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June 27, 2023

Mr. Darren Nielsen
Vice President/KC Studio Leader
HNTB
715 Kirk Drive
Kansas City, MO 64105

VIA EMAIL: dnielsen@HNTB.com

Subject: Northwestern University Ryan Field
Environmental Assessment Review and Summary

Dear Mr. Nielsen;

As requested, WJHW has assembled the following report for Northwestern University regarding the Ryan Field redevelopment. Northwestern previously engaged Henderson Engineers to complete on-site sound level measurements, as well as modeling of future sound generated by the stadium using environmental sound analysis software.

The information below summarizes the results and data collected and developed by Henderson Engineers (draft, dated January 26, 2023) and includes comments on the potential impact of sport and concert activities at the stadium on the surrounding communities. Information contained herein is based solely on the data presented by Henderson and no additional analysis was conducted.

Site Sound Measurements During Football Game Day and Non-Event Days

Henderson Engineers conducted a series of environmental sound measurements at and around the Ryan Field property. Measurements were conducted both during game day (football) and non-game day times to identify environmental sound levels and establish current sound levels experienced in the surrounding residential areas.

Both long-term and short-term (spot) measurements were conducted during two separate measurement periods. Game day sound measurements were conducted over the weekend of October 7-10, 2022. A second set of measurements were conducted on a non-game day weekend, December 2-4, 2022, to establish current ambient sound levels in the residential communities. Measurements were made at the stadium property as well as through the surrounding neighborhoods.

Measurement equipment information and location descriptions are summarized in Appendix A. Equipment used for the survey achieves, at minimum, requirements from ANSI standards to complete this assessment.

Figures 1 and 2 show the time history results of the sound measurements on game day and non- game day weekends, respectively. Data presented is for 10-minute LeqA values.

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Figure 1: Time History of LeqA Values during Game Day Activities (October 7-10, 2022)

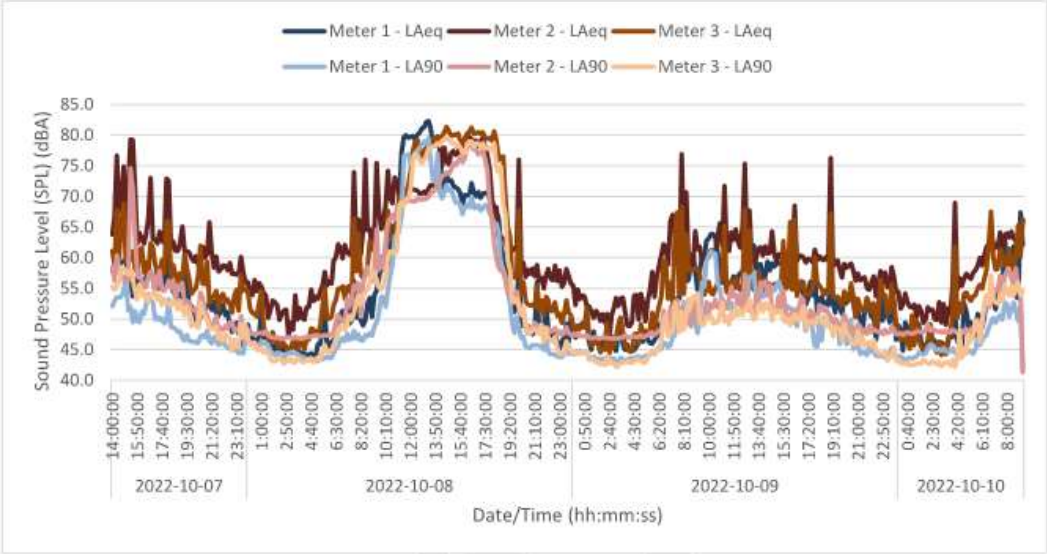
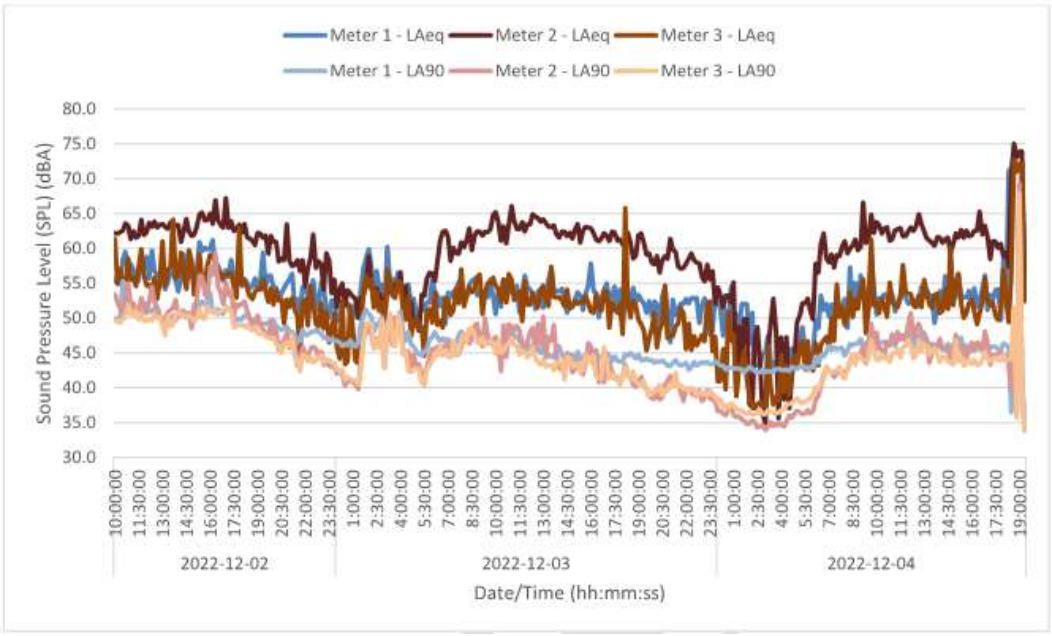


Figure 2: Time History of LeqA Values during Non-Game Day Activities (December 2-4, 2022)



A review of the measured sound data during the game day weekend at the existing stadium shows an increase in sound levels on Saturday, October 8, during the time the football game and associated activities would occur. By reviewing the graph, it is showing sound levels begin increasing rapidly around 9-10 am and continue through game time before subsiding around 6pm. The levels on Saturday are higher than the Sunday, October 9, sound levels and are indicative of the sound generated at the stadium compared to typical ambient sound. Further, the sound measurements taken during a non-game day weekend confirm the typical ambient sound levels in the area are consistently lower than the measured pre-game/game activity at the existing stadium. It is shown in these figures that the current

weekend daytime ambient sound levels are around 60-65 dBA, and that game day activities increase these sound levels up to 70-80 dBA, notably for a period of time that extends beyond just the football game itself.

It should be noted the sound monitoring positions during game day measurements were located on the Ryan Field/Northwestern University property and were identified as tailgating activities, music in the parking lot(s), and large crowds. As the measurement locations are essentially "within" the sound source, these are considered the highest sound levels in the area. Sound level will diminish at some rate as it moves into the residential communities meaning the actual stadium sound impact may be less in the neighborhoods as compared to what was measured in the parking lots.

For the neighborhoods, the better comparison of stadium sound to ambient sound can be made with the "spot" measurement data. Henderson completed a series of short-term sound measurements on October 8 during the football game at various neighborhood locations to the east, south, and west of the project property. Measured LeqA values in these areas averaged between 50-65 dBA levels that are not appreciably greater than the typical ambient sound levels measured on a non- game day weekend (Figures 1 and 2) which indicate sound levels between 50-65 dBA during the same time period as the game day football activities. While this does not indicate the football stadium activities are inaudible, it does show that they do not add appreciably to the typical daytime ambient sound levels in the neighborhoods. The exception would be those residential properties nearest the stadium (along Central Street, Eastwood Avenue, and Asbury Avenue) which may be more greatly impacted by stadium sound (from loudspeakers and cheering spectators) and parking lot sound (due to increased traffic, tailgaters, and fans).

In summary, the on-site sound measurements at the football stadium during non-game day activities indicate the typical daytime ambient sound levels are between 50-65 dBA. During game days at the existing stadium, sound levels increase at the stadium property and these activities are audible within the surrounding residential neighborhoods. However, the stadium sound – as spot measured during the October 8 football game – generally falls into the ambient sound levels within the surrounding community. We reiterate that stadium sound is not inaudible at the residences, but it does not appear to appreciably add to the typical ambient levels therein.

Notable New Stadium Design Elements

The following best practice design elements are currently included in the stadium design.

1. <u>Utilize a distributed house sound system within the seating bowl</u>

   We understand the current sound system at the existing stadium is a single cluster at the north end zone with a few fill speakers throughout the seating bowl. This type of design has been found to lead to more community concerns due to the high sound level required to cover the entire spectator area. The new stadium design includes a distributed speaker system. This type of system has several important benefits including: a) bringing sound sources closer to the audience so the loudspeakers do not have to be run at high volume, b) better control of sound to the audience and less sound emitted to the environment/community, and c) ability to control which speakers are used during smaller events therefore limiting the potential impact on the surrounding communities. Including this sound system design will be helpful in reducing

community sound impact and will likely result in less sound emission to the surrounding communities.

2. Provide a canopy above the seating areas that provides adequate sound reduction characteristics

   Providing a canopy above the seating bowl – as currently designed – narrows the aperture through which sound can be emitted to the environment and creates an acoustic "shadow" to the nearest residential properties. The acoustic shadow is an area wherein sound waves fail to propagate due to a barrier and thus sound levels are lower (similar to a light shadow that is blocked by an opaque barrier). Reducing the amount of sound energy emitted to the community will reduce the overall impact of the stadium sound levels on the residences and would be considered an improvement over the existing stadium.

While not eliminating sound emanating completely from the new stadium, the new stadium design elements will be helpful in reducing sound in the neighboring communities when compared to the open nature of the current stadium. We would expect that these design features, combined with lower capacity, will ultimately result in less sound exposure to the residential properties surrounding the stadium compared to the current experience.

Concert Sound Analysis

Henderson Engineers completed an analysis of the potential concert sound impact on the surrounding community utilizing an industry standard modeling software, CadnaA. This analysis was conducted on the new stadium design, including the features above. This software, utilizing inputs related to sound source location, directionality, and level as well as architectural barriers (including buildings), provides an idea of the sound transmission levels to various locations around the stadium. While regulatory ordinances and statutes, and industry standards typically reference dBA levels, the projected dBC levels have been modeled as well as the request of the City of Evanston. The analysis results, based upon an sound level of 101 dBA at the sound board, are shown for dBA values in Figure 3 and dBC values in Figure 4.

Figure 3: Concert Environmental Assessment Results (dBA)

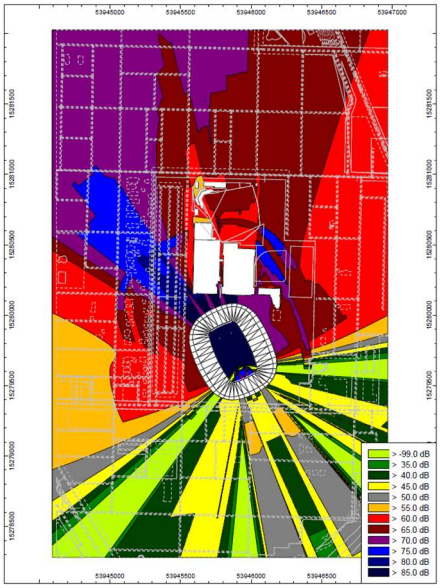
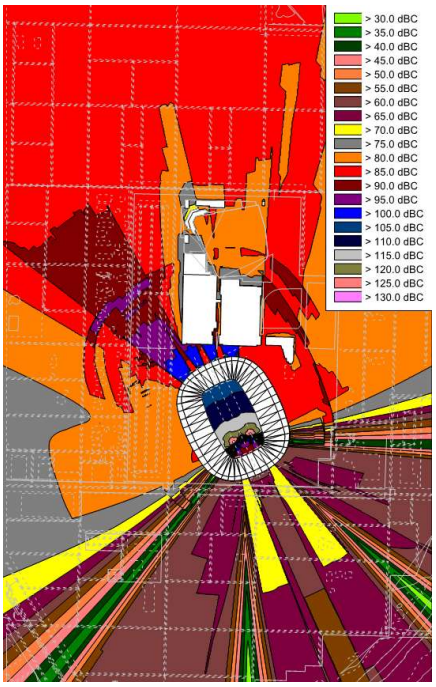


Figure 4: Concert Environmental Assessment Results (dBC)



The results of this analysis show sound generated at the new stadium is projected to the north and west. Areas to the east and south also show sound impact, but less so than to the north. Sound transmission to the south could be described as noticeable but generally does not substantially exceed the ambient sound levels measured in the area. Alternative stage locations do not appear to be an attractive option for sound mitigation, given the sound reduction benefits of the building barrier effect related to Welsh-Ryan Arena and other existing Northwestern structures. That is, the existing structures

help block/shield transmission to the north residential properties; there is no such barrier at the south of the property to provide the same barrier effect to those southern residences.

Predicted sound levels are approximately 55-75 dBA and 85-95 dBC; dBA levels will reach similar peak levels to those measured for game day activities at the existing stadium. Levels associated with concerts, while elevated, are expected to occur for shorter aggregate periods of time than football game day activities, though they may be more consistent during that period. We estimate the typical concert to be approximately 3-4 hours (doors open to end of encore), less than the 6-8 hours observed for game day events.

Projected concert sound levels were evaluated at the surrounding property lines. The Henderson model accounts for disruption to sound patterns caused by University-owned structures (such as impact seen in the graphic above), but does not account for the impact of non-University owned property. Therefore, the model doesn't account for the impact of residential buildings or other structures, which would limit how far into the residential area sound travels before it reaches ambient levels. The sound levels in the residential community will be lower than at the property line, when factoring in the impact of other structures, distance, directivity, and other factors.

The Henderson model results shown above does not account for any additional sound mitigation efforts beyond the two design features noted above.

Additional Sound Barrier Mitigation Option

Many stadiums across the country utilize additional sound barriers around the concourse areas or other openings in the stadium building shell as a mechanism to further contain sound within the facility. These barriers can be utilized effectively when a stadium is not fully enclosed.

Similar to the canopy, adding vertical barriers around open concourse or other areas will reduce the amount of sound that can be directly transmitted to the community. Vertical barriers may be most effective on the east, south, and west facades of the stadium. Options may include permanent barriers or retractable barriers (such as sound curtains, demountable walls, or operable partitions) that narrow the side openings at the stadium.

Henderson adjusted the sound model to account for these types of mitigation efforts.

Figure 5: Concert Environmental Assessment Results with Additional Sound Mitigation (dBA)

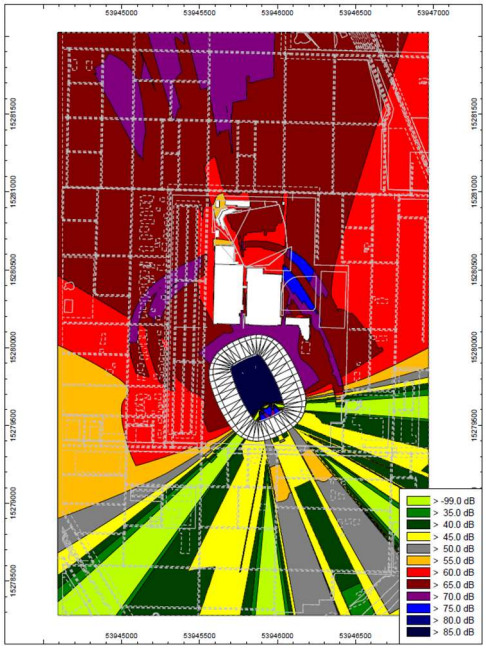
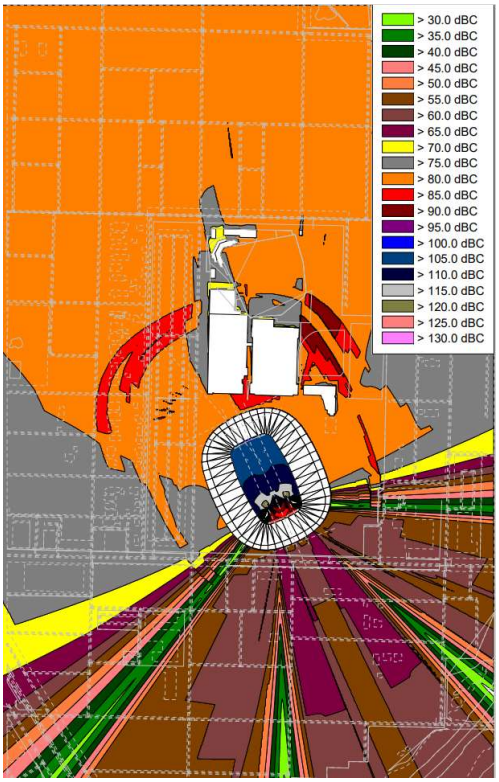


Figure 6: Concert Environmental Assessment Results with Additional Sound Mitigation (dBC)



With additional effective mitigations, there is a noticeable reduction in sound impact on the immediate West property line, and a noticeable reduction in sound impact to the Northwest. While sound will still be audible, projections generally fall in the 60 and 65 dBA ranges. There is a small sound shadow impact to the north that would positively impact a small number of residents. Again, this model does not account for the beneficial sound reduction impact that would be generated by the residential houses at the property lines.

Additional modeling is required to determine the exact extent of the barriers and the necessary sound reduction qualities of the materials installed, but our recommendation is that Northwestern consider including this mitigation in the project, or have the opportunity to add them at a later time as an additional mechanism to mitigate environmental sound transmission.

Sound Mitigation Options for Concerts

An assessment was completed of potential sound transmission to the community during a concert at the new stadium. This assessment was completed using an environmental sound prediction software – CadnaA – utilizing specific assumptions on the stage location, speaker type/mounting, frequency spectrum/level, and existing campus building size and location.

Discussion and Comments

The site sound level measurements show the typical weekend ambient sound levels in the area surrounding Ryan Field are between 50-65 dBA (depending on proximity to the football stadium). This is a useful starting point for reviewing mitigation options in the stadium and the various uses. Based on these values, we think targeting a sound level of approximately 65 dBA at the residential properties would be appropriate to maintain current event sound level transmission to the neighborhoods. While not being inaudible, limiting the sound exposure at the surrounding community to these levels would be helpful by keeping the intruding sound from noticeably exceeding current ambient levels and not appreciably adding to the local ambient sound in the neighborhoods.

The current football operations exceed ambient community sound levels and may be used as a reference point for improvement targets associated with the new stadium design and uses. Concert sound levels with appropriate mitigation, as predicted in the CadnaA software and developed by Henderson Engineers, show sound levels peaking at 65-70 dBA. As noted above, while audible and higher than ambient noise, these levels are similar to the current football game activities.

It may be helpful to put some of these sound levels in perspective. Sound levels measured in the neighborhoods are similar to a busy open plan office (50 dBA) or moderately busy street/traffic (65 dBA). Other common sound sources with similar sound level include refrigerator (50 dBA), air conditioner (50-70 dBA), and normal conversation level (60-65 dBA). These are audible sound levels, but are not excessive for typical activities. It should also be noted that these predicted game day/concert sound levels are measured outdoors in open air, and interior sound would be mitigated by the structure of a home. Sound sources such as an ambulance (120 dBA), which is a common occurrence on Central Street, are substantially louder than those sounds emitted from the stadium.

We think the design of the new Ryan Field, and reduction in capacity of stadium, will be helpful in reducing sound impact when compared to the current stadium design. However, as with football game days, concerts will generate sound– there is no way to reduce it to zero. Northwestern and the City will need to work together to weigh the impact of sound generated by a limited number of concerts, versus the social and economic benefits of those same concerts. WJHW is not in a position to evaluate that decision. Our understanding is that there are already outdoor concerts occurring in Evanston in the same neighborhood, with no sound restrictions, and other local venues like Ravinia have managed to find a way to balance the sound generated by concerts with the benefits they derive.

However, there are some additional steps we think Northwestern could take to be cognizant of sound impacts and be a good partner with the residential community:

Limit concert sound levels

We recommend considering a limit on sound level produced by touring concerts within the stadium. Simply put, a quieter concert will result in a quieter neighborhood. We do not intend the limits set to be at such low volume that the enjoyment of the concert is compromised, nor to make the venue uncompetitive in a competitive market. Rather, the limit should be set to avoid specific bands/uses from excessively loud performances.

It may be difficult to determine an appropriate interior sound limit at this time without understanding exactly how concert sound escapes the stadium in real events. However, there are two options available to help determine potential limits a) model various concert setups in CadnaA (or similar, SoundPlan) to estimate a maximum sound level limit, and/or b) prior to the first event, set up a stage/speaker arrangement and test sound levels within the seating bowl with spot checks in the neighborhood for compliance. Both options may be necessary to finalize the preferred sound level limits.

It's also important to note that this is not a tool that creates certainty. But, it is a tool that venues across the country use and insert into contracts with artists. Northwestern could consider including a contractual penalty/fine for a performer who violates the interior sound limit.

Install sound monitoring devices in and/or around the stadium

Installing sound monitoring stations in the stadium seating bowl (typically at the mix position), on the stadium property, and/or within the residential communities allows real-time analysis of the sound levels generated by activities at the stadium. If located within the stadium, the monitoring equipment could help the facility staff quickly react to sound exceedances established for the event. If mounted outside the stadium, sound monitoring equipment could indicate if certain types of activities or acts are having a more significant impact on the community sound levels than others.

Limit concert times and days

Limiting concert times – particularly late evenings and weekdays – will reduce potential annoyance in the neighborhoods. It is often necessary to shut down concerts slightly earlier to reduce the potential of sleep interference in the community. This should be considered when developing activity schedules for the stadium.

The above recommended considerations may have an impact on sound reduction over a wide area or may be more targeted to specific complaints/issues that may arise. We recommend considering all or portion of the above mitigation options for a complete plan to mitigate sound transmission to the community.

I trust this information to be helpful. Please let me know if you have questions.

Regards,

Greg Hughes
Principal