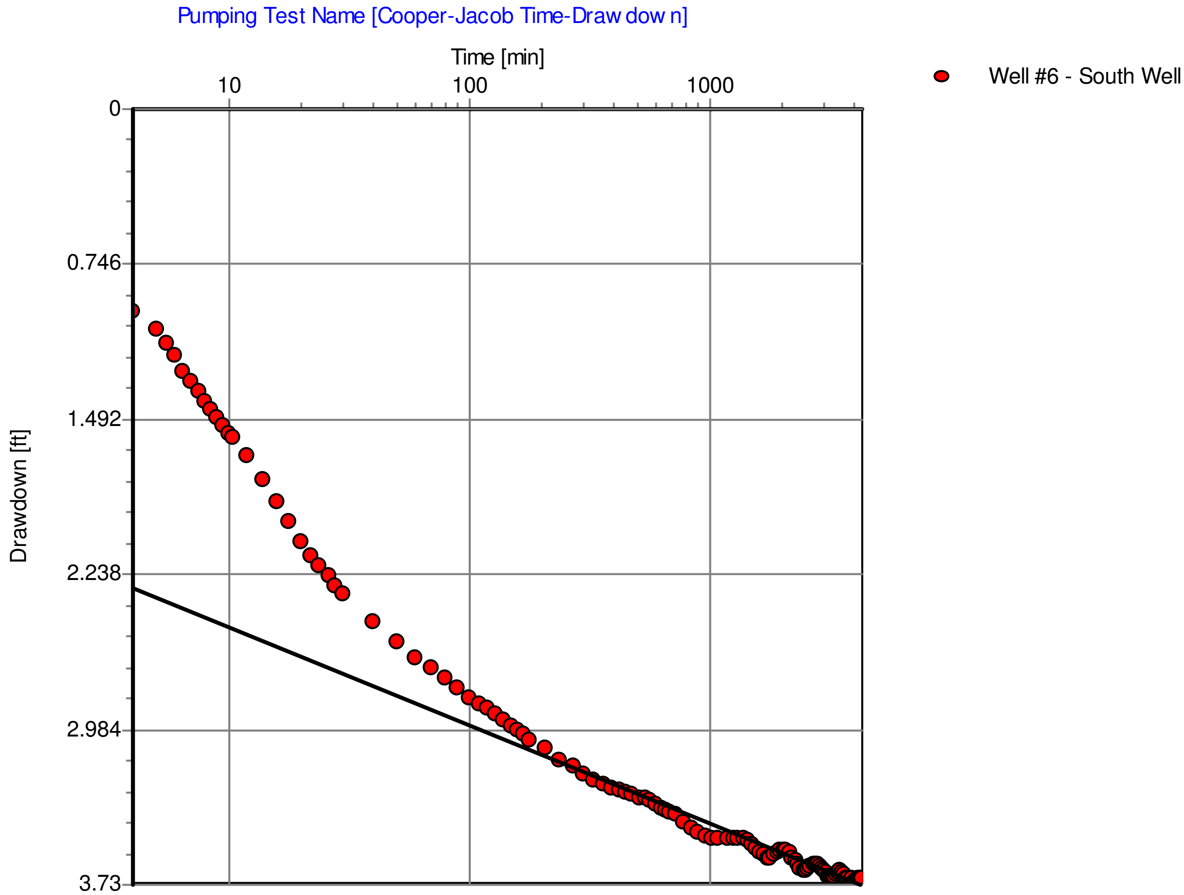
Waterloo Hydrogeologic, Inc.
460 Philip Street - Suite 101
Waterloo, Ontario, Canada
Phone: +1 519 746 1798

Pumping Test Analysis Report

Project: Rough Acres

Number:

Client:



Pumping Test: **Pumping Test Name**

Analysis Method: **Cooper-Jacob Time-Drawdown**

Analysis Results:	Transmissivity:	3.75E+3 [ft²/d]	Conductivity:	7.50E+0 [ft/d]
	Storativity:	2.28E-7		

Test parameters:	Pumping Well:	Well #6a	Aquifer Thickness:	500 [ft]
	Casing radius:	0.167 [ft]	Confined Aquifer	
	Screen length:	310 [ft]		
	Boring radius:	0.271 [ft]		
	Discharge Rate:	50 [U.S. gal/min]		

Comments: Match to latest time data. Observation Well.

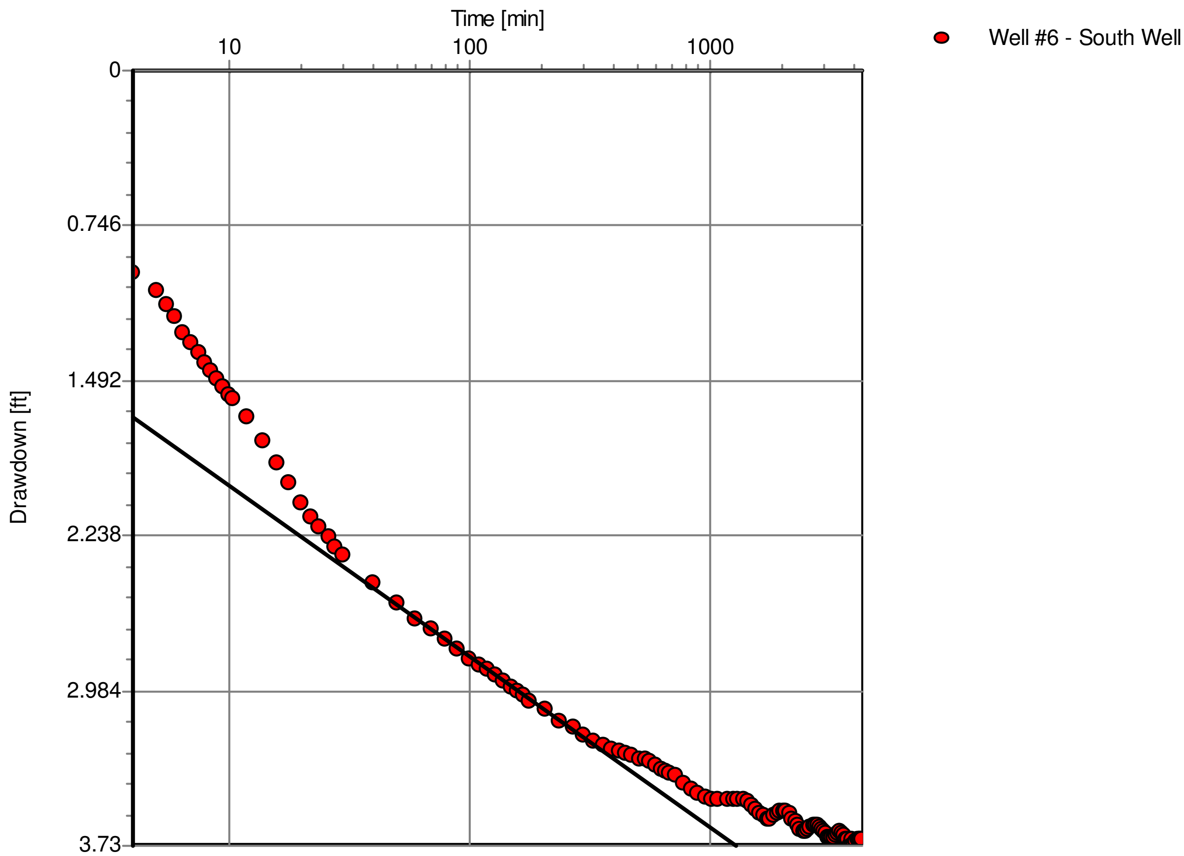
Evaluated by: MWV

Evaluation Date: 11/18/2010

Waterloo Hydrogeologic, Inc.
460 Philip Street - Suite 101
Waterloo, Ontario, Canada
Phone: +1 519 746 1798

Pumping Test Analysis Report	
Project:	Rough Acres
Number:	
Client:	

Pumping Test Name [Cooper-Jacob Time-Draw dow n]



Pumping Test:	**Pumping Test Name**
Analysis Method:	**Cooper-Jacob Time-Drawdown**

Analysis Results:	Transmissivity:	2.14E+3 [ft²/d]	Conductivity:	4.28E+0 [ft/d]
	Storativity:	1.01E-4		

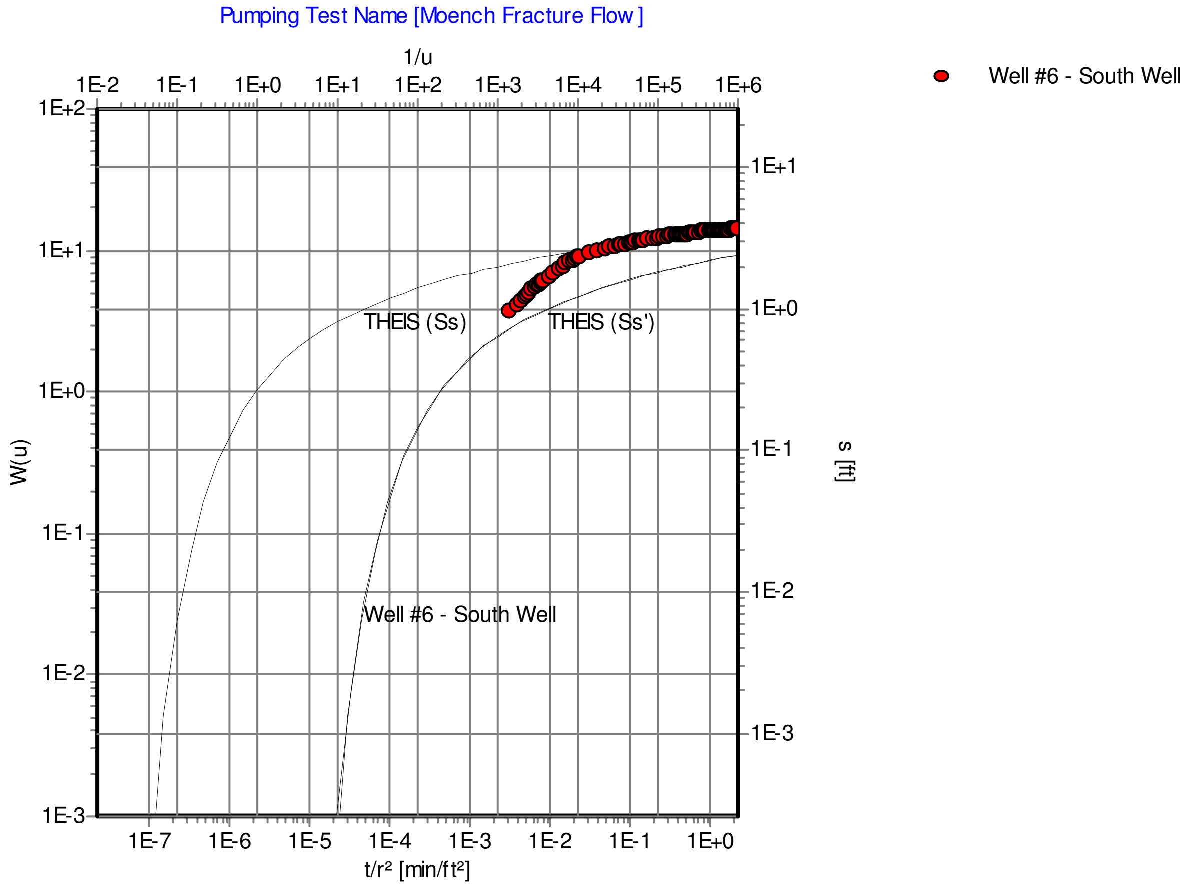
Test parameters:	Pumping Well:	Well #6a	Aquifer Thickness:	500 [ft]
	Casing radius:	0.167 [ft]	Confined Aquifer	
	Screen length:	310 [ft]		
	Boring radius:	0.271 [ft]		
	Discharge Rate:	50 [U.S. gal/min]		

Comments: Match to middle time data. Observation Well.

Evaluated by: MWV

Evaluation Date: 11/18/2010

Waterloo Hydrogeologic, Inc.	**Pumping Test Analysis Report**
460 Philip Street - Suite 101	Project: Rough Acres
Waterloo, Ontario, Canada	Number:
Phone: +1 519 746 1798	Client:

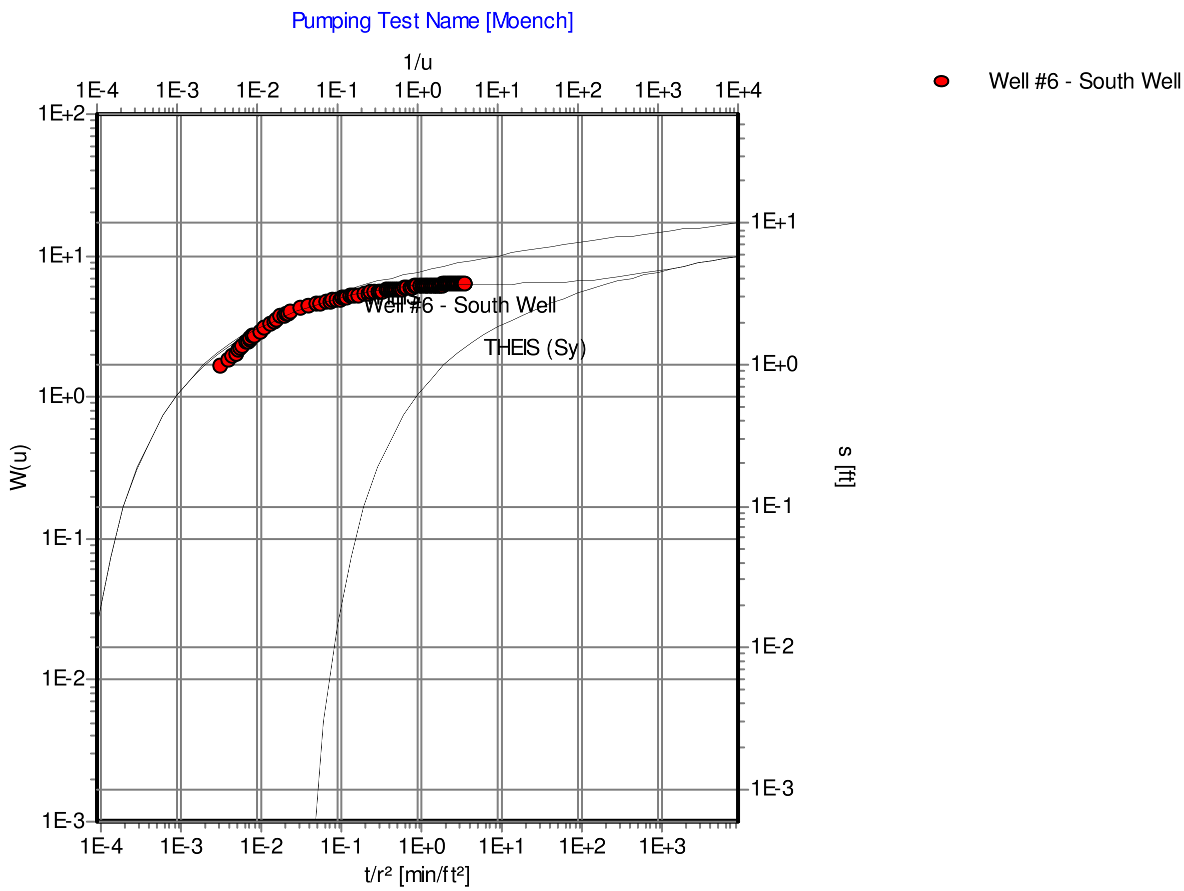


Pumping Test:	**Pumping Test Name**			
Analysis Method:	**Moench Fracture Flow**			
Analysis Results:	Transmissivity:	2.95E+3 [ft²/d]	Conductivity:	5.91E+0 [ft/d]
	Storativity:	4.48E-6		
Test parameters:	Pumping Well:	Well #6a	Aquifer Thickness:	500 [ft]
	Casing radius:	0.167 [ft]	b:	357 [ft]
	Screen length:	310 [ft]	Kv/Kh:	0.1
	Boring radius:	0.271 [ft]	C:	0.231
	Discharge Rate:	50 [U.S. gal/min]	K(block)/K(Skin):	0.1
	Ss(blk)/Ss(fract):	200	K(block)/K(fracture):	0.1
Comments:	Match to late time data.			

Evaluated by: MWV

Evaluation Date: 11/18/2010

Waterloo Hydrogeologic, Inc.	**Pumping Test Analysis Report**
460 Philip Street - Suite 101	Project: Rough Acres
Waterloo, Ontario, Canada	Number:
Phone: +1 519 746 1798	Client:



Pumping Test: **Pumping Test Name**

Analysis Method: **Moench**

Analysis Results:	Transmissivity:	1.30E+3 [ft²/d]	Conductivity:	2.60E+0 [ft/d]
	Storativity:	7.87E-1	Conductivity (vertical):	2.60E-1 [ft/d]

Test parameters:	Pumping Well:	Well #6a	Aquifer Thickness:	500 [ft]
	Casing radius:	0.167 [ft]	Unconfined Aquifer	
	Screen length:	310 [ft]	S/Sy:	0.001
	Boring radius:	0.271 [ft]	Kv/Kh:	0.1
	Discharge Rate:	50 [U.S. gal/min]	Gamma:	1E9
	b:	357 [ft]		

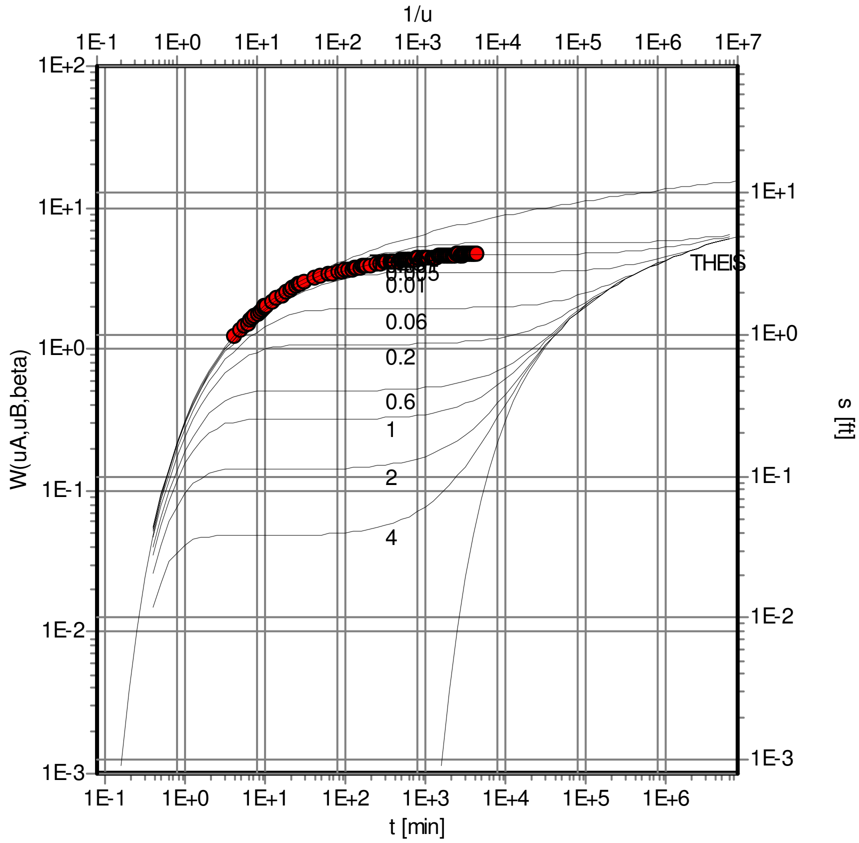
Comments: Match to late time data.

Evaluated by: MWV

Evaluation Date: 11/18/2010

Waterloo Hydrogeologic, Inc.
460 Philip Street - Suite 101
Waterloo, Ontario, Canada
Phone: +1 519 746 1798

Pumping Test Analysis Report
Project: Rough Acres
Number:
Client:



Pumping Test: **Pumping Test Name**

Analysis Method: **Neuman**

Analysis Results:	Transmissivity:	9.67E+2 [ft²/d]	Conductivity:	1.93E+0 [ft/d]

Test parameters:	Pumping Well:	Well #6a	Aquifer Thickness:	500 [ft]
	Casing radius:	0.167 [ft]	Beta:	0.005
	Screen length:	310 [ft]		
	Boring radius:	0.271 [ft]		
	Discharge Rate:	50 [U.S. gal/min]		
	LOG(Sy/S):	4		

Comments: Match to entire data set.

Evaluated by: MWV

Evaluation Date: 11/18/2010

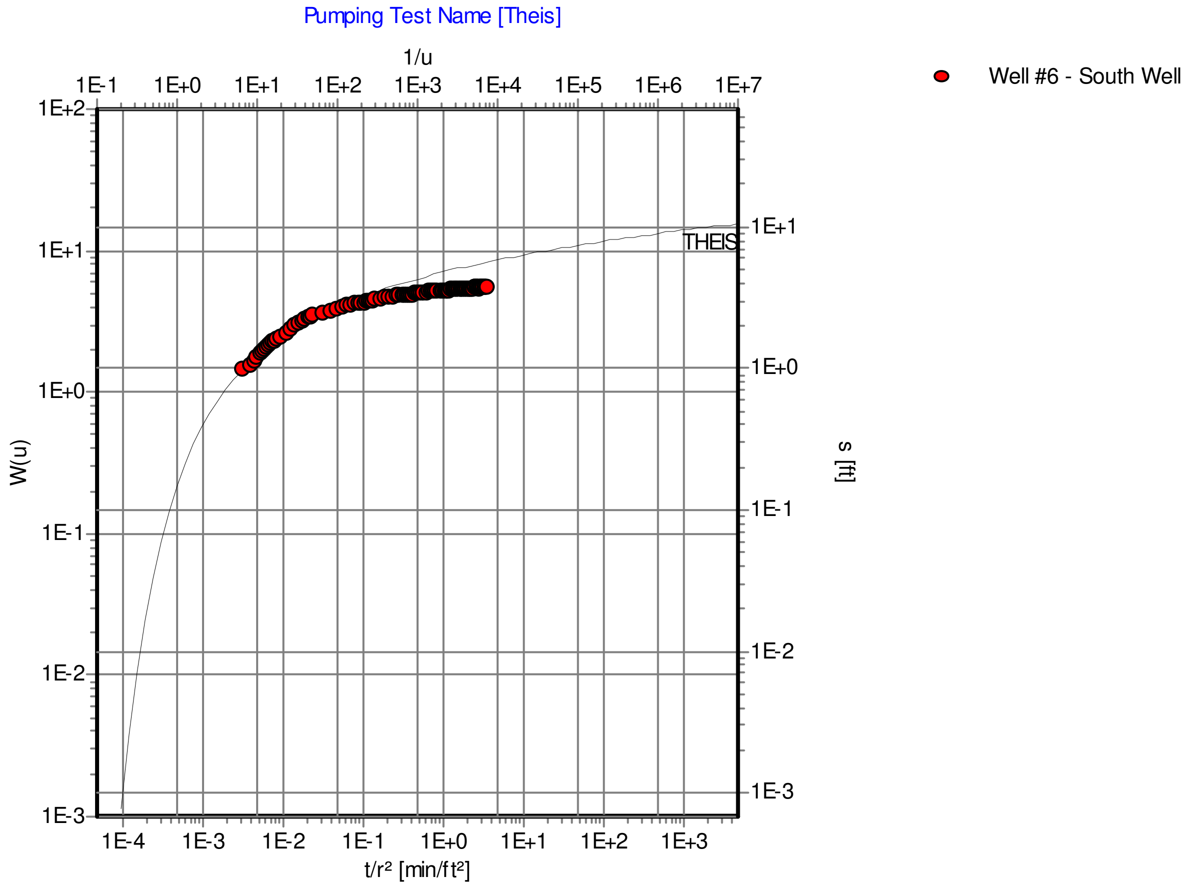
Waterloo Hydrogeologic, Inc.
460 Philip Street - Suite 101
Waterloo, Ontario, Canada
Phone: +1 519 746 1798

Pumping Test Analysis Report

Project: Rough Acres

Number:

Client:



Pumping Test: **Pumping Test Name**

Analysis Method: **Theis**

Analysis Results:	Transmissivity:	1.13E+3 [ft²/d]	Conductivity:	2.26E+0 [ft/d]
	Storativity:	1.47E-3		

Test parameters:	Pumping Well:	Well #6a	Aquifer Thickness:	500 [ft]
	Casing radius:	0.167 [ft]	Confined Aquifer	
	Screen length:	310 [ft]		
	Boring radius:	0.271 [ft]		
	Discharge Rate:	50 [U.S. gal/min]		

Comments: Match to early time data. Observation Well.

Evaluated by: MWV

Evaluation Date: 11/18/2010

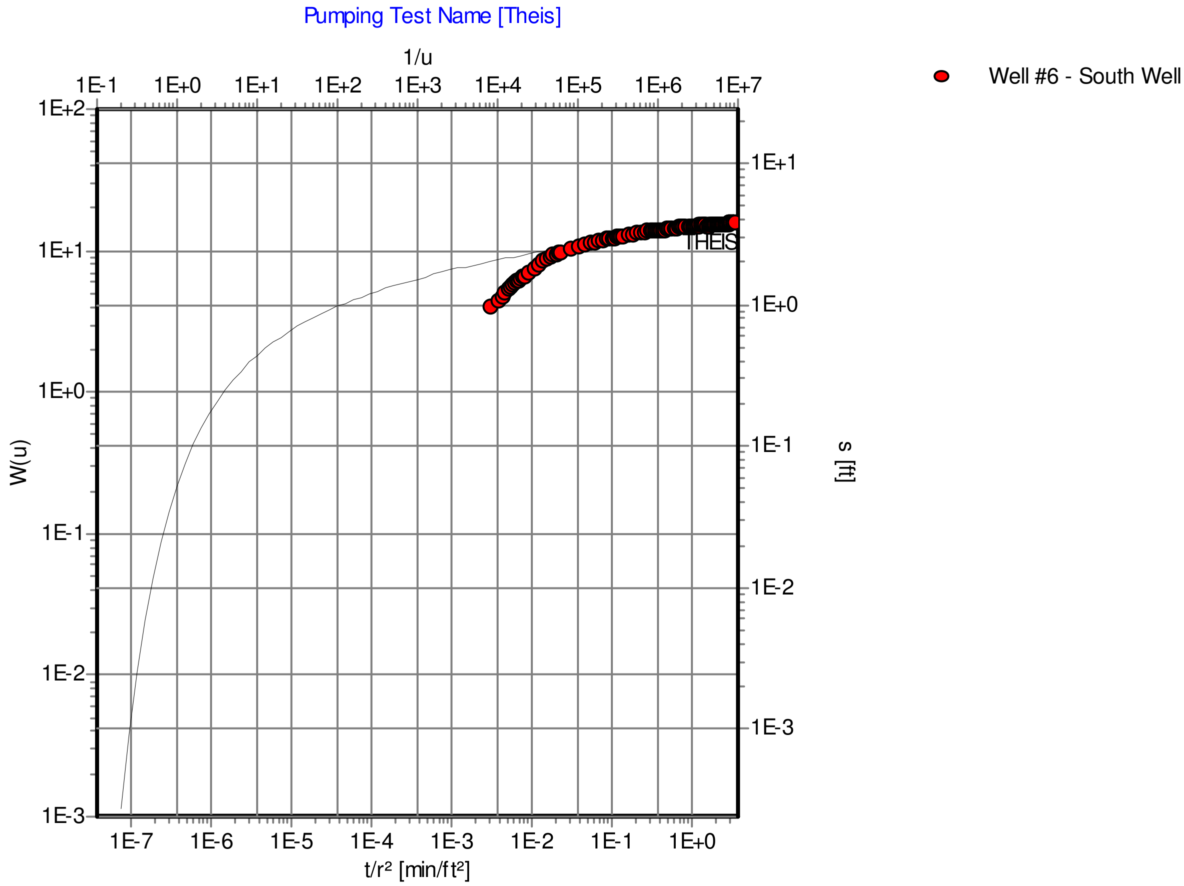
Waterloo Hydrogeologic, Inc.
460 Philip Street - Suite 101
Waterloo, Ontario, Canada
Phone: +1 519 746 1798

Pumping Test Analysis Report

Project: Rough Acres

Number:

Client:



Pumping Test:	**Pumping Test Name**			
Analysis Method:	**Theis**			
Analysis Results:	Transmissivity:	3.18E+3 [ft²/d]	Conductivity:	6.36E+0 [ft/d]
	Storativity:	3.29E-6		
Test parameters:	Pumping Well:	Well #6a	Aquifer Thickness:	500 [ft]
	Casing radius:	0.167 [ft]	Confined Aquifer	
	Screen length:	310 [ft]		
	Boring radius:	0.271 [ft]		
	Discharge Rate:	50 [U.S. gal/min]		

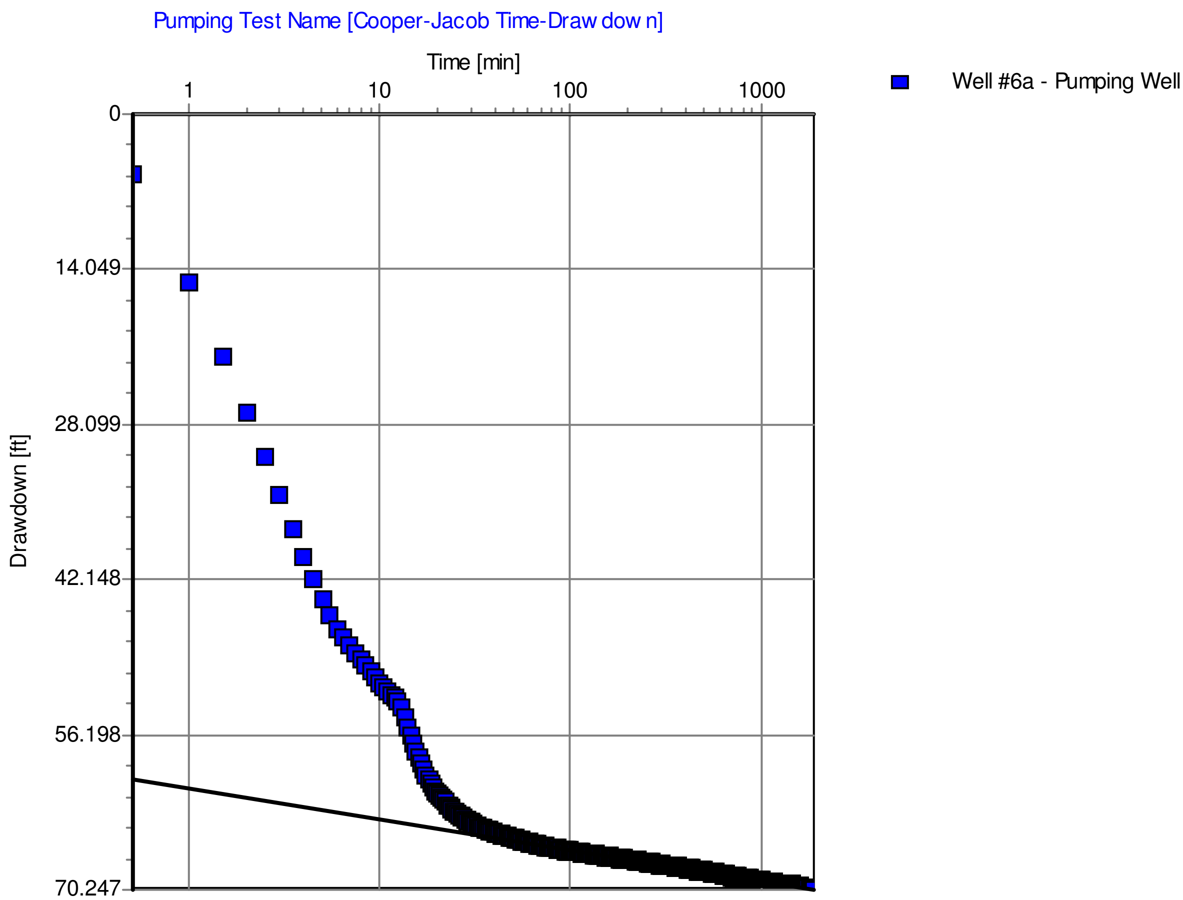
Comments: Match to late time data.

Evaluated by: MWV

Evaluation Date: 11/18/2010

Waterloo Hydrogeologic, Inc.
460 Philip Street - Suite 101
Waterloo, Ontario, Canada
Phone: +1 519 746 1798

Pumping Test Analysis Report	
Project:	Rough Acres
Number:	
Client:	



Pumping Test: **Pumping Test Name**

Analysis Method: **Cooper-Jacob Time-Drawdown**

Analysis Results:	Transmissivity:	6.30E+2 [ft²/d]	Conductivity:	1.26E+0 [ft/d]

Test parameters:	Pumping Well:	Well #6a	Aquifer Thickness:	500 [ft]
	Casing radius:	0.167 [ft]	Unconfined Aquifer	
	Screen length:	310 [ft]		
	Boring radius:	0.271 [ft]		
	Discharge Rate:	50 [U.S. gal/min]		

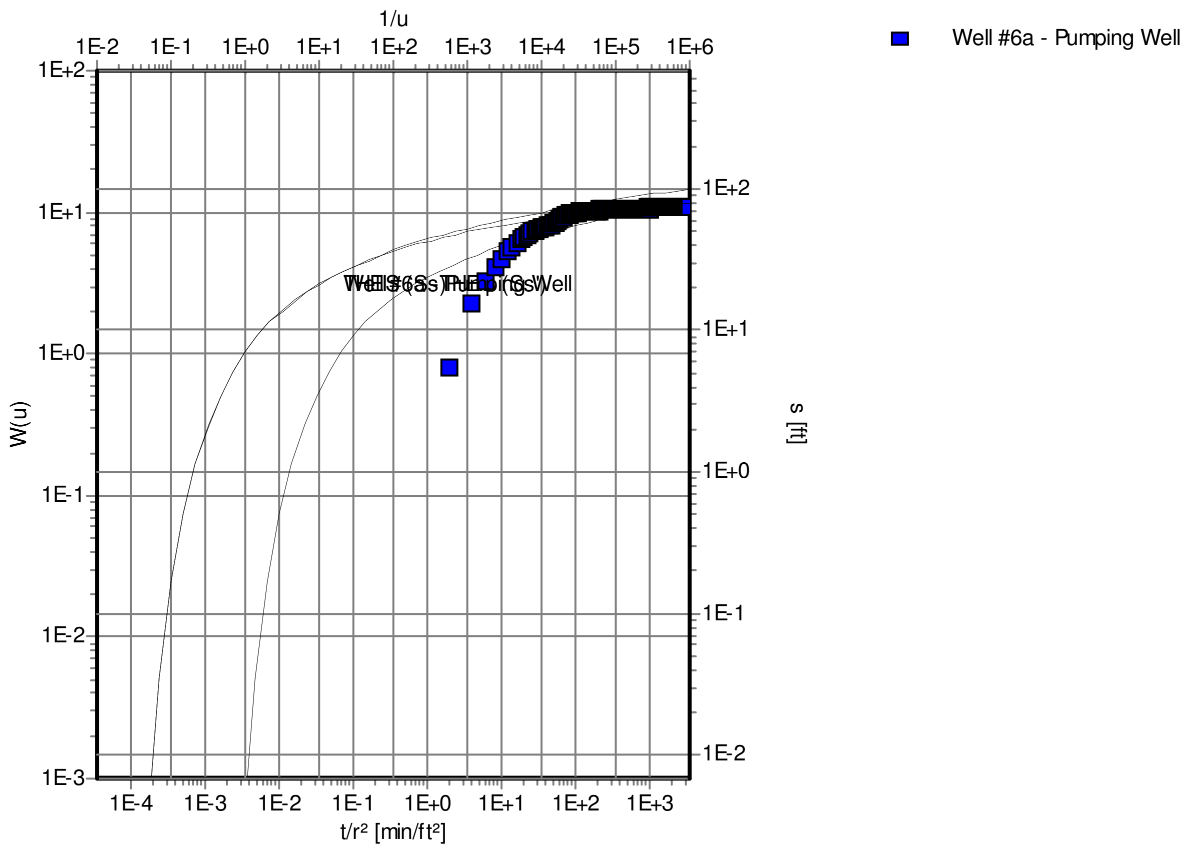
Comments: Match to late time data.

Evaluated by: MWV

Evaluation Date: 11/17/2010

Waterloo Hydrogeologic, Inc.	Pumping Test Analysis Report
460 Philip Street - Suite 101	Project: Rough Acres
Waterloo, Ontario, Canada	Number:
Phone: +1 519 746 1798	Client:

Pumping Test Name [Moench Fracture Flow]



Pumping Test: **Pumping Test Name**

Analysis Method: **Moench Fracture Flow**

Analysis Results:	Transmissivity:	1.12E+2 [ft²/d]	Conductivity:	2.25E-1 [ft/d]
	Storativity:	2.70E-4		

Test parameters:	Pumping Well:	Well #6a	Aquifer Thickness:	500 [ft]
	Casing radius:	0.167 [ft]	b:	357 [ft]
	Screen length:	310 [ft]	Kv/Kh:	1
	Boring radius:	0.271 [ft]	C:	0.231
	Discharge Rate:	50 [U.S. gal/min]	K(block)/K(Skin):	0.1
	Ss(blk)/Ss(fract):	20	K(block)/K(fracture):	0.1

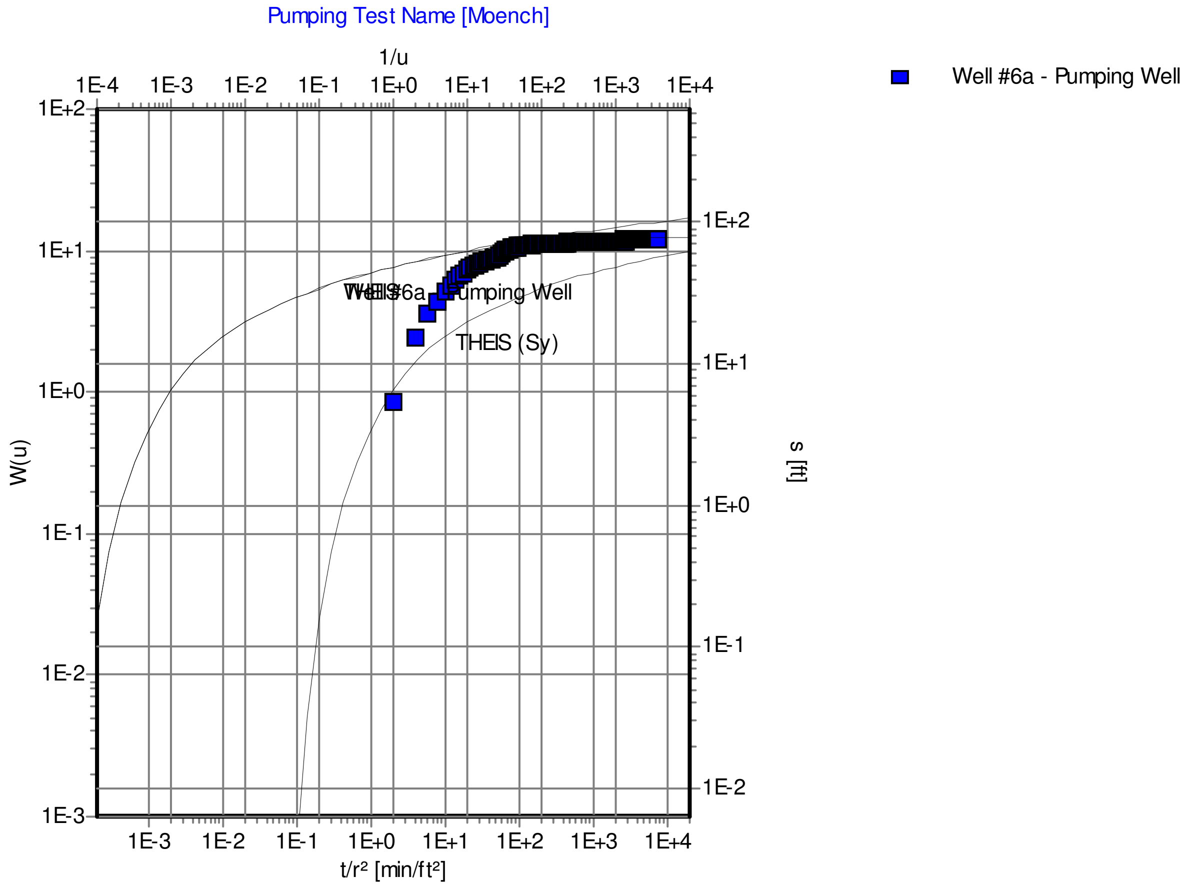
Comments: Match to late time data.

Evaluated by: MWV

Evaluation Date: 11/17/2010

Waterloo Hydrogeologic, Inc.
460 Philip Street - Suite 101
Waterloo, Ontario, Canada
Phone: +1 519 746 1798

Pumping Test Analysis Report
Project: Rough Acres
Number:
Client:



Pumping Test: **Pumping Test Name**

Analysis Method: **Moench**

Analysis Results:	Transmissivity:	1.21E+2 [ft²/d]	Conductivity:	2.43E-1 [ft/d]
	Storativity:	1.72E-1	Conductivity (vertical):	2.43E-1 [ft/d]

Test parameters:	Pumping Well:	Well #6a	Aquifer Thickness:	500 [ft]
	Casing radius:	0.167 [ft]	Unconfined Aquifer	
	Screen length:	310 [ft]	S/Sy:	0.001
	Boring radius:	0.271 [ft]	Kv/Kh:	1
	Discharge Rate:	50 [U.S. gal/min]	Gamma:	1E9
	b:	357 [ft]		

Comments:

Evaluated by:

Evaluation Date: 11/17/2010

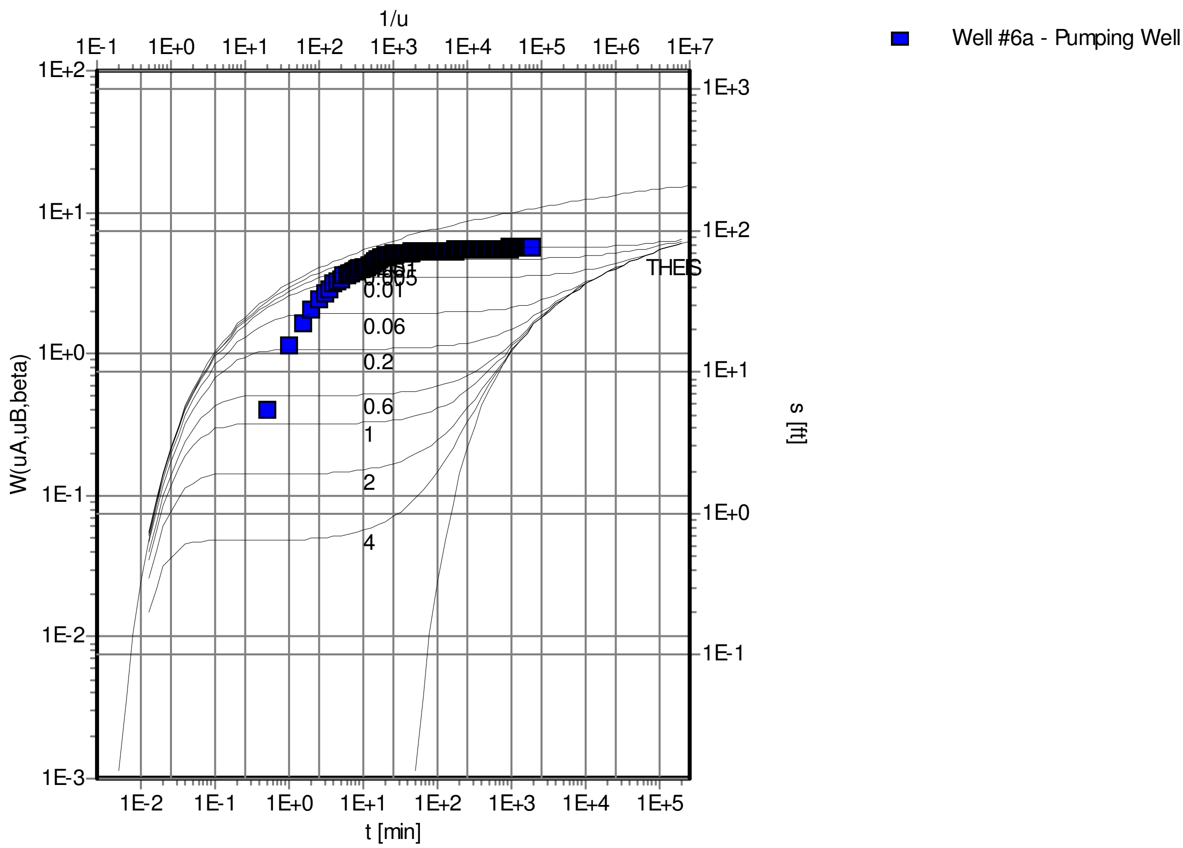
Waterloo Hydrogeologic, Inc.
460 Philip Street - Suite 101
Waterloo, Ontario, Canada
Phone: +1 519 746 1798

Pumping Test Analysis Report

Project: Rough Acres

Number:

Client:



Pumping Test: **Pumping Test Name**

Analysis Method: **Neuman**

Analysis Results:				
	Transmissivity:	5.69E+1 [ft²/d]	Conductivity:	1.14E-1 [ft/d]
	Storativity:	1.62E-2	Specific Yield:	1.62E+2

Test parameters:				
	Pumping Well:	Well #6a	Aquifer Thickness:	500 [ft]
	Casing radius:	0.167 [ft]	Beta:	0.005
	Screen length:	310 [ft]		
	Boring radius:	0.271 [ft]		
	Discharge Rate:	50 [U.S. gal/min]		
	LOG(Sy/S):	4		

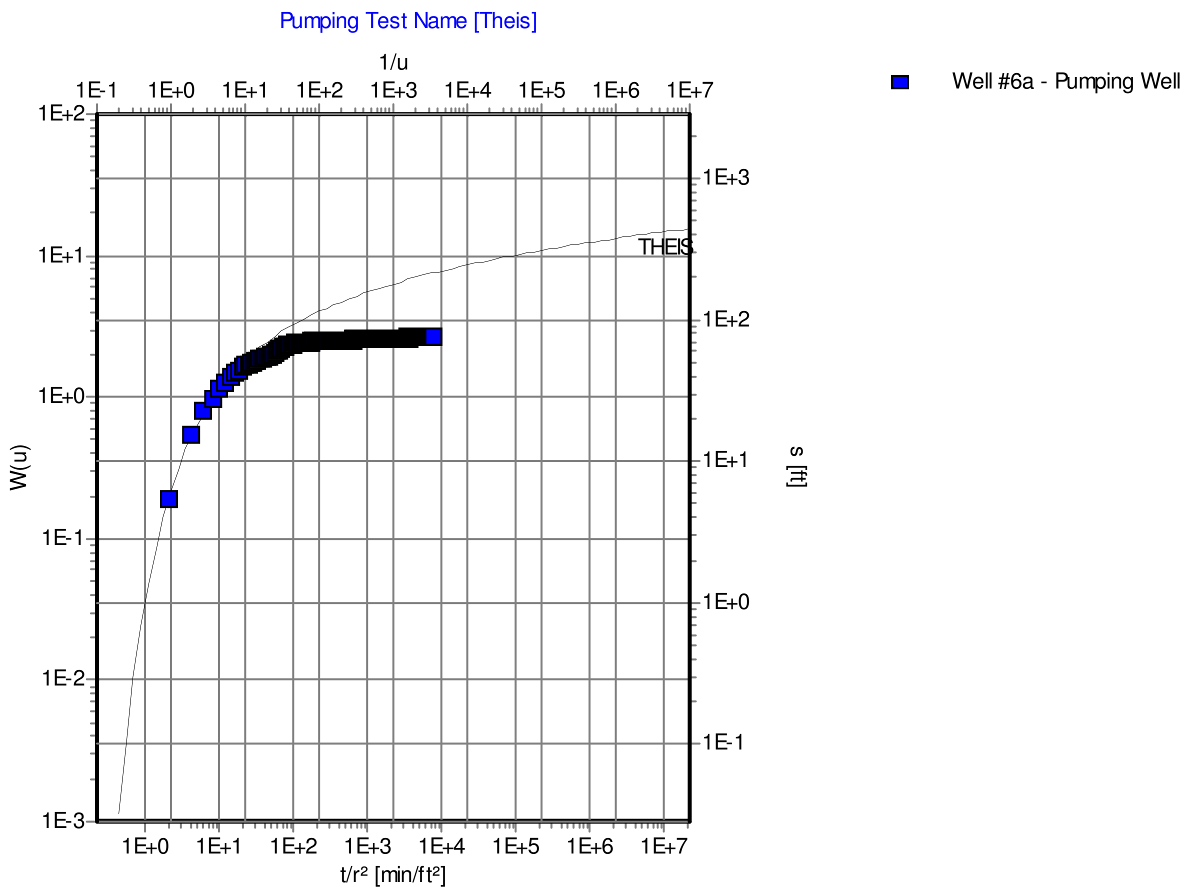
Comments: Match to late time drawdown data.

Evaluated by: MWV

Evaluation Date: 11/17/2010

Waterloo Hydrogeologic, Inc.
460 Philip Street - Suite 101
Waterloo, Ontario, Canada
Phone: +1 519 746 1798

Pumping Test Analysis Report
Project: Rough Acres
Number:
Client:



Pumping Test:	**Pumping Test Name**			
Analysis Method:	**Theis**			
Analysis Results:	Transmissivity:	2.69E+1 [ft²/d]	Conductivity:	5.39E-2 [ft/d]
	Storativity:	1.64E-1		
Test parameters:	Pumping Well:	Well #6a	Aquifer Thickness:	500 [ft]
	Casing radius:	0.167 [ft]	Confined Aquifer	
	Screen length:	310 [ft]		
	Boring radius:	0.271 [ft]		
	Discharge Rate:	50 [U.S. gal/min]		
Comments:	Match to early time data.			

Evaluated by: MWV
Evaluation Date: 11/18/2010

Waterloo Hydrogeologic, Inc.
460 Philip Street - Suite 101
Waterloo, Ontario, Canada
Phone: +1 519 746 1798

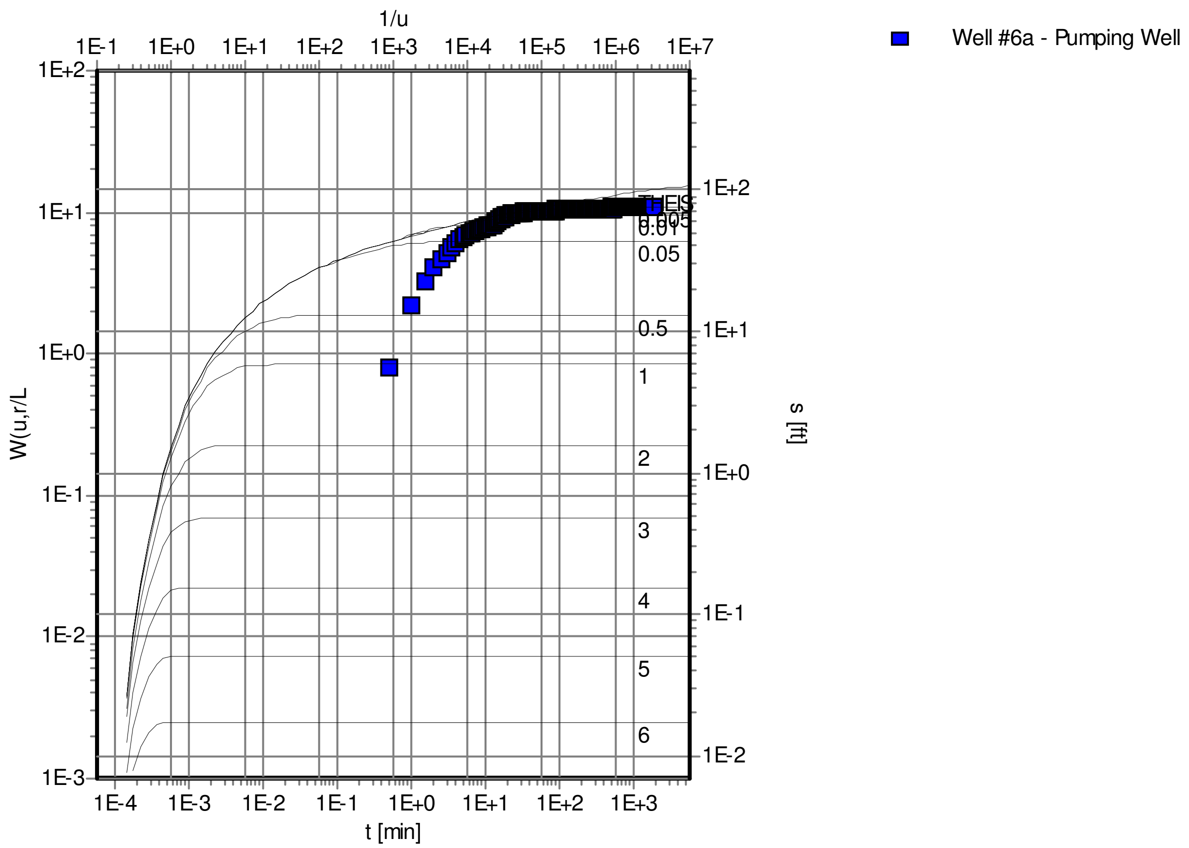
Pumping Test Analysis Report

Project: Rough Acres

Number:

Client:

Pumping Test Name [Walton]



Pumping Test:	**Pumping Test Name**			
Analysis Method:	**Walton**			
Analysis Results:	Transmissivity:	1.11E+2 [ft²/d]	Conductivity:	2.21E-1 [ft/d]
	Storativity:	7.08E-4	c:	1.30E+5 [min]
Test parameters:	Pumping Well:	Well #6a	Aquifer Thickness:	500 [ft]
	Casing radius:	0.167 [ft]	r/L:	0.005
	Screen length:	310 [ft]		
	Boring radius:	0.271 [ft]		
	Discharge Rate:	50 [U.S. gal/min]		

Comments:

Evaluated by: MWV

Evaluation Date: 11/17/2010

Appendix B
Department of Water Resources Well Completion Reports

#4

Power at well

<u>NO</u> pump

Across Road from Bathrooms in West Canyon

water was Discolored & hence quit using

COUNTY OF SAN DIEGO
DEPARTMENT OF ENVIRONMENTAL HEALTH
1255 Imperial Ave
San Diego, CA 92101
619-338-2222

#4

INVOICE

ERMIT TYPE & NUMBER: LWEL 16226 — INVOICE DATE: 16 SEP 2004

ERMIT OWNER:
ADEM ROBERT S&MARY O TRUST B1
53 OCEAN ST

92008

CONTACT:

PN: ~~611-110-01-00~~ 611-060-03
611-070-01

APPLICANT:
FADEM ROBERT S&MARY O TRUST B1

ITE ADDRESS: ~~2533~~ MCCAIN VALLEY RD

OCATION DESCRIPTION: ~~2533~~ MCCAIN VALLEY RD,

ROJECT DESCRIPTION/SCOPE
umber of Wells on Permit Application:1
escription of Work:new
ype of Use for Each Well:private

EE/DEPOSIT DETAILS

FEE CODE	DESCRIPTION	TIME ACCT.	ACCT. CODE	AMOUNT
6LE01--EHO	WATER WELL PERMIT	429E01	9773-773	390.00

09-16-04
11:30
9773 773 429E01
CHECK

	TOTAL AMOUNT DUE	$390.00

276
c.15

COUNTY OF SAN DIEGO
DEPARTMENT OF ENVIRONMENTAL HEALTH
WELL PERMIT APPLICATION

Parcel 1 [?] ~~12~~ 600

DEH USE ONLY
PERMIT # W LWCL162[?]
WELL COMPUTER #
FEE:
WATER DIST:

1. Property Owner: Hamann Companies Phone: [illegible]-7424[?]
   1000 Pioneer Way[?] (Mailing Address) El Cajon[?] (City) 92020[?] (Zip)
2. Well Location - Assessors Parcel Number ~~611-110-04~~ 611-060-03 611-070-01
   [illegible] (Site Address) [illegible] BOULEVARD (City) 91905 (Zip)
3. Well Contractor - Well Driller Jim Mayes[?] Company Name: [illegible] Drilling[?]
   [illegible] (Mailing Address) [illegible] (City) [illegible] (Zip)
   Phone#: [illegible]-1926[?] C-57#: [illegible] ☐ Cash Deposit ☐ Bond Posted
4. Use: ☒ Private ☐ Public ☐ Industrial ☐ Cathodic ☐ Other ______
5. Type of Work: ☐ New ☐ Reconstruction ☐ Destruction Time Extension: ☐ 1st ☐ 2nd
6. Type of Equipment: Air Rotary[?]
7. Depth of Well: Proposed: 300[?] Existing: ______
8. Proposed:

Casing	Conductor Casing	Filter/Filler Material	Perforations
Type: Steel[?]	☐ Yes ☐ No	☐ Yes ☐ No	From: ____ To: ____
Depth: 20[?]	Depth: ____ ft.	From: ____ To: ____	From: ____ To: ____
Diameter 7 in.	Diameter ____ in.	Type: ____	From: ____ To: ____
Wall/Gauge: [illegible]	Wall/Gauge: ____	Wall/Gauge: ____	

9. Annular Seal: Depth: [illegible] ft. Sealing Material: [illegible]
   Borehole diameter: ____ in. Conductor diameter: ____ in. Annular Thickness ____ in.
10. Date of Work: Start: [illegible] Complete: 7-27-04[?]

On sites served by public water, contact the local water agency for meter protection requirements.

I hereby agree to comply with all regulations of the Department of Environmental Health, and with all ordinances and laws of the County of San Diego and the State of California pertaining to well construction, repair, modification and destruction. Immediately upon completion of work, I will furnish the Department of Environmental Health with a complete and accurate log of the well. I accept responsibility for all work done as part of this permit and all work will be performed under my direct supervision.

Contractor's Signature: [signature] Date: [illegible]

DISPOSITION OF APPLICATION (Department of Environmental Health Use only)

☒ **Approved** ☐ **Denied** Special Conditions: Grading and clearing associated with access to, or the construction, maintenance or destruction of water wells, may require additional permits from the County of San Diego and/or other agencies.

Specialist: [signature] Date: 4/16/04

[illegible]

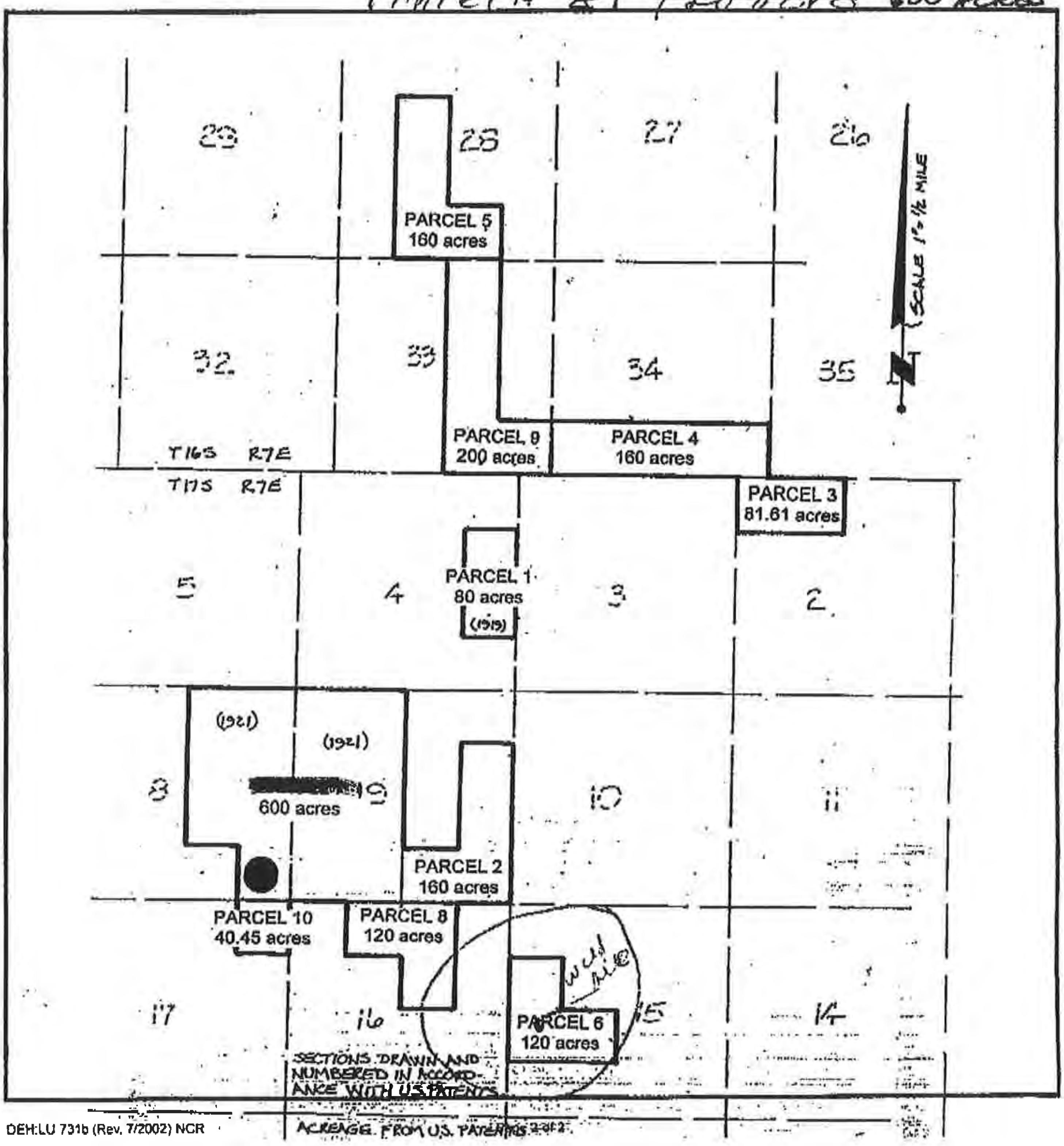
COUNTY OF SAN DIEGO
DEPARTMENT OF ENVIRONMENTAL HEALTH

Control #: LWCL 16226
Assessor's Parcel Number: ~~611-110-07~~
611-060-03
611-070-01

LOCATION

Indicate below the vicinity and exact location of well with respect to the following items: Property lines, water bodies or water courses, drainage pattern, easements, roads, existing wells, sewers and private sewage disposal systems and other potential contamination sources, including dimensions.

Parcel # ~~8~~ ~~[illegible]~~ 600 ACRES



County Mail Station – A-21

FIRST CARBON COPY

ASSESSORS PARCEL NUMBER:

COUNTY OF SAN DIEGO
DEPARTMENT OF HEALTH SERVICES
1700 PACIFIC HIGHWAY, SAN DIEGO, CA 92101–2417

Notice of Intent No.
Local Permit No. or Date

WATER WELL DRILLERS REPORT
(INSERT under ORIGINAL PAGE w/carbon of State Form)

State Well No.
Other Well No.

(1) OWNER: Name JOHN WELL NO 2
Address BOXER ACRES
City Zip

(2) LOCATION OF WELL (See instructions):
County Owner's Well Number
Well address if different from above
Township Range Section
Distance from cities, roads, railroads, fences, etc.

DEPARTMENT USE ONLY
Completed Well Construction:
Date
Date Inspected
Comments
Water Sample Taken?
Sanitarian's Approval:

Jetter #8

(3) TYPE OF WORK:
New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item (12)

(4) PROPOSED USE:
Domestic ☒
Irrigation ☒
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other ☐

(5) Equipment:
Rotary ☒ Reverse ☐
Cable ☐ Air ☒
Other ☐ Bucket ☐

(6) Gravel Pack: 3/8ths
Yes ☒ No ☐ Size
Diameter of above 9"
Packed from 0 to 185 ft.

(7) Casing Installed:
Steel ☒ Plastic ☐ Concrete ☐

(8) Perforations:
Type of perforation or size of screen

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot Size
0	91	6 5/8	.188	0	185	3/32nds

(9) WELL SEAL:
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 91' ft.
Were strata sealed against pollution? Yes ☐ No ☒ Interval ft.
Method of sealing BENTONITE – CEMENT

(10) WATER LEVELS:
Depth of first water, if known 130 ft.
Standing level after well completion 35 ft.

(11) WELL TESTS:
Was well test made? Yes ☒ No ☐ If yes, by whom? Driller
Type of test Pump ☐ Bailer ☐ Air lift ☒
Depth to water at start of test — ft. At end of test — ft.
Discharge 15 gal/min after 1 hours Water temperature Cool
Chemical analysis made? Yes ☐ No ☒ If yes, by whom?
Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

(12) WELL LOG: Total depth 260 ft. Depth of completed well 185 ft.
from ft. to ft. Formation (Describe by color, character, size or material)

0-91 – SANDY, D.G.
91-130 – SOFT, ORANGE, WHITE & BROWN
130-133 – GRAY SOFT (3 GPM)
133-185 – SOFT ORANGE, WHITE, BLACK
185-190 – LOOSE ROCKS (20 GPM)
190-260 – SOFT & HARD

Work Started 19 Completed 19

WELL DRILLERS STATEMENT: I hereby declare under penalty of perjury that the information provided in this report is true. This water well was installed in compliance with San Diego County Code and State of California, Department of Water Resources, Bulletin No. 74.

SIGNED [signature]
(Well Driller)

NAME
(Person, firm, or Corporation) (Type or Print)

ADDRESS

CITY ZIP

LICENSE NO. DATE THIS REPORT

DHS:EHP-732 (83) CONFIDENTIAL – NOT FOR PUBLIC USE – WATER CODE SEC. 13752

DUPLICATE
Driller's Copy

Page 1 of 1

Owner's Well No. # 1

Date Work Began 9-25-04, Ended 9-27-04

Local Permit Agency San Diego E.H.S.

Permit No. LWEL16226 Permit Date 9-16-04

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 0909442

DWR USE ONLY — DO NOT FILL IN

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

CONFIDENTIAL

NOT FOR PUBLIC USE

WATER CODE SEC. 13752

GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD rotary FLUID air

DEPTH FROM SURFACE Ft. to Ft.	DESCRIPTION Describe material, grain size, color, etc.
0 - 91	sandy, dg
91 - 130	soft, orange, white & brown
130 - 133	very soft
133 - 185	soft, orange, white & black
185 - 190	loose rocks
190 - 260	soft & hard

TOTAL DEPTH OF BORING 260 (Feet)

TOTAL DEPTH OF COMPLETED WELL 185 (Feet)

WELL OWNER

Name Hamann Companies

Mailing Address 1000 Pioneer Way

El Cajon, Ca. 92020

CITY STATE ZIP

WELL LOCATION

Address McCain Valley Rd

City Jacumba

County San Diego

APN Book 611 Page 110 Parcel 01

Township 17 Range 7E Section 15

Lat ___ N Long ___ W (DEG. MIN. SEC.)

LOCATION SKETCH

NORTH — WEST — EAST — SOUTH

See attached

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

X NEW WELL

MODIFICATION/REPAIR

___ Deepen

___ Other (Specify)

___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

USES (✓)

WATER SUPPLY

X Domestic ___ Public

___ Irrigation ___ Industrial

MONITORING ___

TEST WELL ___

CATHODIC PROTECTION ___

HEAT EXCHANGE ___

DIRECT PUSH ___

INJECTION ___

VAPOR EXTRACTION ___

SPARGING ___

REMEDIATION ___

OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 130 (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 35 (Ft.) & DATE MEASURED 9-27-04

ESTIMATED YIELD * 15 (GPM) & TEST TYPE airlift

TEST LENGTH 1 (Hrs.) TOTAL DRAWDOWN - (Ft.)

* May not be representative of a well's long-term yield.

CASING (S)

DEPTH FROM SURFACE Ft. to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0 - 91	11	x				steel	6 5/8	.188	
0 - 185	6½		x			pvc	4	sch 40	

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft. to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0 - 91	x	x		
0 - 185			x	5/16 pea gravel

ATTACHMENTS (✓)

___ Geologic Log

___ Well Construction Diagram

___ Geophysical Log(s)

___ Soil/Water Chemical Analyses

___ Other

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME JIM MANOS DRILLING & PUMP
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

16052 LAWSON VLY RD, JAMUL, CA 91935
ADDRESS CITY STATE ZIP

Signed [signature] C-57 LICENSED WATER WELL CONTRACTOR

2-6-05 DATE SIGNED

360722 C-57 LICENSE NUMBER

DWR 188 REV. 05-03

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

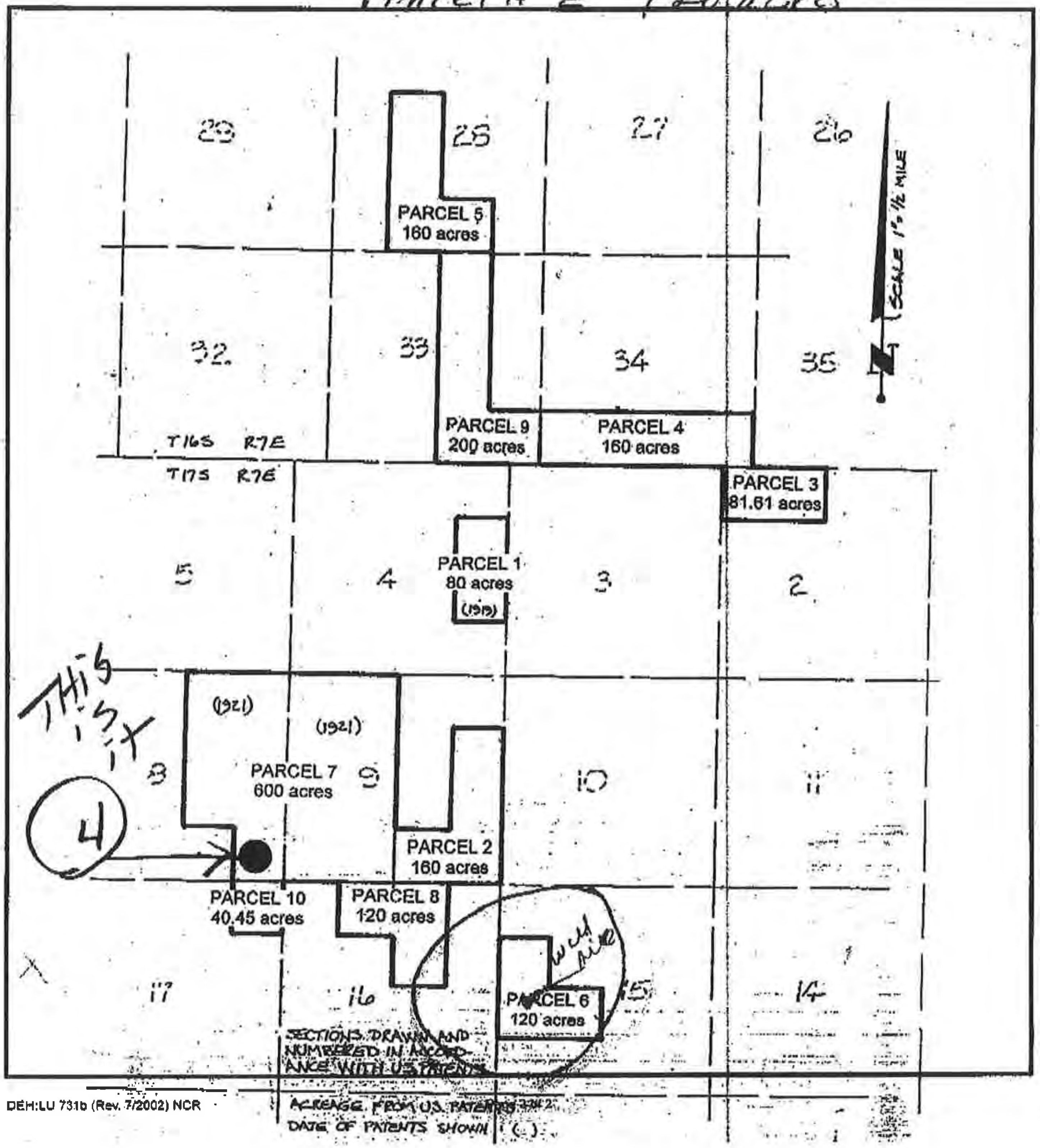
COUNTY OF SAN DIEGO
DEPARTMENT OF ENVIRONMENTAL HEALTH

Control #: LWEL 16226
Assessor's Parcel Number: 611-110-01

LOCATION

Indicate below the vicinity and exact location of well with respect to the following items: Property lines, water bodies or water courses, drainage pattern, easements, roads, existing wells, sewers and private sewage disposal systems and other potential contamination sources, including dimensions.

Parcel # 6 120 acres



Fully operational

#6 NO Logs
Available

origional
well on
Ranch

6A NEW
Public
well

Fully operational

QUADRUPLICATE — FEB 09 2010

For Local Requirements

Page 1 of 1 — County of San Diego, Dept. of Environmental Health, Land & Water Quality Div.

Owner's Well No. 1

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 1089956

— DWR USE ONLY — DO NOT FILL IN —

STATE WELL NO./STATION NO.

LATITUDE — LONGITUDE

APN/TRS/OTHER

Date Work Began 11-4-09, Ended 11-10-09

Local Permit Agency San Diego C.E.H.

Permit No. [illegible]20420 Permit Date 11-13-09

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD ROTARY FLUID AIR

DEPTH FROM SURFACE Ft. to Ft.	DESCRIPTION Describe material, grain size, color, etc.
0 - 10	sandy-rocks
10 - 30	sandy-slightly firm
30 - 32	soft
32 - 70	sandy
70 - 85	harder
85 - 87	cracks
87 - 230	black & white rock, softer areas
230 - 233	softer, orange
233 - 330	black, white & orange
330 - 332	softer, orange
332 - 395	black & white rock, softer areas
395 - 395	sand
395 - 420	black & white rock

Completed Well Construction

Date 2/9/10

Date Inspected

Comments KIVA entered in this date.

Water Sample Taken?

TOTAL DEPTH OF BORING 420 (Feet)

TOTAL DEPTH OF COMPLETED WELL [illegible] (Feet)

WELL OWNER

Name [illegible] Drive Partners

Mailing Address 1000 Pioneer Way

CITY El Cajon, Ca STATE 92020 ZIP

WELL LOCATION

Address Mc [illegible] Valley Road

City [illegible], Ca

County San Diego

APN Book 511 Page 090 Parcel 04

Township 15 S Range [illegible] Section 17

Lat ___ DEG. ___ MIN. ___ SEC. N Long ___ DEG. ___ MIN. ___ SEC. W

LOCATION SKETCH

NORTH — WEST — EAST — SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR
- ___ Deepen
- ___ Other (Specify)

___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

USES (✓)

WATER SUPPLY
- ___ Domestic ___ Public
- ___ Irrigation ✓ Industrial

- MONITORING ___
- TEST WELL ___
- CATHODIC PROTECTION ___
- HEAT EXCHANGE ___
- DIRECT PUSH ___
- INJECTION ___
- VAPOR EXTRACTION ___
- SPARGING ___
- REMEDIATION ___
- OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 30 (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 30 (Ft.) & DATE MEASURED 11-10-09

ESTIMATED YIELD * 60 (GPM) & TEST TYPE airlift

TEST LENGTH 2 (Hrs.) TOTAL DRAWDOWN -- (Ft.)

** May not be representative of a well's long-term yield.*

DEPTH FROM SURFACE Ft. to Ft.	BORE-HOLE DIA. (Inches)	CASING TYPE: BLANK	SCREEN	CONDUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0 - 56	12	x				steel		.188	
0 - 75		x				steel	6 5/8	.188	
0 - 865	6½		x			pvc	4	CL200	

DEPTH FROM SURFACE Ft. to Ft.	ANNULAR MATERIAL TYPE: CEMENT (✓)	BENTONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0 - 56	x (cement was pumped)			
0 - 75		x		
0 - 365			x	3/16 pea gravel

ATTACHMENTS (✓)

- ___ Geologic Log
- ___ Well Construction Diagram
- ___ Geophysical Log(s)
- ___ Soil/Water Chemical Analyses
- ___ Other [illegible]

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME TIM MANOS DRILLING & PUMP (PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

16052 LAWSON VALLEY ROAD, JAMUL, CA 91935 — ADDRESS, CITY, STATE, ZIP

Signed [signature] C-57 LICENSED WATER WELL CONTRACTOR — DATE SIGNED 2/1/10 — C-57 LIC. 3601

DWR 188 REV. 05-03

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

8

This WELL HAS
NO pump or power
NEEDS to be
relocated EAST
outside of
TRANSMISSION LINE
power EASEMENT

Fain Drilling & Pump Co. Inc.
12029 Old Castle Rd.
Valley Center, CA 92082
Phone (760) 749-0701
Fax (760) 749-6380

Invoice

#8

Date	Invoice #
2/11/2005	8048

Bill To
THE HAMANN COMPANIES 1000 PIONEER WAY EL CAJON, CA 92020

P.O. No.	Terms	Project
	Due on receipt	

Description	Qty	Rate	Amount
DRILLING 970 FT DEEP WELL APN 611 110 01			
PARCEL 6 120 AC			
EQUIPMENT SET UP	1	500.00	500.00
DRILLING 6.5" DIA HOLE	400	12.00	4,800.00
DRILLING 400-800' 6.5" DIA HOLE	400	14.00	5,600.00
DRILLING 800 - 970' 6.5" DIA HOLE	170	16.00	2,720.00
REAMING 6" TO 10" DIA HOLE	226	12.00	2,712.00
FURNISH AND INSTALL 6" WELL CASING	228	13.00	2,964.00
INSTALL 50 FT. SURFACE SEAL	1	1,500.00	1,500.00
WELL PERMIT AND FILING FEES	1	490.00	490.00

Total	$21,286.00
Payments/Credits	$0.00
Balance Due	$21,286.00

TRIPLICATE
Owner's Copy
Page 1 of 1
Owner's Well No. Par. 6 -120
Date Work Began 2/1/05, Ended 2/9/05
Local Permit Agency DEH
Permit No. 16456 Permit Date 2/1/05

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet
No. 0909549

DWR USE ONLY — DO NOT FILL IN
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD Rotary FLUID Air

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
0	12	Slope wash - sandy decomposed granite - brown color
12	212	Weathered Granitic Rock
212	225	Broken Rock
226	310	Weathered granitic rock mostly white quartz
310		Water 8 gpm
310	961	Granitic rock large crystals of white quartz
961		Water 40+ gpm
961	970	Fractured granitic rock large quartz crystals

TOTAL DEPTH OF BORING 970 (Feet)
TOTAL DEPTH OF COMPLETED WELL 970 (Feet)

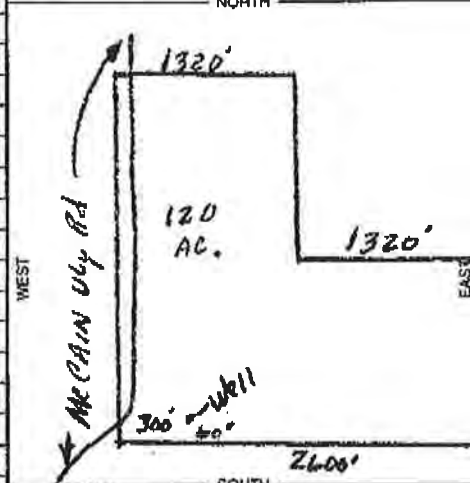
WELL OWNER

Name The Hamann Companies
Mailing Address 1000 Pioneer Way
El Cajon CITY Ca STATE 92020 ZIP

WELL LOCATION

Address Rough Acres Ranch McCain Valley Rd.
City Boulevard
County San Diego
APN Book 611 Page 110 Parcel 01
Township 17S Range 7E Section 15
Lat 36 16 772 N (DEG. MIN. SEC.) Long 115 64 465 W (DEG. MIN. SEC.)

LOCATION SKETCH



Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. **PLEASE BE ACCURATE & COMPLETE.**

ACTIVITY (✓)

✓ NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY *(Describe Procedures and Materials Under "GEOLOGIC LOG")*

USES (✓)
WATER SUPPLY
✓ Domestic ___ Public
___ Irrigation ___ Industrial
MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 30 (Ft.) BELOW SURFACE
DEPTH OF STATIC WATER LEVEL 18 (Ft.) & DATE MEASURED ___
ESTIMATED YIELD * 50 (GPM) & TEST TYPE airlift
TEST LENGTH 8 (Hrs.) TOTAL DRAWDOWN 800 (Ft.)
** May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE: BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	226	10	X				Steel	6	.188	

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	50	X			
50	226			X	

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other ___

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

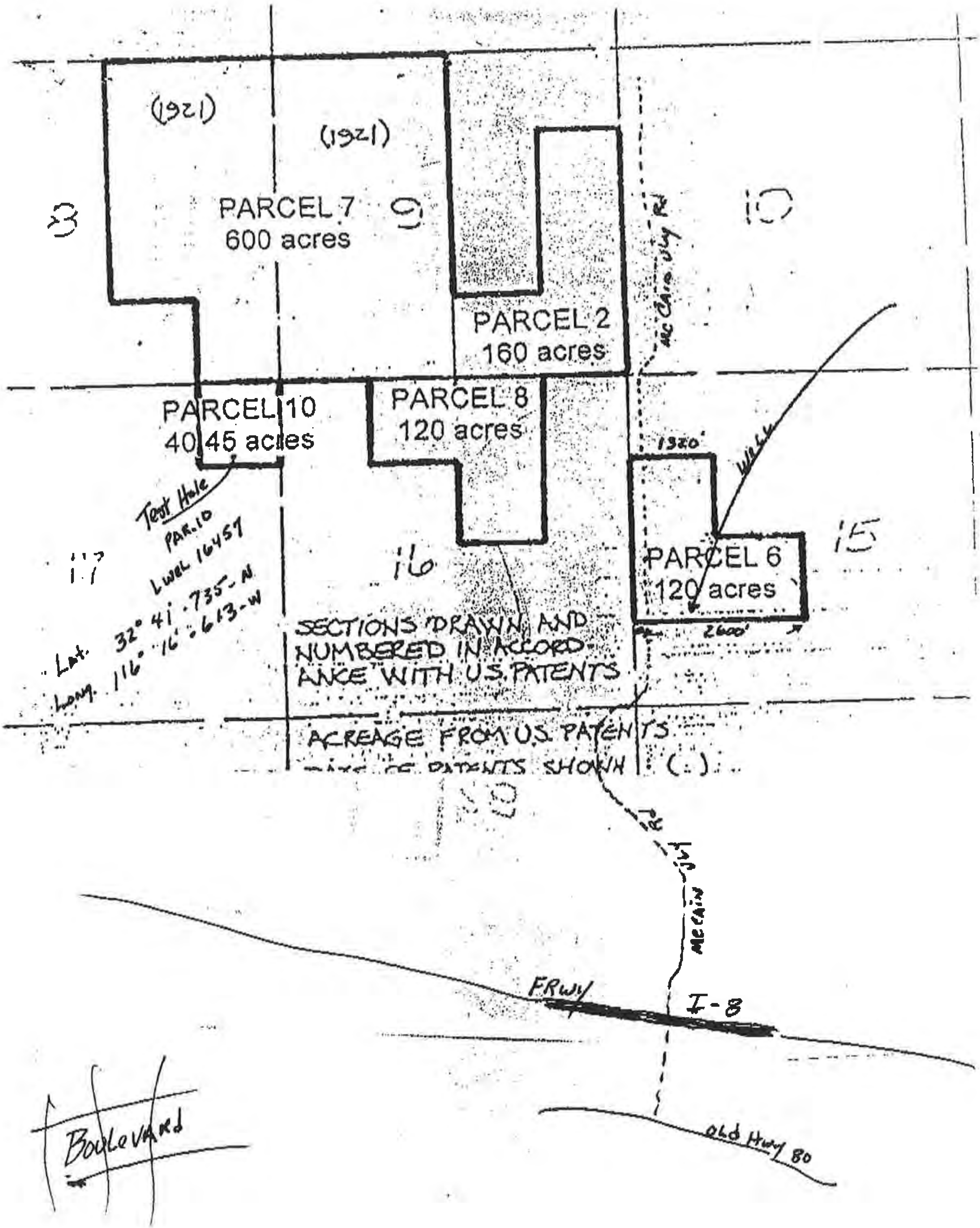
CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Fain Drilling & Pump Co. Inc.
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
ADDRESS 12029 Old Castle Rd. Valley Center, Ca 92082 CITY STATE ZIP
Signed Joe R. Fain (C-57 LICENSED WATER WELL CONTRACTOR) 2/11/05 DATE SIGNED 328287 C-57 LICENSE NUMBER

DWR 188 REV. 05-03

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM


(1921)
(1921)
PARCEL 7
600 acres
9
8
PARCEL 2
160 acres
McCain Vly Rd
10
PARCEL 10
40 45 acres
PARCEL 8
120 acres
1320'
WELL
Test Hole
PAR. 10
LWEL 16457
15
17
16
PARCEL 6
120 acres
Lat. 32° 41' .735-N
Long. 116° 16' .613-W
2600'
SECTIONS DRAWN AND NUMBERED IN ACCORDANCE WITH U.S. PATENTS
ACREAGE FROM U.S. PATENTS
McCain Vly Rd
FRWY
I-8
Boulevard
Old Hwy 80

9

Fully operational
old well
No info
probably 5-10 GPM
& shallow

APPENDIX C

CUMULATIVE WATER QUANTITY IMPACTS ANALYSIS

ROUGH ACRES RANCH WATER PRODUCTION AREA

MCCAIN VALLEY, EAST SAN DIEGO COUNTY, CALIFORNIA

Table 1
Estimated Groundwater Demand - Rough Acres Ranch Water Production Area

Land Use Scenario	Land Use	Quantity	Water Demand per Unit (afy)	Total Demand (afy)
Existing Conditions	Single Family Residential	7	0.5	3.5
	Cattle/Livestock Free-Range Grazing (100 head)	1	2.13	2.13
	Poultry (500 hens)	1	0.11	0.11
	Total Water Demand (Existing Conditions)			5.74
Existing Conditions Plus 9-Month Construction at 50 gpm	Single Family Residential	7	0.5	3.5
	Cattle/Livestock Free-Range Grazing (100 head)	1	2.13	2.13
	Poultry (500 hens)	1	0.11	0.11
	Project 9-month Construction (50 gpm)	1	60	60
	Total Water Demand (Existing Conditions Plus 9-Month Construction at 50 gpm)			65.74
Existing Conditions Plus 9-Month Construction at 100 gpm	Single Family Residential	7	0.5	3.5
	Cattle/Livestock Free-Range Grazing (100 head)	1	2.13	2.13
	Poultry (500 hens)	1	0.11	0.11
	Project 9-month Construction (50 gpm)	1	120	120
	Total Water Demand (Existing Conditions Plus 9-Month Construction at 100 gpm)			125.74

Note: afy - acre feet per year; gpm - gallons per minute

Table 2
Groundwater in Storage Calculation - Effects of Pumping at 50 GPM
Rough Acres Ranch Water Production Area

Hydrogeologic Unit	Area (acres)	Specific Yield (%)	Saturated Thickness (ft)	GW in Storage (af)
Fractured Rock	502	0.10%	500	251
Residuum	502	5%	10	251
Alluvium	250	10%	20	500
Total				**1002**

Change in Groundwater in Storage (50 gpm)

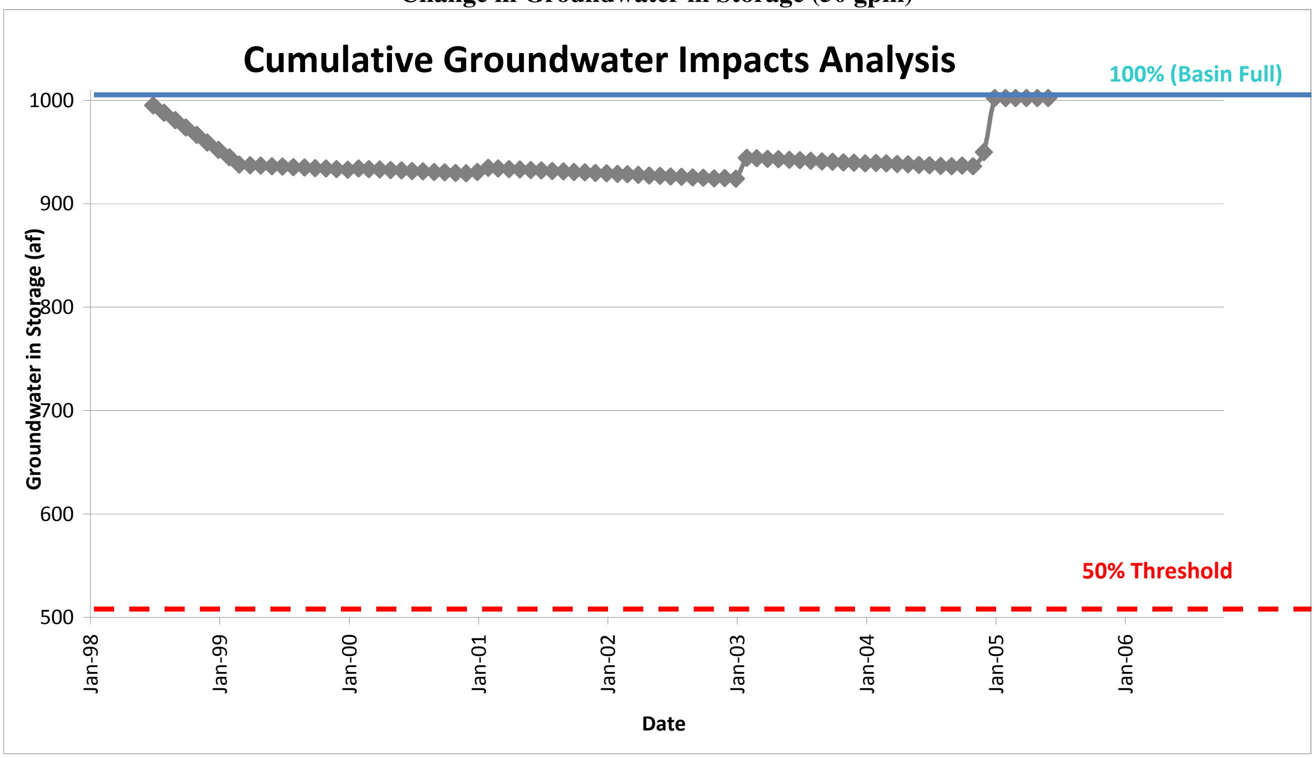


Table 3
Groundwater in Storage Calculation - Effects of Pumping at 100 GPM
Rough Acres Ranch Water Production Area

Hydrogeologic Unit	Area (acres)	Specific Yield (%)	Saturated Thickness (ft)	GW in Storage (af)
Fractured Rock	502	0.10%	500	251
Residuum	502	5%	10	251
Alluvium	250	10%	20	500
Total				**1002**

Change in Groundwater in Storage (100 gpm)

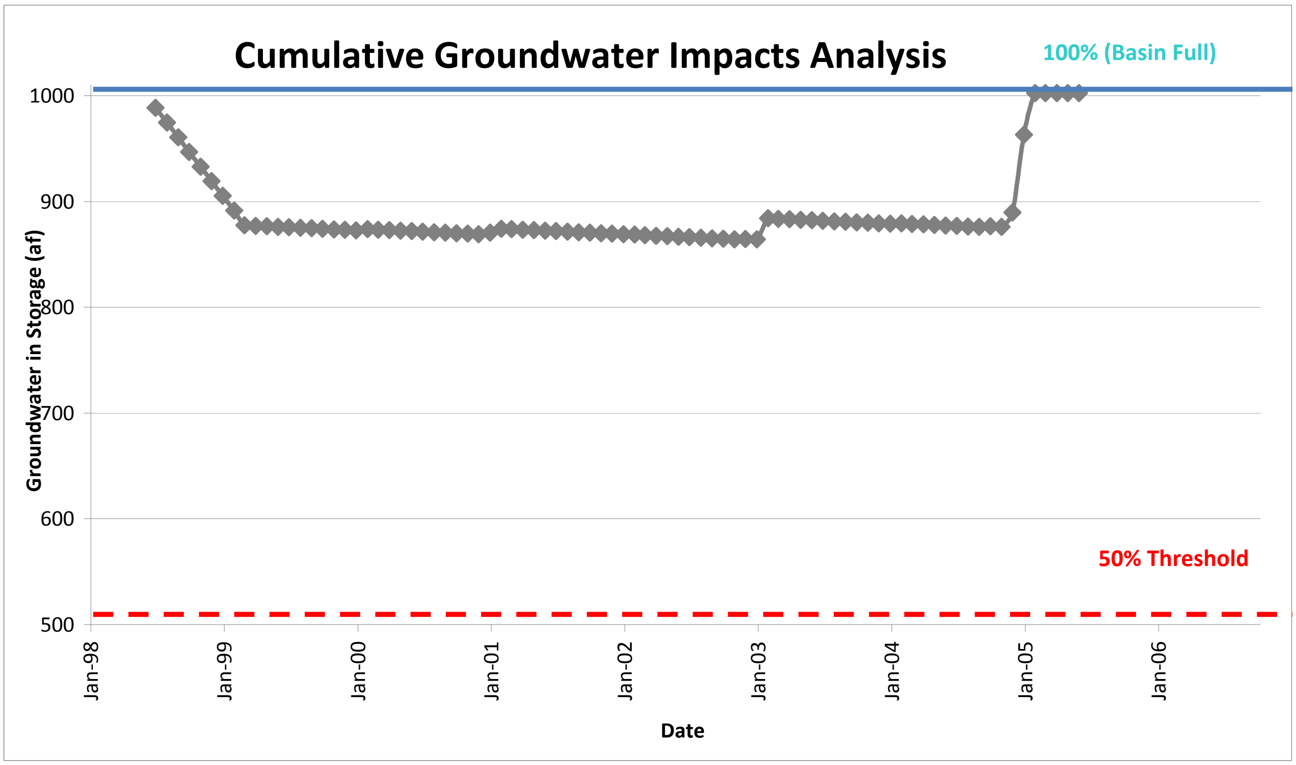
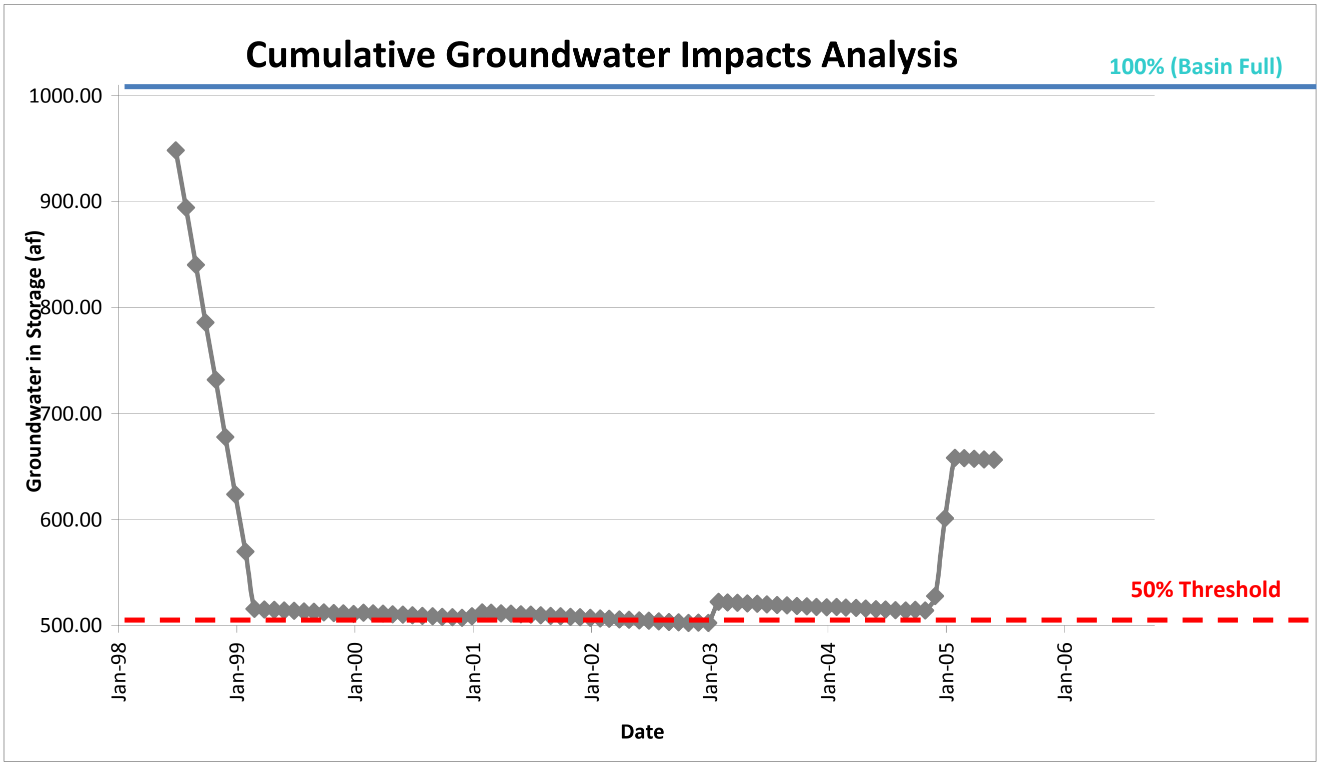


Table 4
Groundwater in Storage Calculation - Effects of Pumping at 400 GPM
Rough Acres Ranch Water Production Area

Hydrogeologic Unit	Area (acres)	Specific Yield (%)	Saturated Thickness (ft)	GW in Storage (af)
Fractured Rock	502	0.10%	500	251
Residuum	502	5%	10	251
Alluvium	250	10%	20	500
Total				**1002**

Change in Groundwater in Storage (400 gpm)



Geo-Logic
ASSOCIATES
Geologists, Hydrogeologists and Engineers

MEMORANDUM

TO: Patrick O'Neill, HDR

FROM: Sarah J. Battelle, Geo-Logic Associates

DATE: February 28, 2011

SUBJECT: **MODIFIED CONSTRUCTION WATER SUPPLY EVALUATION**
TULE WIND PROJECT
EAST SAN DIEGO COUNTY, CALIFORNIA

At your request, this memorandum is being provided to supplement the Tule Wind Farm Groundwater Investigation Report (Geo-Logic, 2010), and to address the change in anticipated water needs for the Tule Wind Project construction based on recent revisions to the project description, which reduces the number of wind turbines from 134 to 128.

1. Water Capacity Analysis in Groundwater Investigation Report

The conclusions reached in the Groundwater Investigation (Geo-Logic 2010) remain valid. The groundwater investigation revealed that the combined groundwater resources on Tribal land and Rough Acres Ranch are sufficient to accommodate the maximum anticipated pumping rate of 130 gallons per minute (gpm) during the construction of the Tule Wind Project.

2. Water Supply Analysis

The purpose of our groundwater investigation was to evaluate the available groundwater resources in the area to support project construction based on initial gross water supply needs for various construction elements associated with a 134 wind turbine project as provided by Iberdrola Renewables, Inc. (IRI). The Groundwater Investigation Report assumed the total volume of extracted groundwater to support the construction of the 134-turbine Tule Wind Project conservatively could be approximately 65 to 125 acre-feet (approximately 21 to 41 million gallons). This analysis utilized a conservative estimate of the anticipated total volume of extracted groundwater to assess whether groundwater resources had sufficient capacity to support the maximum total required project water demand over the estimated nine (9) month construction period. The report concluded that there was sufficient groundwater to support the project water needs (Geo-Logic, 2010).

However, following additional discussions with project members, subsequent to the release of the Groundwater Investigation Report, as described below, the Tule Wind Project's anticipated construction water supply demand is significantly less than that estimated in the Groundwater Investigation Report, and in line with the 17.5 million gallon estimate included in the Draft Environmental Impact Report/Environmental Impact Statement (EIR/EIS).

2.1. <u>Calculating the Tule Wind Project's Water Supply Demand</u>

Based on information provided by IRI (2010) the estimated water demand has been refined. Table A (below) summarizes the project construction activities that require water (IRI, 2010). The table provides estimated water use totals for the original 134 wind turbine project, and the more recently proposed 128 wind turbine project, during the construction period. Analysis of groundwater resources in the area available for construction activity is provided in the Groundwater Investigation Report (Geo-Logic, 2010).

As provided by IRI, construction activities include turbine foundation construction, new and modified access road construction, and associated dust suppression. The construction period for these activities is anticipated to be approximately nine (9) months in length. Table A identifies the estimated water demand based on IRI's construction experience. In addition, the water demand estimates provided in the table include filling four (4) 10,000 gallon water tanks one time for fire suppression. The San Diego Rural Fire Protection District will be responsible for maintaining water tank levels for the life of the Project.

2.2. Project Construction Activities – Estimated Water Demand

1. ***Road Construction*** – Up to 120,000 gallons per day (gpd) will be required over an approximate 72-day construction period, or approximately 8,640,000 gallons of water for road construction. This amount is not anticipated to change for the 128 turbine project.

2. ***Turbine Foundation Concrete Mixing*** – Turbine foundation construction is estimated to require 7,500 to 15,000 gallons of water per foundation, depending on the size of the wind turbine selected (larger turbines require more water for their foundations). Assuming construction of two foundations per day, water demand will be approximately 15,000 to 30,000 gpd. However, if larger turbines are used (such as a 3.0 MW turbine), then less turbines would be built to create a 201 MW project. For purposes of estimating total water demand for this construction activity, 15,000 gpd (67 days for 134 turbine foundations), or approximately 1,005,000 gallons is estimated for turbine foundation concrete mixing. This amount would decrease slightly by approximately 45,000 gallons (6 turbines x 7,500 gallons per foundation) for the 128 turbine project.

3. ***Dust Suppression During Turbine Foundation Construction*** **–** Dust suppression activities during turbine foundation construction is estimated to require 100,000 gpd for a maximum of 67 days for 134 turbines, or approximately 6,700,000 gallons. This amount would decrease slightly by approximately 300,000 gallons (2 foundations per day, 6 less foundations x 100,000 gpd) for the 128 turbine project.

4. ***Dust Suppression During Turbine Erection*** – An estimated sixty (60) days for turbine erection will be required. During this period of turbine erection, approximately 50,000 gpd will be required for dust control on project roads, or approximately 3,000,000 gallons. This amount would decrease slightly by approximately 100,000 gallons (2-3 turbines erected per day x 50,000 gpd).

5. ***Fire Protection (Four 10,000 gallon tanks)*** – 40,000 gallons total, which constitutes a one-time filling of all four (4) 10,000 gallon tanks. There would be no change in this water supply estimate under either the 134 or 128 turbine project.

Table A (below) summarizes the anticipated water demand for the 134 and 128 wind turbine projects.

Table A
Estimated Project Construction Water Supply
for 134 Wind Turbines versus 128 Wind Turbines

134 Turbines	Daily rate (gpd)	Days	Gallons	128 Turbines	Daily rate (gpd)	Days	Gallons
Road construction	120,000	72	8,640,000	Road construction	120,000	72	8,640,000
Turbine Foundations	15,000	67	1,005,000	Turbine Foundations	15,000	64	960,000
Dust Suppression During Foundation Construction	100,000	67	6,700,000	Dust Suppression During Foundation Construction	100,000	64	6,400,000
Dust Suppression During Turbine Erection	50,000	60	3,000,000	Dust Suppression During Turbine Erection	50,000	58	2,900,000
Fire Protection - 4 tanks		1	40,000	Fire Protection - 4 tanks		1	40,000
		Total (gals)	**19,385,000**			**Total (gals)**	**18,940,000**
		Total (acre-feet)	**59.5**			**Total (acre-feet)**	**58.0**

2.3. Analysis of Construction Water Demand Reduction with 128 Turbine Project

As presented in the table above, a reduction of six turbines will reduce construction water demand during turbine foundation construction by approximately 45,000 gallons (at 7,500 gallons per turbine foundation), dust suppression during foundation construction by approximately 300,000 gallons (3 days at 100,000 gpd), and dust suppression during turbine erection by approximately 100,000 gallons (2 days at 50,000 gpd), for a total reduction of approximately 445,000 gallons (approximately 1.4 acre-feet).

The Draft EIR estimates that the construction of the Tule Wind Project would require approximately 17.5 million gallons of water (approximately 53.7 acre-feet). (Draft EIR/EIS, 2010). The modified 128 turbine project would exceed this estimate by approximately 8%, or 1,440,000 gallons (approximately 4.4 acre-feet).

The Groundwater Investigation Report conservatively assumed that construction water supply required would be 65 to 125 acre-feet and concluded that there would be a sufficient water supply available to serve this demand. Based on the revised analysis presented above, the identified groundwater supply will be sufficient to serve either the 134 or 128 turbine projects.

3. Operations

Future operational needs for the project associated with the turbine operations and maintenance (O&M) have been estimated at 2,500 gallons per day, equivalent to about two (2) gallons per minute supplied by a well to be drilled in the vicinity of the O&M building. No change in water demand associated with operation of the wind project is anticipated due to the reduction of six wind turbines.

4. Conclusion

Based on the assumptions used for the project water needs, as provided by IRI (2010) and presented herein, when comparing the 134 turbine project (analyzed in the Draft EIR/EIS) to the 128 turbine project, the reduction in wind turbines will result in an estimated reduction of approximately 445,000 gallons. The existing analysis included in our Groundwater Investigation Report dated December 2010, which evaluated a more conservative, higher water demand, supplemented by the analysis herein associated with a lesser demand and smaller impact to the local groundwater resource, demonstrates that there is a sufficient water supply available to serve the 128 turbine project. Accordingly, the conclusions reached in the Groundwater Investigation (Geo-Logic 2010) remain valid, as supplemented by the information and analysis provided herein. If you have any questions, please call me at (858) 451-1136.