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Noise Impact Analysis for the Darien High School Stadium

A. INTRODUCTION

The proposed installation of athletic lighting at the Darien High School Stadium would allow night-time sporting events, such as soccer, lacrosse, and football games, to be held on the Darien High School Campus during evening hours (i.e., from 7:00 PM to 10:00 PM). The proposed project would increase the hours of use of the field and the temporary noise associated with the games would be expected to occur in the evening when existing ambient noise levels are slightly lower than daytime noise levels. In addition, nighttime games would be expected to generate a larger number of spectators than daytime games. Therefore, while total noise levels when nighttime events occur would not be expected to be significantly greater than those currently experienced during daytime events, because background noise levels are lower in the evening and nighttime events are expected to generate larger numbers of spectators, the nighttime events would be expected to result in larger increases over background noise levels than daytime events.

The purpose of this noise analysis is to examine the potential for noise impacts related to the proposed installation of athletic lighting at the Darien High School Stadium. The noise analysis considers existing background noise levels during the early evening time periods during which the lights would be in use; as well as the noise levels expected from the game's announcer, the school band, and spectators cheering at the game. While it can be concluded that the noise levels at the site during evening home games played on the field would be substantially more than the background noise levels, the noise levels generated by nighttime use of the field during the football games with the largest number of spectators would result in a barely perceptible increase in noise levels over daytime game noise levels.

B. BACKGROUND

Daytime athletic events currently held at the Darien High School Stadium range in attendance from 100 to 2,500 spectators, depending on the sport and event. The Senior Varsity Football Games draw the largest number of spectators, with regular games generating between 800 and 1200 spectators. Every year, Darien High School hosts a Turkey Bowl Football Game that draws approximately 2,500 people. This annual event, which generates the greatest number of daytime spectators, is played on Thanksgiving Day and would never occur in the evening.

The addition of nighttime lighting is expected to increase the number of spectators attending athletic events. Table 1 shows the maximum number of spectators that would be projected to attend the 12 nighttime games expected to be held in the Fall and the 10 nighttime games expected to be held in the Spring.

Table 1
Fall and Spring Nighttime Events

Event	Number of Games	Number of Spectators
Fall		
Football	2	1,500 to 2,100
Football	2	1,200 to 1,500
Football	2	800 to 1,200
Soccer and Field Hockey	6	100 to 200
Spring		
Lacrosse	6	300 to 500
Lacrosse	4	100 to 200

Source: Darien Public Schools

In addition, to reduce the potential for noise impacts to nearby residences, the Darien Board of Education is proposing a number of restrictions to limit the frequency and duration of nighttime events including[1]:

- No more than 12 Darien High School interscholastic games (including playoffs) will be held in the evening in the fall on the Stadium Field.
- No more than 10 Darien High School interscholastic games (including playoffs) will be held in the evening in the spring on the Stadium Field.
- During the school year there will be no evening games or practices on the Stadium Field from the end of the CIAC fall season until the beginning of the CIAC spring season.
- There will be no lights on Sundays.
- There will be no lights used during the summer months from the end of the CIAC spring season to the beginning of the CIAC fall season.
- For practices and other activities (Monday through Saturday) lights will be out by 8:00 p.m.
- For Darien High School interscholastic games (Monday through Saturday) lights will be out by 9:00 p.m. with the exception of football games where lights will be out by 10:00 p.m.
- Games may be scheduled on only one evening of a weekend, within the time parameters outlined above. Games will not be scheduled on both Friday and Saturday evenings of the same weekend.
- Football games are permitted on Fridays only, within the time parameters outlined above.

Further, the current public address system is proposed to be replaced and modernized as part of the Stadium improvements. The speakers for the new public address system would be directed away from nearby residents and would include a scoop shield to direct sound onto the field and away from the surrounding residences.

C. NOISE FUNDAMENTALS

Quantitative information on the effects of airborne noise on people is well documented. If sufficiently loud, noise may adversely affect people in several ways. For example, noise may interfere with human activities, such as sleep, speech communication, and tasks requiring concentration or coordination. It may also cause annoyance, hearing damage, and other physiological problems. Although it is possible to study these effects on people on an average

[1] See Appendix __ for a complete list of the athletic lighting use restrictions proposed by the Darien Board of Education.

or statistical basis, it must be remembered that all the stated effects of noise on people vary greatly with the individual. Several noise scales and rating methods are used to quantify the effects of noise on people. These scales and methods consider such factors as loudness, duration, time of occurrence, and changes in noise level with time.

"A"-WEIGHTED SOUND LEVEL (DBA)

Noise is typically measured in units called decibels (dB), which are ten times the logarithm of the ratio of the sound pressure squared to a standard reference pressure squared. Because loudness is important in the assessment of the effects of noise on people, the dependence of loudness on frequency must be taken into account in the noise scale used in environmental assessments. Frequency is the rate at which sound pressures fluctuate in a cycle over a given quantity of time, and is measured in Hertz (Hz), where 1 Hz equals 1 cycle per second. Frequency defines sound in terms of pitch components. One of the simplified scales that accounts for the dependence of perceived loudness on frequency is the use of a weighting network known as A-weighting in the measurement system, to simulate response of the human ear. For most noise assessments the A-weighted sound pressure level in units of dBA is used in view of its widespread recognition and its close correlation with perception. In this analysis, all measured noise levels are reported in dBA or A-weighted decibels. Common noise levels in dBA are shown in Table 2.

Table 2
Common Noise Levels

Sound Source	(dBA)
Air Raid Siren at 50 feet	120
Maximum Levels at Rock Concert (Rear Seats)	110
On Platform by Passing Subway Train	100
On Sidewalk by Passing Heavy Truck or Bus	90
On Sidewalk by Typical Highway	80
On Sidewalk by Passing Automobiles with Mufflers	70
Typical Urban Area	60-70
Typical Suburban Area	50-60
Quiet Suburban Area at Night	40-50
Typical Rural Area at Night	30-40
Isolated Broadcast Studio	20
Audiometric (Hearing Testing) Booth	10
Threshold of Hearing	0

Note: A change in 3dB(A) is just noticeable change in SPL. A change in 10 dB(A) is perceived as a doubling or halving in SPL.

Source: Cowan, James P. Handbook of Environmental, Acoustics. Van Nostrand Reinhold, New York, 1994.

Egan, M. David, Architectural Acoustics. McGraw-Hill Book Company, 1988.

COMMUNITY RESPONSE TO CHANGES IN NOISE LEVELS

The average ability of an individual to perceive changes in noise levels is well documented (see Table 3). Generally, changes in noise levels less than 3 dBA are barely perceptible to most listeners, whereas 10 dBA changes are normally perceived as doublings (or halvings) of noise levels. These guidelines permit direct estimation of an individual's probable perception of changes in noise levels.

Table 3
Average Ability to Perceive Changes in Noise Levels

Change (dBA)	Human Perception of Sound
2-3	Barely perceptible
5	Readily noticeable
10	A doubling or halving of the loudness of sound
20	A dramatic change
40	Difference between a faintly audible sound and a very loud sound

Source: Bolt Beranek and Neuman, Inc., *Fundamentals and Abatement of Highway Traffic Noise*, Report No. PB-222-703. Prepared for Federal Highway Administration, June 1973.

It is also possible to characterize the effects of noise on people by studying the aggregate response of people in communities. The rating method used for this purpose is based on a statistical analysis of the fluctuations in noise levels in a community, and integrates the fluctuating sound energy over a known period of time, most typically during 1 hour or 24 hours. Various government and research institutions have proposed criteria that attempt to relate changes in noise levels to community response.

NOISE DESCRIPTORS USED IN IMPACT ASSESSMENT

Because the sound pressure level unit of dBA describes a noise level at just one moment and very few noises are constant, other ways of describing noise over extended periods have been developed. One way of describing fluctuating sound is to describe the fluctuating noise heard over a specific time period as if it had been a steady, unchanging sound. For this condition, a descriptor called the "equivalent sound level," L_{eq}, can be computed. L_{eq} is the constant sound level that, in a given situation and time period (e.g., 1 hour, denoted by $L_{eq(1)}$, or 24 hours, denoted as $L_{eq(24)}$), conveys the same sound energy as the actual time-varying sound. Statistical sound level descriptors such as L_1, L_{10}, L_{50}, L_{90}, and L_x, are sometimes used to indicate noise levels that are exceeded 1, 10, 50, 90 and x percent of the time, respectively. Discrete event peak levels are given as L_1 levels. L_{eq} is used in the prediction of future noise levels, by adding the contributions from new sources of noise (e.g., increases in traffic volumes) to the existing levels and in relating annoyance to increases in noise levels.

The relationship between L_{eq} and levels of exceedance is worth noting. Because L_{eq} is defined in energy rather than straight numerical terms, it is not simply related to the levels of exceedance. If the noise fluctuates very little, L_{eq} will approximate L_{50} or the median level. If the noise fluctuates broadly, the L_{eq} will be approximately equal to the L_{10} value. If extreme fluctuations are present, the L_{eq} will exceed L_{90} or the background level by 10 or more decibels. Thus the relationship between L_{eq} and the levels of exceedance will depend on the character of the noise. In community noise measurements, it has been observed that the L_{eq} is generally between L_{10} and L_{50}. The relationship between L_{eq} and exceedance levels has been used in this analysis to characterize the noise sources and to determine the nature and extent of their impact at all receptor locations.

For the purposes of this project, the maximum 1-hour equivalent sound level ($L_{eq(1)}$) has been selected as the noise descriptor to be used in the noise impact evaluation. $L_{eq(1)}$ is the noise descriptor used by most governmental agencies for noise impact evaluation, and is used to provide an indication of highest expected sound levels.

NOISE STANDARDS AND CRITERIA

There are no Federal, State, or Local noise standards that apply to the proposed project. However,, in general, it is desirable in residential areas to have noise levels below approximately 67 dBA $L_{eq(1)}$.

D. NOISE PREDICTION METHODOLOGY

Noise levels produced by a football game were based upon noise levels monitored at Harrison High School in Harrison, NY during a varsity football game (i.e., Harrison High School vs. Peekskill High School) on September 21, 2006. (See Appendix A.) Four noise measurements were performed at 3 locations on site. Based on these measurements the maximum noise level on the West end of the football field was found to be 77.0 dBA, with approximately 75.3 dBA due to noise generated by the 400 spectators at the game, and approximately 72.1 dBA contributed by the loudspeaker system and high school band. The noise generated by the spectators can be scaled proportionately to account for whatever size crowd is expected and recombined with the loudspeaker and band noise to find the maximum sound pressure level at the boundary of a given football field. For this analysis, the maximum number of spectators expected to attend a nighttime football game was projected to be 2100. Assuming an attendance of approximately 2100 spectators at a game, the maximum L_{eq} sound level at the field boundary would be approximately 82.9 dBA. Also based on the Harrison High School measurements, noise levels at a distance of 100 feet from the field are assumed to be 4.6 dBA less than those at the edge of the field. Then, a 6 dBA drop-off per doubling of distance from the field can be applied to determine the noise level at different receptor distances.

E. EXISTING CONDITIONS

NOISE MONITORING

The closest sensitive noise receptors to the Darien High School stadium were homes on Hummingbird Lane, Linda Lane, and Middlesex Road. Receptor sites were selected at each of these locations. Site 1 was located at 11 Hummingbird Lane, Site 2 was located at 14 Linda Lane, and Site 3 was located at 369 Middlesex Road. These sites are representative of other sensitive noise receptors in the area, and since they are the closest to the stadium, they are the most likely to experience increased noise levels from nighttime football games. Noise levels were measured at these sensitive receptors between 7 and 10 PM, which is the time period during which the lights could be used. Measurements of approximately 20 minutes in duration were made at each site throughout the three hour time period of interest.

EQUIPMENT USED DURING NOISE MONITORING

Three instruments were used for the noise monitoring program to determine background noise levels. The instrumentation used for the noise measurements was a Brüel & Kjær Type 4189 ½-inch microphone connected to a Brüel & Kjær Model 2260 Type 1 (according to ANSI Standard S1.4-1983) sound level meter. This assembly was mounted at a height of 5 feet above the ground surface on a tripod and at least 6 feet away from any large sound-reflecting surface to avoid major interference with sound propagation. The meter was calibrated before and after readings with a Brüel & Kjær Type 4231 sound-level calibrator using the appropriate adaptor. Measurements at each location were made on the A-scale (dBA). The data were digitally recorded by the sound level meter and displayed at the end of the measurement period in units of dBA. Measured quantities included L_{eq}, L_1, L_{10}, L_{50}, and L_{90}. A windscreen was used during all sound measurements except for calibration. Only traffic related noise was measured; noise from other sources (e.g. emergency sirens, aircraft flyovers, etc.) was excluded from the measured noise levels. Weather conditions were noted to ensure a true reading as followed: wind speed under 12 mph; relative humidity under 90 percent; and temperature above 14^{o}F and below 122^{o}F. All measurement procedures conformed with the requirements of ANSI Standard S1.13-1971 (R2005).

EXISTING NOISE LEVELS AT NOISE RECEPTOR LOCATIONS

Results of the noise measurements are presented in Tables 2-4 in Appendix A. The dominant noise source during this measurement was the traffic on nearby roadways.

Hummingbird Lane and Linda Lane end in culs-de-sac with very low traffic levels, and therefore have extremely low noise levels. Measured 20-minute L_{eq} noise levels at 11 Hummingbird Lane ranged between 41.8 and 48.0 dBA, while measured 20-minute L_{eq} noise levels at 14 Linda Lane ranged between 40.3 and 48.7 dBA. Middlesex Road is a fairly well trafficked road, and therefore has a somewhat higher noise level. Measured 20-minute L_{eq} noise levels at 369 Middlesex Road ranged between 61.7 and 66.3 dBA.

F. FUTURE WITH THE PROPOSED PROJECT

As described above, data collected during a high school football game in a similar suburban area was used to predict the noise levels that would occur during the night-time events. To ensure a conservative analysis, there was assumed to be no attenuation due to shielding from the trees surrounding the field. Table 4 shows the results of the analysis at each receptor site for the maximum number of spectators expected for all of the proposed events.

Assuming the maximum number of 2100 spectators, the noise level increase above the background noise levels at Site 3 would be less than 3 dBA, and would therefore be barely perceptible and insignificant. However, the increases at Sites 1 and 2, which are closest to the field and have very low background noise levels, would increase as much as 25.7 and 27.4 dBA, respectively. Increases of this magnitude would be readily noticeable and may be considered to be intrusive. However, this is expected to be the greatest increase possible during a nighttime football game, with most games having significantly fewer attendees, and therefore producing less noise (see Table 4). In addition, maximum nighttime noise levels during games would be expected to be within 3 dBA of the current maximum daytime noise levels during games, a difference that would be barely perceptible. While the increase over background levels may be more pronounced during the early evening games, the magnitude of the noise is not expected to significantly exceed the noise levels currently experienced during daytime games. Furthermore, all nighttime football games at the field would be required to end by 10 PM and all other sporting events would be required to end by 9PM, which precludes generation of such noise levels during the hours when sleep usually occurs. Therefore, while the generated noise levels are substantial, they are infrequent, of short duration, and not significantly greater than those that already occur at these locations during daytime events and would not be expected to result in a significantly greater impact on nearby residents than already exists.

Table 4

Predicted Noise Levels During Night-time Football Games

Site	Location	Distance To Field (feet)	Minimum Measured Existing L_{eq}	Noise Emission at Field	Field-Generated Noise At Receptor	Combined Noise Level	Noise Level Increment
2100 Spectators							
1	11 Hummingbird Lane	347	41.8	82.9	67.5	67.5	25.7
2	14-16 Linda Lane	337	40.3	82.9	67.7	67.7	27.4
3	357-369 Middlesex Road	736	61.7	82.9	60.9	64.3	2.6
1500 Spectators							
1	11 Hummingbird Lane	347	41.8	81.6	66.2	66.2	24.4
2	14-16 Linda Lane	337	40.3	81.6	66.4	66.4	26.1
3	357-369 Middlesex Road	736	61.7	81.6	59.6	63.8	2.1
1200 Spectators							
1	11 Hummingbird Lane	347	41.8	80.7	65.3	65.3	23.5
2	14-16 Linda Lane	337	40.3	80.7	65.6	65.6	25.3
3	357-369 Middlesex Road	736	61.7	80.7	58.8	63.5	1.8
500 Spectators							
1	11 Hummingbird Lane	347	41.8	77.7	62.3	62.3	20.5
2	14-16 Linda Lane	337	40.3	77.7	62.5	62.6	22.3
3	357-369 Middlesex Road	736	61.7	77.7	55.7	62.7	1.0
200 Spectators							
1	11 Hummingbird Lane	347	41.8	75.2	59.8	59.9	18.1
2	14-16 Linda Lane	337	40.3	75.2	60.1	60.1	19.8
3	357-369 Middlesex Road	736	61.7	75.2	53.3	62.3	0.6