Veneklasen Associates
Consultants in Acoustics | AV | IT | Environmental Noise

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SDG Architects, Inc.
3361 Walnut Boulevard, Suite 120
Brentwood, California 94513

Attention: **Mr. David Myers, Architect, Senior Project Manager**

Subject: **31 West Jackson Street**
Hayward, California
Exterior Envelope Acoustical Design
VA Project #5345-001

Dear Mr. Myers:

Veneklasen Associates (VA) has completed our acoustical review of the 31 West Jackson Development Site located in Hayward, California. This report represents the results of our findings.

1.0 INTRODUCTION

This study was conducted to determine the impact of the exterior noise sources on the 31 West Jackson Residential Development. VA's scope of work included calculating the exterior noise and vibration levels impacting the site, determining the method, if any, required to lower the exterior sound and vibration levels to meet the applicable code requirements and review the planned exterior facade construction (including doors, windows, walls and roofs) to determine compliance of the interior sound and vibration levels with the State of California and the City of Hayward noise requirements. The results of VA's analysis are presented in this report.

The project reviewed consists of a 2.5 acre site containing approximately 50 townhome units. The project site is bounded by Jackson Street and Diadon Drive to the southeast, the Union Pacific Railroad to the northeast, and residential developments to the south and west.

2.0 NOISE CRITERIA

LDN is the 24-hour equivalent sound pressure level in which the nighttime noise levels, occurring between the hours of 10 p.m. and 7 a.m., are weighted by adding 10 dB of sound level to the measured hourly average. Since this is a 24 hour metric, single event noise levels (truck pass-bye, bus, trains, etc.) are smoothed over the hour time frame meaning that the single event noise levels are not as prominent in the analysis.

Leq (equivalent continuous sound level) is defined as the steady sound pressure level which, over a given period of time, has the same total energy as the actual fluctuating noise.

2.1 Interior Average Noise Levels (LDN)

The City of Hayward General Plan states that *interior LDN* values for residential land uses are not to exceed 45 LDN in any habitable room.

If the windows must be closed to meet an interior level of 45 LDN, then a mechanical ventilating system or other means of natural ventilation shall be provided.

2.2 Interior Maximum Noise Levels

The General Plan also states that interior maximum noise levels should not exceed 50 dBA in bedrooms at night and 55 dBA in bedrooms and other rooms during the day.

2.3 Exterior Noise Levels

Exterior noise levels at primary open space areas of townhomes and multi-family developments are acceptable up to 65 LDN. This standard does not apply to secondary open space areas, such as front yards, balconies, stoops, and porches.

2.4 Vibration Criteria

The General Plan does not specifically state vibration criteria due to trains. For this analysis, VA utilized the ground vibration goals recommended by the U.S. Department of Transportation, Federal Transit Administration (FTA), Office of Planning, "Transit Noise and Vibration Impact Assessment," dated May 2006. The criterion, presented in Table 8-1 of that report, is shown in Table 1, below.

Table 1 – Ground-borne Vibration Impact Criteria

Land Use Category	Ground-borne Vibration Impact Levels (re: 10^{-6} inches per second)		
	Frequent Events (> 70 events/day)	Occasional Events (30-70 events/day)	Infrequent Events (< 30 events/day)
Residences and buildings where people normally sleep	< 72 VdB	< 75 VdB	< 80 VdB

3.0 EXTERIOR NOISE MEASUREMENTS

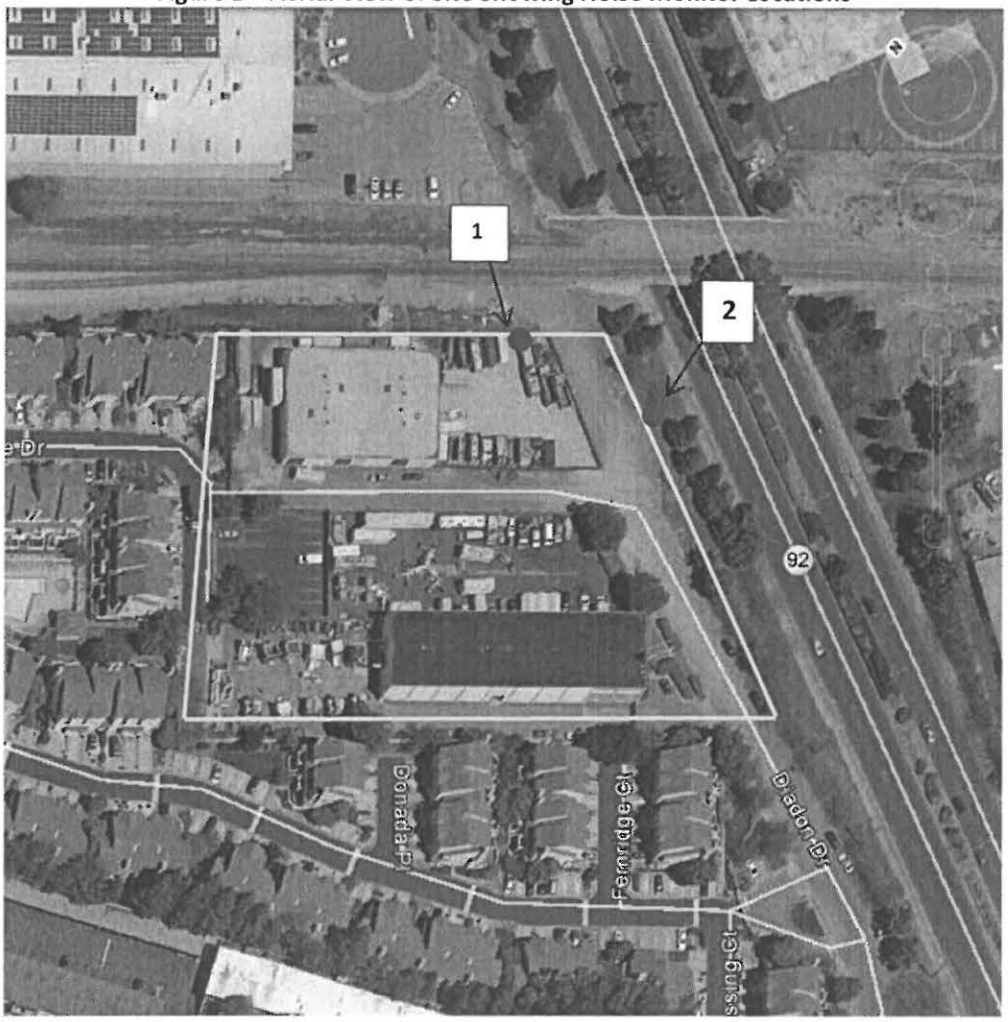
3.1 Noise Measurements

Vehicular movement on the surrounding streets and railway activity are the dominant exterior sound sources affecting the site. A site visit was performed to complete acoustical measurements of the existing sound exposure. VA performed noise and vibration measurements on the project site on Tuesday, January 21, to Wednesday, January 22, 2014. Table 2 provides a calculated LDN value and measured maximum sound level for the monitor locations. The LDN values were estimated from the measurements.

Table 2 – Measured Sound Levels

Measurement	Exterior Sound Level, LDN	Exterior Maximum, dBA	
		Freight Train	Commuter Train
1	65	92	88
2	71	-	81

Figure 1 – Aerial View of Site Showing Noise Monitor Locations



3.2 Computer Modeling

VA has utilized the Traffic Noise Model computer software program developed by the FHWA (Federal Highway Administration) in order to predict vehicular noise levels at various locations. The primary purpose of the computer model was to determine how the noise environment will change due to traffic and site changes.

Current and future traffic conditions were obtained from the West Jackson Street Housing Traffic Impact Analysis Report by Kittelson and Associates, dated December 20, 2013. According to this

information, the future traffic count for Jackson Street near the project site is not expected to change significantly.

3.3 UPRR Railway

VA understands that the railway is used by Commuter and Freight trains. VA understands that there are between 5-10 trains per day, operating at all hours. There are no at-grade crossings so the trains are not expected to sound the horn. However, VA understands that the train will sound the horn if pedestrians are present near the site. The current condition of the site vicinity allows for pedestrians to cross the tracks at unauthorized crossings. For this reason, the trains may sound the horn. During the measurement period, VA did not capture a measurement of the horn. Typically, horn events would be louder than the train pass-bys that were measured during the site visit.

4.0 EXTERIOR NOISE ENVIRONMENT

4.1 Noise Barrier

In order to reduce the noise levels from train pass-bys to the project site, a noise barrier is recommended adjacent to the railway. The tracks are elevated near the project site approximately 2-3 feet. This will reduce the effectiveness of the barrier. VA understands that the City will only allow the maximum barrier heights as shown in Figure 2, measured from the project grade (not the train tracks). The future mitigated noise levels with noise barriers are shown in Table 3.

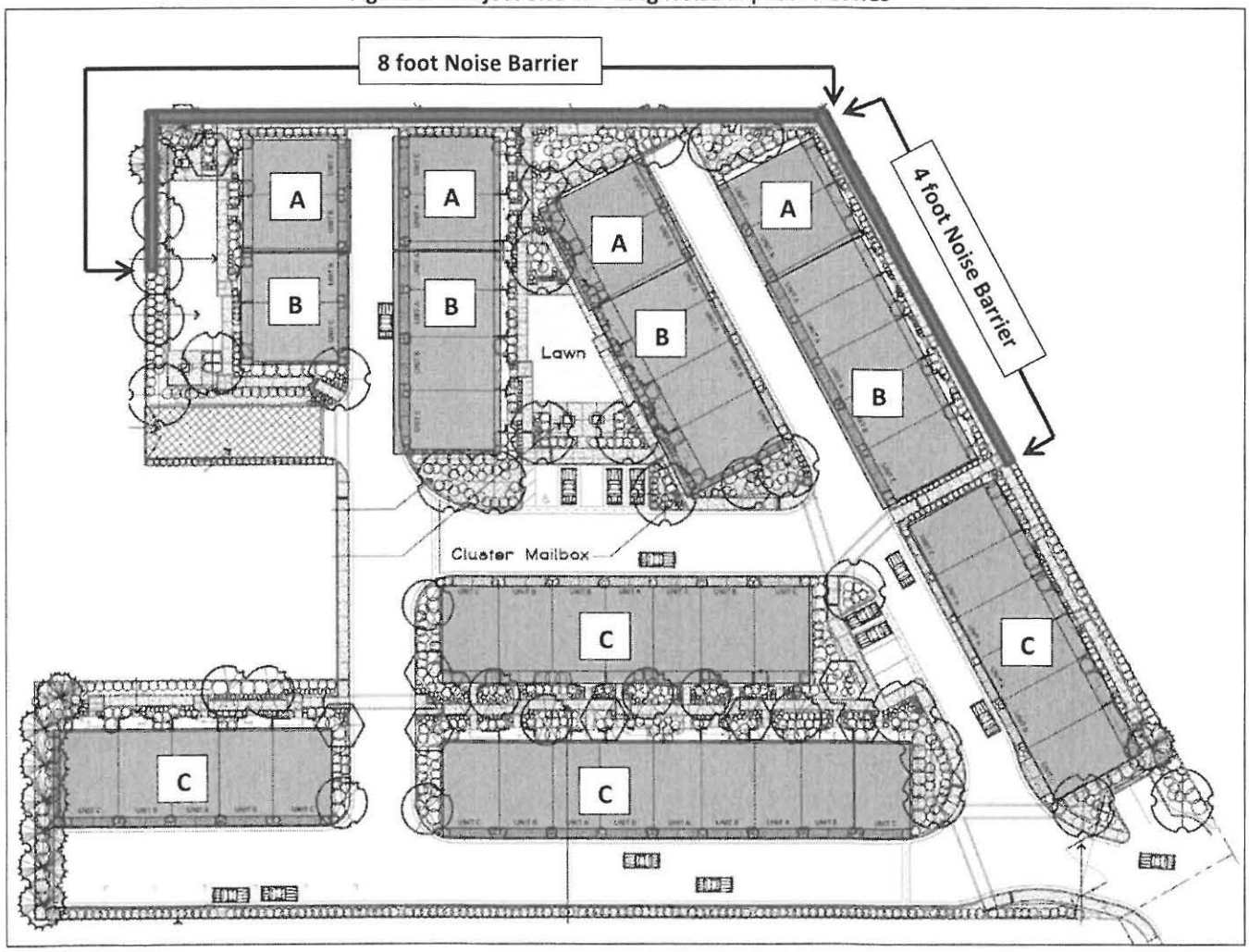
4.2 Overall Exterior Noise

Based on our measurements, the computer model, and the project site plan provided by the Client, VA calculated the existing and future (year 2023) LDN noise levels at various locations within the project site. To simplify the analysis and presentation of our results, VA has separated the site into locations based on the sound exposure and required mitigation. The noise levels reported are worst-case for each location and some areas will be exposed to a lower noise level due to shielding from building facades and structures on site. The predicted sound levels at each location, shown in Figure 2, are listed in Table 3.

Table 3 – Future Exterior Noise Levels

Location	Floor	Future Average Noise Level, LDN	Future Maximum Noise Level, dBA
Zone A	1	60-63	87
	2-3	65-68	92
Zone B	1	57-63	81
	2-3	62-68	86
Zone C	All	60-68	78

Figure 2 –Project Site Showing Noise Exposure Zones



4.3 Exterior Noise Levels at Outdoor Use Areas

As described in section 2.1, exterior noise levels at primary open space areas of townhomes and multi-family developments are acceptable up to 65 LDN. This standard does not apply to secondary open space areas, such as front yards, balconies, stoops, and porches.

With the recommended noise barrier along the railway side, all first floor outdoor use areas included within the project will have exterior noise impacts less than 65 LDN. No further mitigation is required.

5.0 INTERIOR NOISE CALCULATION

5.1 Assembly Descriptions

VA calculated the interior level within the residential units given the measured noise environment. Floor plans and elevations were not available and VA estimated the dimensions using typical unit layouts and glazing areas. VA also utilized the assumed construction assemblies shown in Table 4.

Table 4 – Example Glazing Assembly Descriptions

Assembly	Assembly Rating	Thickness	Typical Glazing Construction		
Windows, Sliding Doors, French Doors	STC 30	1" dual	1/8" lite, 3/4" airspace, 1/8" lite		
	STC 35	1" dual	1/4" laminate, 1/2" airspace, 1/4" laminate		
	STC 40	3-1/2" triple	1/8" lite, 1/2" airspace, 1/8" lite, 2.5" airspace, 1/8" storm		
	STC 44	3-1/2" triple	3/16" lite, 7/16" airspace, 1/8" lite, 2.5" airspace, 1/4" storm		
	STC 54 Double Window	5" double window	Approx. STC 31 dual window assembly (1/8" lite, 1/2" airspace, 1/8" lite)	Min. 4" airspace	Single glazed window assembly (7/32" laminate)
Wall	Standard	Stucco, wood studs with batt insulation, 1 layer gypsum board			
	Upgraded	Stucco, 2x4 wood studs staggered on 2x6 plate with batt insulation, 2 layers gypsum board or Stucco, wood studs with batt insulation, resilient channel, 2 layers gypsum board			
	Double	Stucco, double wood studs with 1-inch airspace and batt insulation, 2 layers gypsum board or Standard wall, airspace, wood or light gauge steel studs with batt insulation, 1 layer gyp bd			

5.2 Interior Noise Levels

As stated in Section 2.0, there are criteria for interior average noise levels (LDN) and interior Maximum noise levels (dBA). The glazing recommendations in the following tables show what is required to meet both criteria. Due to the vicinity of the project to the railway, the noise level impacts will be controlled by the maximum noise levels from train pass-bys.

As stated in Section 2.0, interior maximum noise levels should not exceed 50 dBA in bedrooms at night and 55 dBA in bedrooms and other rooms during the day. The results for each location are presented in Table 5.

Table 5 – Recommended Mitigation to Meet Interior Noise Criteria

Location	Floor	Exterior Maximum Noise Level, dBA	Room	Glazing Rating	Exterior Wall
Zone A	1	87	Bedroom	STC 44	Upgraded
	2-3	92	Living room	STC 44	Upgraded
			Bedroom	Double	Double
Zone B	1	81	Bedroom	STC 35	Standard
	2-3	86	Living rooms	STC 40	Standard
			Bedroom	STC 44	Upgraded
Zone C	All	78	Living rooms	STC 30	Standard
			Bedrooms	STC 35	Standard

5.3 Mechanical Ventilation Requirement

Because the windows and doors must be kept closed to meet the noise requirements at some locations, mechanical ventilation is required. All of the residential units will require mechanical ventilation. The mechanical ventilation shall meet all Code requirements, including the capability to provide sufficient fresh air exchanges, without depending on open windows or leakage through windows and doors. The ventilation system shall not compromise the sound insulation capability of the exterior facade assembly.

6.0 VIBRATION IMPACT

VA measured existing ground borne vibration from the railway on the project site at Position 1. The measured vibration levels were compared with the ground vibration criteria recommended by the Federal Transit Administration. VA understands that there are approximately 5-10 train events per day. According Section 2.3, the FTA criteria for infrequent events (< 30 per day) is 80 VdB. Note that the Federal Guideline does not specifically have input for freight trains and this guideline is specifically for light rail.

The vibration measurement location was approximately 50 feet from the railroad tracks, near where the proposed building façade will be. VA measured one freight train and three commuter train pass-bys during the measurement period. The average measured ground vibration velocity level is shown in Table 6.

Table 6 – Measured Ground Vibration Impact Levels Compared with FTA Criteria

Location	Vibration Level, VdB	Criteria, VdB	Conclusion
Zone A	83	80	Site vibration level greater than criteria
Zone B	80	80	Site vibration level equal to criteria
Zone C	< 80	80	Site vibration level below criteria

As shown in the table above, the ground vibration levels exceed the FTA criterion at Zone A and meets the criterion in Zone B, resulting in feelable vibration and a level of annoyance. Feelable vibration occurs at approximately 65 VdB so the Federal guideline does not mean that vibration is not feelable.

VA has used the Federal guideline calculation method to provide information within this report. It is not straightforward to translate ground vibration to floor vibration in the units. A massive spread foundation will reduce the transfer of vibration from the soil into the structure. On the other hand, vibration levels are usually amplified as the height of a structure increases, because of the nature of lightweight construction. Actual vibration propagation and structural amplification can vary greatly and cannot be predicted with precision. Based on our experience VA would expect the vibration levels to be amplified slightly from the ground level at the upper floors. No structural damage should occur, however, tenants will feel vibration from trains.

Lightweight structures tend to have low stiffness and therefore increased vibration levels on upper floors. Therefore, a reduction in vibration level on the upper floors can be achieved by stiffening the structure beyond typical structural design. The structure should be designed to achieve a minimum natural frequency of around 19 Hz. VA therefore suggests that the following measures be incorporated into the project structural design.

The structural changes will likely include the following:

- Shorter joist spans: add bearing walls or break spans with LVL or steel beams.
- Deeper joists.
- Stronger joists (for engineered I-joists).
- Additional blocking and strapping.
- Reduced joist spacing.
- Glue and screw plywood sheathing to joists.
- Thicker or stronger plywood sheathing.

VA recommends these structural changes be installed for the entire building. Additionally, disclosure of the vibration should be part of the documents to potential occupants.

7.0 CONCLUSIONS

The following is a summary of the conclusions within this report.

- Noise barriers are required, as shown in Figure 2.
- Exterior glazing and wall mitigation shown in Table 5 should be implemented.
- Disclose the sound level due to train operations will be clearly audible.
- Disclose that vibration from train operations may be feelable.
- All units will require mechanical ventilation.
- There are no City or State code requirements for train vibration. However, existing vibration levels will exceed the FTA ground vibration goals at Zones A and B. VA recommends investigating options to stiffen the structure to a natural frequency of 19 Hertz to reduce the amplification of vibration in the structure.

Various noise mitigation methods may be utilized to satisfy the noise criteria described in this report. Alteration of mitigation methods that deviate from requirements should be reviewed by the acoustical consultant.

We trust this information is satisfactory. If you have any questions or comments regarding this report, please do not hesitate to contact us.

Sincerely,
Veneklasen Associates, Inc.

John LoVerde
Associate Principal

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