AMBIENT NOISE MEASUREMENTS

AND

GRANDSTAND NOISE SIMULATION MODEL

for

EDGEWOOD HIGH SCHOOL

GOODMAN ATHLETIC COMPLEX

Madison, Wisconsin

prepared by

TALASKE and TLC Engineering
For
Professional Audio Designs, Inc.
Wauwatosa, WI

Issue Date: January 4, 2019

I. EXECUTIVE SUMMARY

Professional Audio Designs was asked to provide a sound study predicting the noise related effects of the proposed new Grandstand at Edgewood High School Goodman Athletic Complex. We employed the services of TALASKE of Oak Park, IL and TLC Engineering to accomplish this task. What follows is an evaluation of the existing conditions, a prediction of the conditions that can be anticipated based on a detailed computer model simulation of the proposed grandstands, and commentary on the modeled predictions as well as options for sound reduction.

II. MEASUREMENT OF AMBIENT NOISE LEVELS

The ambient noise level was measured at three locations surrounding the Edgewood campus as approximately noted on Figure 1. Measurements were performed for approximately 2 hours duration during late afternoon hours using two Larson-Davis LXT sound level meters and one Larson-Davis 831 sound level meter. Time history information was measured for the two LXT sound level meters. The equipment was calibrated at the start and end of the measurement sessions using a Larson-Davis CAL200 precision sound calibrator. All equipment has been calibrated by Larson-Davis within the past year.

Figure 1 – Location of ambient noise level measurements.

The results of the ambient noise measurements are noted Figures 2 and 3. The results indicate L_{eq} values ranging from 50.6 to 63.2, with an average of 56.5 dBA. Peak levels measured ranged from 68.5 to 75.8 dBA, with an average of 72.5 dBA.

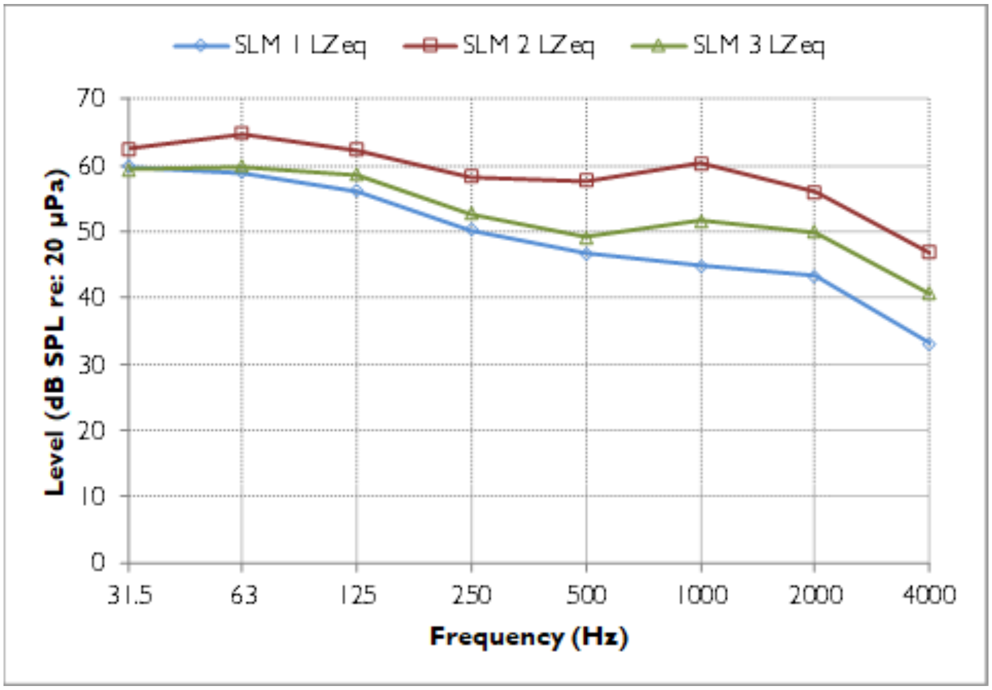


Figure 2 – Summary of average octave band ambient noise level measurements during late afternoon of 6 December 2018, presented as L_{eq} per octave band. The results indicate L_{eq} values ranging from 50.6 to 63.2, with an average of 56.5 dBA.

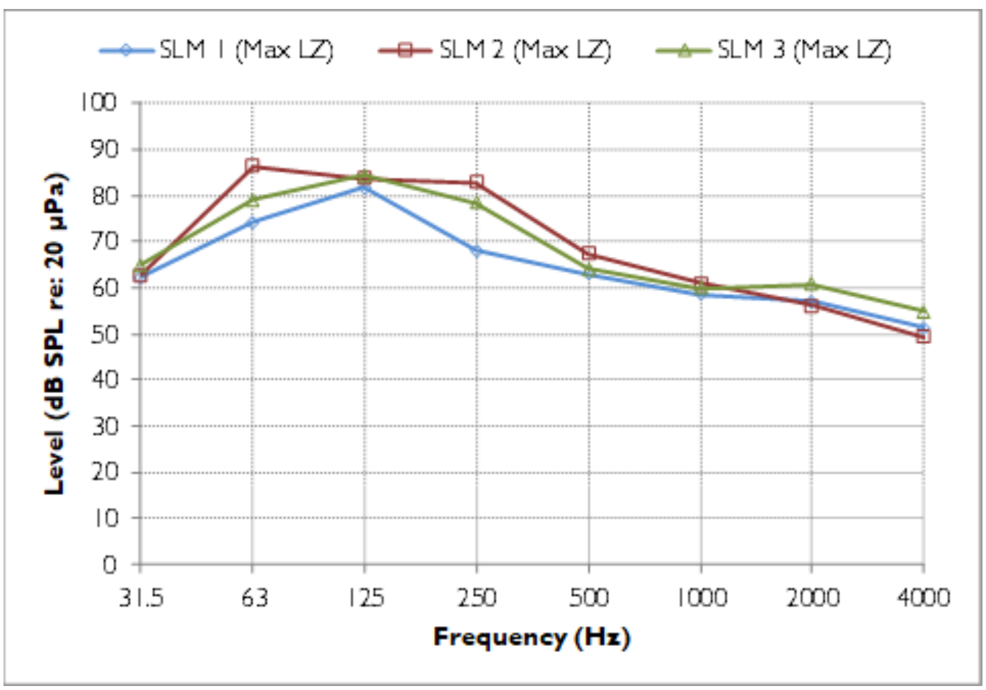


Figure 3 – Summary of maximum measured octave band ambient noise level measurements during late afternoon of 6 December 2018, presented as L_{max} per octave band. Peak levels measured ranged from 68.5 to 75.8 dBA, with an average of 72.5 dBA.

III. REVIEW OF MADISON NOISE ORDINANCE

A search was performed to determine the noise limits established by the City of Madison. The sections we feel are pertinent to the Edgewood High School Stadium are excerpted below and shown in Figure 4. The legal counsel for the City of Madison should confirm the legality and applicable requirements. The comments which follow are based on our understanding of established limits along with opinions regarding the technical meaning and shortcomings of the language of the Ordinance.

Considering many activities at the stadium are expected to occur during evening time periods, the 70 dBA appears to be the applicable limit associated with sound entering adjacent residential property. It is not clear to us regarding how to address the fluctuations in sound level which are inherent to sound radiating from the stadium. Reference is made to the needle of the sound level meter, but contemporary (precision) sound level meters do not utilize needles.

Most ordinances identify an objective means for addressing the normal variation in sound level versus time. Examples include utilizing the "slow setting" (one second integration time) or "fast setting" (1/8th second integration time) or L_{eq} (equivalent, or average) sound pressure level over a defined time period, usually many minutes, an hour, or a day. Since the sound level from the stadium will certainly vary more than plus or minus two decibels, this aspect of the Noise Regulation seems to not be applicable to this application.

24.08 NOISE REGULATION.

(1) Sound levels under this section shall be measured with a Type 1 sound level meter manufactured according to standards prescribed by the American National Standards Institute in specification S1.4 (Revised 1971). Measurements shall be made using an "A" weighted network of the sound level meter. All noises shall be subject to the standards contained in subsection (2) provided that such noise shall be capable of being accurately measured with such equipment. Under this section, noises capable of being accurately measured with such equipment shall be deemed to be those noises which cause fluctuations of the needle of the sound level meter with a variation of no more than plus or minus two (2) decibels.

SOUND PRESSURE LEVEL TABLE

Zone	Time	Decibel (dBA) Level
R1, R2, R3, R4, R4A, R4L, Agriculture Conservancy, Office Residence	7:00 p.m. to 7:00 a.m.	70 dBA
	7:00 a.m. to 7:00 p.m.	75 dBA
R5, R6	All times	75 dBA
Commercial, Manufacturing	All times	80 dBA
Except where such operations are adjacent to Residential District		75 dBA

5

(2) In the following zoning districts established under Chapter 28 of the Madison General Ordinances, the noise emitted from any source and measured at any point within any distance beyond fifty (50) feet of the property or public right-of-way where the noise is produced or beyond fifty (50) feet from the noise source when such exists on public property shall not exceed the amounts indicated in the table.

Figure 4 - Excerpts from the Madison Noise Ordinance

To address the situation of the noise leaving the stadium, we adopted two methods of predicting sound levels in the surrounding neighborhood. These are:

1. Identify the maximum sound level expected in the neighborhood due to normal stadium activities.
2. Identify the L_{eq} over a typical loud activity within the stadium based on a presumed distribution of noisy and quiet activities over a one-hour period.

Determination of the maximum sound level expected in the neighborhood due to normal stadium activities included the sound contributions from crowd noise, whistle from referee, audio system announcements, and pep bands (see section V for details).

Estimating the L_{eq} over the duration of a typical loud activity within the stadium. A football game was assumed and is based on the following presumed distribution of noisy and quiet activities"

- 120 plays from scrimmage per game, or 60 plays per hour.
- 20-second duration of each play from scrimmage. Crowd noise averages six decibels less than the maximum sound level capable for the assembly.

Noise Sources	Characteristics
150-1000 Spectators	Shouting, 20 sec per play
2 Loudspeakers	Broadband music* / voice, 20 sec per play
28 Pep Band Musicians	Various tonalities, 20 min per hour
22 Football Players	Shouting, 5 sec per play
1 Referee's Whistle	Once per play
Background Noise	56.5 dBA, based on site measurements

The analysis was perform using the following attendance figures:

- 150 people
- 500 people
- 1000 people.

In all cases, the people in attendance are distributed throughout the stadium seating area.

*Note: Even though broadband music was included in this simulation, it is our understanding that the school has committed to no music being played over the loud speakers (other than national anthem).

Based on these two analysis methods, maximum sound pressure levels and average sound pressure levels over a one-hour period, have been estimated over the neighborhood adjacent to the Edgewood campus. See attached document "SoundPLAN Runs 101-303 (2018-12-21).pdf" for output of this analysis. Note: predictions are not a guarantee of results, but the findings illustrated here represent a thorough, highly detailed, quantitative prognosis of the noise levels the school and the surrounding neighbors can expect to experience using the best tools available. If levels at the center of the field are exceeded, sound levels in the residential areas will increase commensurately.

IV. NOISE SIMULATION MODEL

Calculations for predicted noise levels were simulated using SoundPLAN®, a software suite of indoor and outdoor noise prediction modules developed to comply with international standards for environmental noise calculations. On the market since 1986, it has a worldwide user base who use it for urban planning, traffic and railway noise studies, indoor room acoustics, factory noise, outdoor noise propagation, aircraft noise, sound system coverage, and wind turbine analysis.

Terrain & Buildings

This model was started using Google Maps topography data to provide a basis for terrain. Buildings were then located in the model including residential homes, school buildings, and the proposed new grandstands for the Goodman Athletic Complex.

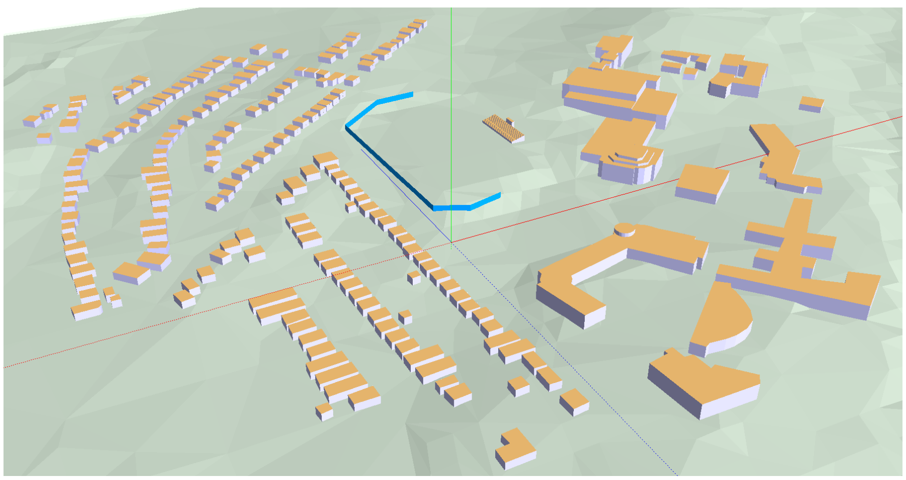


Figure 5 - Overview of 3D Noise Model

Areas of terrain were marked with their appropriate *Ground Factor*. Areas such as parking lots and the nearby waterfront have a "Hard" ground factor that is acoustically reflective, whereas areas with grass and dense foliage are "Soft" and are marginally absorptive. Trees and foliage were not individually modeled however as they are not considered acoustically significant and have minimal absorptive properties.

Spectator Noise

Various quantities of spectators were located on the grandstands as noise sources. Each human noise source in the model is based on measured laboratory data for spectral content and directivity of people shouting.

Game Noise

Players were located on the field for two football teams with an estimated amount of shouting between players during each play. A referee's whistle was included in this noise group from the sidelines at the 50-yard line.

Pep Band

An ensemble of musicians was located on the track near the stands, with a varied range of tonalities and intensities to represent different instruments such as bass drums, flutes, clarinets, trumpets, and trombones.

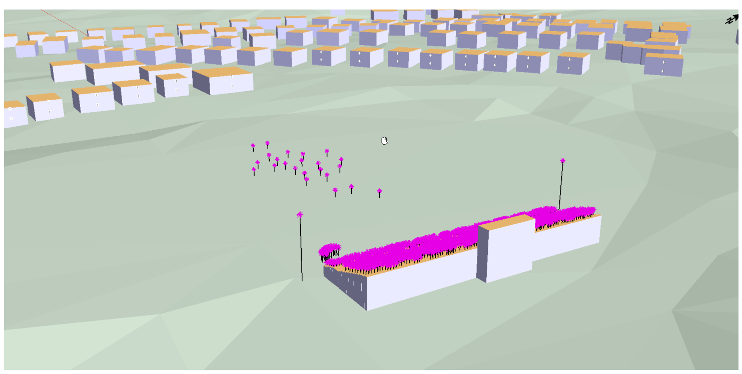


Figure 6 - View of Stands (Pink Dots Indicate Noise Sources)

A separate series of simulations was not performed for the event that the pep band may march on the field during half-time. This is because while the pep band itself would be more prominent -- the crowd cheering/shouting, audio system announcements, and player noise would not be concurrent with a half-time performance and overall noise levels would not be significantly impacted.

Loudspeakers

A pair of loudspeakers were modeled, one on each of the light poles flanking either side of the stands, at the approximate height and angle these speakers would be installed. Calibrated speaker data was used representing Community R2-96 speakers. These are of the same product series and brand as the speakers being proposed for this project. Voice announcements and occasional broadband music clips were the assumed content to be played on the speakers for an estimated amount of time per hour.

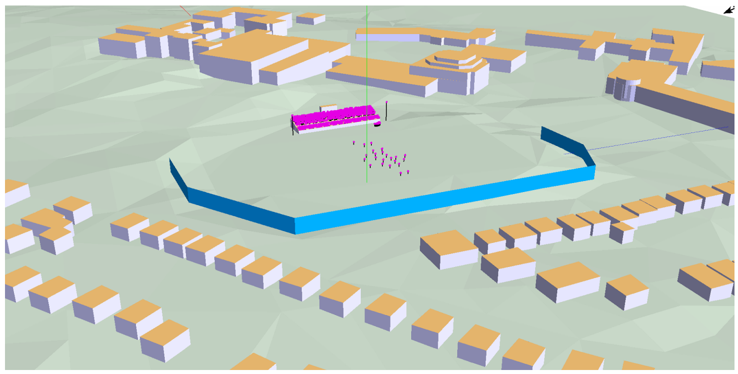


Figure 7 - Noise Model with Noise Barrier Shown

Possible Noise Barrier

For a comparative analysis of the effectiveness of a noise control barrier, a wall was modeled around the edge of the field and additional simulations were performed at two heights to demonstrate the noise reduction impact of a barrier to the surrounding areas.

V. EXPECTED RESULTS

For residents exposed to sound levels produced during normal waking hours as predicted on the attached *SoundPlan* diagrams, we offer the following conclusions. These comments are based on 1) measured ambient noise levels at the site, 2) the predicted sound levels in the neighborhood due to expected activities within the stadium, and 3) typical human response to the expected sound levels:

- The average exposure of residents (LA_{eq} 1-Hour Average) to noise from a typical football game event at the stadium is less than the stated maximum 70 dBA level within the Madison Noise Ordinance, understanding that the averaging method is not clearly identified within the Noise Ordinance.
- The maximum estimated sound level is expected to exceed occasionally the stated maximum 70 dBA level within the Madison Noise Ordinance. The expected maximum levels are similar in intensity to noise events measured at the site. See Figure 3.
- The *SoundPlan* studies presented within this report are based on neutral weather conditions. The prevailing winds in the area, generally from the south, http://www.aos.wisc.edu/~sco/clim-history/stations/msn/madwind.html will tend to 1) steer westbound sound somewhat to the north, and 2) bend northbound sound downward. During such wind conditions, close in residents to the west will experience somewhat lesser sound levels versus those noted on the *SoundPlan* studies and residents to the north beyond Monroe Street will experience somewhat greater sound levels versus those noted on the *SoundPlan* studies.
- Constructing a barrier can reduce sound impact to nearby residents, as discussed further below.
- The noise exposure is well below the requirements established by OSHA (which start at 85/90 dBA over 8 hours on a daily basis) which are intended to minimize risk of hearing impairment.
- The nature of the sound produced at the stadium is not threatening to the general public.
- The sound generally does not include tonal qualities or regular/repetitive impulsive sounds which are generally deemed more disturbing versus other sounds.
- The sound created at the stadium does not include sub-audible, very low-pitched sound which is known to cause distress for some members of the population. Likewise, ground-borne vibration associated with activities within the stadium is not expected to be feelable.
- The expected sound levels, especially low-pitched sound, are expected to be sufficiently quiet to avoid rattling of windows and/or other lightweight building materials.
- While the sound levels may be loud enough to impair conversation between residents when outdoors (such as in a restaurant) these louder sound levels are expected to occur for only short time periods.

- The arrangement of houses most impacted by the sound from the stadium is such were backyard areas benefit from the barrier effect of individual houses. Sound levels are lower in areas where owners are most likely to be enjoying relaxing outdoor activities.
- If activities are restricted to avoid nighttime time periods (which is recommended) normal sleep patterns of the residents should not be negatively impacted. Generally, nighttime periods are defined as starting at 10:00 pm based on other typical municipal codes. Note that the 70 dBA reference in the Madison Noise Ordinance is the stated limit between 7:00 PM to 7:00 AM, which of course includes the time period before and after 10:00 PM.
- Indoors within houses of normal construction, the sound levels are expected to be 5 decibels less (with windows open) to 30-plus decibels less (with windows closed) versus the predicted exterior sound levels. The indoor sound levels are expected to be well below standards for suitable interior sound levels (average 45 dBA with windows closed) established by the Housing and Urban Develop department of the U.S. federal government.

VI. SOUND REDUCTION OPTIONS

Sound levels within the residential areas located west and northwest of the stadium can be reduced by the construction of a barrier. An effective noise barrier can take many forms, including:

- Solid wall.
- Berm landform.
- Building.

Effective barriers are non-porous with a minimum surface weight of five pounds per square foot. This could be concrete or wood. If wood, the gaps between wood sections would need to be relatively airtight.

The key considerations for an effective noise barrier are:

- Breaking line-of-sight (line-of-hearing) between the sound source and the sound receiver, as a minimum. Additional height above this reference line is desirable and often ranges from and additional four to ten feet.
- Placing the noise barrier in close proximity to the source of sound or the receiver.
- Minimizing sound reflections off secondary surfaces.

If additional control of the sound from the stadium is desirable, constructing a barrier remains an option. Based on our *SoundPlan* evaluation, we have concluded that sound from the stadium as heard by the nearest residents could be reduced up to 5 dBA with a 16.6-foot tall barrier and up to 10 dBA for a 26.2-foot tall barrier, assuming neutral weather conditions.

We envision no significant change would result if the grandstands were redesigned to be lower and wider. Because of the long distance between stands and the wall, and that the primary goal is to eliminate line of sight from the stands to the homes, a change in grandstand height would be of marginal impact (maybe 6-12" difference in the height of the wall for equivalent performance).

The presence of the existing retaining wall / grade change along Monroe street may allow for a slightly lower (in appearance to the neighbors) barrier to be built to achieve equivalent effectiveness. This could be studied further if this option is pursued.

The development of any barrier walls will require design review to avoid problematic sound reflections back into the residential community and/or reflections which may impair sound clarity during the operation of the audio system.

Other noise reduction options for consideration include:

- Restrict activities in the stadium to daytime time periods only. Generally, municipalities limit activities creating exterior noise events to 7:00 AM to 10:00 PM.
- Design the audio system to minimize sound impact to the residents. The current preliminary design concept utilizes directional loudspeakers that are aimed at the stands from the light poles and away from the surrounding housing. Ultimately, a limiter could be put on the system so that it would not be permitted to produce sound levels above a certain threshold. This threshold could be established to assure a certain maximum level at the property lines of the adjacent houses. However, this could result in the sound system level falling below the level of the crowd in scenarios involving large crowds and enthusiastic cheering.
- Constructing a sound barrier above the audience seating with sound absorbing finishes facing the attendees.

Goodman Athletic Complex

101 - No Wall 150 People

Rev. 12/21/2018

Levels
in dB(A)

dark green	< 40
green	40 - 45
light green	45 - 50
cyan	50 - 55
light blue	55 - 60
blue	60 - 65
violet	65 - 70
magenta	70 - 75
pink	75 - 80
yellow	80 - 85
orange	85 - 90
red-orange	90 - 95
red	>= 95

Noise Sources:

(150) Spectators

(22) Players On Field

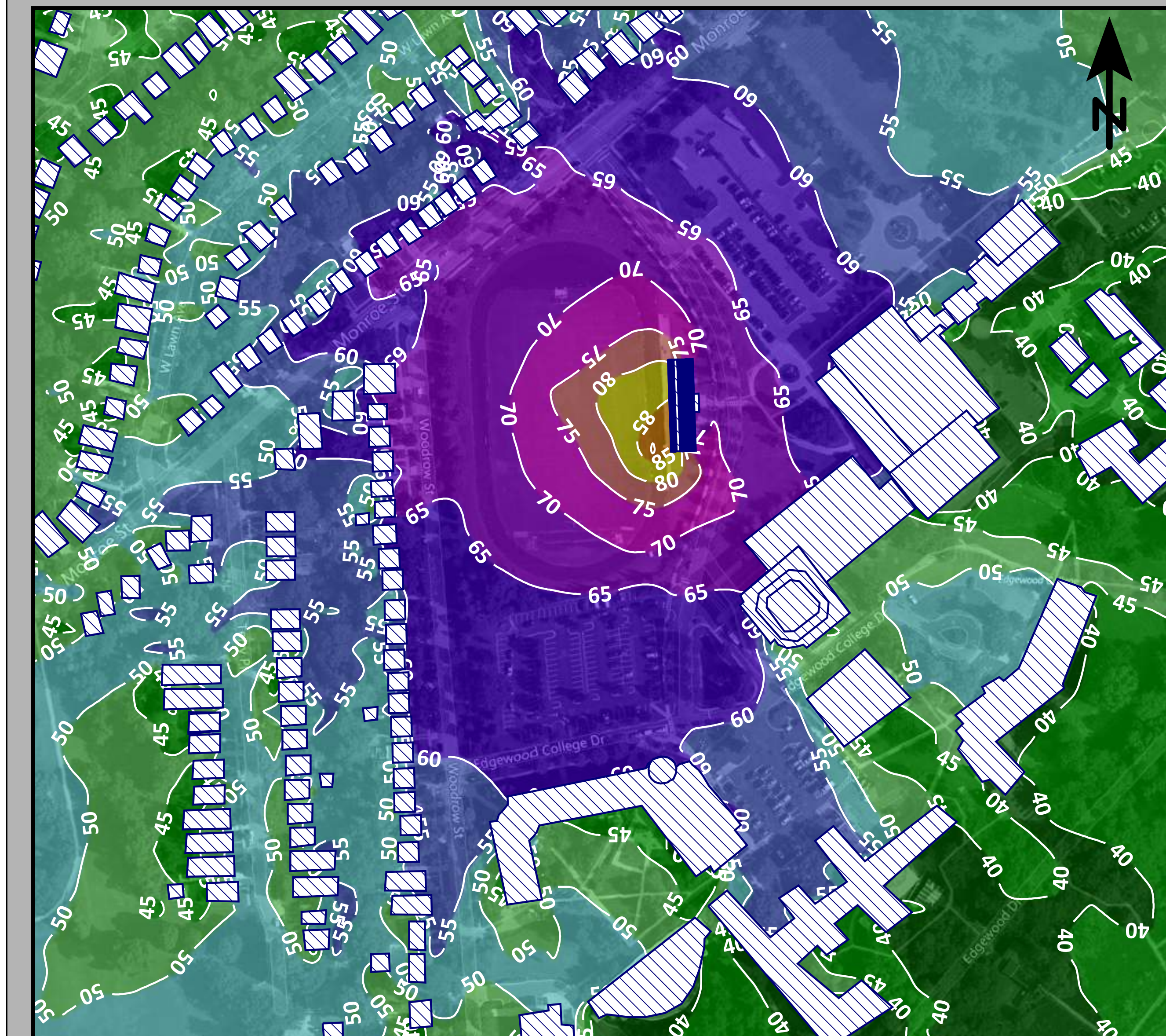
(1) Referee's Whistle

(2) R2-94 Loudspeakers

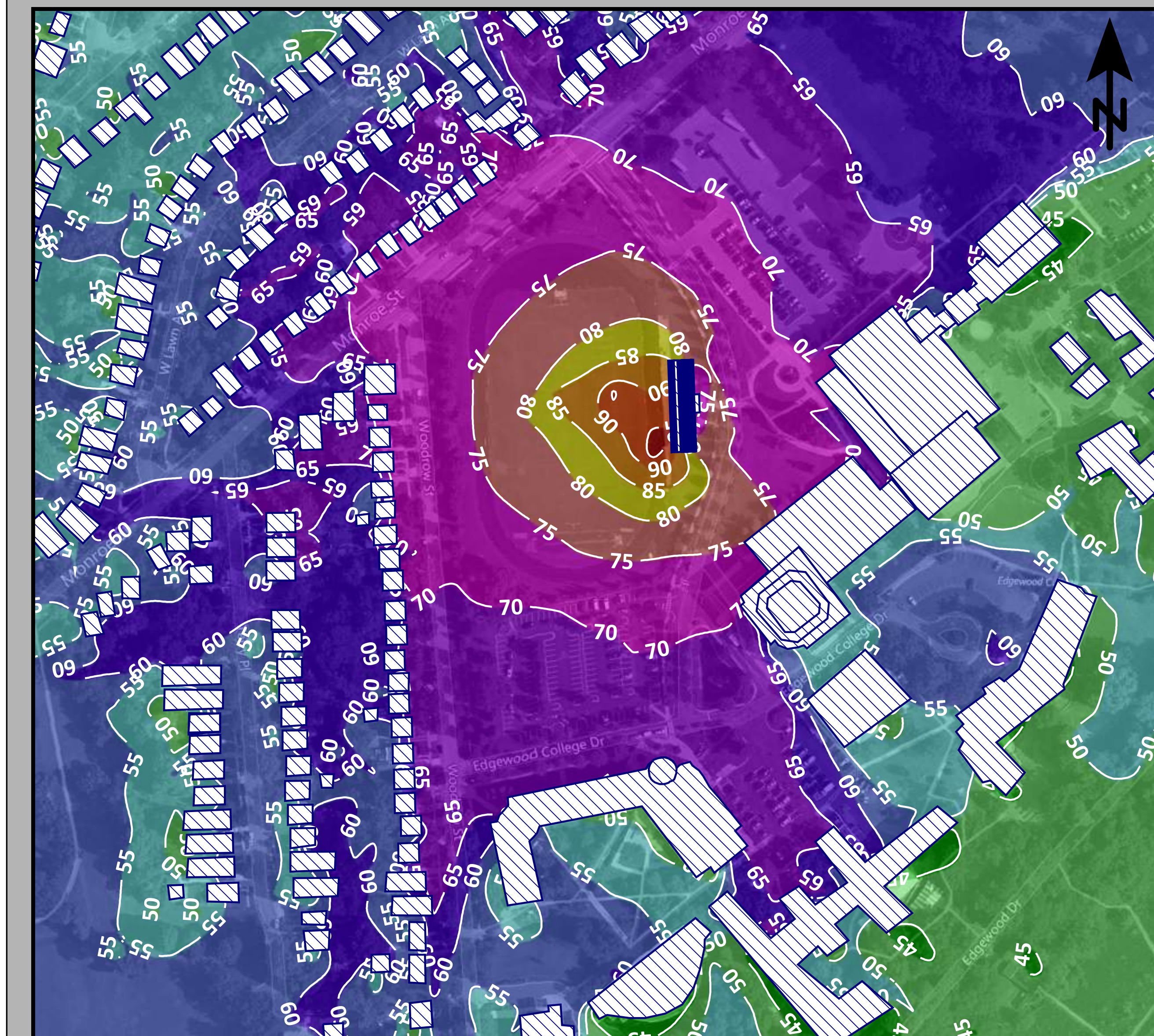
(28) Pep Band Musicians

Conditions

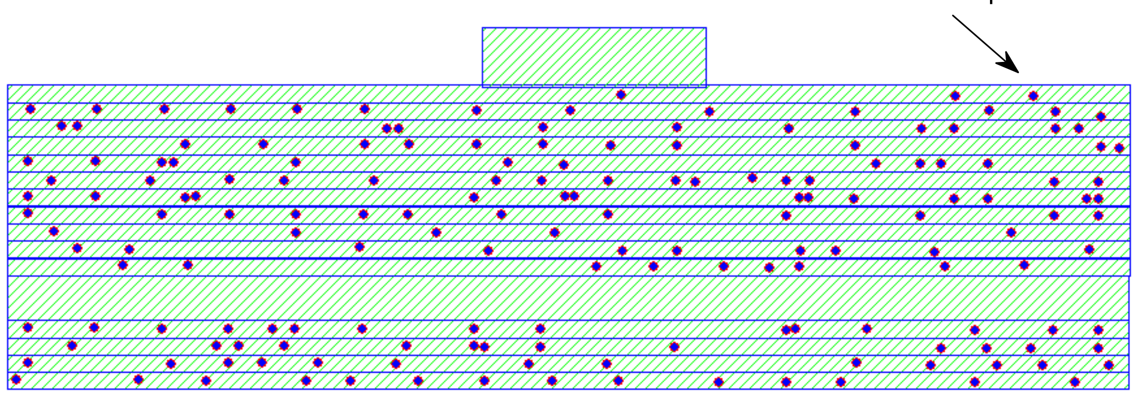
Calculations based at 1.5m above terrain.

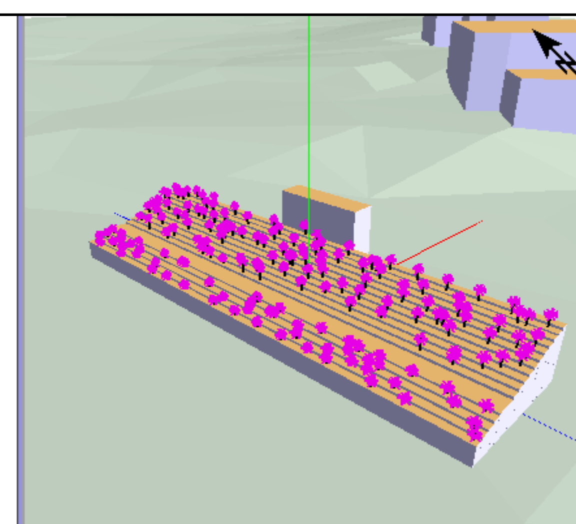


LAeq (1-Hour Average)



LAmax (Peak)





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Calculation Date: 12/21/2018 *Run No. 101* *Run: 101-No Wall/150 People* *SoundPLAN 8.0 11/9/2018*

Length Scale 1:278

0 100 200 400 600 800 feet

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Goodman Athletic Complex

102 - No Wall 500 People

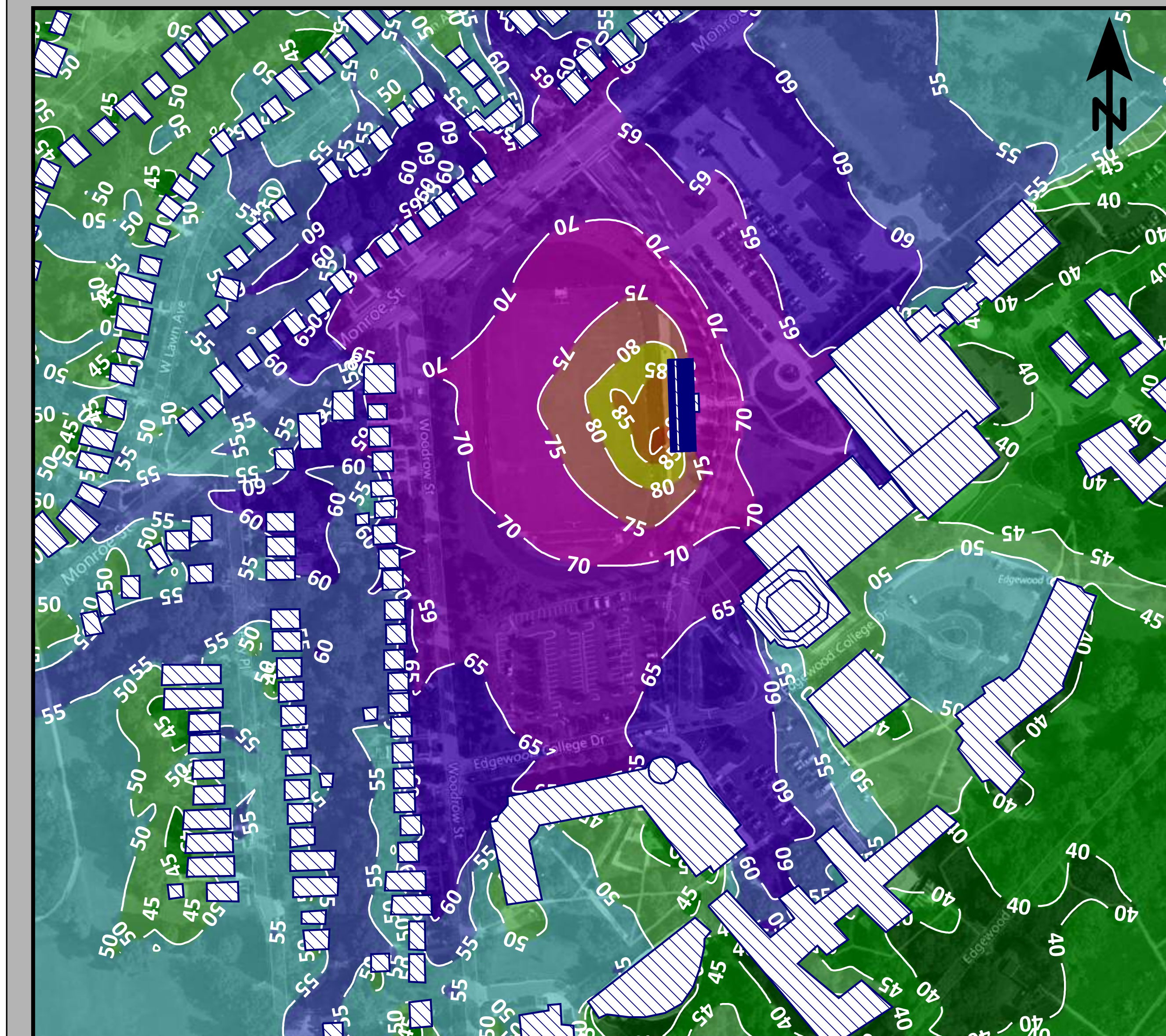
Rev. 12/21/2018

Levels
in dB(A)

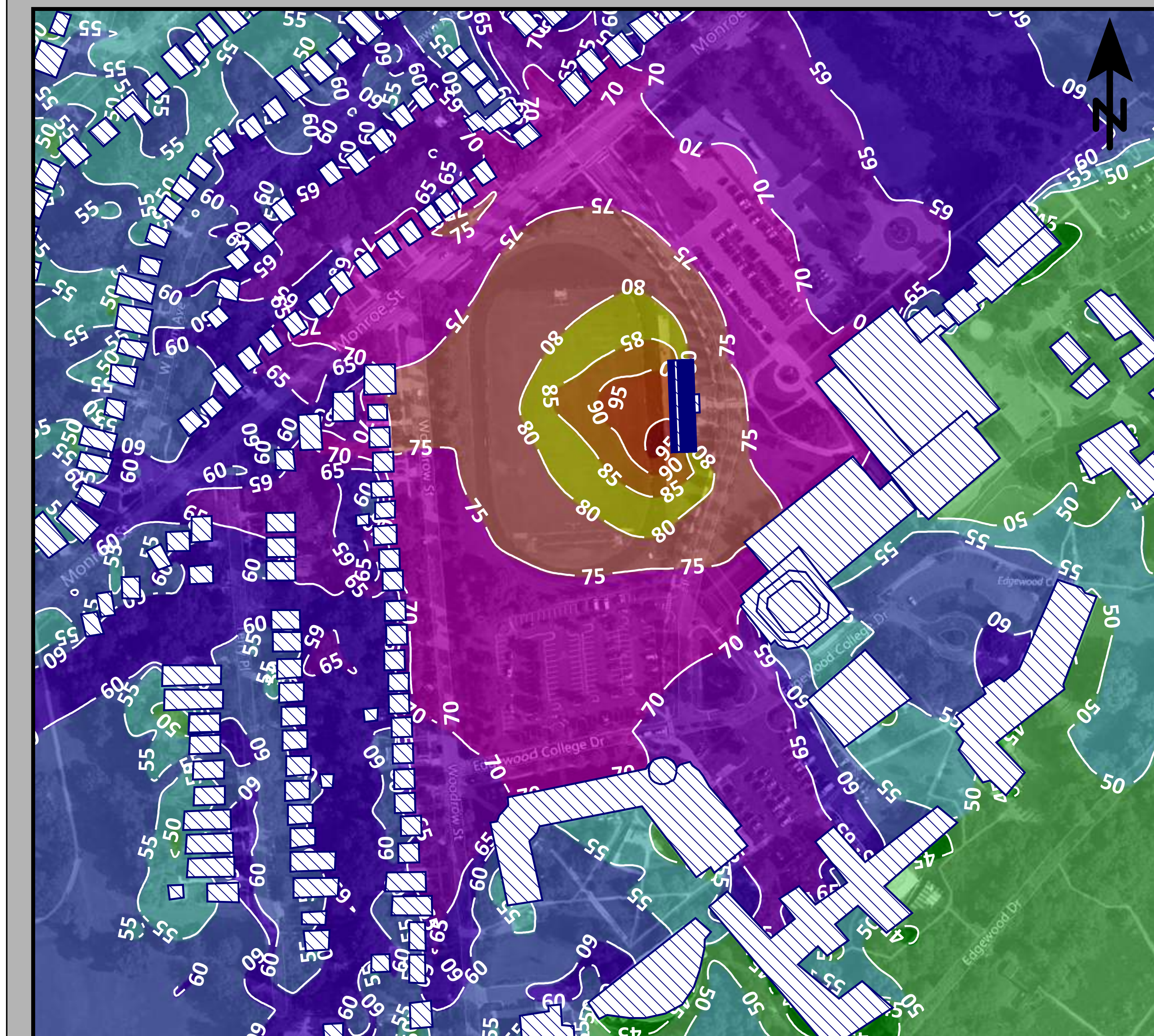
	< 40
	40 - 45
	45 - 50
	50 - 55
	55 - 60
	60 - 65
	65 - 70
	70 - 75
	75 - 80
	80 - 85
	85 - 90
	90 - 95
	>= 95

Noise Sources:
(500) Spectators
(22) Players On Field
(1) Referee's Whistle
(2) R2-94 Loudspeakers
(28) Pep Band Musicians

Conditions
Calculations based at 1.5m above terrain.



LAeq (1-Hour Average)



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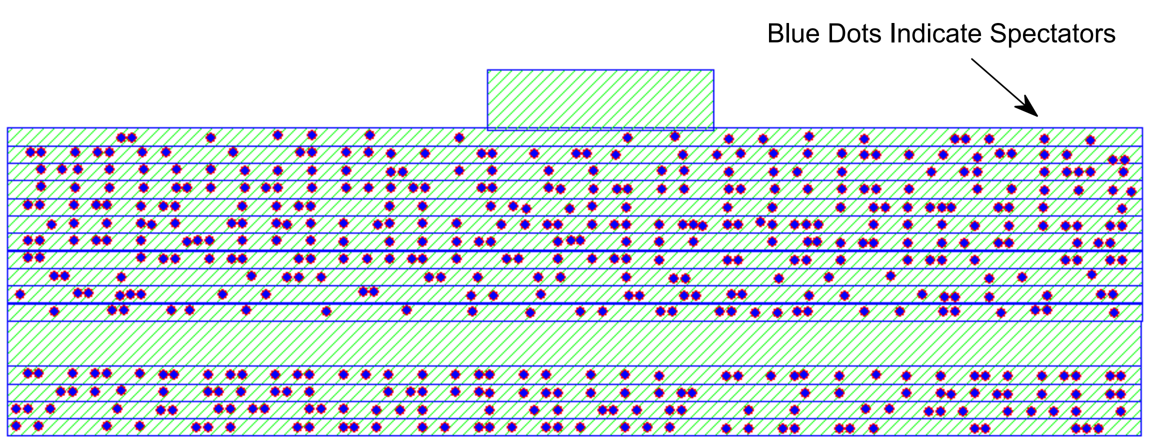

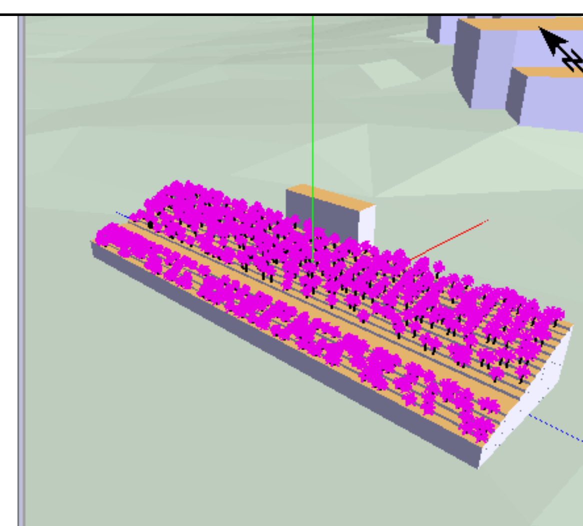

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Calculation Date: 12/21/2018 *Run No. 102* *Run: 102-No Wall/500 People* *SoundPLAN 8.0 11/9/2018*

Length Scale 1:278

0 100 200 400 600 800 feet

Goodman Athletic Complex

103 - No Wall 1000 People

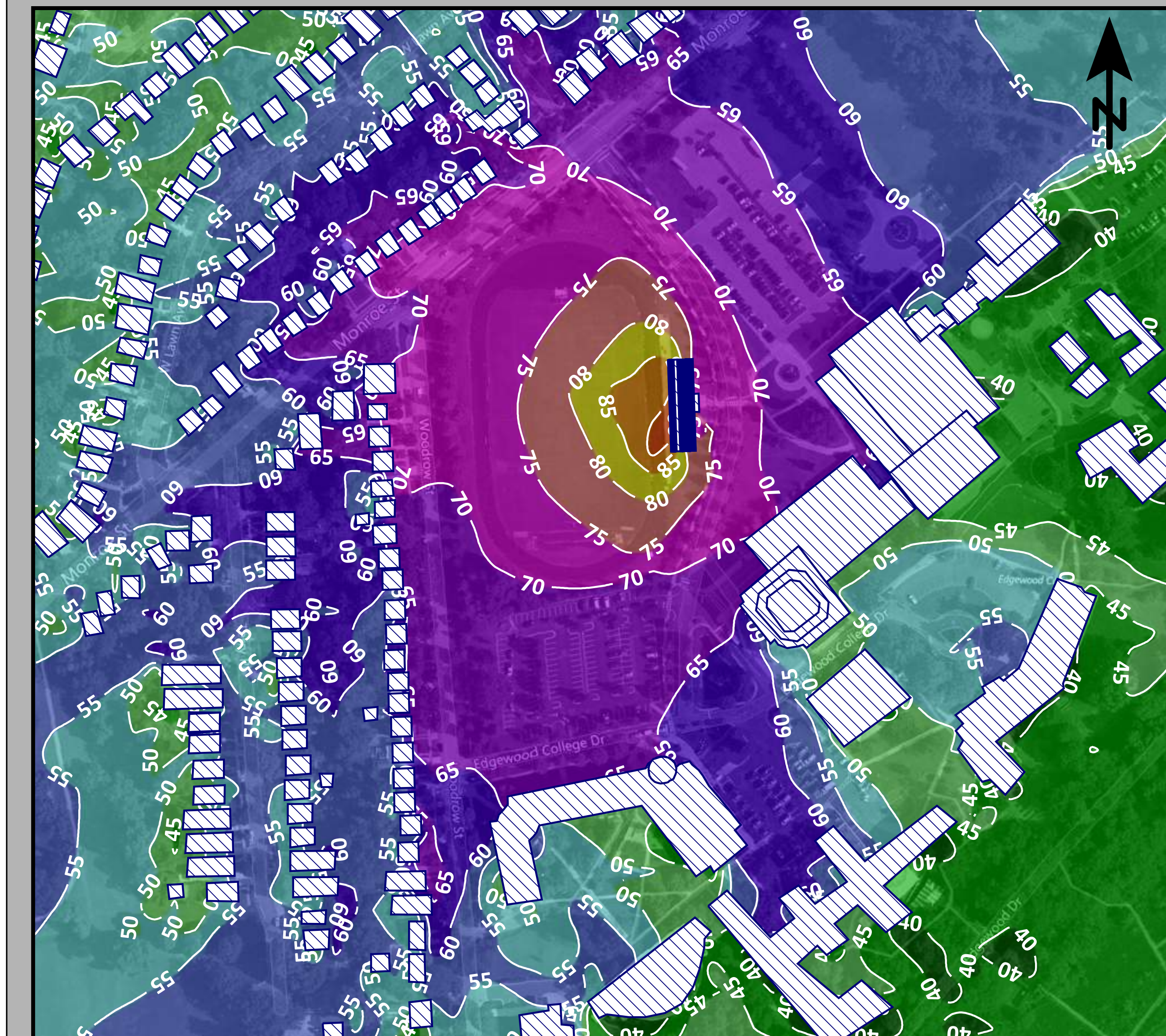
Rev. 12/21/2018

Levels
in dB(A)

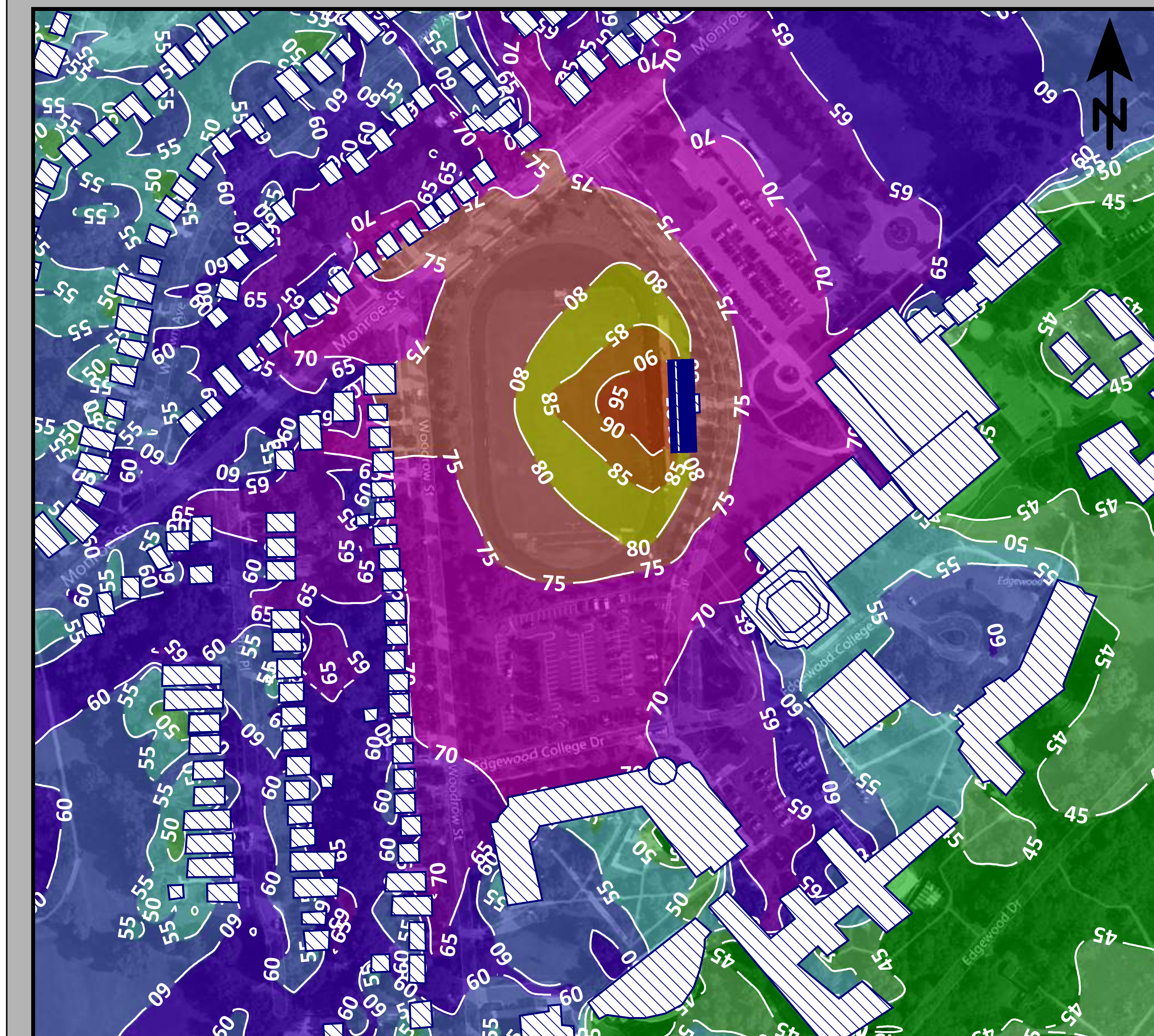
Level
< 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
90 - 95
>= 95

Noise Sources:
(1000) Spectators
(22) Players On Field
(1) Referee's Whistle
(2) R2-94 Loudspeakers
(28) Pep Band Musicians

Conditions
Calculations based at 1.5m above terrain.



LAeq (1-Hour Average)



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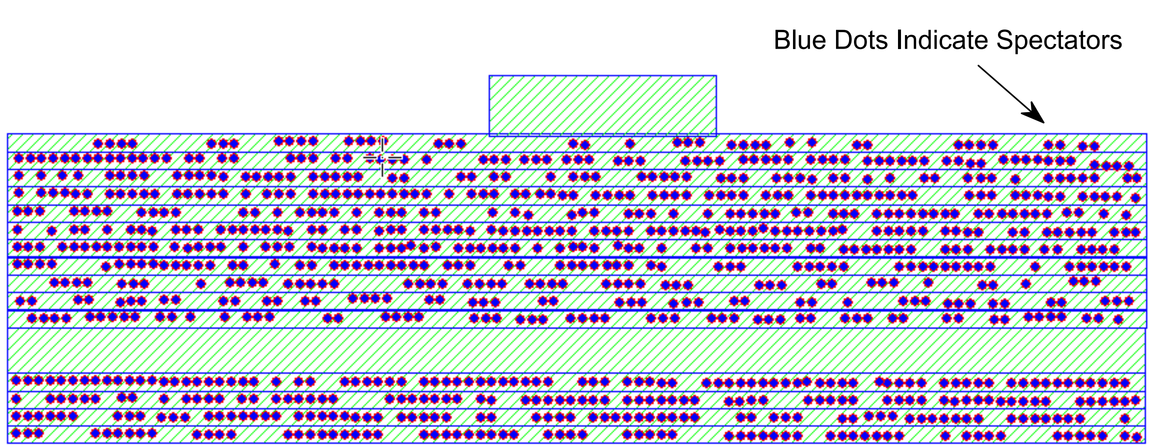

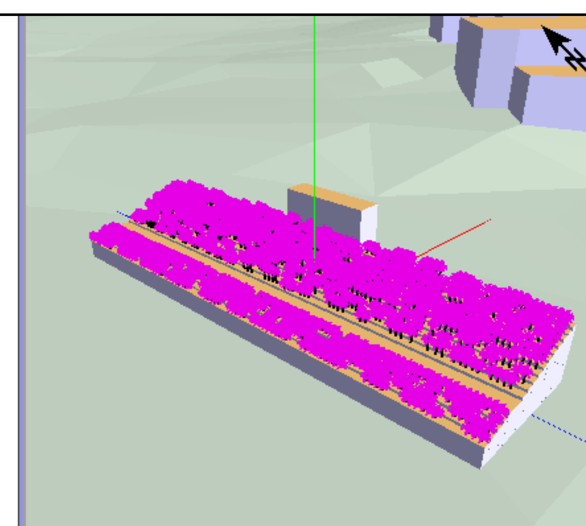

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Project Owner:
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Madison, WI

Calculation Date: 12/21/2018 *Run No. 103* *Run: 103-No Wall/1000 People* *SoundPLAN 8.0 11/9/2018*

Length Scale 1:278

0 100 200 400 600 800 feet

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Goodman Athletic Complex

201 - Medium Barrier 150 People

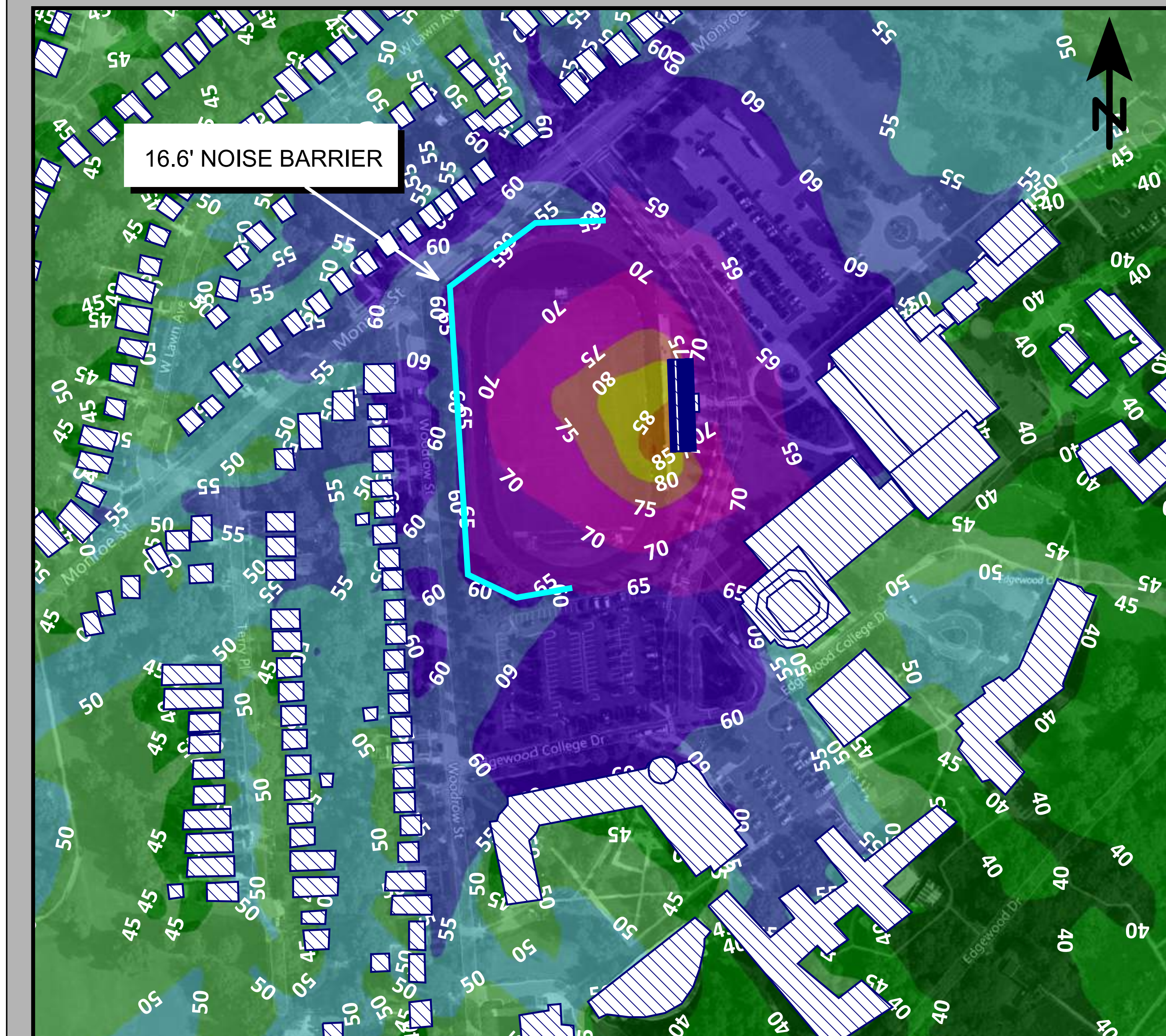
Rev. 12/21/2018

Levels
in dB(A)

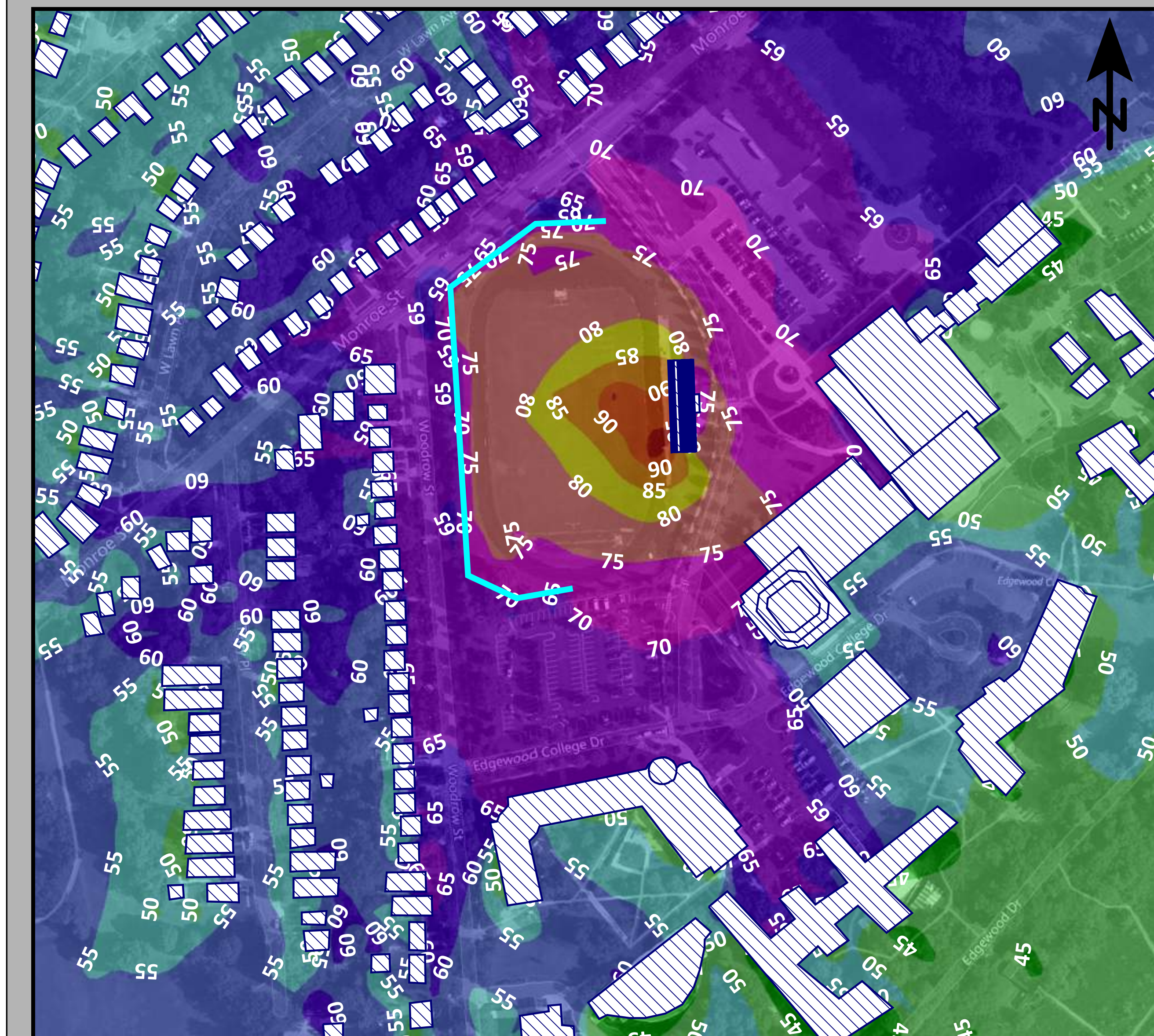
< 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
90 - 95
>= 95

Noise Sources:
(150) Spectators
(22) Players On Field
(1) Referee's Whistle
(2) R2-94 Loudspeakers
(28) Pep Band Musicians

Conditions
Calculations based at 1.5m above terrain.



LAeq (1-Hour Average)



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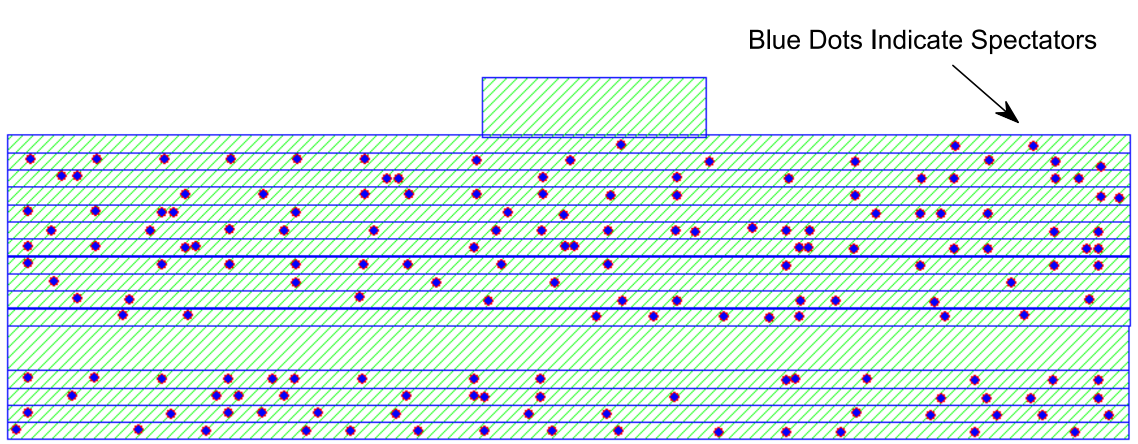

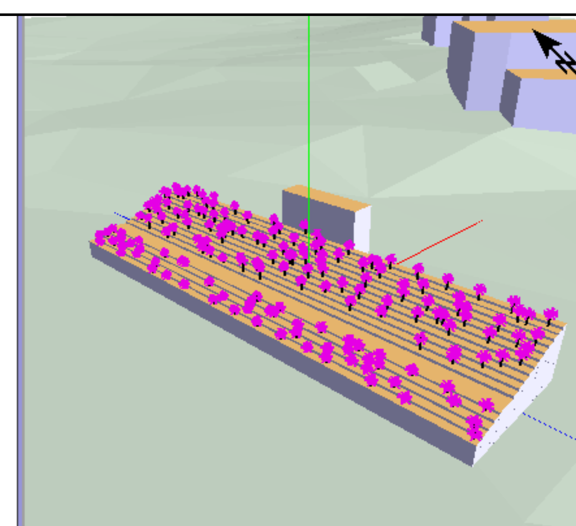

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Project Owner:
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Madison, WI

Calculation Date: 12/21/2018 *Run No. 201* *Run: 201-Medium Wall/150 People* *SoundPLAN 8.0 11/9/2018*

Length Scale 1:278
0 100 200 400 600 800 feet

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Goodman Athletic Complex

202 - Medium Barrier 500 People

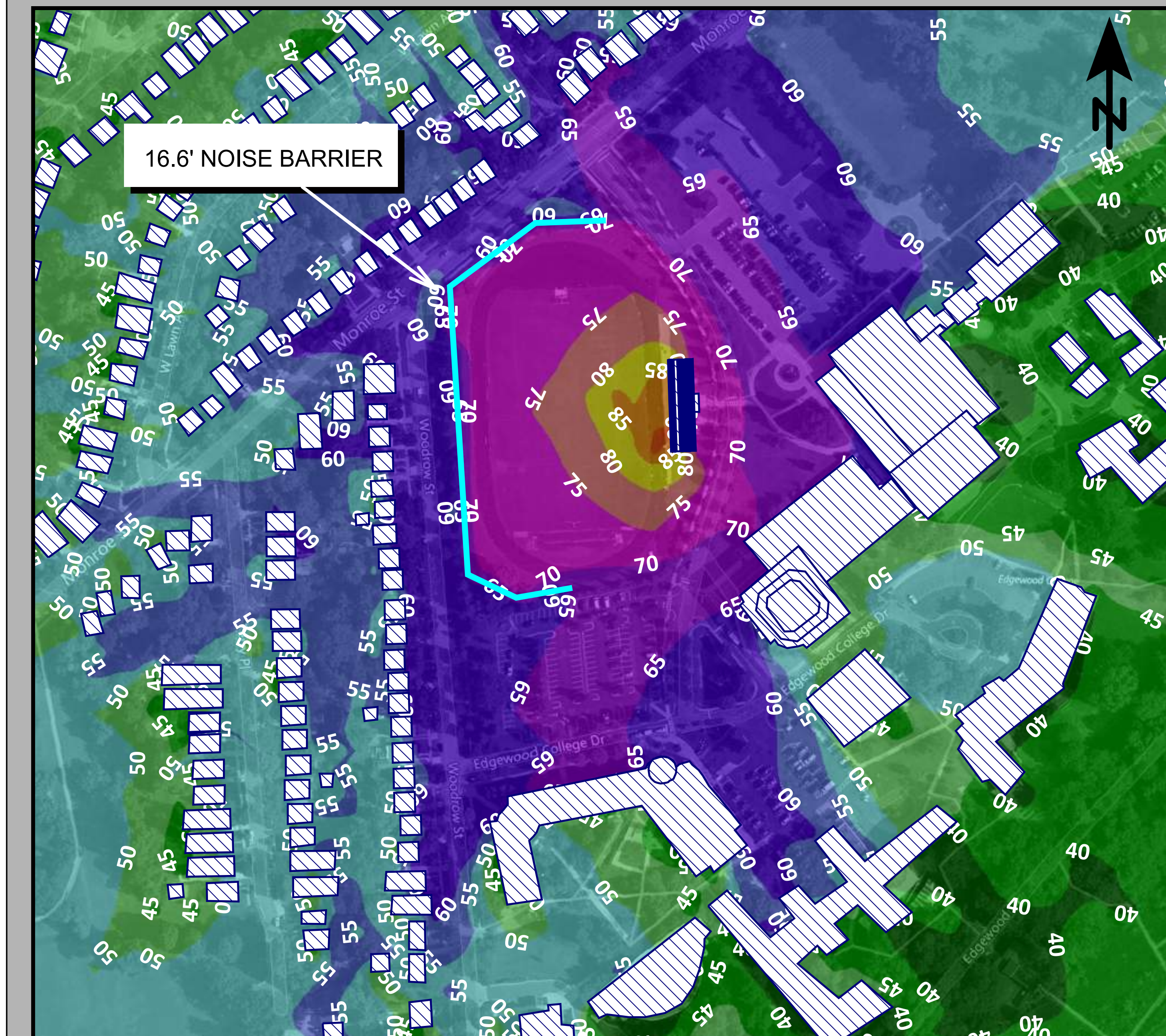
Rev. 12/21/2018

Levels
in dB(A)

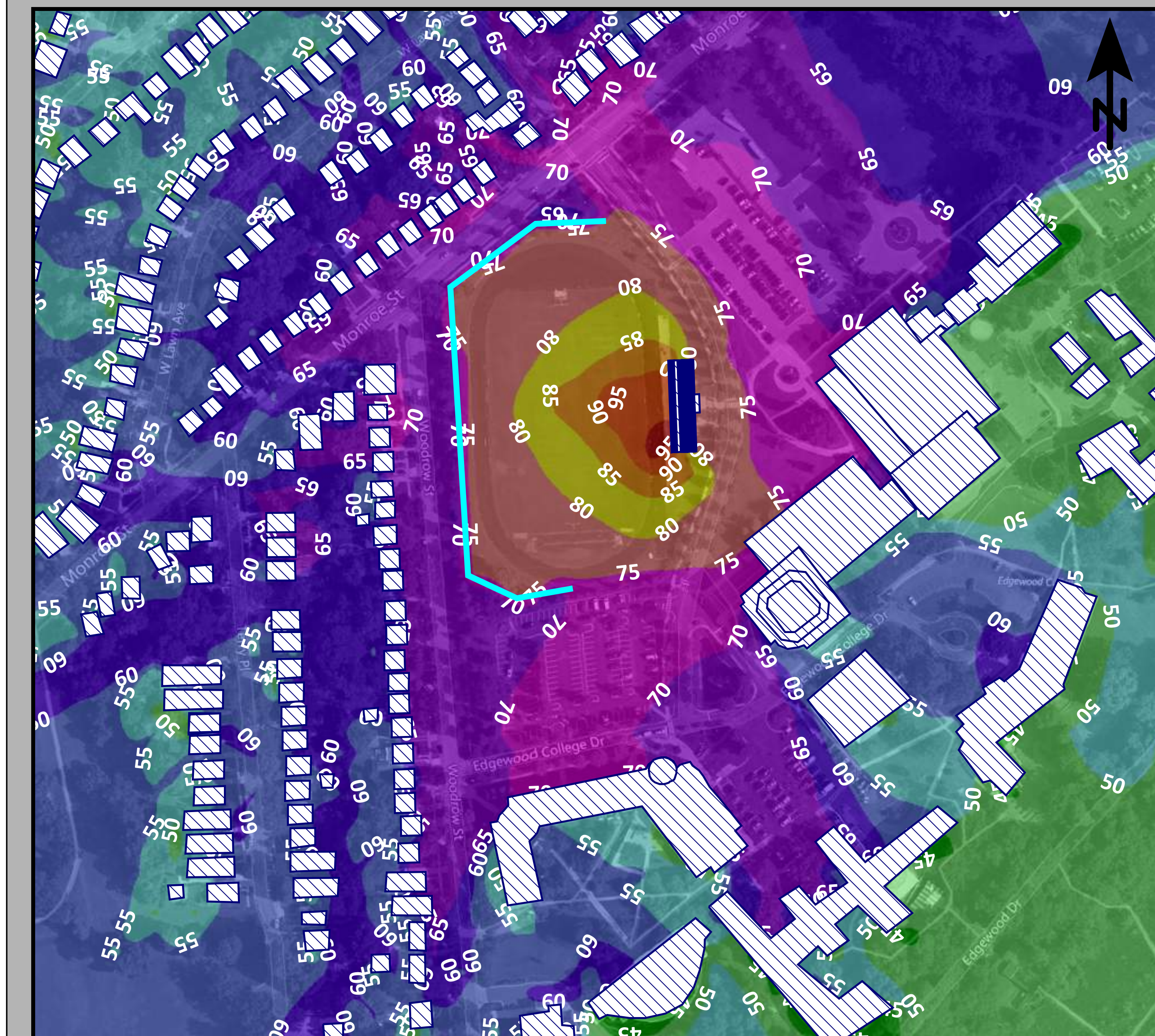
Levels in dB(A)
< 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
90 - 95
>= 95

Noise Sources:
(500) Spectators
(22) Players On Field
(1) Referee's Whistle
(2) R2-94 Loudspeakers
(28) Pep Band Musicians

Conditions
Calculations based at 1.5m above terrain.



LAeq (1-Hour Average)



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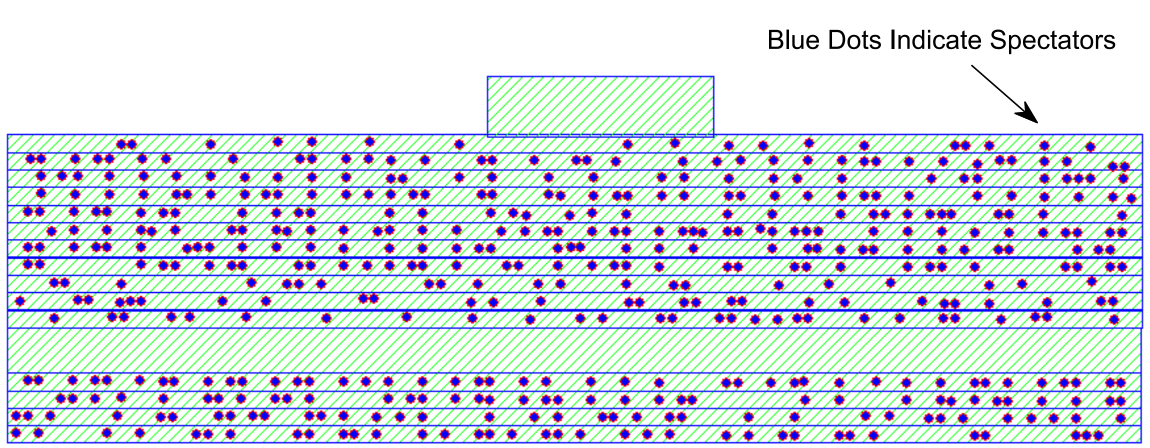
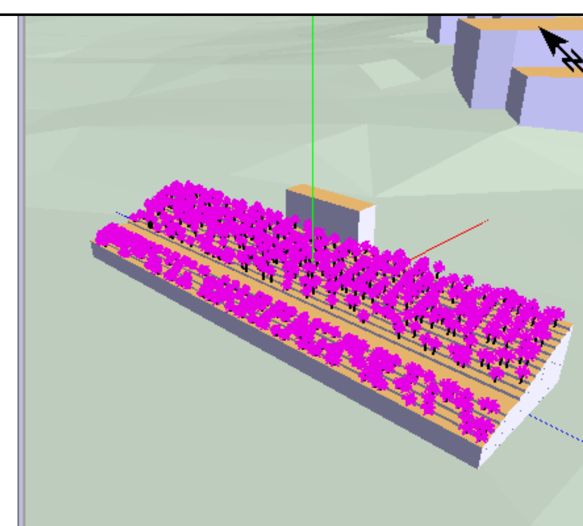




Prepared For:	Prepared By:	Reviewed By:	Project Owner:
Phillip Roeglin Professional Audio Designs, Inc.	Mike Nicolai TLC Engineering for Architecture	Richard Talaske The Talaske Group	Edgewood High School Madison, WI

Calculation Date: 12/21/2018 | Run No. 202 | Run: 202-Medium Wall/500 People | SoundPLAN 8.0 11/9/2018

Length Scale 1:278

0 100 200 400 600 800 feet

Goodman Athletic Complex

203 - Medium Barrier 1000 People

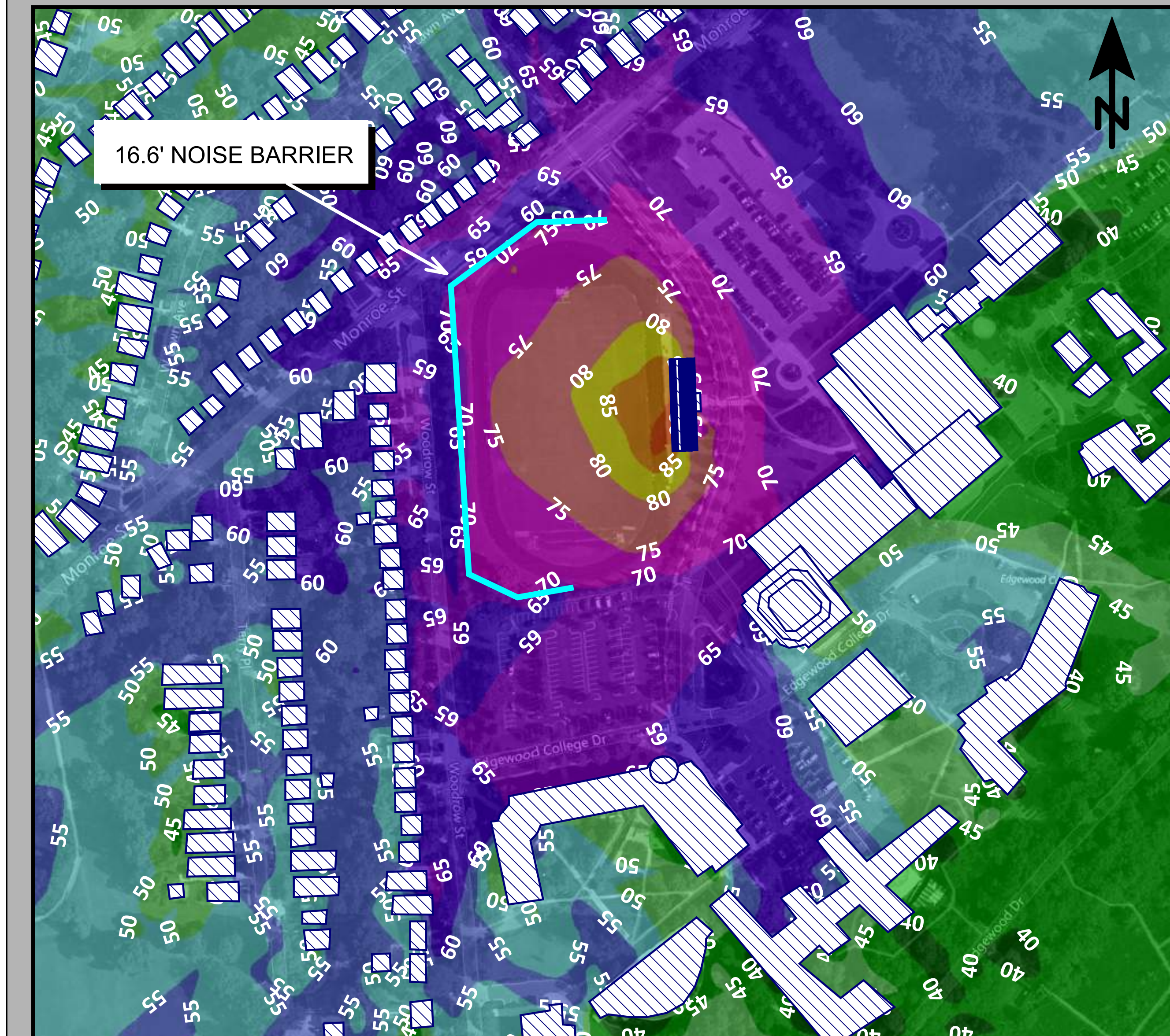
Rev. 12/21/2018

Levels
in dB(A)

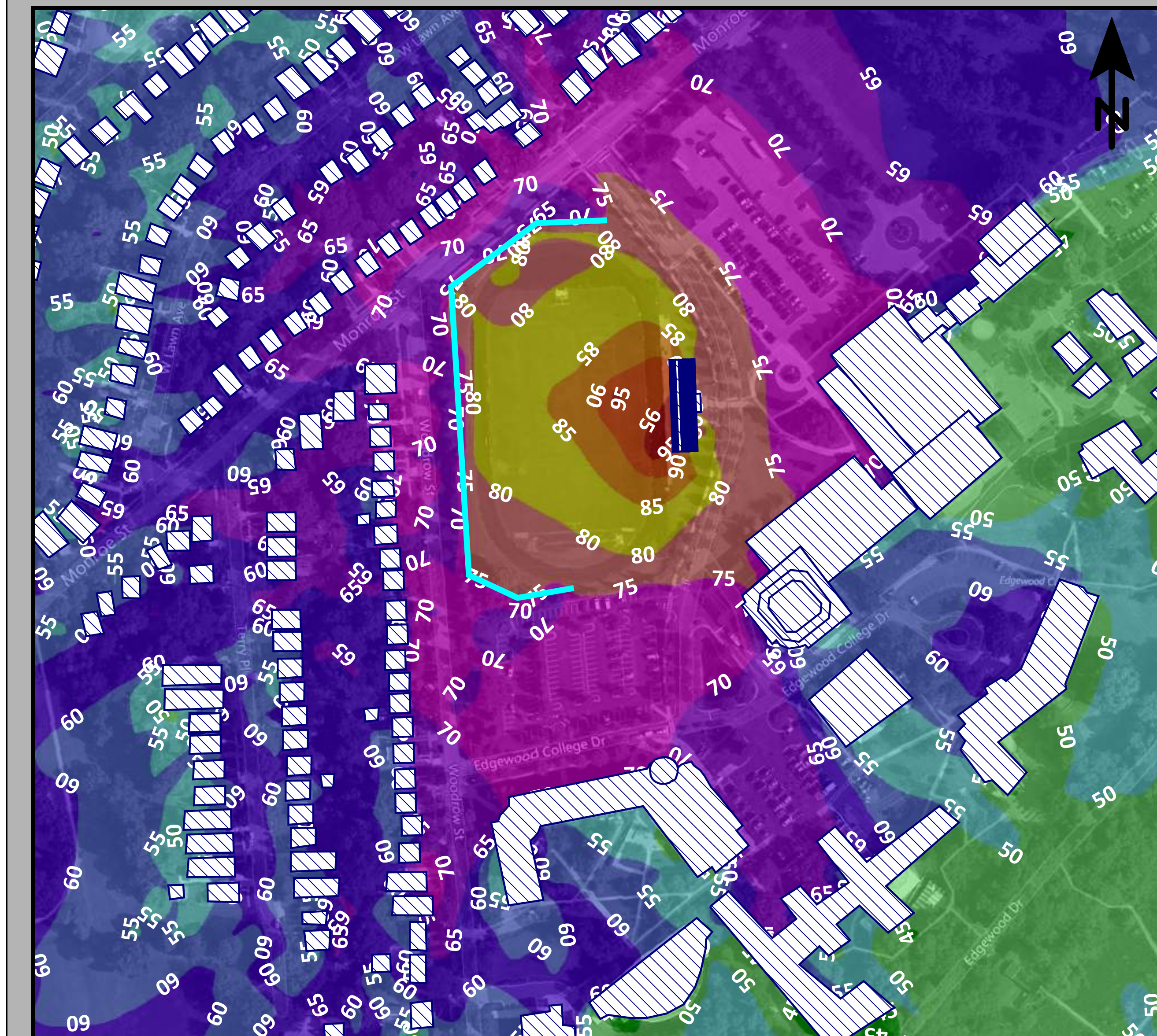
	< 40
	40 - 45
	45 - 50
	50 - 55
	55 - 60
	60 - 65
	65 - 70
	70 - 75
	75 - 80
	80 - 85
	85 - 90
	90 - 95
	>= 95

Noise Sources:
(1000) Spectators
(22) Players On Field
(1) Referee's Whistle
(2) R2-94 Loudspeakers
(28) Pep Band Musicians

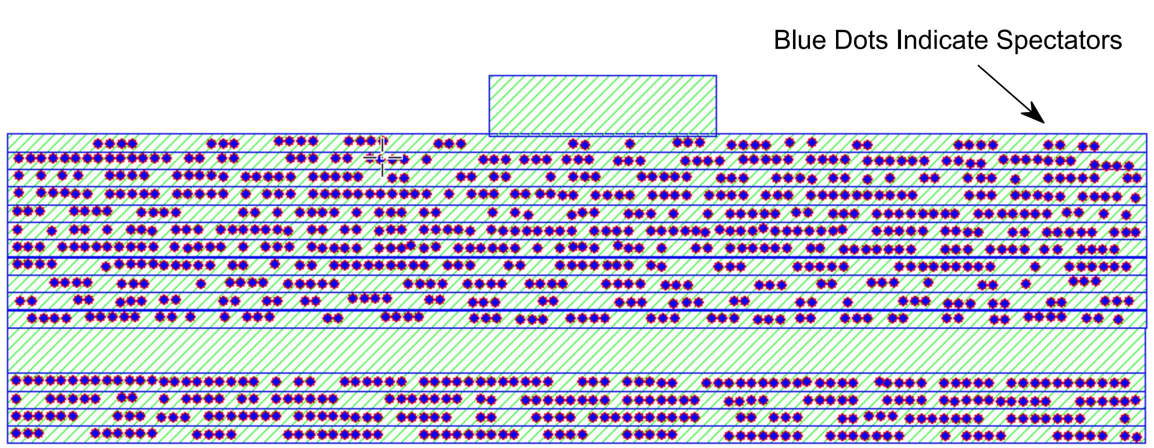
Conditions
Calculations based at 1.5m above terrain.

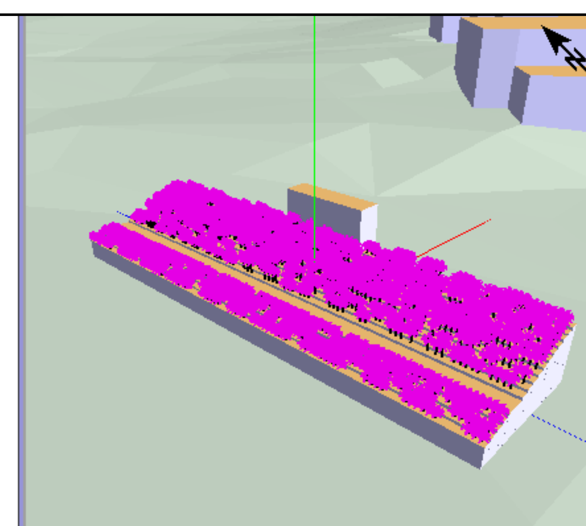


LAeq (1-Hour Average)



LAmax (Peak)





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Project Owner:
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Madison, WI

Calculation Date: 12/21/2018 *Run No. 203* *Run: 203-Medium Wall/1000 People* *SoundPLAN 8.0 11/9/2018*

Length Scale 1:278

0 100 200 400 600 800 feet

M:\Discipline - Acoustics & Sound\SoundPLAN Models\Edgewood HS\Edgewood HS\203 - Medium Barrier 1000 People.sgs - last edit 12/21/2018

Goodman Athletic Complex

301 - High Barrier 150 People

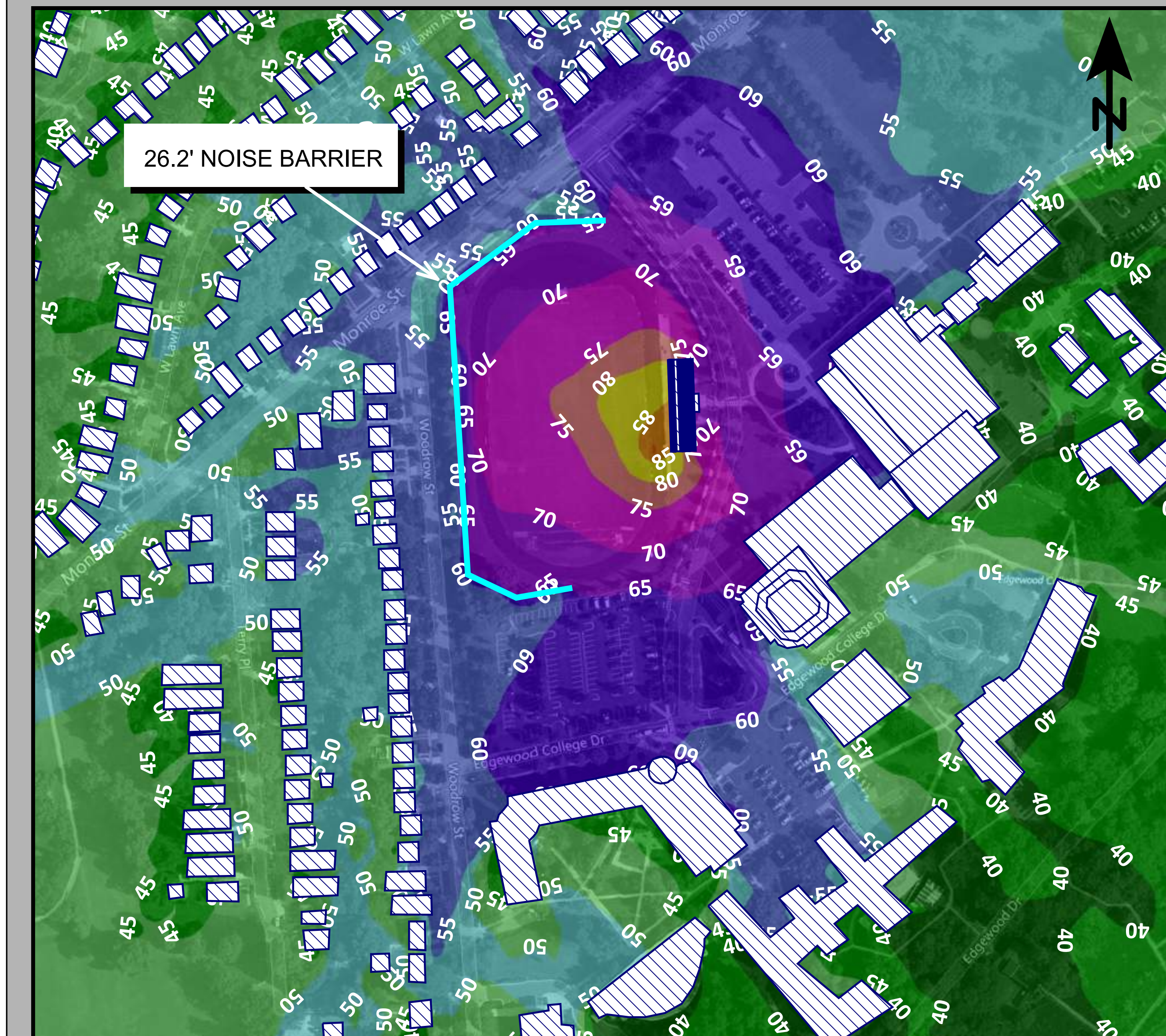
Rev. 12/21/2018

Levels
in dB(A)

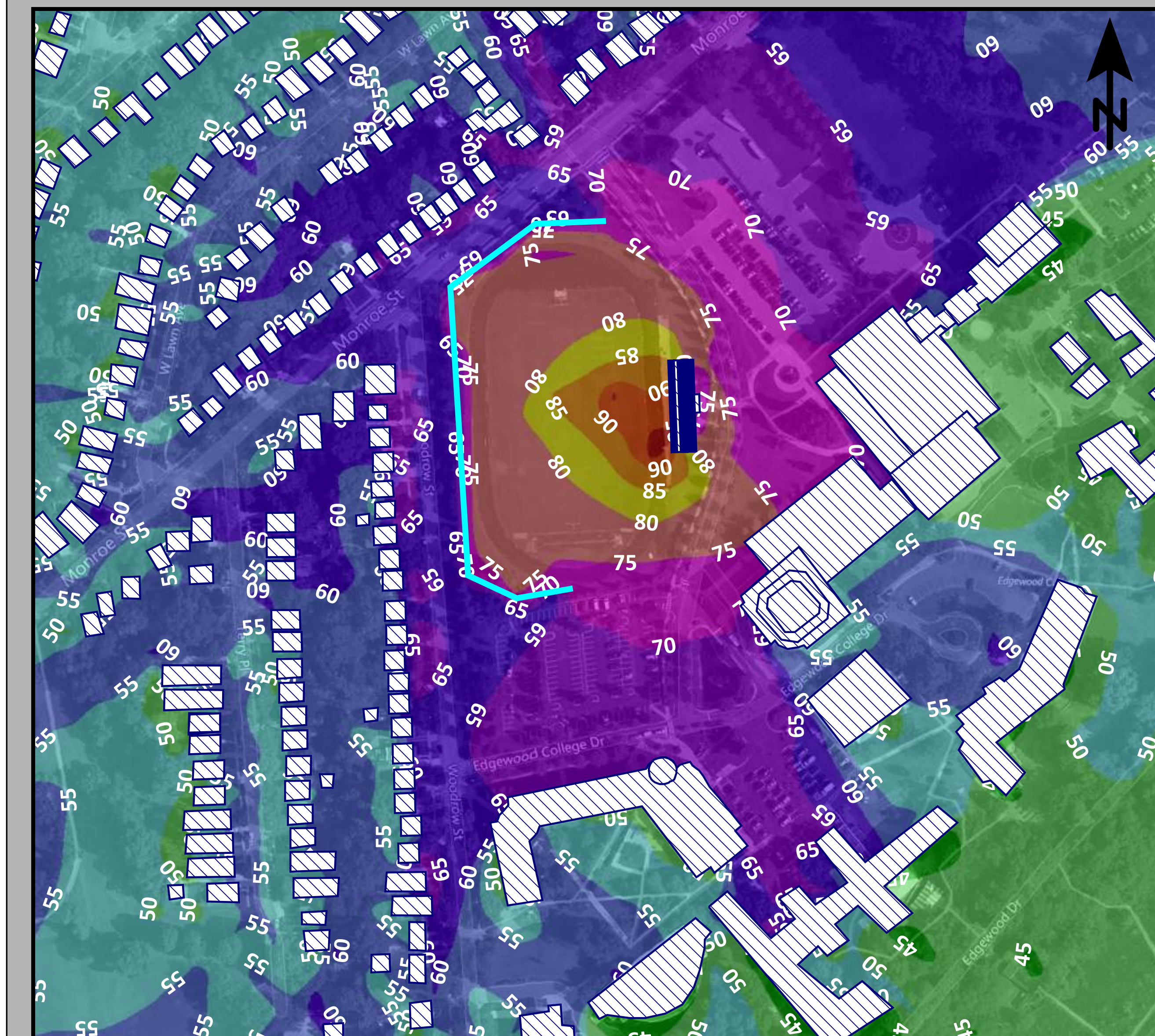
	< 40
	40 - 45
	45 - 50
	50 - 55
	55 - 60
	60 - 65
	65 - 70
	70 - 75
	75 - 80
	80 - 85
	85 - 90
	90 - 95
	>= 95

Noise Sources:
(150) Spectators
(22) Players On Field
(1) Referee's Whistle
(2) R2-94 Loudspeakers
(28) Pep Band Musicians

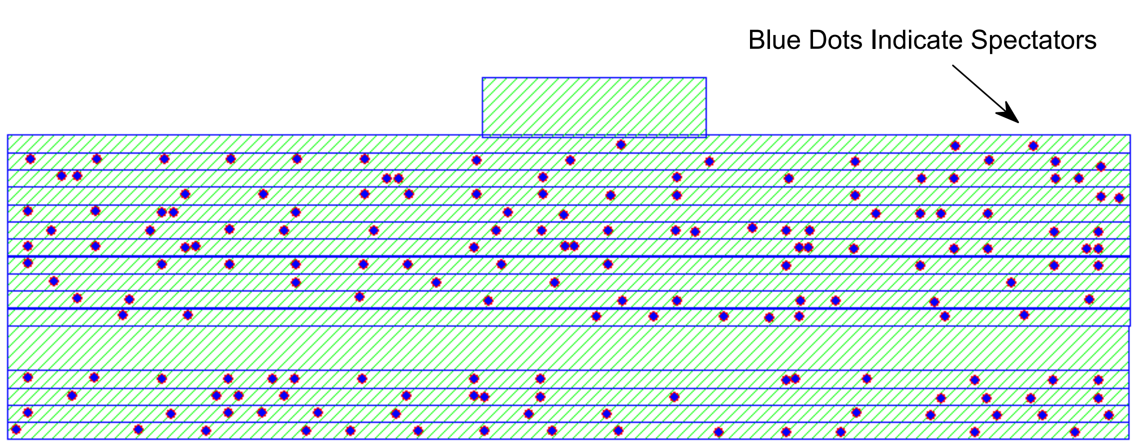
Conditions
Calculations based at 1.5m above terrain.

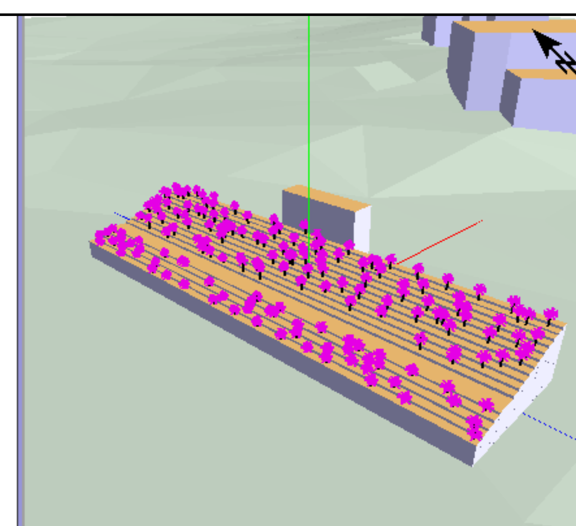


LAeq (1-Hour Average)



LAmax (Peak)





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Calculation Date: 12/21/2018 *Run No. 301* *Run: 301-High Wall/150 People* *SoundPLAN 8.0 11/9/2018*

Length Scale 1:278

0 100 200 400 600 800 feet

M:\Discipline - Acoustics & Sound\SoundPLAN Models\Edgewood HS\Edgewood HS\301 - High Barrier 150 People.sgs - last edit 12/21/2018

Goodman Athletic Complex

302 - High Barrier 500 People

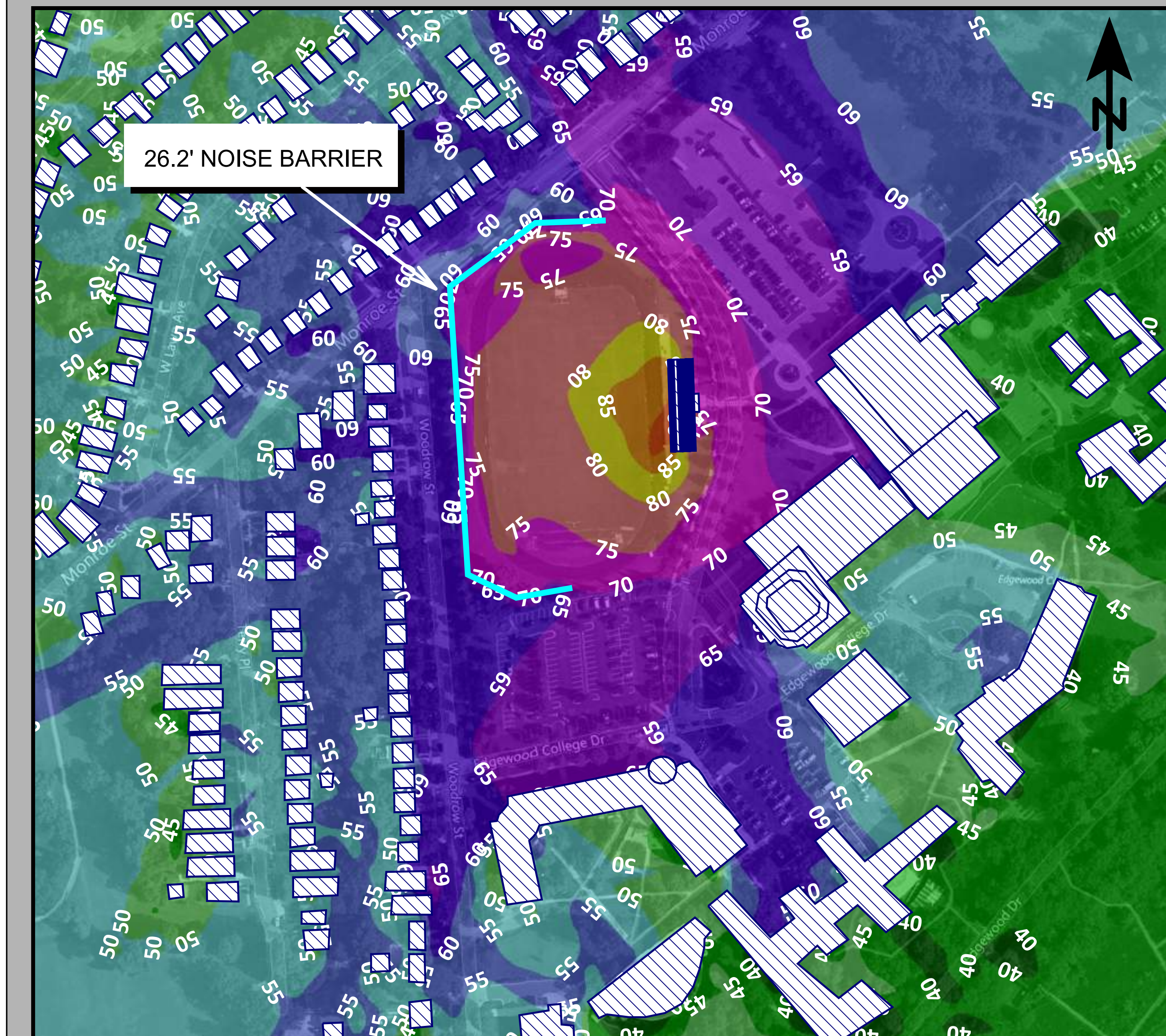
Rev. 12/21/2018

Levels
in dB(A)

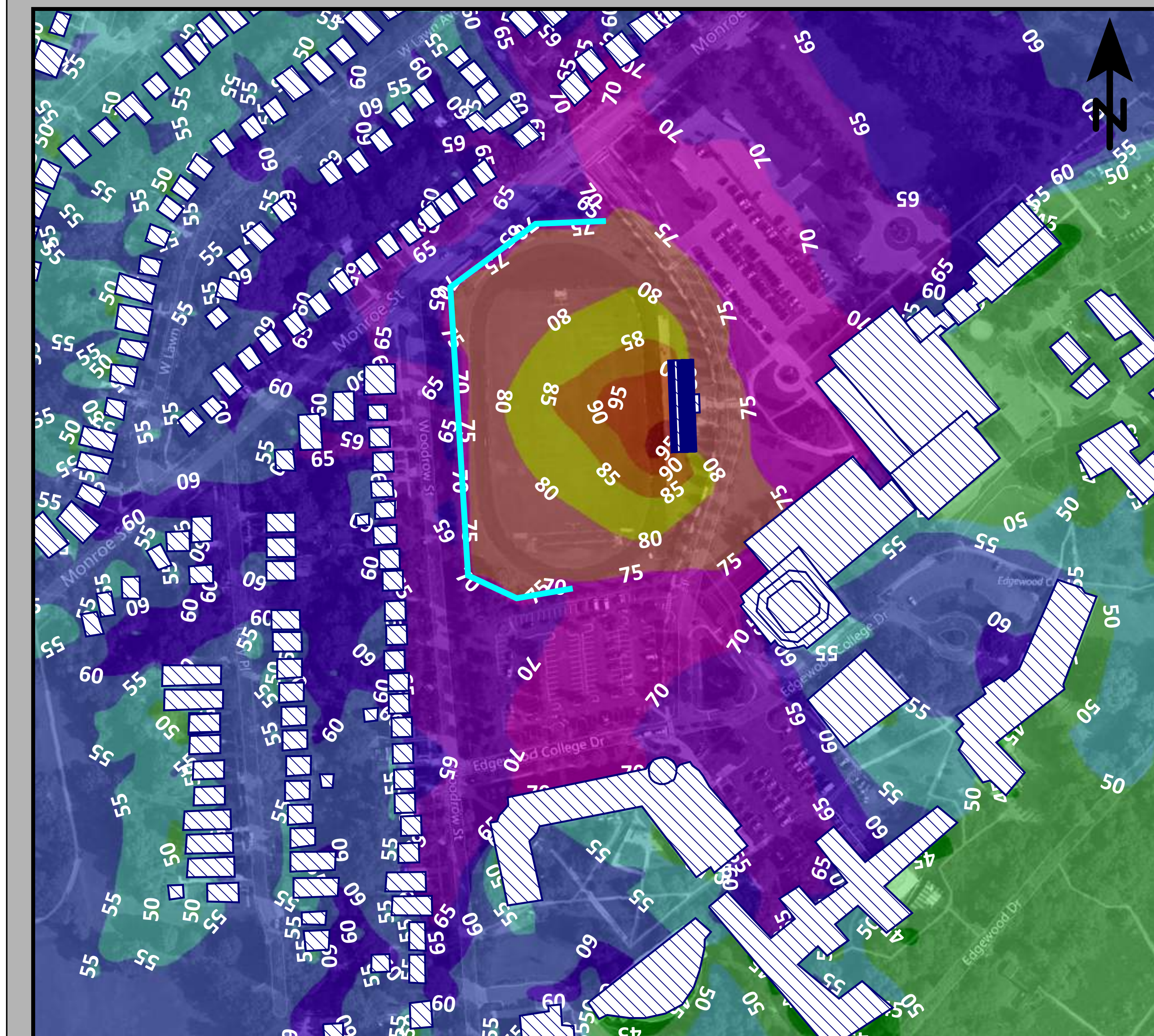
	< 40
	40 - 45
	45 - 50
	50 - 55
	55 - 60
	60 - 65
	65 - 70
	70 - 75
	75 - 80
	80 - 85
	85 - 90
	90 - 95
	>= 95

Noise Sources:
(500) Spectators
(22) Players On Field
(1) Referee's Whistle
(2) R2-94 Loudspeakers
(28) Pep Band Musicians

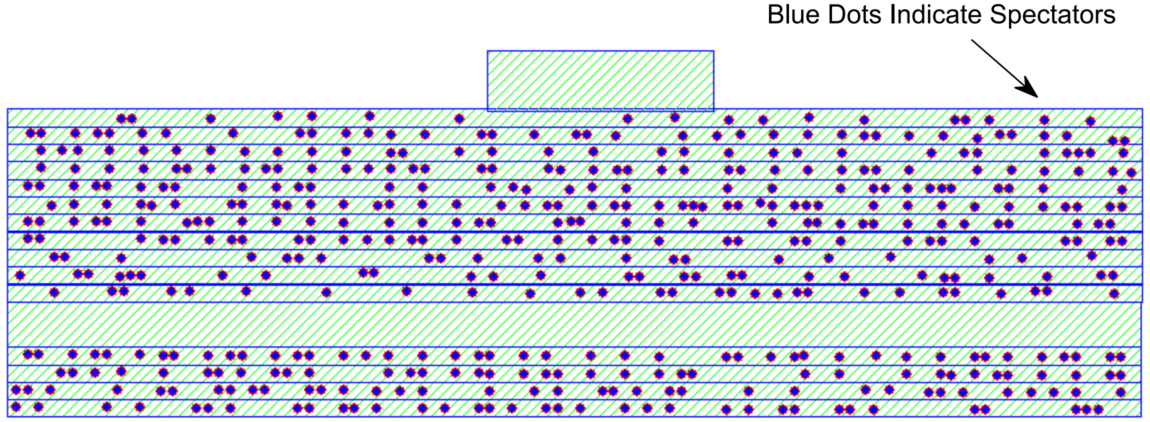
Conditions
Calculations based at 1.5m above terrain.

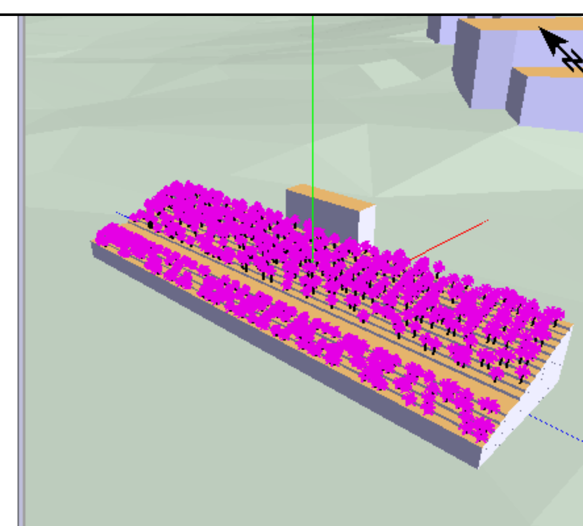


LAeq (1-Hour Average)



LAmax (Peak)





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Professional AUDIO DESIGNS inc

TLC ENGINEERING FOR ARCHITECTURE

TALASKE SOUND THINKING

EDGEWOOD HIGH SCHOOL OF THE SACRED HEART

Calculation Date: 12/21/2018 *Run No. 302* *Run: 302-High Wall/500 People* *SoundPLAN 8.0 11/9/2018*

Length Scale 1:278

0 100 200 400 600 800 feet

M:\Discipline - Acoustics & Sound\SoundPLAN Models\Edgewood HS\Edgewood HS\302 - High Barrier 500 People.sgs - last edit 12/21/2018

Goodman Athletic Complex

303 - High Barrier 1000 People

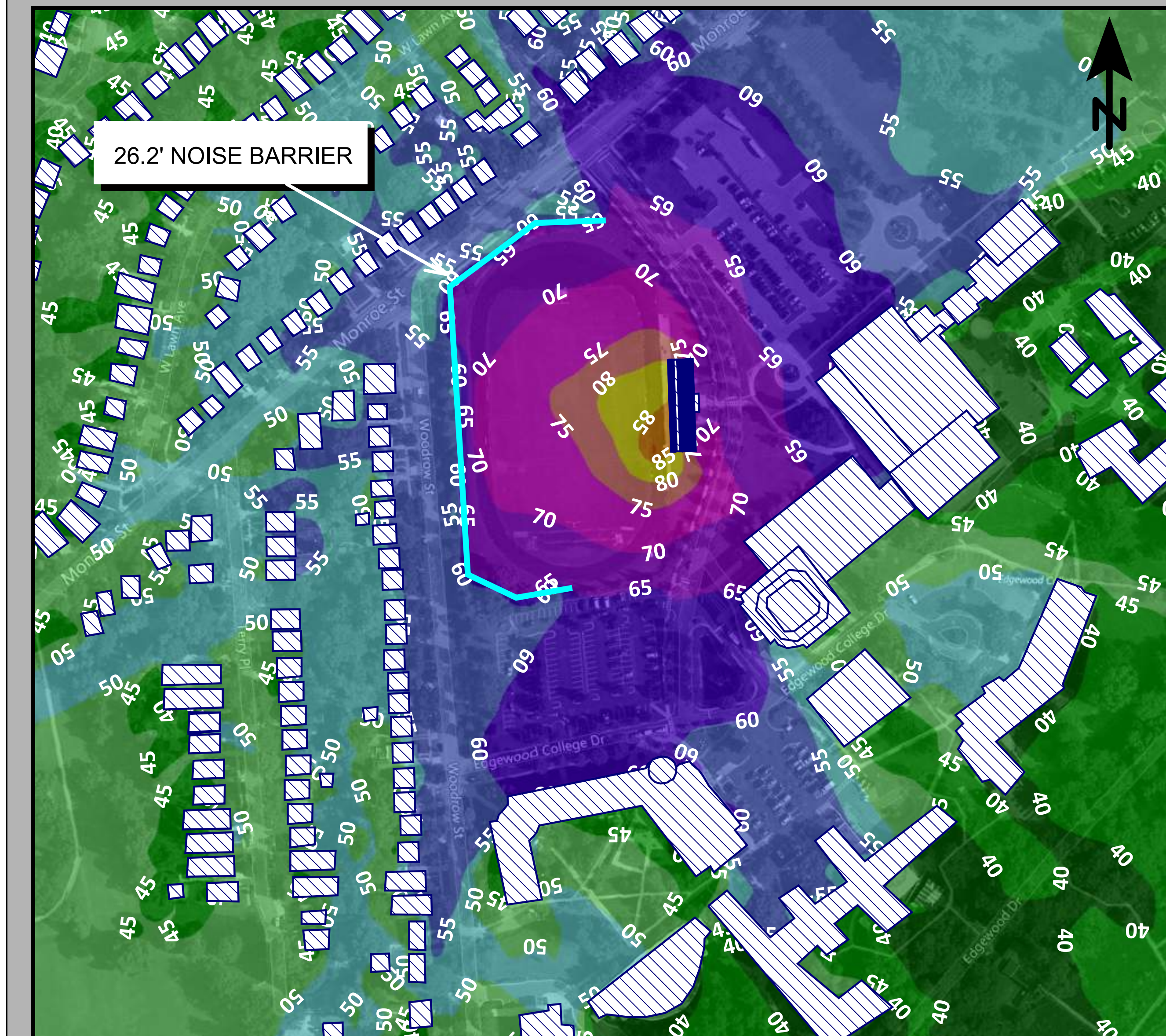
Rev. 12/21/2018

Levels
in dB(A)

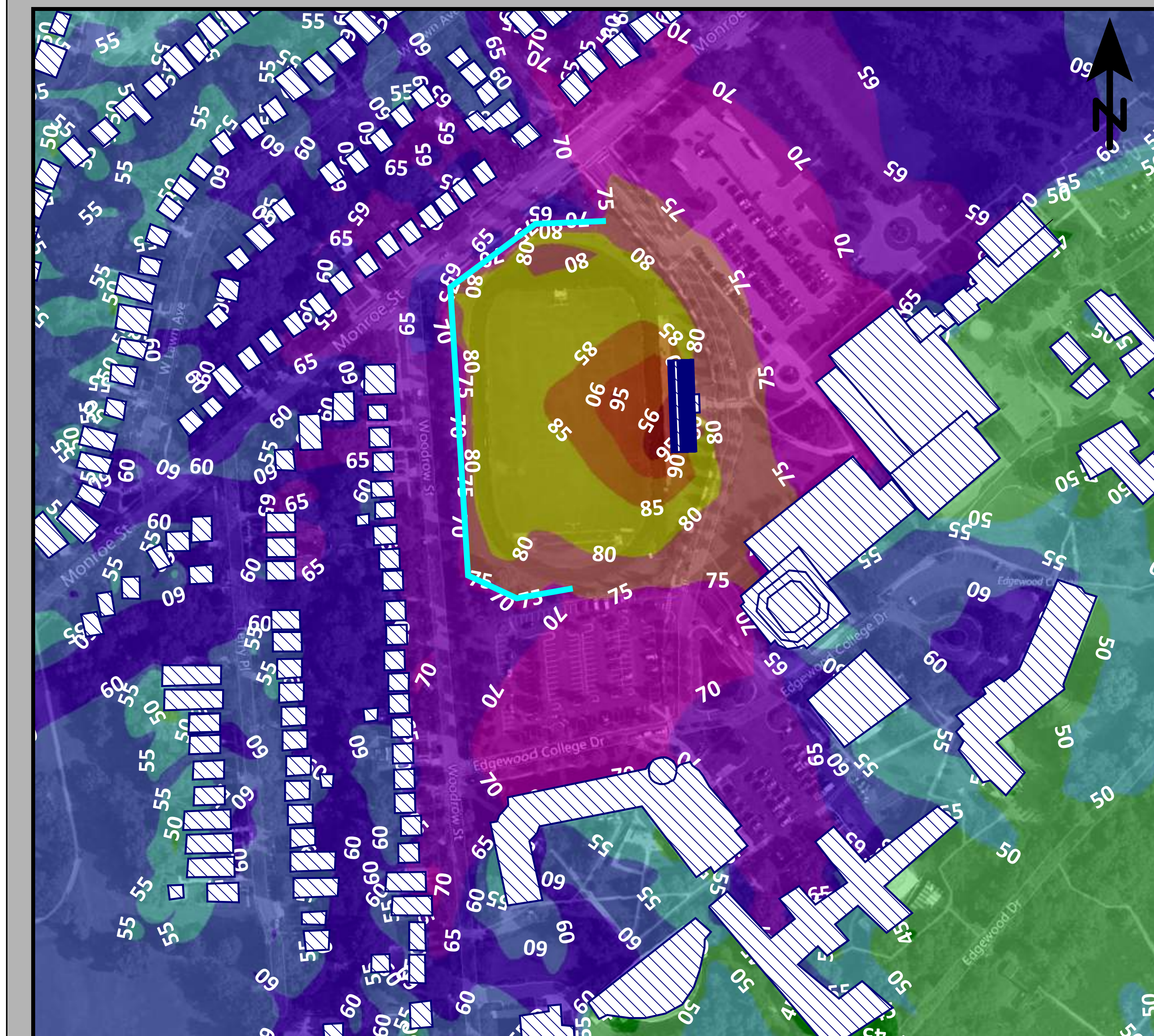
	< 40
	40 - 45
	45 - 50
	50 - 55
	55 - 60
	60 - 65
	65 - 70
	70 - 75
	75 - 80
	80 - 85
	85 - 90
	90 - 95
	>= 95

Noise Sources:
(1000) Spectators
(22) Players On Field
(1) Referee's Whistle
(2) R2-94 Loudspeakers
(28) Pep Band Musicians

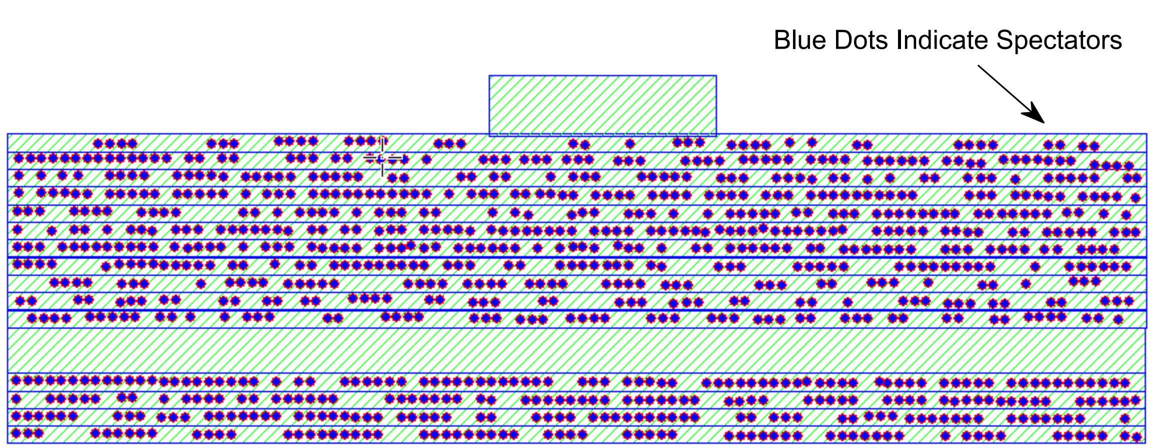
Conditions
Calculations based at 1.5m above terrain.

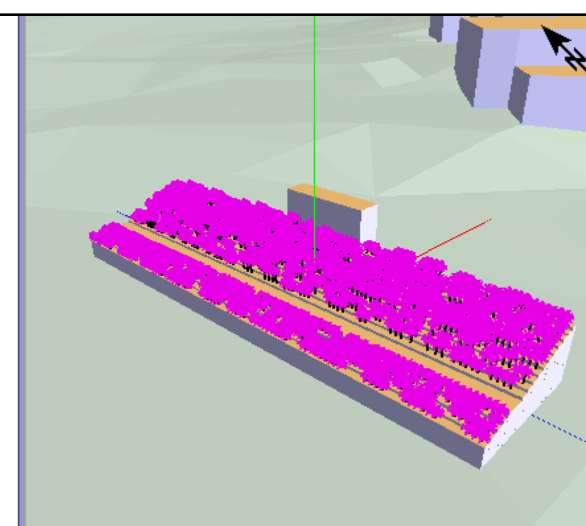


LAeq (1-Hour Average)



LAmax (Peak)





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Calculation Date: 12/21/2018 | Run No. 303 | Run: 303-High Wall/1000 People | SoundPLAN 8.0 11/9/2018

Length Scale 1:278

0 100 200 400 600 800 feet