inter-noise 2009
innovations in practical noise control
2009 August 23-26
Ottawa, Canada

Is drag racing louder than a NASCAR speedway?

Timothy M. Johnson[a]
Christopher W. Menge[b]
Harris Miller Miller & Hanson Inc.
77 South Bedford Street
Burlington, MA 01803 USA

ABSTRACT

A professional racing facility with an oval track speedway used for NASCAR events recently expanded by adding a major drag strip track with large grandstands. Residents in the nearby community have been exposed to noise from races at the speedway for many years, while the drag strip racing noise is new and very different in character. The goal of the noise study, based on a commitment from the speedway owner, was to determine whether the noise from the drag strip on its opening weekend was comparable to, louder than or quieter than the noise from the speedway. Noise measurements were made during both drag strip and speedway races at multiple locations in the community. Several metrics were used to compare the noise, including the average hourly Leq and Lmax for the entire racing period and a representative loud racing hour. Also discussed is the complexity of dealing with insect noise which contributed to the overall noise levels during the evening speedway race, but not the daytime drag racing. The contribution of insect noise during the speedway race measurements needed to be addressed to enable a comparison of the noise levels from racing activity alone.

1. INTRODUCTION

The City of Concord, North Carolina has long been the home of the Lowe's Motor Speedway racing facility. In 2008, the facility expanded by opening the zMAX Dragway, a major drag strip track near the speedway. Harris Miller Miller & Hanson Inc. (HMMH) was retained by the City of Concord to conduct a noise study in the community surrounding the racing facilities. The primary objective of the study, based on a commitment from the speedway owner to the City, was to assess the noise in the nearby community and determine whether the noise from the drag strip was comparable to, louder than or quieter than the noise from the speedway.

HMMH staff conferred with City officials to determine specific locations to conduct noise measurements that would be representative of the nearby noise-sensitive areas. Four representative locations were chosen to conduct noise measurements: three sites in the residential

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[a] Email address: tjohnson@hmmh.com
[b] Email address: cmenge@hmmh.com

community to the north, and one site at the high school to the east. Noise measurements were made during the opening weekend NHRA Drag Racing event at the zMax Dragway between September 12 and September 13, 2008. The same four sites were utilized for noise measurements during the NASCAR Bank of America 500 at the Lowe's Motor Speedway on October 11, 2008. HMMH staff periodically attended the four noise measurement site locations during both measurement periods.

2. NOISE MEASUREMENT SITES

The four noise measurement locations represent the noise-sensitive areas nearby the racing facilities. Figure 1 below shows the locations of the measurement sites relative to the drag strip and the speedway. Site 1 was a single-family residence located in the neighborhood nearest to the end of the quarter-mile (402 meter) long drag strip track. Site 2 was a high school located to the east of the racing facilities. Both sites 3 and 4 were located in the residential community nearest the start of the drag strip track. Site 3 was a single-family residence located back into the community near an elementary school, and site 4 was located at the future site of a residence in the development near the drag strip. A golf course is located between the drag strip track and the residential area containing sites 3 and 4.

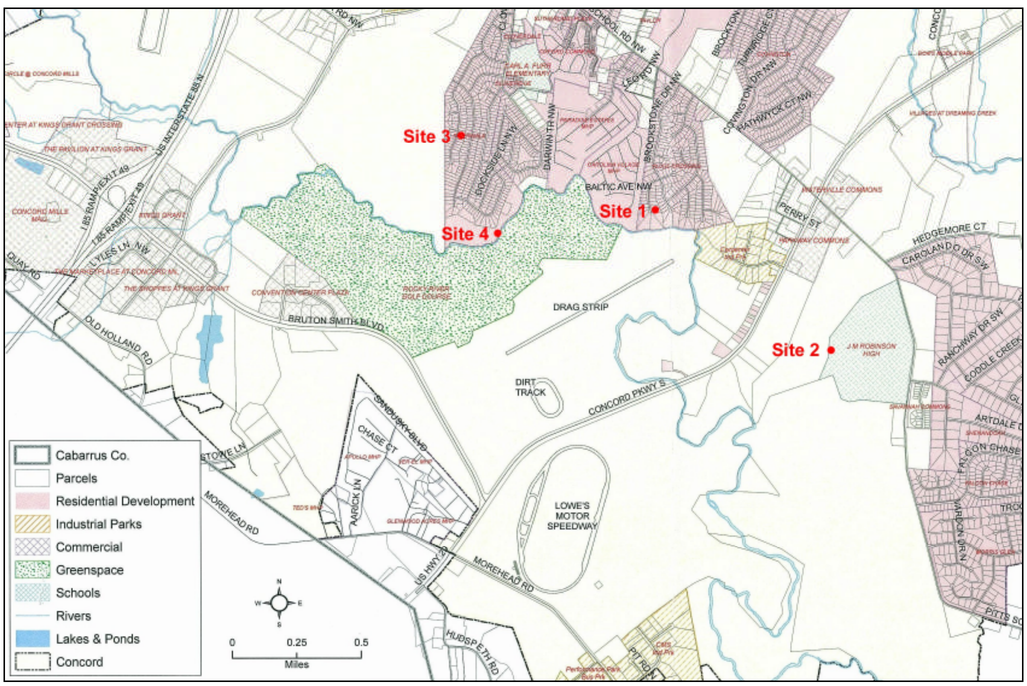

Figure 1: Noise Measurement Site Locations

The zMAX Dragway facility also includes spectator grandstands along both sides at the starting end of the track. These grandstands provide some noise shielding when the race vehicles are at the starting end of the track. As the race vehicles proceed down the track past the end of the grandstands there is a short (relative to the height of the grandstands) noise barrier along the north side of the track. The noise barrier extends the full quarter-mile down the track to the finish line, but the race vehicles can pass beyond the end of it toward the end of the track. Figure 2 below are photographs of the grandstands and the barrier taken from the Rocky River golf course.

Figure 2: zMAX Dragway Grandstand and Noise Barrier

3. DRAG STRIP NOISE MEASUREMENTS

The NHRA Drag Racing at the zMax Dragway took place over the course of three days. Each day the races would occur mainly between the late morning hours through the early evening hours of the day. The background noise at all measurement sites was mainly from limited community activity, and was low in level compared to the noise from vehicles racing on the drag strip. Figure 3 below shows a sample time history during the drag racing at site 1. The figure shows a plot of the overall A-weighted sound level for the drag strip over a five-minute period in which there were two separate races. The events shown here were from the Nitro Top Fuel category of vehicles, which were the loudest types of vehicles that raced at the event. The first peak is a race. The second peak at 150 seconds is the next pair of vehicles warming up the tires for their race, and the third peak at the 240 seconds is the next actual race.

Between individual races, the noise levels were mostly in the low- to mid-50s dBA. In addition to local residential community sounds some noise from the race facility was audible at this site between races, including occasional announcements for the spectators. As an individual drag race would start, the noise level would increase by 20 to 40 decibels very quickly to the mid 80s dBA or low 90s dBA at site 1, fast and high enough to be startling. These Nitro vehicles reached speeds as high as 310 mph (500 km/hr) and covered the length of the quarter-mile track in less than four seconds. Some of the vehicles have over 5000 horsepower and they do not have exhaust headers or mufflers. The drag race noise events lasted only a few seconds, and would repeat every few minutes until all of the vehicles in a class had raced. After a few minutes, another class of cars would begin racing. These races continued fairly steadily throughout the day. Dragsters other than the Nitro Top Fuel vehicles produced somewhat lower maximum noise levels; those ranged from 65-75 dBA for the Pro Stock cars to 80-85 dBA for the Top Alcohol cars at site 1. While not as startling, these vehicles produced sound levels high enough to be plainly audible in the nearby surrounding community under most conditions.

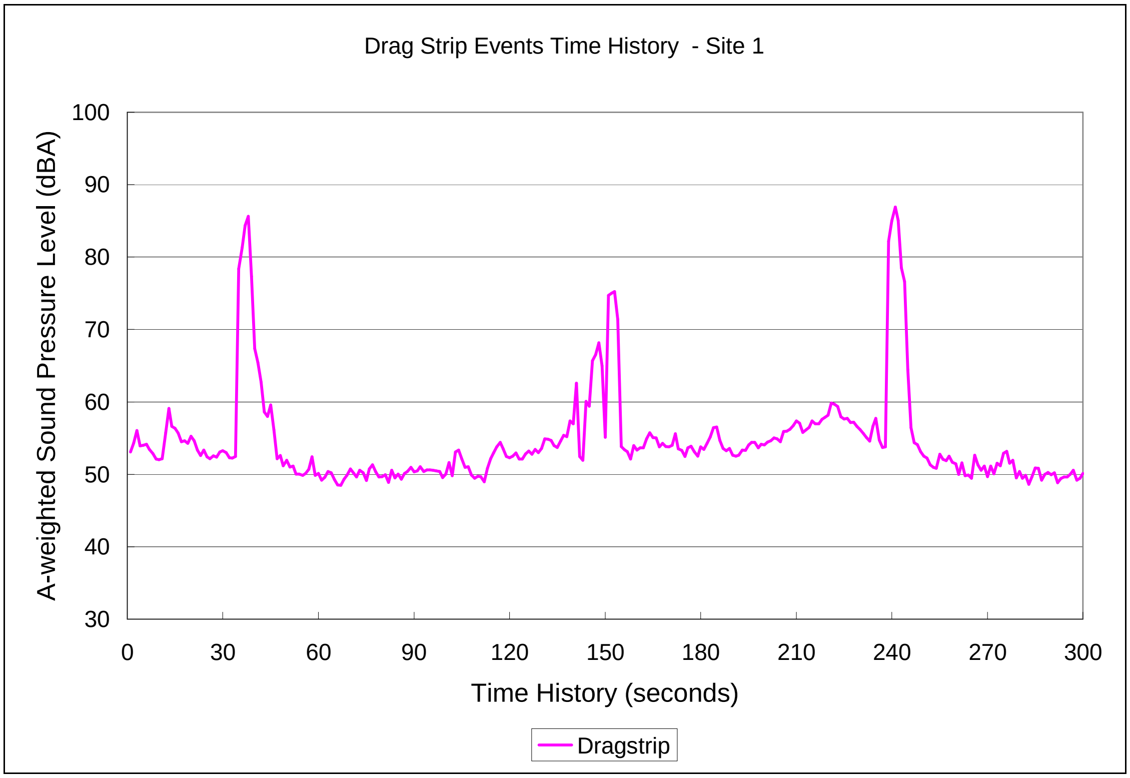

Figure 3: Drag Strip Sample Time History

4. SPEEDWAY NOISE MEASUREMENTS

The NASCAR Bank of America 500 at the Lowe's Motor Speedway took place in the evening from about 7:00 PM to about midnight. Because the speedway race occurred at night, the background noise was very different compared to the background noise during the daytime drag racing. During the nighttime hours over which the speedway race occurred, noise from insects contributed greatly to the overall background noise levels.

As the speedway race began in the early evening hours, noise from insects began to increase. HMMH staff observed that the insect noise increased from an audible level to a level high enough to contribute greatly to the A-weighted background noise levels. The insect noise stayed relatively constant throughout the race. The noise from the speedway race could still clearly be heard at the same time as the insect noise at all four measurement sites, however, due to the different frequency content.

Figure 4 below shows the frequency content in one-third octave bands of the noise during one representative hour of speedway racing at one representative site. This figure is shown as an example of the range of frequencies dominated by insect noise and racing noise. The vertical axis shows un-weighted one-third octave band sound pressure levels. The 2,000 Hz to 10,000 Hz range contains the high frequencies of the insect noise and the left portion of the graph contains the low- and mid-frequency content of the racing noise. The curves shown in the figure represent the four metrics Lmax, L33, L90, and Leq.

Noise from insects is typically found to be in the 2,000-8,000 Hz range. The peaks in the spectrum below at 2,500 and 4,000 Hz are clearly produced by insects, since the L90 is nearly equal to the Leq at those frequencies, and the sound of insects is very steady.

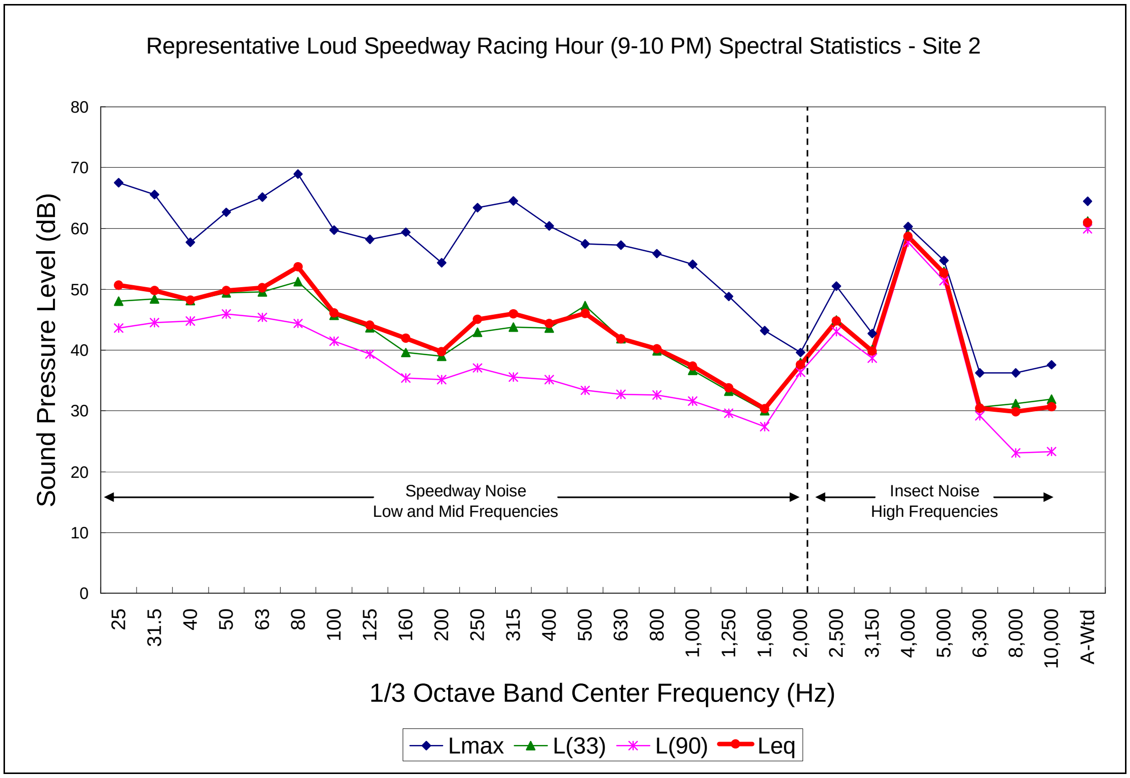

Figure 4: Example Frequency Spectrum of Speedway Measurements Illustrating Insect Noise

The A-weighted levels for each of these metrics are also shown in the graph at the far right. Note that there is virtually no difference among the A-levels, in spite of the clear differences of up to about 10 dB between Leq and L90 in the mid-frequency bands between 315 and 800 Hz, where racing noise was dominant. This illustrates how completely the insect noise dominates the overall A-level, while the racing noise controls the low and middle frequencies.

As stated earlier, the goal of the study was to compare the noise from races at the drag strip to the noise from races at the speedway, and to determine which was louder under different conditions. Since speedway racing noise was clearly audible during the evening when the insects dominated the noise levels, the authors thought it necessary to develop an appropriate metric to isolate the speedway noise levels, and not attribute the insect-dominated A-levels to the speedway. A surrogate A-level for the noise contribution from the speedway was developed by cutting off the frequency bands above 1,600 Hz, and calculating the overall level by summing the sound energy in the 1/3 octave-bands from 20 Hz to 1,600 Hz, after A-weighting each of the bands. Figure 5 below shows the overall A-weighted sound level and the adjusted A-weighted level without the high frequency insect noise as they vary over the course of a representative hour of speedway racing activity at a representative site (site 3). The sound levels shown in the upper curve (green) include the insect noise and are very steady over the entire hour at about 62 dBA. The lower curve (blue) is the adjusted A-level without insect noise, and levels are considerably lower, indicating the significant degree to which the insects dominate the overall A-weighted sound level from moment to moment. Much more variation in the low- and mid-frequency noise level without insects can be seen in blue from 300-600 seconds as the levels range from about 48-58 dBA. The levels decrease from 600-1000 seconds as the race activity lulled, and then increased again as racing resumed.

Another element of the noise environment during the speedway race that can be gleaned from figure 5 is when the race went into a caution period. During a yellow-flag caution period, the cars would be much closer to one another behind a pace car, and then as the race resumed the vehicles would slowly start to increase speed and separate from one another around the track. When the race was in a caution period the noise levels would vary more with time as seen between 300 and 600 seconds along the graph. When the race resumed and the vehicles were again spread out around the track, the noise levels were more steady and consistent as seen between 2000 and 3000 seconds along the graph.

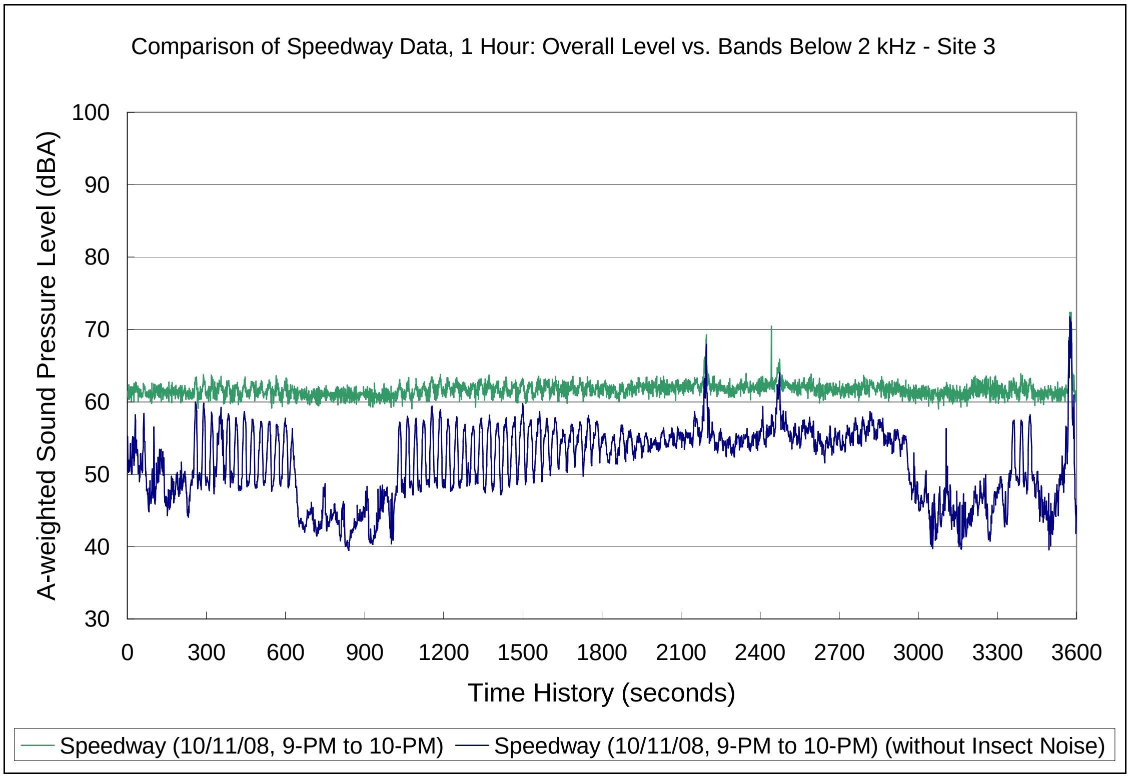

Figure 5: One Hour Example Comparison of Speedway Measurements: Overall Level vs. Bands Below 2 kHz

5. COMPARISON OF NOISE MEASUREMENT RESULTS

The noise environment at each measurement site was quite different during the races at the drag strip and the race at the speedway. Figure 6 below shows a comparison of the noise levels at site1 during a one-hour period of both drag strip and speedway racing. The figure shows plots of the overall A-weighted sound level for the drag strip in the upper curve (pink) and the adjusted A-weighted level without insect noise for the speedway in the lower curve (blue) as it varies from second to second over the course of a busy hour of racing activity. Due to its proximity to the drag strip, the noise levels at site 1 show the greatest difference between the two types of racing events.

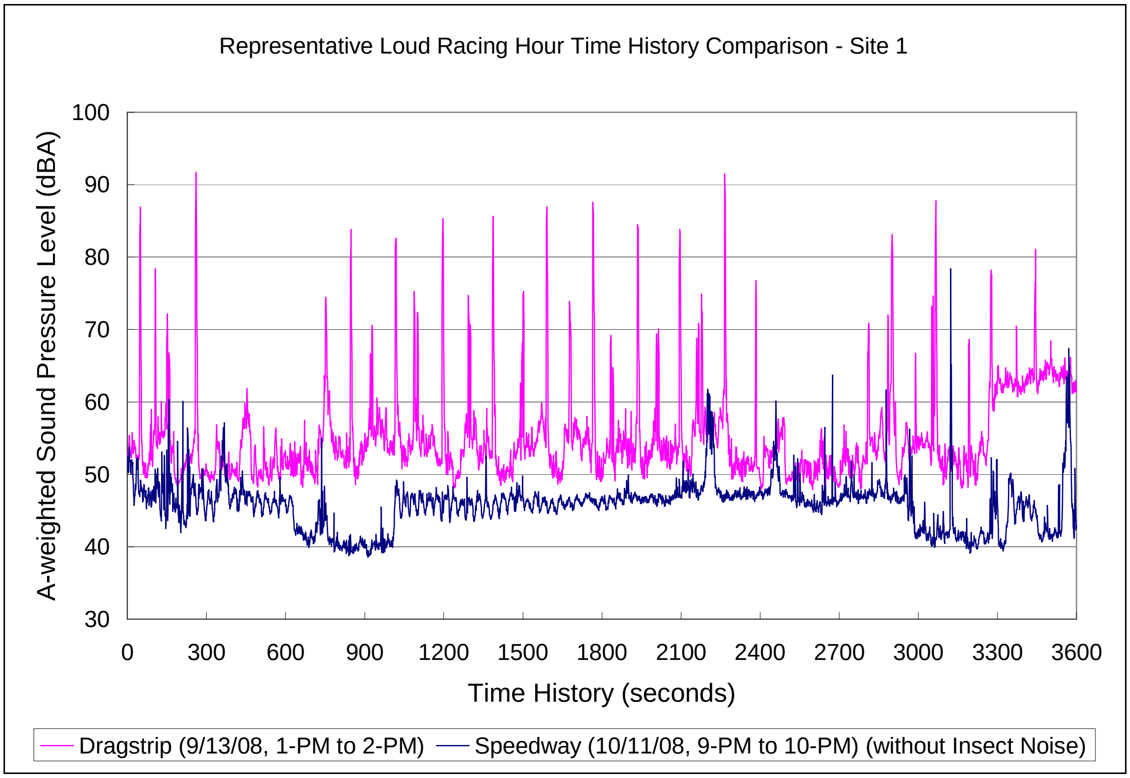

Figure 6: Representative Loud Racing Hour Time History Comparison

Given the very different nature of the noise generated by the two types of racing, the authors provided the City of Concord with information on both the average noise levels of racing activity in terms of hourly Leq value, and the maximum noise levels from racing in terms of Lmax.

The two tables below show a comparison of the Leq and Lmax noise levels for the two types of racing events at each of the four measurement sites. One table gives results for a representative loud hour of racing for both events. The other table compares results over a peak racing period of the day. For the speedway measurements, both the overall Leq and the adjusted Leq without insect noise are given. A two-decibel range is given for the Leq without insect noise levels; the lower number is the A-weighted summation of the measured 1/3 octave-band levels from 20-1,600 Hz, and the higher number is two decibels higher. Two decibels is added to the computed value as an estimate of the highest expected speedway noise level if the higher-frequency 1/3-octave bands could have been included without the contribution of insect sounds.

Table 1 compares the levels during one representative loud racing hour. The specific hour of data presented is indicated. The drag strip racing hour consisted of mostly Nitro Top Fuel vehicles racing consistently every few minutes.

At site 1 the drag strip Leq is 16-18 dB higher than the speedway and the Lmax is 9 dB higher. At site 2 the drag strip Leq is 11-13 dB higher than the speedway and the Lmax is 24 dB higher. The speedway Leq is higher than the drag strip by 1-3 dB at site 3 and the Lmax values vary by 6 dB. At site 4 the Leq and Lmax values are similar for both types of racing events.

Table 1: Representative Loud Racing Hour Data

	Sound Energy Average, Leq (dBA)					Average Hourly Maximum Sound Level, Lmax (dBA)			
	Drag Strip		Speedway			Drag Strip		Speedway	
Site #	Leq	Period[1]	Overall Leq	Leq without Insect Noise[3]	Period[2]	Lmax	Period[1]	Lmax	Period [2]
1	67	1 PM	54	49-51	9 PM	91	1 PM	82	9 PM
2	62	1 PM	61	49-51	9 PM	88	1 PM	64	9 PM
3	53	1 PM	62	54-56	9 PM	78	1 PM	72	9 PM
4	62	1 PM	62	59-61	9 PM	82	1 PM	80	9 PM

1 September 13th, 2008
2 October 11th, 2008
3 Range of A-weighted summation of 1/3 octave-band levels from 20-1,600 Hz plus 2 dB

Table 2 shows the same comparison of noise levels by racing type and measurement site, but is an average of the levels over the peak racing period. The peak racing period was determined to be 12 PM to 9 PM for the drag strip when most of the races took place, and for the actual time of the speedway race activity from 7 PM to midnight. The Leq values are the energy-average of the hourly Leqs during the period, or a period-long Leq. The Lmax values are an arithmetic average of the hourly Lmax results during the period.

When averaged over the peak racing period the Leq at site 1 during drag racing events is 6-8 dB higher than during the speedway race and the Lmax is 9 dB higher. These are similar results as seen in Table 1, but the difference between racing types is not as great. The Leq at site 2 during the drag racing is also 6-8 dB greater than during the speedway racing and the Lmax is 9 dB more. So, the Leq and Lmax levels were greater at site 1 than at site 2 for both types of racing events, but relative difference between drag strip and speedway levels was about the same. The results at site 3 indicate that the speedway is about equally as loud as the drag strip at this location. The speedway average hourly Leq is within 2 dB of the drag strip and the average Lmax levels are within 1 dB. As with the representative hour, the peak racing period comparison results between racing types at site 4 are similar, with the drag strip slightly louder. The drag strip Leq is 2-4 dB higher than the speedway, and the drag strip average Lmax is 5 dB greater than the speedway.

Table 2: Peak Racing Hourly Data

	Sound Energy Average, Leq (dBA)					Average Hourly Maximum Sound Level, Lmax (dBA)			
	Drag Strip		Speedway			Drag Strip		Speedway	
Site #	Leq	Period[1]	Overall Leq	Leq without Insect Noise	Period[2]	Lmax	Period[1]	Lmax	Period [2]
1	65	12 PM - 9 PM	58	57-59	7 PM - 12 AM	85	12 PM - 9 PM	76	7 PM - 12 AM
2	58	12 PM - 9 PM	60	50-52	7 PM - 12 AM	76	12 PM - 9 PM	67	7 PM - 12 AM
3	57	12 PM - 9 PM	62	55-57	7 PM - 12 AM	74	12 PM - 9 PM	73	7 PM - 12 AM
4	61	12 PM - 9 PM	62	57-59	7 PM - 12 AM	80	12 PM - 9 PM	75	7 PM - 12 AM

1 September 12th & 13th, 2008
2 October 11th, 2008
3 Range of A-weighted summation of 1/3 octave-band levels from 20-1,600 Hz plus 2 dB

6. CONCLUSIONS

The character of the noise from drag racing and speedway racing in the neighborhoods is very different. Noise from speedway racing is relatively steady and continuous, but that continuous sound can vary up and down slowly with time during caution flags when the cars tend to bunch together. Drag racing noise generally consists of short bursts of notably higher sound levels, with periods of relative quiet in between. The bursts produced by the loudest “nitro” cars can be quite sudden and high in level, such that some might consider the noise startling.

An equitable comparison of speedway noise to drag strip noise required the removal of the contribution from insect noise that controlled the overall noise levels measured during the evening speedway race.

As indicated in Tables 1 and 2 above, the average hourly equivalent noise levels are significantly greater during the drag strip racing events than during the speedway racing only at measurement sites 1 and 2, which are the sites located closest to the end of the drag strip. The drag racing is 6-8 dB louder than the speedway at these sites. At both of the other sites closer to the start of the strip, the Leq values during the drag strip events are within 4 dB of the speedway results. The lower noise levels near the beginning of the drag strip relative to the end may well be due to significant noise shielding that is undoubtedly provided by the very high grandstand seating along the first several hundred feet of the track. A modest-height noise barrier is located along a portion of the north side of the track beyond the grandstands, but it does not extend the full length of the track.

The City of Concord is currently working with the developer on potential mitigation.

ACKNOWLEDGMENTS

The authors would like to acknowledge Mr. Jim Hipp, Assistant City Manager and Ms. Margaret Pearson with the City of Concord, North Carolina for their assistance with the study as well as James Ferguson III with Harris Miller Miller & Hanson Inc. for his contributions with field noise measurements and observations.

REFERENCES

[1] Timothy M. Johnson, Christopher W. Menge, “Drag Strip Racing Noise Study – City of Concord, North Carolina,” Harris Miller Miller & Hanson Inc. report #303100.000, February 8, 2009.