



March 3, 2014

Mrs. Kathleen Barnett
16 Pine Road
Sharon, MA 02067

Re: Oak Bluff Bowling Alley – Acoustic Review

Dear Kathleen,

We have performed our acoustical review of the proposed design, the acoustical evaluation and recommendations by Cavanaugh Tocci Associates, Inc. on February 19th and February 26th 2014 and provide the following as our acoustical comments and considerations. We have commented on what has been provided. Other work, reports, designs and recommendations may be in process or have been completed and we would be glad to provide further review of other materials if requested.

1.0 Summary

The proposed design is not considered to provide sufficient acoustical isolation to suitably limit the noise transmitted to the adjacent residences based on the goal being inaudibility of the music or thuds and impacts associated with bowling. We recommend that the design be provided such that all transmitted sounds from the operation of the proposed building be limited to 10 dB below the ambient noise levels. By providing calculations or narratives of the proposed design that outline that confidently state that transmitted sound will be quieter than the existing conditions, the goal of inaudibility has the highest chance of being achieved.

We recommend that ambient sound measurements be made at the site to quantify the existing ambient sound conditions. These existing conditions should then be used as a baseline for the design of the building to contain noise levels (from Music, Bowling or any other programmed activity in the proposed building) transmitted to adjacent residential property lines to be 10 dB below the existing ambient noise levels during all hours of operation in all octave bands. Ambient shall be defined as the lowest sound level measured during the hours of operation, stated as a 15 minute duration L_{eq} sound level, measured in all octave bands from 31.5 Hz to 8,000 Hz and will require measurements to be taken during both daytime and nighttime hours to capture sound levels into the evening and nighttime hours of operation.

We request that the design be validated to meet these levels, with a summary narrative stating that acoustical design considerations have been implemented into the design and that the goals of being 10 dB below ambient will be achieved once constructed. To achieve this, we anticipate that further consideration of floor, wall, ceiling and roof construction be considered and that this may include double walls

isolated construction, added layers of sheathing materials, drywall and insulation, separated pours of concrete and noise control of HVAC, Kitchen exhaust and other building systems.

2.0 Goals

We note that it has been acknowledged that inaudibility is the design goal. This should be interpreted as sounds from the operations of proposed bowling alley not being heard within the property boundaries of adjacent properties. This is a difficult condition to quantify, as the audibility of a given transmitted sound will depend on the ambient conditions. We recommend that further acoustical design efforts be made to design the building to meet this goal of inaudibility. If the ambient noise conditions without traffic, wind and other typical noises is very low then transmitted sounds from the proposed bowling alley are much more likely to be heard.

Based on the location and setting, it is expected that ambient sound levels day, evening and nighttime are very quiet in the residential area adjacent to the proposed Bowling Alley. We recommend that ambient sound measurements be made at the site to quantify how quiet the location is. Ambient shall be defined as the lowest sound level measured during the hours of operation, stated as a 15 minute duration L_{eq} sound level, measured in all octave bands from 31.5 Hz to 8,000 Hz. We recommend that at a minimum a few hours of measurements be taken in the daytime (Noon through 5 PM) as well as the evening (6PM through 10 PM) to capture times where outdoor use of residences is most likely while the proposed Bowling Alley is in operation.

The lowest levels measured during these periods should be used as the baseline ambient. The goal of the acoustical envelope for isolation of noise (Music, Bowling or any other noise) shall be to control noise transmitted to the property line to be 10 dB lower than the measured sound levels in all octave bands. By demonstrating that the transmitted sounds from the loudest activities are 10 dB below the existing ambient in all octave bands, the transmitted sound has the best likelihood of being inaudible.

3.0 Proposed Design

We note that recommendations have been provided to improve the airborne sound isolation performance of both the walls and the ceiling/roof in the areas of the Bowling alley that are anticipated to generate noise. A wall construction incorporating increased layers of drywall and sheathing, as well as including resilient clip systems will provide acoustical benefit. Upgrades to the layers of sheathing and insulation at the ceiling and roof will also increase the sound mitigation.

We did not see any assessment or opinion on the expected level of sound that may transmit to the adjacent residences as a result of these upgrades. These modifications will certainly reduce the level of sound transmitted; however, to determine if a sound may be audible, noticeable, bothersome, or a nuisance, further description of the transmitted sound (including its level, regularity and frequency) is needed.

4.0 Acoustic Considerations

The descriptions made regarding the sounds generated by bowling activity are accurate. The ball impacting the pins, the clattering of pins and cheers of people are all components of sounds that may be heard. When assessing what sounds may be transmitted to a very proximate residential neighbor, we would also add that the bowling ball impacting the lane and the bowling ball hitting the pit-cushion at the end of the lane after hitting the pins as well as the operations of the pinsetter machines are key components. These sounds represent both high and low frequency sounds, and can be considered impulsive sounds in the case of the bowling ball impacts. These impulsive sounds are very short duration sounds, perhaps heard as thumps or thuds.

When considering sound within the bowling area, the clattering of pins and pinsetter sounds may be considered 'louder' than the impulsive sounds but when considering what may be transmitted to a very nearby property line outside the building, the low frequency and impulsive sounds are the most difficult to contain or attenuate.

It is likely the upgraded wall and ceiling/roof construction will provide improved sound control for the containment of the high frequency sounds of voices and pin clattering; however, the thuds, thumps, and impacts associated with the bowling ball impacts may not be so readily controlled.

Based on measurements at other bowling alleys, both novice and experienced bowlers vary the way they bowl which can make ball impacts on the lane smooth or of very high impact. The noise levels associated with Bowling Balls impacting the lane/floor when bowling can be in the range of 105 dBA (including low frequency content of 98 dB at 31.5Hz octave band and 110 dB at both 63Hz and 125 Hz octave bands) measured at the edge of the lane (around 5 feet from the Ball impact). The area shown in PURPLE in figure 1 below is the likely area where balls will impact the floor. Bowling activities measured in the pinsetter area at a distance of around 5 feet above the pin-setting machine with balls being bowled, pins being impacted and the ball hitting the pit-cushion at the end of the lane can be in the range of 110 dBA (including low frequency content of 90 dB at 31.5Hz octave band and 95 dB and 105 dB at 63Hz and 125 Hz octave bands

respectively. The area shown in ORANGE in figure 1 below is the pinsetter machine areas where balls will impact pins and the end of the lane.

Our assessment of the proposed design, with recommended upgrades to the walls (to provide an STC 62 rating) and ceiling (to provide around an STC 60 rating) indicates that sound levels at the residential property boundary during these impulsive events associated with bowling activity will likely be in the range of 55 dBA, and thuds or thumps associated with ball impacts will be audible on the exterior. If the ambient sound environment in the residential area adjacent to the proposed Bowling Alley is a quiet location, we would expect that this sound level would be clearly audible. Because of the impulsive nature of these thumps, we do not consider this sound could be considered to blend into the existing ambient sound conditions as these events are distinct and likely different from the existing sound conditions.



Figure 1: Proposed Layout: Green areas: Possible Music and People Activity Sound Generation, Purple Area: Bowling Ball impact on the lane/floor, Orange Area: Pinsetter and Ball Impact Pins and Pit-Cushion. All highlighted areas are high noise level spaces, Orange being the likely location for highest noise level, although music in the Green areas could be as loud depending on settings.

We note that the proposed design has excluded the programming of live music, however we noted no assessment of amplified music sounds and how these sounds may transmit to the adjacent residences or how these sounds may be controlled from the Bar or the second level Events space. Amplified Music (from a DJ, etc.) can be as loud as live music or live bands (and may be as loud or louder than bowling). These areas are highlighted in GREEN in figure 1 above.

In order to control sound levels from these areas to suitable limits, 10 dB below measured ambient levels in each octave band, specialty constructions may be needed including double isolated independent stud construction for the exterior walls with multiple layers of drywall or sheathing on each stud row, independent drywall ceilings below the roof with multiple layers of drywall and insulation, separate pours of concrete to isolate impacts of bowling and pinsetter areas and music areas from the structure supporting the exterior stud row of the building envelope and fiberglass batt insulation in all exterior constructions. In addition to the primary issues above of Bowling Alley and Music Sounds being transmitted, the proximity of the proposed building and its various systems to the residential boundary may make any noise emitting systems important for consideration and possibly for noise mitigation. In other locations, where the proximity of a residential boundary is not as close as in this case these systems may not require consideration from a noise mitigation standpoint. In this case, we suggest that some narrative and explanation of the expected noise impact relative to ambient sound conditions be provided for operational equipment and systems including but not limited to; Air Conditioning systems, Kitchen Exhaust Systems, Music Amplification Systems, Bowling Systems, and Refrigeration Systems.

This concludes our comments. We make ourselves available for questions or feedback, so please feel free to contact us.

Very truly yours,



Christopher J. Pollock, PE, CTS, LEED AP
Partner