



# ABD Engineering & Design

Architectural Acoustics • AV Design • Noise & Vibration

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## Re: Tommy Car Wash – Hudsonville – Noise Study Report

### **Introduction**

ABD Engineering & Design, Inc., (ABD) was asked to complete a noise study at the existing Tommy Car Wash located at 4665 32<sup>nd</sup> Ave, Hudsonville, MI. As part of this noise study, long-term (24-hour) noise measurements were completed at the site and along the property line of adjacent commercial properties from Thursday morning on May 30, 2024, to Friday morning on May 31, 2024.

The primary goal for this report is to capture the Tommy Car Wash noise levels during operation at the site and nearby commercial property lines. These noise levels have been compared to the Code of Ordinances of Hudsonville, Michigan (COHM) and the existing noise levels measured at the site during times the car wash was not operating. The following report details relevant acoustical concepts and the results of our long-term acoustical measurements.

### **Acoustical Terminology and Concepts**

When dealing with sound, the physical quantity is expressed as sound pressure level (SPL), while the perceived level is expressed as loudness. Sound pressure level is measured in units called decibels (abbreviated dB), which are power ratios quantified using logarithmic units. Using the logarithmic scale, an increase of 10 dB corresponds to a doubling of the perceived loudness; therefore, an increase of 20 dB is considered 4 times as loud, and an increase of 30 dB is considered 8 times as loud. Table 1 describes the subjective evaluation of how humans perceive a change in sound level.


**Table 1: Subjective Effects of Changes in Sound Levels**

Change in Sound Level	Change in Apparent Loudness
3 dB	Just perceptible
5 dB	Clearly noticeable
10 dB	Twice or half as loud
20 dB	Much louder or quieter

Adapted from Table 12.2 in *Engineering Principles of Acoustics* by Douglas D. Reynolds (1981)

Audible sound occurs over a wide frequency range, from approximately 20 Hertz (Hz) to 20,000 Hz. Human hearing does not respond equally to sounds at different frequencies (or pitches) – low-frequency noise (bass/rumble) is perceived as quieter than high-frequency noise (treble/hiss) of the same decibel level. To accommodate this variation in frequency sensitivity of human hearing, a frequency weighting can be applied to sound level measurements. When the weighting is applied, the resulting sound level measurements are said to be “A-weighted,” and the decibel level is abbreviated dBA. Table 2 lists some commonly encountered noises, their A-weighted sound pressure levels, and associated subjective evaluations.

**Table 2: Noise Source Comparison**

Subjective Evaluation	A-weighted Decibels		Examples
Deafening	140 dBA		Near Jet Engine
	130 dBA		Threshold of Pain
	120 dBA		Threshold of Feeling – Hard Rock Band
Very Loud	100 dBA		Loud Auto Horn (at 10 ft)
	90 dBA		OSHA 8 Hour Noise Exposure Limit
Loud	80 dBA		Shouting at 1m (3 ft)
	70 dBA		Busy Office
Moderate	60 dBA		Conversational Speech at 1m (3 ft)
	50 dBA		Average Office
Faint	40 dBA		Soft Radio Music in Apartment
	30 dBA		Average Residence without Stereo Playing
Very Faint	20 dBA		Average Whisper
	10 dBA		Human Breathing
Threshold of Hearing	0 dBA		Threshold of Audibility

Adapted from *Concepts in Architectural Acoustics* by M. David Egan (1972) and *Architectural Acoustics: Principles and Design* by M. Mehta, J. Johnson, and J. Rocafort (1999)

While the decibel or A-weighted decibel are the basic units used for noise measurement, other indices are also used. One common index, the equivalent sound level (abbreviated as  $L_{eq}$ , or  $LA_{eq}$  when A-weighted), is commonly used to indicate the average sound level over a period of time. The  $L_{eq}$  represents the steady level of sound which would contain the same amount of sound energy as does the actual time varying sound level. Although it is an average, it is strongly influenced by the loudest events occurring during the time period because these loudest events contain most of the sound energy.

Other common metrics indicate the sound level exceeded a certain percentage of time. The  $L_{90}$  is the sound level that is exceeded 90% of the time and is representative of average continuous noise without influence from short-term noise events.

### **Noise Ordinance**

The section of Code of Ordinances of Hudsonville, Michigan (COHM) addressing noise is regarding disturbances of the peace. Below is an excerpt from Article V of the COHM. Note that normal conversation levels between people are around 60 dBA on average.

#### **Sec. 16-49. Disturbance of the peace.**

It shall be unlawful for any person to:

- (4) Willfully create any noise originating from a residence or business between the hours of 9:00 p.m. and 7:00 a.m. which is unreasonably loud under the circumstances. Such noise will be considered unreasonably loud under the circumstances if:
  - a. Such noise is clearly audible at a distance of fifty (50) feet from the property line of that residence or business;
  - b. At a distance of fifty (50) feet from the property line such noise is louder than that of a normal conversation between two (2) people; and
  - c. Such noise would be unreasonably loud and disturbing to the average member of the community under the circumstances.

It is important to note that the time period specified in the COHM falls outside of the Tommy Car Wash normal operating hours (7 a.m. to 9 p.m.). Additionally, these types of qualitative descriptions do not provide any quantitative acoustical criteria for comparison or enforcement. However, based on Table 2, we can quantify the noise levels of normal conversation between two people as typically ~60 dBA.

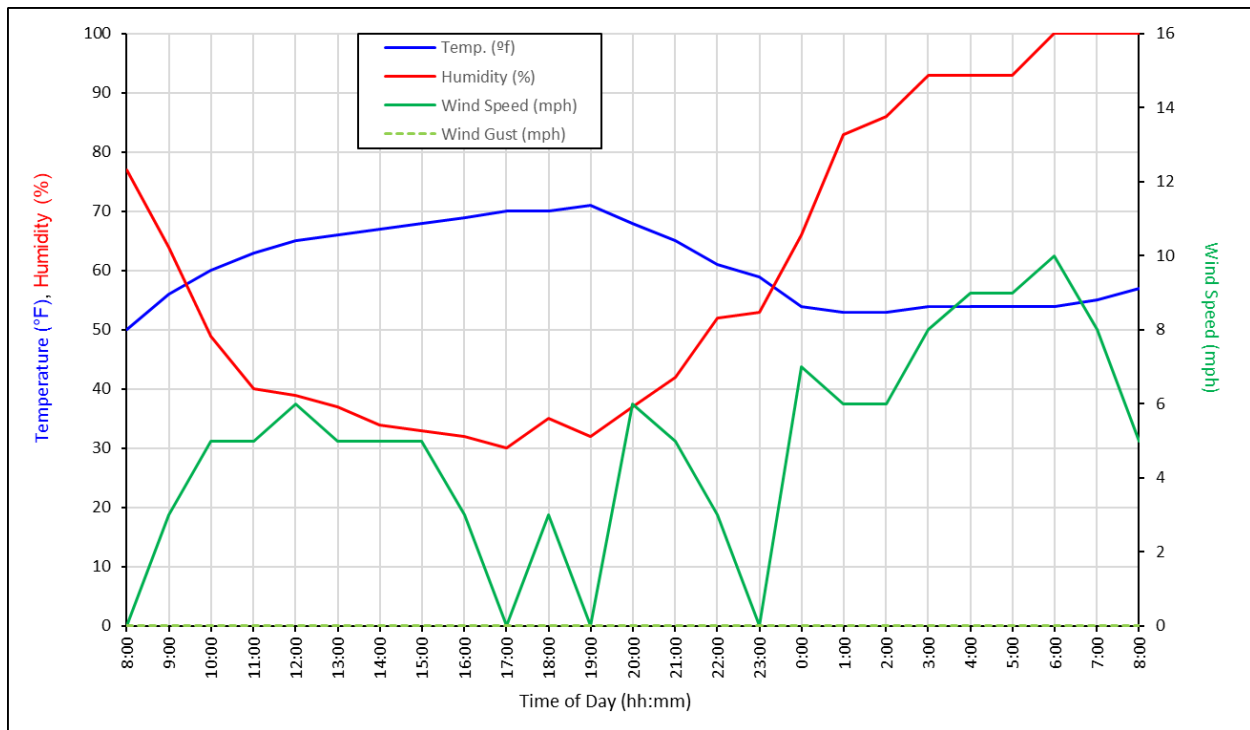
### **Noise Study**

To determine the existing sound levels at the Hudsonville Tommy Car Wash site, ABD performed long-term sound level measurements over a 24-hour period. The noise study was started on May 30, 2024, at 8:00 a.m. and was concluded on May 31, 2024, at 8:00 a.m. This time frame was chosen to capture ambient data during and outside of the Tommy Car Wash operating hours of 7 a.m. to 9 p.m. We have presented the hourly, 1-minute, and in some cases, 1-second  $LA_{eq}$  depending on the variability of the noise source.

### Atmospheric Conditions

ABD performs noise measurements within the weather limitations specified in ANSI S12.9 *Quantities and Procedures for Description and Measurement of Environmental Sound* and S12.18 *Outdoor Measurement of Sound Pressure Level* for environmental noise measurements. Data measured during higher wind speeds risk reliability contamination due to wind noise on the microphone, and repeatability limitations due to the directionality of the receiver relative to the noise source. High wind speeds were only present for a one-hour period before business hours on May 31, 2024 during the measurement period.

The environmental conditions were obtained from [www.wunderground.com](http://www.wunderground.com) for the Gerald R. Ford International Airport Weather Station (KMIGRAND151), in Grand Rapids, MI. Figure 1 summarizes the weather parameters during the measurement period.



**Figure 1: Environmental Conditions During Noise Study on May 30, 2024**

### Long Term Measurements

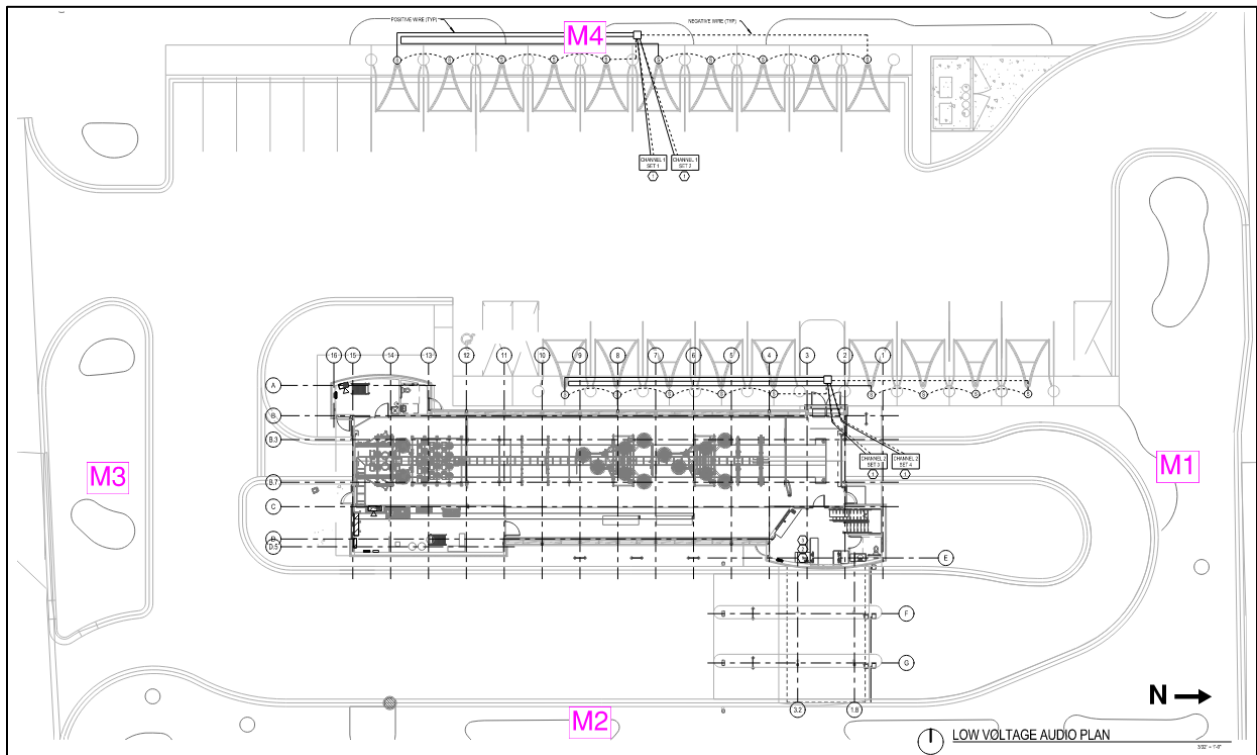
To determine the existing outdoor noise levels at the site, ABD conducted long term sound level measurements at three locations as seen in Figure 2 and described below:

**Location M1:** east property line, near entrance to car wash

**Location M2:** south, along 32<sup>nd</sup> Ave

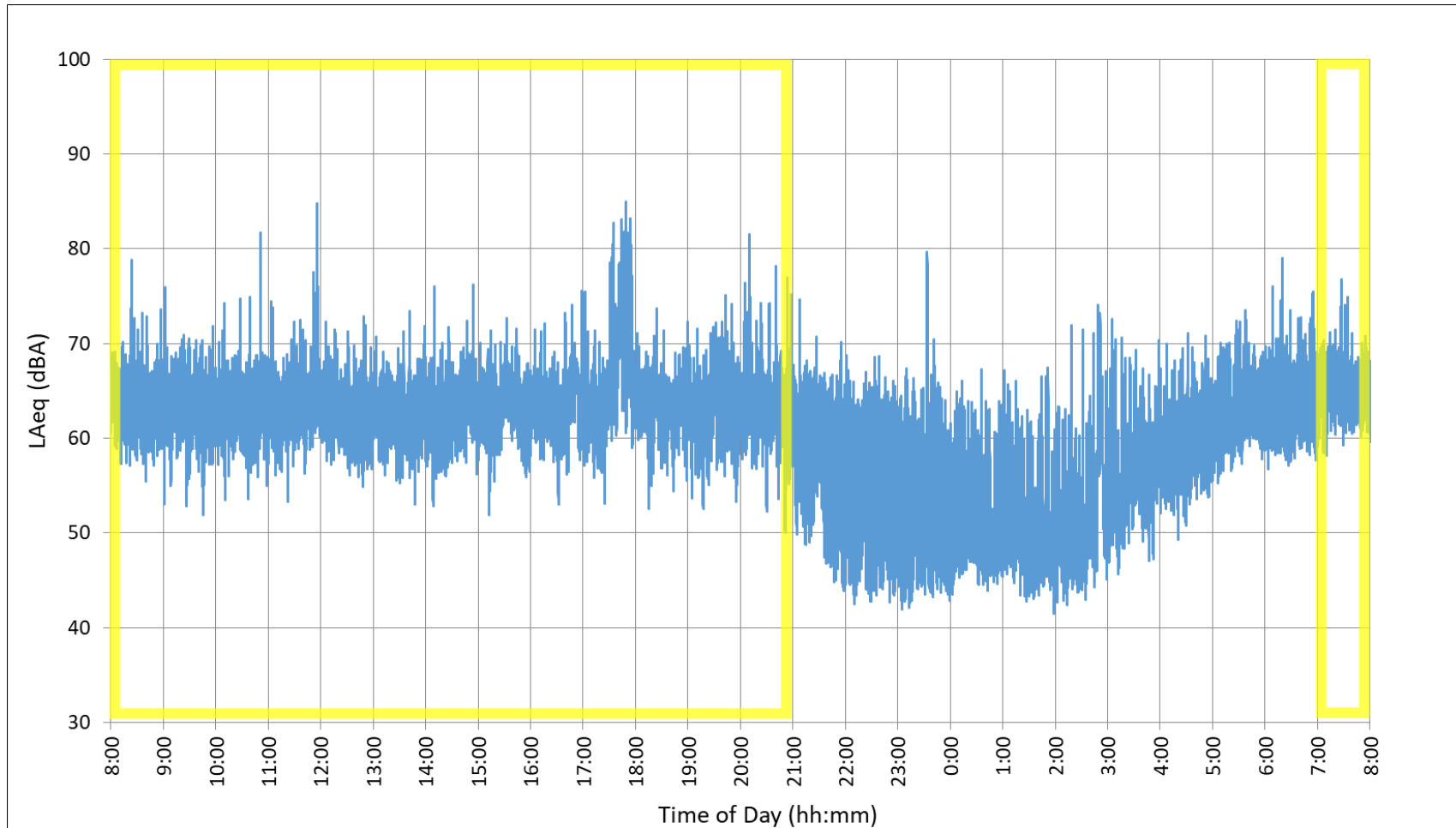
**Location M3:** west property line, near exit of car wash

**Location M4:** north, near vacuums

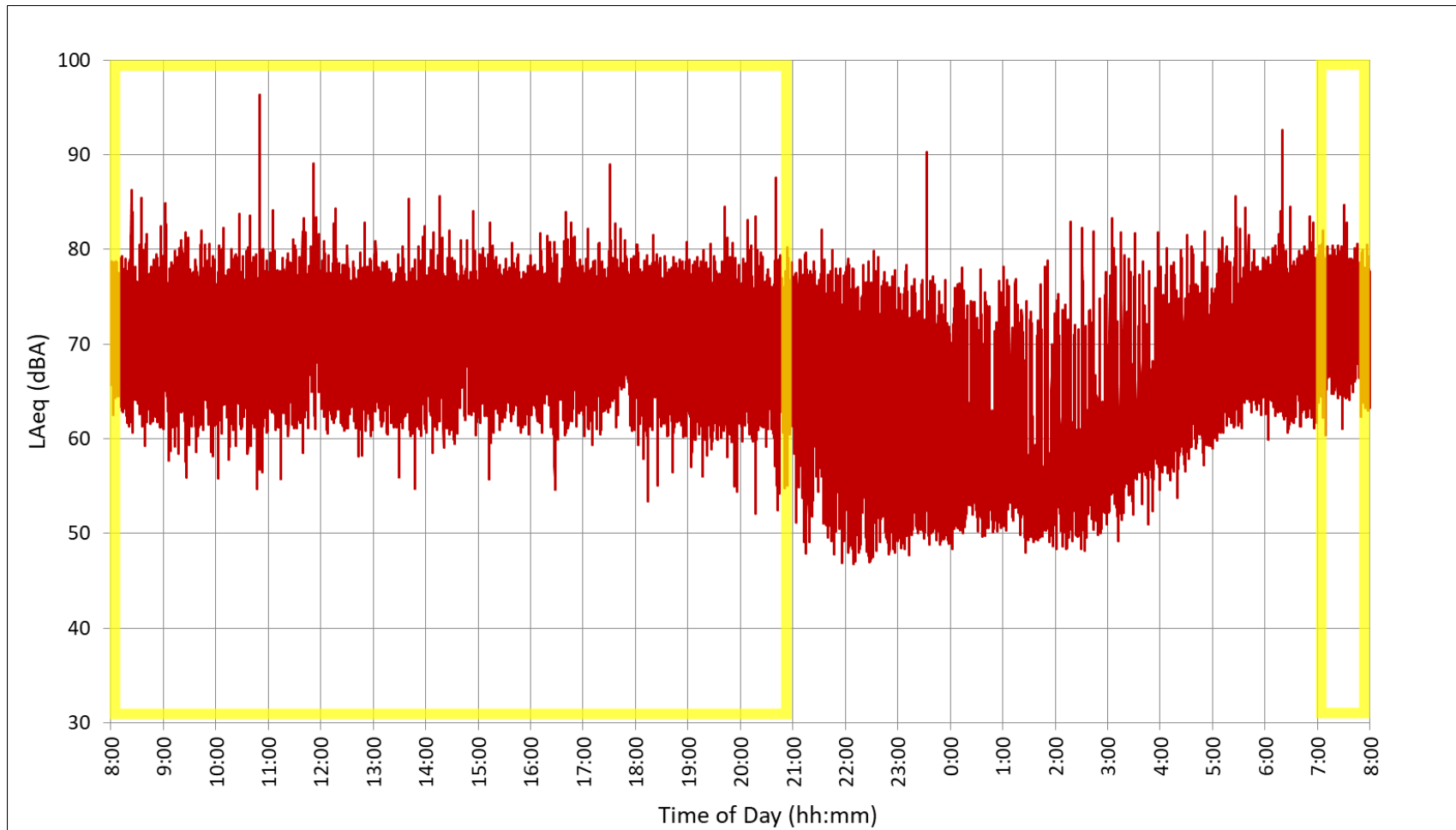


**Figure 2: Hudsonville Site Plan with Long-Term Measurement Locations**

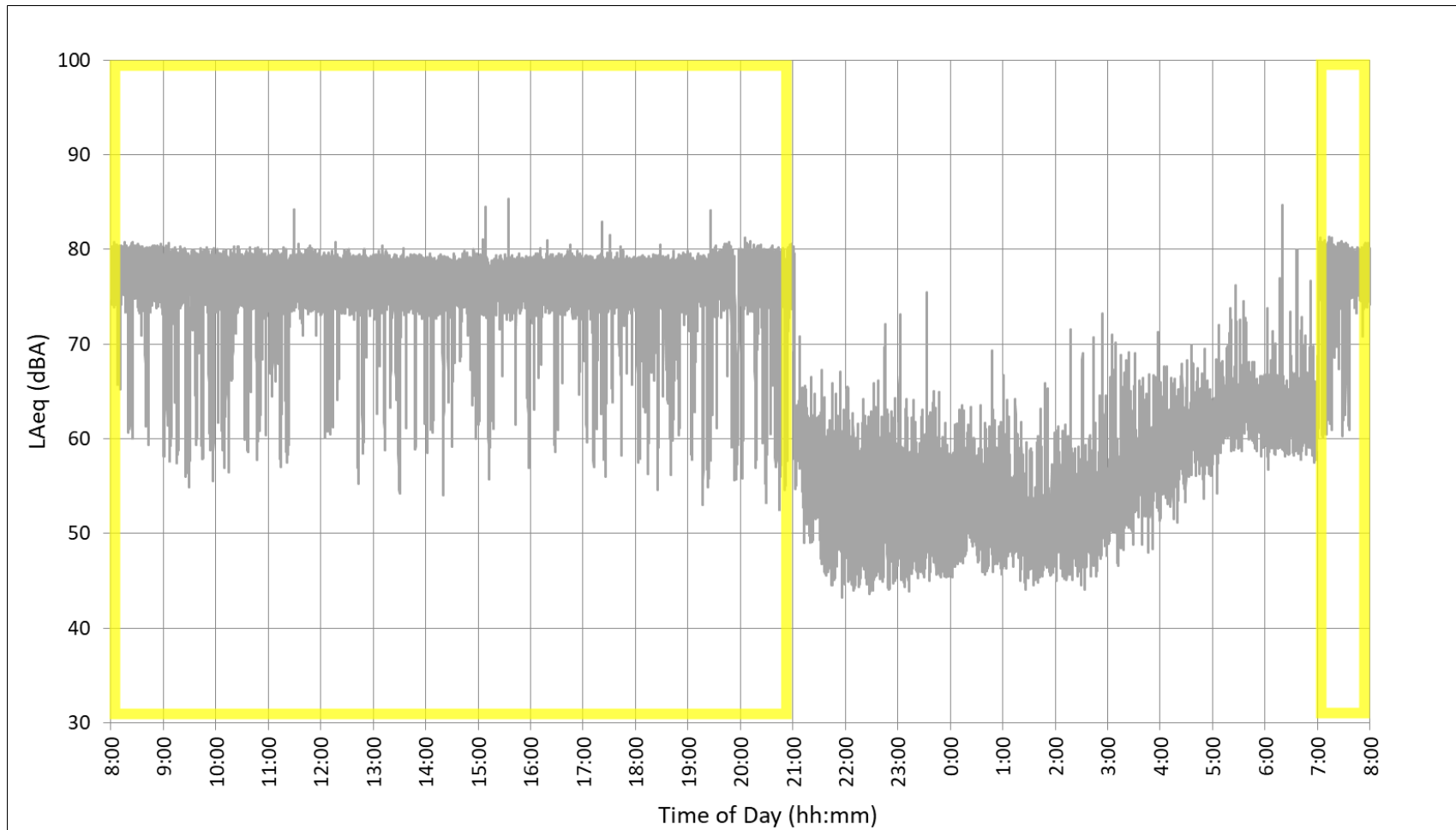
The long-term measurements (M1 – M4) were taken using the Soft dB Piccolo II sound level meters located at the four sides of the car wash (shown in magenta in Figure 2). All meters were set to run with a 1-second sampling interval and using exponential (slow) detector integration. The time-history results of these long-term measurements are shown in Figures 3 through 6 in terms of 1-second  $LA_{eq}$  sound levels over the 24-hour measurement period. The operating hours of the TCW are highlighted by the yellow box.



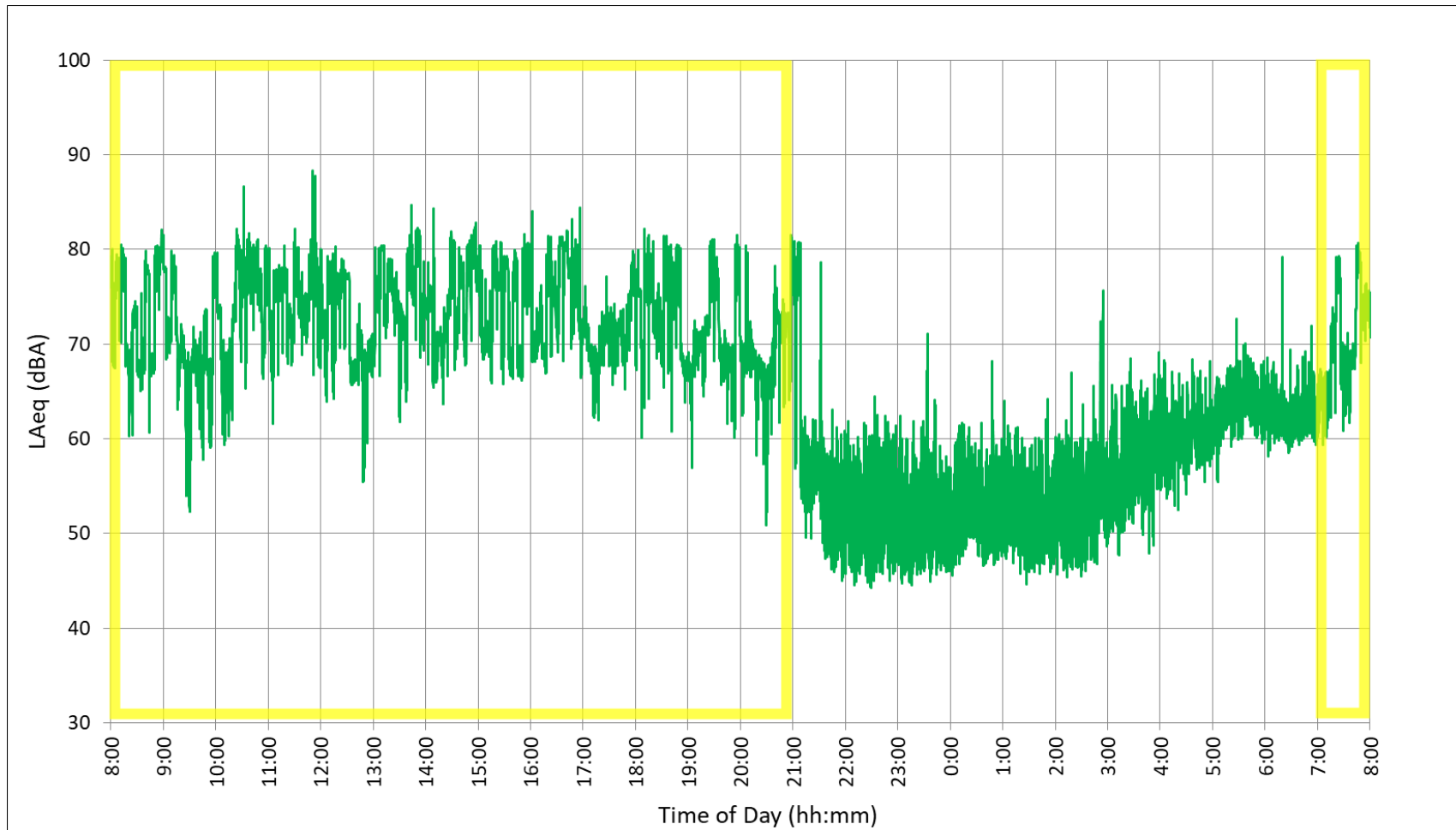
**Figure 3: Location M1 (Car Wash Entrance) – 1-Second LAeq Sound Levels**



**Figure 4: Location M2 (32<sup>nd</sup> Ave) – 1-Second LAeq Sound Levels**



**Figure 5: Location M3 (Car Wash Exit) – 1-Second LAeq Sound Levels**



**Figure 6: Location M4 (Vacuums) – 1-Second LAeq Sound Levels**

As the figures above show, noise levels were significantly higher during the daytime while the car wash is in operation. Locations M1, M2, and M3 are close to 32<sup>nd</sup> Ave and influenced by traffic noise, with M2 being closest. Despite the noise from 32<sup>nd</sup> Ave, all measurement locations show noticeable noise impact during the car wash operation. Location M4 is located by the vacuums on the north side of the Tommy Car Wash and is shielded from traffic noise by the building. The maximum peaks in noise levels throughout the day are identifiable as emergency vehicles, and the elevated levels at M1 between 5 pm and 6 pm on May 30<sup>th</sup> are likely caused by activity near the Piccolo II meter M1 and unrelated to normal TCW operations.

Figure 3 shows the car wash noise levels at the entrance of the TCW. While the noise from inside the car wash generates significant noise levels at the entrance, the noise levels at M1 are not consistent. Noise levels at the car wash exit, shown in Figure 5, are consistently higher, around 77 to 80 dBA during operating hours, due to the blowers. Noise levels at M1 and M3 drop to nighttime ambient levels once TCW is closed, showing direct correlation between the heightened noise levels and operating hours.

Figure 5 shows the impact of traffic noise near 32<sup>nd</sup> Ave to the south of TCW and shows daytime levels between 55-80 dBA during operating hours, depending on traffic volume throughout the day.

Figure 6 shows the measured noise levels near the vacuums to the north of the TCW building at the M4 position. Traffic noise is largely absent at this position, and the measured noise levels vary significantly due to inconsistent vacuum usage by customers. Noise from the car wash building is also much lower at M4, and noise drops to ambient nighttime levels once TCW is closed.

### **Short Term Measurements**

In 2020, ABD completed measurements at this TCW location to capture short term measurements of the main noise-generating equipment. These measurements captured the frequency content of each of these noise sources and overall A-weighted noise levels (dBA) of the car wash operation.

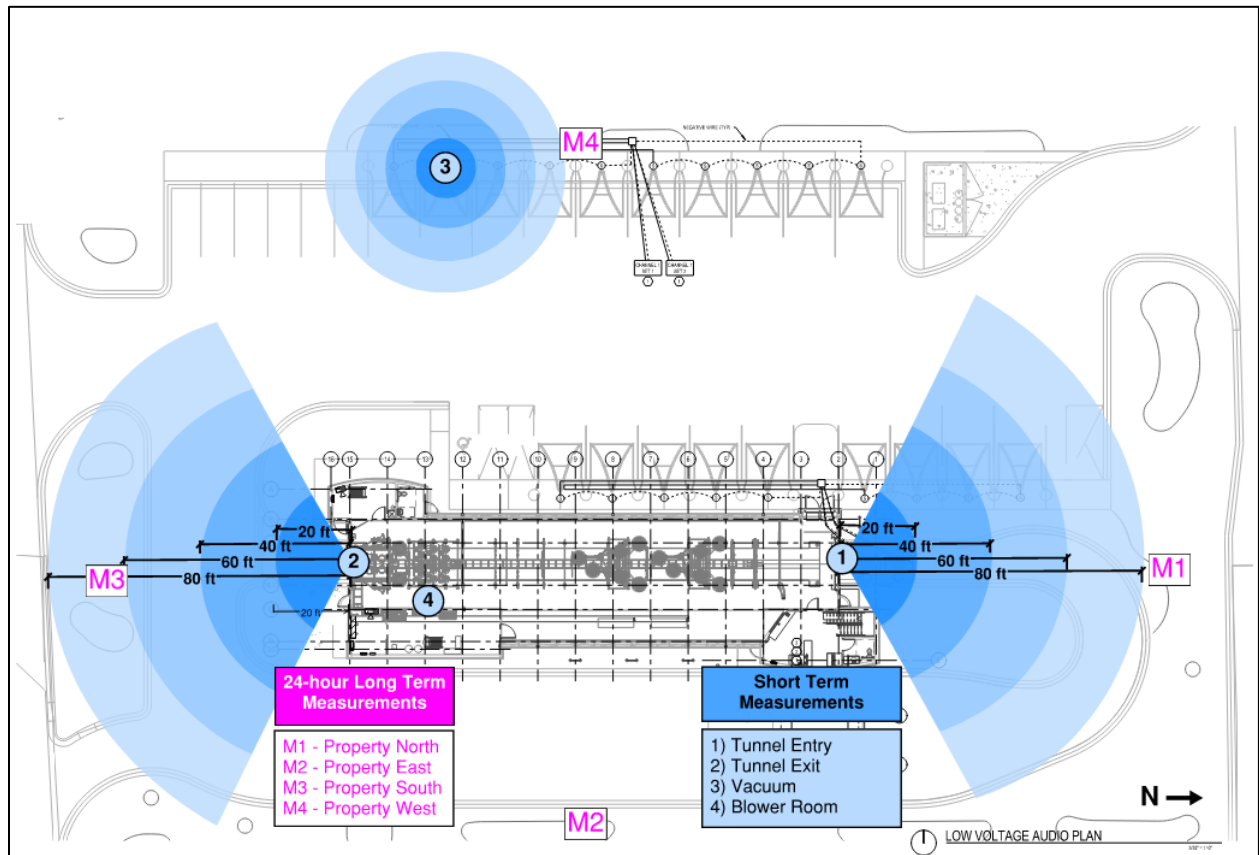
The blowers and vacuums have been updated at the Hudsonville location and will be the new basis of design for future TCW locations. To determine the noise levels of this updated equipment at the site, ABD conducted sound level measurements using Larson Davis 831 sound level meters at the locations described and seen in Figure 7 below:

**Location 1:** Tunnel Entry

**Location 2:** Tunnel Exit

**Location 3:** Vacuums

**Location 4:** Blower Room



**Figure 7: Site Plan with Short Term Measurement Locations**

The main contributors of noise are the blowers, which generate significant noise at the exit of the car wash; the vacuums, which operate outside the car wash and can collectively add significant noise in the parking lot; and the entry where cars are being washed and announcements are taking place. The exit noise created by the blowers is the primary noise source and generates noise far above the ambient background noise when the car wash is not in operation.

Table 3 below shows the short-term measurement results at key areas during the 2020 and 2024 measurements.

**Table 3: Short-Term Measurement Comparison 2020 vs 2024**

#	Location	2020 Measured Sound Pressure Level (dBA)	2024 Measured Sound Pressure Level (dBA)
1a	Tunnel Entry (0 ft)	86	84
1b	Tunnel Entry (40 ft)	70	69
1c	Tunnel Entry (80 ft)	n/a	65
2a	Tunnel Exit (0 ft)	95	101
2b	Tunnel Exit (40 ft)	83	86
2c	Tunnel Exit (80 ft)	79	78
3a	Vacuum	81	78
3b	Vacuum (60 ft)	73	69
4	Blower Room	106	104
5	Ambient at Exit (80 ft)	n/a	53

As the table indicates, the noise levels at the car wash entry are slightly lower, but a 1-2 dBA difference is not noticeable to an average listener. The 2024 blower noise levels at the tunnel exit are 5-6 dBA higher than 2020 measured noise levels. As stated by Table 1 in the Acoustical Terminology section, this increase in noise level is clearly noticeable. However, as indicated by the 40 ft and 80 ft measurements, the blower noise levels decrease with distance to 78 dBA, which is close to the 2020 noise levels. We note that 15 of the total 18 blowers were active during measurements. If all 18 blowers are operating simultaneously, we predict a 1 dB increase in the noise levels at the exit, which is not a noticeable increase but may be impactful for meeting noise level limits set by local noise ordinances.

Although these noise levels at 80 ft are similar, they are still 20-25 dBA louder than the measured background noise levels. For the 2024 Hudsonville ambient noise levels, we measured 53 dBA with no car wash operation and only light traffic. During this early morning condition, the resulting increase in noise level with the operating blowers is significantly louder and exceeds some noise limits of city noise ordinances, such as the Byron Center noise ordinance.

## **Conclusion**

Since the COHM does not specify quantifiable limits on noise levels at property lines during daytime hours, it is not possible to confirm if the measured noise levels would constitute a violation of the ordinance. Note that the COHM specifies that noise levels are not to exceed normal conversation levels between the hours of 9 p.m. and 7 a.m., when TCW is closed.

While the COHM may not technically apply, the noise levels at the TCW exit are significantly high, with the blowers being the main source. During car wash operation, the blowers consistently generate approximately 80 dBA at the property line. Due to the high level of noise generated by the blowers, we recommend providing mitigation to reduce the noise level at the property line, so that there are fewer disturbances to neighboring properties. Possible mitigation strategies include noise barriers, adding absorptive materials at the blower area, modifying how the blowers are utilized, or installing quieter blowers. If it is desired to analyze and develop these mitigation strategies, we will analyze potentially achievable noise reductions in Phase 2: Mitigation Recommendations upon approval.

Finally, note that our comments only apply directly to acoustics; we cannot comment on such things as local codes, ordinances, electrical systems, fire suppression systems, or any other non-acoustic issues. Our recommendations should be reviewed by the appropriate design professionals for code compliance before they are implemented.

If you have any questions, please contact us.

Sincerely,

ABD Engineering & Design, Inc.

Per:



John Kramer  
*Acoustical Consultant*



Quincey Smail, INCE Bd. Cert.  
*Senior Acoustical Consultant*

cc: Melinda Miller, Marci Boks – ABD Engineering & Design