JAGUAR WAY EXTENSION PROJECT NOISE AND VIBRATION ASSESSMENT

Windsor, California

October 10, 2019
Finalized on March 12, 2020

Prepared for:

Olivia Ervin
M-Group
Environmental Planner
1303 Jefferson Street, Suite 100-B
Napa, California 94559

Prepared by:

Dana M. Lodico, PE, INCE Bd. Cert.

ILLINGWORTH & RODKIN, INC.
Acoustics • Air Quality

429 E. Cotati Avenue
Cotati, CA 94931
(707) 794-0400

Project: 17-194

INTRODUCTION

The Town of Windsor is proposing a 0.5-mile extension of Jaguar Way to provide east/west connectivity between Starr Road on the west and Windsor Road on the east. The proposed Jaguar Way Extension Project (Project) would introduce two lanes of travel for vehicles (one in each direction) and provide pedestrian and bicycle facilities, as well as street trees, landscaping, bioretention and low impact development (LID) facilities, and ancillary improvements. The Project would also include a bridge overcrossing of Starr Creek. The Town's existing right-of-way for Jaguar Way would be utilized and may require temporary or permanent encroachment onto adjacent properties to accommodate construction. A new three-way intersection would be created at Starr Road and would be stop sign controlled at Jaguar Way. The existing signalized intersection at Windsor Road would be retained and improvements would be limited to the western leg of this intersection. Three options are currently under consideration for the Project:

- Design Option 1: Town Standard. This design is based on the Town's General Plan vision for Jaguar Way and the Town's Street Design Standards, composed of 6 foot wide sidewalks on both sides of the roadway separated by a landscape strip, two 11 foot wide vehicle travel lanes (one in each direction), Class III bicycle routes, and street trees planted within landscape strip which will be used for bioretention.

- Design Option 2: Class II (On-Street) Bicycle Lanes. Design Option 2 provides for one 6 foot wide contiguous sidewalk on the south side of the roadway west of the high school parking lot and a 10 foot wide contiguous sidewalk on the south side of the roadway along the high school parking lot, two 10 foot wide vehicle travel lanes (one in each direction), and two 5 foot wide Class II bicycle lanes (one in each direction).

- Design Option 3: Separated Multi-Use Path. This design introduces an off-street multi-use path to be shared by pedestrian and bicycles. The right-of-way would be comprised of two 11 foot wide vehicle travel lanes (one in each direction), and curb separated multi-use path containing an 8 foot wide two-way Class I bicycle lane, a 6 foot wide sidewalk, a one foot separator between the bike and pedestrian travel lanes, and a 6 foot wide bioswale along the southside of Jaguar Way.

This report assesses potential noise and vibration impacts resulting from the construction and operation of the proposed extension of Jaguar Way in Windsor, California. This report evaluates the project's potential to result in significant impacts with respect to the applicable California Environmental Quality Act (CEQA) guidelines. The report is divided into two sections: 1) the Setting Section provides a brief description of the fundamentals of environmental noise and groundborne vibration, summarizes applicable regulatory criteria, and discusses the results of the ambient noise monitoring survey completed to document existing noise conditions at nearby noise sensitive locations and 2) the Impacts and Mitigation Measures Section describes the significance criteria used to evaluate project impacts, provides a discussion of each project impact, and presents mitigation measures, where necessary, to provide a compatible project in relation to adjacent noise sources and land uses.

SETTING

Fundamentals of Environmental Noise

Noise may be defined as unwanted sound. Noise is usually objectionable because it is disturbing or annoying. The objectionable nature of sound could be caused by its pitch or its loudness. Pitch is the height or depth of a tone or sound, depending on the relative rapidity (frequency) of the vibrations by which it is produced. Higher pitched signals sound louder to humans than sounds with a lower pitch. Loudness is intensity of sound waves combined with the reception characteristics of the ear. Intensity may be compared with the height of an ocean wave in that it is a measure of the amplitude of the sound wave.

In addition to the concepts of pitch and loudness, there are several noise measurement scales which are used to describe noise in a particular location. A decibel (dB) is a unit of measurement which indicates the relative amplitude of a sound. The zero on the decibel scale is based on the lowest sound level that the healthy, unimpaired human ear can detect. Sound levels in decibels are calculated on a logarithmic basis. An increase of 10 decibels represents a ten-fold increase in acoustic energy, while 20 decibels is 100 times more intense, 30 decibels is 1,000 times more intense, etc. There is a relationship between the subjective noisiness or loudness of a sound and its intensity. Each 10 decibel increase in sound level is perceived as approximately a doubling of loudness over a fairly wide range of intensities. Technical terms are defined in Table 1.

There are several methods of characterizing sound. The most common in California is the A-weighted sound level (dBA). This scale gives greater weight to the frequencies of sound to which the human ear is most sensitive. Representative outdoor and indoor noise levels in units of dBA are shown in Table 2. Because sound levels can vary markedly over a short period of time, a method for describing either the average character of the sound or the statistical behavior of the variations must be utilized. Most commonly, environmental sounds are described in terms of an average level that has the same acoustical energy as the summation of all the time-varying events. This energy-equivalent sound/noise descriptor is called L_{eq}. The most common averaging period is hourly, but L_{eq} can describe any series of noise events of arbitrary duration.

The scientific instrument used to measure noise is the sound level meter. Sound level meters can accurately measure environmental noise levels to within about plus or minus 1 dBA. Various computer models are used to predict environmental noise levels from sources, such as roadways and airports. The accuracy of the predicted models depends upon the distance the receptor is from the noise source. Close to the noise source, the models are accurate to within about plus or minus 1 to 2 dBA.

Since the sensitivity to noise increases during the evening and at night -- because excessive noise interferes with the ability to sleep -- 24-hour descriptors have been developed that incorporate artificial noise penalties added to quiet-time noise events. The Community Noise Equivalent Level (CNEL) is a measure of the cumulative noise exposure in a community, with a 5 dB penalty added to evening (7:00 pm - 10:00 pm) and a 10 dB addition to nocturnal (10:00 pm - 7:00 am) noise levels. The Day/Night Average Sound Level (DNL or L_{dn}) is essentially the same as CNEL, with the exception that the evening time period is dropped and all occurrences during this three-hour period are grouped into the daytime period.

Effects of Noise - Sleep and Speech Interference

The thresholds for speech interference indoors are about 45 dBA if the noise is steady and above 55 dBA if the noise is fluctuating. Outdoors the thresholds are about 15 dBA higher. Steady noises of sufficient intensity (above 35 dBA) and fluctuating noise levels above about 45 dBA have been shown to affect sleep. Interior residential standards for multi-family dwellings are set by the State of California at 45 dBA L_{dn}. Typically, the highest steady traffic noise level during the daytime is about equal to the L_{dn} and nighttime levels are 10 dB lower. The standard is designed for sleep and speech protection and most jurisdictions apply the same criterion for all residential uses. Typical structural attenuation is 12 to 17 dB with open windows. With standard construction and closed windows in good condition, the noise attenuation factor is around 20 dB for an older structure and 25 dB for a newer dwelling. Sleep and speech interference is therefore of concern when exterior noise levels are about 57 to 62 dBA L_{dn} with open windows and 65 to 70 dBA L_{dn} if the windows are closed. Levels of 55 to 60 dBA are common along collector streets and secondary arterials, while 65 to 70 dBA is a typical value for a primary/major arterial. Levels of 75 to 80 dBA are normal noise levels at the first row of development outside a freeway right-of-way. In order to achieve an acceptable interior noise environment, bedrooms facing secondary roadways need to be able to have their windows closed, those facing major roadways and freeways typically need special glass windows.

TABLE 1 Definition of Acoustical Terms Used in this Report

Term	Definition
Decibel, dB	A unit describing, the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. The reference pressure for air is 20 micro Pascals.
Sound Pressure Level	Sound pressure is the sound force per unit area, usually expressed in micro Pascals (or 20 micro Newtons per square meter), where 1 Pascal is the pressure resulting from a force of 1 Newton exerted over an area of 1 square meter. The sound pressure level is expressed in decibels as 20 times the logarithm to the base 10 of the ratio between the pressures exerted by the sound to a reference sound pressure (e.g., 20 micro Pascals). Sound pressure level is the quantity that is directly measured by a sound level meter.
Frequency, Hz	The number of complete pressure fluctuations per second above and below atmospheric pressure. Normal human hearing is between 20 Hz and 20,000 Hz. Infrasonic sounds are below 20 Hz and Ultrasonic sounds are above 20,000 Hz.
A-Weighted Sound Level, dBA	The sound pressure level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise.
Equivalent Noise Level, L_{eq}	The average A-weighted noise level during the measurement period.
L_{max}, L_{min}	The maximum and minimum A-weighted noise level during the measurement period.
L_{01}, L_{10}, L_{50}, L_{90}	The A-weighted noise levels that are exceeded 1%, 10%, 50%, and 90% of the time during the measurement period.
Day/Night Noise Level, L_{dn} or DNL	The average A-weighted noise level during a 24-hour day, obtained after addition of 10 decibels to levels measured in the night between 10:00 pm and 7:00 am.
Community Noise Equivalent Level, CNEL	The average A-weighted noise level during a 24-hour day, obtained after addition of 5 decibels in the evening from 7:00 pm to 10:00 pm and after addition of 10 decibels to sound levels measured in the night between 10:00 pm and 7:00 am.
Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.
Intrusive	That noise which intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, and time of occurrence and tonal or informational content as well as the prevailing ambient noise level.

Source: Handbook of Acoustical Measurements and Noise Control, Harris, 1998.

TABLE 2 Typical Noise Levels in the Environment

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
	110 dBA	Rock band
Jet fly-over at 1,000 feet		
	100 dBA	
Gas lawn mower at 3 feet		
	90 dBA	
Diesel truck at 50 feet at 50 mph		Food blender at 3 feet
	80 dBA	Garbage disposal at 3 feet
Noisy urban area, daytime		
Gas lawn mower, 100 feet	70 dBA	Vacuum cleaner at 10 feet
Commercial area		Normal speech at 3 feet
Heavy traffic at 300 feet	60 dBA	Large business office
Quiet urban daytime	50 dBA	Dishwasher in next room
Quiet urban nighttime	40 dBA	Theater, large conference room
Quiet suburban nighttime		
	30 dBA	Library
Quiet rural nighttime		Bedroom at night, concert hall (background)
	20 dBA	
		Broadcast/recording studio
	10 dBA	
	0 dBA	

Source: Technical Noise Supplement to the Traffic Noise Analysis Protocol (TeNS), Caltrans, September 2013.

Fundamentals of Groundborne Vibration

Ground vibration consists of rapidly fluctuating motions or waves with an average motion of zero. Several different methods are typically used to quantify vibration amplitude. One method is the Peak Particle Velocity (PPV). The PPV is defined as the maximum instantaneous positive or negative peak of the vibration wave. In this report, a PPV descriptor with units of mm/sec or in/sec is used to evaluate construction generated vibration for building damage and human complaints. Table 3 displays the reactions of people and the effects on buildings that continuous or frequent intermittent vibration levels produce. The guidelines in Table 3 represent syntheses of vibration criteria for human response and potential damage to buildings resulting from construction vibration.

Construction activities can cause vibration that varies in intensity depending on several factors. The use of pile driving and vibratory compaction equipment typically generates the highest construction related groundborne vibration levels. Because of the impulsive nature of such activities, the use of the PPV descriptor has been routinely used to measure and assess groundborne vibration and almost exclusively to assess the potential of vibration to cause damage and the degree of annoyance for humans.

The two primary concerns with construction-induced vibration, the potential to damage a structure and the potential to interfere with the enjoyment of life, are evaluated against different vibration limits. Human perception to vibration varies with the individual and is a function of physical setting and the type of vibration. Persons exposed to elevated ambient vibration levels, such as people in an urban environment, may tolerate a higher vibration level.

Structural damage can be classified as cosmetic only, such as paint flaking or minimal extension of cracks in building surfaces; minor, including limited surface cracking; or major, that may threaten the structural integrity of the building. Safe vibration limits that can be applied to assess the potential for damaging a structure vary by researcher. The damage criteria presented in Table 3 include several categories for ancient, fragile, and historic structures, the types of structures most at risk to damage. Most buildings are included within the categories ranging from "Historic and some old buildings" to "Modern industrial/commercial buildings". Construction-induced vibration that can be detrimental to the building is very rare and has only been observed in instances where the structure is at a high state of disrepair and the construction activity occurs immediately adjacent to the structure.

The annoyance levels shown in Table 3 should be interpreted with care since vibration may be found to be annoying at lower levels than those shown, depending on the level of activity or the sensitivity of the individual. To sensitive individuals, vibrations approaching the threshold of perception can be annoying. Low-level vibrations frequently cause irritating secondary vibration, such as a slight rattling of windows, doors, or stacked dishes. The rattling sound can give rise to exaggerated vibration complaints, even though there is very little risk of actual structural damage.

TABLE 3 Reaction of People and Damage to Buildings from Continuous or Frequent Intermittent Vibration Levels

Velocity Level, PPV (in/sec)	Human Reaction	Effect on Buildings
0.01	Barely perceptible	No effect
0.04	Distinctly perceptible	Vibration unlikely to cause damage of any type to any structure
0.08	Distinctly perceptible to strongly perceptible	Recommended upper level of the vibration to which ruins and ancient monuments should be subjected
0.1	Strongly perceptible	Threshold at which there is a risk of damage to fragile buildings with no risk of damage to most buildings
0.25	Strongly perceptible to severe	Threshold at which there is a risk of damage to historic and some old buildings.
0.3	Strongly perceptible to severe	Threshold at which there is a risk of damage to older residential structures
0.5	Severe - Vibrations considered unpleasant	Threshold at which there is a risk of damage to new residential and modern commercial/industrial structures

Source: Transportation and Construction Vibration Guidance Manual, California Department of Transportation, September 2013.

Regulatory Background

The State of California and the Town of Windsor have established regulatory criteria that are applicable in this assessment. The State CEQA Guidelines, Appendix G, are used to assess the potential significance of impacts pursuant to local General Plan policies, Municipal Code standards, or the applicable standards of other agencies. A summary of the applicable regulatory criteria is provided below.

State CEQA Guidelines. The CEQA contains guidelines to evaluate the significance of effects of environmental noise attributable to a proposed project. Under CEQA, noise impacts would be considered significant if the project would result in:

(a) Generation of a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies;

(b) Generation of excessive groundborne vibration or groundborne noise levels;

(c) For a project located within the vicinity of a private airstrip or an airport land use plan or where such a plan has not been adopted within two miles of a public airport or public use airport, if the project would expose people residing or working in the project area to excessive noise levels.

Checklist items (a) and (b) are applicable to the proposed project. The project is not located within the vicinity of a public airport or private air strip and would not expose persons in the project area to excessive airport-related noise. The project site is outside of the 65 dB contour for the Sonoma County Airport. Therefore, CEQA checklist item (c) is not carried forward for further analysis.

Town of Windsor General Plan. The Town of Windsor 2040 General Plan contains policies to "minimize, control, and abate noise interference from indoor and outdoor noise sources and activities that exceed desirable sound levels."

The noise and land use compatibility guidelines contained in Figure PHS-7 of the Public Health and Safety Element identify "normally acceptable" noise levels for new land uses. The guidelines show that single family residential land uses are considered to be "normally acceptable" in noise environments up to 55 dBA L_{dn}/CNEL, multi-residential land uses are considered to be "normally acceptable" in noise environments up to 60 dBA L_{dn}/CNEL, and school land uses are considered to be "normally acceptable" in noise environments up to 60 dBA L_{dn}/CNEL.

The following General Plan policies are applicable to the proposed project:

PHS-8.1 Ambient Sound Levels for New Development. The Town shall encourage new development to maintain the current ambient sound environment as much as possible. All noise sources that cause the ambient sound levels to rise by more than 5 dBA should be required to incorporate conditions or design modifications to reduce the potential increase in the noise environment.

PHS-8.5 Noise Attenuation Techniques. The Town shall encourage new development to identify alternatives to the use of sound walls to attenuate noise impacts. Other techniques that would be viewed more favorably by the Town include:

a. Modifications to site planning such as incorporating setbacks; and

b. Revisions to the architectural layout such as changing building orientation, providing noise attenuation for portions of outdoor yards, and construction modification (e.g., noise attenuating windows).

In the event that sound walls are the only practicable alternative, such walls shall be subject to development review to ensure that they are designed to be as aesthetically pleasing as possible, incorporating landscaping, variations in color and patterns, and/or changes in texture or building materials.

PHS-8.10 Construction Site Noise Restrictions. The Town shall restrict construction working hours as designated in the Municipal Code, to allow efficient construction mobilization and activities, while also protecting the noise environment of noise sensitive land uses.

PHS-8.17 Project and Environmental Review for Noise. The Town shall consider as part of its discretionary review of proposed new development the potential for a proposed project to either generate significant new noise sources or be significantly impacted by existing noise sources as shown in Figure PHS-7 (not shown, described above). If the Town determines there may be a potential for significant noise effects related to a proposed new development, the Town shall require an acoustical study be conducted by a qualified acoustician and include appropriate mitigation measures for the proposed development based on that study.

Town of Windsor Zoning Ordinance. Chapter 27.20, General Property Development and Use Standards, of the Town of Windsor Zoning Ordinance presents the following:

F. Noise. No use, activity, or process shall exceed the maximum allowable noise standards identified in Table 3-1 (Table 4 of this report).

1. Noise measurement criteria. Exterior noise levels shall be measured at the property line of the noise source. Noise measurement shall be made with a sound level meter using the 'A' weighted scale at slow meter response. Fast meter response shall be used only for an impulsive noise.

2. Exterior noise standards. Exterior noise levels, when measured at any receiving property, shall conform to the noise level standards identified in Table 3-1 (Table 4 of this report).

a. If the measured ambient noise level exceeds the applicable noise level standard in any category above, the applicable standards shall be adjusted to equal the ambient noise level.

b. If the intruding noise source is continuous and cannot reasonably be discontinued or stopped to allow measurement of the ambient noise level, the noise level measured while the source is in operation shall be compared directly to the applicable noise level standards identified in Table 3-1 (Table 4 of this report).

3. Conflicts with late night, early morning, or 24-hour operations. Nonresidential activities shall not impact surrounding residential land uses (e.g., single-, multifamily, and mobile home parks).

4. Construction hours allowed. In order to allow construction schedules to take advantage of the weather, normal day light hours, to allow construction to proceed in an efficient

manner, and to ensure that nearby residents as well as nonresidential activities are not disturbed by the early morning or late night activities, the Town has adopted, in the Municipal Code of the Town of Windsor, Title VII Building and Housing Section 7-1-190 which establishes construction working hours related to the days and hours in which construction activity can occur. In addition, the Municipal Code has established procedures for seeking relief from the restrictions. Construction hours and days and any relief sought shall comply with the Municipal Code of the Town of Windsor.

TABLE 4 Town of Windsor General Plan Table 3-1, Maximum Noise Level by Receiving Land Use

Type of Land Use	Maximum Allowable Noise Levels		
	Time Interval	Exterior Noise	Interior Noise
Single- or multi-family residential	10 p.m. to 7 a.m.	50 dB(A)	45 dB(A)
	7 a.m. to 10 p.m.	55 dB(A)	35 dB(A)
Commercial	10 p.m. to 7 a.m.	55 dB(A)	50 dB(A)
	7 a.m. to 10 p.m.	65 dB(A)	
Industrial or manufacturing	Anytime	70 dB(A)	55 dB(A)
Public parks, public open space, and Civic Center	10 p.m. to 7 a.m.	50 dB(A)	N.A.
	7 a.m. to 10 p.m.	55 dB(A)	

Notes:
(1) Each of the noise limits specified in Table 4, above shall be reduced by 5 dB(A) for impulse or simple tone noises, or for noise consisting of speech or music. If the ambient noise level exceeds the resulting standard, the ambient noise level shall be the standard.
(2) It shall be unlawful for any person within a residentially zoned area of the Town to operate any noise amplified device (e.g., bull horns, microphones, musical instruments, speakers, etc.), that exceeds a noise level of 45 dB(A) measured at the property line or cause loud excessive noise which disturbs the peace of the neighborhood.

Town of Windsor Municipal Code. The Municipal Code of the Town of Windsor, Title VII Building and Housing Section 7-1-190 establishes the following with regard to allowable hours of construction:

> Construction, alteration or repair activities which are authorized by a valid Town permit may be conducted between the hours of 7:00 a.m. and 7:00 p.m. Monday through Friday and between the hours of 8:00 a.m. and 7:00 p.m. on Saturday. No construction, alteration or repair activities shall be permitted on Sunday unless expressly authorized by the Building Official; but in no event shall such construction activity be permitted on Sunday before 9:00 a.m. or after 5:00 p.m.

Existing Noise Environment

As shown on Figure 1, noise sensitive land uses along the project corridor include residences, Keiser Park, and Windsor High School. Residences are also located along Starr Road and Windsor Road.

An ambient noise monitoring survey was conducted from Thursday, December 7th through Monday December 11th, 2017 and included two long-term (LT-1 and LT-2) and seven short-term (ST-1 to ST-7) noise measurements. Based on a review of the athletic schedule from Windsor High School, there were no events taking place at the outdoor athletic fields during the noise monitoring survey. Indoor events included wrestling matches on the evening of Thursday, January 7th, 2017. The primary noise sources affecting the noise environment at the site and in the surrounding areas is local traffic on Starr Road, Windsor Road, Jaguar Way, and within the Windsor High School parking lot, residential activities such as lawn maintenance, and students conversing in the parking lot. The results of the long-term measurements are shown in Appendix A. A summary of the results of the short-term noise measurements is given in Table 5.

Noise measurements were made with Larson Davis Model 820 Integrating Sound Level Meters (SLMs) set at "slow" response. The sound level meters were equipped with G.R.A.S. Type 40AQ ½-inch random incidence microphones fitted with windscreens. The sound level meters were calibrated prior to the noise measurements using a Larson Davis Model CAL200 acoustical calibrator. The response of the system was checked after each measurement session and was always found to be within 0.2 dBA. No calibration adjustments were made to the measured sound levels. At the completion of each monitoring event, the measured interval noise level data were obtained from the SLM using the Larson Davis SLM utility software program.

Long-term noise measurement LT-1 was located east of Starr Creek, about 90 feet west of the Windsor High School stadium boundary fence. The noise environment at this site was made up of distant traffic and local residential and school activities. Hourly average noise levels during the daytime ranged from 44 to 58 dBA L_{eq} at this location, with no significant difference between weekday and weekend noise levels. Hourly average noise levels ranged from 37 to 51 dBA L_{eq} at night. The 24-hour average CNEL calculated at this location ranged from 54 to 55 dBA.

Long-term noise measurement LT-2 was situated along the existing segment of Jaguar Way, opposite the Windsor High School parking lot. The noise environment at this site was also made up of distant traffic and local residential and school activities. Daytime hourly average noise levels at LT-2 ranged from 50 to 64 dBA L_{eq}. Nighttime hourly average noise levels at LT-2 ranged from 44 to 57 dBA L_{eq}. The 24-hour average CNEL calculated at LT-2 ranged from 59 to 60 dBA during the week, 58 dBA on Saturday, and 56 dBA on Sunday.

FIGURE 1 Noise Measurement Locations

TABLE 5 Summary of Short-Term Noise Measurement Data

Noise Measurement Location	$L_{(10)}$	$L_{(50)}$	$L_{(90)}$	L_{eq}	Primary Noise Source
ST-1: 901 Indiana Avenue (12/6/2017, 1:10 p.m.-1:20 p.m.)	63	44	39	58	Local traffic, light aircraft
ST-2: Windsor High School Athletic Fields (12/6/2017, 1:50 p.m.-2:00 p.m.)	47	41	39	44	Track activities, light aircraft
ST-3: East of Windsor High School Gym (12/6/2017, 12:00 p.m.-12:10 p.m.)	45	42	40	44	Natural sounds (birds), car in parking lot (no outdoor school activities)
ST-4: 45 feet from center of Windsor Road (12/6/2017, 11:40 a.m.-11:50 a.m.)	67	60	50	65	Traffic on Windsor Road
ST-5: Across from Windsor High School Parking Lot (12/6/2017, 12:10 p.m.-12:20 p.m.)	61	52	46	61	Parking lot and student activities (during lunch)
ST-6: Across from Windsor High School Parking Lot (12/6/2017, 2:10 p.m.-2:20 p.m.)	62	54	48	60	Parking lot and student activities (class out)
ST-7: Ginny Drive, 75 feet from center of Windsor Road (12/11/2017, 2:00 p.m.-2:10 p.m.)	63	57	46	59	Traffic on Windsor Road

NOISE IMPACTS AND MITIGATION MEASURES

This section describes the significance criteria used to evaluate project impacts under CEQA, provides a discussion of each project impact, and presents mitigation measures, where necessary, to provide a compatible project in relation to adjacent noise sources and land uses.

Significance Criteria

The following criteria were used to evaluate the significance of environmental noise and vibration resulting from the project:

1. **Temporary or Permanent Noise Increases in Excess of Established Standards.** A significant impact would be identified if project construction or operations would result in a substantial temporary or permanent increase in ambient noise levels at sensitive receivers in excess of the local noise standards contained in the Town of Windsor General Plan or Municipal Code, as follows:

    - Operational Noise in Excess of Standards. A significant noise impact would be identified if the project would expose persons to or generate noise levels that would exceed applicable noise standards presented in the General Plan or Municipal Code.

    - Permanent Noise Increase. A significant impact would be identified if traffic noise generated by the project would substantially increase noise levels at sensitive receivers in the vicinity. Consistent with General Plan Policy PHS-8.1, a substantial increase in ambient noise levels would occur if the noise level due to project generated traffic is 5 dBA or greater.

    - Temporary Noise Increase. A significant temporary noise impact would be identified if construction would occur outside of the hours specified in the Municipal Code. Additionally, a significant temporary noise increase would be identified if construction-related noise would result in hourly average noise levels exceeding 60 dBA L_{eq} at the property lines shared with residential land uses, and the ambient by at least 5 dBA L_{eq}, for a period of more than one year.

2. **Generation of Excessive Groundborne Vibration.** The Town of Windsor does not specify a construction vibration limit; therefore, a significant impact would be identified if the construction of the project would expose persons to vibration levels exceeding the levels indicated in Table 3.

Impact 1: Permanent or Temporary Noise Increases in Excess of Established Standards. Permanent project operations and temporary construction activities would not result in a substantial noise level increase or expose existing noise-sensitive land uses to noise levels in excess of the applicable noise thresholds. **This is a less-than-significant impact.**

a. Permanent Noise from Traffic on New Roadway Segment

Under the Town's 2040 General Plan noise and land use compatibility guidelines, single family residential land uses are considered to be "normally acceptable" in noise environments up to 55 dBA CNEL and educational land uses are considered to be "normally acceptable" in noise environments up to 60 dBA CNEL. New transportation-related noise sources that cause the ambient sound levels to rise by more than 5 dB should be required to incorporate conditions or design modifications to reduce the potential increase in the noise environment.

The project will introduce noise barriers along the Jaguar Way frontage of the two existing residential properties adjacent to Starr Road. Three options are currently under consideration for the Project, as described in detail in the Introduction.

Noise levels were modeled using FHWA's Traffic Noise Model (TNM v. 2.5), as implemented in SoundPLAN v 8.1. A three-dimensional noise model was created, taking into account the roadway, receptor, and building geometries, traffic volumes, speeds, and truck percentages, and ground type. Future + Project traffic volumes provided by *W-Trans* (received September 12, 2019), as shown in Table 6, were used in the analysis to represent a worst-case condition.

TABLE 6 Jaguar Way Future + Project Traffic Volumes Used in Noise Modeling

Roadway Segment	Speed	Truck Percentage	Eastbound (veh/hr)		Westbound (veh/hr)	
			AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour
Jaguar Way – West of Windsor High School Parking Lot Entrance	25 mph	2%	21	8	4	13
Jaguar Way – East of Windsor High School Parking Lot Entrance	25 mph	2%	78	83	174	83

Noise levels for each of the three alternative options were modeled both with and without the inclusion of the proposed barriers (assumed to be 6-feet in height). In all cases, differences between the three options with the inclusion of the 6-foot high barriers were 1 dBA or less. Differences of 1 dBA would not typically be distinguishable. The noise reduction provided by the proposed 6-foot high barrier ranged from 1 to 5 dBA, depending on the option selected.

Table 7 shows the hourly average results of the noise modeling with the inclusion of the 6-foot high barriers; in all cases the highest noise level of the three options is shown for each receiver location. Table 8 shows the noise level increases anticipated as a result of the project. Receiver locations are shown in Figure 2.

TABLE 7 Jaguar Way Future + Project Traffic Noise Levels, dBA

Receiver Location	Future + Project Noise Levels			Noise Limit, CNEL	Exceeds Noise Limit?
	AM Peak Hour, L_{eq}	PM Peak Hour, L_{eq}	Calculated CNEL[2]		
R1 - 9010 Starr Road – Facade[1]	43	42	43	55	No
R2 - 9010 Starr Road[1]	42	41	42	55	No
R3 - 9050 Starr Road - Facade[1]	41	40	41	55	No
R4 - 9050 Starr Road[1]	41	40	41	55	No
R5 – Keiser Park Field	40	38	40	60	No
R6 - Windsor HS Edge of Track	38	37	38	60	No
R7 - Windsor HS Baseball Field	44	43	44	60	No
R8 - Windsor HS Baseball Field	45	44	45	60	No
R9 - Windsor HS	45	44	44	60	No
R10 - Ginny Road Residence	47	46	47	55	No
R11 - Ginny Road Residence	48	46	48	55	No
R12 - Ginny Road Residence	47	46	47	55	No
R13 - Ginny Road Residence	47	45	47	55	No
R14 - Ginny Road Residence	47	46	47	55	No

[1] Includes the construction of 6-foot high noise barriers along the Jaguar Way frontage of the two existing residential properties adjacent to Starr Road.
[2] Assumes CNEL is equivalent to loudest peak hour level.

TABLE 8 Increase in CNEL Resulting from Project Operations, dBA CNEL

Receiver Location	Existing Ambient	Project	Ambient + Project	Increase	Exceeds 5 dBA?
R1 - 9010 Starr Road – Facade[1]	54	43	54	0.3	No
R2 - 9010 Starr Road[1]	54	42	54	0.3	No
R3 - 9050 Starr Road - Facade[1]	54	41	54	0.2	No
R4 - 9050 Starr Road[1]	54	41	54	0.2	No
R5 – Keiser Park Field	54	40	54	0.2	No
R6 - Windsor HS Edge of Track	54	38	54	0.1	No
R7 - Windsor HS Baseball Field	54	44	54	0.4	No
R8 - Windsor HS Baseball Field	54	45	55	0.5	No
R9 - Windsor HS	59	44	59	0.2	No
R10 - Ginny Road Residence	59	47	59	0.3	No
R11 - Ginny Road Residence	59	48	59	0.3	No
R12 - Ginny Road Residence	59	47	59	0.3	No
R13 - Ginny Road Residence	59	47	59	0.3	No
R14 - Ginny Road Residence	59	47	59	0.3	No

[1] Includes the construction of 6-foot high noise barriers along the Jaguar Way frontage of the two existing residential properties adjacent to Starr Road.

FIGURE 2 Noise Modeling Receiver Locations

As indicated in Table 7, Project generated noise levels would not exceed the Town's noise and land use compatibility thresholds, even under Future + Project conditions. Project generated noise levels would also not result in a substantial increase in noise levels at noise sensitive locations (see Table 8). Table 9 shows the noise reduction provided by the proposed 6-foot high noise barriers along Jaguar Way for the two Starr Road residences.

TABLE 9 Noise Reduction Provided by Proposed 6-foot High Barriers, dBA

Receiver Location	Future + Project Noise Levels, dBA CNEL		Noise Reduction Provided by Barrier, dBA
	No Barriers	6-ft High Barriers	
R1 - 9010 Starr Road – Facade	46	43	3
R2 - 9010 Starr Road	44	42	2
R3 - 9050 Starr Road - Facade	45	41	4
R4 - 9050 Starr Road	43	41	3

As shown in Table 9, the proposed 6-foot high noise barrier along Jaguar Way Extension is anticipated to provide 2 to 4 dBA of noise reduction to the adjacent residences. Noise levels with or without the inclusion of the barrier would meet the Town's noise and land use compatibility thresholds (55 dBA CNEL), even under Future + Project conditions. This is a **less-than-significant** impact.

Mitigation Measure 1a: None required.

b. Permanent Project Generated Noise Increases on Roadway Network

A significant increase in traffic noise levels would be identified if project generated traffic were to result in a permanent noise level increase of 5 dBA or greater in a noise sensitive area (residential, school).

AM and PM peak hour traffic volumes provided by *W-Trans* (received September 12, 2019) were reviewed to calculate potential traffic noise level increases attributable to the project expected along roadways serving the site. Roadways evaluated in the analysis included Starr Road, Windsor River Road, Windsor Road, and the existing segments of Jaguar Way. Roadway link traffic volumes under the Existing plus Project scenario were compared to Existing conditions and traffic volumes under Future plus Project conditions were compared to Future conditions to calculate the traffic noise increase attributable to the project during AM and PM peak hour conditions. Based on these calculations, project generated traffic is not anticipated to result in a measurable traffic noise increase along the roadway network surrounding the site (increase is less than 1 dBA). For the existing segment of Jaguar Road, this conclusion is also verified in Table 8. Traffic noise increases would be well below 5 dBA. This is a **less-than-significant** impact.

Mitigation Measure 1b: None required.

c. Temporary Noise Increases from Project Construction

The Town of Windsor Municipal Code establishes allowable hours for construction of proposed projects. "Construction, alteration or repair activities which are authorized by a valid Town permit may be conducted between the hours of 7:00 a.m. and 7:00 p.m. Monday through Friday and between the hours of 8:00 a.m. and 7:00 p.m. on Saturday. No construction, alteration or repair activities shall be permitted on Sunday unless expressly authorized by the Building Official; but in no event shall such construction activity be permitted on Sunday before 9:00 a.m. or after 5:00 p.m. This analysis assumes that construction activities will only occur during allowable hours.

Construction activities generate considerable amounts of noise, especially during earth-moving activities and during the construction of the bridge's foundation when heavy equipment is used. Noise impacts resulting from construction depend upon the noise generated by various pieces of construction equipment, the timing and duration of noise-generating activities, and the distance between construction noise sources and noise-sensitive areas. Construction noise impacts primarily result when construction activities occur during noise-sensitive times of the day (e.g., early morning, evening, or nighttime hours), the construction occurs in areas immediately adjoining noise-sensitive land uses, or when construction lasts over extended periods of time.

Typical construction noise levels at a distance of 50 feet are shown in Tables 9 and 10. Table 9 shows the average noise level range by construction phase and Table 10 shows the maximum noise level range for different construction equipment. Table 10 levels are consistent with construction noise levels calculated for the project in the Federal Highway Administration (FHWA) Roadway Construction Noise Model (RCNM), including the anticipated equipment that would be used for each phase of the project. Construction-generated noise levels drop off at a rate of about 6 dBA per doubling of the distance between the source and receptor. Shielding by buildings or terrain can provide an additional 5 to 10 dBA noise reduction at distant receptors.

TABLE 9 Typical Ranges of Construction Noise Levels at 50 Feet, L_{eq} (dBA)

	Domestic Housing		**Office Building, Hotel, Hospital, School, Public Works**		**Industrial Parking Garage, Religious Amusement & Recreations, Store, Service Station**		**Public Works Roads & Highways, Sewers, and Trenches**	
	I	**II**	**I**	**II**	**I**	**II**	**I**	**II**
Ground Clearing	83	83	84	84	84	83	84	84
Excavation	88	75	89	79	89	71	88	78
Foundations	81	81	78	78	77	77	88	88

Erection	81	65	87	75	84	72	79	78
Finishing	88	72	89	75	89	74	84	84
I - All pertinent equipment present at site. **II** - Minimum required equipment present at site.								

Source: U.S.E.P.A., Legal Compilation on Noise, Vol. 1, p. 2-104, 1973.

TABLE 10 Construction Equipment, 50-foot Noise Emission Limits

Equipment Category	L_{max} Level (dBA)[1,2]	Impact/Continuous
Arc Welder	73	Continuous
Auger Drill Rig	85	Continuous
Backhoe	80	Continuous
Bar Bender	80	Continuous
Boring Jack Power Unit	80	Continuous
Chain Saw	85	Continuous
Compressor[3]	70	Continuous
Compressor (other)	80	Continuous
Concrete Mixer	85	Continuous
Concrete Pump	82	Continuous
Concrete Saw	90	Continuous
Concrete Vibrator	80	Continuous
Crane	85	Continuous
Dozer	85	Continuous
Excavator	85	Continuous
Front End Loader	80	Continuous
Generator	82	Continuous
Generator (25 KVA or less)	70	Continuous
Gradall	85	Continuous
Grader	85	Continuous
Grinder Saw	85	Continuous
Horizontal Boring Hydro Jack	80	Continuous
Hydra Break Ram	90	Impact
Impact Pile Driver	105	Impact
Insitu Soil Sampling Rig	84	Continuous
Jackhammer	85	Impact
Mounted Impact Hammer (hoe ram)	90	Impact
Paver	85	Continuous
Pneumatic Tools	85	Continuous
Pumps	77	Continuous
Rock Drill	85	Continuous
Scraper	85	Continuous
Slurry Trenching Machine	82	Continuous
Soil Mix Drill Rig	80	Continuous
Street Sweeper	80	Continuous
Tractor	84	Continuous
Truck (dump, delivery)	84	Continuous
Vacuum Excavator Truck (vac-truck)	85	Continuous
Vibratory Compactor	80	Continuous
Vibratory Pile Driver	95	Continuous
All other equipment with engines larger than 5 HP	85	Continuous

Notes: [1] Measured at 50 feet from the construction equipment, with a "slow" (1 sec.) time constant.
[2] Noise limits apply to total noise emitted from equipment and associated components operating at full power while engaged in its intended operation.
[3] Portable Air Compressor rated at 75 cfm or greater and that operates at greater than 50 psi.

Project construction is anticipated to take 18 to 24 months, with the duration of noise generating activities at individual locations along the project alignment being significantly shorter as construction moves along the alignment. Construction would include site preparation and demolition to remove existing built and natural features within the Jaguar Way roadway alignment, grading to redistribute soils along the Jaguar Way alignment, roadway construction and paving, and construction of the bridge over Starr Creek. Construction staging and equipment will occur along the Jaguar Way right of way within limits of work, as appropriate and within a previously disturbed area of Keiser Park adjacent to the project site. Construction is anticipated to occur between the hours of 7:00 a.m. and 7:00 p.m. Monday through Friday and between the hours of 8:00 a.m. and 7:00 p.m. on Saturday, consistent with the Town Municipal Code Section 7-1-190. No construction would occur on Sundays or national holidays. The construction schedule will take into consideration Windsor High School operations and events, with the intention of minimizing potential conflicts with access.

Construction equipment and vehicles would include excavators, motor graders, bulldozers, backhoes, loaders, tractors, cranes, lifts, concrete trucks, pavers, compactors/rollers, water trucks, haul trucks, and material delivery trucks. Power tools and equipment expected to be utilized over the construction period include jackhammers, air compressors, generators, concrete saws, power drills, welding equipment, sandblasting equipment, painting equipment, power and impact wrenched, and similar tools. Pile driving is anticipated as part of the construction of the project bridge over Starr Creek.

As shown in Table 9, typical hourly average construction-generated noise levels for public works roads are about 78 to 88 dBA L_{eq} measured at a distance of 50 feet from the center of the site during busy construction periods (e.g., earth moving equipment, impact tools, etc.). As shown in Table 10, the typical range of maximum instantaneous noise levels from this equipment would be 73 to 90 dBA L_{max} at a distance of 50 feet. Impact pile driving, which could be used for the bridge structure construction, could generate maximum noise levels as high as 105 dBA L_{max} at 50 feet. At a distance of 100 feet, the closest distance between pile driving and receptors, maximum noise levels from pile driving would be about 99 dBA L_{max}.

Construction of the project would be limited to within the allowable hours specified in the Municipal Code. With inclusion of the following standard noise suppression devices and techniques, project construction activities would be anticipated to meet the Municipal Code noise thresholds to the degree that is technically and economically feasible.

- Construction activities shall be limited to the hours between 7:00 am and 7:00 pm, Monday through Friday, and between the hours of 8:00 a.m. and 7:00 p.m. on Saturday. No construction, alteration or repair activities shall be permitted on Sunday unless expressly authorized by the Building Official.

- Limit noise-producing signals, including horns, whistles, alarms, and bells, to safety warning purposes only.

- Equip all internal combustion engine-driven equipment with intake and exhaust mufflers that are in good condition and appropriate for the equipment.

- Unnecessary idling of internal combustion engines should be strictly prohibited.

- Locate stationary noise-generating equipment, such as air compressors or portable power generators, as far as possible from sensitive receptors as feasible. If they must be located near receptors, adequate muffling (with enclosures where feasible and appropriate) shall be used reduce noise levels at the adjacent sensitive receptors. Any enclosure openings or venting shall face away from sensitive receptors.

- Utilize "quiet" air compressors and other stationary noise sources where technology exists.

- Construction staging areas shall be established at locations that will create the greatest distance between the construction-related noise sources and noise-sensitive receptors nearest the project site during all project construction.

- Control noise from construction workers' radios to a point where they are not audible at existing residences bordering the project site.

- Pre-drill foundation pile holes to minimize the number of impacts required to seat the pile.

- Consider the use of "acoustical blankets" during pile driving activities.

- Prepare and implement a detailed construction plan identifying the schedule for major noise-generating construction activities. The construction plan shall identify a procedure for coordination with adjacent land uses including residents abutting the project site, Windsor High School, and Keiser Park, so that construction activities can be scheduled to minimize noise disturbance.

- Designate a "disturbance coordinator" who would be responsible for responding to any complaints about construction noise. The disturbance coordinator will determine the cause of the noise complaint (e.g., bad muffler, etc.) and will require that reasonable measures be implemented to correct the problem. Conspicuously post a telephone number for the disturbance coordinator at the construction site and include in it the notice sent to neighbors regarding the construction schedule.

This impact is **less-than-significant**.

Mitigation Measure 1c: None Required.

Impact 2: **Groundborne Vibration.** The proposed project will result in groundborne vibration levels exceeding 0.3 in/sec at structures within 20 feet of roadway construction. **This is a potentially significant impact.**

A significant impact would be identified if project construction activity or project-related vehicle traffic would result in vibration levels of 0.3 in/sec PPV or greater at nearby structures (see Table 3). Project-related vehicle traffic is not anticipated to generate perceptible levels of groundborne vibration at nearby structures (vibration levels are anticipated to be below 0.01 in/sec PPV).
Construction equipment and vehicles would include excavators, motor graders, bulldozers, backhoes, loaders, tractors, cranes, lifts, concrete trucks, pavers, compactors/rollers, water trucks, haul trucks, and material delivery trucks. Power tools and equipment expected to be utilized over the construction period include jackhammers, air compressors, generators, concrete saws, power drills, welding equipment, sandblasting equipment, painting equipment, power and impact wrenched, and similar tools. Pile driving is anticipated as part of the construction of the project bridge over Starr Creek.

Construction activities with the greatest potential of generating perceptible vibration levels would include pile driving, the removal of pavement and soil, the movement of heavy tracked equipment, and vibratory compacting of roadway base materials by use of a roller. Construction of the roadway could be located as close as 10 feet from Starr Road residential structures; however, pile driving would not be located within 100 feet of structures. Table 11 summarizes typical vibration levels associated with varying pieces of construction equipment at a reference distance of 25 feet and distances of 10, 50, and 100 feet to represent the nearest structures to the project site. Vibration levels exceeding 0.3 in/sec PPV are indicated in bold.

TABLE 11 Vibration Source Levels for Construction Equipment

Equipment		PPV (in/sec)			
		10 ft	**25 ft**	**50 ft**	**100 ft**
Pile Driver (Impact)	upper range	n/a	n/a	n/a	0.252
	typical	n/a	n/a	n/a	0.140
Pile Driver (Sonic)	upper range	n/a	n/a	n/a	0.160
	typical	n/a	n/a	n/a	0.037
Clam shovel drop		**0.553**	0.202	0.094	0.044
Hydromill (slurry wall)	in soil	0.022	0.008	0.004	0.002
	in rock	0.047	0.017	0.008	0.004
Vibratory Roller		**0.575**	0.210	0.098	0.046
Hoe Ram		0.244	0.089	0.042	0.019
Large bulldozer		0.244	0.089	0.042	0.019
Caisson drilling		0.244	0.089	0.042	0.019
Loaded trucks		0.208	0.076	0.035	0.017
Jackhammer		0.096	0.035	0.016	0.008
Small bulldozer		0.008	0.003	0.001	0.001

Source: Transit Noise and Vibration Impact Assessment, United States Department of Transportation, Office of Planning and Environment, Federal Transit Administration, September 2018 and modified by Illingworth & Rodkin, Inc., September 2019.

A review of the anticipated construction equipment and the vibration level data provided in Table 11 indicates that vibration levels generated by proposed activities and equipment other than pile driving would be below the 0.3 in/sec PPV criteria when construction occurs at distances of 20 feet or greater from structures. Two Starr Road residences are located within 20 feet of roadway construction; both located at distances of about 10 feet from construction activities. There are no other structures located within 20 feet of project construction. Pile driving activities would be below the 0.3 in/sec PPV criteria when construction occurs at distances of 100 feet or greater from structures. There are no structures located within 100 feet of potential pile driving activities.

The two Starr Road residences located within 20 feet of the project would be located as close as 10 feet from some construction activities. At 10 feet, vibration levels from vibratory rollers, clam shovel drops, and other similar equipment may reach 0.575 in/sec PPV. The US Bureau of Mines has analyzed the effects of blast-induced vibration on buildings in USBM RI 85071, and these findings have been applied to vibrations emanating from construction equipment on buildings[2]. Figure 3 presents the damage probability as reported in USBM RI 8507 and reproduced by Dowding assuming a maximum vibration level of 0.58 in/sec PPV. As shown on Figure 3, these studies indicate an approximate 7% probability of "threshold damage" (referred to as cosmetic damage elsewhere in this report) at vibration levels of 0.58 in/sec PPV or less and no observations of "minor damage" or "major damage". Based on this data, there is a 7% chance that cosmetic or threshold damage could be manifested in the form of hairline cracking in plaster, the opening of old cracks, the loosening of paint or the dislodging of loose objects. However, as indicated in Figure 3, minor damage (e.g., hairline cracking in masonry or the loosening of plaster) or major structural damage (e.g., wide cracking or shifting of foundation or bearing walls) to the structures would not be anticipated to occur assuming the maximum vibration level of 0.58 in/sec PPV that is anticipated at the two residential structures adjoining the project.

For structures located more than 20 feet from general construction activities and more than 100 feet from pile driving, where structural damage is not a concern, vibration levels generated by construction activities could still be perceptible indoors. Secondary vibration, such as a slight rattling of windows or doors, may be considered annoying at times. However, architectural damage to normal residential structures would not be anticipated at these distances and vibration levels would be below those anticipated to cause structural damage. In addition, construction would occur during daytime hours only, thus reducing the potential for residential annoyance during typical periods of rest or sleep, and the duration of vibration generating construction activities at individual locations along the project alignment would be limited as construction moves along the roadway alignment as progress occurs.

---

1 Siskind, D.E., M.S. Stagg, J.W. Kopp, and C.H. Dowding, Structure Response and Damage Produced by Ground Vibration form Surface Mine Blasting, RI 8507, Bureau of Mines Report of Investigations, U.S. Department of the Interior Bureau of Mines, Washington, D.C., 1980.

2 Dowding, C.H., Construction Vibrations, Prentice Hall, Upper Saddle River, 1996.

This is a **potentially significant** impact when construction is located within 20 feet of structures.

Mitigation Measure 2: The implementation of the following measures would reduce the vibration impact to a less-than-significant level.

- Place operating equipment on the construction site as far as possible from vibration sensitive receptors.

- Use smaller equipment to minimize vibration levels below the limits when construction is anticipated to occur within 20 feet of structures.

- Avoid using vibratory rollers and tampers within 20 feet of structures.

- Select demolition methods not involving impact tools.

- Avoid dropping heavy objects or materials.

- A list of all heavy construction equipment to be used for this project known to produce high vibration levels (tracked vehicles, vibratory compaction, jackhammers, hoe rams, etc.) shall be submitted to the Town by the contractor. This list shall be used to identify equipment and activities that would potentially generate substantial vibration and to define the level of effort required for continuous vibration monitoring during periods where heavy construction is proposed within 20 feet of structures.

- A construction vibration-monitoring plan shall be implemented to document structural conditions at all structures located within 20 feet of non-pile driving activities and any structures located within 100 feet of pile driving prior to, during, and after vibration generating construction activities. All plan tasks shall be undertaken under the direction of a licensed Professional Structural Engineer in the State of California and be in accordance with industry accepted standard methods. The construction vibration monitoring plan should be implemented to include the following tasks:

    - Performance of a photo survey, elevation survey, and crack monitoring survey for all structures located within 20 feet of non-pile driving activities and any structures located within 100 feet of pile driving. These surveys shall be performed prior to, in regular intervals during, and after completion of vibration generating construction activities and shall include internal and external crack monitoring in the structure, settlement, and distress and shall document the condition of the foundation, walls and other structural elements in the interior and exterior of said structure.

    - Conduct a post-survey on the structure where either monitoring has indicated high levels or complaints of damage. Make appropriate repairs in accordance with the

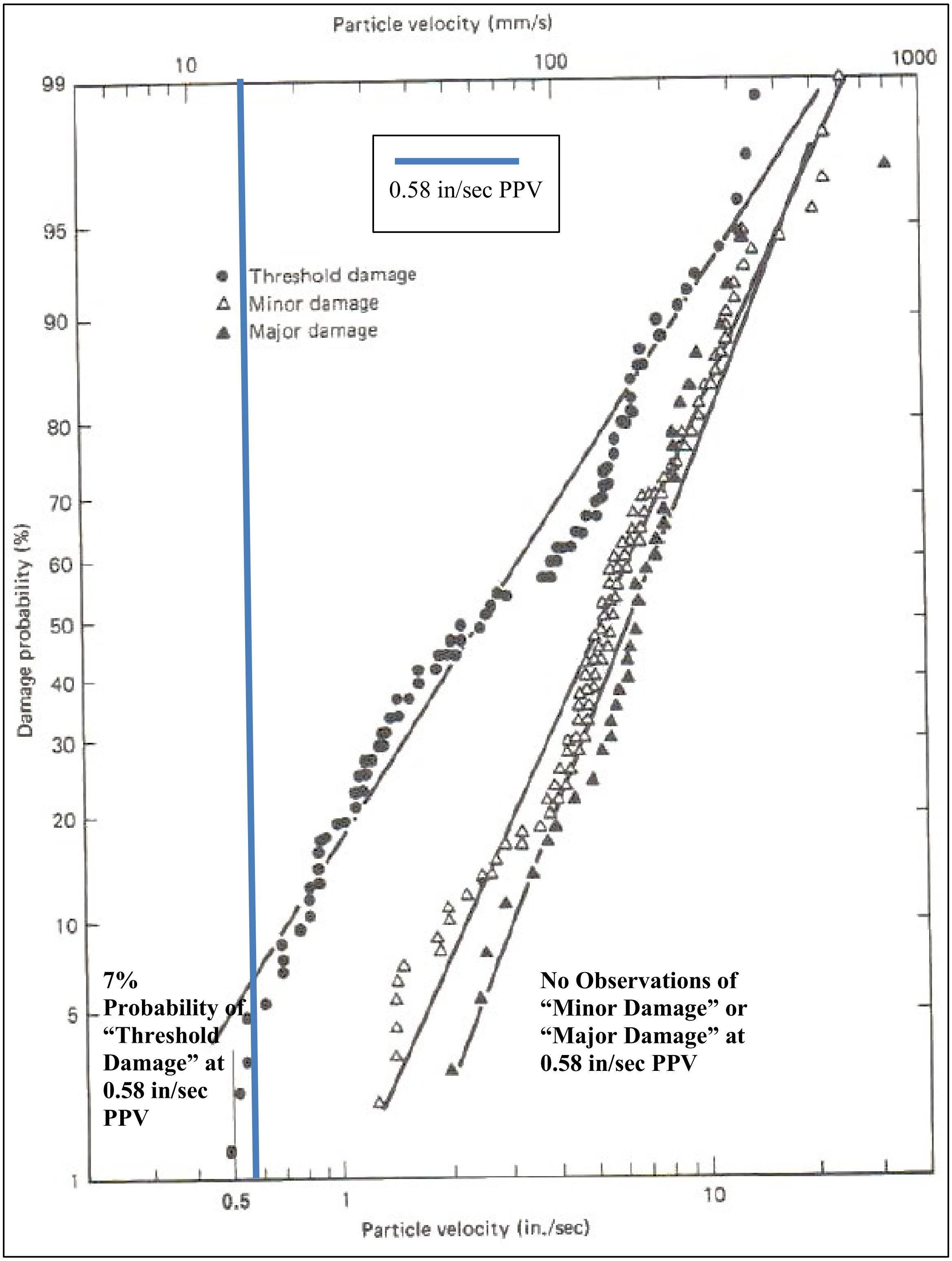
Secretary of the Interior's Standards where damage has occurred as a result of construction activities.

- The results of the surveys shall be summarized and submitted in a report shortly after substantial completion of each phase identified in the project schedule to have potential vibration impacts. The report will include a description of measurement methods, equipment used, calibration certificates, and graphics as required to clearly identify any vibration-monitoring locations.

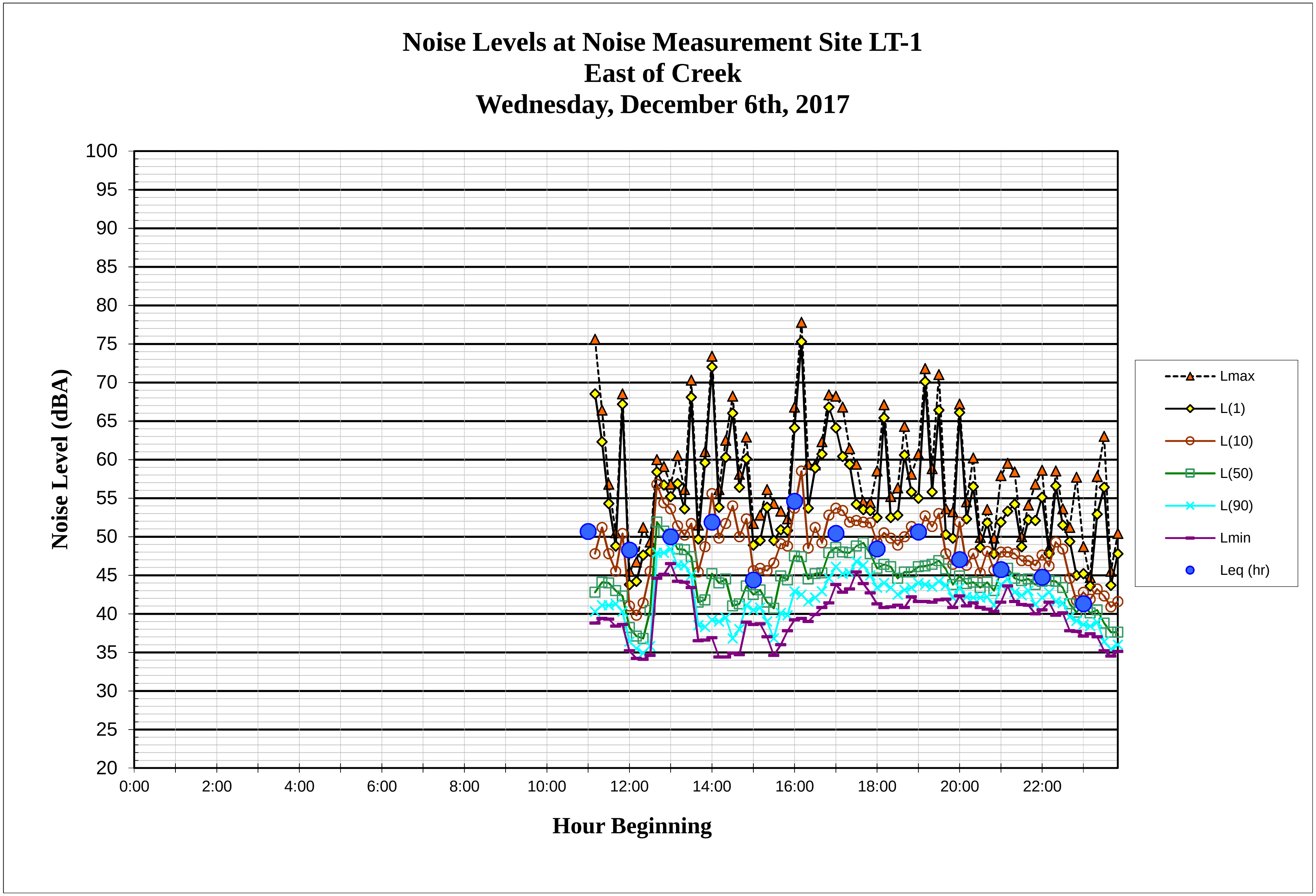
- Designate a person responsible for registering and investigating claims of excessive vibration. The contact information of such person shall be clearly posted on the construction site.

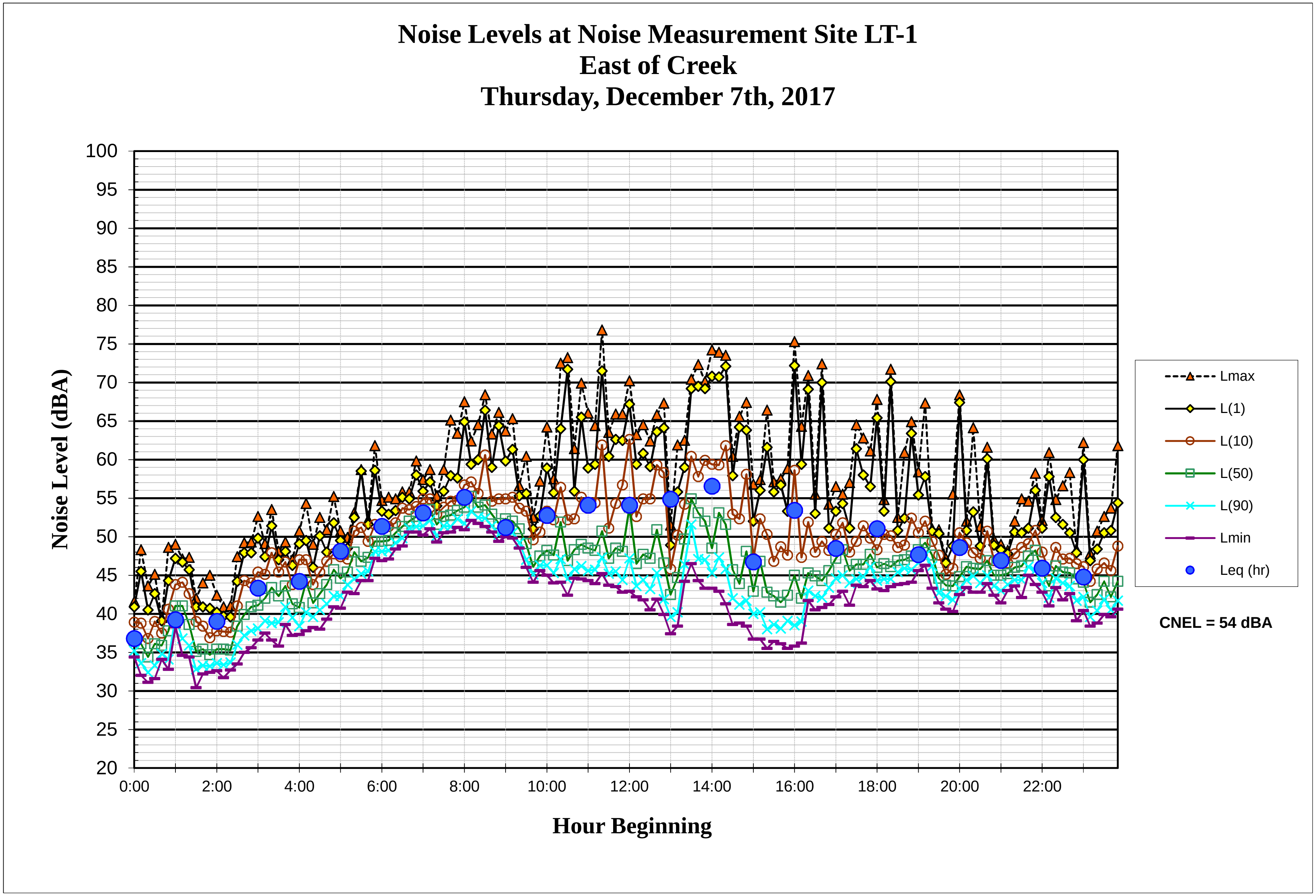
Implementation of the above measures would reduce this impact to a **less-than-significant** level.

FIGURE 3 Probability of Cracking and Fatigue from Repetitive Loading

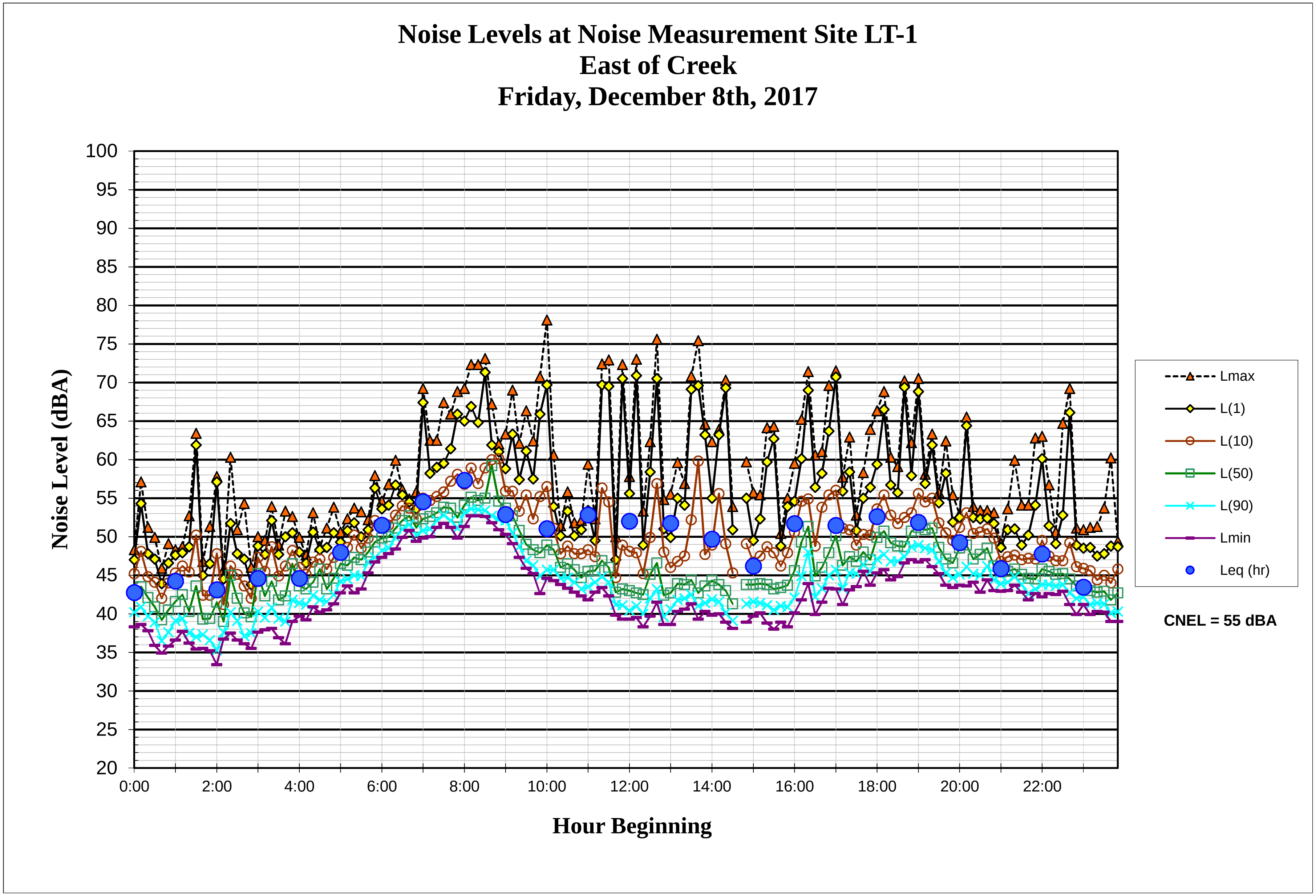


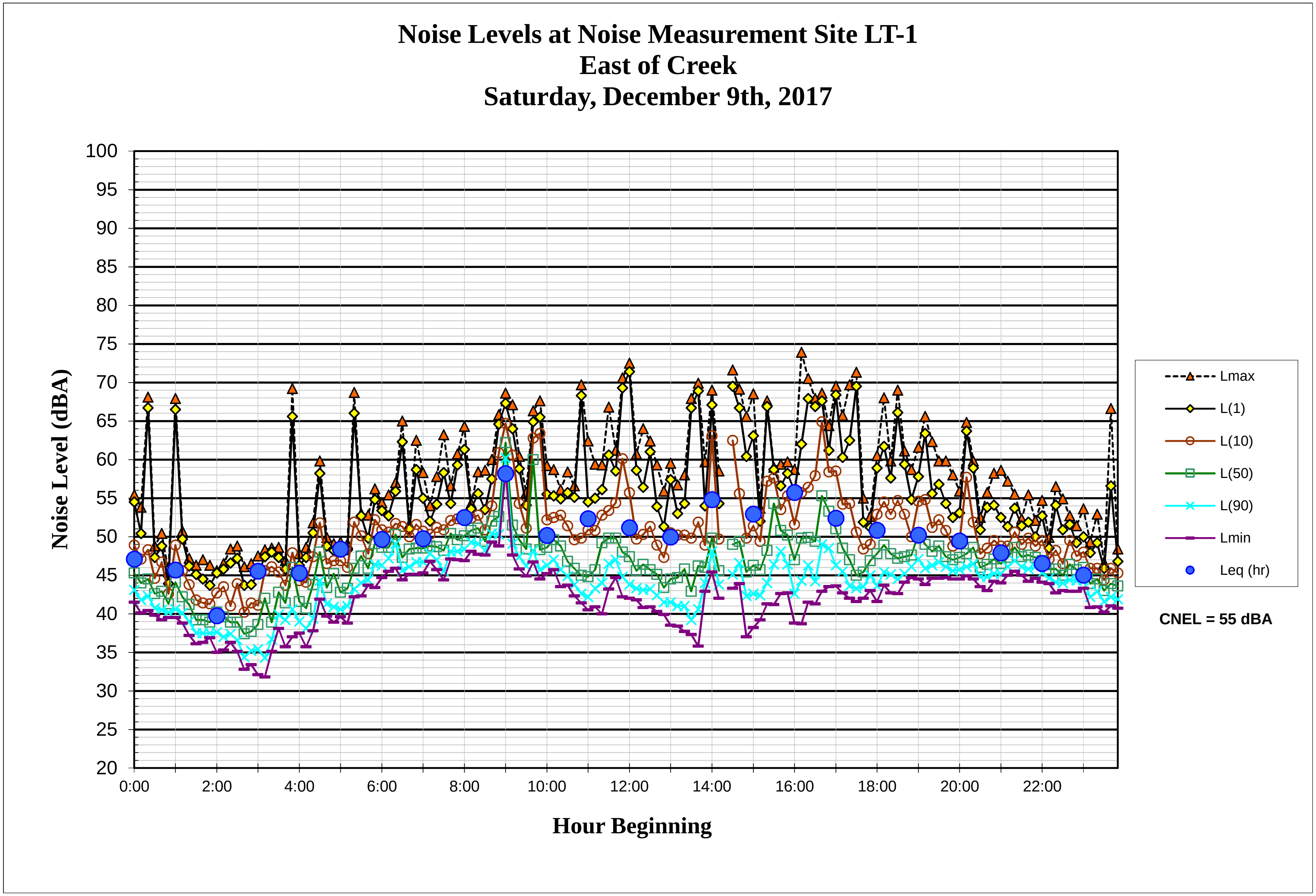
Source: Dowding, C.H., Construction Vibrations, Prentice Hall, Upper Saddle River, 1996 as modified by Illingworth & Rodkin, Inc., September 2019.


Noise Levels at Noise Measurement Site LT-1
East of Creek
Wednesday, December 6th, 2017
Noise Level (dBA)
Hour Beginning
Lmax
L(1)
L(10)
L(50)
L(90)
Lmin
Leq (hr)

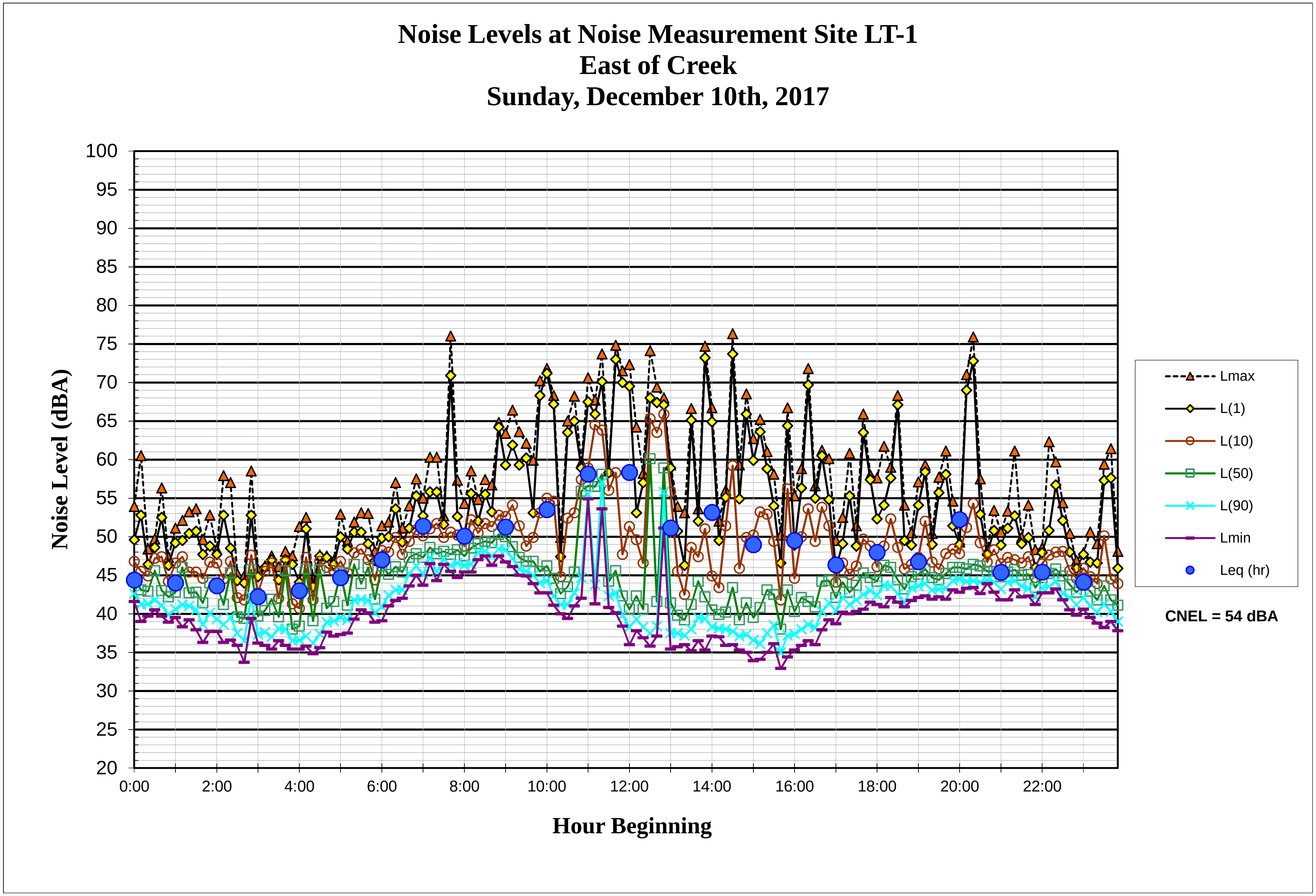


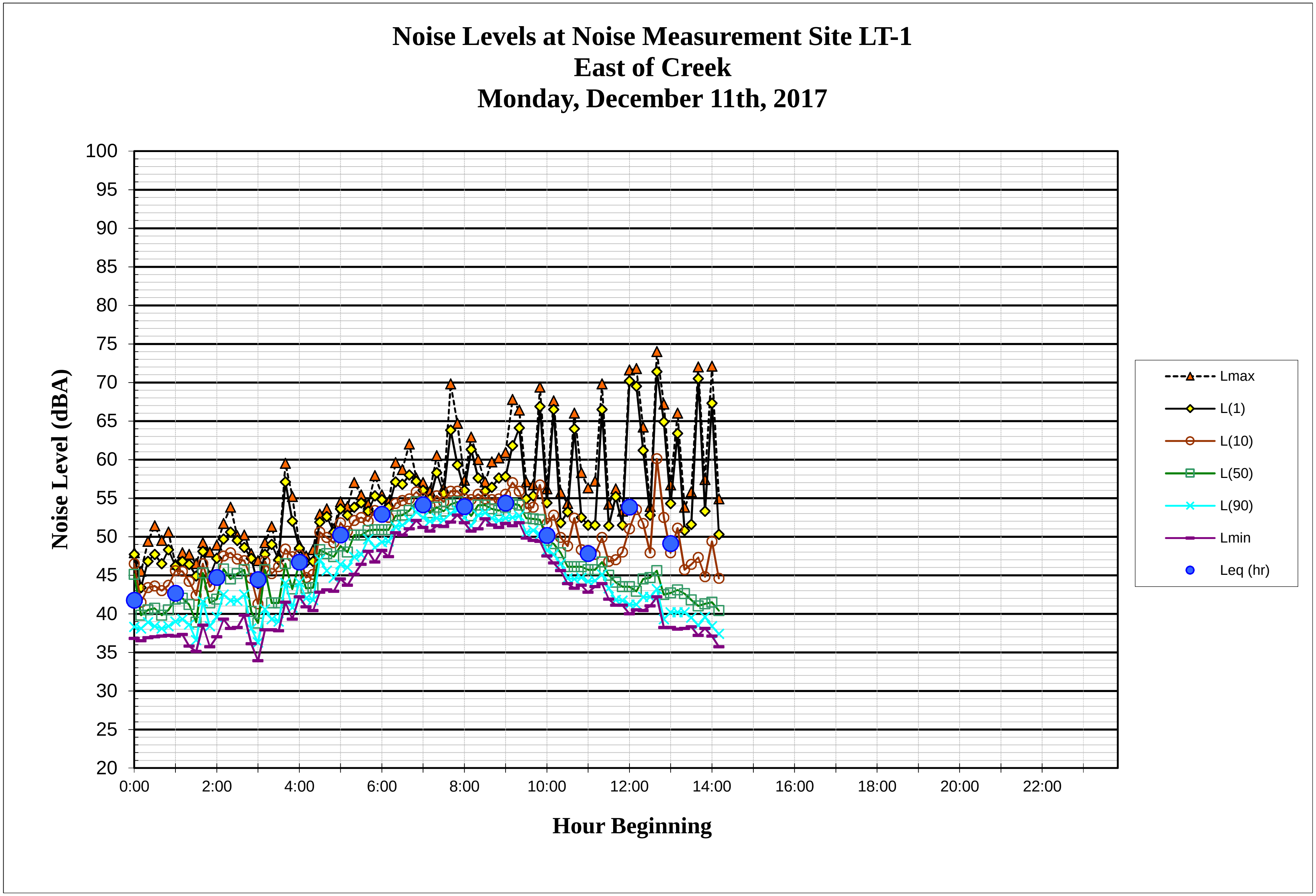
Noise Levels at Noise Measurement Site LT-1
East of Creek
Thursday, December 7th, 2017
Noise Level (dBA)
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
Hour Beginning
Lmax
L(1)
L(10)
L(50)
L(90)
Lmin
Leq (hr)
CNEL = 54 dBA

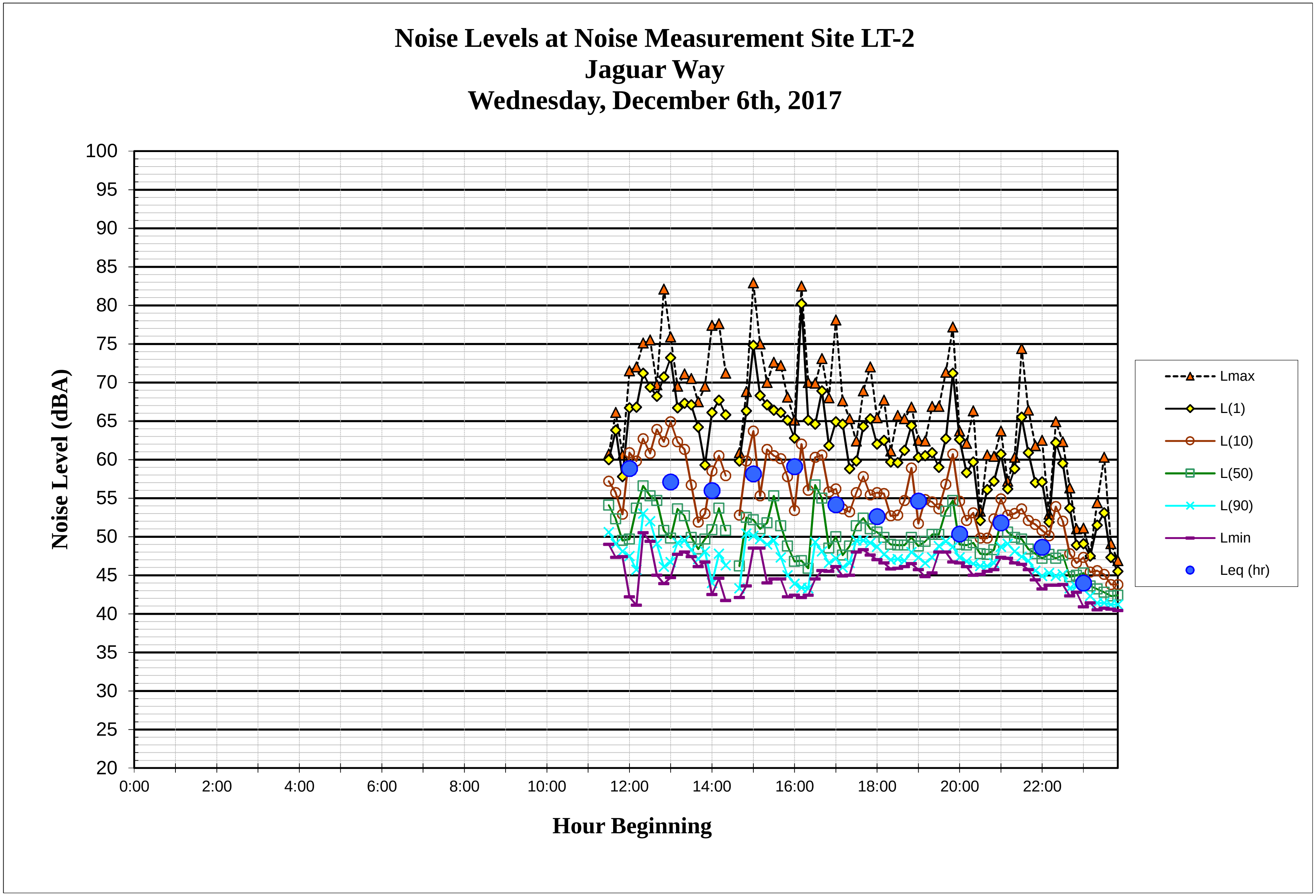

Noise Levels at Noise Measurement Site LT-1
East of Creek
Friday, December 8th, 2017
Noise Level (dBA)
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
Hour Beginning
Lmax
L(1)
L(10)
L(50)
L(90)
Lmin
Leq (hr)
CNEL = 55 dBA



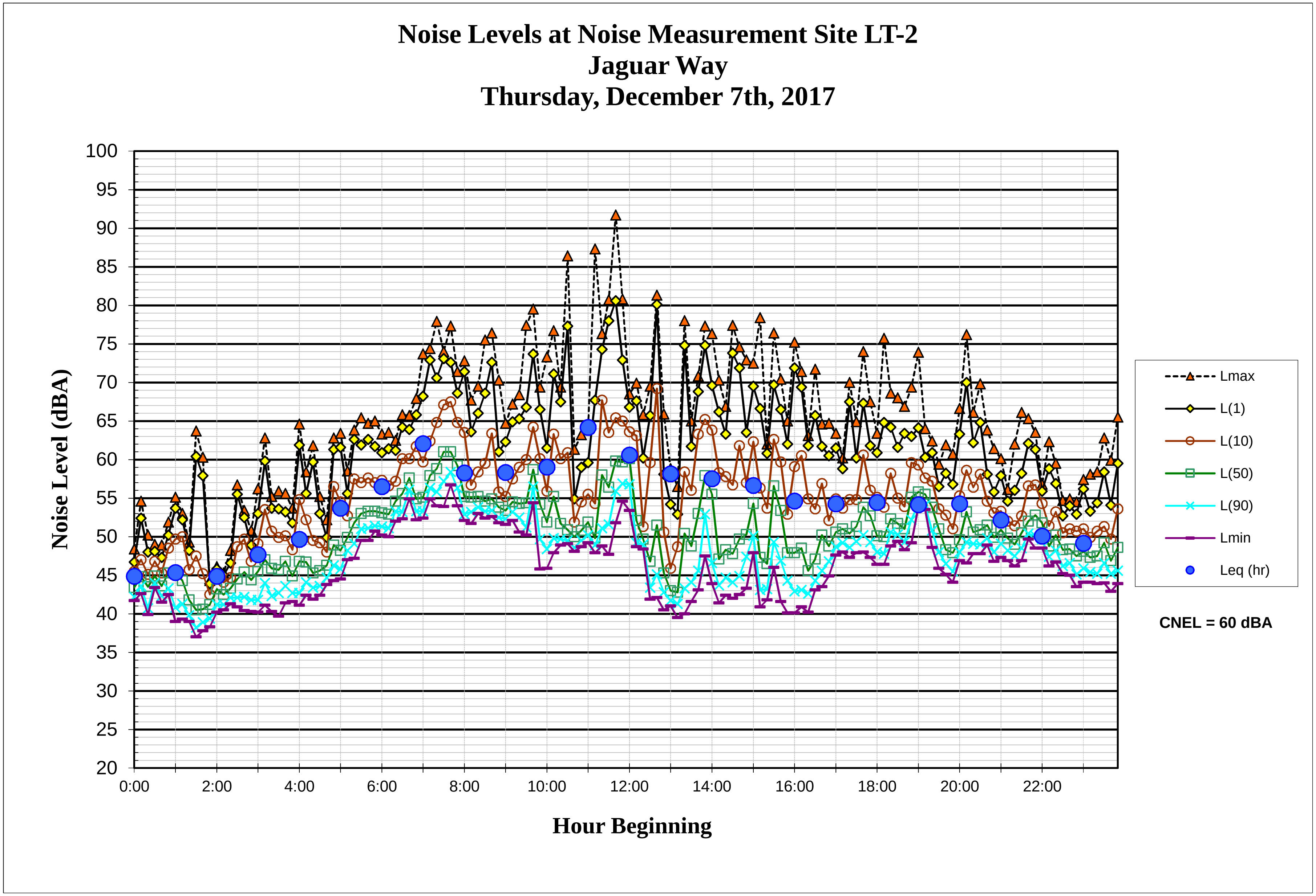
Noise Levels at Noise Measurement Site LT-1
East of Creek
Saturday, December 9th, 2017
Noise Level (dBA)
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
Hour Beginning
Lmax
L(1)
L(10)
L(50)
L(90)
Lmin
Leq (hr)
CNEL = 55 dBA

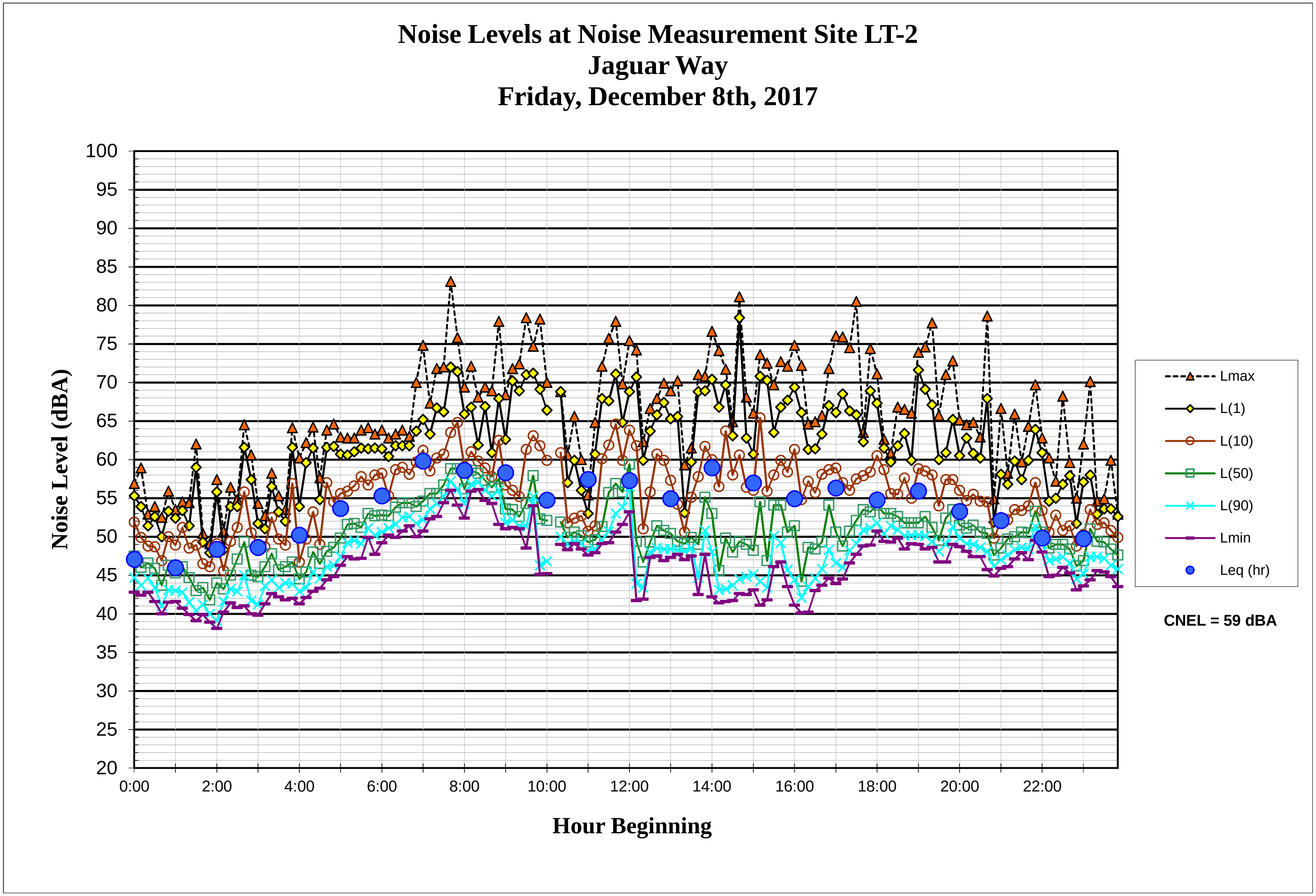

Noise Levels at Noise Measurement Site LT-1
East of Creek
Sunday, December 10th, 2017
Noise Level (dBA)
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
Hour Beginning
Lmax
L(1)
L(10)
L(50)
L(90)
Lmin
Leq (hr)
CNEL = 54 dBA

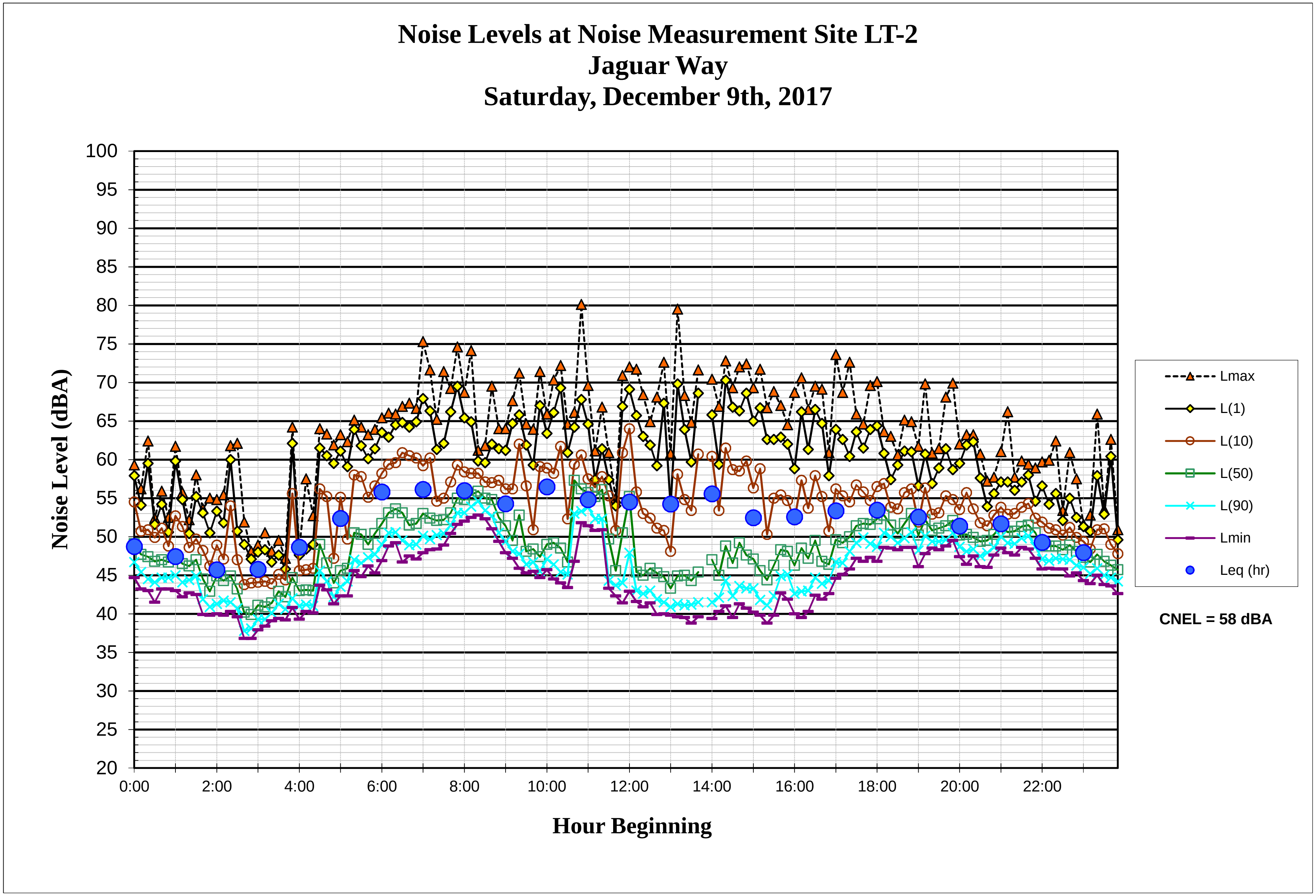

Noise Levels at Noise Measurement Site LT-1
East of Creek
Monday, December 11th, 2017
Noise Level (dBA)
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
Hour Beginning
Lmax
L(1)
L(10)
L(50)
L(90)
Lmin
Leq (hr)

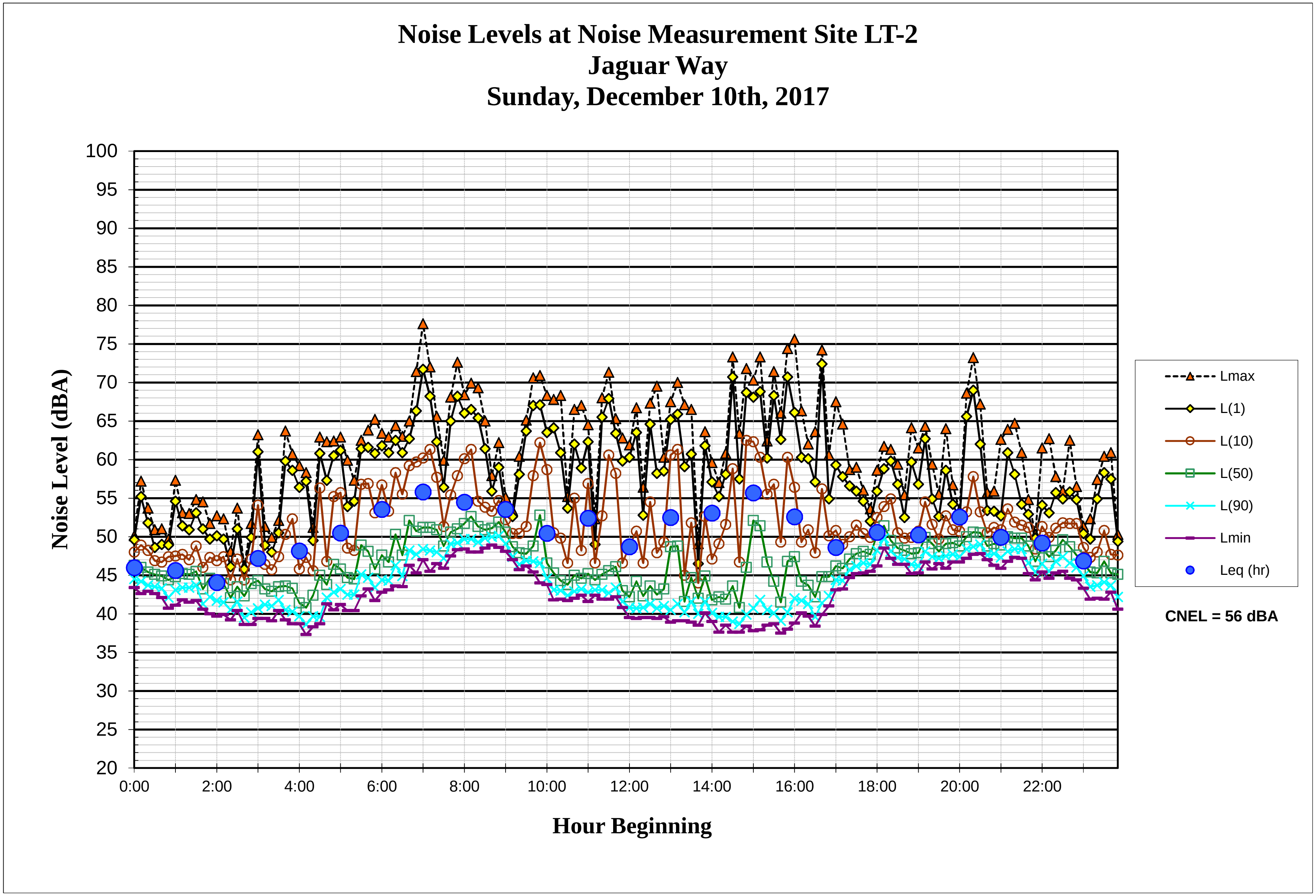


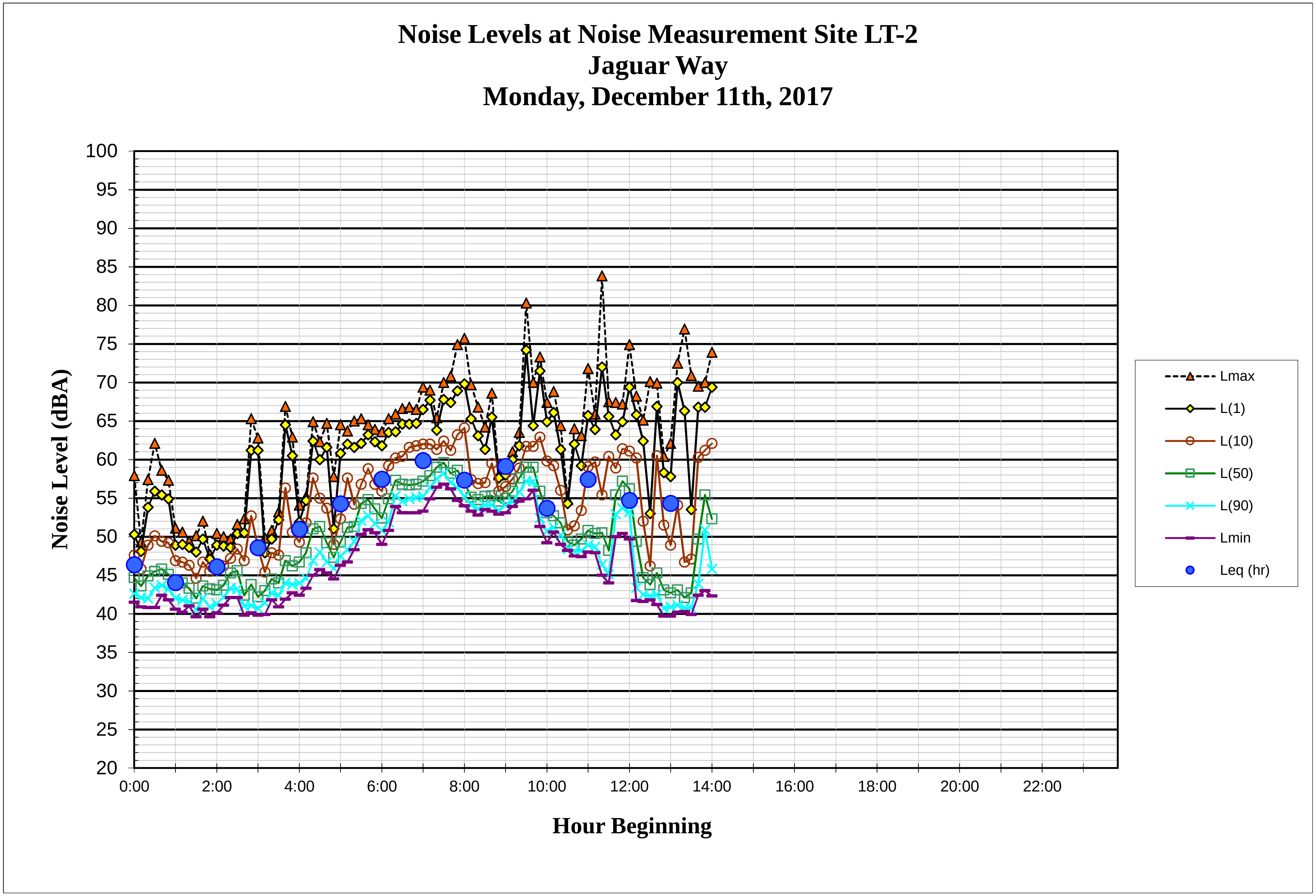
Noise Levels at Noise Measurement Site LT-2
Jaguar Way
Wednesday, December 6th, 2017
Noise Level (dBA)
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
Hour Beginning
Lmax
L(1)
L(10)
L(50)
L(90)
Lmin
Leq (hr)


Noise Levels at Noise Measurement Site LT-2
Jaguar Way
Thursday, December 7th, 2017
Noise Level (dBA)
Hour Beginning
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
Lmax
L(1)
L(10)
L(50)
L(90)
Lmin
Leq (hr)
CNEL = 60 dBA


Noise Levels at Noise Measurement Site LT-2
Jaguar Way
Friday, December 8th, 2017
Noise Level (dBA)
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
Hour Beginning
Lmax
L(1)
L(10)
L(50)
L(90)
Lmin
Leq (hr)
CNEL = 59 dBA


Noise Levels at Noise Measurement Site LT-2
Jaguar Way
Saturday, December 9th, 2017
Noise Level (dBA)
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
Hour Beginning
Lmax
L(1)
L(10)
L(50)
L(90)
Lmin
Leq (hr)
CNEL = 58 dBA


Noise Levels at Noise Measurement Site LT-2
Jaguar Way
Sunday, December 10th, 2017
Noise Level (dBA)
Hour Beginning
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
Lmax
L(1)
L(10)
L(50)
L(90)
Lmin
Leq (hr)
CNEL = 56 dBA


Noise Levels at Noise Measurement Site LT-2
Jaguar Way
Monday, December 11th, 2017
Noise Level (dBA)
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
Hour Beginning
Lmax
L(1)
L(10)
L(50)
L(90)
Lmin
Leq (hr)