DOWNTOWN SPECIFIC PLAN ENVIRONMENTAL NOISE AND VIBRATION ASSESSMENT

Sunnyvale, California

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INTRODUCTION

This report evaluates the project's potential to result in significant noise and vibration impacts with respect to applicable California Environmental Quality Act (CEQA) guidelines. The report is divided into three 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 and vibration monitoring surveys completed to document existing conditions; 2) the General Plan Consistency Section discusses land use compatibility utilizing policies in the City's General Plan; and, 3) 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.

Project Description

The City of Sunnyvale originally adopted the Downtown Specific Plan (DSP) in 1993 and updated it in 2003 and 2013. The DSP area consists of approximately 125 acres, divided into 22 blocks. This project proposes amendments to six sites within three blocks of the DSP area to change the land use mix and intensity of development and proposes specific development plans for the six sites. The six project sites are currently located within Blocks 1a, 18 and 22 and are as follows:

- **100 Altair Way** (Block 1a): A 0.5-acre site located south of Altair Way and between Aries Way and South Taaffe Street. The project would demolish existing on-site buildings and construct a seven-story office building with four levels of underground parking. The rooftop terrace would provide space for recreational amenities.

- **300 Mathilda Avenue** (Sub-block 1): A 1.9-acre undeveloped site along Mathilda Avenue, south of West McKinley Avenue. The project would construct a five-story commercial and office use building with two levels of underground parking. In addition, a surface parking lot would be constructed south of the building with access to the existing three-story parking lot the east of the site.

- **300 West Washington Avenue** (Sub-block 2): A 0.9-acre site at the southwest corner of West Washington Avenue and South Taaffe Street. This site is currently under construction to develop a five-story, mixed use building with commercial use on ground floor and 124 residential units. The project proposes to convert the storage space within the building to one new residential unit.

- **Macy's and Redwood Square** (Sub-block 3): A 7.3-acre site located south of West Washington Avenue and north of West McKinley Avenue, between South Murphy Avenue and South Taaffe Street. The project would demolish the existing on-site building and construct two seven-story commercial/office buildings and two ten-story mixed use buildings for commercial and residential uses with two levels of underground parking provided for each building.

- **Sub-block 6**: A 3.9-acre site located between West Washington Avenue, West McKinley Avenue, South Murphy Avenue and South Sunnyvale Avenue. The project would construct a seven-story mixed use building for commercial and residential uses.

- **Murphy Square** (Block 22): A 1.5-acre site located at the northwest corner of West Evelyn Avenue and South Sunnyvale Avenue. The project would construct a four-story office building with three levels of underground parking and a rooftop deck.

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

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 sound 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 (TeNS), California Department of Transportation, 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.

Railroad and light-rail operations are potential sources of substantial ground vibration depending on distance, the type and the speed of trains, and the type of railroad track. People’s response to ground vibration from rail vehicles has been correlated best with the average, root mean square

(RMS) velocity of the ground. The velocity of the ground is expressed on the decibel scale. The reference velocity is 1 x 10-6 in/sec RMS, which equals 0 VdB, and 1 in/sec equals 120 VdB. Although not a universally accepted notation, the abbreviation "VdB" is used in this document for vibration decibels to reduce the potential for confusion with sound decibels.

Typical background vibration levels in residential areas are usually 50 VdB or lower, well below the threshold of perception for most humans. Perceptible vibration levels inside residences are attributed to the operation of heating and air conditioning systems, door slams and foot traffic. Construction activities, train operations, and street traffic are some of the most common external sources of vibration that can be perceptible inside residences. Table 4 illustrates some common sources of vibration and the association to human perception or the potential for 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.

TABLE 4 Typical Levels of Groundborne Vibration

Human/Structural Response	Velocity Level, VdB	Typical Events (50-foot setback)
Threshold, minor cosmetic damage	100	Blasting, pile driving, vibratory compaction equipment
		Heavy tracked vehicles (Bulldozers, cranes, drill rigs)
Difficulty with tasks such as reading a video or computer screen	90	
		Commuter rail, upper range
Residential annoyance, infrequent events	80	Rapid transit, upper range
Residential annoyance, occasional events		Commuter rail, typical Bus or truck over bump or on rough roads
Residential annoyance, frequent events	70	Rapid transit, typical
Approximate human threshold of perception to vibration		Buses, trucks and heavy street traffic
	60	
		Background vibration in residential settings in the absence of activity
Lower limit for equipment ultra-sensitive to vibration	50	

Source: Transit Noise and Vibration Impact Assessment Manual, U.S. Department of Transportation Federal Transit Administration, September 2018.

Regulatory Background – Noise

The State of California and the City of Sunnyvale 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.

2018 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), (b), and (c) are applicable to the proposed project.

2016 California Building Code, Title 24, Part 2. The current version of the California Building Code (CBC) requires interior noise levels attributable to exterior environmental noise sources to be limited to a level not exceeding 45 dBA L_{dn}/CNEL in any habitable room.

2016 California Green Building Standards Code (Cal Green Code). The State of California established exterior sound transmission control standards for new non-residential buildings as set forth in the 2016 California Green Building Standards Code (Section 5.507.4.1 and 5.507.4.2). Section 5.507 states that either the prescriptive (Section 5.507.4.1) or the performance method (Section 5.507.4.2) shall be used to determine environmental control at indoor areas. The prescriptive method is very conservative and not practical in most cases; however, the performance method can be quantitatively verified using exterior-to-interior calculations. For the purposes of this report, the performance method is utilized to determine consistency with the Cal Green Code. The sections that pertain to this project are as follows:

> **5.507.4.1 Exterior noise transmission, prescriptive method.** Wall and roof-ceiling assemblies exposed to the noise source making up the building envelope shall meet a composite STC rating of at least 50 or a composite OITC rating of no less than 40, with exterior windows of a minimum STC of 40 or OITC of 30 when the building falls within the 65 dBA L_{dn} noise contour of a freeway or expressway, railroad, industrial source or fixed-guideway noise source, as determined by the local general plan noise element.

5.507.4.2 Performance method. For buildings located, as defined by Section 5.507.4.1, wall and roof-ceiling assemblies exposed to the noise source making up the building envelope shall be constructed to provide an interior noise environment attributable to exterior sources that does not exceed an hourly equivalent noise level ($L_{eq\ (1\text{-}hr)}$) of 50 dBA in occupied areas during any hour of operation.

The performance method, which establishes the acceptable interior noise level, is the method typically used when applying these standards.

Santa Clara County Airport Land Use Commission Comprehensive Land Use Plan. The Comprehensive Land Use Plan adopted by the Santa Clara County Airport Land Use Commission contains standards for projects within the vicinity of Moffett Federal Airfield which are relevant to this project:

4.1 Land Use Planning Issues

- **Noise Restriction Area.** The Noise Restriction Area is defined as the 65 dB CNEL contour, inside which an acoustical analysis is required by the local agency with land use jurisdiction demonstrating how low-density, single-family, multi-family and mobile home dwelling units and schools have been designed to meet an interior noise level of 45 dB CNEL.

City of Sunnyvale General Plan. Chapter 6 of the City of Sunnyvale's General Plan sets forth goals, policies, and standards for evaluating community noise in the City. The following are applicable to this proposed project:

Goal SN-8. Compatible Noise Environment. Maintain or achieve a compatible noise environment for all land uses in the community.

Policy SN-8.1 Enforce and supplement state laws regarding interior noise levels of residential units.

Policy SN-8.4 Prevent significant noise impacts from new development by applying state noise guidelines and Sunnyvale Municipal Code noise regulations in the evaluation of land use issues and proposals.

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Policy SN-8.5 Comply with "State of California Noise Guidelines for Land Use Planning" (Figure 6-5 of the Safety-Noise Chapter) for the compatibility of land uses with their noise environments, except where the City determines that there are prevailing circumstances of a unique or special nature.

Policy SN-8.6 Use Figure 6-6 (of the Safety-Noise Chapter), "Significant Noise Impacts from New Development on Existing Land Use" to determine if proposed development results in a "significant noise impact" on existing development.

Policy SN-8.7 Supplement Figure 6-5, "State of California Noise Guidelines for Land Use Planning" for residential uses by attempting to achieve an outdoor L_{dn} of no greater than 60 dBA for common recreational areas, backyards, patios, and medium and large-size balconies. These guidelines should not apply where the noise source is a railroad or an airport. If the noise source is a railroad, then an L_{dn} of no greater than 70 dBA should be achieved in common areas, backyards, patios, and medium and large-size balconies. If the noise source is from aircraft, then preventing new residential land uses within areas of high L_{dn} from aircraft noise is recommended.

Policy SN-8.8 Avoid construction of new residential uses where the outdoor L_{dn} is greater than 70 dBA as a result from train noise.

Policy SN-8.9 Consider techniques that block the path of noise and insulate people from noise.

Goal SN-9. Acceptable Limits for Community Noise. Maintain or achieve acceptable limits for the levels of noise generated by land use operations and single-events.

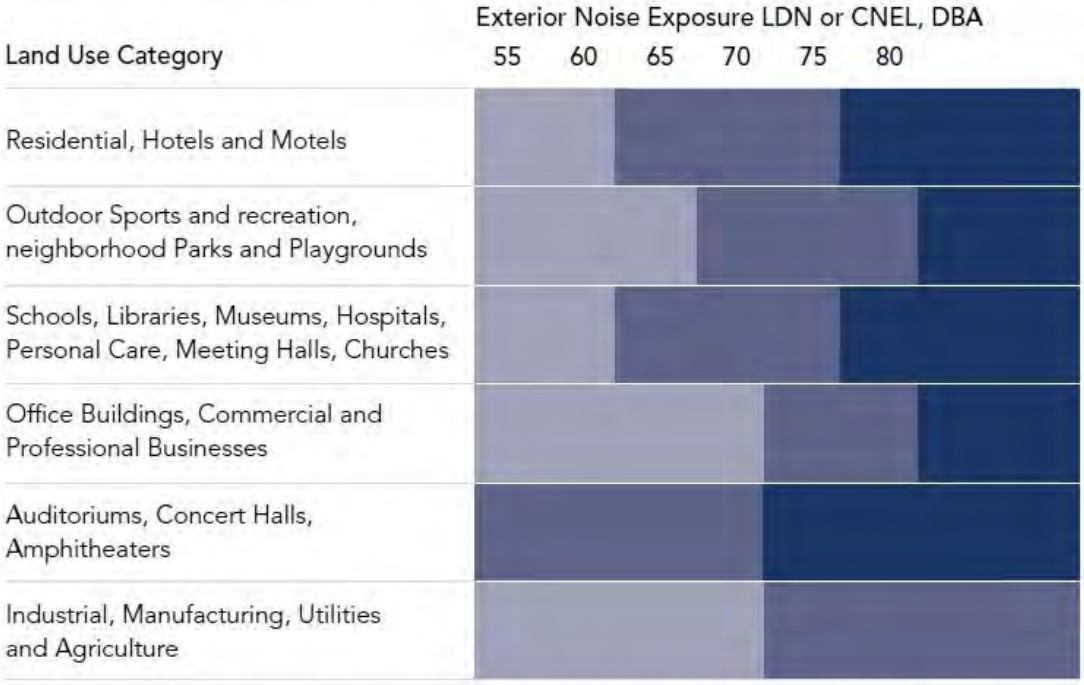
Policy SN-9.1 Regulate land use operation noise.

Policy SN-9.3: Apply conditions to discretionary land use permits which limit hours of operation, hours of delivery and other factors which affect noise.

Goal SN-10. Maintained or Reduced Transportation Noise. Preserve and enhance the quality of neighborhoods by maintaining or reducing the levels of noise generated by transportation facilities.

Policy SN-10.1 Refrain from increasing or reduce the noise impacts of major roadways.

Figure 6-5: State of California Noise Guidelines for Land Use Planning
Summary of Land Use Compatibility for Community Noise Environment



Normally Acceptable — Specified Land Use is satisfactory, based on the assumption that any buildings involved are of normal conventional construction, without any special insulation requirements.

Conditionally Acceptable — Specified land use may be permitted only after detailed analysis of the noise reduction requirements and needed noise insulation features are included in the design.

Unacceptable — New construction or development should generally not be undertaken because mitigation is usually not feasible to comply with noise element policies.

Source: City of Sunnyvale General Plan, July 2011.

Figure 6-6: Significant Noise Impacts from New Development on Existing Land Use

Ldn Category of Existing Development Per Figure 6-4	Noise Increase Considered "Significant" over Existing Noise Levels
Normally Acceptable	An increase of more than 3 dBA and the total Ldn exceeds the "normally acceptable" category
Normally Acceptable	An increase of more than 5 dBA
Conditionally Acceptable	An increase of more than 3 dBA
Unacceptable	An increase of more than 3 dBA

Source: City of Sunnyvale General Plan, July 2011.

City of Sunnyvale Municipal Code. The City's Municipal Code establishes construction noise regulations. According to Title 16, Chapter 16.08.030, construction activity shall be permitted between the hours of 7:00 am and 6:00 pm daily Monday through Friday. Saturday hours of operation shall be between 8:00 am and 5:00 pm There shall be no construction activity on Sunday or federal holidays when city offices are closed. No loud environmentally disruptive noises, such as air compressors without mufflers, continuously running motors or generators, loud playing musical instruments, radios, etc., will be allowed where such noises may be a nuisance to adjacent residential neighborhoods. The following exceptions are stated in Title 16, Chapter 16.08.030:

(a) Construction activity is permitted for detached single-family residential properties when the work is being performed by the owner of the property, provided no construction activity is conducted prior to 7:00 am or after 7:00 pm Monday through Friday, prior to 8:00 am or after 7:00 pm on Saturday and prior to 9:00 am or after 6:00 pm on Sunday and national holidays when city offices are closed. It is permissible for up to two persons to assist the owner of the property so long as they are not hired by the owner to perform the work. For purposes of this section, "detached single-family residential property" refers only to housing that stands completely along with no adjoining roof, foundation or sides.

(b) As determined by the chief building official:

1) No loud environmentally disruptive noises, such as air compressors without mufflers, continuously running motors or generators, loud playing musical instruments, radios, etc., will be allowed where such noises may be a nuisance to adjacent properties.

2) Where emergency conditions exist, construction activity may be permitted at any hour or day of the week. Such emergencies shall be completed as rapidly as possible to prevent any disruption to other properties.

3) Where additional construction activity will not be a nuisance to surrounding properties, based on location and type of construction, a waiver may be granted to allow hours of construction other than as stated in this section.

In the City's Municipal Code, operational noise standards enforced on residentially zoned property lines are also presented. Title 19, Chapter 19.42.030 states the following:

(a) Operational noise shall not exceed seventy-five dBA at any point on the property line of the premises upon which the noise or sound is generated or produced; provided, however, that the noise or sound level shall not exceed fifty dBA during nighttime or sixty dBA during daytime hours at any point on adjacent residentially zoned property. If the noise occurs during nighttime hours and the enforcing officer has determined that the noise involves a steady, audible tone such as a whine, screech or hum, or is a staccato or intermittent noise (e.g., hammering) or includes music or speech, the allowable noise or sound level shall not exceed forty-five dBA.

(b) Powered equipment used on a temporary, occasional, or infrequent basis which produces a noise greater than the applicable operational noise limit set forth in subsection (a) shall be used only during daytime hours when used adjacent to a property with a residential zoning district. Powered equipment used on other than a temporary, occasional or infrequent basis shall comply with the operational noise requirements. For the purpose of this section, powered equipment does not include leaf blowers. Construction activity regulated by Title 16 of this code shall not be governed by this section.

(c) It is unlawful for any person to make or allow to be made a nighttime delivery to a commercial or industrial establishment when the loading/unloading area of the establishment is adjacent to a property in a residential zoning district. Businesses legally operating at a specific location as of February 1, 1995, are exempt from this requirement.

(d) A "leaf blower" is a small, combustion engine-powered device used for property or landscape maintenance that can be hand-held or carried on the operator's back and which operates by propelling air under pressure through a cylindrical tube. It is unlawful for any person to operate a leaf blower on private property in or adjacent to a residential area except between the hours of 8:00 am and 8:00 pm. Effective January 1, 2000, all leaf blowers operated in or adjacent to a residential area shall operate at or below a noise level of sixty-five dBA at a distance of fifty feet, as determined by a test conducted by the American National Standards Institute or an equivalent. The dBA rating shall be prominently displayed on the leaf blower.

The City's Code does not define the acoustical time descriptor such as L_{eq} (the average noise level) or L_{max} (the maximum instantaneous noise level) that is associated with the above limits. A reasonable interpretation of the City Code would identify the ambient base noise level criteria as an average noise level (L_{eq}).

Regulatory Background – Vibration

The Federal Transit Administration has established vibration guidelines applicable to this analysis.

Federal Transit Administration. The Federal Transit Authority (FTA) has developed vibration impact assessment criteria for evaluating vibration impacts associated with transit projects. The proposed vibration impact criteria is based on maximum overall levels for a single event. The impact criteria for vibration are shown in Table 5. Note that there are criteria for frequent events (more than 70 events of the same source per day), occasional events (30 to 70 vibration events of the same source per day), and infrequent events (less than 30 vibration events of the same source per day).

TABLE 5 Indoor Groundborne Vibration (GBV) and Groundborne Noise (GBN) Impact Criteria for General Vibration Assessment

Land Use Category	GBV Impact Levels (VdB re 1 µinch/sec, RMS)			GBN Impact Levels (dBA re 20 micro Pascals)		
	Frequent Events[1]	Occasional Events[2]	Infrequent Events[3]	Frequent Events[1]	Occasional Events[2]	Infrequent Events[3]
Category 1 Buildings where vibration would interfere with interior operations.	65 VdB[4]	65 VdB[4]	65 VdB[4]	N/A[5]	N/A[5]	N/A[5]
Category 2 Residences and buildings where people normally sleep.	72 VdB	75 VdB	80 VdB	35 dBA	38 dBA	43 dBA
Category 3 Institutional land uses with primarily daytime use.	75 VdB	78 VdB	83 VdB	40 dBA	43 dBA	48 dBA

1. "Frequent Events" is defined as more than 70 vibration events of the same source per day. Most rapid transit projects fall into this category.
2. "Occasional Events" is defined as between 30 and 70 vibration events of the same source per day. Most commuter trunk lines have this many operations.
3. "Infrequent Events" is defined as fewer than 30 vibration events of the same kind per day. This category includes most commuter rail branch lines.
4. This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. For equipment that is more sensitive, a Detailed Vibration Analysis must be performed.
5. Vibration sensitive equipment is generally not sensitive to groundborne noise; however, the manufacturer's specifications should be reviewed for acoustic and vibration sensitivity.

Source: Transit Noise and Vibration Impact Assessment Manual, U.S. Department of Transportation Federal Transit Administration, September 2018.

Existing Environment

Noise Monitoring Survey

The project consists of six sites in Downtown Sunnyvale, California. A noise monitoring survey was performed in the vicinity of each site from Thursday, September 13, 2018 to Wednesday, September 19, 2018 and on Friday, January 25, 2019. The monitoring survey included five long term and five short-term measurements, as shown in Figure 1. A summary of the short-term attended monitoring results is given in Table 6. The daily trends in noise levels at the long-term locations are shown in Appendix A.

Long-term noise measurement LT-1 was made north of the Murphy Square Building, approximately 35 feet south of the center of the Caltrain tracks. The primary noise source at this location was frequent train passbys. Based on the Caltrain schedule, approximately 92 trains pass by the site each day between the hours of 4:00 a.m. and 1:30 a.m. Hourly average noise levels ranged from 73 to 86 dBA L_{eq} during daytime hours, and from 43 to 82 dBA L_{eq} at night. The day-night average noise levels ranged from 79 to 85 dBA L_{dn}, depending on the frequency of nighttime train events.

Long-term noise measurement LT-2 was made 30 feet from the centerline of West Evelyn Avenue. The primary noise source at this location was the traffic on West Evelyn Avenue. Typical hourly average noise levels at this location ranged from 60 to 70 dBA L_{eq} during the day and from 51 to 71 dBA L_{eq} at night. The day-night average noise levels ranged from 67 to 71 dBA L_{dn}.

Long-term noise measurement LT-3 was made 25 feet from the centerline of West Washington Avenue. The primary noise source at this location was the traffic on West Washington Avenue. Typical hourly average noise levels at this location ranged from 55 to 67 dBA L_{eq} during the day and from 47 to 62 dBA L_{eq} at night. The day-night average noise levels ranged from 62 to 65 dBA L_{dn}.

Long-term noise measurement LT-4 was made 30 feet from the centerline of South Sunnyvale Avenue. The primary noise source at this location was the traffic on South Sunnyvale Avenue. Typical hourly average noise levels at this location ranged from 60 to 69 dBA L_{eq} during the day and from 51 to 66 dBA L_{eq} at night. The day-night average noise levels ranged from 66 to 68 dBA L_{dn}.

Long-term noise measurement LT-5 was made 60 feet from the centerline of Mathilda Avenue, south of West McKinley Avenue. The primary noise source at this location was the vehicular traffic on Mathilda Avenue. Hourly average noise levels at this location ranged from 66 to 74 dBA L_{eq} during the day and from 58 to 69 dBA L_{eq} at night. The day-night average noise levels ranged from 71 to 73 dBA L_{dn}.

TABLE 6 Summary of Short-Term Noise Measurement Data, January 25th, 2019

ID	Location (Start Time)	Measured Noise Levels, dBA				Primary noise source
		L_{10}	L_{50}	L_{90}	L_{eq}	
ST-1	55 feet from center of South Sunnyvale Avenue (1/25/19, 8:40 am to 8:50 am)	74	61	54	67	Traffic on South Sunnyvale Avenue, no train activity during measurement
ST-2	25 feet from center of Altair Way (1/25/19, 9:30 am to 9:40 pm)	58	53	51	58	Distant traffic and trains
ST-3	160 Aries Way (1/25/19, 9:50 am to 10:00 am)	61	56	52	63	Distant traffic, train horn sounding
ST-4	100 feet south of West Washington Avenue, west of 320 West Washington Avenue (1/25/19, 10:10 am to 10:20 am)	63	60	56	61	Traffic on West Washington Avenue
ST-5	60 feet south of West McKinley Avenue and 150 feet east of South Mathilda Avenue (1/25/19, 10:40 am to 10:50 am)	69	63	54	65	Traffic on Mathilda Avenue and West McKinley Avenue

Vibration monitoring survey

Observed and recorded vibration measurements of individual train passbys were conducted on January 25, 2019 at setbacks of 40 feet (V-1) and 75 feet (V-2) from the center of northbound tracks and 25 feet (V-1) and 55 feet (V-2) from center of southbound tracks, as shown in Figure 1. The instrumentation used to conduct the measurements included a Roland R-05 solid state recorder and seismic grade, low noise accelerometers firmly fixed to the ground. This system is capable of accurately measuring very low vibration levels. Vibration levels were measured at the ground level and were representative of the levels that would enter a building's foundation.

A total of eight individual passbys, including four northbound and four southbound trains were observed and recorded at each measurement setback. Two setbacks were used to develop a drop-off rate for groundborne vibration with distance. Vibration levels were measured in the vertical axis because ground vibration is typically most dominant on this axis. Vibration levels measured at each measurement position during train passby events are summarized in Table 7. Train vibration levels ranged from approximately 71 to 91 VdB at V-1 and 68 to 88 VdB at V-2. Vibration levels at V-1 and V-2 for each train passby event is shown in Appendix A.

TABLE 7 Results of Caltrain Vibration Measurements

Event	Maximum Vibration Level (VdB re 1µinch/sec, RMS)	
	Position V-1	Position V-2
NB Caltrain	71 VdB	68 VdB
NB Caltrain	77 VdB	77 VdB
SB bullet train	84 VdB	80 VdB
SB Caltrain	82 VdB	80 VdB
SB bullet train	91 VdB	88 VdB
NB bullet train	81 VdB	80 VdB
SB bullet train	84 VdB	82 VdB
NB Caltrain	75 VdB	71 VdB
Average	79 VdB	77 VdB

Notes: V-1: 40 feet from the center of the northbound tracks and 25 feet from the center of the southbound tracks.
V-2: 75 feet from the center of the northbound tracks and 55 feet from the center of the southbound tracks.
RMS – root-mean-square

FIGURE 1 Noise Measurement Locations

GENERAL PLAN CONSISTENCY ANALYSIS

The impacts of site constraints such as exposure of the proposed project to excessive levels of noise and vibration are not considered under CEQA. This section addresses Noise and Land Use Compatibility for consistency with the policies set forth in the City's General Plan. This section also addresses the compatibility of the project with regard to vibration thresholds established by the Federal Transit Administration.

Noise and Land Use Compatibility

The applicable General Plan policies were presented in detail in the Regulatory Background section and are summarized below for the proposed project:

- The City's "normally acceptable" exterior noise level objective is 60 dBA L_{dn} or less for residential uses. The "conditionally acceptable" exterior noise limit is 75 dBA L_{dn} or less.

- The City's "normally acceptable" exterior noise level objective is 70 dBA L_{dn} for office or commercial uses. The "conditionally acceptable" exterior noise limit is 80 dBA L_{dn}.

- The City's standard for interior noise levels in residences is 45 dBA L_{dn}.

- The Cal Green Code standards specify an interior noise environment attributable to exterior sources not to exceed an hourly equivalent noise level ($L_{eq\ (1\text{-}hr)}$) of 50 dBA in occupied areas of non-residential uses during any hour of operation.

Future Noise Environment

Future exterior noise levels for were calculated based on the results of the noise monitoring survey and considering the traffic noise increases anticipated under future conditions. Traffic volumes provided in the Traffic Impact Study[1] have been used to compare existing traffic volumes, future traffic volumes due to background projects and cumulative traffic volumes including trips attributable to proposed projects.

Interior noise levels would vary depending upon the design of the buildings (relative window area to wall area) and the selected construction materials and methods. Standard residential construction provides approximately 15 dBA of exterior-to-interior noise reduction, assuming the windows are partially open for ventilation. Standard new residential construction with windows closed provides approximately 25 dBA of noise reduction in interior spaces. Standard new commercial construction with windows closed provides approximately 25 to 30 dBA of noise reduction to interior spaces.

[1] Cityline Sunnyvale: Final Transportation Impact Analysis; *Fehr and Peers*, March 19, 2019.

100 Altair Way

100 Altair Way proposes a 7-story office building. The primary noise source at the 100 Altair Way site will continue to be local and distant vehicular traffic and train activities (see ST-2 and ST-3). Future traffic noise levels are anticipated to increase by 2 dBA under Cumulative + Project Conditions.

Outdoor areas of the proposed office building include a balcony on Level 4 and a rooftop terrace which would be exposed to exterior noise levels reaching 61 dBA L_{dn}. This level is below the normally acceptable exterior noise limit of 70 dBA L_{dn} for office and commercial buildings.

The west façade of proposed office building, facing Aries Way and South Mathilda Avenue, would be exposed to noise levels up to 66 dBA L_{dn} under future cumulative conditions, with worst-hour noise levels as high as 65 dBA $L_{eq\text{-}1hr}$. All other facades would be exposed to noise levels up to 61 dBA L_{dn} and 60 dBA $L_{eq\text{-}1hr}$. Assuming standard construction materials with windows partially open for ventilation, interior levels would be up to 50 dBA $L_{eq\text{-}1hr}$ inside offices facing Aries Way and 45 dBA $L_{eq\text{-}1hr}$ inside other exterior facing offices. The interior levels would comply with Cal Green Code noise limit of 50 dBA $L_{eq\text{-}1hr}$ for non-residential interior spaces. Forced air mechanical ventilation would further reduce interior noise by 10 to 15 dBA and provide occupants the option keeping windows closed.

300 Mathilda Avenue

300 Mathilda proposes a 5-story office and commercial building. The primary noise source at the 300 Mathilda Avenue site would continue to be vehicular traffic on South Mathilda Avenue and West McKinley Avenue (see LT-5 and ST-5). Based on site plans[2] dated September 2018, there are no outdoor use areas proposed for this site.

The west facing façade of the building, adjacent to South Mathilda Avenue, would be exposed to exterior noise levels reaching 69 dBA L_{dn} under future traffic conditions and 70 dBA $L_{eq\text{-}1hr}$. The north façade, fronting West McKinley Avenue, would be exposed to exterior noise levels up to 60 dBA L_{dn} and 61 dBA $L_{eq\text{-}1hr}$. With standard construction and windows open, interior noise levels would be up to 55 dBA $L_{eq\text{-}1hr}$ inside western facing offices and 46 dBA $L_{eq\text{-}1hr}$ in northern facing offices. With the inclusion of forced-air mechanical ventilation, allowing occupants the option of keeping windows closed to control noise, noise levels would be 10 to 15 dBA lower. Interior noise levels would comply with the Cal Green Code noise limit of 50 dBA $L_{eq\text{-}1hr}$ for non-residential use interior spaces assuming the windows are closed.

Recommended Conditions of Approval

For consistency with the General Plan, the following Conditions of Approval are recommended for consideration by the City for 300 Mathilda Avenue:

[2] Cityline Sub-block 1B site plans, *Gensler*, September 10, 2018.

- Provide a suitable form of forced-air mechanical ventilation, as determined by the local building official, for all western facing offices at 300 Mathilda Avenue, so that windows can be kept closed to control noise.

300 West Washington Avenue

The project proposes to increase the number of residential units from 50 to 51 units. The project does not propose any additional outdoor use areas for the site. Noise and land use compatibility of the site was already evaluated and would not change with the project amendments.

Macy's and Redwood Square

The Macy's and Redwood Square site proposes two seven story commercial/office buildings and two ten-story mixed use buildings for commercial and residential uses. The primary noise sources at the site would be vehicular traffic on West Washington Avenue (See LT-3) and West McKinley Avenue (See ST-5).

Outdoor areas associated with the commercial/office uses would include decks on Level 2 of Buildings 3B West and 3B East[3], located on the northern portion of the site and perpendicular to West Washington Avenue. Considering a future traffic noise increase of 3 dBA due to traffic volumes on West Washington Avenue, outdoor areas of both buildings would be exposed to exterior noise levels reaching 63 dBA L_{dn}, which would be below the normally acceptable exterior noise limit of 70 dBA L_{dn}. A beer garden and associated outdoor seating area, proposed in the southern portion of the site, would be exposed to an exterior noise levels as high as 65 dBA L_{dn}. There are no criteria specific to outdoor restaurant use; however, noise levels would be below the commercial/office criteria of 70 dBA L_{dn}.

Residential outdoor use areas would include terrace lounges, patios, and accessible roof areas on Level 2 of Buildings 1 and 2, located in the southern portion of the site[4]. The residential outdoor use areas would be located in the interior of the southern portion of the site and well shielded from the surrounding traffic noise sources. Noise levels in these areas would be below 60 dBA L_{dn} and would be considered compatible with the proposed residential use.

The northern façade of the commercial/office buildings facing West Washington Avenue would be exposed to noise levels up to 63 dBA L_{dn} and 65 dBA $L_{eq\text{-}1hr}$. Resulting interior levels with standard construction and windows partially open for ventilation would be up to 50 dBA $L_{eq\text{-}1hr}$. The proposed building would comply with Cal Green Code interior noise limit of 50 dBA $L_{eq\text{-}1hr}$ for non-residential use.

Residential units with façades adjacent to and fronting West McKinley Avenue would be exposed to exterior noise levels as high as 63 dBA L_{dn}. With windows partially open for ventilation, these residences would be exposed to interior noise levels as high as 47 dBA L_{dn}, which would exceed the City's interior limit of 45 dBA L_{dn}. With the inclusion of forced-air mechanical ventilation,

[3] Cityline Sub-block 3B site plans, *Gensler*, September 10, 2018.

[4] Cityline Sub-block 3A Pre-Application Planning Submittal, *Heller Manus Architects*, September 18, 2018.

allowing occupants the option of keeping windows closed to control noise, noise levels would be about 10 dBA lower and would comply with the City's interior limit for residence

Recommended Conditions of Approval

For consistency with the General Plan, the following Conditions of Approval are recommended for consideration by the City for Macy's and Redwood Square:

- Provide a suitable form of forced-air mechanical ventilation, as determined by the local building official, for all residential units proposed at the Macy's and Redwood Square site, so that windows can be kept closed to control noise indoors.

Sub-block 6

Sub-block 6 proposes a seven-story mixed use building for commercial and residential use. The primary noise source at Sub-block 6 would be vehicular traffic on West Washington Avenue, South Sunnyvale Avenue, and West McKinley Avenue (see LT-3, LT-4, and ST-5). Future traffic noise levels under Cumulative Plus Project conditions are anticipated to increase by 2 to 3 dBA over existing noise levels on these roadways.

Based on the site plans[5], residential outdoor use areas would include three central courtyards which are anticipated to include a pool, outdoor BBQ grills, gardens, landscaped areas, and seating areas. There are no outdoor use areas proposed for the commercial uses. The residential outdoor use areas would be in the interior of the site and well shielded from the surrounding traffic noise sources by the proposed building. Noise levels in these areas would be below 60 dBA L_{dn} and would be considered compatible with the proposed residential use.

Residential interior uses would include ground and second level townhomes and apartments located on Levels 3 through 7. North, east, south and west facing residential façades would be exposed to noise levels of 63, 66, 63, and 60 dBA L_{dn}, respectively. With windows partially open for ventilation, these residences would be exposed to interior noise levels as high as 51 dBA L_{dn}, which would exceed the City's interior limit of 45 dBA L_{dn}. With the inclusion of forced-air mechanical ventilation, allowing occupants the option of keeping windows closed to control noise, noise levels would be about 10 dBA lower and would comply with the City's interior noise limit for residences.

Retail uses would be located on the ground floor facing South Murphy Avenue. North, south, and west facing retail façades would be exposed to exterior noise levels of 65, 65, and 61 dBA $L_{eq\text{-}1hr}$, respectively. Resulting interior levels with standard construction and windows partially open for ventilation would be up to 50 dBA $L_{eq\text{-}1hr}$ and would comply with the Cal Green Code noise limit of 50 dBA $L_{eq\text{-}1hr}$.

Recommended Conditions of Approval

For consistency with the General Plan, the following Conditions of Approval are recommended for consideration by the City for Sub-block 6:

[5] Cityline Sub-bock 6 concept design, *Ankrom Moisan Architects*, Inc., June 19, 2018

- Provide a suitable form of forced-air mechanical ventilation, as determined by the local building official, for all residential units proposed at the Sub-block 6 site, so that windows can be kept closed to control noise.

Murphy Square

The Murphy Square site proposes a four-story office building. The primary noise source at the Murphy Square site would be train operations on the adjacent tracks and vehicular traffic on West Evelyn Avenue (see LT-1, LT-2, and ST-1). Outdoor deck areas are proposed for the 3rd and 4th floors and on the rooftop.[6]

The proposed building would be setback 30 feet from the center of the near southbound tracks and 45 feet from the center of the northbound tracks. Decks are proposed on the northeastern and southwestern corners of the 3rd floors of the building and the southern and eastern façades of the 4th floor. The rooftop deck is proposed along the eastern and southern portions of the building's rooftop. Noise levels at the exterior use areas are summarized in Table 8. A range in noise levels is given, dependent on the frequency and timing of train events (see Existing Environment Section).

TABLE 8 Calculated Future L_{dn} Noise Levels at Proposed Exterior Use Areas

Floor	Location	Calculated L_{dn}, dBA No Mitigation
3rd Floor	Deck facing Northeast	78 to 84
	Deck facing South	67 to 70
4th Floor	Deck facing East	76 to 82
	Deck facing South	67 to 70
Rooftop	Eastern Portion of Deck	76 to 82
	Southern Portion of Deck	67 to 70

Noise levels in the southwest facing 3rd floor deck, the south facing 4th floor deck, and the southern portion of the rooftop deck would meet the City's normally acceptable" exterior noise level objective of 70 dBA L_{dn} for office or commercial uses. It is not acoustically feasible to reduce exterior noise levels in northern or eastern facing decks to meet the City's 70 dBA L_{dn} exterior noise level objective. Alternate noise reduction strategies that would reduce day-night average noise levels to meet these noise level objectives include fully enclosing the outdoor use areas or redesigning the site plan to locate the outdoor use areas within the interior of the project building. This strategy allows the building itself to provide acoustical shielding from train noise to the outdoor areas.

Exterior noise levels at north facing office façades are calculated to be 78 to 84 dBA L_{dn}, depending on the daily train activity. Hourly average noise levels during daytime office hours range from 72 to 85 dBA $L_{eq\text{-}1hr}$. Maximum instantaneous noise levels produced by train warning whistles during passbys would typically be in the range of 85 to 100 dBA L_{max}. East and west facing offices would

[6] Murphy Square Office site plans, *Chang Architecture*, March 14, 2017.

be exposed to exterior noise levels of 69 to 82 dBA $L_{eq\text{-}1hr}$ and south facing offices would be exposed to exterior noise levels of 60 to 70 dBA $L_{eq\text{-}1hr}$.

With windows partially open for ventilation, north facing offices would be exposed to interior noise levels as high as 70 dBA $L_{eq\text{-}1hr}$, which would exceed the Cal Green Code noise limit of 50 dBA $L_{eq\text{-}1hr}$ for non-residential use interior spaces by up to 20 dBA. With the inclusion of forced-air mechanical ventilation, allowing occupants the option of keeping windows closed to control noise, noise levels would be 10 to 15 dBA lower and would still exceed the Cal Green Code.

Based on preliminary calculations and assuming a window to wall ratio of 40%, the following construction methods would be required to reduce interior noise levels in offices to meet the Cal Green Code threshold:

- Provide a suitable form of forced-air mechanical ventilation, as determined by the local building official, for all offices, so that windows can be kept closed to control noise.

- For offices with east and west facing façades, a combination of forced-air mechanical ventilation and sound-rated construction methods (typically windows with STC 30 to 40) would be required to meet the Cal Green Code.

- For north facing offices, the construction materials and techniques necessary to reduce interior noise levels to acceptable levels become more expensive and difficult to implement. Noise insulation features such as stucco-sided staggered-stud walls and high STC-rated windows and doors (STC 36 to 42) would likely be required. Units would also need to be equipped with a full heating and air-conditioning system because it is unlikely occupants would open their windows for ventilation.

Recommended Conditions of Approval

For consistency with the General Plan, the following Conditions of Approval are recommended for consideration by the City for Murphy Square:

- When refining the project's site plan, locate common outdoor areas away from adjacent noise sources and continue to shield noise-sensitive outdoor spaces with buildings or noise barriers where feasible.

- Project-specific acoustical analyses are required to confirm that interior noise levels in offices will be reduced to 50 dBA $L_{eq\text{-}1hr}$. The specific determination of what treatments are necessary will be conducted on a unit-by-unit basis. Results of the analysis, including the description of the necessary noise control treatments, will be submitted to the City along with the building plans and approved prior to issuance of a building permit.

- Building sound insulation requirements would need to include the provision of forced-air mechanical ventilation throughout the site so that windows could be kept closed at the occupant's discretion to control noise.

- Special building techniques (e.g., sound-rated windows and building facade treatments) may be required to maintain interior noise levels at or below acceptable levels. These treatments would include, but are not limited to, sound rated windows and doors, sound rated wall constructions, acoustical caulking, protected ventilation openings, etc. Preliminary calculations indicate that offices would require sound rated windows and doors with ratings ranging from STC 30 to 42 to assure that the 50 dBA L_{eq} indoor standard is met.

Vibration and Land Use Compatibility – Murphy Square

Of the six project sites, only the Murphy Square site would be located within 300 feet of any major source of groundborne vibration. Murphy Square is located 30 feet from the center of the near southbound Caltrain tracks and 45 feet from the center of the northbound tracks. The FTA has developed vibration impact assessment criteria for evaluating vibration impacts associated with transit projects (see Table 5). Approximately 92 Caltrain currently pass the site daily. Given the frequency of train events at the site, the Category 3 'frequent event' impact level of 75 VdB would be appropriate for Murphy Square, which is a commercial project and would be anticipated to have primarily daytime usage.

As described in the Setting Section of this report, vibration levels from measured trains ranged from approximately 71 to 91 VdB at V-1 and 68 to 88 VdB at V-2, with an average train vibration level of 79 VdB at V-1 and 77 VdB at V-2. Of the eight trains measured, six train events exceeded the "occasional event" limit of 75 VdB at both setbacks.

Recommended Measures to Ensure Vibration and Land Use Compatibility

For consistency with the General Plan, the following Conditions of Approval are recommended for consideration by the City for Murphy Square:

- The project applicant shall submit a Vibration Reduction Plan prepared by a qualified acoustical consultant for City review and approval that contains vibration reduction measures to reduce groundborne vibration to acceptable levels per FTA standards. Methods available to reduce vibration levels include, but are not limited to, the following:

    - Based on the adjustment factors provided by FTA[7] some vibration attenuation could be realized depending on the specific construction type of the building. In general, the heavier the building, the greater the coupling loss between the ground and the building.

    - Isolation of foundation and footings using resilient elements such as rubber bearing pads or springs, such as a "spring isolation" system that consists of resilient spring supports that can support the podium or residential foundations. The specific system shall be selected so that it can properly support the structural loads and provide adequate filtering of groundborne vibration to the residences above.

[7] See Tables 6-11, 6-12, and 6-13 of Transit Noise and Vibration Impact Assessment Manual, U.S. Department of Transportation Federal Transit Administration, September 2018.

- Trenching, which involves excavating soil between the railway and the project so that the vibration path is interrupted, thereby reducing the vibration levels before they enter the project's structures. Since the reduction in vibration level is based on a ratio between trench depth and vibration wavelength, additional measurements shall be conducted to determine the vibration wavelengths affecting the project. Based on the resulting measurement findings, an adequate trench depth and, if required, suitable fill shall be identified (such as foamed styrene packing pellets [i.e., Styrofoam] or low-density polyethylene).

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 resulting from the project:

1. **Temporary or Permanent Noise Increases in Excess of Established Standards.** A significant impact would be identified in the following cases:

    a. Operational Noise in Excess of Standards. A significant noise impact would be identified if the project operations would generate noise levels that exceeding applicable noise standards presented in the Sunnyvale General Plan or Municipal Code.

    b. Permanent Noise Increase. A significant permanent noise increase would occur if project traffic resulted in an increase of 3 dBA L_{dn} or greater at noise-sensitive land uses where existing or projected noise levels would equal or exceed the noise level considered satisfactory for the affected land use and/or an increase of 5 dBA L_{dn} or greater at noise-sensitive land uses where noise levels would continue to be below those considered satisfactory for the affected land use.

    c. Temporary Noise Increase. Hourly average noise levels exceeding 60 dBA L_{eq} at residential land uses or 70 dBA L_{eq} at commercial land uses, and the ambient by at least 5 dBA L_{eq}, for a period of more than one year would constitute a significant temporary noise increase.

2. **Generation of Excessive Groundborne Vibration.** A significant impact would be identified if the construction of the project would exceed 0.3 in/sec PPV at buildings of conventional construction or 0.25 in/sec PPV at historic buildings in the vicinity of the project.

3. **Exposure to Excessive Aircraft Noise.** The Santa Clara County ALUC has jurisdiction over new land uses in the vicinity of airports and establishes 65 dBA CNEL as the maximum allowable exterior noise level considered compatible with residential uses and 45 dBA CNEL as the maximum allowable interior level for residences.

Impact 1: **Temporary or Permanent Noise Increases in Excess of Established Standards.** The project would not result in a substantial permanent traffic noise level increase at existing noise-sensitive land uses in the project vicinity. However, on-site operational noise could exceed City limits and existing noise-sensitive land uses would be exposed to construction noise levels in excess of the temporary noise increase significance thresholds for a period of more than one year. **This is a potentially significant impact.**

a) Permanent Noise from On-Site Operational Noise

Noise generating on-site operational components of the project would include mechanical equipment and parking lot activities. The City's Municipal Code limits operational noise to 75 dBA at any point on the property line of the premises upon which the noise or sound is generated or produced, provided that the noise or sound level shall not exceed 50 dBA during nighttime or 60 dBA during daytime hours at any point on adjacent residentially zoned property.

Mechanical Equipment

Residential, commercial office, and retail buildings typically include various mechanical equipment such as air conditioners, exhaust fans, chillers, pumps, and air handling equipment. Generators are also proposed. The most substantial noise-generating equipment would be exhaust fans and building air conditioning units. Equipment, such as the air conditioning units, located inside or in a fully enclosed room with a roof would not be anticipated to be audible at off-site locations. Project specific mechanical equipment information was not available at the time of this study. Typical rooftop equipment is anticipated to generate noise levels of 50 to 60 dBA at 50 feet from the equipment, depending on the equipment selected. Shielding from equipment enclosures and surrounding structures would provide 10 to 15 dBA of reduction. Emergency generator use would be exempt from the noise limits, provided that testing is conducted during daytime hours.

100 Altair Way: Mechanical equipment and a 150 kW emergency generator are proposed on the southern portion of the building rooftop, approximately 100 feet above ground level. A 10-foot-high screen wall would be provided. Residential property lines would be located as close as 20 feet from the proposed building with adjacent residential patios located about 40 feet from the building edge. Without consideration of enclosures or barriers, rooftop mechanical equipment is anticipated to produce noise levels ranging from 56 to 66 dBA L_{eq} at the residential property line to the south and from 51 to 61 dBA L_{eq} at the building façade. This would exceed the 50 dBA L_{eq} nighttime threshold for operational noise. Assuming the screen wall is constructed from solid materials with no gaps at the face or the base of the barrier, noise levels would be about 15 dBA lower and would be anticipated to meet the 50 dBA L_{eq} nighttime threshold.

300 Mathilda Avenue: Mechanical equipment and a 100 kW emergency generator are proposed on the western portion of the building rooftop, adjacent to Mathilda Avenue. The nearest residential property line is approximately 140 feet from the western edge of the proposed building. At this distance, the mechanical equipment is anticipated to produce noise levels ranging from 41 to 51 dBA L_{eq}, not considering any shielding provided by the

rooftop or any parapet or screen walls. This could exceed the 50 dBA L_{eq} nighttime threshold for operational noise.

300 West Washington Avenue: This site is currently under construction and the project would not affect the operational noise levels at nearby sensitive receptors.

Macy's and Redwood Square: Two 150 kW emergency generators would be installed on the south side of the Macy's site buildings and a 1000kW emergency generator would be placed on the northern side of the roof of the buildings proposed at the Redwood Square site. Mechanical equipment would be located behind a 3.5-foot-high parapet wall on the Macy's site buildings and inside a 'mechanical penthouse' on the Redwood Square site buildings. Residences are located about 75 feet to the north and west of the Macy's site. In addition, the project proposes to construct residences 50 feet to the east (Sub-block 6). As the location of the rooftop equipment is unknown at this time, a worst-case analysis assumes the equipment would be located at the rooftop edge adjacent to shared property lines. At a distance of 50 feet, mechanical equipment would be anticipated to generate a noise level of 50 to 60 dBA L_{eq}. At 75 feet, mechanical equipment would generate noise levels of 46 to 56 dBA L_{eq}. This could exceed the 50 dBA L_{eq} nighttime threshold for operational noise. Shielding from equipment enclosures and surrounding structures would provide 10 to 15 dBA of reduction.

Sub-block 6: Rooftop mechanical equipment is proposed; however, the location and specifications of the equipment is unknown at this time. Residences are located about 100 feet to the east, across South Sunnyvale Avenue. At a distance of 100 feet, rooftop mechanical equipment is anticipated to produce noise levels ranging from 44 to 54 dBA L_{eq}. This operational noise level could exceed the 50 dBA L_{eq} nighttime threshold. Shielding from equipment enclosures and surrounding structures would provide 10 to 15 dBA of reduction.

Murphy Square: A 450 kW emergency generator is proposed in an enclosure at the northwest corner of the site. Rooftop mechanical equipment is proposed behind a 10-foot high mechanical equipment screen. Residences are located 100 feet to the east. Not taking shielding from the screen wall into account, noise levels at 100 feet would be 44 to 54 dBA L_{eq}. Assuming the screen wall is constructed from solid materials with no gaps at the face or the base of the screen wall, noise levels would be about 15 dBA lower and would be anticipated to meet the 50 dBA L_{eq} nighttime threshold.

Emergency generators would only operate during power outages and during periodic testing and maintenance. Noise produced by these generators would be exempt from the City's operational noise thresholds, provided all testing and maintenance is carried out during daytime hours. Mechanical equipment could potentially exceed the City's Municipal Code limits at adjacent residential land uses. Mechanical equipment located 150 feet or further from residential property lines or in shielded areas would be anticipated to meet the 50 dBA L_{eq} limit. This is a **potentially significant** impact.

Inclusion of **Mitigation Measure 1a** would reduce this impact to less-than-significant level.

Mitigation Measure 1a: Prior to the issuance of building permits, mechanical equipment shall be selected and designed to reduce impacts on surrounding uses to meet the City's requirements. A qualified acoustical consultant shall be retained by the project applicant to review mechanical noise as the equipment systems are selected in order to determine specific noise reduction measures necessary to reduce noise to comply with the City's 50 dBA L_{eq} residential noise limit at the shared property lines. Noise reduction measures could include, but are not limited to, selection of equipment that emits low noise levels and/or installation of noise barriers such as enclosures and parapet walls to block the line of sight between the noise source and the nearest receptors.

Parking Lots

All proposed development would have underground parking facilities. Noise generated from parking lots enclosed by building structures would not be audible outside the buildings. In addition to underground parking, the developments at 300 Mathilda Avenue and Sub-block 6 would provide surface parking. Noise sources associated with the use of the surface parking lots would include vehicular circulation, louder engines, car alarms, squealing tires, door slams, and human voices. The typical sound of a passing car at 15 mph would be about 50 to 60 dBA L_{max} at a distance of 50 feet. The noise of an engine start is similar. Door slams typically produce noise levels lower than engine starts. The hourly average noise level resulting from all these noise-generating activities in a small parking lot would reach 40 dBA L_{eq} at a distance of 50 feet from the parking area.

> 300 Mathilda Avenue:
> The surface parking lot of 300 Mathilda Avenue would be located south of the proposed building and east of the circular building belonging to Bank of West. The nearest residential use building would be located 150 feet southeast of the parking lot. These residences would experience hourly average noise levels of 30 dBA L_{eq} from parking activities. Maximum noise levels would range from about 42 to 50 dBA L_{max}. Parking lot activity noise at 300 Mathilda Avenue would not exceed the City's nighttime 50 dBA L_{eq} limit at residences.
>
> Sub-block 6:
> The podium-level parking proposed at Sub-block 6 development would be capped by the podium structure and surrounded by four levels of residential units. The noise from parking activities will not be audible at the property lines.

Parking lot activities are not anticipated to exceed the City's daytime or nighttime noise limits at any land uses surrounding the project sites. This is a **less-than-significant** impact.

b) Permanent Noise Increases from Project Traffic

A significant permanent noise increase would occur if traffic or activities generated by the project would substantially increase noise levels at sensitive receptors in the project vicinity. A substantial increase would occur if: a) the noise level increase is 5 dBA L_{dn} or greater, with a future noise

level of less than 60 dBA L_{dn}, or b) the noise level increase is 3 dBA L_{dn} or greater, with a future noise level of 60 dBA L_{dn} or greater.

Traffic data provided by the project's traffic study[1] was reviewed to calculate potential traffic noise level increases attributable to the project expected along roadways serving the site. Traffic volumes under Existing and Existing Plus Project scenarios were compared to calculate the traffic noise increases for every project.

Based on this analysis, a project generated traffic noise increase of 3 to 5 dBA would be anticipated along West McKinley Avenue between South Mathilda Avenue and South Sunnyvale Avenue. There are no existing noise sensitive uses along this roadway segment; however, residences are currently under construction on both sides of West McKinley Avenue between South Taaffe Avenue and the extension of Ares Way. These residences would experience a 3 dBA traffic noise increase attributable to the project. Since these residences are being constructed under the Downtown Specific Plan (DSP), it is anticipated that they take future traffic conditions along West McKinley Avenue into account. Based on the results of the noise monitoring survey and Cumulative + Project traffic conditions, the West McKinley Avenue facing façades of these buildings would be exposed to future exterior noise levels of 63 dBA L_{dn}. These residences have been designed with the inclusion of forced-air mechanical ventilation, allowing occupants the option of keeping windows closed to control noise. As a result, interior noise levels in these residences would comply with the City's interior noise limit. This is a **less-than-significant** impact.

Noise increases of 0 to 2 dBA are anticipated along all other roadways in the network. These increases would not typically be noticeable and would be below the 3 dBA L_{dn} thresholds of significance. This is a **less-than-significant** impact.

c) Temporary Noise Increases from Project Construction

The City's Municipal Code limits construction to between the hours of 7:00 am and 6:00 pm Monday through Friday and between 8:00 am and 5:00 pm on Saturdays. No construction activity is allowed on Sundays or federal holidays when city offices are closed. Air compressors without mufflers and continuously running motors or generators are prohibited.

Neither the City of Sunnyvale nor the State of California specify quantitative thresholds for the impact of temporary increases in noise due to construction. The threshold for speech interference indoors is 45 dBA (see Setting Section, Effects of Noise). Assuming a 15 dB exterior-to-interior reduction for standard residential construction with windows open and a 25 dB exterior-to-interior reduction for standard commercial construction, assuming windows closed, this would correlate to an exterior threshold of 60 dBA L_{eq} at residential land uses and 70 dBA L_{eq} at commercial land uses. Therefore, the project would be considered to generate a significant temporary construction noise impact if project construction activities exceeded 60 dBA L_{eq} at nearby residences or exceeded 70 dBA L_{eq} at nearby commercial land uses and exceeded the ambient noise environment by 5 dBA L_{eq} or more for a period longer than one year.

Construction noise would generally be localized to the area surrounding each individual project. 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.

Construction activities for each project would be carried out in stages. During each stage of construction, there would be a different mix of equipment operating, and noise levels would vary by stage and vary within stages, based on the amount of equipment in operation and the location at which the equipment is operating. Typical construction noise levels at a distance of 50 feet are shown in Tables 9 and 10. Table 9 shows the average noise level ranges, by construction phase and Table 10 shows the maximum noise level ranges for different construction equipment. Most demolition and construction noise falls with the range of 80 to 90 dBA at a distance of 50 feet from the source. 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.

Source: Mitigation of Nighttime Construction Noise, Vibrations and Other Nuisances, National Cooperative Highway Research Program, 1999.

100 Altair Way: Project construction for 100 Altair Way would take place over a total period of 27 months and would include demolition, site preparation, grading and excavation, trenching, building construction, and paving. The noisiest periods of construction would include demolition and site work (site preparation, grading and excavation, trenching, and paving) and would occur over a total period of about 8 months. Building construction generally results in much lower noise levels.

As shown in Tables 9 and 10, construction activities generate considerable amounts of noise, especially during demolition and earth-moving activities when heavy equipment is used. Table 11 shows the anticipated project specific construction noise levels calculated for 100 Altair Way using the Federal Highway Administration (FHWA) software - Roadway Construction Noise Model (RCNM). At 50 feet from the noise source, maximum instantaneous noise levels generated by 100 Altair Way project construction equipment are calculated to range from 78 to 90 dBA L_{max} and hourly average noise levels are calculated to range from 74 to 87 dBA L_{eq}.

TABLE 11 Calculated Construction Noise Levels for 100 Altair Way

Construction Phase	At Distance of 50 ft.	
	L_{eq}, dBA	**L_{max}, dBA**
Demolition	87	90
Site Preparation	83	85
Grading/Excavation	80	81
Trenching	77	78
Building – Exterior	81	81
Building – Interior	74	78
Paving	80	80

Noise sensitive uses surrounding the site include the Loft House Apartment buildings, located 45 feet south and 60 feet southeast of the project site, and an office building at 150 Mathilda Place, located 45 feet to the west. At a distance of 45 feet, construction noise levels would typically be in the range of 75 to 84 dBA L_{eq}, with use of concrete or industrial saws during demolition generating noise levels of about 88 dBA L_{eq}. At 60 feet, construction noise levels would typically be in the range of 72 to 81 dBA L_{eq}, with use of concrete or industrial saws during demolition generating noise levels of about 85 dBA L_{eq}.

300 Mathilda Avenue: Construction for 300 Mathilda Avenue would take place over a total period of 21 months and would include demolition, site preparation, grading and excavation, trenching, building construction, and paving. Table 12 shows the anticipated project specific construction noise levels calculated for 300 Mathilda Avenue using RCNM. At 50 feet from the noise source, maximum instantaneous noise levels generated by project construction equipment are calculated to range from 78 to 90 dBA L_{max} and hourly average noise levels are calculated to range from 74 to 85 dBA L_{eq}.

TABLE 12 Calculated Construction Noise Levels for 300 Mathilda Avenue

Construction Phase	At Distance of 50 ft.	
	L_{eq}, dBA	L_{max}, dBA
Demolition	85	90
Site Preparation	83	85
Grading/Excavation	88	88
Trenching	82	82
Building – Exterior	81	81
Building – Interior	74	78
Paving	82	82

The nearest noise sensitive uses to the 300 Mathilda Avenue site are residences located 150 feet to the west and the Bank of West building located 40 feet to the south. At a distance of 40 feet, construction noise levels would be in the range of 76 to 90 dBA L_{eq}. At 150 feet, construction noise levels would be in the range of 64 to 78 dBA L_{eq}.

300 West Washington Avenue: This site is currently under construction and the project would not affect the construction noise impacts at nearby sensitive receptors.

Macy's/ Redwood Square: Project construction for the Macy's and Redwood Square site would take place over a total period of 43 months and would include demolition, site preparation, grading and excavation, trenching, building construction, and paving. The noisiest periods of construction would include demolition and grading and excavation and would occur over a total period of about 10 months.

Table 13 shows the anticipated project specific construction noise levels calculated for Macy's and Redwood Square using RCNM. At 50 feet from the noise source, maximum instantaneous and hourly average noise levels generated by project construction equipment are calculated to range from 80 to 90 dBA L_{max}/L_{eq}.

TABLE 13 Calculated Construction Noise Levels for Macy's & Redwood Square

Construction Phase	At Distance of 50 ft.	
	L_{eq}, dBA	L_{max}, dBA
Demolition	90	90
Site Preparation	85	85
Grading/Excavation	90	90
Trenching	82	82
Building – Exterior	86	86
Building – Interior	80	80
Paving	82	82

Noise sensitive uses surrounding the Macy's and Redwood Square site include residential and restaurant buildings located 75 feet north and 75 feet west of the site. At a distance of 75 feet, construction noise levels would be in the range of 76 to 86 dBA L_{eq}.

Sub-block 6: Sub-block 6 construction would take place over a total period of 38 months. Table 14 shows the anticipated project specific construction noise levels calculated for Sub-block 6 construction using RCNM. At 50 feet from the noise source, maximum instantaneous and hourly average noise levels generated by project construction equipment are calculated to range from 80 to 90 dBA L_{max}/L_{eq}.

TABLE 14 Calculated Construction Noise Levels for Sub-block 6

Construction Phase	At Distance of 50 ft.	
	L_{eq}, dBA	**L_{max}, dBA**
Demolition	88	90
Site Preparation	86	86
Grading/Excavation	90	90
Trenching	82	82
Building – Exterior	86	86
Building – Interior	80	80
Paving	80	80

Noise sensitive uses surrounding the Sub-block 6 site include a residential building 100 feet to the east and commercial uses located 75 feet to the north. At a distance of 75 feet, construction noise levels would be in the range of 76 to 86 dBA L_{eq}. At 100 feet, construction noise levels would be in the range of 74 to 84 dBA L_{eq}.

Murphy Square: Construction of Murphy Square would take place over a period of 20 months. Table 15 shows the anticipated project specific construction noise levels calculated for Macy's and Redwood Square using RCNM. At 50 feet from the noise source, maximum instantaneous and hourly average noise levels generated by project construction equipment are calculated to range from 78 to 85 dBA L_{max} and hourly average noise levels are calculated to range from 74 to 83 dBA L_{eq}.

TABLE 15 Calculated Construction Noise Levels for Murphy Square

Construction Phase	At Distance of 50 ft.	
	L_{eq}, dBA	**L_{max}, dBA**
Demolition	81	82
Site Preparation	83	85
Grading/Excavation	81	82
Trenching	81	78
Building – Exterior	81	78
Building – Interior	74	78
Paving	77	80

Noise sensitive uses surrounding the Murphy Square site include an office building located 40 feet west and a residential building located 100 feet to the east. At a distance of 40 feet, construction noise levels would be in the range of 76 to 85 dBA L_{eq}. At a distance of 100 feet, construction noise levels would be in the range of 68 to 77 dBA L_{eq}.

Construction would comply with the City of Sunnyvale's Municipal Code specified hours of construction. However, noise levels due to construction activities at noise sensitive areas surrounding all project construction would exceed 60 dBA L_{eq} at residences and 70 dBA L_{eq} at commercial areas and the ambient noise environment by 5 dBA L_{eq} for a period more than one year. Noise levels would be lower as construction moved away from shared property lines or into shielded areas. This is a **potentially significant** temporary impact.

Implementation of **Mitigation Measure 1c** would reduce this impact, but construction noise levels would continue to exceed the appropriate thresholds for a period greater than one year.

Mitigation Measure 1c: The following site-specific noise attenuation measures shall be employed during construction to reduce the generation of construction noise and vibration. These measures shall be included in a Noise Control Plan that shall be submitted for review and approval by the City. Measures specified in the Noise Control Plan and implemented during construction shall include, at a minimum, the following noise control strategies:

- Equipment and trucks used for construction shall use the best available noise control techniques (e.g., improved mufflers, equipment redesign, use of intake silencers, ducts, engine enclosures, and acoustically attenuating shields or shrouds);

- Impact tools (e.g., jackhammers, pavement breakers, and rock drills) used for construction shall be hydraulically or electrically powered wherever possible to avoid noise associated with compressed air exhaust from pneumatically powered tools; and

- Stationary noise sources shall be located as far from adjacent receptors as possible, and they shall be muffled and enclosed within temporary sheds, incorporate insulation barriers, or include other measures.

Additionally, the construction crew shall adhere to the following construction best management practices to reduce construction noise levels emanating from the site and minimize disruption and annoyance at existing noise-sensitive receptors in the project vicinity.

Construction Best Management Practices

Include the following controls in the Noise Control Plan:

- Construct temporary noise barriers, where feasible, to screen stationary noise-generating equipment. Temporary noise barrier fences would provide a 5 dBA noise reduction if the noise barrier interrupts the line-of-sight between the noise source and receptor and if the barrier is constructed in a manner that eliminates any cracks or gaps.

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

- 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. Locate material stockpiles, as well

as maintenance/equipment staging and parking areas, as far as feasible from residential receptors.

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

- Where feasible, temporary power service from local utility companies should be used instead of portable generators.

- Locate cranes as far from adjoining noise-sensitive receptors as possible.

- During final grading, substitute graders for bulldozers, where feasible. Wheeled heavy equipment are quieter than track equipment and should be used where feasible.

- Substitute nail guns for manual hammering, where feasible.

- Avoid the use of circular saws, miter/chop saws, and radial arm saws near the adjoining noise-sensitive receptors. Where feasible, shield saws with a solid screen with material having a minimum surface density of 2 lbs/ft^2 (e.g., such as ¾" plywood).

- Maintain smooth vehicle pathways for trucks and equipment accessing the site, and avoid local residential neighborhoods as much as possible.

- During interior construction, the exterior windows facing noise-sensitive receptors should be closed.

- During interior construction, locate noise-generating equipment within the building to break the line-of-sight to the adjoining receptors.

- The contractor shall prepare a detailed construction schedule for major noise-generating construction activities. The construction plan shall identify a procedure for coordination with adjacent residential land uses 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.

The implementation of the reasonable and feasible controls outlined above would reduce construction noise levels emanating from the site, minimizing disruption and annoyance. However, even with the implementation of these controls, as well as the Municipal Code limits on allowable construction hours, construction noise levels would continue to exceed the appropriate limits at some locations for a period greater than one year. This is a **significant and unavoidable impact**.

Impact 2: **Generation of Excessive Groundborne Vibration due to Construction.** Construction-related vibration levels would not exceed 0.3 in/sec PPV at the nearest modern structures or 0.25 in/sec PPV at the nearest historic structures. **This is a less-than-significant impact.**

The City of Sunnyvale does not specify a construction vibration limit. For structural damage, the California Department of Transportation recommends a vibration limit of 0.5 in/sec PPV for buildings structurally sound and designed to modern engineering standards, 0.3 in/sec PPV for buildings that are found to be structurally sound but where structural damage is a major concern, and a conservative limit of 0.25 in/sec PPV for historic and some old buildings (see Table 3). The 0.3 in/sec PPV vibration limit would be applicable to modern structures in the vicinity of the project site and the 0.25 in/sec PPV vibration limit would be applicable to historic structures in the vicinity of the project site.

The construction of the project may generate perceptible vibration in the immediate vicinity when heavy equipment or impact tools (e.g. jackhammers, hoe rams) are used. Construction activities would include site demolition work, preparation work, excavation of below-grade levels, foundation work, and new building framing and finishing.

Table 16 presents typical vibration levels that could be expected from construction equipment at a distance of 25 feet, as given by FTA, and at distances of 50, 80, 100, and 125 feet, representative of the nearest structures to individual project construction. Project construction activities, such as the use of jackhammers, rock drills and other high-power or vibratory tools, and rolling stock equipment (tracked vehicles, compactors, etc.), may generate substantial vibration in the immediate vicinity. Vibration levels would vary depending on soil conditions, construction methods, and equipment used. Pile driving is not anticipated for project construction.

TABLE 16 Vibration Source Levels for Construction Equipment

Equipment		PPV at 25 ft. (in/sec)	PPV at 50 ft. (in/sec)	PPV at 80 ft. (in/sec)	PPV at 100 ft. (in/sec)	PPV at 125 ft. (in/sec)
Clam shovel drop		0.202	0.094	0.056	0.044	0.034
Hydromill (slurry wall)	in soil	0.008	0.004	0.002	0.002	0.001
	in rock	0.017	0.008	0.005	0.004	0.003
Vibratory Roller		0.210	0.098	0.058	0.046	0.036
Hoe Ram		0.089	0.042	0.025	0.019	0.015
Large bulldozer		0.089	0.042	0.025	0.019	0.015
Caisson drilling		0.089	0.042	0.025	0.019	0.015
Loaded trucks		0.076	0.035	0.021	0.017	0.013
Jackhammer		0.035	0.016	0.010	0.008	0.006
Small bulldozer		0.003	0.001	0.001	0.001	0.001

Source: Transit Noise and Vibration Impact Assessment Manual, U.S. Department of Transportation Federal Transit Administration, September 2018 as modified by Illingworth & Rodkin, Inc., April 2019.

Vibration levels at historical old structures within 25 feet from heavy construction and at conventionally built structures within 20 feet from heavy construction would exceed the appropriate threshold limits. Vibration impacts for individual project are discussed below.

100 Altair Way: The nearest structures from the 100 Altair Way site would be residential buildings located 45 feet to the south and 60 feet to the southeast. A commercial structure is located 45 feet to the west. Vibration levels at 45 feet and 60 feet would be up to 0.11 in/sec PPV and 0.08 in/sec PPV, respectively. These levels would be below the 0.3 in/sec PPV limit for structures of conventional construction. There are no historic structures in the vicinity of this site.

300 Mathilda Avenue: The nearest existing structures to the 300 Mathilda Avenue site are residences located 150 feet to the west and the Bank of West building located 40 feet to the south. A building is currently being constructed 35 feet to the east of the site. Vibration levels experienced at 35 feet, 40 feet, and 150 feet from the construction site would be 0.145 in/sec PPV, 0.125 in/sec PPV and 0.029 in/sec PPV, respectively. These levels would be below the 0.3 in/sec PPV limit for structures of conventional construction. There are no historic structures in the vicinity of this site.

300 West Washington Avenue: This project is currently under construction and the project would not affect the construction vibration impacts at nearby sensitive receptors.

Macy's and Redwood: Residential and restaurant buildings are located 75 feet north of the Macy's site and 75 feet west of the Redwood Square site. At 75 feet, existing structures would experience vibration levels up to 0.063 in/sec PPV. These levels would be below the 0.3 in/sec PPV limit for structures of conventional construction. The Murphy Station Heritage Landmark District, which contains buildings that were built in the early 1890's to 1930's, is located approximately 50 feet north of the Redwood Square site. At this distance, the nearest structure in the District would experience up to 0.098 in/sec PPV vibration levels. This would be below the 0.25 in/sec PPV vibration limit for historic structures.

Sub-block 6: The nearest existing structures to Sub-block 6 include a residential building located 100 feet to the east and a commercial building located 75 feet to the north. At 75 and 100 feet, existing structures would experience vibration levels up to 0.063 in/sec PPV and 0.046 in/sec PPV, respectively. These levels would be below the 0.3 in/sec PPV limit for structures of conventional construction. The nearest building of the Murphy Heritage Landmark District is the historic Stowell Spalding Building, located 75 feet north of the Sub-block 6 site. At this distance, vibration levels of up to 0.063 in/sec PPV could occur, which would be below the historic structure threshold of 0.25 in/sec PPV.

Murphy Square: The nearest existing structures to the Murphy Square site include an office building located 40 feet to the west and a residential building located 100 feet to the east. At distances of 40 and 100 feet, existing structures would experience vibration levels up to 0.125 in/sec PPV and 0.046 in/sec PPV, respectively. These levels would be below the 0.3 in/sec PPV limit for structures of conventional construction. The nearest building of the Murphy Heritage Landmark District is the Del Monte Building, located 80 feet southwest

from the Murphy Square site. The building has been identified as a historic structure and would experience up to 0.058 in/sec PPV. This would be below the historic structure threshold of 0.25 in/sec PPV.

Vibration levels may be perceptible to occupants of structures nearby heavy construction activities but would be below the 0.3 in/sec PPV vibration limit for conventional structures and 0.25 in/sec PPV vibration limit for historic structures. Construction vibration would not be anticipated to cause architectural or structural damage to the nearest buildings and would not be considered excessive at any of the construction sites. This is a **less-than-significant** impact.

Mitigation Measure 2: None required

FIGURE 2 Noise Contours for Moffett Federal Airfield[8]

[8] Comprehensive Land Use Plan, Moffett Federal Airfield, Walter B. Windus, PE, Amended November 18, 2016

Impact 3: **Exposure to Excessive Aircraft Noise.** The project site is located outside of the 65 dBA CNEL noise contour for Moffett Federal Airfield. **This is a less-than-significant impact.**

The project sites are located about 2 miles south of Moffett Federal Airfield and within the airport land use plan area. The Santa Clara County ALUC has jurisdiction over new land uses in the vicinity of airports and establishes 65 dBA CNEL as the maximum allowable exterior noise level considered compatible with residential uses and 45 dBA CNEL as the maximum allowable interior level for residences.

Figure 2 shows the 2022 Aircraft Noise Contours for Moffett Federal Airfield. As indicated in Figure 2, the project site would be outside of the 65 dBA CNEL noise contour for the airfield. By ensuring compliance with the City's normally acceptable noise level standards (see General Plan Consistency Section), interior noise levels would also be considered acceptable with aircraft noise. This is a **less-than-significant** impact.

Mitigation Measure 3: None required

Impact 4: **Cumulative Impacts.** Cumulative operational, traffic, and construction noise impacts would be the same as those described under project impacts. **This is a less-than-significant cumulative impact.**

Cumulative Noise from On-Site Operational Noise

Operational noise impacts would be localized to the immediate area surrounding each site. As described in Impact 1a, mechanical equipment located 150 feet or further from residential property lines or in shielded areas would be anticipated to meet the City's 50 dBA L_{eq} limit. There is one reasonably foreseeable project proposed within 300 feet of the project site; 311 South Mathilda Avenue, which is about 150 feet from the 300 Mathilda site. Based on the results of the noise monitoring survey (see LT-5), vehicular traffic along South Mathilda Avenue currently results in traffic noise levels of 71 to 73 dBA L_{dn} at 60 feet from the center of the roadway. Project operational noise, if in compliance with the City's Code limits, would not be discernable above noise levels generated by vehicular traffic along South Mathilda Avenue; therefore, the cumulative operational noise impacts would be identical to those discussed under Impact 1a. Implementation of **Mitigation Measure 1a** would reduce this impact to **less-than-significant** level.

Cumulative Noise Increases from Project Traffic

A significant cumulative traffic noise impact would be identified if noise levels at existing sensitive receivers would be substantially increased (i.e., 3 dBA L_{dn} above existing noise levels where noise levels would exceed 60 dBA L_{dn}) and if the project would make a "cumulatively considerable" contribution to the overall noise level increase. A "cumulatively considerable" contribution would be defined as an increase of 1 dBA L_{dn} or more attributable solely to the project.

Traffic volumes under Existing, Cumulative, and Cumulative Plus Project scenarios were compared to calculate the traffic noise increases anticipated along the surrounding roadway network. Based on this comparison, cumulative traffic noise increases of 3 dBA L_{dn} or greater with

a project contribution of 1 dBA or greater would be anticipated along West McKinley Avenue between South Mathilda Avenue and South Sunnyvale Avenue, West Iowa Avenue between South Mathilda Avenue and the entrance to the 300 Mathilda Avenue parking garage, and South Taaffe Street between West Washington Avenue and West McKinley Avenue. There are no existing residences along these roadway segments. As described under Impact 1b, residences currently under construction on both sides of West McKinley Avenue between South Taaffe Avenue and the extension of Ares Way have been designed to take future traffic conditions along West McKinley Avenue into account. Cumulative traffic noise impacts would be the same as those discussed under Impact 1b. This is a **less-than-significant** impact.

Cumulative Noise Increases from Project Construction

The construction timelines for many of the individual sites within the project would coincide. In addition, there are two approved projects located within 500 feet of the project site. These include a proposal to construct 15, 3-story townhomes at 220 Carroll Street and a proposal to redevelop 311 South Mathilda Avenue with a five-story mixed use building consisting of a ground level restaurant and 75 rental residential units. 220 Carroll Street is located about 410 feet east of Sub-block 6, with the three story Plaza de las Flores building providing considerable acoustical shielding between the two sites. 311 South Mathilda Avenue is located about 150 feet west of the 300 Mathilda Avenue site and is exposed to traffic noise from vehicles on South Mathilda Avenue. These projects would comply with the same policies and ordinances that are described in Impact 1c for this project.

When construction of adjacent properties coincides, temporary construction noise impacts can be increased if surrounding sensitive receptors are exposed to higher noise levels and/or increased duration of noise generating construction activities. Construction noise would generally be localized to the immediate area surrounding the individual project site and most of the projects are located such that they do not have common sensitive receptors; therefore, the cumulative construction noise impacts would be the same as those discussed under Impact 1c. Implementation of **Mitigation Measure 1c** would reduce this impact, but construction noise levels would continue to exceed the appropriate limits some locations for a period greater than one year. This is a **significant and unavoidable impact**.

Mitigation Measure 4: No additional measured required.

ILLINGWORTH & RODKIN, INC.
Acoustics • Air Quality
429 E. Cotati Avenue
Cotati, CA 94931

Memo

Date: April 22, 2019

To: Amy Wang
David J. Powers & Associates, Inc.

From: Dana Lodico, PE, INCE Bd. Cert.
Illingworth & Rodkin, Inc.

SUBJECT: **Downtown Specific Plan Land Use Update, Sunnyvale, California (IR Job # 18-010)**

The City of Sunnyvale originally adopted the Downtown Specific Plan (DSP) in 1993 and updated it in 2003 and 2013. In April 2019, Illingworth & Rodkin, Inc. submitted an Environmental Noise and Vibration Assessment (ENA) addressing the noise and vibration impacts due to proposed amendments to six sites within the DSP area, located within Blocks 1a, 18 and 22. Traffic noise impacts calculated in the ENA were based on traffic volumes provided by Fehr and Peers in March 2019. However, the land use description studied in the traffic study was slightly different from the land use description studied in the rest of the Environmental Impact Report (EIR) that is currently being prepared. This memorandum describes the differences between the traffic impact analysis (TIA) and EIR land use descriptions and presents a summary comparison of the noise and vibration impacts.

Table 1 presents the land use summaries for the TIA and EIR, along with the net changes between the two documents.

Table 1: Summary of Land Use Descriptions

Scenario	Residential Units	Commercial Square Footage	Office Square Footage
TIA Description	773	79,063	852,624
EIR Description	823	79,063	852,624
Difference	50	0	0

As shown in Table 1, the TIA included 50 fewer residential units as compared to the EIR. The commercial and office square footage is the same between the two descriptions.

The locations and specifications of noise generating mechanical equipment and other on-site project operations studied in the ENA were based on project plans and would not be impacted by the project description discrepancy. Likewise, for construction information and scheduling. Aircraft noise impacts are based on the project's location with respect to nearby airport operations, which again does not change between the two descriptions.

Fehr and Peers provided a memorandum assessing the differences in traffic volumes between the two land use descriptions, dated April 8, 2019. Turning volumes along individual roadway segments, which are used to calculate traffic noise impacts, are not given in the memo; however, the memo does provide overall trip generation estimates. Based on a comparison of the trip generation estimates provided with those provided for the previous land use description, the addition of 50 residential units to the project would result in a total of 15 AM Peak Hour and 12 PM Peak Hour additional vehicle trips above those used in the analysis for the ENA. This small increase in traffic volumes would account for less than 1% of the trip generation allowed under the DSP with Proposed Amendments. For reference, a 15% increase in traffic volumes along an individual roadway segment would result in a 1 dBA increase in traffic noise levels and a doubling (100% increase) of traffic volumes would result in a 3 dBA increase in traffic noise. As such, a 1% increase in traffic volumes would not be measurable or noticeable and would not change the traffic noise impacts from those described in the ENA.

With the addition of 50 residential units to the project, operational noise impacts (Impact 1a in the ENA), traffic noise impacts (Impact 1b in the ENA) temporary noise and vibration impacts due to construction (Impacts 1c and 2 in the ENA), and aircraft noise impacts (Impact 3 in ENA) would be the same as those discussed in the ENA. Mitigation Measures 1a and 1c from the ENA would reduce these impacts to **less-than-significant** levels.

Figure A1. Daily Trend in Noise Level at LT-1 on September 14, 2018

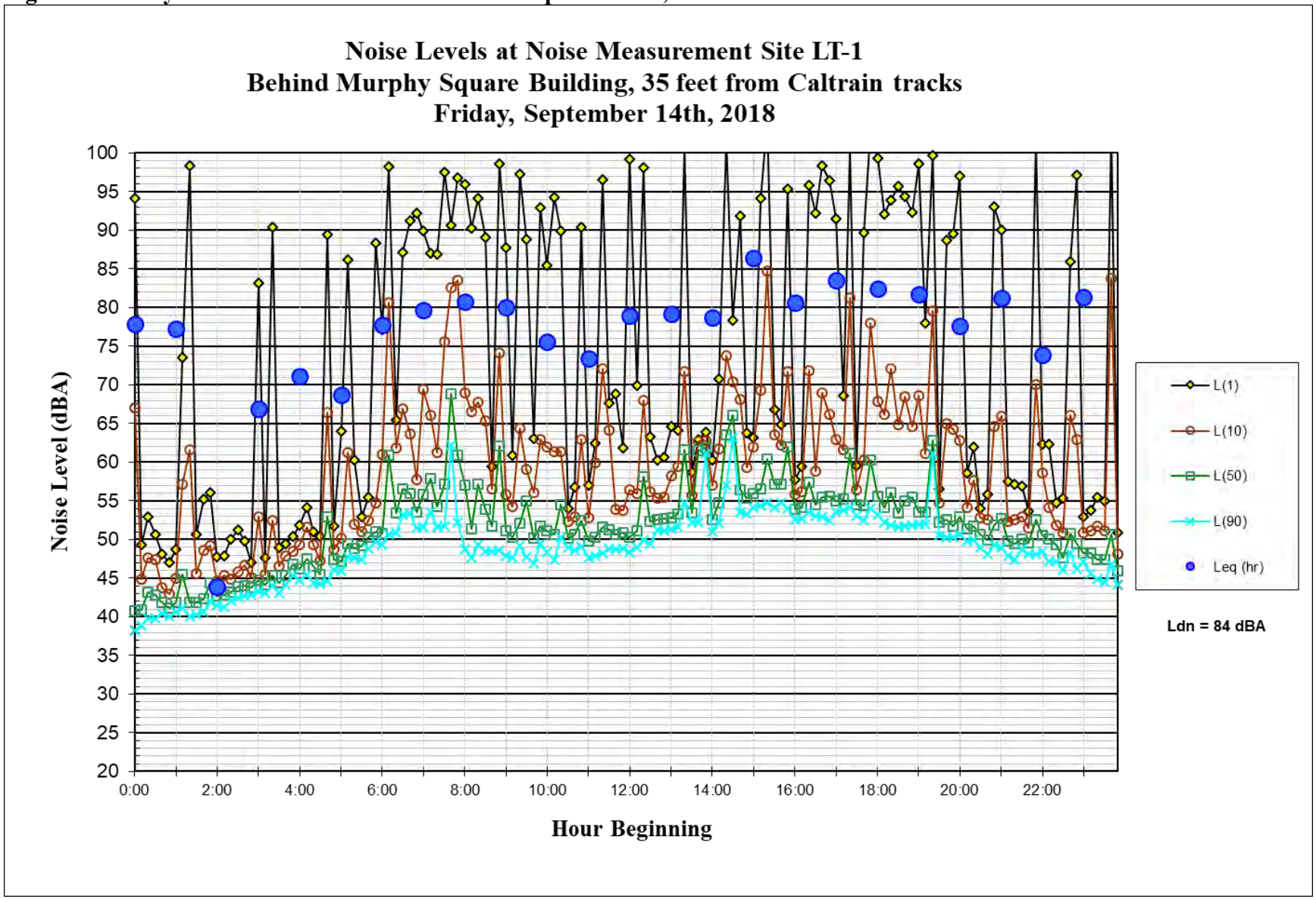


Figure A2. Daily Trend in Noise Level at LT-1 on September 15, 2018

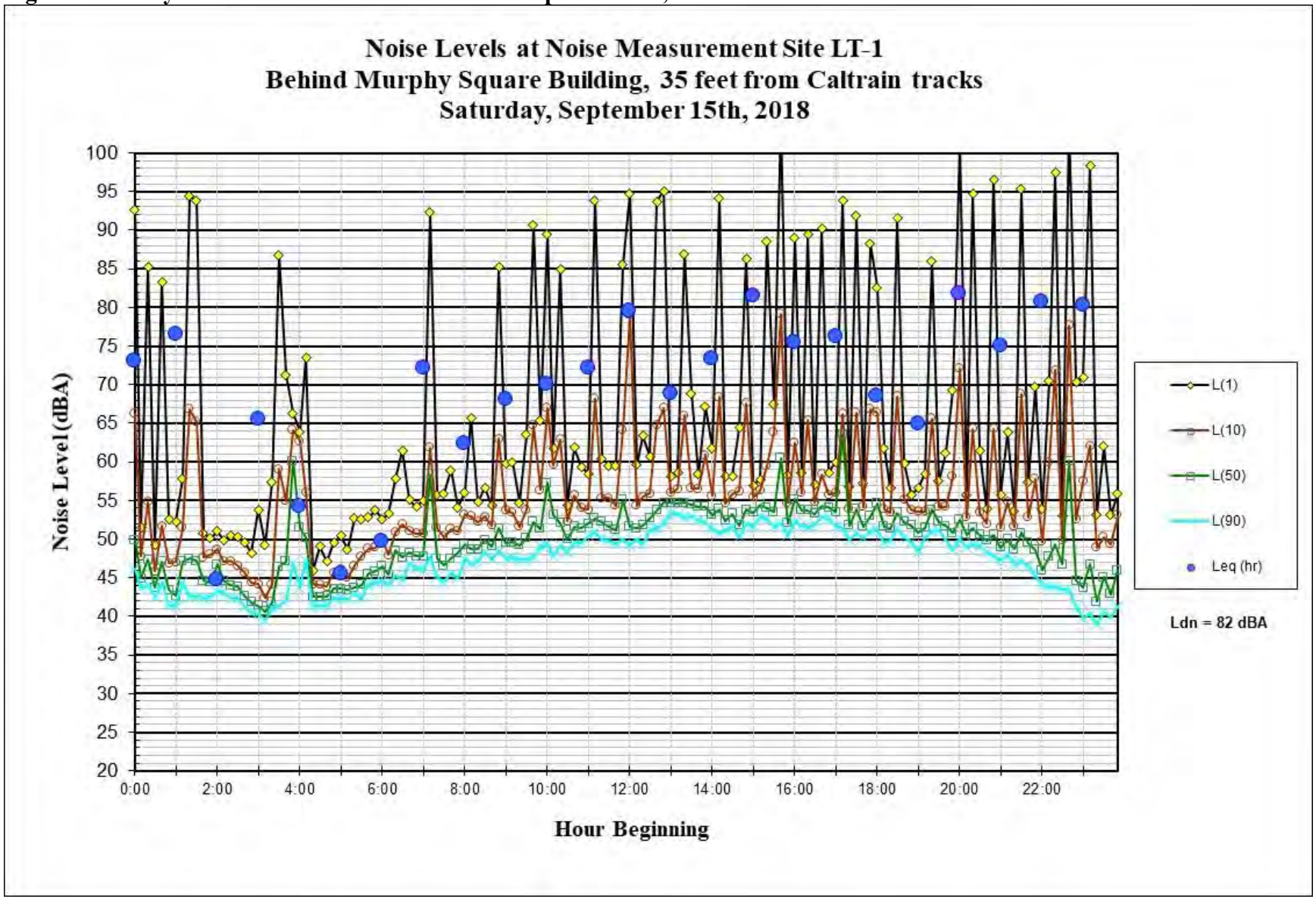


Figure A3. Daily Trend in Noise Level at LT-1 on September 16, 2018

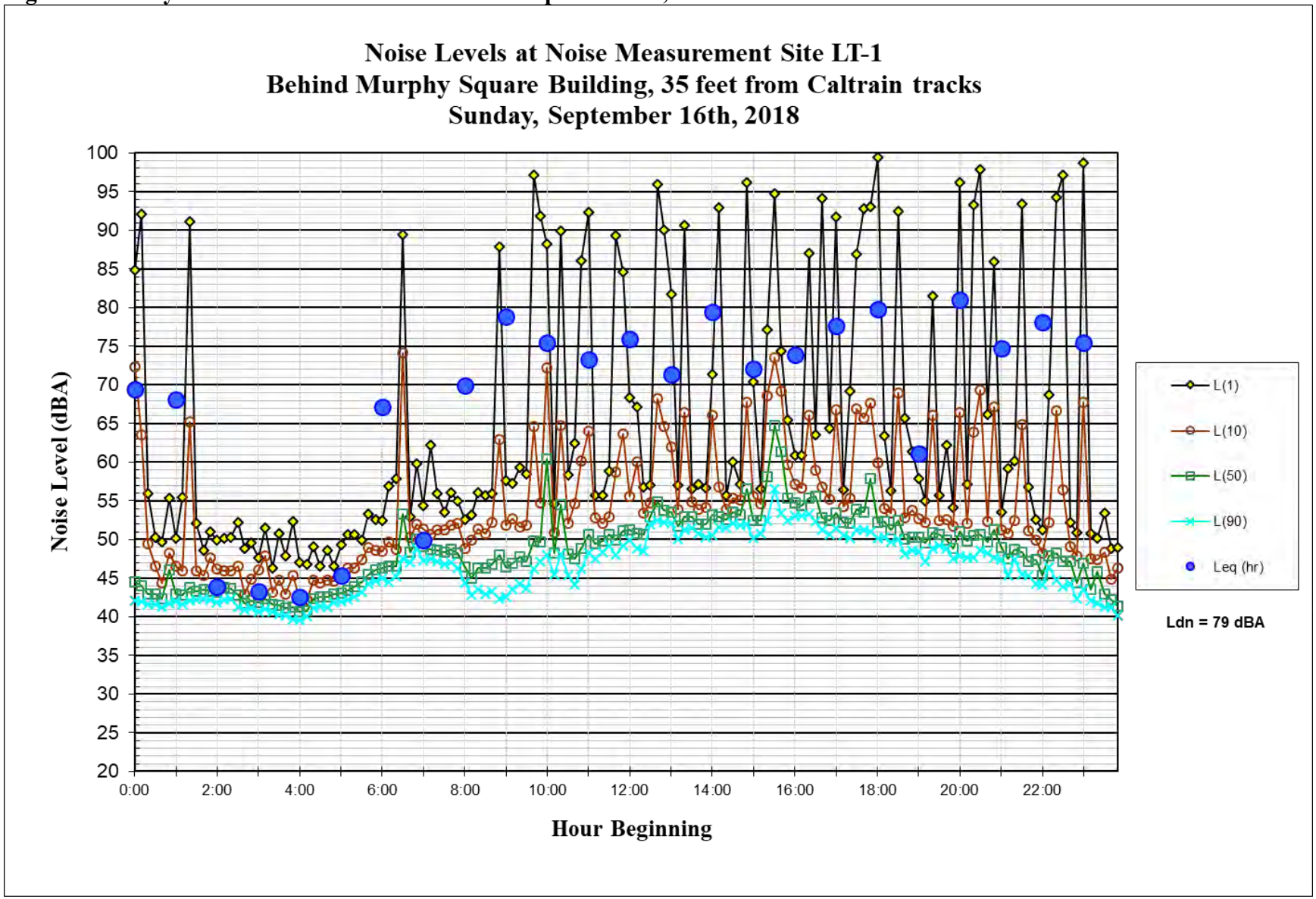


Figure A4. Daily Trend in Noise Level at LT-1 on September 17, 2018

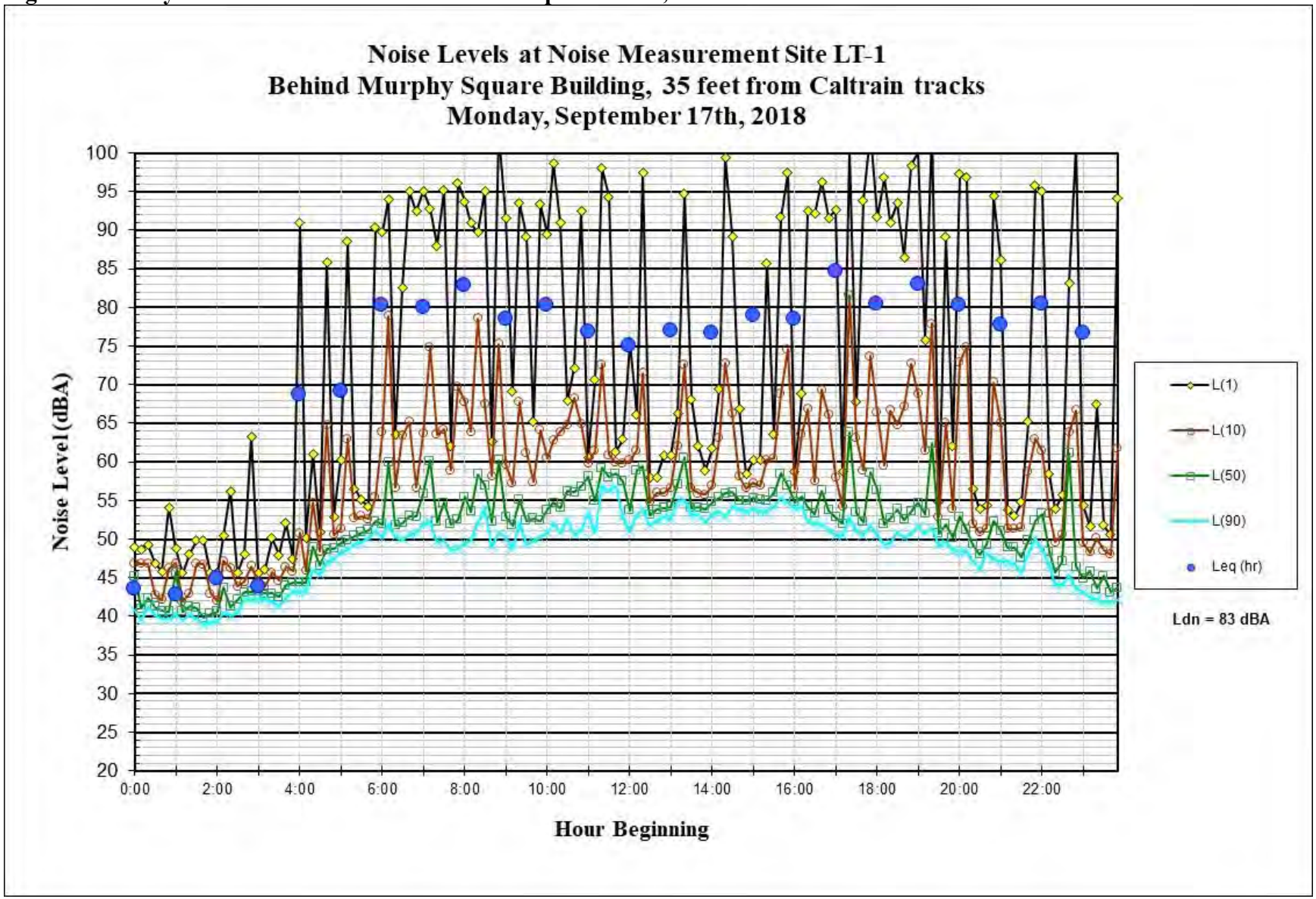


Figure A5. Daily Trend in Noise Level at LT-1 on September 18, 2018

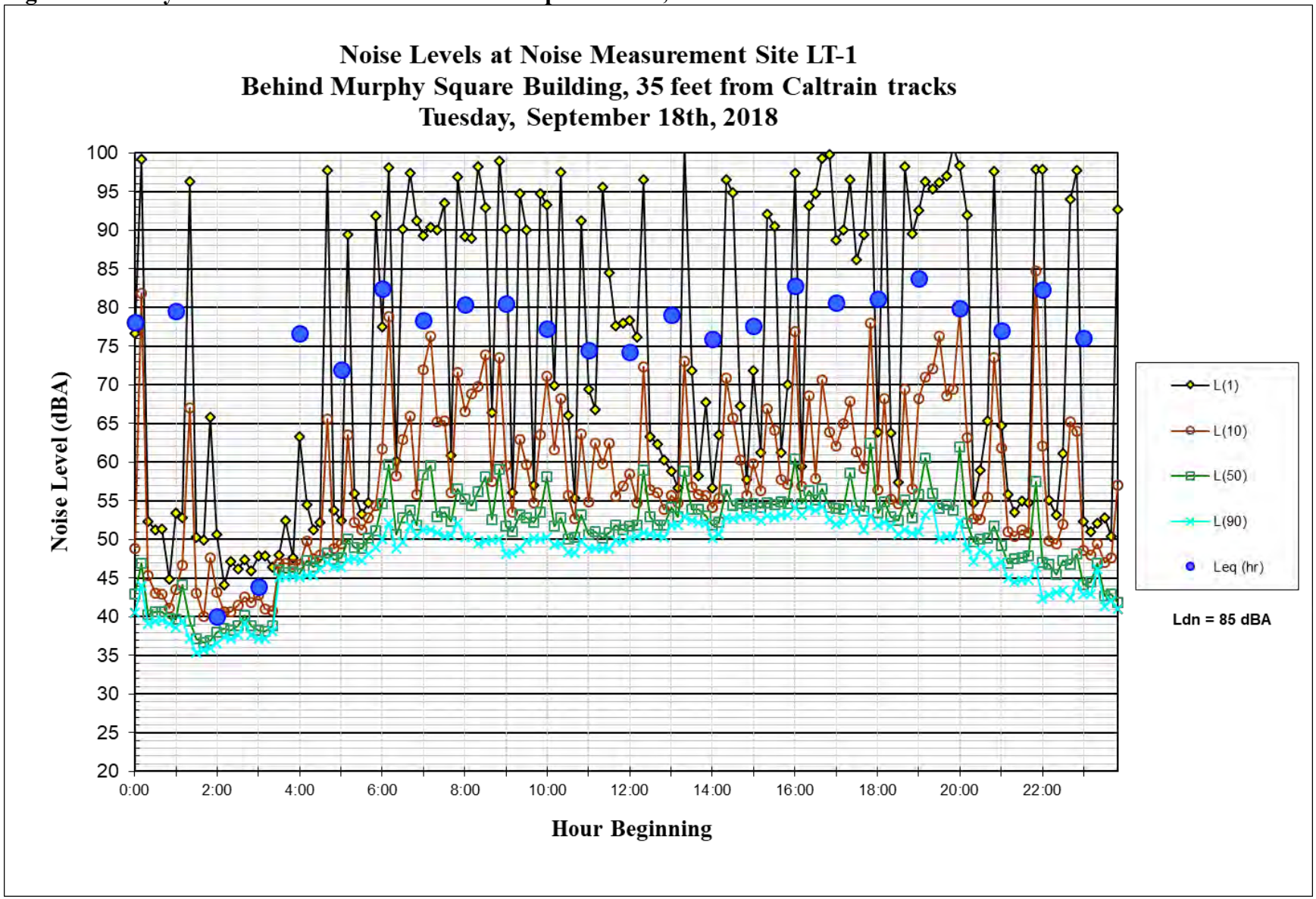


Figure A6. Daily Trend in Noise Level at LT-2 on September 14, 2018

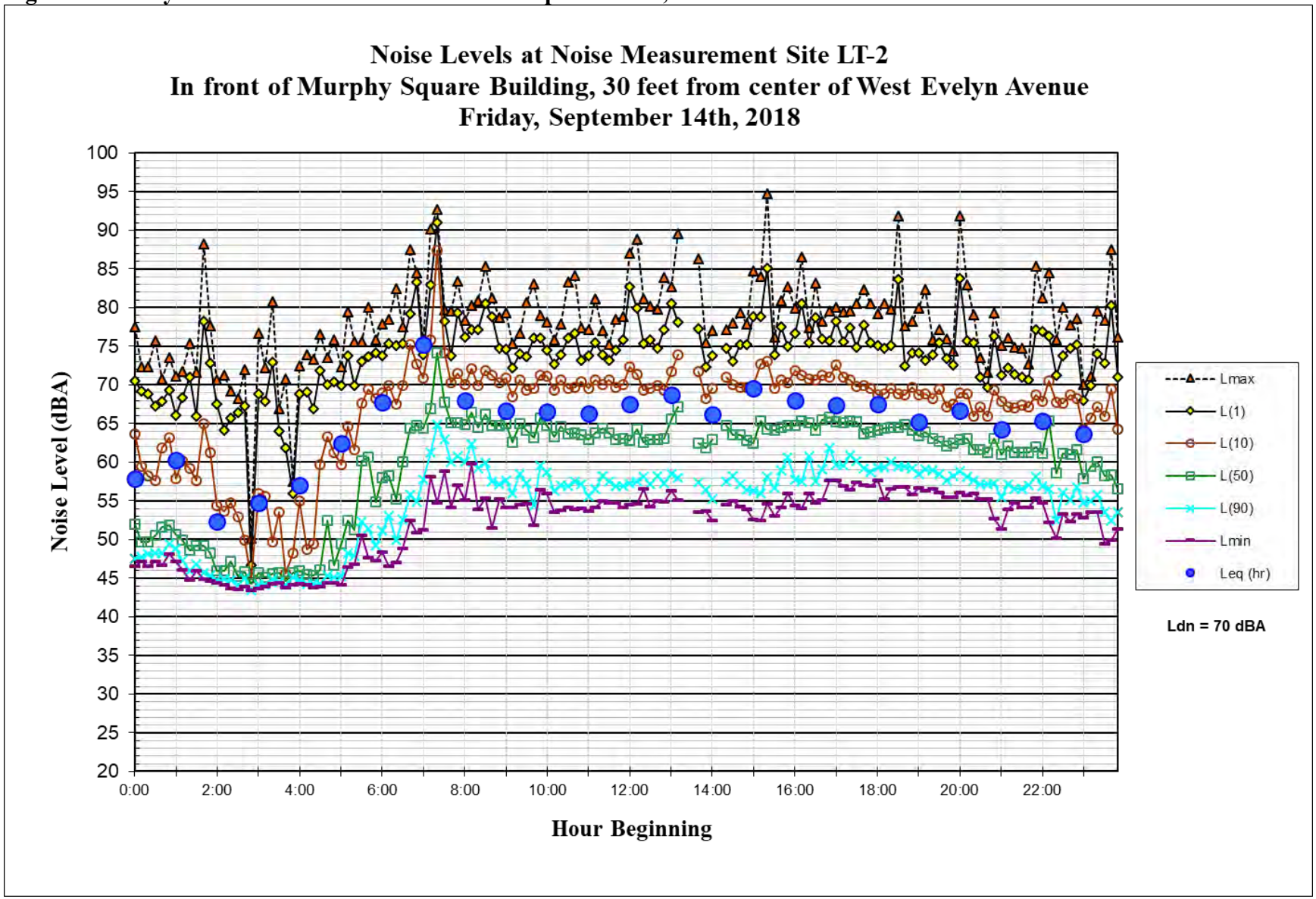


Figure A7. Daily Trend in Noise Level at LT-2 on September 15, 2018

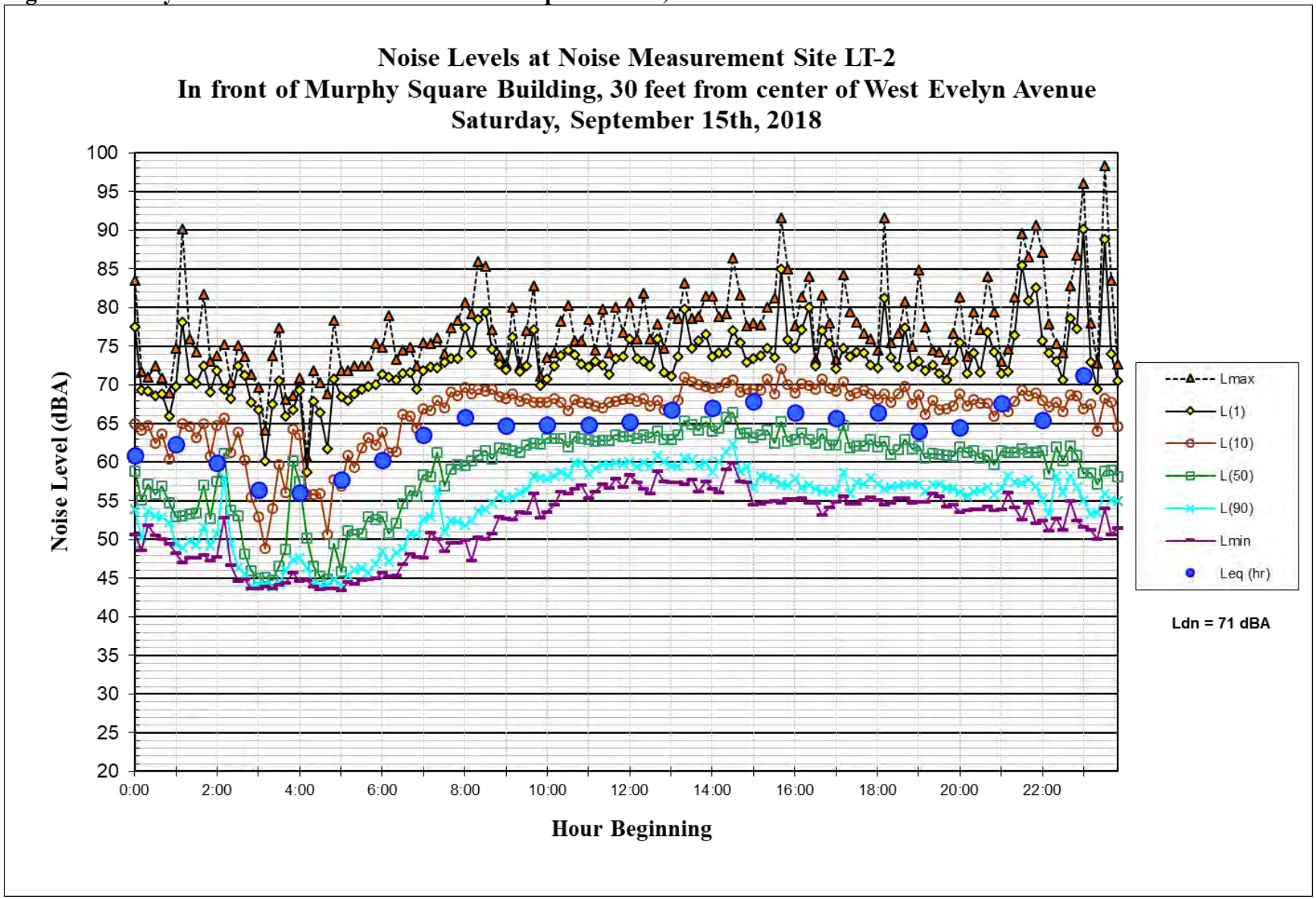


Figure A8. Daily Trend in Noise Level at LT-2 on September 16, 2018

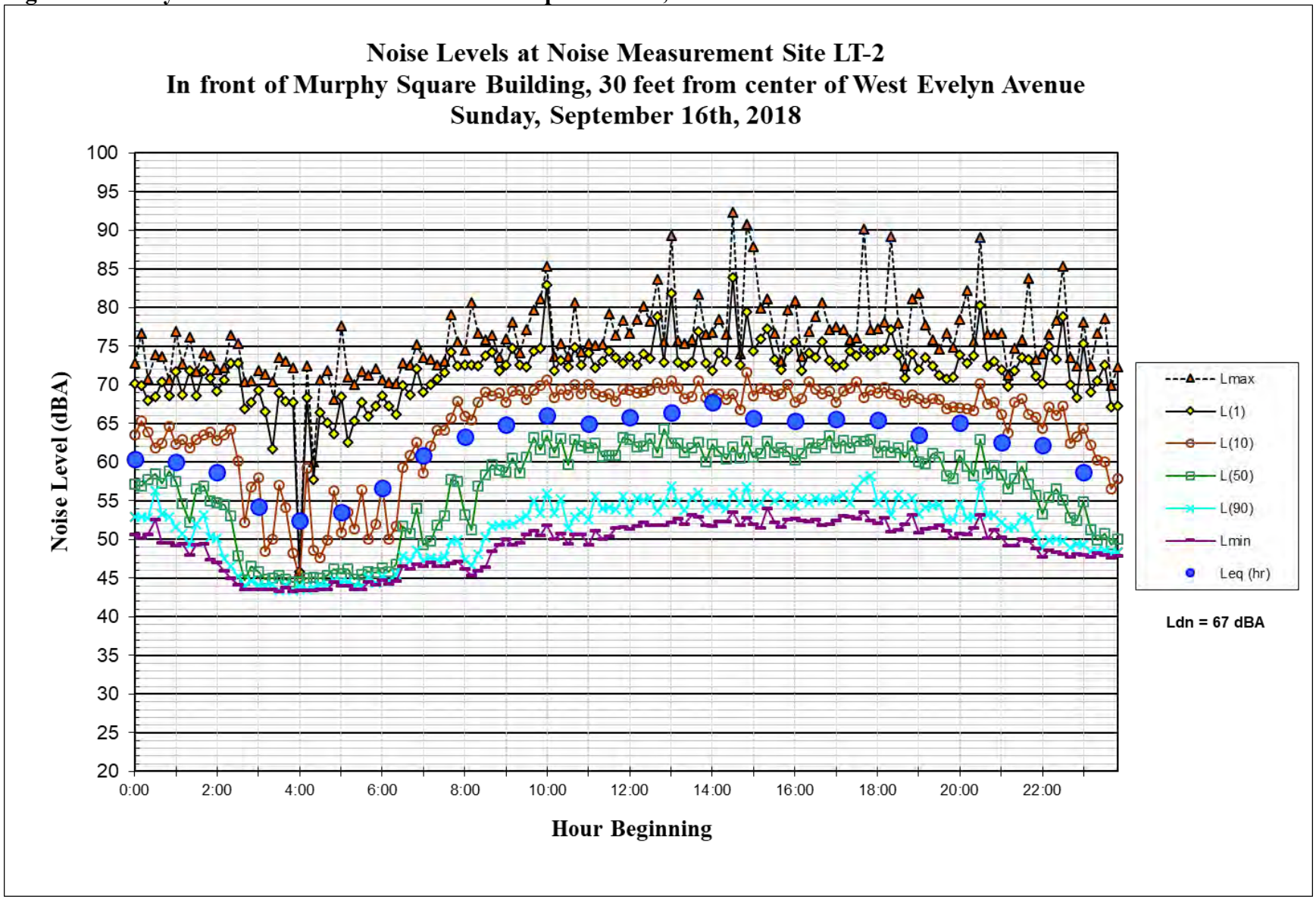


Figure A9. Daily Trend in Noise Level at LT-2 on September 17, 2018

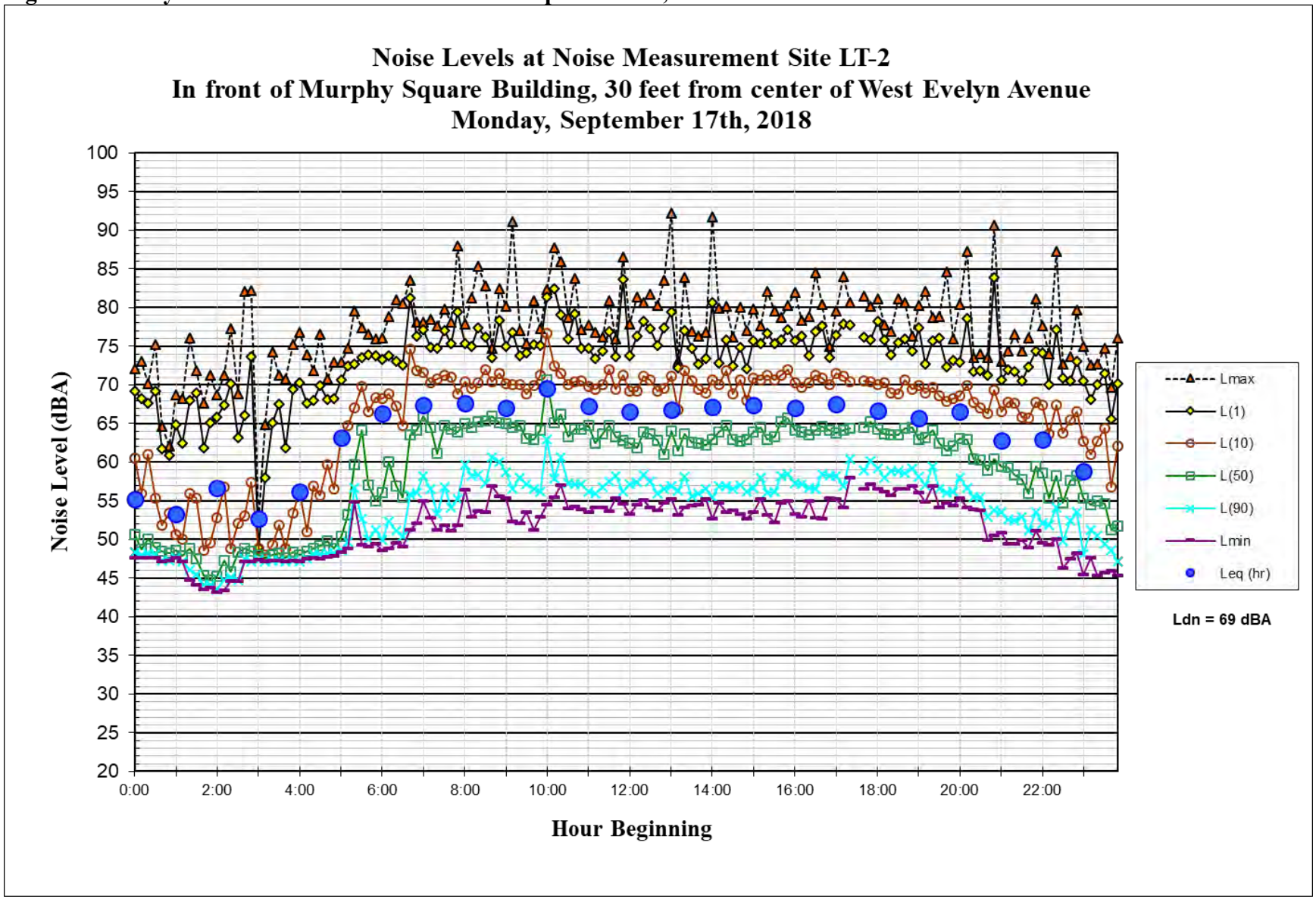


Figure A10. Daily Trend in Noise Level at LT-2 on September 18, 2018

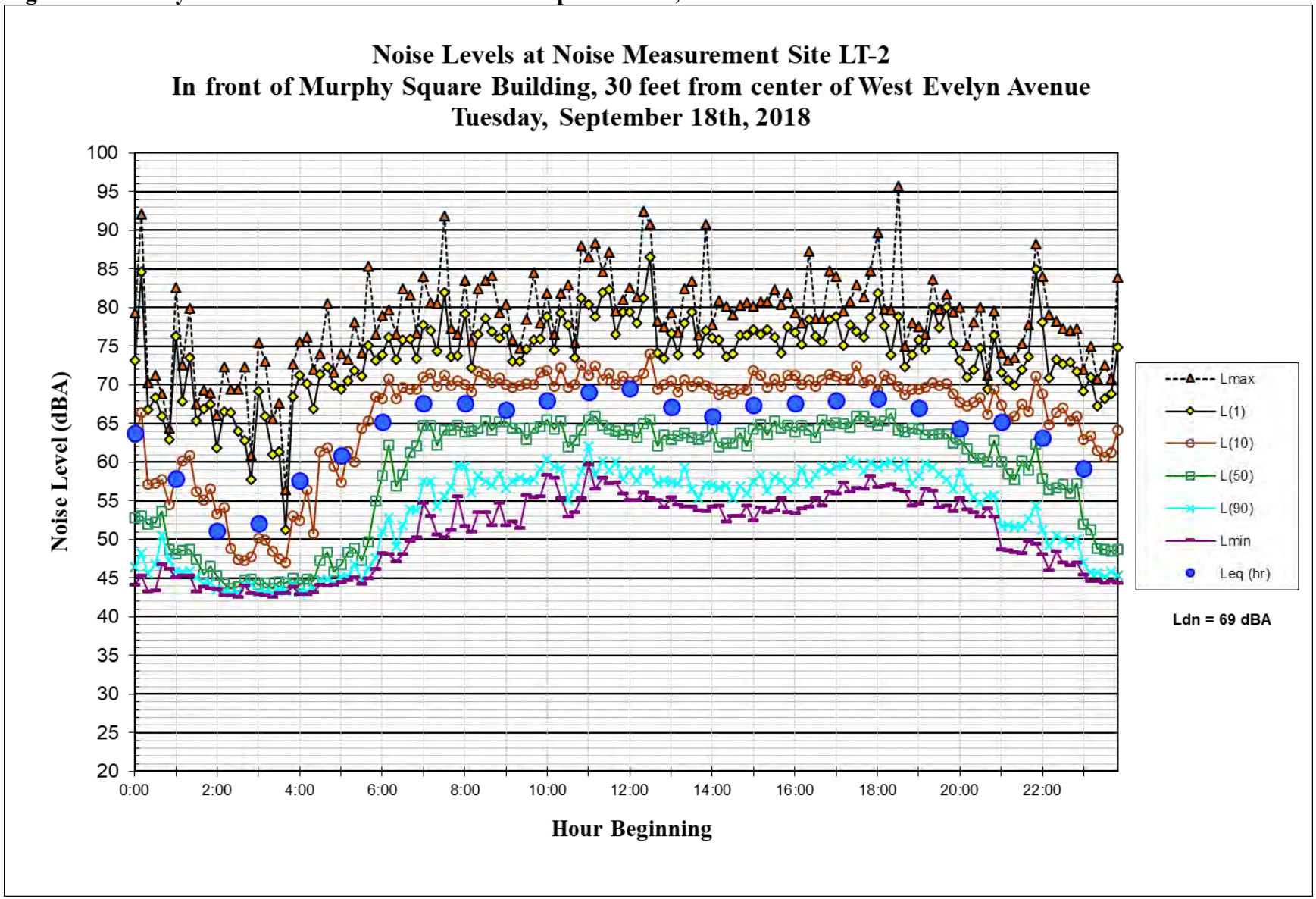


Figure A11. Daily Trend in Noise Level at LT-3 on September 14, 2018

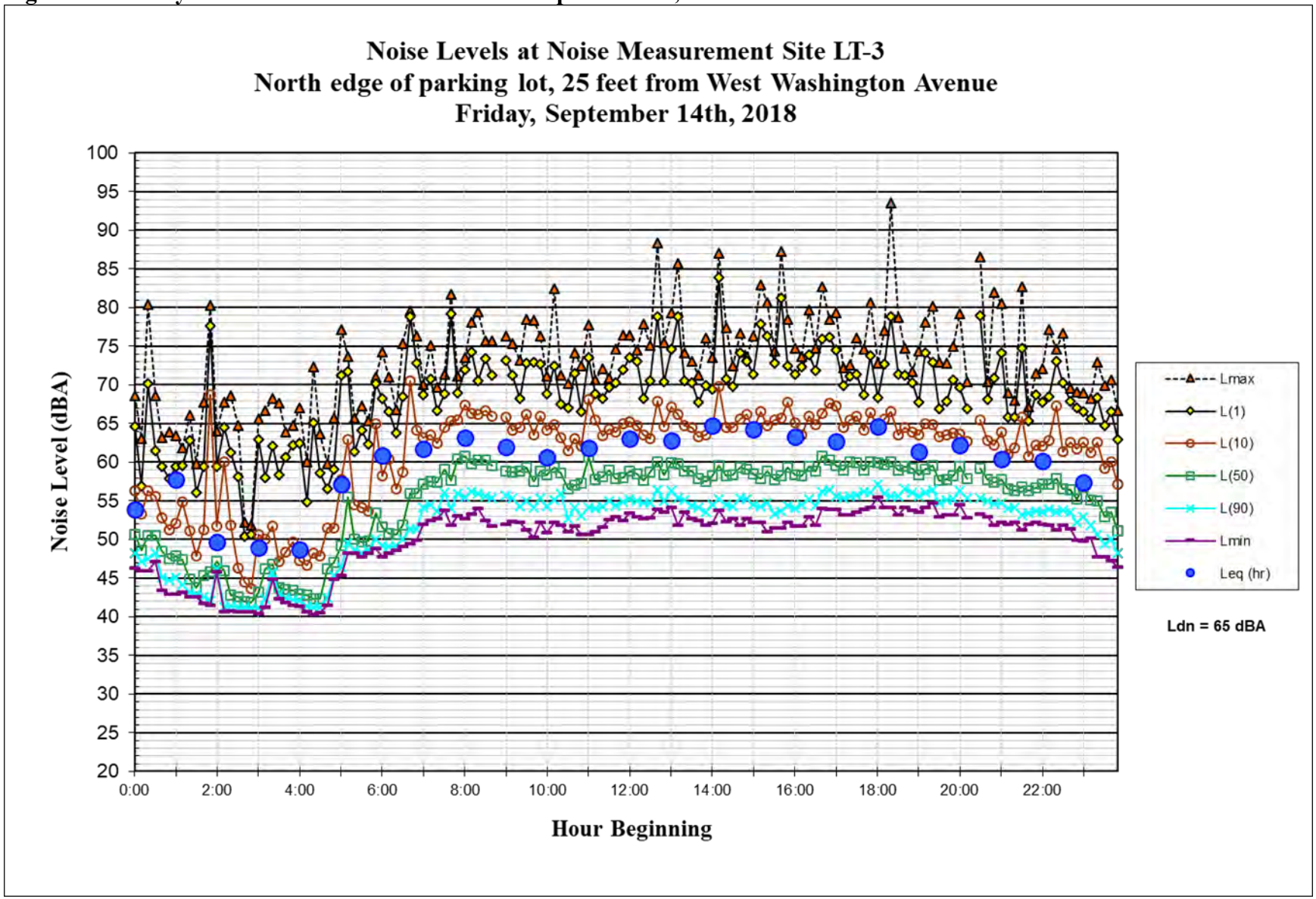


Figure A12. Daily Trend in Noise Level at LT-3 on September 15, 2018

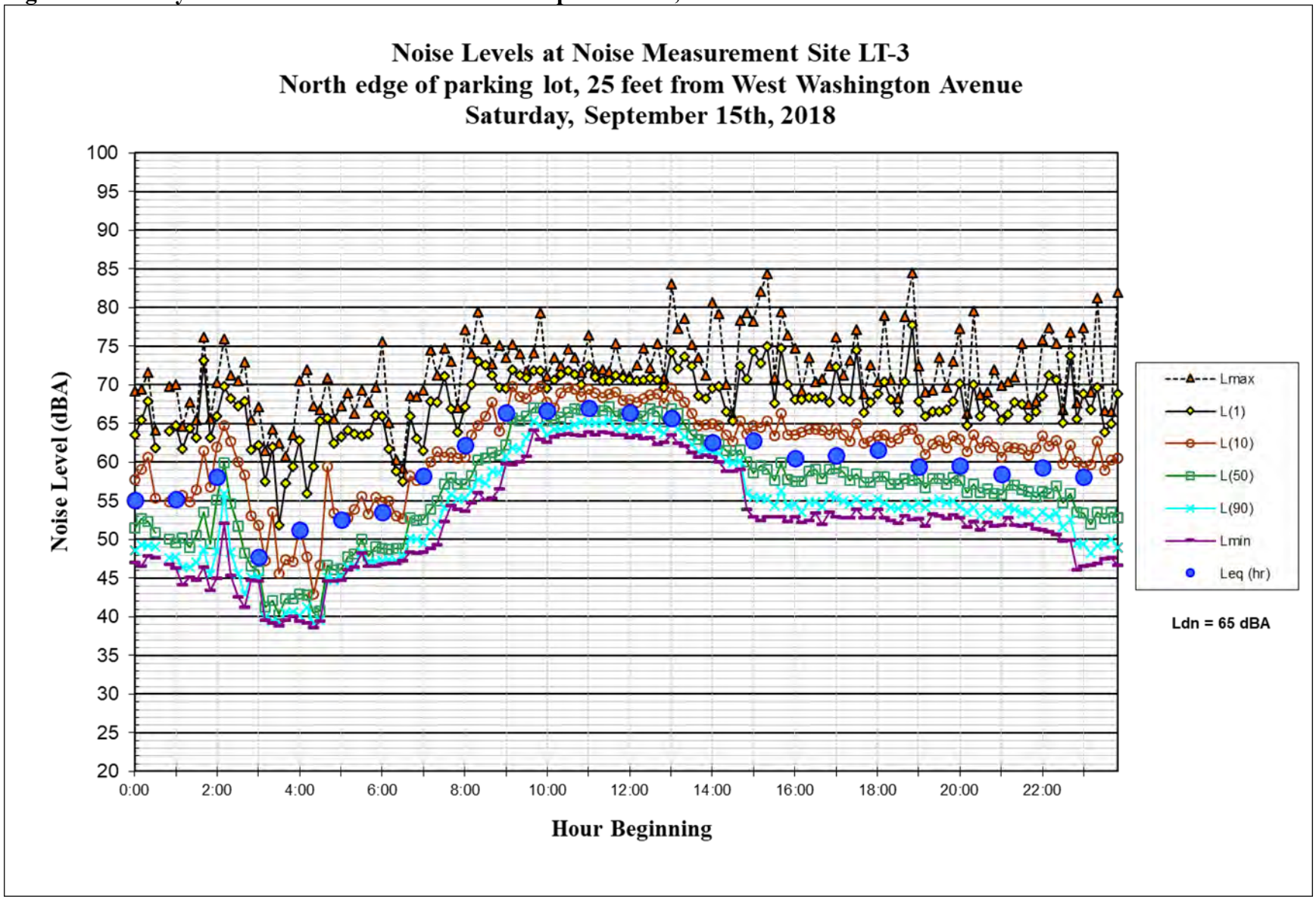


Figure A13. Daily Trend in Noise Level at LT-3 on September 16, 2018

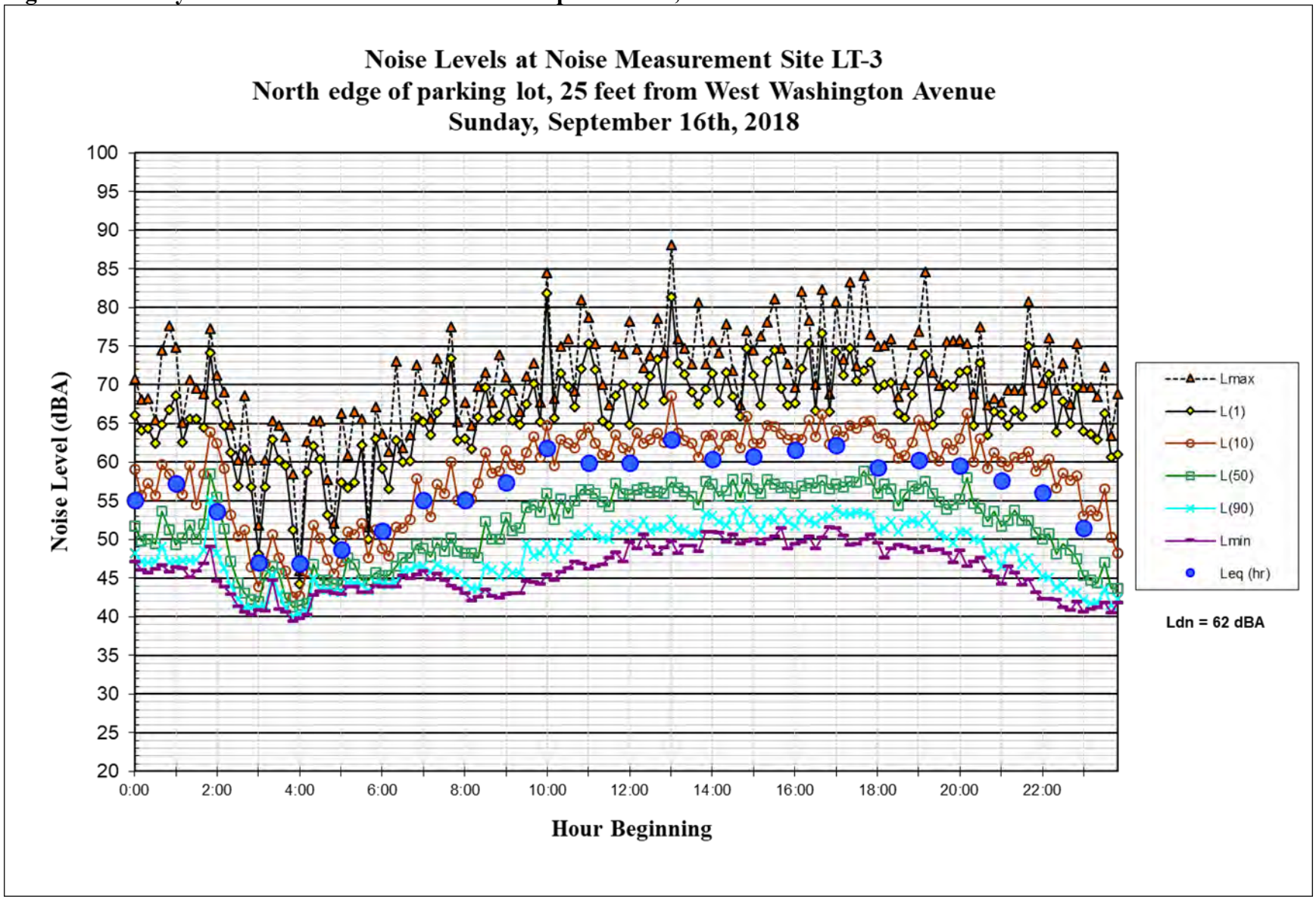


Figure A14. Daily Trend in Noise Level at LT-3 on September 17, 2018

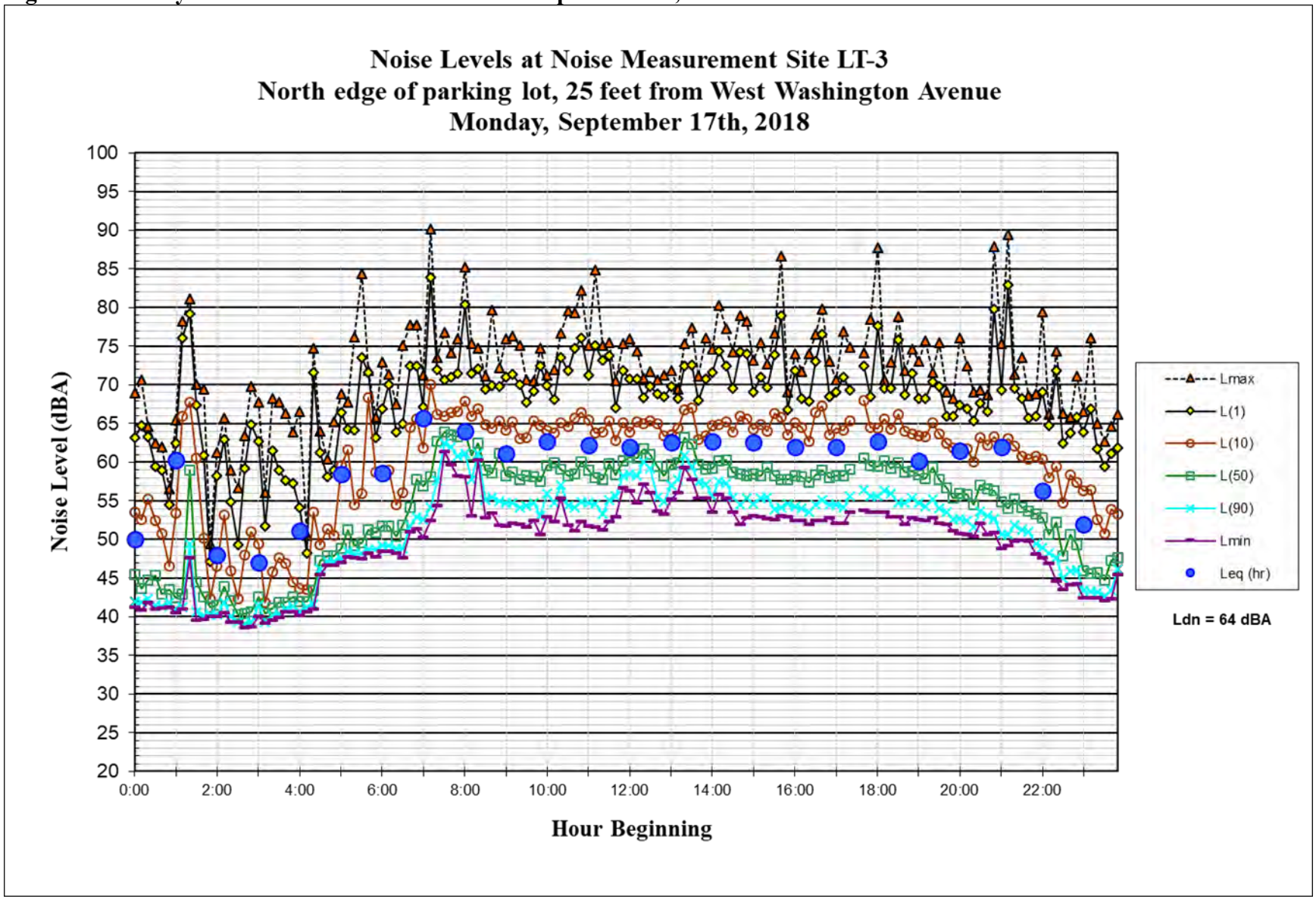


Figure A15. Daily Trend in Noise Level at LT-3 on September 18, 2018

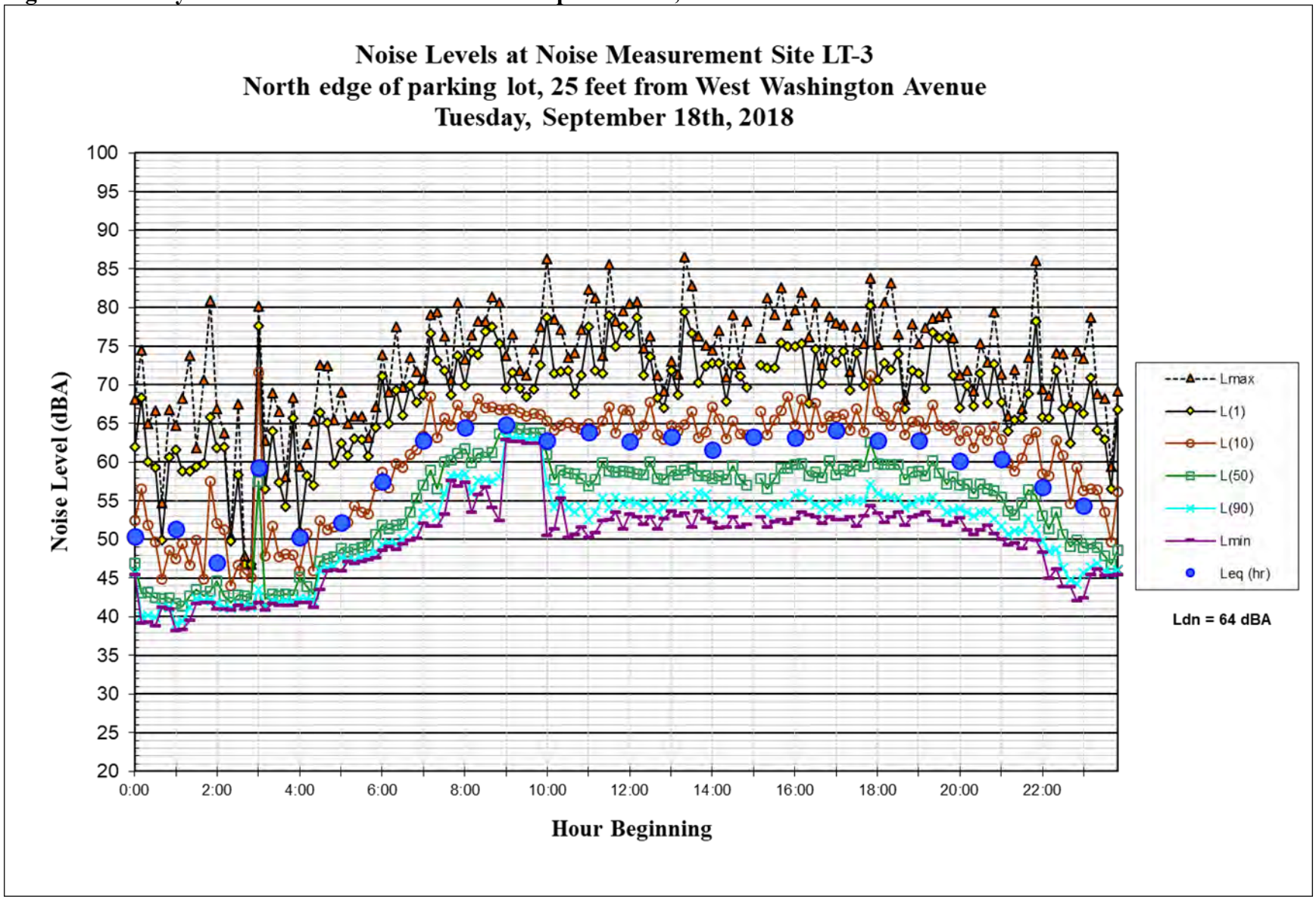


Figure A16. Daily Trend in Noise Level at LT-4 on September 14, 2018

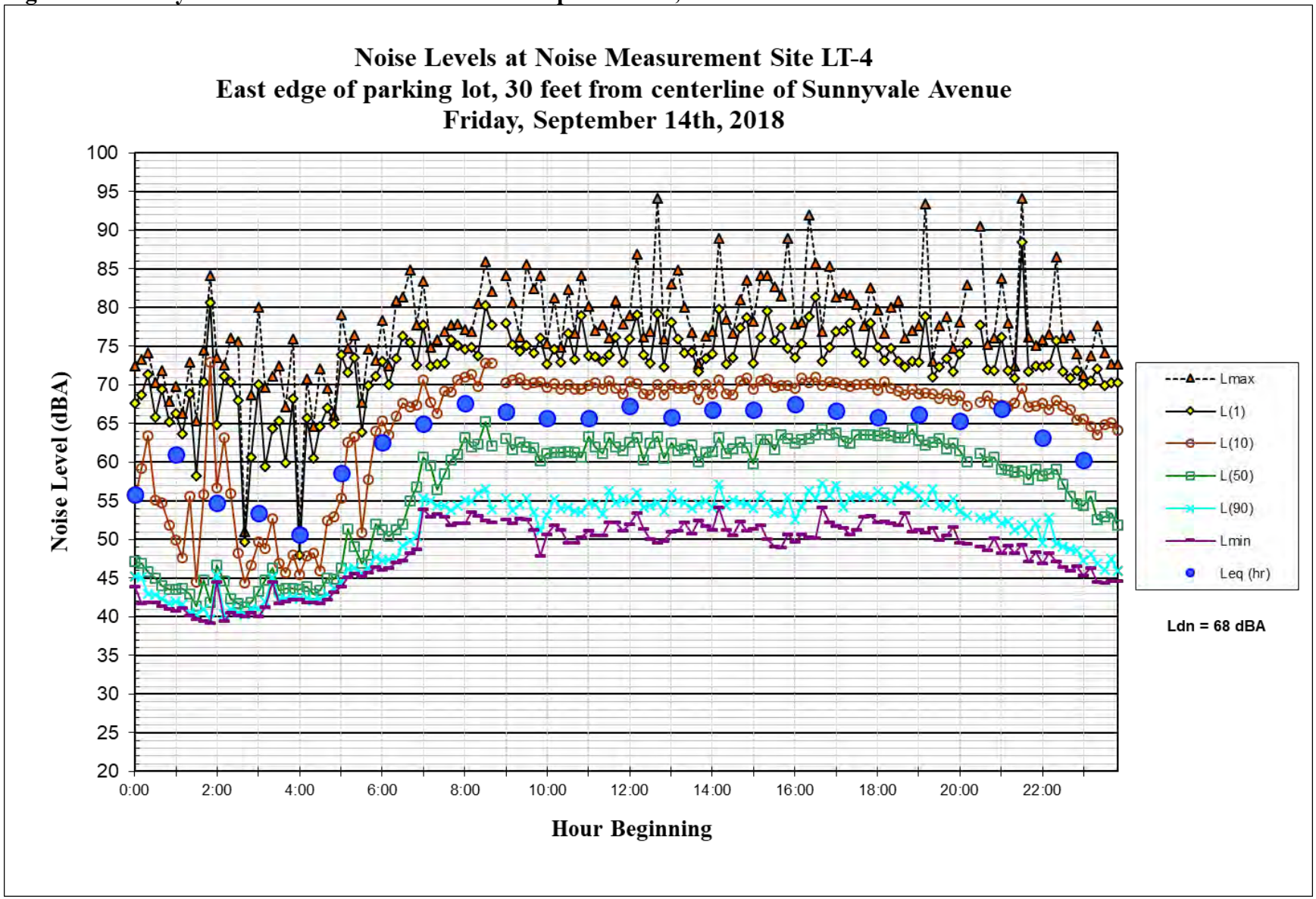


Figure A17. Daily Trend in Noise Level at LT-4 on September 15, 2018

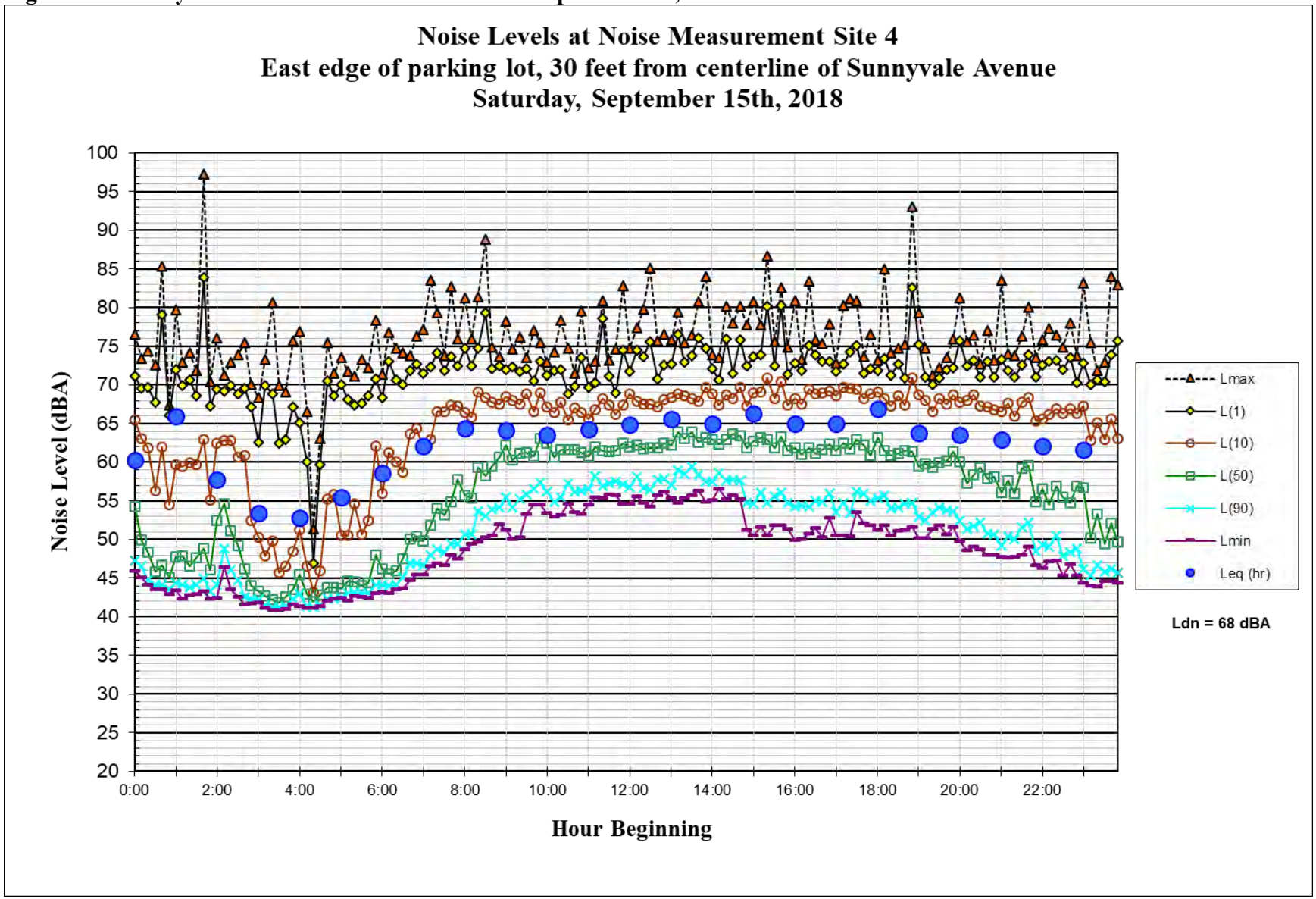


Figure A18. Daily Trend in Noise Level at LT-4 on September 16, 2018

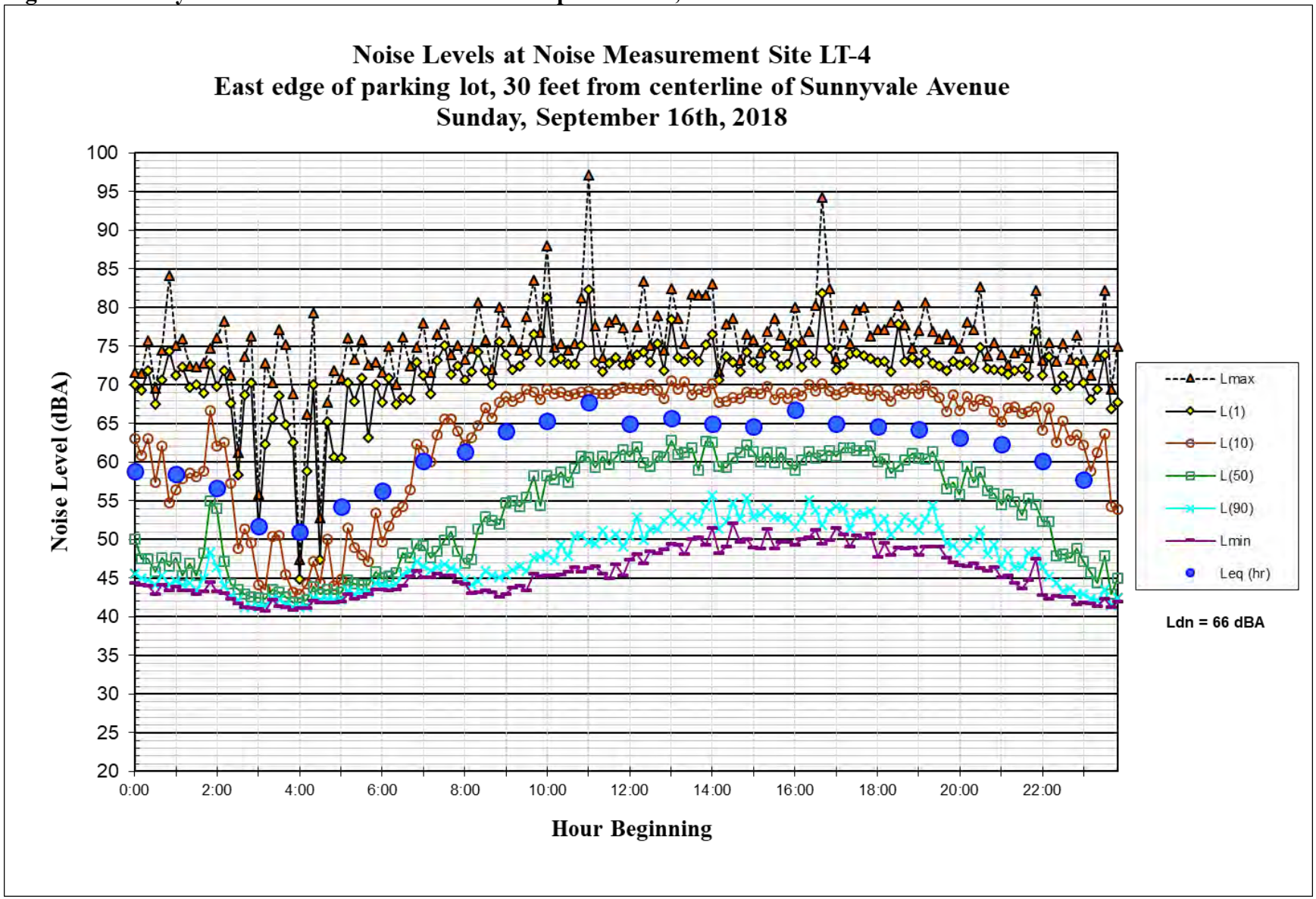


Figure A19. Daily Trend in Noise Level at LT-4 on September 17, 2018

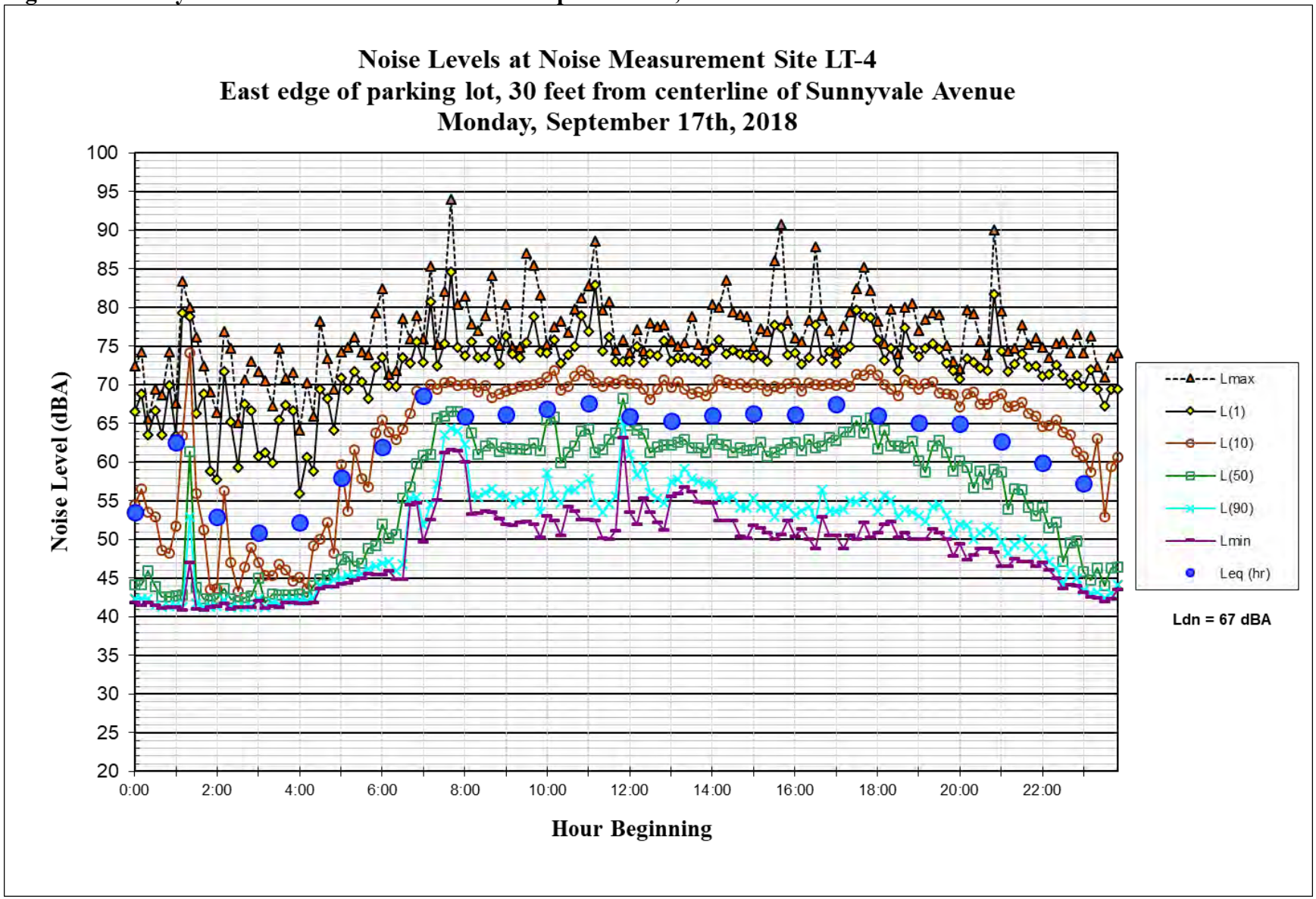


Figure A20. Daily Trend in Noise Level at LT-4 on September 18, 2018

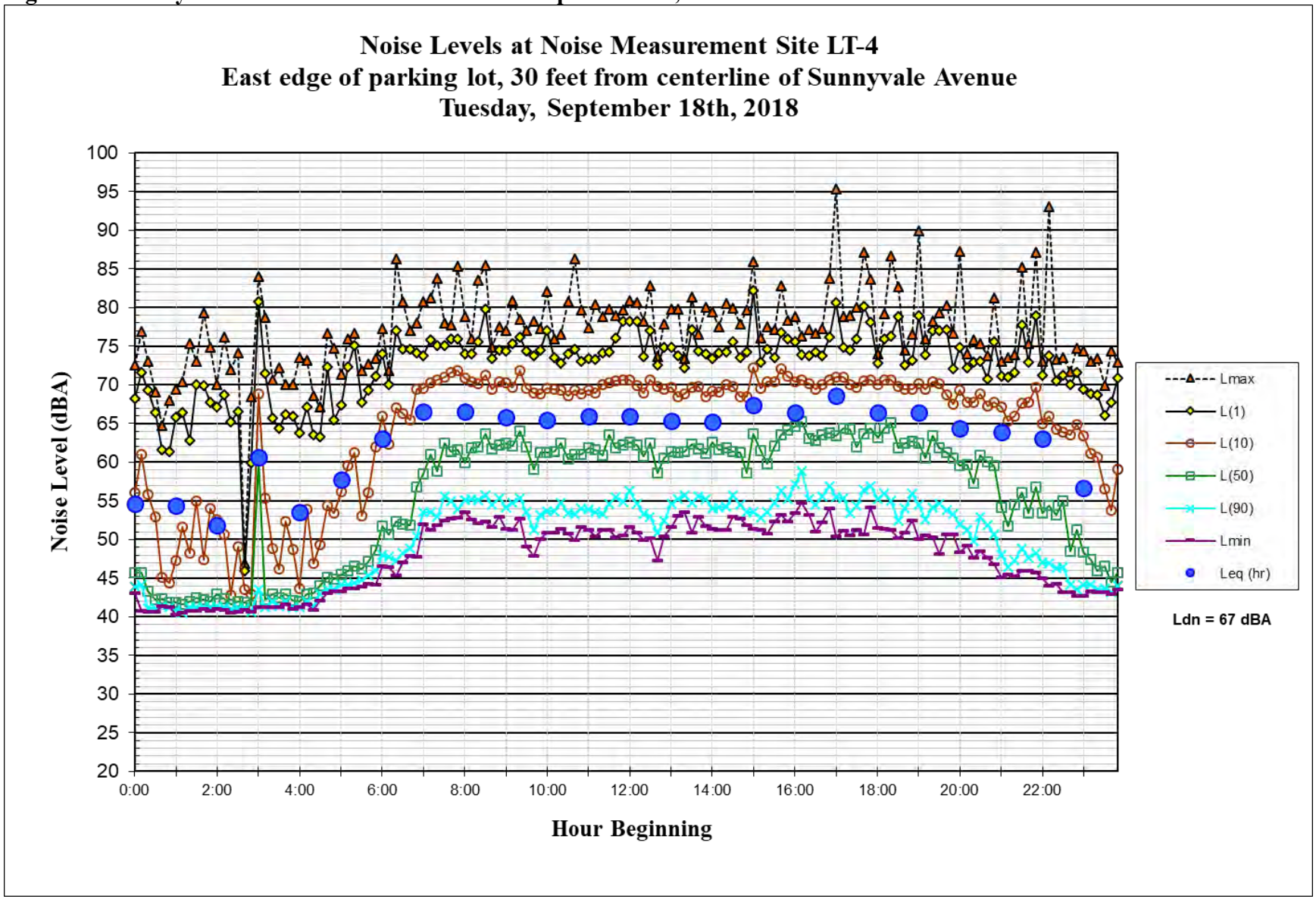


Figure A21. Daily Trend in Noise Level at LT-5 on September 14, 2018

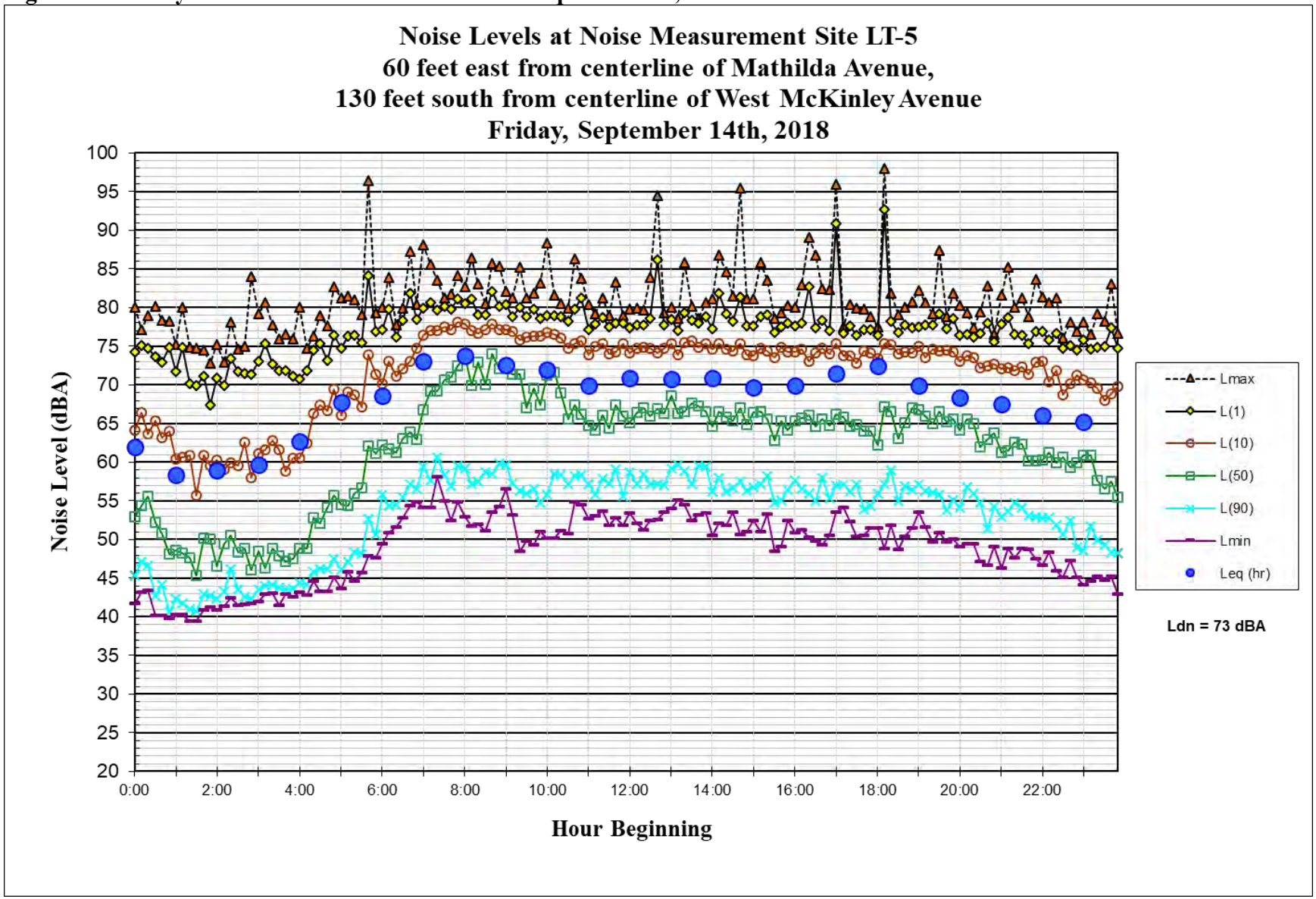


Figure A22. Daily Trend in Noise Level at LT-5 on September 15, 2018

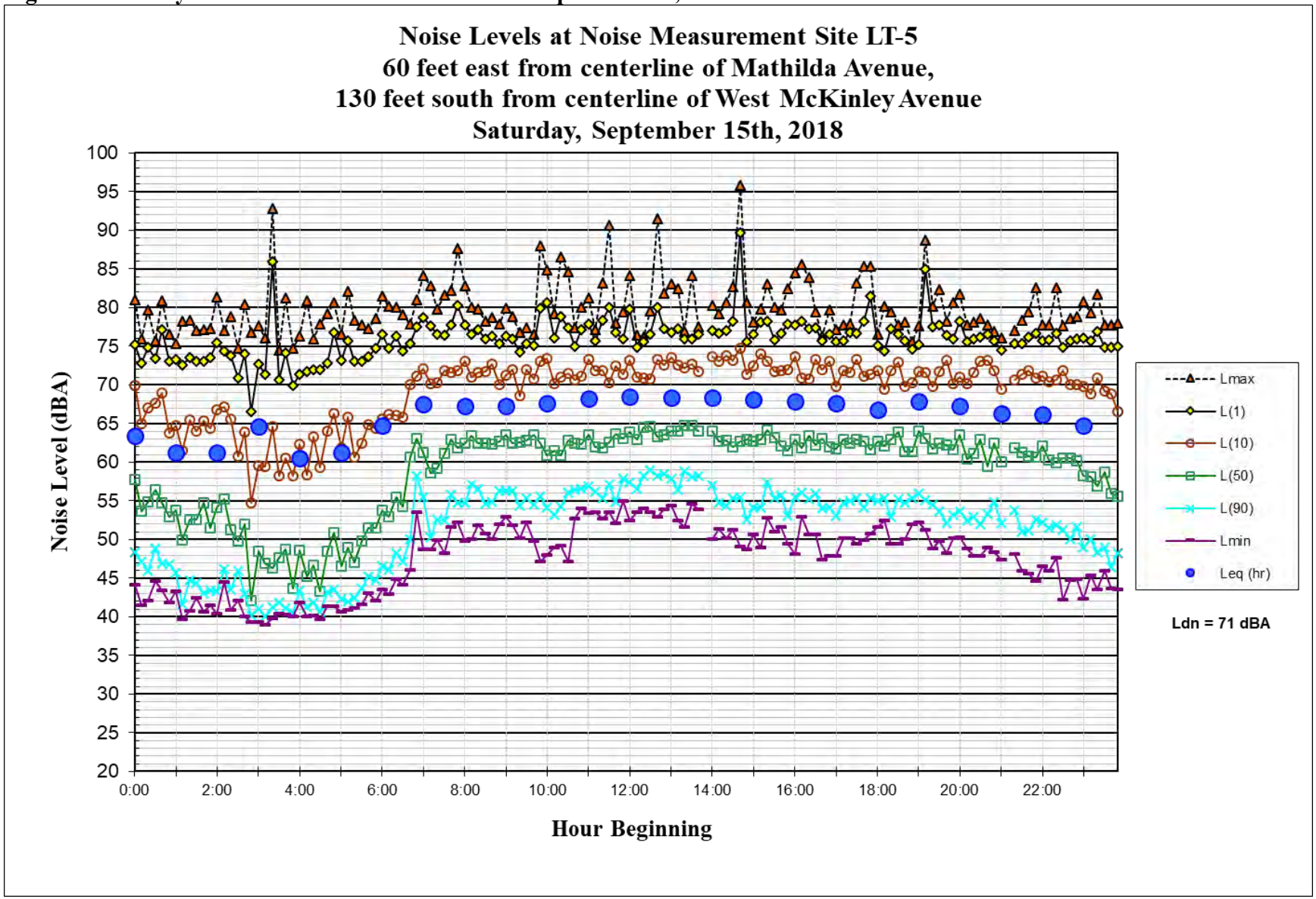


Figure A23. Daily Trend in Noise Level at LT-5 on September 16, 2018

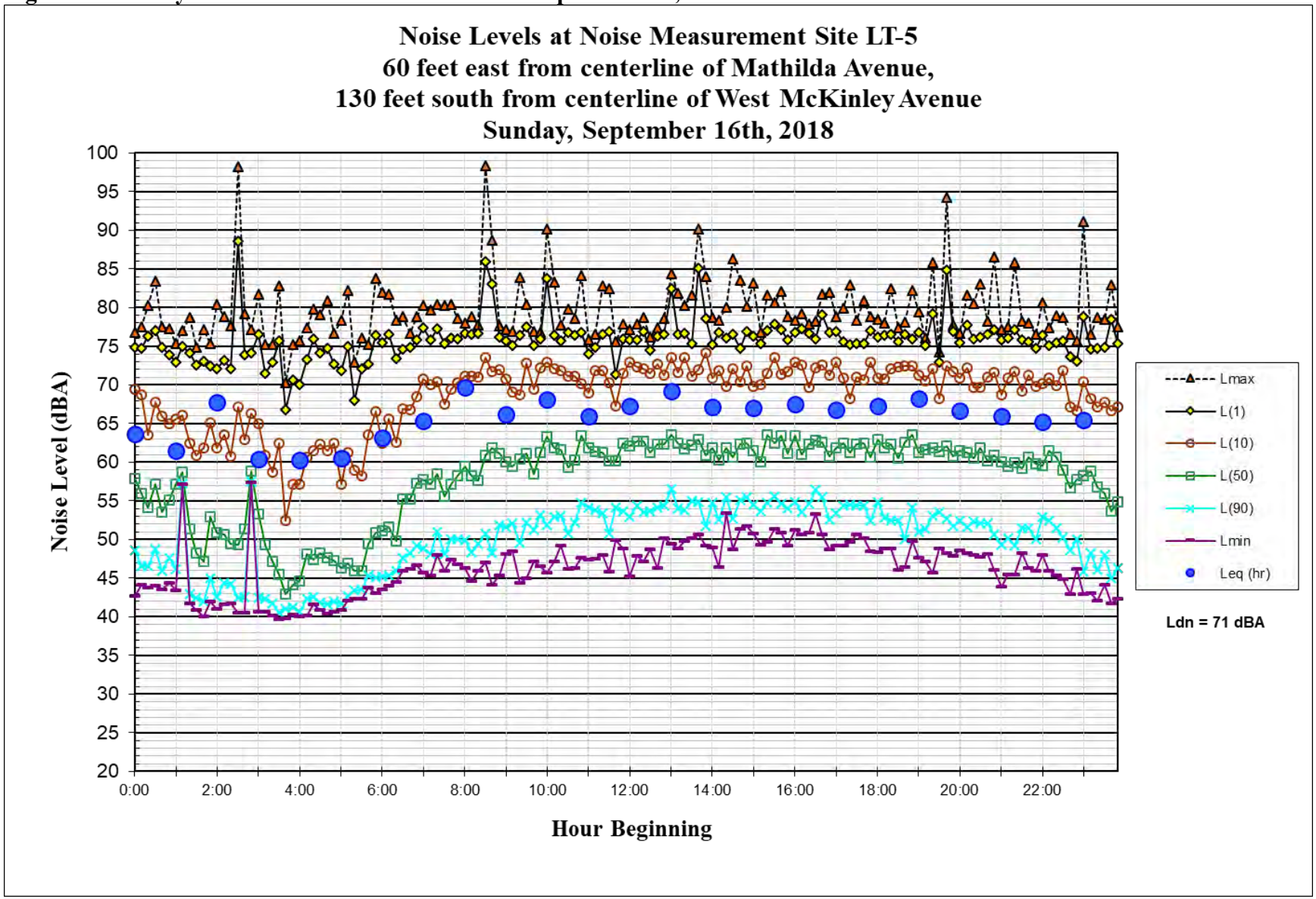


Figure A24. Daily Trend in Noise Level at LT-5 on September 17, 2018

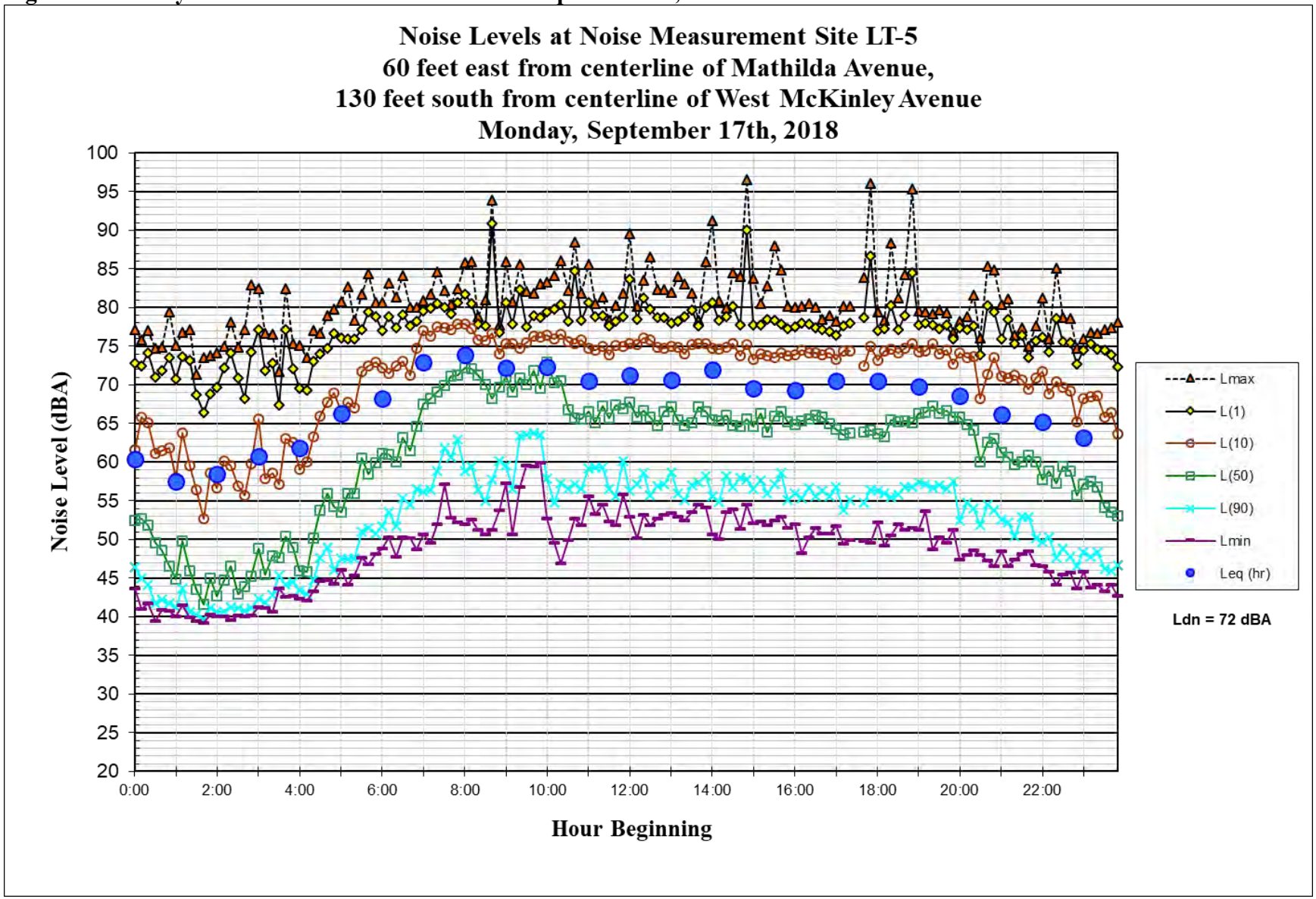


Figure A25. Daily Trend in Noise Level at LT-5 on September 18, 2018

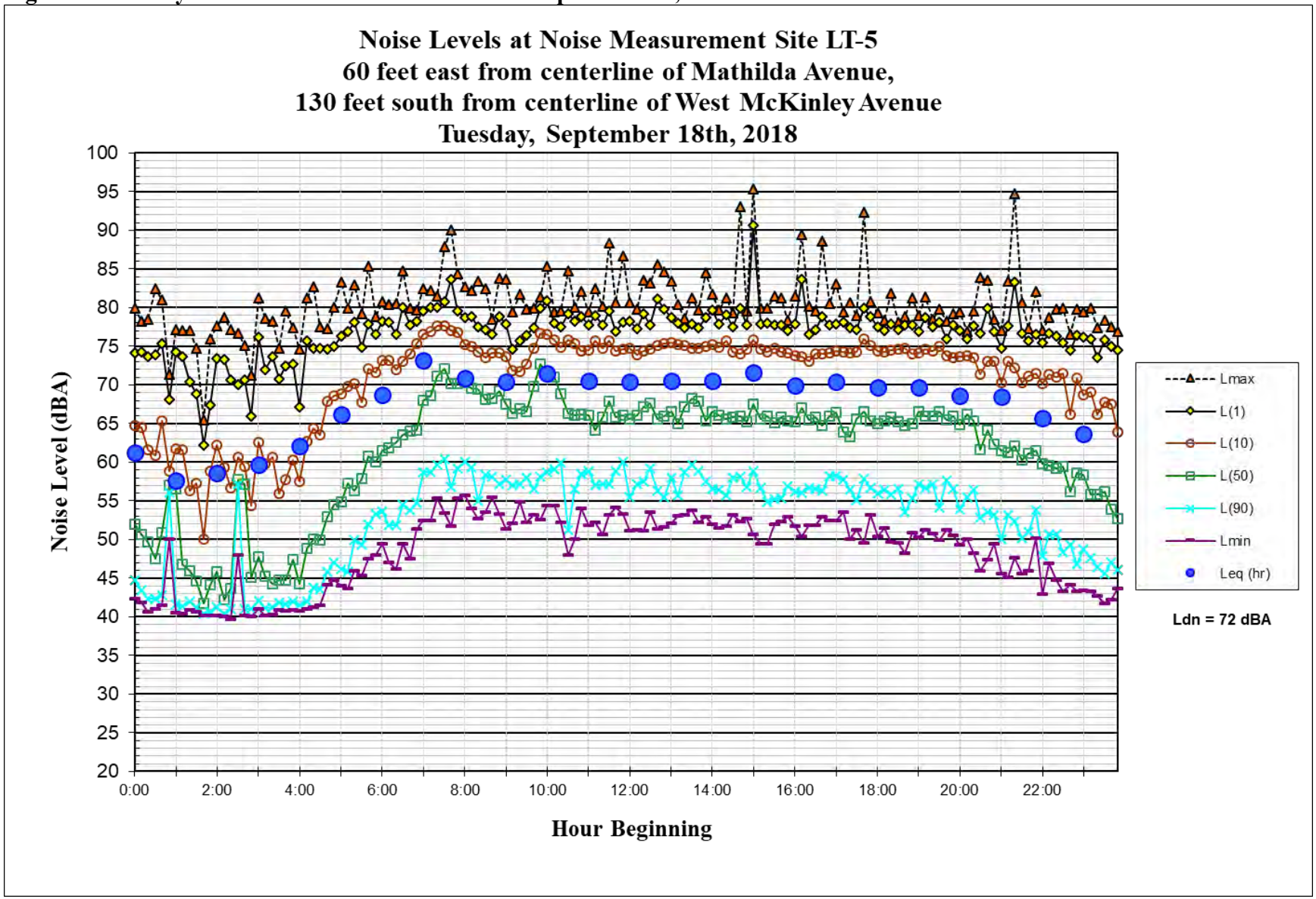


Figure A26. Railroad Train Vibration Levels at V-1

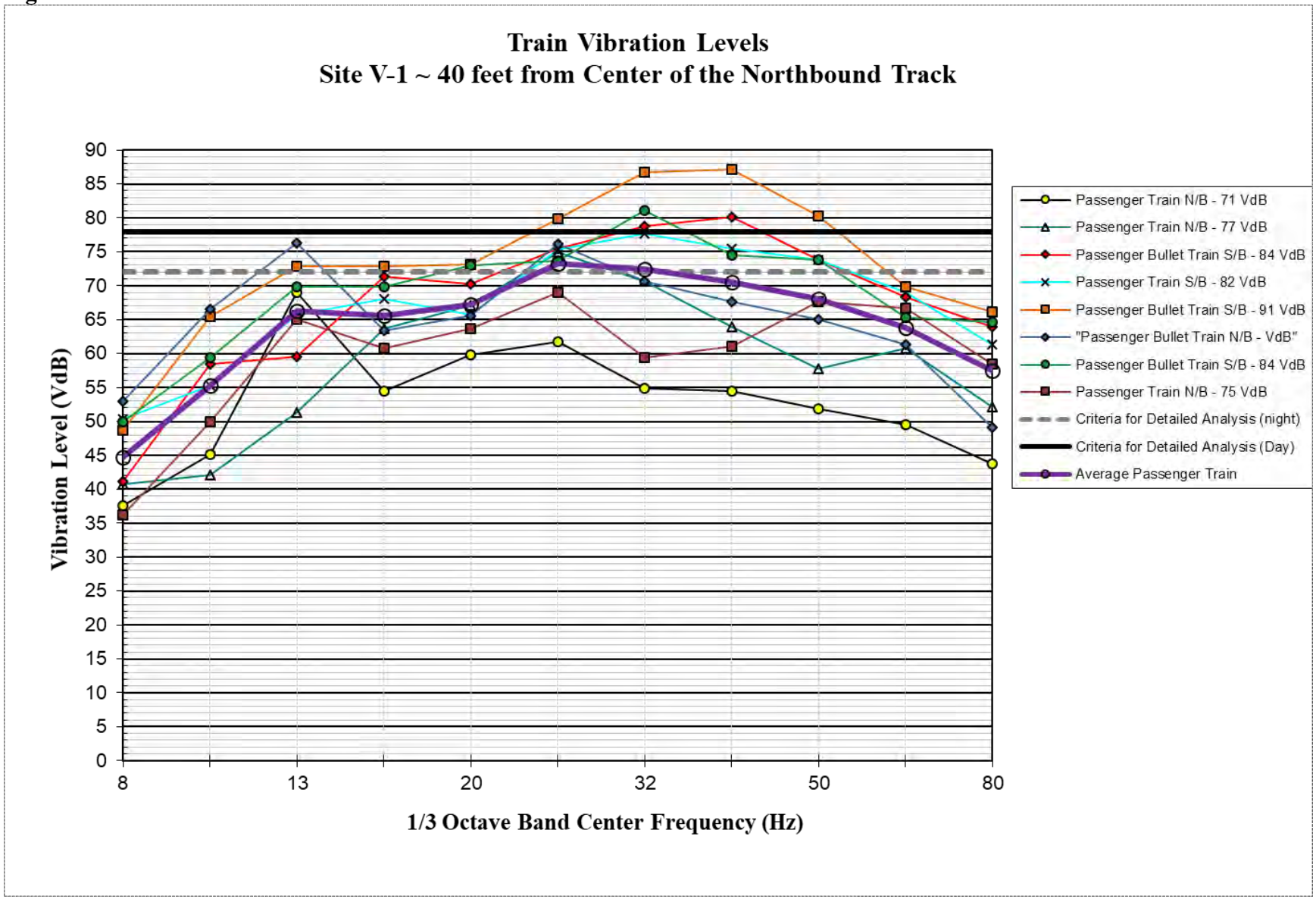


Figure A27. Railroad Train Vibration Levels at V-2