853 LINCOLN WAY, SUITE 208
AUBURN, CALIFORNIA 95603
T 530.887.8500 F 530.887.1250

TECHNICAL MEMORANDUM

To:	Ryan Bane, Senior Planner, City of Santa Cruz
From:	Michael Carr, INCE
Subject:	190 West Cliff Drive (APN 004-081-12) – Noise Analysis
Date:	September 24, 2019
cc:	Stephanie Strelow, Dudek
Attachment(s):	Figure1 – Noise Monitoring Locations; Figure 2 – Project Site Plan Appendices A and B

Cliff Bay Partners, LLC is proposing to construct a four-story, mixed-use development consisting of two levels of underground parking, ground-floor commercial, and residential condominium units on the first through fourth floors at 190 West Cliff Drive (the Project). Concerns were raised in regards to construction noise and vibration associated with the proposed Project as well as operational noise associated with the underground parking garage. This memorandum provides a summary of the noise analysis prepared for the proposed 1Project specific to these issues. Appendix A provides a discussion of acoustical fundamentals and terminology used in this memorandum.

1 Project Information

The Project is located in the Beach and South of Laurel (BSOL) Comprehensive Planning Area of southern Santa Cruz, approximately one-tenth of a mile west of the Santa Cruz Wharf. The Project site is bounded by West Cliff Drive to the east, Bay Street to the south, a mobile home community to the west and north, and a motel to the ortheast of the proposed Project; a hotel also is located across West Cliff Drive (the Dream Inn) and multi-family residential is located further south across Bay Street. The proposed Project site is approximately 2.2 acres and is currently in use as an on-grade paved parking lot for the Dream Inn.

This Project would result in the construction of a four-story, mixed-use development on the proposed site, incorporating two levels of subterranean parking. Underground parking would be fully enclosed, with ingress and egress points along the western and northern perimeter driveway. Commercial and open space uses would comprise the majority of the ground level, with interspersed residential units. No active open space-public use areas are located on the western side of the Project adjacent to existing residences. The second through fourth floors would be residential condominium units with supplemental outdoor open space. Additional outdoor open space would be located above the top floor of residential units as a rooftop deck. A 6-foot tall sound wall is proposed along the western property line.

Construction of the proposed Project is estimated to occur over approximately two years, with excavation of the site taking approximately four months. Construction would require cut and fill volumes of approximately 60,600 cubic yards and 2,600 cubic yards, respectively, with a net of 58,000 cubic yards excavated from the site. Excess excavated material would be off-hauled from the site and disposed at an off-site approved site.

2 Regulatory Setting

The City of Santa Cruz has developed and adopted goals, policies, and actions with the intent of avoiding and minimizing adverse impacts associated with environmental noise within the City and to protect its inhabitants from exposure to excessive noise levels. Local noise standards applicable to the proposed Project are contained in the City of Santa Cruz General Plan and the Santa Cruz Municipal Code.

The City of Santa Cruz General Plan

Applicable noise standards in the City of Santa Cruz General Plan are contained within Chapter 8 of the General Plan (Hazards, Safety, and Noise). The Hazards, Safety, and Noise chapter contains specific goals, policies, and standards for use in planning and land compatibility determinations within the City of Santa Cruz. In particular, the Hazards, Safety, and Noise chapter establishes noise/land-use compatibility standards which are applicable to all new residential, commercial, and mixed-use projects (Figure 2 of the Hazards, Safety, and Noise chapter and Goal HZ3.2.1), and the General Plan seeks to ensure that noise standards are met in the siting of noise-sensitive uses (GP Goal HZ3.2). The Hazards, Safety, and Noise chapter policies establish a maximum interior noise level threshold of 45 dBA Ldn for all residential uses, consistent with California noise insulation standards. Figure 2 of the Hazards, Safety, and Noise chapter indicates that exterior noise levels up to 60 dBA Ldn are normally acceptable for residential development and exterior noise levels up to 65 dBA Ldn are normally acceptable for multi-family residential and transient residential development. Hazards, Safety, and Noise chapter policy HZ3.2.3 reiterates the “noise level target” of 65 dBA Ldn for outdoor activity areas associated with new multi-family residential developments.

The City of Santa Cruz Municipal Code

Chapters 9.36 and 24.14 of the City of Santa Cruz Municipal Code (SCMC) include provisions for noise regulations. The former prohibits excessive noise during nighttime hours (10:00 a.m. through 8:00 a.m.), but without any quantitative limits. However, the latter describes performance standards with respect to noise production from residential and commercial/industrial land uses: up to a 5 dB or 6 dB increase, respectively, above existing outdoor ambient sound levels.

3 Existing Conditions

3.1 Existing Ambient Noise Levels

An ambient noise survey was conducted by Dudek on September 10, 2019 to document the existing ambient noise in the vicinity of the proposed Project. Attended ambient noise level monitoring was performed at three (3) locations on the proposed Project site. Locations of the monitoring sites are presented on an aerial photograph of the area on Figure 1, represented as ST-1 through ST-3. Detailed observations about the measurement environment, existing noise sources, and other elements with the potential to affect the measurement or the Project analysis were documented throughout the monitoring program. The short-term monitoring locations ST-1 and ST-3 were intended to characterize ambient noise levels at the southern and eastern Project boundaries and to quantify traffic noise levels from Bay Street and West Cliff Drive. As such, noise experienced at the short-term monitoring locations ST-1 and ST-3 were predominantly influenced by vehicular traffic on the local roadway network. Short-term monitoring location ST-2 provides representative ambient daytime noise levels in the northwestern portion of the proposed Project site, adjacent to the northern parking garage access point.

Noise measurements were performed using Larson Davis Laboratories (LDL) Model 831 precision integrating sound level meters (SLMs). Field calibrations were performed on the SLM with an acoustic calibrator before and after the measurements. Equipment meets all pertinent specifications of ANSI S1.4-1983 (R2006) for Type 1 SLMs. All instrumentation components, including microphones, preamplifiers, and field calibrators have laboratory certified calibrations traceable to the National Institute of Standards and Technology (NIST). The microphones were located at a minimum height of 5-6 feet above the ground, an average height for a person standing, and located a sufficient distance away from reflective surfaces in the monitoring area. Noise measurements were performed in accordance with American National Standards Institute (ANSI) and American Standards for Testing and Measurement (ASTM) guidelines.

The noise monitoring equipment was configured to catalog all noise metrics pertinent to identification and evaluation of noise levels (i.e., Leq, Lmax, Ln, etc.) in the study area. Monitoring data was collected for the overall measurement period and each one-minute period.

Meteorological conditions during the ambient monitoring periods were stable with temperatures of 71 degrees Fahrenheit (F), light winds from 0 mph to 2 mph during most of the period with occasional gusts up to 5 mph, and cloudy skies. No precipitation was experienced during the monitoring period.

Overall noise levels measured at the short-term monitoring locations ranged from approximately 43 to 80 dBA SPL (sound pressure level); with average noise levels of 53 and 63 dBA Leq. Maximum noise levels documented during the monitoring survey were approximately 68 dBA to 79 dBA Lmax. Table 1 presents the overall monitoring results for each of the short-term monitoring locations.

Table 1. Summary of Event Noise Levels

Site	Description	Time	Average Noise Levels, dBA			
			Leq	Lmax	L50	L90
ST-1	Adjacent to Bay Street. At proposed southwest Project driveway and parking access	10:20 AM	62.5	78.6	58.9	50.1
ST-2	Northwestern Project boundary, adjacent to proposed garage access	10:57 AM	52.9	67.6	51.9	47.6
ST-3	Eastern Project boundary, adjacent to W Cliff Drive	11:20 AM	62.4	75.9	60.4	55.9

Notes:
dBA = A-weighted decibels; ; Leq = average equivalent noise level; Lmax = maximum noise level; L50 = sound level exceeded 50 percent of the period; L90 = sound level exceeded 90 percent of the period.
Locations of noise monitoring sites are shown on Figure 1.

3.2 Existing Traffic Noise Levels

The City of Santa Cruz General Plan 2030 EIR contains existing and future roadway noise levels for the City of Santa Cruz. Existing roadway noise levels presented in the City of Santa Cruz Noise Element were prepared for the 2008 condition; with Future Traffic Noise Levels representing projected traffic noise for the year of 2030.

The roadway traffic noise analysis presented in the Noise Element utilized the Federal Highway Administration (FHWA) Traffic Noise Model 2.5 (TNM 2.5). The FHWA Traffic Noise Model gives consideration for vehicle volume, mix of vehicle types (automobile, medium trucks, and heavy trucks), speed, roadway configuration, distance to the receptor and other site characteristics that effect acoustic propagation. The City of Santa Cruz General Plan EIR traffic noise levels are presented below in Table 2.

Table 2. Summary of Traffic Noise Levels

Roadway	Segment	Existing Ldn at 50 ft from Roadway Centerline (dBA)	Future Condition			
			Ldn at 50 ft from Roadway Centerline (dBA)	Increase in Ldn (dBA)	Ldn Contour Distances (feet)	
					60 dB	65 dB
Bay Street	California Ave to West Cliff	65	66	0.9	200	70
West Cliff Drive	Bay to Pacific	64	65	0.8	160	50

Notes:
dBA = A-weighted decibels; Leq = average equivalent noise level, CNEL = Community Noise Equivalent Level.
Locations of noise monitoring sites are shown on Figure 1.
Source: City of Santa Cruz *General Plan EIR Table 4.13-3*

Site-specific traffic noise levels were further evaluated based on traffic noise levels and concurrent manual traffic counts performed during the ambient noise monitoring survey. Traffic noise measurement and vehicle classification counts were performed for Bay Street and West Cliff Drive. Traffic volumes and vehicle classification counts were used as inputs to the FHWA traffic noise prediction model. The results of the FHWA traffic noise prediction model were compared to the correlating measured noise levels. Modeled traffic noise levels were found to be reasonably consistent of the measured traffic noise levels. Furthermore, the measured traffic noise levels specific to the proposed Project site correlate well with the general roadway traffic noise level contours presented in the City of Santa Cruz General Plan EIR.

4 Project Analysis

4.1 Construction Noise

Construction activities associated with the proposed Project would be expected to occur over approximately two years, with excavation of the site taking approximately four months. Construction would require cut and fill volumes of approximately 60,600 cubic yards and 2,600 cubic yards, respectively, with a net of 58,000 cubic yards excavated from the site. Excess excavated material would be off-hauled from the site.

Construction noise and vibration are temporary phenomena. Construction noise and vibration levels vary from hour to hour and day to day, depending on the equipment in use, the operations performed, and the distance between the source and receptor.

Equipment that would be in use during construction would include, in part, graders, backhoes, rubber-tired dozers, loaders, cranes, forklifts, cement mixers, pavers, rollers, and air compressors. The typical maximum noise levels for various pieces of construction equipment at a distance of 50 feet are presented in Table 3. Note that the equipment noise levels presented in Table 3 are maximum noise levels. Usually, construction equipment operates in alternating cycles of full power and low power, producing average noise levels over time that are less than the maximum noise level. The average sound level of construction activity also depends on the amount of time that the equipment operates and the intensity of construction activities during that time.

Table 3. Typical Construction Equipment Maximum Noise Levels

Equipment Type	Typical Equipment (Lmax, dBA at 50 feet)
Backhoe	78
Compressor (air)	78
Concrete Saw	90
Crane	81
Dozer	82
Excavator	81
Front End Loader	79
Generator	72
Grader	85
Man Lift	75
Paver	77
Roller	80
Scraper	84
Tractor	84
Welder / Torch	73
All Other Equipment > 5 HP	85

Notes:
dBA = A-weighted decibels; Lmax = maximum noise level.
Source: DOT 2006.

Aggregate noise emission from proposed Project construction activities, broken down by sequential phase, was propagated from the geographic center of the construction site to the nearest noise-sensitive residential receptor, an approximate distance of 150 feet. The geographic center of construction operations serves as the time-averaged location or acoustical centroid of active construction equipment for the phase under study. This distance is used in a manner similar to the general assessment technique as described in the Federal Transit Administration (FTA) guidance for construction noise assessment, when the location of individual equipment for a given construction phase is uncertain, and assumed to operate over some extent of (or the entirety of) the construction site area. Because of this uncertainty, all the equipment for a construction phase is assumed to operate—on average—from the acoustical centroid and up to all 8 hours per an individual work day.

A construction noise prediction model employing the calculation algorithms and reference data from the FHWA Roadway Construction Noise Model (RCNM) (FHWA 2008) was used to estimate construction noise levels at the nearest occupied noise-sensitive land use. While the RCNM was funded and promulgated by the FHWA for use on roadway construction projects, it is often used for non-roadway projects, as the same types of construction equipment used for roadway projects are often used for other types of construction. Input variables for the predictive modeling consist of the equipment type and number of each (e.g., two graders, a loader, a tractor), the duty cycle for each piece of equipment (e.g., percentage of time within a specific time period, such as an hour, when the equipment is expected to operate at full power or capacity and thus make noise at a level comparable to what is presented in Table 3), and the distance from the noise-sensitive receiver. The predictive model also considers how many hours that equipment may be on site and operating (or idling) within an established work shift. Conservatively, no topographical or structural shielding was assumed in the modeling. The RCNM has default duty-cycle values for the various pieces of equipment, which were derived from an extensive study of typical construction activity patterns. The default duty-cycle values were used for this noise analysis, which is detailed in Appendix B, Construction Noise Modeling Input and Output. The predicted Project-related construction noise levels at the nearest noise-sensitive receptor are displayed in Table 4.

Table 4. Predicted Construction Noise Levels per Activity Phase

Construction Phase (and Equipment Types Involved)	8-Hour Leq at Nearest Noise-Sensitive Receptor to Acoustical Centroid of Site (dBA)
Demolition (dozer, excavator, concrete saw)	76
Site preparation (dozer, backhoe, front-end loader)	75
Grading (excavator, grader, dozer, front-end loader, backhoe, scraper)	74
Building construction (crane, man-lift, generator, backhoe, front-end loader, welder/torch)	71
Architectural finishes (air compressor)	64
Paving (paver, roller, other equipment)	77

Notes:
dBA = A-weighted decibels; Leq = equivalent noise level.

As presented in Table 4, the estimated construction noise levels are predicted to be as high as 77 dBA Leq over an 8-hour period at the nearest existing residences and thus comply with 80 dBA Leq, which the FTA recommends as a daytime threshold for construction noise exposure over an 8-hour period at a residential receptor. The FTA guidance is often used when there’s no local quantitative threshold (either ordinance or GP noise element) for construction noise.

Although nearby off-site residences would be exposed to elevated construction noise levels, the increased noise levels would typically be relatively short-term. It is anticipated that construction activities associated with the proposed Project would not take place during the hours of 10:00 PM through 8:00 AM, during which time Chapter 9.36.010 of the SCMC prohibits excessive noise. If construction needed to occur within these nighttime hours, Chapter 9.36.010(e) provides the City discretion to allow certain construction-related tasks or activities to occur (e.g., large concrete foundation pours that cannot be split over multiple days). If work were to occur outside of the allowable hours, annoyance or sleep disturbance could result from construction noise; also, the City's 6 dBA allowable increment over existing outdoor ambient sound level may be exceeded.

In summary, typical construction noise during allowable daytime hours would not exceed the aforementioned FTA guidance-based standard and would not be substantially higher than existing ambient daytime noise levels.

4.2 Construction Vibration

Construction activities have the potential to expose persons to excessive groundborne vibration or groundborne noise, causing a potentially significant impact. SCMC Chapter 24.14.262 is a performance standard can be interpreted as prohibiting perceptible vibration; however, construction activity is exempt. Therefore, to evaluate the potential for human annoyance when sufficiently proximate construction vibration occurs, both the FTA and Caltrans offer guidance in situations when local quantitative standards are lacking.

Caltrans has collected groundborne vibration information related to construction activities (Caltrans 2013) that indicate continuous vibrations with a peak particle velocity (PPV) of approximately 0.2 inches per second (in./sec.) is considered annoying. For context, heavier pieces of construction equipment, such as a bulldozer that may be expected on the project site, have peak particle velocities of approximately 0.089 in./sec. PPV or less at a reference distance of 25 feet (DOT 2006).

Groundborne vibration attenuates rapidly, even over short distances. The attenuation of groundborne vibration as it propagates from source to receptor through intervening soils and rock strata can be estimated with expressions found in FTA and Caltrans guidance. By way of example, for a bulldozer operating on site and as close as the western project boundary (i.e., 15 feet from the nearest receiving sensitive land use) the estimated vibration velocity level can be predicted with the equation as follows (FTA 2006):

$$PPV_{rcvr} = PPV_{ref} * (25/D)^{\wedge}1.5 \qquad 0.19 = 0.089 * (25/15)^{\wedge}1.5;$$

Where PPV_{rcvr} is the predicted vibration velocity at the receiver position (nearest receptor), PPV_{ref} is the reference value at 25 feet from the vibration source (the bulldozer), and D is the actual horizontal distance to the receiver. As shown in the equation above, and based on reference vibration data, a bulldozer would produce a vibration velocity of 0.19 in./sec. PPV at the nearest receptor during a pass-by. Therefore, at this predicted PPV, the impact of vibration-induced annoyance to occupants of nearby existing mobile homes would be less than significant.

Construction vibration, at sufficiently high levels, can also present a building damage risk. However, anticipated construction vibration associated with this proposed Project would yield levels of 0.19 in./sec. PPV, which is not predicted to exceed the guidance limit of 0.2 to 0.3 in./sec. PPV for preventing damage to residential structures (Caltrans 2013). As such, the predicted vibration level at 15 feet is less than this guidance limit, the risk of vibration damage to nearby structures is considered less than significant.

Once operational, the proposed project would not be expected to feature major producers of groundborne vibration. Anticipated mechanical systems like heating, ventilation, and air-conditioning units are designed and manufactured to feature rotating (fans, motors) and reciprocating (compressors) components that are well-balanced with isolated vibration within or external to the equipment casings. On this basis, potential vibration impacts due to proposed project operation would be less than significant.

4.3 Operational Noise Levels – HVAC

For purposes of this analysis, each of the new occupied residential units would be expected to feature (or share) a split-system type air-conditioning unit, with a refrigeration condenser unit mounted on the roof. The current roof plans suggest that the condenser units would be installed behind decks and stairwell enclosures to conceal their presence from casual observation, which would along with positions away from the roof perimeter and the rooftop parapet, help block their noise emission paths to nearby neighboring residential receptors. The apparent quantity and distribution of rooftop condenser units would result in the closest existing noise-sensitive residential receptors to the west or north of the Project being exposed to noise levels from up to four (4) condenser units at an approximate distance as close as 40 feet. Assuming each condenser unit has a sound emission source level of 74 dBA at 3 feet (Johnson Controls 2010), and accounting or the Project's roof height and the aforesaid presence of intervening rooftop features, the predicted sound emission level from the combination of four (4) condenser units would result in noise exposure levels of approximately 50 dBA Leq at the nearest noise-sensitive receptor. Therefore, operational noise levels generated by the Project's HVAC and mechanical systems would be compliant with the City's nighttime threshold of no more than 6 dB over the existing outdoor ambient sound level (per SCMC 24.14.260.2). See Appendix C for quantitative details of this prediction.

4.4 Operational Noise Levels – Parking Garage

Empirical sound level emission data for similar parking facilities would indicate that traffic associated with the proposed surface and sub-surface parking areas noise would not be of sufficient level or occurrence to exceed community noise standards based on a time-averaged scale such as CNEL or Leq (Mestre Greve Associates 2011). However, the instantaneous maximum sound levels generated by a car door slamming, an engine starting up, cars pass-by or tire squeal could have the propensity to result in annoyance at noise-sensitive land uses adjacent to the parking area ingress and egress points. These noise sources associated with parking activities are instantaneous rather than steady noise levels, and include sample Lmax value ranges at a distance of 50 feet as follows: door slamming (60-70 dBA); engine ignition (60-70 dBA); and car pass-bys (55-70 dBA) (Mestre Greve Associates 2011). While audible under the certain conditions, their contribution to the outdoor ambient sound environment would be akin to similar infrequent noises produced by vehicles starting up or parking on nearby streets. Additionally, the majority of the parking activities would be occurring within the enclosed underground parking areas, rather than at-grade, as the parking lot currently located on the proposed Project site. The proposed sound wall along the western property line would likely reduce noise to the first-floor neighboring receivers from first-floor level sources (i.e., onsite traffic, the parking garage entrance/exits, etc.). If it blocks direct line of sight between a sound source and receiver, there could be an approximate 3-5 dB reduction.

Because the two-level parking garage of the Project is subsurface, it will likely need to rely on exhaust fans to provide minimum levels of required ventilation: 0.75 cubic feet per minute (cfm) for each gross square foot (gsf) of usable parking area, per the International Mechanical Code (INTEC Controls 2018). For purposes of this analysis, it is assumed the approximate 135,000 gross square feet planned for parking could be ventilated by up to four (4) tube-axial type fans delivering airflow at 1-inch water gauge of static pressure, which would yield a total estimated fan sound power of 99 dBA Leq. Were these fans to be located at roof level on the above-surface structures, the closest existing noise-sensitive receptor to the west or north would be as near as 30 horizontal feet. Assuming that the fans are either located at roof level, or ducted upward to a roof-level discharge vent, the fans would likely be at least 25 feet above grade, and the fan/discharge vent would be behind the rooftop parapet wall. Accounting for the shielding provided by the parapet and reductions in the source noise level from typical axial fan installation methods, fan noise would be reduced by 16 dBA. Predicted sound levels from the closest ventilation fan at the nearest single-story residential receptor to the west or north (i.e., in Clearview Court) would be approximately 50 dBA Leq, and would thus be compliant with the City's nighttime threshold of no more than 6 dB over the existing outdoor ambient sound level (per SCMC 24.14.260.2). See Appendix D for quantitative details of this prediction.

5 Conclusion

Cliff Bay Partners, LLC is proposing to construct a four-story, mixed-use development consisting of two levels of underground parking, ground-floor commercial, and residential condominium units on the first through fourth floors. Dudek performed an acoustical analysis to address concerns associated with Project-related construction activities and operational noise associated with the parking garage.

As part of the analysis, Dudek conducted an existing ambient noise monitoring survey to characterize the existing noise environment on the site and to quantify traffic noise levels on West Cliff Drive and Bay Street. The measured traffic noise levels were found to be reasonably consistent with the traffic noise levels presented in the City of Santa Cruz General Plan 2030 EIR.

Construction activities associated with the proposed Project are expected to occur to varying levels for approximately two years. Construction activities are assumed to be limited to daytime hours and not occur during the more restrictive hours of 10:00 PM to 8:00 AM. Project-related construction noise levels were analyzed using FHWA RCNM and FTA algorithms and reference data. Project-related construction noise levels were calculated to comply with relevant FTA construction noise guidelines and the City of Santa Cruz's 6 dBA above ambient threshold.

Construction vibration levels anticipated to be associated with the proposed Project were calculated to yield levels of 0.19 in./sec. PPV. Project-related construction vibration levels are predicted to be less than the Caltrans guidance limit of 0.2 to 0.3 in./sec. PPV at the nearest sensitive receptors, located approximately 15 feet west and north of the proposed Project boundaries. Operational activities associated with the proposed Project are not anticipated to include major groundborne vibration generating sources or activities. As such, potential groundborne vibration impacts due to the propose Project operation would be less than significant.

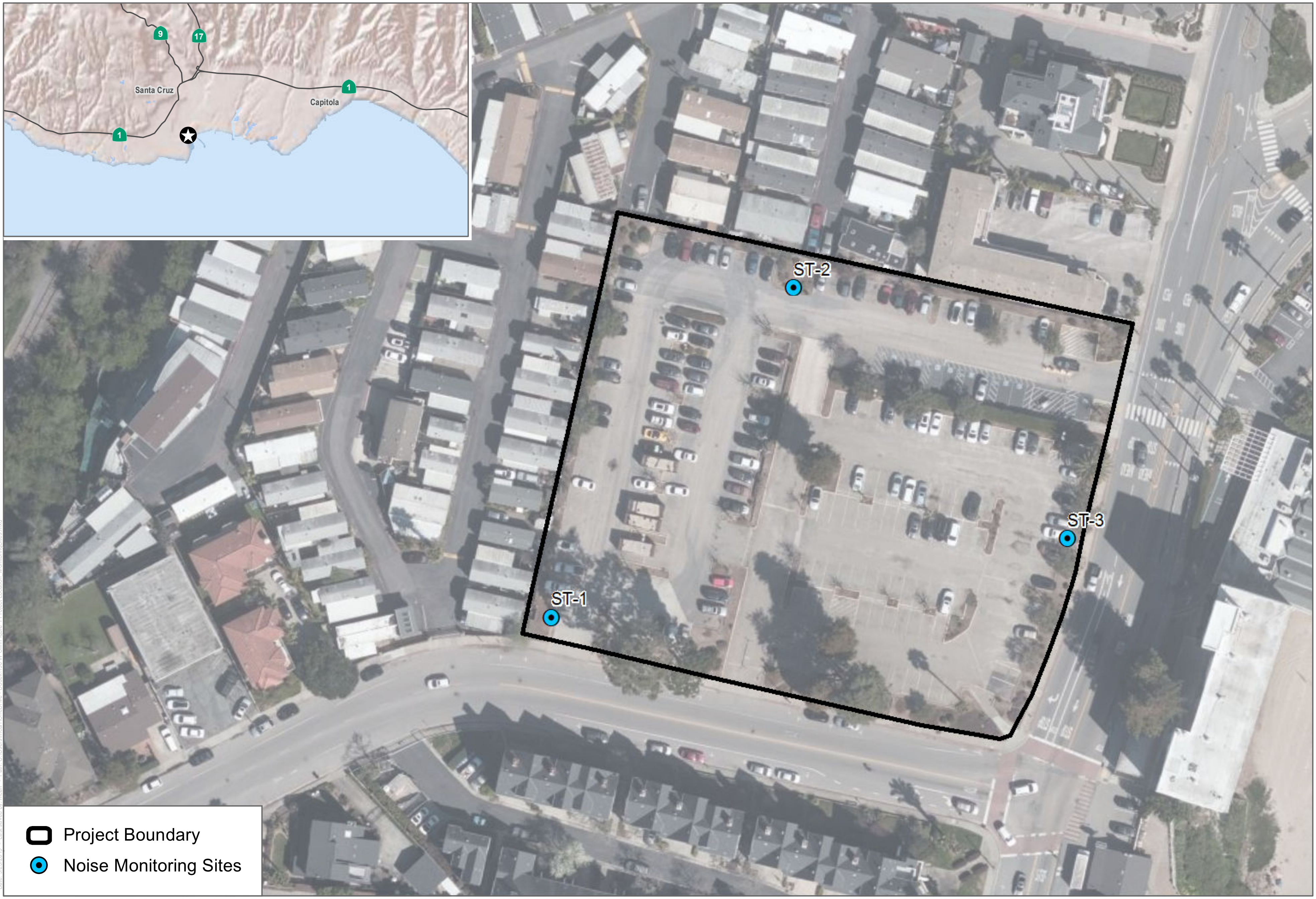
Noise generated in association with the propose Project's parking is anticipated to include noise both directly from the parking activities and from mechanical ventilation equipment. Parking activities will be audible under certain conditions, however they are typically short term and sporadic in nature and, therefore, would not substantially contribute to the overall average acoustical environment. Mechanical ventilation fans for the subterranean parking structure are assumed to be located or vented to the rooftop and shielded by the proposed parapet wall. Noise generated by the subterranean parking structure mechanical ventilation fans is predicted to be approximately 50 dBA Leq at the nearby noise-sensitive receptors. Therefore, noise associated with the proposed Project's parking area is predicted to comply with the City of Santa Cruz noise level thresholds and 6 dBA above ambient criteria.

Operational noise associated with the 190 West Cliff Drive Project is predicted to comply with the City of Santa Cruz noise standards and not predicted to result in significant noise impacts at nearby noise-sensitive receptors; but may be audible during certain conditions. Construction noise and vibration will be performed during daytime hours and be temporary in nature. Construction noise and vibration is predicted to comply with the City of Santa Cruz criteria, as well as Caltrans and FTA recommended guidelines.

6 References

Federal Transit Administration (FTA). 2006. *Transit Noise and Vibration Impact Assessment*. Final Report. FTA-VA-90-1003-06. May 2006.

Caltrans. 2013. *Transportation and Construction Vibration Guidance Manual*. Division of Environmental Analysis, Environmental Engineering, Hazardous Waste, Air, Noise, Paleontology Office. Sacramento, California. September 2013.



SOURCE: DigitalGlobe 2016

DUDEK

0 0.0075 0.015 Miles

FIGURE 1

Project Location and Noise Monitoring Sites

190 West Cliff Drive

SOURCE: Ensemble Investments and Cunningham Group 2019

DUDEK

FIGURE 2
Site Plan
190 West Cliff Drive

Appendix A

Acoustic Fundamentals and Terminology

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.
A-Weighted Sound Level (dBA)	The sound pressure level (SPL) in decibels as measured on a sound level meter (SLM) using the A-weighted filter network, which de-emphasizes the very low and very high frequency components of the measured sound in a manner similar to the frequency response of the average healthy human ear.
Day-night Sound Level (L_{dn})	The A-weighted equivalent continuous sound level over a 24-hour period with a 10 dB adjustment added to sound levels occurring during the nighttime hours (10 p.m. to 7 a.m.).
Decibel (dB)	The unit for expressing SPL and is equal to 10 times the logarithm (to the base 10) of the ratio of the measured sound pressure squared to a reference pressure, which is 20 micropascals.
Equivalent Sound Level ($L_{eq[xh]}$)	The value corresponding to a steady-state sound level containing the same total energy as a time-varying signal over a given sample period. The L_{eq} may feature notation in its subscript indicating the time period (e.g., eight hours as "8h" to populate "[Xh]") of energy averaging.
Maximum Sound Level (L_{max})	The highest value measured by an SLM over a given sample period, based on a time-weighted sound level in dB using a "fast" or "slow" time constant.
Statistical Sound Level (L_{XX})	The SPL exceeded a cumulative XX percent (%) of the measured time period. By way of example, L_{50} is also referred to as a "median" sound level. The L_{90} value is often considered akin to a "background" sound level of indistinct contribution to the outdoor sound environment or an approximation of continuous or steady-state sources of noise such as mechanical equipment.
Peak Particle Velocity (PPV)	The maximum instantaneous positive or negative peak of a vibration wave. (In this document, a PPV descriptor with units of mm/sec or in/sec is used to evaluate construction-generated vibration for building damage risk and human annoyance.
Vibration Velocity Decibel (VdB)	Ten times the common logarithm of the ratio of the square of the amplitude of the RMS vibration velocity to the square of the amplitude of the reference RMS vibration velocity. The reference velocity in the United States is one micro-inch per second.

Appendix B

Construction Noise Calculations

Proposed Project Construction Phase	Federal Highway Administration (FHWA) Roadway Construction Noise Model (RCNM) Equipment Type	Total Equipment Qty	FHWA RCNM Acoustical Usage Factor (AUF) %	FHWA RCNM Reference Lmax @ 50 ft.	Distance-Adjusted Lmax	Allowable Operation Time (hours)	Allowable Operation Time (minutes)	Predicted 8-hour Leq
Demolition	Dozer	1	40	82	72.5	8	480	68
	Front End Loader	3	40	79	69.5	8	480	70
	Concrete Saw	1	20	90	80.5	8	480	73
					Total for Demolition Phase:			76.0
Site Preparation	Scraper	1	40	84	74.5	8	480	70
	Grader	1	40	85	75.5	8	480	71
	Front End Loader	1	40	79	69.5	8	480	65
					Total for Site Preparation Phase:			74.6
Grading	Grader	1	40	85	75.5	8	480	71
	Dozer	1	40	82	72.5	8	480	68
	Front End Loader	1	40	79	69.5	8	480	65
	Backhoe	1	40	78	68.5	8	480	64
					Total for Grading Phase:			74.4
Building Construction	Crane	1	16	81	71.5	8	480	63
	Man Lift	2	20	75	65.5	8	480	61
	Generator	1	50	72	62.5	8	480	59
	Backhoe	1	40	78	68.5	8	480	64
	Front End Loader	1	40	79	69.5	8	480	65
	Welder / Torch	3	40	73	63.5	8	480	64
					Total for Building Construction Phase:			71.3
Architectural Coating	Compressor (air)	1	40	78	68.5	8	480	64
					Total for Architectural Coating Phase:			64.5
Paving	Concrete Mixer Truck	1	40	79	69.5	8	480	65
	Paver	1	50	77	67.5	8	480	64
	Front End Loader	1	40	79	69.5	8	480	65
	Roller	2	20	80	70.5	8	480	66
	All Other Equipment > 5 HP	2	50	85	75.5	8	480	75
					Total for Paving Phase:			76.9

Appendix C

Operational Noise Calculations

Residential HVAC Noise Prediction

Stationary Operation Noise-Producing Activity	Sound Source Description	Total Equipment Qty	Acoustical Usage Factor (AUF) %	Reference Sound Level (dBA)	Reference Distance (feet)	Sound Source Notes	Source to Noise-sensitive Receiver (NSR) Distance (ft.)	Distance-Adjusted Sound Level	Allowable Operation Time (hours)	Allowable Operation Time (minutes)	Sound Path Occluded by Barrier (dB reduction)	Predicted 1-hour Leq
Residential rooftop HVAC	Air-cooled Condenser	4	100	74	3	Johnson Controls data	40	51.5	1	60	8	50

Parking Garage Ventilation Fan Noise Prediction

	1/1-octave band center frequency	63	125	250	500	1000	2000	4000	8000
	A-weighting adjustments	26	13	9	3	0	-1	-1	1
		specific sound power levels (dB)							
largest of values for the two fan diameter ranges, per ENC (Bies & Hansen 1996) -->	plug	36	38	36	34	33	28	20	12
largest of values for the two fan diameter ranges, per ENC (Bies & Hansen 1996) -->	tube	41	41	47	46	44	43	37	35
largest of values for the two fan diameter ranges, per ENC (Bies & Hansen 1996) -->	prop	56	57	56	55	55	52	48	46

fans (tubeaxial-type exhaust fan only, for parking garage ventilation)

Phase	Building Tag	GSF	m^2	facility function	CFM pksf*	m^3/s per 1,000 m^2	Pressure (Pa)	Q (m^3/s)	fantype = plug, tube, or prop	unweighted PWL 63	125	250	500	1000	2000	4000	8000	OA dB	Q (cfm)	Distance to Nearest Receptor (feet)	Number of fans	Hourly dBA Leq	Barrier Atten. (dB)**	with combined barrier effect
return air fans in building rooftop AHUs:																								
	underground parking garage	135000	12548	enclosed parking	750	3.81	250	48	tube	91	91	97	96	94	93	87	85	102	102000					
										A-weighted dB								OA						
										65	78	88	93	94	94	88	84	99		30	4	72	16	50

* is based on 0.75 CFM per square foot, per IMEC standard

** assumes total sound attenuation of 15 dBA due to building parapet and HVAC noise control of fan discharge