MEMORANDUM

DATE: July 31, 2023

TO: Bill Hofman, Hofman Planning Associates

FROM: Jason Lui, Associate/Senior Noise Specialist

SUBJECT: Noise and Vibration Impact Analysis for the LEGOLAND California Project 2025 in Carlsbad, California (LSA Project No. 20231502)

INTRODUCTION

This noise and vibration impact analysis has been prepared to evaluate the potential noise and vibration impacts and reduction measures associated with the LEGOLAND California Project 2025 (project) in Carlsbad, California. This memorandum is intended to satisfy the City of Carlsbad's (City) requirements and the California Environmental Quality Act for a project-specific noise and vibration impact analysis by examining the impacts of the proposed uses on the project site and evaluating the reduction measures that the project requires. All references cited in this memorandum are included in Attachment A.

Project Location

The 2.38-acre project site is located within the Legoland Theme Park in Carlsbad, San Diego County, California. The project is at the site of the existing "Driving School" and "Junior Driving School" attractions, which will be removed. The site is approximately 103,470 square feet (sf) [2.38 acres] in size with a generally flat topography. Local access to the project site is provided by Legoland Drive and Crossings Drive. The project location is shown in Figure 1 (all figures are provided in Attachment B).

Project Description

The new attraction area will have a "space" theme where park guests will train for space exploration, meet other intergalactic travelers, and blast off on missions into the LEGO Galaxy!

The proposed project would demolish the existing "Driving School" and "Junior Driving School" attractions and redevelop the site with a new attraction called "Project Mars." Existing site development to be removed includes the driving school courses, queues, shade covers, a small retail facility, and landscaping. Figure 2 illustrates the project site plan. The major components of the proposed project are as follows:

- **Primary Ride:** The ride consists of an indoor roller coaster housed inside a new single-story, 32,319 sf, 44-foot-high pre-manufactured steel building. Ancillary uses within the building include the ride queue, a LEGO brick building attraction, retail, and maintenance, as well as mechanical and storage spaces.

- **Secondary Ride:** This ride has three cantilever arms that are lifted in the air by hydraulic actuators and carry a counter-rotating gyro element holding four gondolas at each end. The gondolas are designed to accommodate two riders to provide a capacity of up to 24 passengers.

- **A Playscape:** This would be an approximately 1,755 sf exterior area featuring a children's play structure with an alien spaceship theme.

- **A Toddler Play Area ("Tot Spot"):** The project also includes an approximately 1,234 sf exterior area designed for the smallest guests, with LEGO DUPLO play features, shade cover, and seating. Proposed site development will include grading, utilities, new hardscape, planting, and retrofitting of existing recycled water irrigation systems.

Construction would include demolition, site preparation, grading, and building construction activities. Construction of the proposed project is anticipated to commence in January 2024 and end in March 2025.

CHARACTERISTICS OF SOUND

Noise is usually defined as unwanted sound. Noise consists of any sound that may produce physiological or psychological damage and/or interfere with communication, work, rest, recreation, and sleep.

To the human ear, sound has two significant characteristics: pitch and loudness. Pitch is generally an annoyance, while loudness can affect the ability to hear. Pitch is the number of complete vibrations, or cycles per second, of a wave resulting in the tone's range from high to low. Loudness is the strength of a sound that describes a noisy or quiet environment and is measured by the amplitude of the sound wave. Loudness is determined by the intensity of the sound waves combined with the reception characteristics of the human ear. Sound intensity refers to how hard the sound wave strikes an object, which in turn produces the sound's effect. This characteristic of sound can be precisely measured with instruments. The analysis of a project defines the noise environment of the project area in terms of sound intensity and its effect on adjacent sensitive land uses.

Measurement of Sound

Sound intensity is measured through the A-weighted scale to correct for the relative frequency response of the human ear. That is, an A-weighted noise level deemphasizes low and very high frequencies of sound similar to the human ear's de-emphasis of these frequencies. Decibels (dB), unlike the linear scale (e.g., inches or pounds), are measured on a logarithmic scale, which is a scale based on powers of 10.

For example, 10 decibels is 10 times more intense than 0 dB, 20 dB is 100 times more intense than 0 dB, and 30 dB is 1,000 times more intense than 0 dB. Thirty decibels (30 dB) represents 1,000 times as much acoustic energy as 0 dB. The decibel scale increases as the square of the change, representing the sound pressure energy. A sound as soft as human breathing is about 10 times greater than 0 dB. The decibel system of measuring sound gives a rough connection between the physical intensity of sound and its perceived loudness to the human ear. A 10 dB increase in sound level is perceived by the human ear as only a doubling of the loudness of the sound. Ambient sounds generally range from 30 dB (very quiet) to 100 dB (very loud).

Sound levels are generated from a source, and their decibel level decreases as the distance from that source increases. Sound dissipates exponentially with distance from the noise source. For a single point source, sound levels decrease approximately 6 dB for each doubling of distance from the source. This drop-off rate is appropriate for noise generated by stationary equipment. If noise is produced by a line source (e.g., highway traffic or railroad operations), the sound decreases 3 dB for each doubling of distance in a hard site environment; however, line source noise in a relatively flat environment with absorptive vegetation decreases 4.5 dB for each doubling of distance.

There are many ways to rate noise for various time periods, but an appropriate rating of ambient noise affecting humans also accounts for the annoying effects of sound. The equivalent continuous sound level (L_{eq}) is the total sound energy of time-varying noise over a sample period. However, the predominant rating scales for human communities in the State of California are the L_{eq} and community noise equivalent level (CNEL) or the day-night average noise level (L_{dn}) based on A-weighted decibels (dBA). CNEL is the time-varying noise over a 24-hour period, with a 5 dBA weighting factor applied to the hourly L_{eq} for noises occurring from 7:00 p.m. to 10:00 p.m. (defined as relaxation hours), and a 10 dBA weighting factor applied to noises occurring from 10:00 p.m. to 7:00 a.m. (defined as sleeping hours). L_{dn} is similar to the CNEL scale but without the adjustment for events occurring during the evening hours. CNEL and L_{dn} are within 1 dBA of each other and are normally interchangeable. The City uses the CNEL noise scale for long-term noise impact assessment.

Other noise rating scales of importance when assessing the annoyance factor include the maximum noise level (L_{max}), which is the highest exponential time-averaged sound level that occurs during a stated time period. The noise environments discussed in this analysis for short-term noise impacts are specified in terms of maximum levels denoted by L_{max}, which reflects peak operating conditions and addresses the annoying aspects of intermittent noise. L_{max} is often used together with another noise scale, or noise standards in terms of percentile noise levels, in noise ordinances for enforcement purposes. For example, the L_{10} noise level represents the noise level exceeded 10 percent of the time during a stated period. The L_{50} noise level represents the median noise level. Half the time the noise level exceeds this level, and half the time, it is less than this level. The L_{90} noise level represents the noise level exceeded 90 percent of the time and is considered the background noise level during a monitoring period. For a relatively constant noise source, the L_{eq} and L_{50} are approximately the same.

Noise impacts can be described in three categories. The first category includes audible impacts that refer to increases in noise levels noticeable to humans. Audible increases in noise levels generally refer to a change of 3 dB or greater because this level has been found to be barely perceptible in exterior environments. The second category, potentially audible, refers to a change in the noise level between 1 dB and 3 dB. This range of noise levels has been found to be noticeable only in laboratory environments. The last category includes changes in noise levels of less than 1 dB, which are inaudible to the human ear. Only audible changes in existing ambient or background noise levels are considered potentially significant.

Physiological Effects of Noise

Physical damage to human hearing begins at prolonged exposure to noise levels higher than 85 dBA. Exposure to high noise levels affects the entire system, with prolonged noise exposure in excess of 75 dBA increasing body tensions, thereby affecting blood pressure and functions of the heart and the nervous system. In comparison, extended periods of noise exposure above 90 dBA would result in permanent cell damage. When the noise level reaches 120 dBA, a tickling sensation occurs in the human ear, even with short-term exposure. This level of noise is called the threshold of feeling. As the sound reaches 140 dBA, the tickling sensation is replaced by the feeling of pain in the ear (the threshold of pain). A sound level of 160–165 dBA will result in dizziness or loss of equilibrium. The ambient or background noise problem is widespread and generally more concentrated in urban areas than in outlying, less developed area. Table A lists definitions of acoustical terms, and Table B shows common sound levels and their sources.

Table A: Definitions of Acoustical Terms

Term	Definitions
Decibel, dB	A unit of measurement that denotes the ratio between two quantities that are proportional to power; the number of decibels is 10 times the logarithm (to the base 10) of this ratio.
Frequency, Hz	Of a function periodic in time, the number of times that the quantity repeats itself in 1 second (i.e., number of cycles per second).
A-Weighted Sound Level, dBA	The sound level obtained by use of A-weighting. The A-weighting filter deemphasizes 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. (All sound levels in this report are A-weighted, unless reported otherwise.)
L_{01}, L_{10}, L_{50}, L_{90}	The fast A-weighted noise levels that are equaled or exceeded by a fluctuating sound level 1%, 10%, 50%, and 90% of a stated time period.
Equivalent Continuous Noise Level, L_{eq}	The level of a steady sound that, in a stated time period and at a stated location, has the same A-weighted sound energy as the time-varying sound.
Community Noise Equivalent Level, CNEL	The 24-hour A-weighted average sound level from midnight to midnight, obtained after the addition of 5 dBA to sound levels occurring in the evening from 7:00 PM to 10:00 PM and after the addition of 10 dBA to sound levels occurring in the night between 10:00 PM and 7:00 AM.
Day/Night Noise Level, L_{dn}	The 24-hour A-weighted average sound level from midnight to midnight, obtained after the addition of 10 dBA to sound levels occurring in the night between 10:00 PM and 7:00 AM.
L_{max}, L_{min}	The maximum and minimum A-weighted sound levels measured on a sound level meter, during a designated time interval, using fast time averaging.
Ambient Noise Level	The all-encompassing noise associated with a given environment at a specified time; usually a composite of sound from many sources at many directions, near and far; no particular sound is dominant.
Intrusive	The noise that 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 1991).

Table B: Common Sound Levels and Their Noise Sources

Noise Source	A-Weighted Sound Level in Decibels	Noise Environments	Subjective Evaluations
Near Jet Engine	140	Deafening	128 times as loud
Civil Defense Siren	130	Threshold of Pain	64 times as loud
Hard Rock Band	120	Threshold of Feeling	32 times as loud
Accelerating Motorcycle at a Few Feet Away	110	Very Loud	16 times as loud
Pile Driver; Noisy Urban Street/Heavy City Traffic	100	Very Loud	8 times as loud
Ambulance Siren; Food Blender	95	Very Loud	—
Garbage Disposal	90	Very Loud	4 times as loud
Freight Cars; Living Room Music	85	Loud	—
Pneumatic Drill; Vacuum Cleaner	80	Loud	2 times as loud
Busy Restaurant	75	Moderately Loud	—
Near Freeway Auto Traffic	70	Moderately Loud	—
Average Office	60	Quiet	One-half as loud
Suburban Street	55	Quiet	—
Light Traffic; Soft Radio Music in Apartment	50	Quiet	One-quarter as loud
Large Transformer	45	Quiet	—
Average Residence without Stereo Playing	40	Faint	One-eighth as loud
Soft Whisper	30	Faint	—
Rustling Leaves	20	Very Faint	—
Human Breathing	10	Very Faint	Threshold of Hearing
—	0	Very Faint	—

Source: Compiled by LSA (2015).

FUNDAMENTALS OF VIBRATION

Vibration refers to ground-borne noise and perceptible motion. Ground-borne vibration is almost exclusively a concern inside buildings and is rarely perceived as a problem outdoors, where the motion may be discernible, but without the effects associated with the shaking of a building there is less adverse reaction. Vibration energy propagates from a source through intervening soil and rock layers to the foundations of nearby buildings. The vibration then propagates from the foundation throughout the remainder of the structure. Building vibration may be perceived by occupants as the motion of building surfaces, the rattling of items on shelves or hanging on walls, or a low-frequency rumbling noise. The rumbling noise is caused by the vibration of walls, floors, and ceilings that radiate sound waves. Annoyance from vibration often occurs when the vibration exceeds the threshold of perception by 10 vibration velocity decibels (VdB) or less. This is an order of magnitude below the damage threshold for normal buildings. Typical sources of ground-borne vibration are construction activities (e.g., blasting, pile driving, and operating heavy-duty earthmoving equipment), steel-wheeled trains, and occasional traffic on rough roads. Ground-borne vibration and noise from these sources are usually localized to areas within approximately 100 feet (ft) from the vibration source, although there are examples of ground-borne vibration causing interference out to distances greater than 200 ft (see the Federal Transit Administration's [FTA] 2018 *Transit Noise and Vibration Impact Assessment Manual* [FTA Manual]). When roadways are smooth, vibration from traffic, even heavy trucks, is rarely perceptible. It is assumed for most projects that the roadway surface will be smooth enough that ground-borne vibration from street traffic will not exceed the impact criteria; however, both construction of a project and freight train operations on railroad tracks could result in ground-borne vibration that may be perceptible and annoying.

Ground-borne noise is not likely to be a problem because noise arriving via the normal airborne path will usually be greater than ground-borne noise. Ground-borne vibration has the potential to disturb people and damage buildings. Although it is very rare for train-induced ground-borne vibration to cause cosmetic building damage, it is not uncommon for heavy-duty construction processes (e.g., blasting and pile driving) to cause vibration of sufficient amplitudes to damage nearby buildings (FTA 2018). Ground-borne vibration is usually measured in terms of vibration velocity, either the root-mean-square (RMS) velocity or peak particle velocity (PPV). The RMS is best for characterizing human response to building vibration, and PPV is used to characterize potential for damage. Decibel notation acts to compress the range of numbers required to describe vibration. Vibration velocity level in decibels is defined as:

$$L_v = 20 \log_{10} [V/V_{ref}]$$

where Lv is the VdB, "V" is the RMS velocity amplitude, and "Vref" is the reference velocity amplitude, or 1×10^{-6} inches/second (in/sec) used in the United States.

REGULATORY SETTING

Federal Guidelines

Federal Transit Administration

Noise. The construction noise criteria included in the FTA Manual (2018) were used to evaluate potential construction noise impacts because Section 8.48.010 of the City's Municipal Code does not have daytime construction noise level limits for activities that occur within the specified hours. Table C shows the FTA's Detailed Assessment Daytime Construction Noise Criteria based on the composite noise levels for each construction phase.

Table C: Detailed Assessment Daytime Construction Noise Criteria

Land Use	Daytime 1-hour L_{eq} (dBA)
Residential	80
Commercial	85
Industrial	90

Source: *Transit Noise and Vibration Impact Assessment Manual* (FTA 2018).
dBA = A-weighted decibels
L_{eq} = equivalent continuous sound level

Vibration. Vibration standards included in the FTA Manual (2018) were used to evaluate vibration impacts because the City does not have vibration standards. Table D provides the criteria for assessing the potential for interference or annoyance from vibration levels in a building, while Table E lists the potential vibration building damage criteria associated with construction activities.

Table D: Interpretation of Vibration Criteria for Detailed Analysis

Land Use	Maximum L_v (VdB)[1]	Description of Use
Workshop	90	Vibration that is distinctly felt. Appropriate for workshops and similar areas not as sensitive to vibration.
Office	84	Vibration that can be felt. Appropriate for offices and similar areas not as sensitive to vibration.
Residential Day	78	Vibration that is barely felt. Adequate for computer equipment and low-power optical microscopes (up to 20×).
Residential Night and Operating Rooms	72	Vibration is not felt, but ground-borne noise may be audible inside quiet rooms. Suitable for medium-power microscopes (100×) and other equipment of low sensitivity.

Source: *Transit Noise and Vibration Impact Assessment Manual* (FTA 2018).
[1] As measured in ⅓-octave bands of frequency over the frequency range 8 to 80 Hertz.
FTA = Federal Transit Administration
L_V = velocity in decibels
VdB = vibration velocity decibels

Table E: Construction Vibration Damage Criteria

Building Category	PPV (in/sec)	Approximate L_V (VdB)[1]
Reinforced concrete, steel, or timber (no plaster)	0.50	102
Engineered concrete and masonry (no plaster)	0.30	98
Non-engineered timber and masonry buildings	0.20	94
Buildings extremely susceptible to vibration damage	0.12	90

Source: *Transit Noise and Vibration Impact Assessment Manual* (FTA 2018).
[1] RMS vibration velocity in decibels (VdB) re 1 µin/sec.
µin/sec = microinches per second
FTA = Federal Transit Administration
in/sec = inches per second
L_V = velocity in decibels
PPV = peak particle velocity
RMS = root-mean-square
VdB = vibration velocity decibels

Local Regulations

City of Carlsbad

Noise Element of the General Plan. The Noise Element of the City's General Plan (2015) has established allowable exterior and interior noise exposure for various land uses, noise standards from non-transportation noise sources (stationary noise sources), and policies to meet the City's noise-related goals. The allowable exterior and interior noise exposure for each land use are summarized in Table F and noise standards from stationary noise sources are shown in Table G. Applicable goals and policies for the proposed project are listed below.

- **Goal 5-G.3.** Guide the location and design of transportation facilities, industrial uses and other potential noise generators to minimize the effects of noise on adjacent land uses.

- **Policy 5-P.5.** Noise Generation. As part of development project approval, require that noise generated by a project does not exceed standards established in Table 5-3 (Table G).

Table F: Allowable Noise Exposure[1]

Land Use	Outdoor Activity Areas[2,3] (dBA CNEL)	Interior Spaces (dBA CNEL)
Residential	60[4]	45
Motels, Hotels	65	45
Hospitals, Residential Care Facilities, Schools, Libraries, Museums, Churches, Day Care Facilities	65	45
Playgrounds, Parks, Recreation Uses	65	50
Commercial and Office Uses	65	50
Industrial Uses	70	65

Source: City of Carlsbad General Plan Noise Element (September 2015).

1 Development proposed within the McClellan-Palomar Airport Area of Influence shall also be subject to the noise compatibility policies contained in the ALUCP.

2 The standard does not apply for nonresidential uses where an outdoor activity area is not proposed. Where the location of outdoor activity areas is unknown, the exterior noise level standard shall be applied to the property line of the receiving use.

3 Where it is not possible to reduce noise in outdoor activity areas to the allowable maximum, levels up to 5 dBA higher may be allowed provided that available exterior noise level reduction measures have been implemented and interior noise levels are in compliance with this table.

4 An exterior noise exposure level of 65 dBA CNEL is allowable for residential uses in a mixed-use project and for residential uses within the McClellan-Palomar Airport Area of Influence, pursuant to the noise compatibility policies contained in the ALUCP.

ALUCP = Airport Land Use Consistency Plan
CNEL = Community Noise Equivalent Level
dB = decibels
dBA = A-weighted decibels

Table G: Performance Standards for Non-Transportation Sources (As Measured at Property Line of Source/Sensitive Land Use)

Noise Level Descriptor	Daytime (7:00 a.m. to 10:00 p.m.)	Nighttime (10:00 p.m. to 7:00 a.m.)
Hourly L_{eq}, dBA	55	45
Maximum Level, dBA	75	65

Source: City of Carlsbad General Plan Noise Element (September 2015).
Note: Each of the noise levels specified above shall be lowered by 5 dBA for simple-tone noises, noises consisting of speech or music, or recurring impulsive noises.
dB = decibels
L_{eq} = Equivalent continuous sound level

Municipal Code. Section 8.48.010 of the City’s Municipal Code prohibits construction after 6:00 p.m. on any day and before 7:00 a.m. Monday through Friday and before 8:00 a.m. on Saturday. Construction is prohibited on Sundays and federal holidays.

EXISTING SETTING

Land Uses in the Project Vicinity

The project site is surrounded by a business park to the west across Legoland Drive and the existing theme park immediately to the north, east, and south. Noise-sensitive land uses closest to the project site include residences located approximately 2,900 ft to the south and a resort hotel approximately 780 ft to the south.

Overview of the Existing Noise Environment

The primary existing noise sources in the project area are transportation facilities. Traffic on Legoland Drive and other local streets contributes to the ambient noise levels in the project vicinity. Noise from motor vehicles is generated by engines, interaction between tires and the road, and vehicle exhaust systems. In addition, business park industrial activities and McClellan-Palomar airport operations contribute to the background ambient noise in the project vicinity.

Existing Aircraft Noise

The McClellan-Palomar Airport is 1.3 miles east of the project site. The future airport noise contour map contained in the McClellan-Palomar Airport Land Use Compatibility Plan (SDCALUC 2011) shows that the project site is located within the 60 to 65 dBA CNEL noise contour. Also, there are no private airstrips within 2 miles of the project site. The project site is a theme park, and the land use would be similar to recreational and commercial use, which would be considered compatible uses based on the McClellan-Palomar Airport noise compatibility criteria and the allowable noise exposure levels from the City's Noise Element of the General Plan. In addition, the project would not change the noise exposure levels for people working in the project area. Therefore, the project would not expose people working in the project area to excessive noise levels, and this topic is not further discussed.

IMPACTS

Short-Term Construction Noise Impacts

Two types of short-term noise impacts would occur during project construction. The first type would be from construction crew commutes and the transport of construction equipment and materials to the project site and would incrementally raise noise levels on roadways leading to the project site. The pieces of construction equipment for construction activities would move on site, would remain for the duration of each construction phase, and would not add to the daily traffic volume in the project vicinity. Although there would be a relatively high single-event noise exposure potential causing intermittent noise nuisance (passing trucks at 50 ft would generate up to a maximum of 84 dBA), the effect on longer-term ambient noise levels would be small because the number of daily construction-related vehicle trips is small compared to existing daily traffic volume on roadways leading to the project site. The grading phase would generate the most trips out of all of the construction phases, at a Passenger Car Equivalent (PCE) of 263 trips per day based on the California Emissions Estimator Model (CalEEMod) (Version 2022.1) results contained in Attachment B of the *Air Quality Impact Analysis Memorandum for the LEGOLAND California Project 2025* (LSA 2023). Roadways leading to the project site would have traffic volumes higher than 263, and construction-related traffic would not double the traffic volume on roadways leading to the project. It takes a doubling of traffic to increase traffic noise levels by 3 dBA. Therefore, construction-related traffic would not increase noise by 3 dBA. A noise level increase of less than 3 dBA would not be perceptible to the human ear in an outdoor environment. Therefore, no short-term, construction-related impacts associated with worker commutes and transport of construction equipment and material to the project site would occur, and no noise reduction measures would be required.

The second type of short-term noise impact is related noise generated from construction activities. Construction is performed in discrete steps, each of which has its own mix of equipment and, consequently, its own noise characteristics. The proposed project anticipates demolition, site preparation, grading, building construction, paving, and architectural coating phases of construction. These various sequential phases change the character of the noise generated on a project site. Therefore, the noise levels vary as construction progresses. Despite the variety in the type and size of construction equipment, similarities in the dominant noise sources and patterns of operation allow construction-related noise ranges to be categorized by work phase. Table H lists the L_{max} recommended for noise impact assessments for typical construction equipment included in the Federal Highway Administration's (FHWA) *Highway Construction Noise Handbook* (2006), based on a distance of 50 ft between the equipment and a noise receptor.

Table H: Typical Construction Equipment Noise Levels

Equipment Description	Acoustical Usage Factor[1] (%)	Maximum Noise Level (L_{max}) at 50 ft[2]
Backhoe	40	80
Compactor (ground)	20	80
Compressor	40	80
Crane	16	85
Dozer	40	85
Dump Truck	40	84
Excavator	40	85
Flatbed Truck	40	84
Man Lift (Forklift)	20	85
Front-End Loader	40	80
Generator	50	82
Generator (<25KVA, VMS signs)	50	70
Grader	40	85
Jackhammer	20	85
Pavement Scarifier	20	85
Paver	50	85
Pickup Truck	40	55
Pneumatic Tools	50	85
Pump	50	77
Rock Drill	20	85
Roller	20	85
Scraper	40	85
Tractor	40	84
Welder/Torch	40	73

Source: Table 9.1, *FHWA Highway Construction Noise Handbook* (FHWA 2006).
Note: The noise levels reported in this table are rounded to the nearest whole number.
1 Usage factor is the percentage of time during a construction noise operation that a piece of construction equipment is operating at full power.
2 Maximum noise levels were developed based on Specification 721.560 from the CA/T program to be consistent with the City of Boston, Massachusetts, Noise Code for the "Big Dig" project.
CA/T = Central Artery/Tunnel
FHWA = Federal Highway Administration
ft = foot/feet
L_{max} = maximum instantaneous noise level

Table I lists the anticipated construction equipment for each construction phase based on the CalEEMod (Version 2020.4.0) results contained in Attachment B of the *Air Quality Impact Analysis Memorandum for the LEGOLAND California Project 2025* (LSA 2023). Table I shows the combined noise level at 50 ft from all of the equipment in each phase and the L_{eq} noise level for each piece of equipment at 50 ft based on the quantity, reference instantaneous maximum (L_{max}) noise level at 50 ft, and the acoustical usage factor. As shown in Table I, construction noise levels would reach up to 87.1 L_{eq} at a distance of 50 ft.

Table I: Summary of Construction Phase, Equipment, and Noise Levels

Construction Phase	Construction Equipment	Quantity	Reference Noise Level at 50 ft (dBA L_{max})	Acoustical Usage Factor[1] (%)	Noise Level at 50 ft (dBA L_{eq})	Combined Noise Level at 50 ft (dBA L_{eq})
Demolition	Front-End Loader	3	80	40	80.8	86.5
	Dozer	1	85	40	81.0	
	Concrete Saw	1	90	20	83.0	
Site Preparation	Graders	1	85	40	81.0	84.7
	Scraper	1	85	40	81.0	
	Front-End Loader	1	80	40	76.0	
Grading	Graders	1	85	40	81.0	85.2
	Dozers	1	85	40	81.0	
	Front-End Loader	2	80	40	79.0	
Building Construction	Cranes	1	85	16	77.0	85.1
	Forklifts	2	85	20	81.0	
	Generator	1	82	50	79.0	
	Front-End Loader	1	80	40	76.0	
	Welders	3	73	40	73.8	
Paving	Front-End Loader	1	80	40	76.0	87.1
	Pavers	1	85	50	82.0	
	Pavement Scarafier	1	85	20	78.0	
	Rollers	2	85	20	81.0	
	Concrete Mixer Truck	1	85	40	81.0	
Architectural Coating	Air Compressors	1	80	40	76.0	76.0

Source: Compiled by LSA (2023).

[1] The acoustical usage factor is the percentage of time during a construction noise operation that a piece of construction equipment operates at full power.

dBA = A-weighted decibels
ft = foot/feet
L_{eq} = equivalent continuous sound level
L_{max} = maximum instantaneous noise level

The closest residence and resort hotel property lines are approximately 3,065 ft and 925 ft, respectively, from the center of the project site and may be subject to short-term construction noise reaching 51.4 and 61.8 dBA L_{eq}, generated by construction activities in the project area. Construction noise is temporary and would stop once project construction is completed. Compliance with the City's hours of construction pursuant to Section 8.48.010 of the City's Municipal Code listed below would ensure construction-related noise would not be generated during the more sensitive nighttime hours. Furthermore, construction-related noise levels would be below the FTA noise level standards of 80 and 85 dBA L_{eq} for residential and commercial uses, respectively. Therefore, no construction noise impacts would occur, and no noise reduction measures are required.

- The construction contractor shall limit construction activities to between the hours of 7:00 a.m. and 6:00 p.m. on weekdays and between the hours of 8:00 a.m. and 6:00 p.m. on Saturdays pursuant to Section 8.48.010 of the City's Municipal Code (City of Carlsbad 2023). Construction is prohibited outside these hours and on Sundays and federal holidays.

Short-Term Construction Vibration Impacts

This construction vibration impact analysis discusses the level of human annoyance using vibration levels in RMS (VdB) and assesses the potential for building damage using vibration levels in PPV (in/sec). Vibration levels calculated in RMS velocity are best for characterizing human response to building vibration, whereas vibration levels in PPV are best for characterizing damage potential.

Table J shows the reference vibration levels at a distance of 25 ft for each type of standard construction equipment from the FTA Manual (2018). Project construction is expected to require the use of large bulldozers and loaded trucks, which would generate ground-borne vibration levels of up to 87 VdB (0.089 PPV [in/sec]) and 86 VdB (0.076 PPV [in/sec]), respectively, when measured at 25 ft.

Table J: Vibration Source Amplitudes for Construction Equipment

Equipment	Reference PPV/L_V at 25 ft	
	PPV (in/sec)	L_V (VdB)[1]
Pile Driver (Impact), Typical	0.644	104
Pile Driver (Sonic), Typical	0.170	93
Vibratory Roller	0.210	94
Hoe Ram	0.089	87
Large Bulldozer[2]	**0.089**	**87**
Caisson Drilling	0.089	87
Loaded Trucks[2]	**0.076**	**86**
Jackhammer	0.035	79
Small Bulldozer	0.003	58

Source: *Transit Noise and Vibration Impact Assessment Manual* (FTA 2018).

[1] RMS vibration velocity in decibels (VdB) is 1 μin/sec.

[2] The equipment shown in **bold** is expected to be used on site.

μin/sec = microinches per second
ft = foot/feet
FTA = Federal Transit Administration
in/sec = inches per second
L_V = vibration velocity in decibels
PPV = peak particle velocity
RMS = root-mean-square
VdB = vibration velocity decibels

The greatest vibration levels are anticipated to occur during the site preparation and grading phases. All other phases are expected to result in lower vibration levels. The distance to the nearest buildings for vibration impact analysis is measured between the nearest off-site buildings and the project boundary (assuming the construction equipment would be used at or near the project boundary) because vibration impacts normally occur within the buildings.

The formula for vibration transmission is provided below:

$$L_v dB (D) = L_v dB (25 \text{ ft}) - 30 \text{ Log } (D/25)$$

$$PPV_{equip} = PPV_{ref} \times (25/D)^{1.5}$$

Table K lists the projected vibration levels from various construction equipment expected to be used on the project site in the active construction area to the nearest buildings in the project vicinity. As shown in Table K, the closest building to the west is approximately 565 ft from the center of the project and would experience a vibration level of up to 46 VdB. This vibration level would not have the potential to result in community annoyance because vibration levels would not exceed the FTA community annoyance threshold of 84 VdB for offices and buildings not as sensitive to vibration.

Table K: Potential Construction Vibration Annoyance

Land Use	Direction	Equipment/ Activity	Reference Vibration Level (VdB) at 25 ft	Distance to Structure (ft)[1]	Vibration Level (VdB)
Business Park	West	Large bulldozers	87	565	46
		Loaded trucks	86	565	45

Source: Compiled by LSA (2023).
Note: The FTA threshold perception is 65 VdB.
[1] Distance from the center of the project site to the building structure.
ft = foot/feet
VdB = vibration velocity decibels
FTA = Federal Transit Administration

Similarly, Table L lists the projected vibration levels from various construction equipment expected to be used on the project site at the project construction boundary to the nearest off-site building in the project vicinity. As shown in Table L, the closest business park building west of the project site is approximately 305 ft from the project construction boundary and would experience a vibration level of up to 0.002 PPV (in/sec). These vibration levels would not result in building damage because business park buildings would be constructed equivalent to or better than non-engineered timber and masonry and vibration levels would not exceed the FTA vibration damage threshold of 0.20 PPV (in/sec). Therefore, no construction vibration impacts during project construction would occur. No vibration reduction measures are required.

Table L: Potential Construction Vibration Damage

Land Use	Direction	Equipment/ Activity	Reference Vibration Level at 25 ft	Distance to Structure (ft)[1]	Vibration Level
			PPV (in/sec)		PPV (in/sec)
Business Park	West	Large bulldozers	0.089	305	0.002
		Loaded trucks	0.076	305	0.002

Source: Compiled by LSA (2023).
Note: The FTA-recommended building damage threshold is 0.20 PPV [in/sec]) at the receiving non-engineered timber and masonry building.
[1] Distance from the project construction boundary to the building structure.
ft = foot/feet
PPV = peak particle velocity
FTA = Federal Transit Administration
VdB = vibration velocity decibels
in/sec = inches per second

Long-Term Traffic Noise Impacts

Based on the *LEGOLAND California Project 2025 – California Environmental Quality Act (CEQA) Infill Development Categorical Exemption (Transportation)* [C^2 Consulting Collective 2023], the trip generation of the project is not expected to change because there is no expansion of the existing LEGOLAND theme park footprint and there is no measurable change to the land use type. Given the above, traffic noise along roadways leading to the project site would remain the same under with project condition. Therefore, no traffic noise impacts from project-related traffic on off-site sensitive receptors would occur. No noise reduction measures are required.

Long-Term Stationary Noise Impacts

As discussed above, the proposed project would replace the existing "Driving School" and "Junior Driving School" attractions. Based on the project plans, the proposed project would include three rooftop heating, ventilation and air conditioning (HVAC) units, seven split air conditioning systems, and 19 outdoor speakers that would generate noise. It is expected that noise generated from the proposed project would be similar to the existing "Driving School" and "Junior Driving School" attractions as well as other attractions located within the theme park, particularly the existing "Emmet's Flying Adventure – Masters of Flight" attraction located immediately south of the proposed project, which is also an indoor ride. Noise-sensitive land uses closest to the project site include residences and a resort hotel to the south, which are located approximately 3,065 ft and 925 ft, respectively, from the center of the project. At these distances and a reference distance of 50 ft, noise would be attenuated by 35.7 dBA and 25.3 dBA, respectively. Based on the above, noise generated from the proposed project is not expected to exceed the City's daytime performance standards of 55 dBA L_{eq} and 75 dBA L_{max} for non-transportation sources (stationary sources). The City's nighttime performance standards for stationary sources would not be exceeded because the proposed project and the theme park would not operate during nighttime hours. Also, traffic noise on roadways closest to the nearest residences and the resort hotel south of the project site would be the primary noise source, and noise generated by the proposed project would not contribute to any perceptible increase in ambient noise level. Therefore, noise impacts from project operations would not occur. No noise reduction measures are required.

Long-Term Vibration Impacts

The proposed project would not generate vibration. In addition, vibration levels generated from project-related traffic on roadways leading to the project site are unusual for on-road vehicles because the rubber tires and suspension systems of on-road vehicles provide vibration isolation. Vibration generated from operations of the project would not exceed the FTA's vibration perception threshold of 65 VdB. Therefore, vibration impacts from project-related operations would be less than significant. No mitigation measures are required.

REGULATORY COMPLIANCE MEASURES

The following measure would ensure than construction noise be only generated during allowable times:

- The construction contractor shall limit construction activities to between the hours of 7:00 a.m. and 6:00 p.m. on weekdays and between the hours of 8:00 a.m. and 6:00 p.m. on Saturdays pursuant to Section 8.48.010 of the City's Municipal Code (City of Carlsbad 2023). Construction is prohibited outside these hours and on Sundays and federal holidays.

Attachments: A: References
B: Figures

ATTACHMENT A

REFERENCES

C[2] Consulting Collective. 2023. LEGOLAND California Project 2025 – California Environmental Quality Act (CEQA) Infill Development Categorical Exemption (Transportation). June 26.

City of Carlsbad. 2015. *Carlsbad General Plan, Noise Element*. September.

_____. 2023. *Municipal Code*. May.

Federal Highway Administration (FHWA). 2006. *Highway Construction Noise Handbook*. Roadway Construction Noise Model, FHWA-HEP-06-015. DOT-VNTSC-FHWA-06-02. NTIS No. PB2006-109012. August.

Federal Transit Administration (FTA). 2018. *Transit Noise and Vibration Impact Assessment Manual*. FTA Report No. 0123. September. Website: https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/research-innovation/118131/transit-noise-and-vibration-impact-assessment-manual-fta-report-no-0123_0.pdf (accessed July 2023).

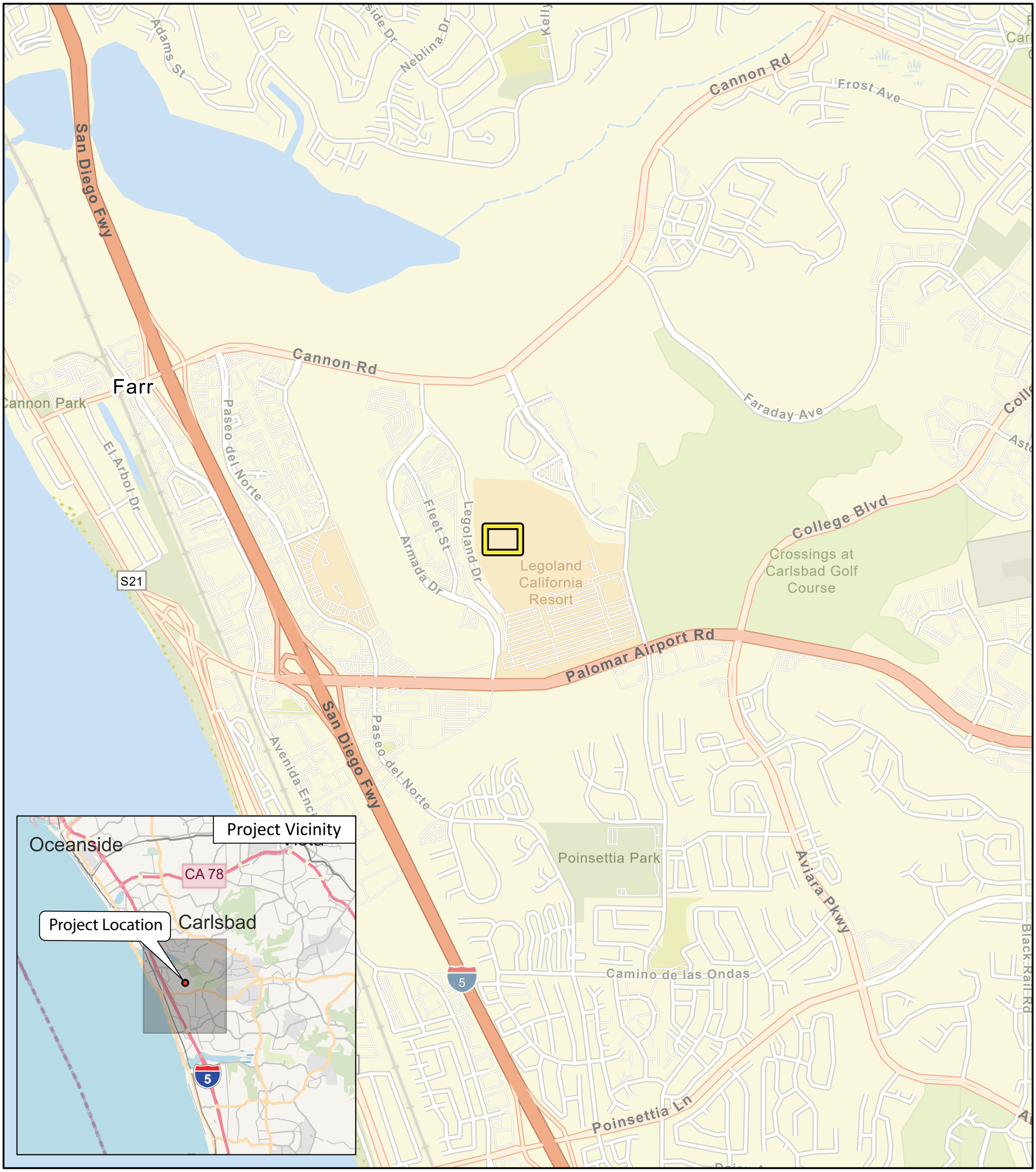
Harris, Cyril M., editor. 1991. *Handbook of Acoustical Measurements and Noise Control*. Third Edition.

LSA Associates, Inc. (LSA). 2023. *Air Quality Impact Analysis Memorandum for the LEGOLAND California Project 2025.* July 31.

San Diego County Airport Land Use Commission (SDCALUC). 2011. *McClellan-Palomar Airport Land Use Compatibility Plan.* December 1. Website: https://www.lee-associates.com/elee/sandiego/LeeLandTeam/Ponto/McClellan-Palomar_ALUCP_20111.pdf (accessed July 2023).

ATTACHMENT B

FIGURES



LSA

Project Location

FIGURE 1

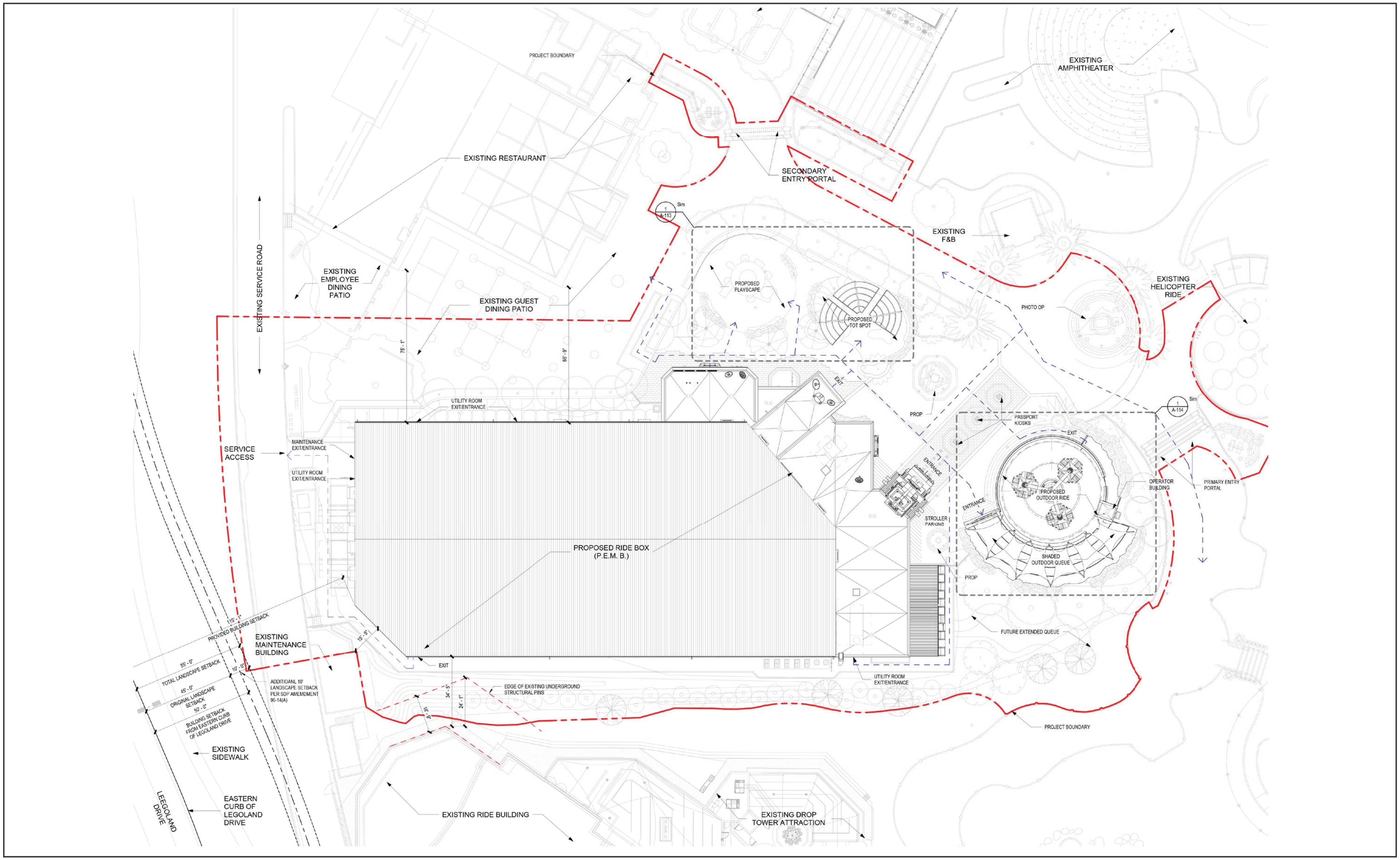
0 1000 2000
FEET

SOURCE: ESRI StreetMap, 2023

LEGOLAND California Project 2025

Project Location

I:\20231502\G\Location.ai (7/14/2023)



LSA

FIGURE 2

0 40 80
FEET

SOURCE: HHCP

LEGOLAND California Project 2025

Site Plan

I:\20231502\G\Site_Plan.ai (7/14/2023)