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Experts in acoustics, noise and vibration

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Date:	**December 20, 2016**		
Subject:	**Bascom Valero Car Wash Noise Study**		
	MWA Project – 15059		

Mei Wu Acoustics is providing acoustical consulting services for the proposed expansion of the Bascom Valero located at 3702 S Bascom Ave, San Jose, CA. The project requires an environmental noise study to show compliance with applicable San Jose City codes and regulations. The following report details the results of this environmental noise study.

1. Applicable Noise Codes and Standards

1.1. City of San Jose General Plan

San Jose General Plan, Chapter 3, Goal EC-1 Community Noise Levels and Land Use Compatibility, contains details of the acceptable limits of noise hazards. For this project the applicable noise policies are paraphrased as follows:

EC-1.1 *Locate new development in areas where noise levels are appropriate for the proposed uses. Consider federal, state and City noise standards and guidelines as a part of new development review. Applicable standards and guidelines for land uses in San José include:*

Exterior Noise Levels
The City's acceptable exterior noise level objective is 60 dBA DNL or less for residential and most institutional land uses (Table EC-1). The acceptable exterior noise level objective is established for the City, except in the environs of the San José International Airport and the Downtown, as described below:

- *For new multi-family residential projects and for the residential component of mixed-use development, use a standard of 60 dBA DNL in usable outdoor activity areas, excluding balconies and residential stoops and porches facing existing roadways. Some common use areas that meet the 60 dBA DNL exterior standard will be available to all residents. Use noise attenuation techniques such as shielding by buildings and structures for outdoor common use areas. On sites subject to aircraft overflights or adjacent to elevated roadways, use noise attenuation techniques to achieve the 60 dBA DNL standard for noise from sources other than aircraft and elevated roadway segments.*

- *For single family residential uses, use a standard of 60 dBA DNL for exterior noise in private usable outdoor activity areas, such as backyards.*

Table EC-1: Land Use Compatibility Guidelines for Community Noise in San José

LAND USE CATEGORY	EXTERIOR NOISE EXPOSURE (DNL IN DECIBELS (DBA)) 55 60 65 70 75 80
1. Residential, Hotels and Motels, Hospitals and Residential Care[1]	
2. Outdoor Sports and Recreation, Neighborhood Parks and Playgrounds	
3. Schools, Libraries, Museums, Meeting Halls, Churches	
4. Office Buildings, Business Commercial, and Professional Offices	
5. Sports Arena, Outdoor Spectator Sports	
6. Public and Quasi-Public Auditoriums, Concert Halls, Amphitheaters	

[1]Noise mitigation to reduce interior noise levels pursuant to Policy EC-1.1 is required.

Normally Acceptable:

- Specified land use is satisfactory, based upon the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements.

Conditionally Acceptable:

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

Unacceptable:

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

EC-1.2 *Minimize the noise impacts of new development on land uses sensitive to increased noise levels (Categories 1, 2, 3 and 6) by limiting noise generation and by requiring use of noise attenuation measures such as acoustical enclosures and sound barriers, where feasible. The City considers significant noise impacts to occur if a project would:*

- *Cause the DNL at noise sensitive receptors to increase by five dBA DNL or more where the noise levels would remain "Normally Acceptable"; or*
- *Cause the DNL at noise sensitive receptors to increase by three dBA DNL or more where noise levels would equal or exceed the "Normally Acceptable" level.*

EC-1.3 *Mitigate noise generation of new nonresidential land uses to 55 dBA DNL at the property line when located adjacent to existing or planned noise sensitive residential and public/quasi-public land uses.*

1.2. City of San Jose Zoning Code

The Bascom Valero Car Wash is zoned in a Commercial Neighborhood (CN) District and is subject to the following paraphrased section of the San Jose Zoning Code:

20.40.600 Performance Standards

B. ...the following specific standards shall apply in the Commercial Zoning Districts:

2. Noise

The sound pressure level generated by any use or combination of uses on a property shall not exceed the decibel levels indicated in Table 20-105 at any property line, ***except upon issuance and in compliance with a Conditional Use Permit as provided in Chapter 20.100.***

Table 20-105 Noise Standards	
	Maximum Noise Level in Decibels at the Property Line
Commercial use adjacent to a property used of zoned for residential purposes	55
Commercial use adjacent to a property used or zoned for commercial or other non-residential purposes	60

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2. Acoustic Terminology

Definitions for acoustic terminology that may be found throughout this report are as follows:

Term	Description
Decibel, dB	A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micropascals.
Frequency, HZ	The number of complete pressure fluctuations per second above and below atmospheric pressure.
A-Weighted Sound Level, dB	The sound pressure level in decibels as measured on a sound level meter using the A-weighting filter network. 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_1, L_{10}, L_{50}, L_{90}	The A-weighted noise levels that are exceeded 1%, 10%, 50%, and 90% of the time during the measurement period.
Equivalent Noise Level, L_{eq}	The average A-weighted noise level during the measurement period
Community Noise Equivalent Level, CNEL	The average A-weighted noise level during a 24-hour day, obtained after addition of 5 decibels in the evening from 7:00 pm to 10:00 pm and after addition of 10 decibels to sound levels measured in the night between 10:00 pm and 7:00 am.
Day/Night Noise Level, L_{dn}	The average A-weighted noise level during a 24-hour day, obtained after addition of 10 decibels to levels measured in the night between 10:00 pm and 7:00 am.
L_{max}, L_{min}	The maximum and minimum A-weighted noise level during the measurement period.
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. This is usually taken to be the lowest hourly L_{90} recorded during a 24-hour measurement period.

3. Project Description

The existing Valero station and garage will be demolished to provide for a new store, office and car wash. The project site (indicated in yellow in Figure 1) is at the corner of S Bascom Ave and Woodard Rd. On the remaining property lines are commercial (to the south) and two-level residential (to the east).

Figure 1: Aerial image of the project site (from Google Maps)

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The carwash will be located in the rear of the main building, between the store and the residential property line.

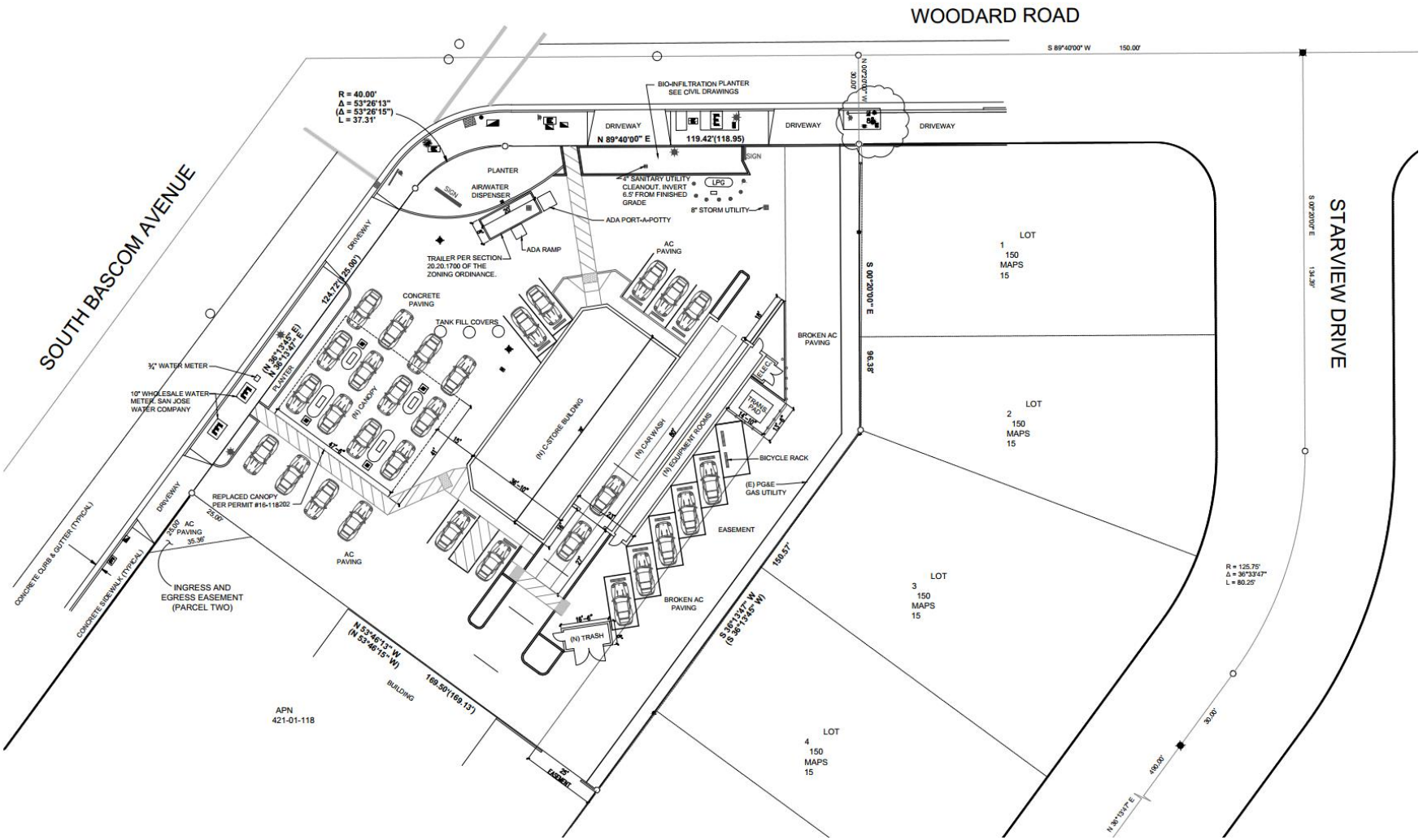

Figure 2: Project site plan

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4. Existing Noise Levels

According to the San Jose General Plan, the project site falls under the 75-70 dBA L_{dn} contour with the boundary with the residential representing the beginning of the 70-65 dBA L_{dn} contour. Therefore, the noise levels at the residential and commercial property lines are assumed to be 70 dBA L_{dn}.

Figure 3 shows an overlay of the San Jose General Plan existing condition noise contours on the street map of the area.

Figure 3: Overlay of the existing noise contour on the street map of the area (from Google Maps)

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5. Noise Level Prediction

MWA has performed many noise studies for carwashes in the neighboring cities and counties. The following sound data comes from these studies and is considered to be representative of the currently proposed car wash.

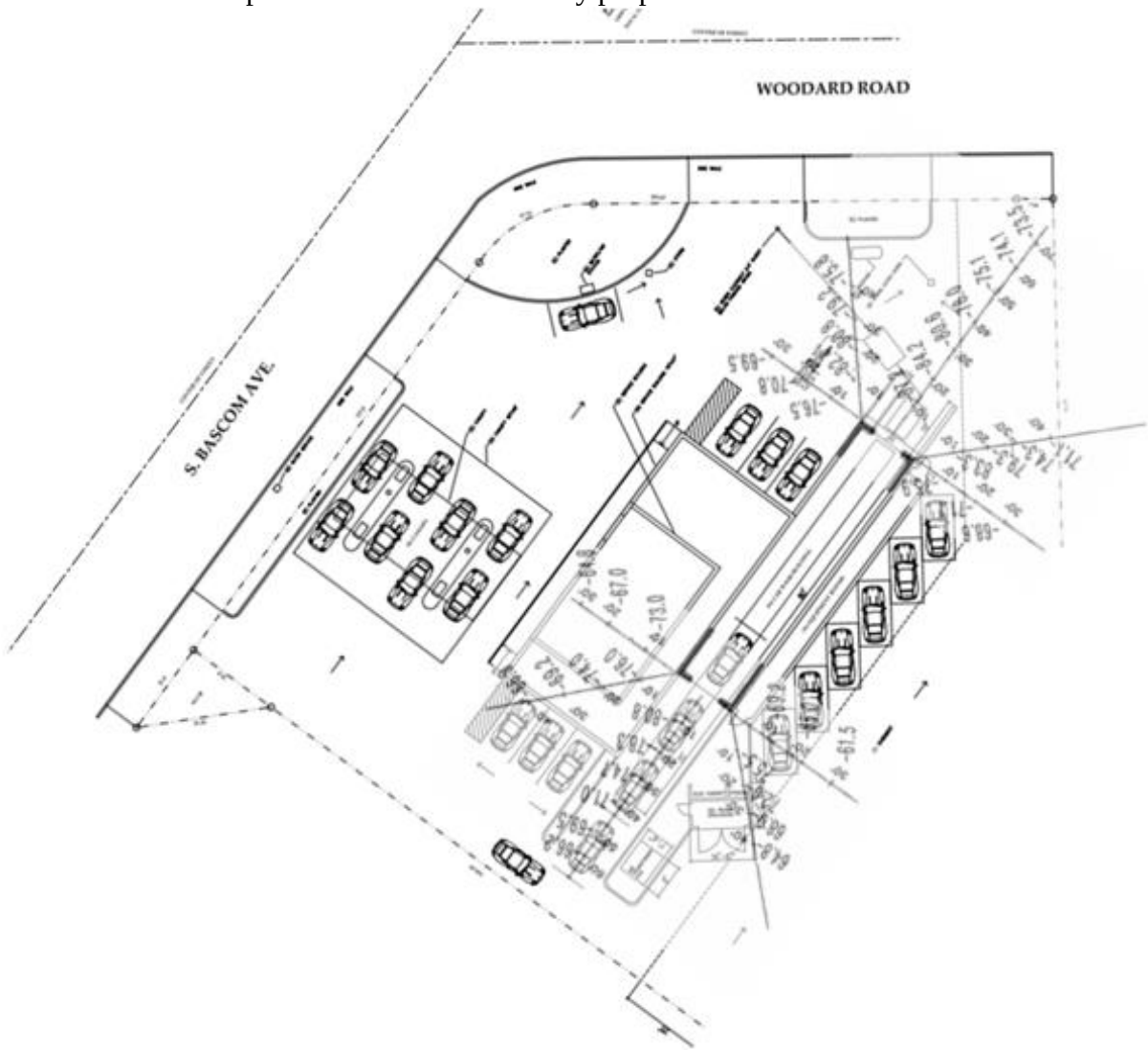

Figure 4: Predicted noise from the proposed car wash

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Estimated carwash noise levels from the manufacturer (which is superimposed over the site plan in Figure 4) is provided in Figure 5 and included in Table 1. The data are the predicted noise levels as a function of distance from the entrance and exit of the car wash, not including any barrier attenuation effects. Predicted noise levels are lower for directions oblique to the entrance and exit of the car wash.

Side of Car Wash	Distance [ft]	Noise Level [dBA]	Noise Level at 45º [dBA]	Noise Level at 90 º [dBA]
Entrance	20	78.3	72.0	65.0
	40	71.0	64.8	-
	60	66.2	-	-
Exit	20	84.2	79.3	68.6
	40	78.0	71.1	-
	60	74.1	-	-

Table 1: Predicted noise levels around car wash

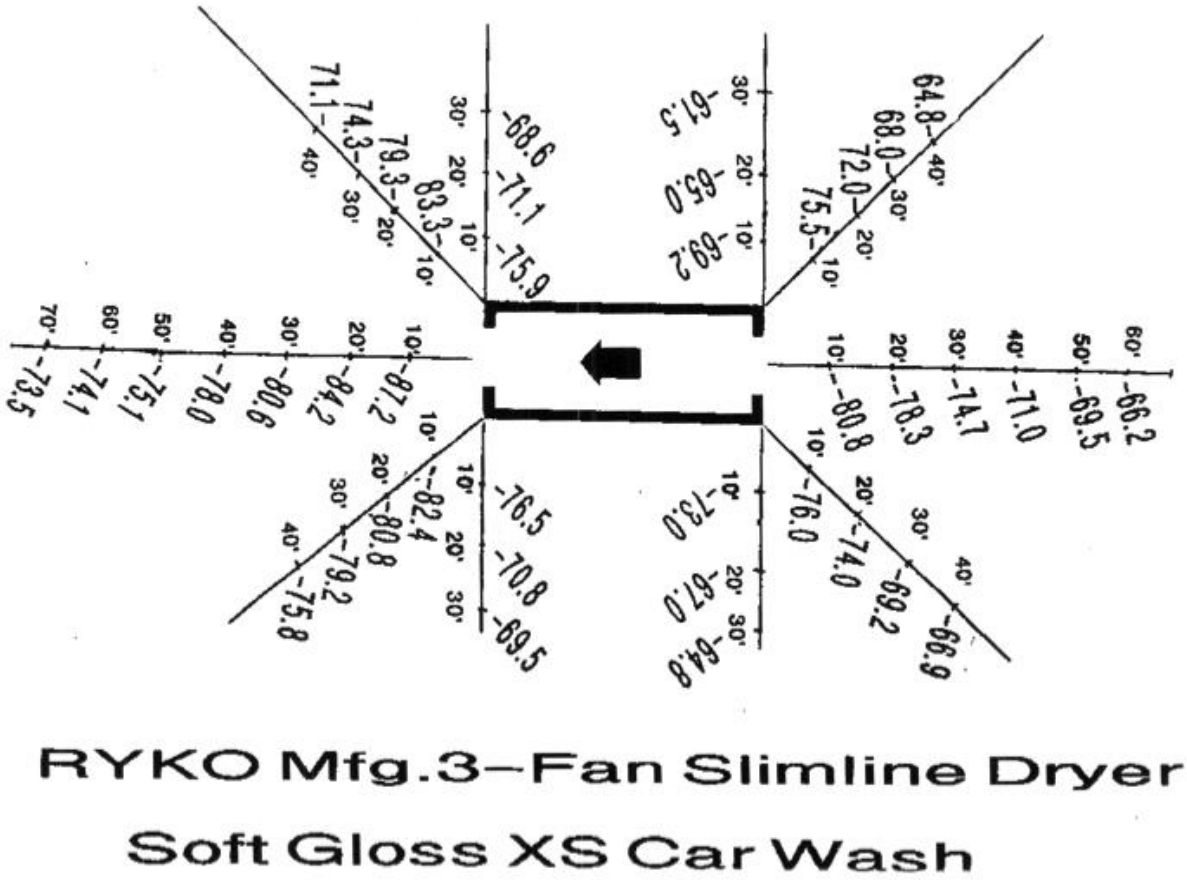

Figure 5: Manufacturer estimated carwash noise levels

The nearest point on the property line from the car wash entrance to each of the two residential properties are approximately 50 ft and 60 ft away, and the distance to the commercial property line is 70 ft. These distances are greater than the noise data available (in Table 1), however at these distances noise is attenuated at a rate of 6 dB for every doubling of distance, allowing noise levels

at the receivers to be calculated. Equation 1 provides a method for estimating sound pressure level (SPL) as a function of distance. The sound power level (PWL) of the carwash may be calculated from the sound pressure level distribution over distance, where Q is a directionality factor, and r is the distance from the source to location of interest.

$$SPL = PWL - 10 * log\left(\frac{Q}{4\pi r^2}\right) \quad \text{Eqn. 1}$$

The San Jose General Plan Goal EC-1.2 states that noise impact of new land developments on residential land uses is considered significant if the project would cause the day-night average noise level (L_{dn}) at noise sensitive receptors to increase by three (3) dBA L_{dn} or more where noise levels would equal or exceed the "Normally Acceptable" level.

The day night average noise level (L_{dn}) is a single number metric defined as the 24-hour average noise level with a 10 dB penalty added to noise occurring at night (10PM-7AM). The current L_{dn} of the project site is 70 dBA. To calculate the L_{dn} with the addition of this project, we assume the carwash will be operating continuously during daytime hours (7AM-10PM). The L_{dn} may be calculated with equation 2 when there is a total of n sources, where dB_n is the sound pressure level of the n'th source at the location of interest.

$$L_{dn} = \ 10 * log\left(\sum_1^n 10^{\frac{dB_n}{10}}\right) - 10 * log(n) \quad \text{Eqn. 2}$$

Sound pressure levels at the property planes have been calculated and are provided in Table 2. The table includes the sound pressure level at the nearest location on the property line adjacent to a receiver. We have also calculated the resulting L_{dn} considering the existing level of 70 dBA L_{dn} as one source, and the noise levels due to the carwash as another.

Receiver	Distance to Property Line [ft]	Noise Level at Receiver no Barriers [dBA]	Noise Level at Receiver with Barriers [dBA]	L_{dn} at Receiver with Barriers [dBA L_{dn}]	Existing Noise Level [dBA L_{dn}]
Residential (1)	60	62	55	70.5	70.0
Residential (2)	50	57	52	70.5	
Residential (3)	50	69	57	70.6	
Commercial (4)	70	65	53	70.5	

Table 2: Predicted noise levels at sensitive receptors

Table 2 shows that the noise levels at the property planes will be above the levels allowed by the zoning code, but that they will not significantly increase the existing day-night average noise levels (L_{dn}). Goal EC-1.2 requires limiting noise generation and the use of noise attenuation measure such as acoustical enclosure and sound barriers, where feasible. Therefore, this project will implement the following noise reduction measures to minimize the noise impact of the new development.

6. Noise Reduction Measures

Sound barriers will be utilized to reduce the noise levels at the property planes. A graphical representation barrier locations is indicated in Figure 6.

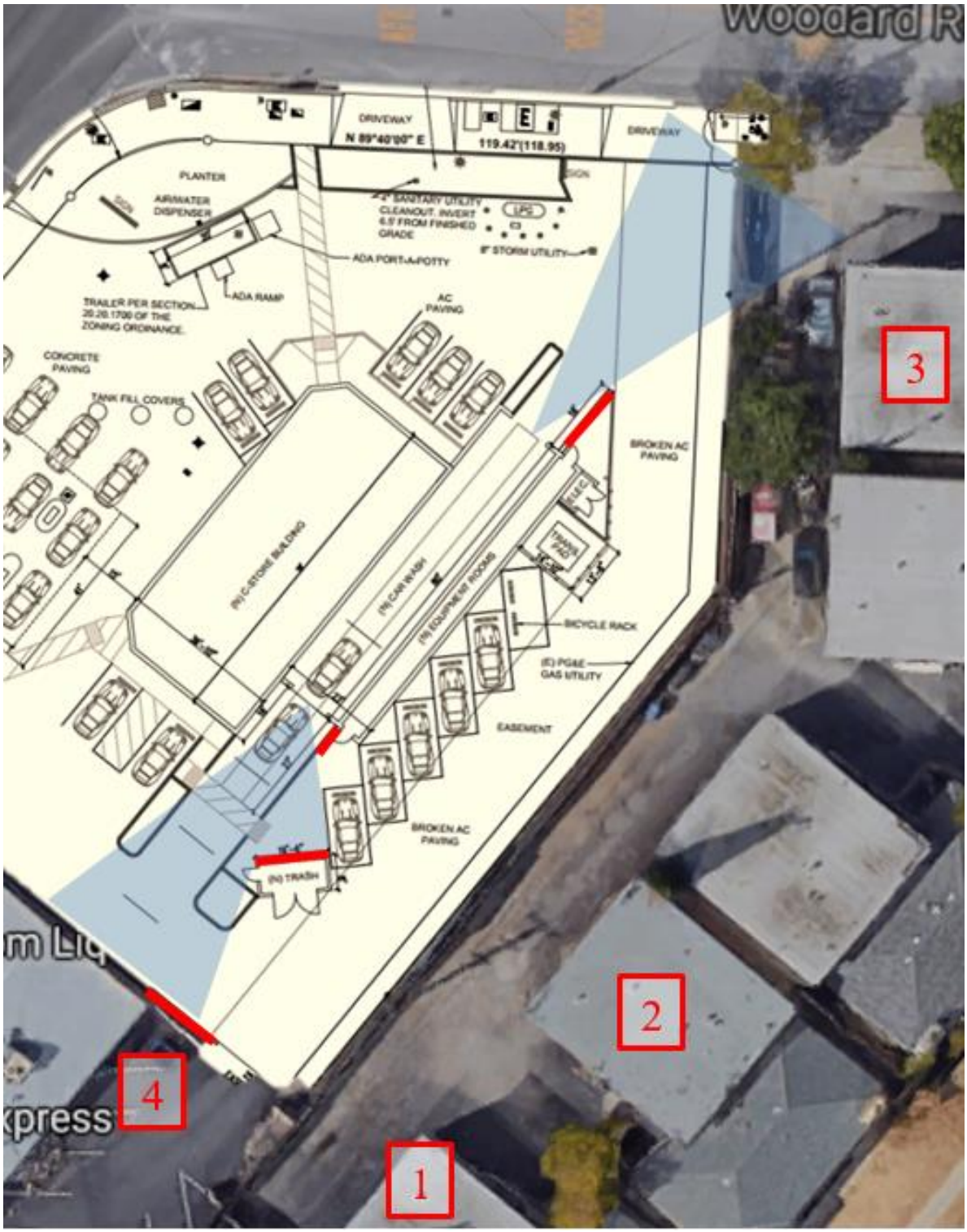

Figure 6: Site plan with existing and planned barriers as red lines.

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The insertion loss of a barrier is the difference in sound pressure level at a receiver when a barrier is inserted between the noise source and the receiver. To provide insertion loss, barriers must be monolithic (without any major holes or gaps) and constructed of a material with at least 2 lbs/sqft surface density. Materials meeting this requirement include ½-inch thick wood, ½-inch outdoor plywood, 16 gauge steel sheet, and any masonry units.

These material conditions ensure that the transmission loss of sound penetrating through the barrier will be greater than insertion loss provided by the barrier. For a sound barrier to be effective, we also assume that the acoustic permittivity of the ground is much greater than that of the barrier. This ensures that acoustic energy which migrates underneath the barrier and reemits on the other side need not be considered.

Even when effective sound barriers are inserted in between a sound source and sensitive receiver, noise is not completely eliminated. A portion of the sound energy that passes near the edge of the barrier is diffracted and propagates towards the receiver on the other side of the barrier (see Figure 7).

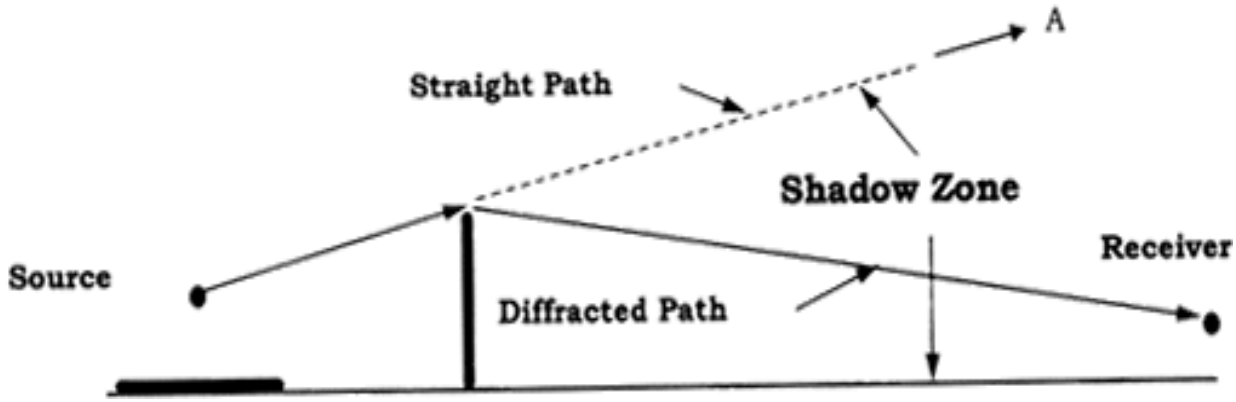

Figure 7: Geometric relationship of barriers to sources and receivers.

The area between the straight (non-diffracted) path and the ground is referred to as the shadow zone. When the receiver is located in the shadow zone, the diffracted path may intercept the receiver location. The difference in the sound pressure level of the diffracted path and the straight path is called the insertion loss of the barrier.

The insertion loss of the barrier is proportional to the geometric relations of the source, barrier, and receiver. The total path length of the diffracted sound wave is found as the shortest distance of a broken line that goes form the source to the edge of the barrier (labelled distance A) and then to the receiver (labelled distance B). The difference between the total path length of the diffracted sound wave and the horizontal distance between the source and receiver (labelled distance d) is used to calculated a dimensionless term called the Fresnel number, found by equation 3 below. The Fresnel number also depends on the frequency (or wavelength, λ) of the sound wave being diffracted.

$$N = \pm\left(\frac{2}{\lambda}\right)(A + B - d) \qquad \text{Eqn. 3}$$

Directivity factors in the direction from the source to the barrier edge and in the direction from the source to the receiver may be considered by introducing extra terms into the calculation for insertion loss. In the case where the total path length of the directed path is significantly (at least an order of magnitude) different from the horizontal separation of the source and receiver, an extra term may be included in the calculation for insertion loss. Where these factors are not included, the insertion loss of a barrier for a given path at a given frequency may be estimated by equation 4[1], where N is the appropriate Fresnel number.

$$IL = 20 * log\left(\frac{\sqrt{2\pi N}}{\tanh\sqrt{2\pi N}}\right) + 5 \qquad \text{Eqn. 4}$$

The project plans the construction of an 18 ft long, 10 ft high barrier at the exit of the carwash, blocking the eastern property line (barriers are indicated by red lines in Figure 6). This barrier completely blocks line of sight from the car wash exit to the northernmost residential building (as show in Figure 6). Therefore, a receiver standing at the property line between the carwash and the residential building (labelled '3' in Figure 6) will fall in the shadow zone of the proposed barrier. The geometric relationships between the dimensions of the barrier and the locations of the sound source and receiver satisfy the requirements as descried in this section to provide insertion loss for receivers at the residential building.

A trash enclosure will be constructed to conceal the dumpster onsite. This enclosure will be 8 feet tall and made of concrete masonry units (CMU). The enclosure will be 16' 6" in length and positioned such that it breaks the line of sight from the carwash entrance to one of the residential properties to the southeast. This barrier will provide insertion loss for receivers at the residential property labelled '1' in Figure 6.

The project also plans the construction of an 11 ft long, 10 ft high barrier at the entrance of the carwash, blocking the eastern property line. The combination of this barrier and the trash enclosure completely blocks line of sight from the car wash entrance to the southern residential buildings. The addition of this barrier provides insertion loss for receivers at the residential property labelled '2' in Figure 6.

There is an existing CMU barrier that blocks the line of sight between the carwash entrance and the commercial property to the south. We assume the height of this barrier to be 6 feet. This existing barrier will provide insertion loss for receivers at the commercial property line.

[1] This equation is an alternative method for calculating insertion loss, based on the work of Kurze and Anderson in 1971. The expression is an approximation to the curve developed by Maekawa in 1968. Source "Engineering Noise Control, Theory and Practice" by David A. Bies and Colin H. Hansen 3rd. Edition, copyright 2003.

7. Conclusion

According to the San Jose Zoning Code, the maximum allowable noise levels at the property lines of residential properties is 55 dBA. However, the project site is located in the 70 dBA L_{dn} noise contour (see Section 4 of this report). This implies that noise levels due to existing sources (such as traffic noise) are already in excess of the zoning code.

To determine noise impact to the residential properties, we use the definition provided by the San Jose General Plan Goal EC-1.2 that noise impact of new land developments on residential land uses is considered significant if the project would cause the day-night average noise level (L_{dn}) at noise sensitive receptors to increase by three (3) dBA L_{dn} or more where noise levels would equal or exceed the "Normally Acceptable" level.

Based on the results of calculations in Section 5, including the noise reduction measures of Section 6, we find that the most that the L_{dn} at the project site would increase is by 0.6 dBA L_{dn}. This increase is much less than the 3 dBA Ldn increase specified in the San Jose General Plan Goal EC-1.2, therefore the noise impact of the proposed project is less than significant.

This concludes our environmental noise impact study for the Bascom Ave Valero Car Wash project. Please contact Mei Wu Acoustics if you have any questions or comments.

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