OSTERGAARD ACOUSTICAL ASSOCIATES

SITE SOUND EVALUATION AND CONTROL

PROPOSED HUDSON LOGISTICS CENTER
Hudson, NH

Revision 2

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INTRODUCTION

Ostergaard Acoustical Associates (OAA) was retained to evaluate potential sound emissions from a new logistics center planned for construction in Hudson, Hillsborough County, New Hampshire. Plans call for the redevelopment of a golf course, known as the Greenmeadow Golf Club, located at the southwest corner of the intersection of Circumferential Highway and Lowell Road (New Hampshire Route 3A) to accommodate the development, which will be called the Hudson Logistics Center. The development includes three warehouse buildings located in the western and southern portions of the site, and the project improvements are depicted on the latest site plans filed with the Planning Board by Langan Engineering and Environmental Services, Inc. All proposed buildings will be surrounded by auto and trailer parking, and we understand the site will be combined into a single lot with frontage off Lowell Road, but that proposed improvements will be in the same locations as proposed when the site was divided into three separate lots. Note that this change in lot lines has no impact on our analysis. Although each building is expected to have its own unique tenant and operating schedule, to be conservative the development was assumed to be active 24/7. Hence, there is an interest in evaluating the on-site noise radiated to existing residential receptors in the area.

The purpose of this sound study is to analyze future site sound emissions for comparison with applicable code limits and evaluate the potential for noise complaints. Each of the three buildings will contribute steady sound from rooftop HVAC equipment. Intermittent sound from truck and car[1] activity will also be created and will occur at all hours of the day potentially affecting residential receptors.

This revised report is an update to the 18 May acoustical report, and the 13 July acoustical report update, and reflects updates to the plans and layout, and comments from the board and board professionals, including input and comment from the Planning Board's peer review professionals, HMMH, Inc.

Site sound emissions were evaluated against State and local noise codes, ambient sound survey data, and criteria recommended by OAA based on professional experience. Aspects of this study were coordinated with the town's peer reviewer, Christopher Bajdek of Harris Miller Miller and Hanson, Inc. (HMMH).

This report presents the findings.

[1] Note that throughout this report, the term "car" collectively refers to personal passenger vehicles including automobiles, vans, pick-ups, or SUVs intended to be driven to work by employees as well as invitees. The term "truck" refers to heavy trucks, such as over-the-road, tractor trailer, box, or line-haul trucks.

Work by OAA was overseen by Benjamin C. Mueller, P.E., with assistance from OAA Staff Engineer Michael T. Conaway. The representative for Hillwood is Brian Kutz; the representative for the design team, Langan, is Nathan Kirschner.

SITE AND VICINITY

Figure 1 is an aerial image from Google Earth showing the site outlined in red. The site currently comprises a golf course in the G-1, General, zone and will be redeveloped to accommodate the warehouse and distribution facility redevelopment. Abutting the site to the north is Circumferential Highway with commercial and industrial uses beyond in the I, Industrial, zone. Several uses border the site to the east also in the G-1 zone, including a fast-food restaurant, a bank, a manufacturing use, a golf driving range, and a small residential development. A Sam's Club is northeast of the site; this is an industrial use that also uses heavy trucking. Beyond Lowell Road to the east are additional residences and commercial uses in the B, Business, and R-2, Residential 2, zones. South of the site is a residential development fronting on Fairway Drive, Eagle Drive, and other roads in the R-1, Residential 1, and R-2 zones. The Merrimack River borders the site to the west with industrial uses beyond in Nashua.

The developable land available consist of three buildings and related improvements located on a single lot to be converted to a condominium form of ownership. There will be three separate units for Buildings A, B, and C. Each building will be a distribution facility. Building A is the northernmost building. This distribution facility contains truck docks along the north and west facades with outboard truck trailer parking. Employee vehicle parking is allocated east of the building. Building B is the southwestern building. This distribution facility contains truck docks along the west and east façades of the building with a northern employee parking lot. An access road is provided south of Building B for trucks needing to traverse between the two sides. Building C is the southeastern building and will accommodate truck docks along the west and east facades and employee parking lots north and south of the building. All three buildings will be less than 50 feet tall. At the center of the three buildings, a cul-de-sac with access roads leading to a private roadway will be constructed to tie into Lowell Road. Access to the site will be provided via this newly constructed access road as well as a northern driveway that ties into Walmart Boulevard adjacent to the Sam's Club. Most of the eastern portion of the site will not be developed as this land is wetlands and developable land that will not be disturbed.

As part of the sound study, OAA worked with the design team to implement several sound mitigation features. An earthen berm and sound fences are planned south of Buildings B and C to shield residences from on-site sound. In addition, a 15-foot sound fence is proposed between Building C parking lots and residences to the south. These mitigation features are discussed in more detail in subsequent sections and will reduce the logistics center sound emissions to meet code limits and minimize the potential for complaints. As a result, there is no need to move the sound fence further north; however, doing so would not result in any negative impact to the site from a compliance perspective. Any substantive site plan changes affecting noise would warrant an updated report.

Since site operations will be 24/7, the primary concern with sound emissions is achieving adequate quiet/meeting goals at night at residences. Maximum sound levels will likely be dominated by on-site truck activity, such as truck movements, coupling/decoupling, and air brakes. Other activities, such as back-up alarms, are lower in level but can sometimes cause complaints because of the tonal nature of the sound. This intermittent activity is the main focus of this study. It is also important to achieve adequate quiet at potential noise-sensitive receptors from rooftop HVAC equipment.

Figure 1 — Google Earth image showing proposed Hudson site and vicinity. The approximate site boundary is outlined in red. Ambient sound survey locations also shown.

REGULATIONS/GOALS

When developing a site of this type, it is appropriate to establish an acoustical goal. At minimum, the goal should be to comply with applicable noise code limits. Consideration should also be given to how sound from the facility will likely be received, especially by noise-sensitive receptors. Sound produced by logistics centers includes truck activity, such as idling, back-up alarms, and vehicle movement, as well as HVAC rooftop equipment. While there will also be employee and other invitee vehicles arriving and departing the site, sound produced by these sources is of a much lower magnitude than tractor trailer, box, or line-haul trucks and therefore is typically not an acoustical issue and not a specific acoustical concern at this site.

State and local noise codes were reviewed. No Hillsborough County noise code could be found. Hudson discusses noise in code Chapter 249: Noise. This code chapter provides various noise regulations for site sound emissions. Specifically, Section 249-4 identifies ten separate noise compliance levels, and states that "…no person or persons owning, leasing or controlling the operations of any source or sources of noise shall willfully, negligently or through failure to provide necessary equipment or facilities or through failure to take necessary precautions make or permit the emission of noise levels or conditions exceeding the following noise limits for the applicable land use:

A. Noise Limit 1: General prohibition of noise emissions, and "noise pollution" as defined under in § 249-2 of the Ordinance.

B. Noise Limit 2: Continuous sound-level limits not exceeding the one hour average limitations based on receptor land category listed under Limit 2 in the Ordinance

C. Noise Limit 3: Impulsive sound-level limits which cannot exceed limits listed under Limit 3 in the Ordinance.

D. Noise Limit 4: Background referenced sound level. No person shall cause the background noise level, as defined in § 249-2 of this chapter, to increase by more than 10 dBA in any receptor area at any time of day.

E. Noise Level 5: Pure-tone conditions. No person shall produce a pure-tone condition at the nearest receptor buildings or activity areas in rural/residential/-institutional or business/recreational/industrial zoned property.

F. Noise Level 6: High noise-level areas. In areas where the ambient sound level is already as high as or higher than three dB below the sound-level limits of Noise Limit 2, no person shall cause the noise level in any area to increase by more than three dB. This limit is in lieu of Noise Limit 2, but shall not supersede any other noise limit as defined in this chapter.

G. Noise Limit 7: Snow-traveling vehicles, trail bikes and off-highway recreational vehicles. Any person owning, leasing or controlling the operation of such vehicles shall comply with the provisions of RSA 215-A:12.

H. Noise Limit 8: Motorboats and powered water vessels. Any person owning, leasing or controlling the operation of such vehicles shall comply with the provisions of RSA 270:37.

I. Noise Limit 9: Construction, such as outdoor construction by commercial contractors which is permitted between Monday through Saturday between the hours of 7:00 a.m. and 7:00 p.m. Such construction shall not exceed the noise limits set forth in Chapter 249-4B and C.

J. Noise Limit 10: Prohibited noise-generating activities such as vehicle horns, certain idling activities when such vehicle is parked on a residential premises or on a town road next to or across from a residential premises, when such vehicle is parked on a residential premises or on a town road next to or across from a residential premises, and stationary sources.

The most applicable to this site is that site sound is limited to specific continuous average hourly levels at a receiving land use based on its zone or use (Noise Limit 2). For a residential receptor, an average hourly level (Leq) of 55 dB(A) must be met during the daytime and 50 dB(A) during the nighttime. Daytime is defined as between the hours of 0700 and 1800 hours on weekdays; nighttime is the complementary hours as well as all day on Saturday and Sunday. For commercial uses, the hourly average limit is 65 dB(A) during the day and 55 dB(A) at night; the industrial hourly average limit is 75 dB(A) all day. Section 249-4D of the code also states that no use shall increase the background level by 10 dB(A) during any time of day (Noise Limit 4). This code chapter also requires that trucks over 10,000 pounds must not idle for more than 10 minutes when such a vehicle is parked on a residential premise or on a town road next to or across from a residences (Noise Limit 10).

The State of New Hampshire does not provide any specific language that limits site sound emissions. However, the State requires that all motor vehicles are equipped with proper working mufflers to prevent noise in Section 266:59.

Ambient Sound Survey

OAA retained Reuter Associates (RA) to conduct an ambient sound survey in the vicinity of the site. The ambient survey was conducted in using professionally accepted measurement protocols that were acceptable to the town peer reviewer and in accordance with provisions under § 249-3. (Guidelines for Determining Sound Levels) of the Hudson Noise Ordinance. In summary, three long term sound level meters (NTi Audio XL2) were deployed from 0900 on Thursday 6 August through 0900 on Tuesday 11 August on the outer perimeter of the site, near existing receptors. Data were acquired over a period of three weekdays and a weekend. Monitor locations are shown in Figure 1 as Locations 1 through 3. The sound level meters were calibrated before and after deployment. Weather across the survey period were conducive to testing and included average daytime temperatures of 85-to-90° F with nighttime temperatures in the 60s. Wind gusts averaged 9-to-13 mph and there was no precipitation. Weather details for a weather monitor in the area and calibration certificates for survey equipment are included in the Appendix.

Hourly statistical data were acquired in one-third octave band frequencies to show how levels vary over time. Important statistics include the background sound level (L_{90}), which is defined in the Town code and in industry as the level that occurs over 90 percent of the measurement period, and the metric of the Hudson noise code as defined under § 249-2. This metric is best used to evaluate continuous noise sources such as HVAC (under Noise Limit 2). The L_5, or level that occurs over 5 percent of the time, is the indicator that typifies the extent of intrusive noise sources in the area, such as dog barks, surges in traffic noise, or aircraft passbys. Maximum (L_{max}), minimum (L_{min}), and average (L_{eq}) statistics were also recorded.

The purpose of this survey was to understand the existing acoustical conditions for comparison to project sound emissions. These data are important for use in establishing specific project noise goals to ensure no negative acoustical impact which could result if the emission of noise levels or conditions exceed the noise limits described under Section §249-4 and are not otherwise excluded or exempt under §249-5. A great deal of data were obtained; in the interest of a concise report, data are summarized in this report. Full data are available upon request. The most critical ambient to scrutinize is across the nighttime period when sound levels are typically low. OAA has specifically reviewed statistical data between 2200 and 0600 hours over each night, which align with sleeping hours and is a more conservative night timeframe than the town defines. A summary of these nighttime ambient survey results is as follows:

	Night of:	L_{min}	L_{90}	L_{eq}	L_5	L_{max}
Location 1	**6-Aug**	42	43	46	48	57
	7-Aug	43	45	46	48	55
	8-Aug	45	47	48	50	58
	9-Aug	49	50	51	52	55
	10-Aug	49	50	51	53	57

	Night of:	L_{min}	L_{90}	L_{eq}	L_5	L_{max}
Location 2	**6-Aug**	40	41	44	46	58
	7-Aug	40	42	44	46	55
	8-Aug	47	44	43	48	58
	9-Aug	51	50	48	52	56
	10-Aug	52	50	49	53	58

	Night of:	L_{min}	L_{90}	L_{eq}	L_5	L_{max}
Location 3	**6-Aug**	40	41	43	45	54
	7-Aug	41	42	43	44	51
	8-Aug	43	47	46	44	57
	9-Aug	47	50	49	48	54
	10-Aug	47	50	49	48	55

OAA's review of the data provides the following conclusions:

- The ambient survey results are as expected for a developed suburban area that is in proximity to well-traveled roadways and less than a mile of a major state highway, Everett Turnpike.

- Ambient sound levels were mostly consistent each day across the three locations. Thursday and Friday exhibited the lowest sound levels whereas Sunday and Monday were higher in level. Average sound levels ranged from the mid-to-high 40s on an A-weighted scale.

- The nighttime background sound levels varied by 7-to-9 dB across the survey period depending on the day, not the location. For example, the background sound level was near 40 dB(A) on Thursday and Friday night but increase to near 50 dB(A) on Sunday and Monday night. The reason for this is unknown but it shows the diversity in the existing nighttime conditions. To be conservative, the lowest average nighttime background

sound level was used to determine Town code criteria. The resulting L_{90} was 43 dB(A) for Location 1 and 41 dB(A) for Locations 2 and 3. The Town code allows for 10 dB above this which equates to a criteria of 53 dB(A) at Location 1 and 51 dB(A) at Locations 2 and 3. For simplicity, the site should not exceed maximum sound levels of 51 dB(A) for all residential receptors in this area.

- The L_5 on the other hand, saw less fluctuation and typically remained around 50 dB(A) at Locations 1 and 2 and 45 at Location 3. Maximum sound levels were routinely in the mid-to-high 50's regardless of the location.

Project Noise Goals

Based on OAA's experience, the local code nighttime limit of 50 dB(A) aligns with the approach of State and local codes across the country. The Hudson Noise Ordinance is appropriate and sufficiently protective for receptors in this area; meeting such limits at residential receptors will adequately minimize noise complaints and otherwise comply with the Hudson Noise Ordinance, in addition to adequately providing for measures which abate noise deemed harmful to persons, structures or adjacent properties under Site Plan Review criteria under § 275-6 of the Hudson Site Plan Review Ordinance.. The metric of using hourly average levels allow sites to produce higher sound levels for short periods of time while still complying with the limit. While this provision alone would generally be sufficient to minimize the potential for complaints, the code also requires, among other things, that the site blends in with existing conditions by requiring site sound to not contribute levels 10 dB higher than the background sound level (Noise Limit 4).

While the background sound level can be highly variable, OAA took survey results over a 5-day period and conservatively used the lowest average nighttime background sound level documented over the survey period. While limiting site sound emissions relative to the ambient has the potential to be more stringent than the Town's hourly code limit approach, for this location of Town the background sound level code provision Section 249-4.D aligns well and validates the Town's code limits (Section 294-4.B). To ensure that site sound emissions meet code and have no negative acoustical impact on residential receptors, OAA recommends that all site maximum sound levels should not exceed 51 dB(A) at residences. Minimizing site sound to not exceed 51 dB(A) at residential receptors will result in adequately quiet indoor sound levels. An open window will reduce exterior sounds by approximately 12 dB; a closed window can reduce sound by 25 dB or more depending on the thickness of the window. This reduces site sound inside a dwelling to the 26-to-39 dB(A) range. The Town's hourly average sound limit of

75 dB(A) for industrial uses is appropriate. The site must still meet an hourly average sound level of 50 dB(A) at all residences, which is generally not difficult to achieve if all intermittent maximums are controlled to not exceed 51 dB(A).

Additionally, Noise Limits 9 and 10 include certain performance standards designed to ensure compliance with the Hudson Noise Ordinance. Specifically, when construction activities take place at the Site, the performance standards under Noise Limit 9 must be met in order to ensure compliance with Chapter 249-4B (Noise Limit 2) and C (Noise Limit 3).

To meet the requirements and standards of Noise Limit 10, site activities including horns and certain idling activities will need to be complied with to ensure that no prohibited noise-generating activities are undertaken. Assuming these performance standards are complied with, we conclude the Project will have no issues with meeting these Noise Limits under the Noise Ordinance.

EXPECTED SOUND EMISSIONS

Acoustical modelling software, specifically CadnaA, was used to create and analyze site sound emissions for the site. This modelling software uses industry standard protocols and is a widely accepted methodology for evaluating environmental sound. The model takes into account relevant parameters between the noise source and receptors of interest to predict how sound will propagate. In addition to distance attenuation, the model accounts for the effects of terrain, types of ground cover, shielding by structures, and reflections from buildings. In the model, buildings are shown in white and the property line is outlined in red. Sound fences are shown in light blue. These include rooftop parapets on all buildings, the proposed 15-foot sound fence to mitigate Building C, and the 10-foot tall fence along the top of the southern berm. North is pointing up in all figures.

The acoustical model shows the results graphically as A-weighted sound level contours, in 1 dB increments, at ear height, 5 feet above grade. This is a generally accepted measuring height for studies of this nature. A-weighted sound levels are also tabulated at nine discrete locations typifying nearby receptors. Locations B, C, D, F, and H are at nearby existing residential receptor locations. Locations E, G, I and J are located at nearby industrial use properties. These Locations are at 5 feet above grade, which is a typical ear height for a person. Prime Locations (B′, C′, D′, and F′) for residential receptors are located at the dwelling façade at a 2nd story receptor height. Evaluating this upper level is important to ensure that mitigation height is

sufficient; 2nd story windows are generally the location of bedrooms. Location A is not used and reserved for future use.

Rooftop HVAC Sound

Rooftop HVAC plan have continued to be refined during the design process. HVAC plans for Buildings A and B are generally completed and include an assortment of equipment ranging from 3-ton to 25-ton units. Of most concern are the large 25-ton units which have a sound power level of 93 dB(A) re 1 picowatt based on manufacturers' data. Manufacturer's data were used as input for the smaller units, which range from 5 tons to 12.5 tons, and are lower in level than the 25-ton units. Building A has 57 rooftop units in total, of which 36 are 25-ton units. For Building B, 30 of the total 35 rooftop units will be 25-ton. The HVAC design for Building C's mechanical plan has not been completed yet but is assumed to have 36 25-ton rooftop units distributed across the roof. This is conservative as Building C is smaller than Building B. All buildings will have a parapet around the perimeter of the roof of a height of 4-feet. In some places the parapet approaches 6 feet in height. The parapets are included in the sound model and shown a light blue line.

The noise from all rooftop units on all three building was included in the HVAC acoustical model. Noise sources were placed 4 feet above the rooftop, and sound was projected off site. Figure 2 shows the results graphically and tabulates the summed A-weighted sound levels at the nine discrete locations. The results show that with all rooftop units operating, HVAC sound levels are in the 34-to-40 dB(A) range at all locations which complies with Noise Limits 1 and 2.

This analysis shows that there is little concern about HVAC sound. HVAC sound is sufficiently controlled via distance and roof edge shielding effects so that this noise meets the hourly 50 dB(A) (Noise Limit 2) and maximum 51 dB(A) (Noise Limit 4) Town nighttime code limits by wide margins at all receptors. Levels of this magnitude will generally be below the existing background sound levels documented during the ambient sound survey meaning it will be difficult to hear HVAC sound at off-site vantage points. No additional mitigation measures are needed provided planned equipment is acoustically aligned with what was modelled.

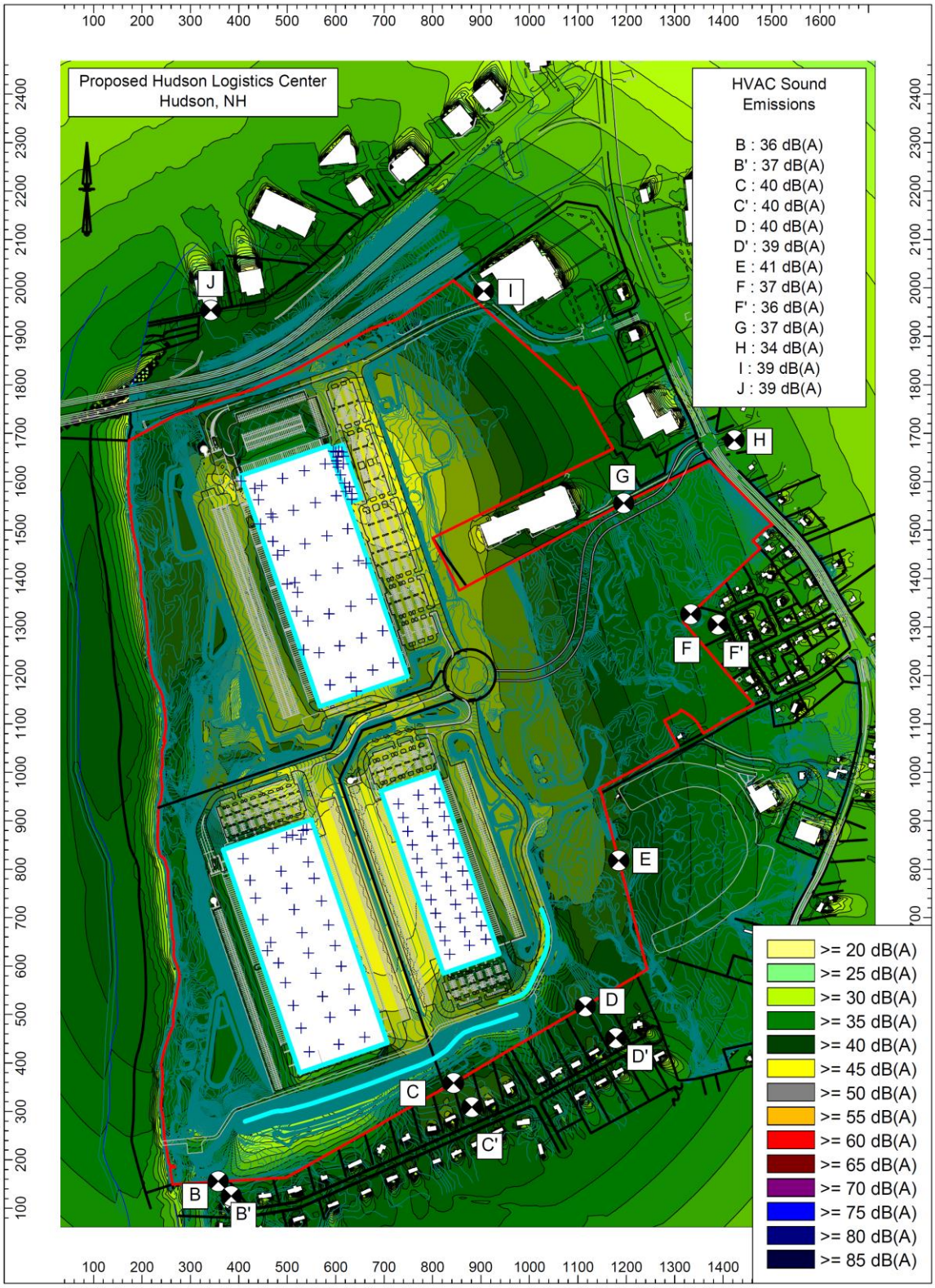


Figure 2 — A-weighted sound emission contours, 5 feet above grade, for sound from rooftop HVAC equipment. Rooftop units shown with a blue "+" sign. Parapets and noise control fence shown in light blue. Sound emissions at Locations are 5 feet above grade, except at prime Locations which are 15 feet above grade.

Truck Activity

OAA has had the opportunity to visit various logistics facilities over the years to survey and document the sounds of truck activity. On-site heavy truck yard activity can periodically contribute maximum sound levels of 74-to-79 dB(A) at 50 feet depending on the activity. Employee vehicles are generally standard personal vehicles, which are much lower in level than trucks and are typically on the order of magnitude of 59 dB(A) at 50 feet. At the nearest house, 500 feet away, such vehicle noise is reduced to below 40 dB(A) with distance alone. Employee vehicles are also active infrequently, primarily during shift changes. For these reasons, employee vehicles were not analyzed and are not expected to be an issue. The focus of this study is on truck noise.

In previous reports, OAA used our typical approach of analyzing truck sound using a single conservative worst-case design level that is based on a collection of sources. However, based on feedback from the Town, its professionals, and the public, a more precise acoustical model was requested to show the variety of sources and activity expected to occur on site. More noise sources at their appropriate sound level were added to the model. Activity includes truck movement, air brakes, back-up alarms, and coupling/decoupling. Backup alarms were all assumed to be of the tonal variety to be conservative; other varieties such as broadband or smart ambient sensing alarms more readily blend in with distant ambient sound. All truck noise is dynamic in nature. Maximum sound levels only occur for a short duration and are not representative of the constant sound level produced by on-site trucks. Sound power levels for specific truck activities, along with their source height, is provided in the following table.

		Octave Band Center Frequency, Hz								
Sound Source	**Height (ft)**	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**A***
Truck Airbrake	3	102	102	98	98	103	108	112	111	116
Truck Backup Alarm (Tonal)	3	95	95	90	91	109	100	87	73	109
Truck Couple/Decouple	4	109	108	108	109	109	106	101	95	113
Truck Driving	8	123	113	109	106	101	99	98	92	108

*** Denotes the A-weighted Sound Level**

Truck activity is planned in all truck dock areas for all three buildings. Off-site trucks typically travel directly to docks to load or unload. Once completed, truck trailers will be moved and deposited in parking areas by terminal tractors, which are commonly called “yard jockeys” or “yard dogs”. Terminal tractors are acoustically equivalent to over-the-road trucks, and emit the same source levels as shown above, but do not leave the truck court. Access to each facility is

via Walmart Boulevard to the north as well as the new access road that connects into Lowell Road to the east. Driving trucks can be found anywhere on the access roads. In coordination efforts between OAA and the design team, mitigation was developed at the optimum heights to balance cost, acoustical performance, and feasibility. A 15-foot tall sound fence is proposed along the southeastern edge of Building C as well a strategically-designed earthen berm south of Buildings B and C. A 10-foot sound fence, approximately 2,000 feet in length, is also placed along the spline of the earthen berm. The Building C fence is approximately 550 feet in length and primarily needed to screen truck court activity. This fence was needed to make up for berm placement limitations due to proximity to existing wetlands.

Sound from trucks/terminal tractor activity was analyzed in various areas of the site, also using the CadnaA software. While multiple trucks may be on a particular site and active at a given time, they will not all produce maximum sound levels at the same time. In addition, to maintain safe truck court operations, trucks rarely operate in proximity to each other and instead stagger movements and activity. To model site operations across a typical active period, multiple truck sources were modelled producing maximum levels all at once. A driving truck is shown as a pink "+", air brake activity is shown as a white "+", coupling/decoupling activity is shown as a green "+" and a tonal backup alarm activity is shown with a yellow "+". Eight trucks on each Building area were modelled along with 3 trucks driving on access roads nearby receptors of interest. Data and heights for sources was given above.

Figure 3 shows the results of 27 trucks generating maximum sound levels at the same time throughout the site. HVAC sound from Figure 2 is included. The model includes areas of concern to the Town and residences such as trucks driving along the southern access road. Several conclusions can be drawn from this figure. Trucks in the southern areas of Buildings B and C produce maximum levels of 48-to-51 dB(A) at residences to the south. Results meet both the hourly and maximum project goal and code limits (Noise Limits 2,3, and 4). Residences at Locations F and H will also meet all code limits. Levels up to 68 dB(A) are produced at nearby industrial uses; this meets the project goal and code limits by wide margins (Noise Limits 2.

These results show that site sound emissions, with the help of distance, a strategically arranged layout, and mitigation measures provided by the fences and earthen berm, meet code limits at all nearby receptors. Intermittent maximum sound emissions of 51 dB(A) will meet code limits when averaged over the course of an hour; they would need to occur continuously for an entire hour for this code to be exceeded. No noise issues are expected at nearby industrial receptors. Based on this analysis, no negative acoustical impact is anticipated from on-site operations with the proposed layout.

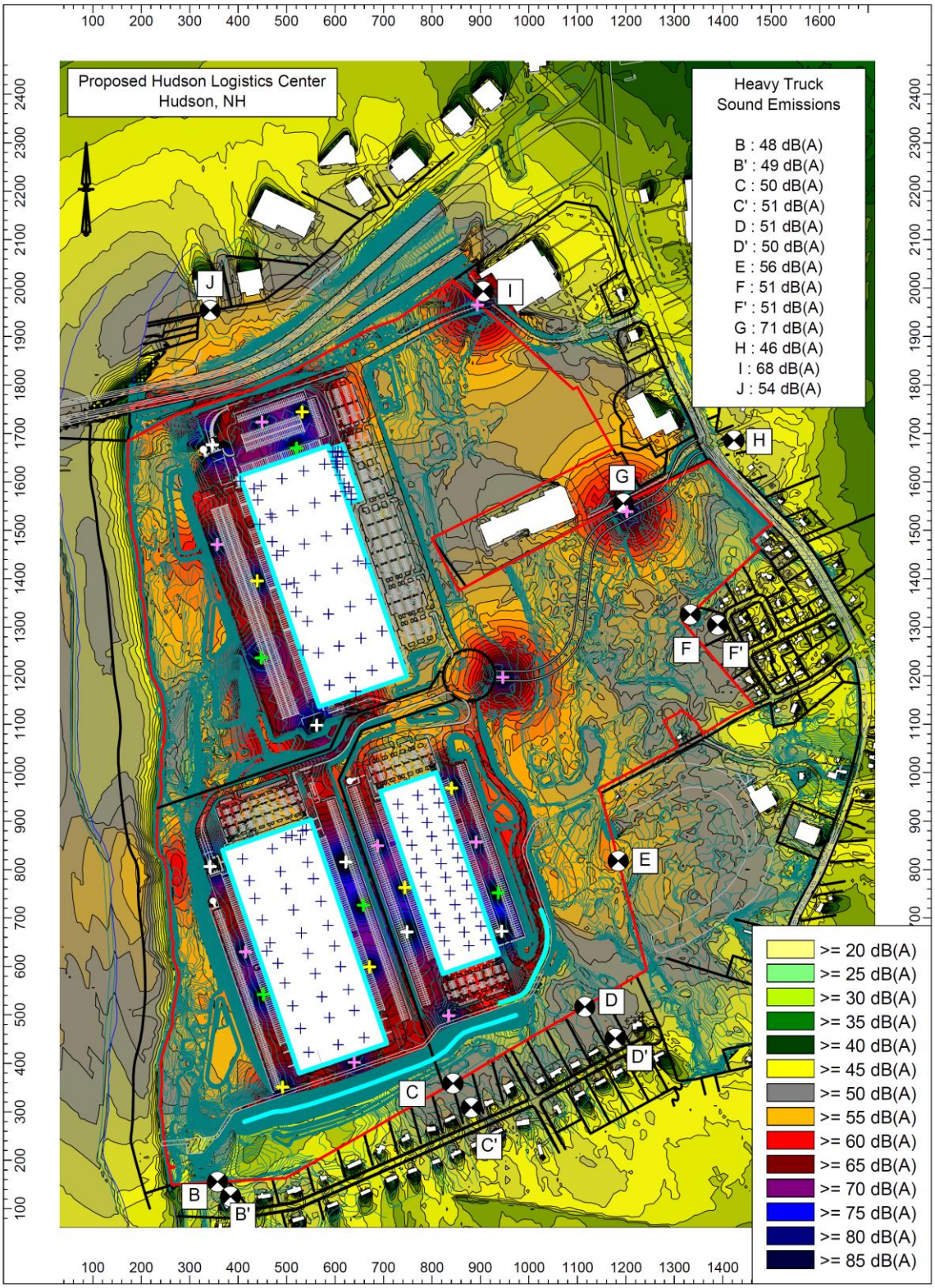


Figure 3 — A-weighted sound level contours, 5-feet above grade, expected from various truck activity across the site (white, pink, green, and yellow "+'s") and rooftop HVAC equipment (blue "+"). Noise control fences/parapets shown in light blue. A-weighted sound emissions tabulated at 5 feet above grade for most Locations; Prime Locations are at 15 feet above grade.

No tonal concerns are seen when reviewing Figure 3 results in octave band frequencies as shown in the following table:

	Octave Band Center Frequency, Hz								
Location	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**A***
B	59	51	48	45	43	38	23	-	48
B'	64	52	49	47	44	38	24	-	49
C	65	55	50	47	46	39	29	3	50
C'	63	54	49	47	47	41	32	-	51
D	62	53	49	48	47	43	38	15	51
D'	63	52	49	47	46	41	35	7	50
E	68	56	50	50	51	50	46	21	56
F	69	56	49	48	45	41	33	6	51
F'	68	54	50	49	46	41	30	-	51
G	83	76	72	69	64	62	61	53	71
H	62	51	47	44	40	34	25	-	46
I	85	73	67	65	61	59	58	49	68
J	63	53	50	50	50	46	40	15	54

*** Denotes the A-weighted Sound Pressure Level**

Generator Sound

Each building will have an emergency generator to provide electrical power in case of a power outage. The generator for each building will be located along the northwest side of the building. Generators are not expected to run often but will routinely, bur infrequently, be operated to test the units. Each emergency generator will be 625kW and will have an approximate sound power level of 114 dB(A) at full load. This equates to a sound pressure level of 89 dB(A) at a distance of 50 feet from the generator. Note that when operated for testing, the generator is not normally at full load and usually results in somewhat lower sound levels.

An acoustical model was created to show all three emergency generators being operated at the same time at full load. HVAC sound was also included. Figure 4 shows the result of this analysis. Results show that HVAC sound combined with emergency generator sound, whether being run for routine testing or in an actual emergency, would contribute sound levels in the mid-40's at residential receptors. Results in Figure 4 do not dramatically different from Figure 2, which is only HVAC sound, with the exception of Location B and B'. Regardless, all receptors are well below 50 dB(A) (Noise Limit 2) ensuring compliance with code limits and no negative acoustical impact. When the generators are operated, sound levels local to the equipment will be elevated but remain mostly unchanged at off-site vantage points, and thus continue to meet applicable limits under the Hudson Ordinance.

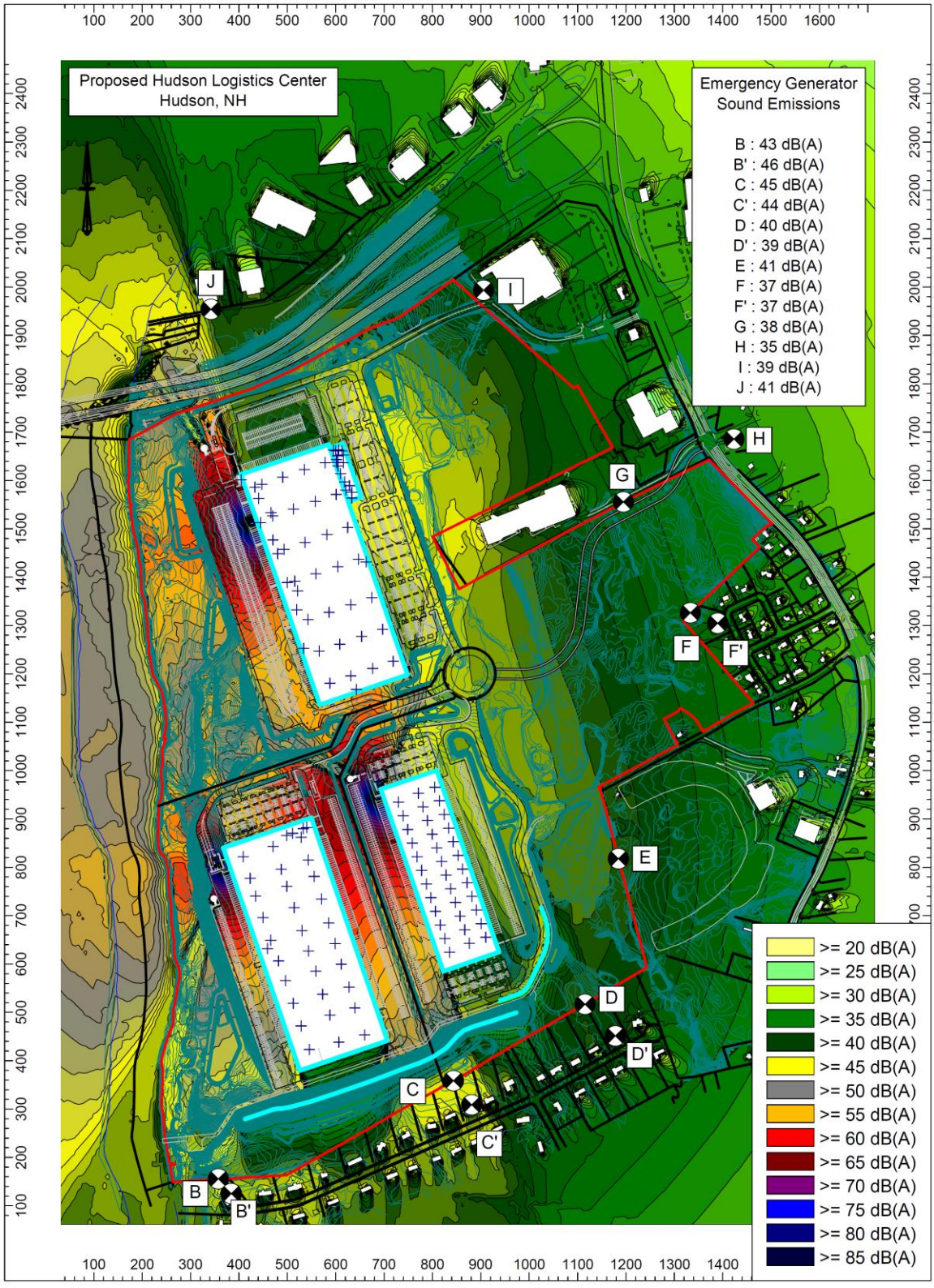


Figure 4 — A-weighted sound level contours, 5-feet above grade, for sound from HVAC rooftop equipment (blue "+") and emergency generators (near NW corner of each building. Noise control fences/parapets shown in light blue. A-weighted sound emissions tabulated at 5 feet above grade for most Locations; Prime Locations are at 15 feet above grade.

RECOMMENDATIONS

1. Construct the earthen berm as designed at the height and length shown in drawings to mitigate truck court sound from Buildings B and C to residences to the south.

2. Install a 550-foot-long noise control fence as proposed around the southeastern corner of Building C, carried to a height of 15 feet above grade, to mitigate Building C truck activity noise to off-site residential receptors. Note that to be effective, the sound fence needs to meet the following requirements:

   - The fence needs to be solid, without openings, and be of sufficient surface weight to force sound to travel over or around the fence and not leak through it. A recommended minimum surface weight for the fence is 7 lbs/ft^2.

   - Appropriate materials of construction for the fence include $^5/_8$-inch thick sheet steel piling, precast or poured-in-place concrete, acoustical metal panels, or other hybrid system specifically manufactured for the purpose.

   - The fence, being solid, must be designed to resist wind load and will require engineered footings.

3. Install an approximately 2,000-foot-long 10-foot tall noise control fence along the spline of the proposed earthen berm. This fence will be constructed of material that matches the requirements above.

4. Terminal tractors are responsible for the majority of back-up movements on site. To minimize potential complaints from back-up alarms, plan to equip all terminal tractors with smart, ambient sensing, multi-frequency back-up alarms. These types of equipment are available from a variety of manufacturers, such as Ecco Model EA9724. These devices reduce annoyance generated from constant level, pure tone back-up alarms. The reduction in annoyance is accomplished in two ways:

   - A broadband sound is less intrusive than a pure tone sound since, at a distance, it can blend in easier with other ambient sounds.

- The smart, ambient-sensing feature allows back-up alarms to operate safely and effectively at far lower sound levels than typical brute-force, constant level devices. The smart alarms sample ambient noise and adjust the warning signal to be 5-to-10 dB higher than the ambient nearby the alarm, therefore reducing levels both close to the source as well as off-site.

5. When construction activities take place at the site, the performance standards under Noise Limit 9 must be met in order to ensure compliance with Chapter 249-4B and C.

6. To meet the requirements and standards of Noise Limit 10, the site activities will need to ensure that no prohibited noise-generating activities are undertaken.

7. Proceed with HVAC equipment plans, keeping in mind acoustical performance to ensure project noise goals are met in compliance with Hudson Ordinances.

CONCLUSION

Plans call for a golf course facility in the G-1 General zone to be redeveloped into the Hudson Logistics Center in Hudson, NH. The new development will contain three buildings that will all utilize heavy trucking. Existing residences are nearby to the east and south; industrial and non-noise sensitive uses are in the other directions. The Hudson Noise Ordinance provides average hourly code and other limits that apply to site sound. In addition to this, the Hudson Noise Ordinance requires that site sound not exceed the background sound level by more than 10 dB. These code limits align with our professional experience and codes found across the country as being appropriate noise criteria to minimize the acoustical impact and the potential for complaints.

Analyses demonstrate that the site with the proposed mitigation measures and, provided that appliable performance practices under the Hudson Noise Ordinance are complied with, the proposed project will meet the applicable code limits under the Hudson Zoning Ordinance, including those applicable limits under Section 249-4 that are not otherwise excluded or exempt under Section 249-5, and applicable Site Plan Ordinance criteria at all receptors. Thus, no negative acoustical impact is anticipated. The proposed mitigation features and using smart, multi-frequency back-up alarms for on-site terminal tractors represents good acoustical planning

and will put the end users in the best position to minimize the potential for noise complaints and to be a good neighbor. Results are summarized with respect to the Hudson Noise Ordinance:

A. Noise Limit 1: General prohibition of noise emissions is complied with per analyses in this report.

B. Noise Limit 2: Continuous sound-level limits are shown to not exceed the hour average night limit of 50 dB(A) in in page 12 of this report.

C. Noise Limit 3: Impulsive sound-level limits will be well below permitted limits. This report has taken a more conservative approach by applying maximum site sound to Noise Limit 4 using the A-weighted metric.

D. Noise Limit 4: Maximum site sound will not exceed sound levels of 51 dB(A), which is based on 10 dB(A) above documented nighttime ambient sound levels.

E. Noise Level 5: There are no pure-tone conditions of concern as shown in page 16 of this report.

F. Noise Level 6: High noise-level area provisions are not applicable as this area has levels equal to, but not higher than, those given under Noise Limit 2.

G. Noise Limit 7: Limits pertaining to snow-traveling vehicles, trail bikes and off-highway recreational vehicles is not applicable to this site.

H. Noise Limit 8: Limits pertaining to motorboats and powered water vessels is not applicable to this site.

I. Noise Limit 9: Construction noise will comply with time and limit provisions.

J. Noise Limit 10: Prohibited noise-generating activities such as vehicle horns, certain idling activities will be avoided and prevented on site.

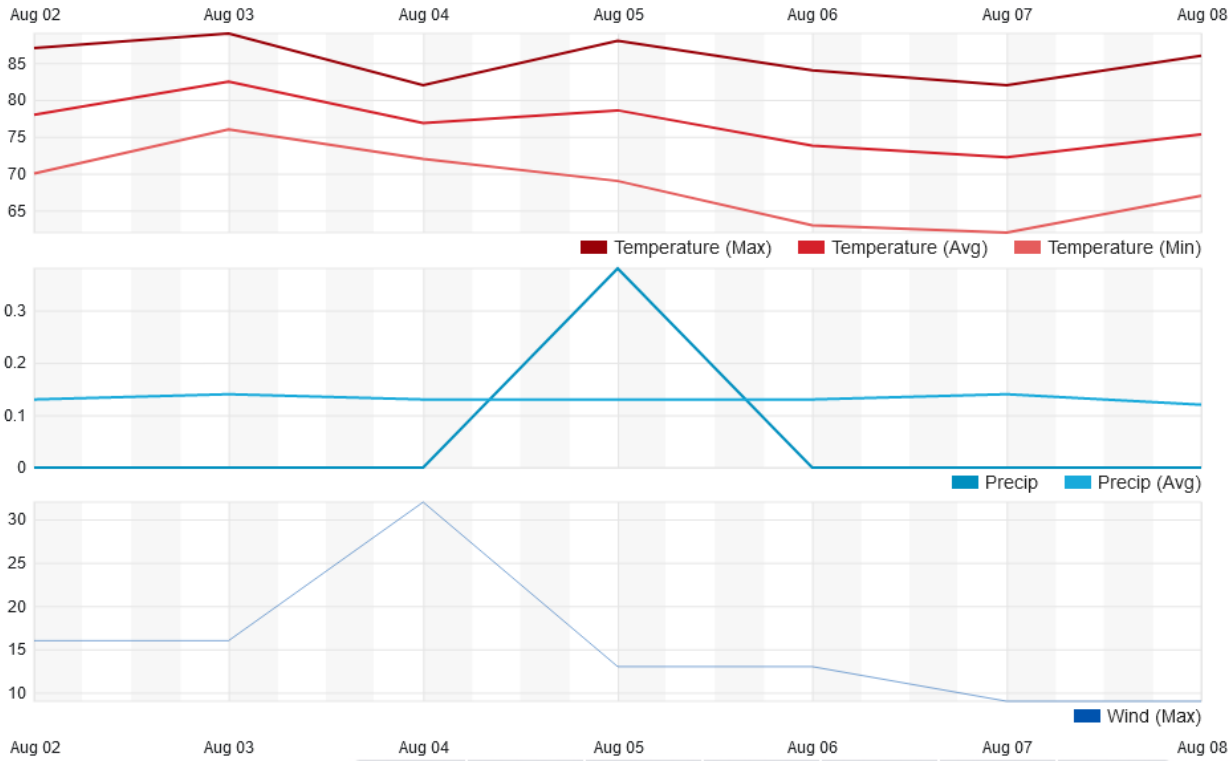
Section 249-1 of Chapter 249 of the Hudson Ordinances states the Noise Ordinance "is enacted to protect, preserve and promote the health, safety, welfare and quality of life for the citizens of Hudson, New Hampshire, through the reduction, control and prevention of noise by establishing maximum noise levels upon and between premises, prohibiting certain noise-producing activities ….". Based upon the foregoing, and assuming the performance standards described in the Hudson Noise Ordinance above are followed, the proposed site activities will comply with the applicable standards described under Chapter 249. Moreover, since we have demonstrated that the applicable provisions of the Hudson Noise Ordinance will be complied with, the proposed Project and related operations at the site make adequate provision "… to guard against such conditions as would involve danger or injury to health or safety,…" and will eliminate "….undesirable and preventable elements of pollution, such as noise, ..., into the environment which might prove harmful to persons, structures or adjacent properties," all as required under Section 275-8 of the Hudson Site Plan Ordinance.

APPENDIX

Historic Weather Data from www.wunderground.com

42.93 °N, 71.44 °W Manchester, NH Weather History

61 Manchester-Boston Regional Airport Station|Change



Summary

Temperature (° F)	Max	Average	Min
Max Temperature	89	85.43	82
Avg Temperature	82.46	76.74	72.21
Min Temperature	76	68.43	62

Dew Point (° F)	Max	Average	Min
Dew Point	75	61.58	49

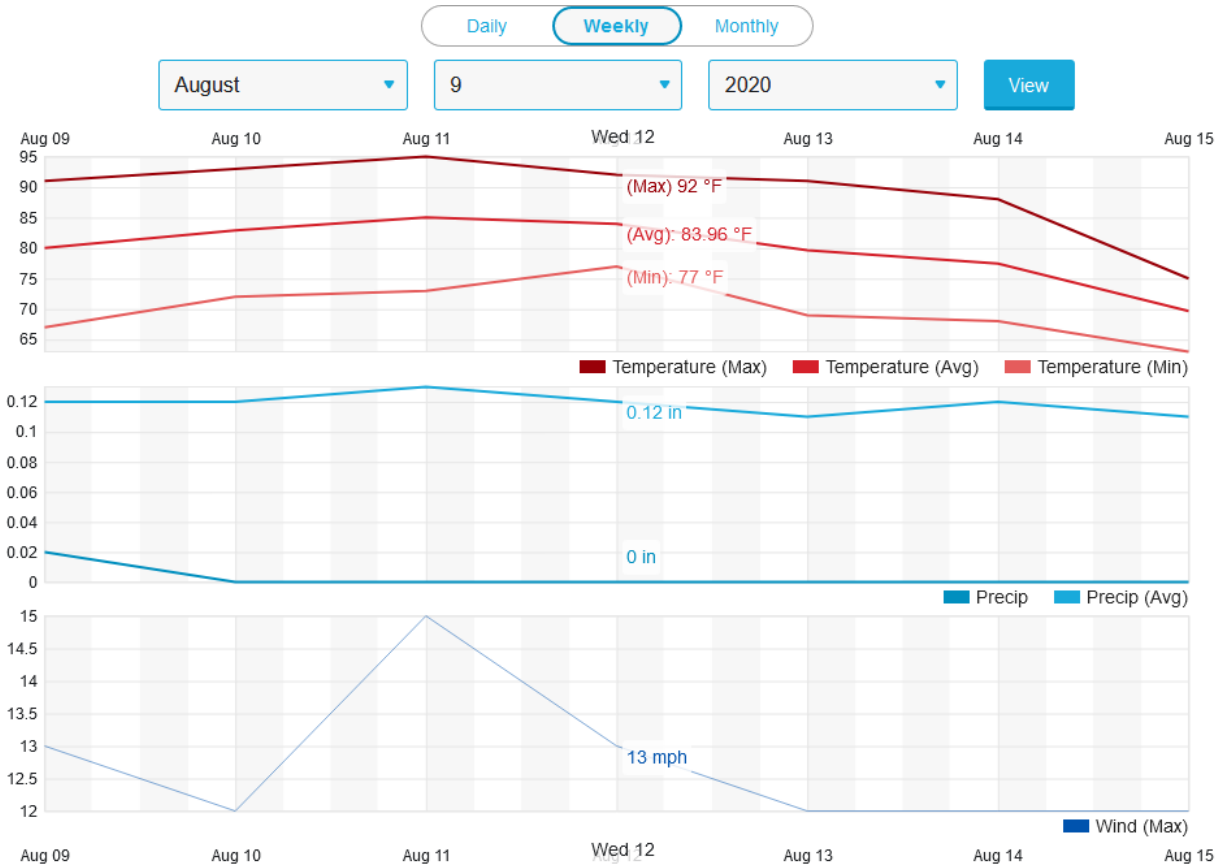
Precipitation (Inches)	Max	Average	Min	Sum
Precipitation	0.38	0.05	0.00	0.38
Snowdepth	0.00	0.00	0.00	0.00

Wind	Max	Average	Min
Wind	32	7.28	0
Gust Wind	44	5.14	0

Sea Level Pressure	Max	Average	Min
Sea Level Pressure	29.95	29.75	29.38

Daily Observations

Time	Temperature (° F)			Dew Point (° F)			Humidity (%)			Wind Speed (mph)			Pressure (Hg)			Precipitation (in)
Aug	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Total
2	87	78.0	70	74	67.2	61	84	70.8	41	16	8.0	0	29.7	29.7	29.6	0.00
3	89	82.5	76	75	65.5	58	94	59.6	38	16	9.5	3	29.8	29.7	29.6	0.00
4	82	76.8	72	74	68.1	62	90	74.3	64	32	13.6	0	29.8	29.6	29.4	0.00
5	88	78.6	69	67	60.5	51	84	56.2	39	13	7.3	0	29.8	29.7	29.6	0.38
6	84	73.8	63	57	52.8	49	75	50.2	33	13	4.3	0	29.9	29.8	29.8	0.00
7	82	72.2	62	62	56.6	53	80	60.0	38	9	4.6	0	29.9	29.9	29.9	0.00
8	86	75.3	67	65	60.3	56	84	61.8	36	9	3.6	0	29.9	29.9	29.8	0.00



Summary

Temperature (° F)	Max	Average	Min
Max Temperature	95	89.29	75
Avg Temperature	85.04	79.82	69.68
Min Temperature	77	69.86	63
Dew Point (° F)	Max	Average	Min

Dew Point	71	62.56	52

Precipitation (Inches)	Max	Average	Min	Sum
Precipitation	0.02	0.00	0.00	0.02
Snowdepth	0.00	0.00	0.00	0.00

Wind	Max	Average	Min
Wind	15	5.85	0
Gust Wind	22	0.76	0

Sea Level Pressure	Max	Average	Min
Sea Level Pressure	29.86	29.76	29.6

Daily Observations

Time	Temperature (° F)			Dew Point (° F)			Humidity (%)			Wind Speed (mph)			Pressure (Hg)			Precipitation (in)
Aug	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Total
9	91	80.0	67	68	63.4	59	90	60.3	34	13	4.2	0	29.9	29.8	29.7	0.02
10	93	82.9	72	69	66.7	62	91	60.7	37	12	4.8	0	29.8	29.7	29.6	0.00
11	95	85.0	73	69	67.5	64	87	58.3	36	15	7.2	0	29.7	29.7	29.6	0.00
12	92	84.0	77	71	64.5	60	82	54.4	35	13	7.4	3	29.8	29.7	29.7	0.00
13	91	79.7	69	62	58.5	53	75	50.9	28	12	4.5	0	29.9	29.8	29.8	0.00
14	88	77.5	68	63	57.3	52	81	53.0	29	12	6.4	0	29.8	29.8	29.8	0.00
15	75	69.7	63	62	60.0	58	87	71.7	60	12	6.5	0	29.9	29.8	29.8	0.00

Scantek, Inc.
CALIBRATION LABORATORY

ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP®
CALIBRATION
NVLAP Lab Code: 200625-0

Calibration Certificate No.43142

Instrument: **Sound Level Meter**
Model: **XL2**
Manufacturer: **NTI AG**
Serial number: **A2A-14423-E0**
Tested with: **Microphone 377B02 s/n 305847**
Preamplifier 426E01 s/n 053838
Type (class): **1**
Customer: **Cross-Spectrum Acoustics Inc.**
Tel/Fax: **413-315-5770 x710 /**

Date Calibrated: **7/1/2019** *Cal Due:*

Status:	Received	Sent
In tolerance:	X	X
Out of tolerance:		
See comments:		

Contains non-accredited tests: __Yes X No
Calibration service: __ Basic X Standard
Address: **25A Granby Street, East**
Longmeadow, MA 01028

Tested in accordance with the following procedures and standards:
Calibration of Sound Level Meters, Scantek Inc., Rev. 6/26/2015
SLM & Dosimeters – Acoustical Tests, Scantek Inc., Rev. 7/6/2011

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	31061	Jul 30, 2018	Scantek, Inc./ NVLAP	Jul 30, 2019
DS-360-SRS	Function Generator	61646	Sep 7, 2018	ACR Env./ A2LA	Sep 7, 2020
34401A-Agilent Technologies	Digital Voltmeter	MY47022043	Sep 17, 2018	ACR Env./ A2LA	Sep 17, 2019
HM30-Thommen	Meteo Station	1040170/39633	Nov 13, 2018	ACR Env./ A2LA	Nov 13, 2019
PC Program 1019 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
1251-Norsonic	Calibrator	30878	Nov 11, 2018	Scantek, Inc./ NVLAP	Nov 11, 2019

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK).

Environmental conditions:

Temperature (°C)	Barometric pressure (kPa)	Relative Humidity (%)
21.3	100.28	50.3

Calibrated by:	Jeremy Gotwalt	**Authorized signatory:**	Steven E. Marshall
Signature		Signature	
Date	7/1/19	Date	7/1/2019

Results summary: Device complies with following clauses of mentioned specifications:

CLAUSES [1] FROM IEC/ANSI STANDARDS REFERENCED IN PROCEDURES:	RESULT [2,3]	EXPANDED UNCERTAINTY (coverage factor 2) [dB]
INDICATION AT THE CALIBRATION CHECK FREQUENCY - IEC61672-3 ED.2 CLAUSE 10	Passed	0.15
SELF-GENERATED NOISE - IEC 61672-3 ED.2 CLAUSE 11	Passed	0.3
FREQUENCY WEIGHTINGS: A NETWORK - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	0.2
FREQUENCY WEIGHTINGS: C NETWORK - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	0.2
FREQUENCY WEIGHTINGS: Z NETWORK - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	0.2
FREQUENCY AND TIME WEIGHTINGS AT 1 KHZ IEC 61672-3 ED.2.0 CLAUSE 14	Passed	0.2
LEVEL LINEARITY ON THE REFERENCE LEVEL RANGE - IEC 61672-3 ED.2 CLAUSE 16	Passed	0.25
LEVEL LINEARITY INCLUDING THE LEVEL RANGE CONTROL - IEC 61672-3 ED.2.0 CLAUSE 17	Passed	0.25
TONEBURST RESPONSE - IEC 61672-3 ED.2.0 CLAUSE 18	Passed	0.3
PEAK C SOUND LEVEL - IEC 61672-3 ED.2.0 CLAUSE 19	Passed	0.35
OVERLOAD INDICATION - IEC 61672-3 ED.2.0 CLAUSE 20	Passed	0.25
HIGH LEVEL STABILITY TEST - IEC 61672-3 ED.2.0 CLAUSE 21	Passed	0.1
LONG TERM STABILITY TEST - IEC 61672-3 ED.2.0 CLAUSE 15	Passed	0.1
FILTER TEST 1/1OCTAVE: RELATIVE ATTENUATION - IEC 61260, CLAUSE 4.4 & #5.3	Passed	0.25
FILTER TEST 1/3OCTAVE: RELATIVE ATTENUATION - IEC 61260, CLAUSE 4.4 & #5.3	Passed	0.25
COMBINED ELECTRICAL AND ACOUSTICAL TEST - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	See test report

1 The results of this calibration apply only to the instrument type with serial number identified in this report.

2 Parameters are certified at actual environmental conditions.

3 The tests marked with (*) are not covered by the current NVLAP accreditation.

Comments: The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent testing organization responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2, to demonstrate that the model of sound level meter fully conforms to the requirements in the IEC 61672-2, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1.

Note: The instrument was tested for the parameters listed in the table above, using the test methods described in the listed standards. All tests were performed around the reference conditions. The test results were compared with the manufacturer's or with the standard's specifications, whichever are larger.
Compliance with any standard cannot be claimed based solely on the periodic tests.

Tests made with the following attachments to the instrument:

Microphone: PCB Piezotronics 377B02 s/n 305847 for acoustical test
Preamplifier: PCB 426E01 s/n 053838 for all tests
Other: line adaptor ADP005 (18pF) for electrical tests
Accompanying acoustical calibrator: none
Windscreen: none

Measured Data: in Test Report # 43142 of 9+1 pages.

Place of Calibration: Scantek, Inc.
6430 Dobbin Road, Suite C
Columbia, MD 21045 USA

Ph/Fax: 410-290-7726/ -9167
callab@scantekinc.com

Scantek, Inc.
CALIBRATION LABORATORY

ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP®
CALIBRATION
NVLAP Lab Code: 200625-0

Calibration Certificate No.43520

Instrument: **Sound Level Meter**
Model: **XL2**
Manufacturer: **NTI AG**
Serial number: **A2A-08102-E0**
Tested with: **Microphone 377B20 s/n 110105**
Preamplifier 426E01 s/n 013740
Type (class): **1**
Customer: **Reuter Associates LLC**
Tel/Fax: **603-430-2081; -498-8818 /**

Date Calibrated: **9/3/2019** *Cal Due:*

Status:	Received	Sent
In tolerance:	X	X
Out of tolerance:		
See comments:		

Contains non-accredited tests: __Yes X No
Calibration service: __ Basic X Standard
Address: **10 Vaughan Mall, Suite 201A**
Portsmouth, NH 03801

Tested in accordance with the following procedures and standards:
Calibration of Sound Level Meters, Scantek Inc., Rev. 6/26/2015
SLM & Dosimeters – Acoustical Tests, Scantek Inc., Rev. 7/6/2011

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	31061	Jul 31, 2020	Scantek, Inc./ NVLAP	Jul 31, 2020
DS-360-SRS	Function Generator	61646	Sep 7, 2018	ACR Env./ A2LA	Sep 7, 2020
34401A-Agilent Technologies	Digital Voltmeter	MY47022043	Sep 17, 2018	ACR Env./ A2LA	Sep 17, 2019
HM30-Thommen	Meteo Station	1040170/39633	Nov 13, 2018	ACR Env./ A2LA	Nov 13, 2019
PC Program 1019 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
1251-Norsonic	Calibrator	30878	Nov 11, 2018	Scantek, Inc./ NVLAP	Nov 11, 2019

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK).

Environmental conditions:

Temperature (°C)	Barometric pressure (kPa)	Relative Humidity (%)
22.7	100.29	63.4

Calibrated by:	Jeremy Gotwalt	**Authorized signatory:**	Steven E. Marshall
Signature		Signature	
Date	9/3/19	Date	9/3/2019

Results summary: Device complies with following clauses of mentioned specifications:

CLAUSES [1] FROM IEC/ANSI STANDARDS REFERENCED IN PROCEDURES:	RESULT [2,3]	EXPANDED UNCERTAINTY (coverage factor 2) [dB]
INDICATION AT THE CALIBRATION CHECK FREQUENCY - IEC61672-3 ED.2 CLAUSE 10	Passed	0.15
SELF-GENERATED NOISE - IEC 61672-3 ED.2 CLAUSE 11	Passed	0.3
FREQUENCY WEIGHTINGS: A NETWORK - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	0.2
FREQUENCY WEIGHTINGS: C NETWORK - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	0.2
FREQUENCY WEIGHTINGS: Z NETWORK - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	0.2
FREQUENCY AND TIME WEIGHTINGS AT 1 KHZ IEC 61672-3 ED.2.0 CLAUSE 14	Passed	0.2
LEVEL LINEARITY ON THE REFERENCE LEVEL RANGE - IEC 61672-3 ED.2 CLAUSE 16	Passed	0.25
LEVEL LINEARITY INCLUDING THE LEVEL RANGE CONTROL - IEC 61672-3 ED.2.0 CLAUSE 17	Passed	0.25
TONEBURST RESPONSE - IEC 61672-3 ED.2.0 CLAUSE 18	Passed	0.3
PEAK C SOUND LEVEL - IEC 61672-3 ED.2.0 CLAUSE 19	Passed	0.35
OVERLOAD INDICATION - IEC 61672-3 ED.2.0 CLAUSE 20	Passed	0.25
HIGH LEVEL STABILITY TEST - IEC 61672-3 ED.2.0 CLAUSE 21	Passed	0.1
LONG TERM STABILITY TEST - IEC 61672-3 ED.2.0 CLAUSE 15	Passed	0.1
FILTER TEST 1/1OCTAVE: RELATIVE ATTENUATION - IEC 61260, CLAUSE 4.4 & #5.3	Passed	0.25
FILTER TEST 1/3OCTAVE: RELATIVE ATTENUATION - IEC 61260, CLAUSE 4.4 & #5.3	Passed	0.25
COMBINED ELECTRICAL AND ACOUSTICAL TEST - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	See test report

1 The results of this calibration apply only to the instrument type with serial number identified in this report.

2 Parameters are certified at actual environmental conditions.

3 The tests marked with (*) are not covered by the current NVLAP accreditation.

Comments: The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent testing organization responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2, to demonstrate that the model of sound level meter fully conforms to the requirements in the IEC 61672-2, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1.

Note: The instrument was tested for the parameters listed in the table above, using the test methods described in the listed standards. All tests were performed around the reference conditions. The test results were compared with the manufacturer's or with the standard's specifications, whichever are larger.
Compliance with any standard cannot be claimed based solely on the periodic tests.

Tests made with the following attachments to the instrument:

Microphone: PCB Piezotronics 377B20 s/n 110105 for acoustical test
Preamplifier: PCB 426E01 s/n 013740 for all tests
Other: line adaptor ADP005 (18pF) for electrical tests. 6' BNC-BNC cable (#2) for all tests.
Accompanying acoustical calibrator: Larson Davis CAL200 s/n 9234
Windscreen: none

Measured Data: in Test Report # 43520 of 9+1 pages.

Place of Calibration: Scantek, Inc.
6430 Dobbin Road, Suite C
Columbia, MD 21045 USA

Ph/Fax: 410-290-7726/ -9167
callab@scantekinc.com

Summary of Test Report No.:43520

NTI AG Type: XL2 Serial no: A2A-08102-E0

Customer:	**Reuter Associates LLC**
Address:	**10 Vaughan Mall, Suite 201A, Portsmouth, NH 03801**
Contact Person:	**Eric Reuter**
Phone No.:	**603-430-2081; -498-8818**
eMail:	**ereuter@reuterassociates.com**

Instrument software version: 4.03

Microphone:	PCB Piezotronics	Type: 377B20	Serial no: 110105	Sens:-24.59dB
Preamplifier	PCB	Type: 426E01	Serial no: 013740	
Calibrator:	Larson Davis	Type: CAL200	Serial no: 9234	Level:113.96dB

Measurement Results:

Indication at the calibration check frequency - IEC61672-3 Ed.2 Clause 10	Passed
Self-generated noise - IEC 61672-3 Ed.2 Clause 11	Passed
Frequency weightings: A Network - IEC 61672-3 Ed.2.0 Clause 13	Passed
Frequency weightings: C Network - IEC 61672-3 Ed.2.0 Clause 13	Passed
Frequency weightings: Z Network - IEC 61672-3 Ed.2.0 Clause 13	Passed
Frequency and time weightings at 1 kHz IEC 61672-3 Ed.2.0 Clause 14	Passed
Level linearity on the reference level range - IEC 61672-3 Ed.2 Clause 16	Passed
Level linearity including the level range control - IEC 61672-3 Ed.2.0 Clause 17	Passed
Toneburst response - IEC 61672-3 Ed.2.0 Clause 18	Passed
Peak C sound level - IEC 61672-3 Ed.2.0 Clause 19	Passed
Overload indication - IEC 61672-3 Ed.2.0 Clause 20	Passed
High level stability test - IEC 61672-3 Ed.2.0 Clause 21	Passed
Long term stability test - IEC 61672-3 Ed.2.0 Clause 15	Passed
Filter Test 1/1octave: Relative attenuation - IEC 61260, Clause 4.4 & #5.3	Passed
Filter Test 1/3octave: Relative attenuation - IEC 61260, Clause 4.4 & #5.3	Passed
Combined electrical and acoustical test - IEC 61672-3 Ed.2.0 Clause 13	Passed

Environmental conditions:

Pressure:	Temperature:	Relative humidity:
100.29	22.7	63.4

Date of calibration: 9/3/2019
Date of issue: 9/3/2019
Supervisor: Steven E. Marshall
Measurements performed by:

Jeremy Gotwalt

Software version: 6.1 T

Scantek, Inc.
6430 Dobbin Rd., Suite C, Columbia, MD 21045
Ph: 410-290-7726 eMail: callab@scantekinc.com

Scantek, Inc.
CALIBRATION LABORATORY

ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP®
CALIBRATION
NVLAP Lab Code: 200625-0

Calibration Certificate No.43517

Instrument:	**Acoustical Calibrator**
Model:	**CAL200**
Manufacturer:	**Larson Davis**
Serial number:	**9234**
Class (IEC 60942):	**1**
Barometer type:	
Barometer s/n:	
Customer:	**Reuter Associates LLC**
Tel/Fax:	**603-430-2081; -498-8818 /**

Date Calibrated: **8/29/2019** *Cal Due:*

Status:	**Received**	**Sent**
In tolerance:		X
Out of tolerance:	X	
See comments:	X	

Contains non-accredited tests: __Yes _X_ No

Address: **10 Vaughan Mall, Suite 201A, Portsmouth, NH 03801**

Tested in accordance with the following procedures and standards:
Calibration of Acoustical Calibrators, Scantek Inc., Rev. 10/1/2010

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	31052	Oct 31, 2018	Scantek, Inc./ NVLAP	Oct 31, 2019
DS-360-SRS	Function Generator	33584	Oct 24, 2017	ACR Env./ A2LA	Oct 24, 2019
34401A-Agilent Technologies	Digital Voltmeter	MY47011118	Oct 1, 2018	ACR Env. / A2LA	Oct 1, 2019
HM30-Thommen	Meteo Station	1040170/39633	Nov 13, 2018	ACR Env./ A2LA	Nov 13, 2019
140-Norsonic	Real Time Analyzer	1406423	Nov 3, 2018	Scantek / NVLAP	Nov 3, 2019
PC Program 1018 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
4134-Brüel&Kjær	Microphone	173368	Nov 11, 2018	Scantek, Inc. / NVLAP	Nov 11, 2019
1203-Norsonic	Preamplifier	14059	Feb 28, 2019	Scantek, Inc./ NVLAP	Feb 28, 2020

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK)

Calibrated by:	Jeremy Gotwalt	**Authorized signatory:**	Steven E. Marshall
Signature		Signature	
Date	8/29/19	Date	9/3/2019

Document stored as: Z:\Calibration Lab\Cal 2019\LDCAL200_9234_M3.doc

Results summary: Device was tested and complies with following clauses of mentioned specifications:

CLAUSES[1] FROM STANDARDS REFERENCED IN PROCEDURES:	MET[2]	NOT MET	COMMENTS
Manufacturer specifications			
Manufacturer specifications: Sound pressure level	X		
Manufacturer specifications: Frequency	X		
Manufacturer specifications: Total harmonic distortion	X		
Current standards			
ANSI S1.40:2006 B.3 / IEC 60942: 2003 B.2 - Preliminary inspection	X		
ANSI S1.40:2006 B.4.4 / IEC 60942: 2003 B.3.4 - Sound pressure level	X		
ANSI S1.40:2006 A.5.4 / IEC 60942: 2003 A.4.4 - Sound pressure level stability	X		
ANSI S1.40:2006 B.4.5 / IEC 60942: 2003 B.3.5 - Frequency	X		
ANSI S1.40:2006 B.4.6 / IEC 60942: 2003 B.3.6 - Total harmonic distortion	X		

1 The results of this calibration apply only to the instrument type with serial number identified in this report.

2 The tests marked with (*) are not covered by the current NVLAP accreditation.

Main measured parameters [3]:

Measured[4]/Acceptable[5] Tone frequency (Hz):	Measured[4]/Acceptable[5] Total Harmonic Distortion (%):	Measured [4]/Acceptable Level[5] (dB):
993.69 ± 0.99/1000.0 ± 10.0	0.23 ± 0.10/ < 3	93.96 ± 0.12/94.0 ± 0.4
993.65 ± 0.99/1000.0 ± 10.0	0.35 ± 0.10/ < 3	113.96 ± 0.12/114.0 ± 0.4

3 The stated level is valid at measurement conditions.

4 The above expanded uncertainties for frequency and distortion are calculated with a coverage factor k=2; for level k=2.00

5 Acceptable parameters values are from the current standards

Environmental conditions:

Temperature (°C)	Barometric pressure (kPa)	Relative Humidity (%)
23.9 ± 1.5	100.02 ± 0.025	53.3 ± 5.4

Tests made with following attachments to instrument:

Calibrator ½" Adaptor Type:
Other:

Adjustments: Unit was adjusted for level.
Comments: As received, the instrument produced sound pressure level above the upper limit of the admissible range. The level was adjusted close to the nominal value. After adjustment, the instrument was tested and met all specifications found in the referenced procedures.

Note: The instrument was tested for the parameters listed in the table above, using the test methods described in the listed standards. All tests were performed around the reference conditions. The test results were compared with the manufacturer's or with the standard's specifications, whichever are larger.
Compliance with any standard cannot be claimed based solely on the periodic tests.

Measured Data: in Acoustical Calibrator Test Report # 43517 of four pages.

Place of Calibration: Scantek, Inc.
6430 Dobbin Road, Suite C
Columbia, MD 21045 USA
Ph/Fax: 410-290-7726/ -9167
callab@scantekinc.com

Scantek, Inc.
CALIBRATION LABORATORY

ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP®
CALIBRATION
NVLAP Lab Code: 200625-0

Calibration Certificate No.43518

Instrument: **Sound Level Meter**
Model: **XL2**
Manufacturer: **NTI AG**
Serial number: **A2A-07587-E0**
Tested with: **Microphone 377B20 s/n 110108**
Preamplifier 426E01 s/n 013741
Type (class): **1**
Customer: **Reuter Associates LLC**
Tel/Fax: **603-430-2081; -498-8818 /**

Date Calibrated: **9/3/2019** *Cal Due:*

Status:	Received	Sent
In tolerance:	X	X
Out of tolerance:		
See comments:		

Contains non-accredited tests: __Yes X No
Calibration service: __ Basic X Standard
Address: **10 Vaughan Mall, Suite 201A**
Portsmouth, NH 03801

Tested in accordance with the following procedures and standards:
Calibration of Sound Level Meters, Scantek Inc., Rev. 6/26/2015
SLM & Dosimeters – Acoustical Tests, Scantek Inc., Rev. 7/6/2011

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	31061	Jul 31, 2020	Scantek, Inc./ NVLAP	Jul 31, 2020
DS-360-SRS	Function Generator	61646	Sep 7, 2018	ACR Env./ A2LA	Sep 7, 2020
34401A-Agilent Technologies	Digital Voltmeter	MY47022043	Sep 17, 2018	ACR Env./ A2LA	Sep 17, 2019
HM30-Thommen	Meteo Station	1040170/39633	Nov 13, 2018	ACR Env./ A2LA	Nov 13, 2019
PC Program 1019 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
1251-Norsonic	Calibrator	30878	Nov 11, 2018	Scantek, Inc./ NVLAP	Nov 11, 2019

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK).

Environmental conditions:

Temperature (°C)	Barometric pressure (kPa)	Relative Humidity (%)
23.6	100.23	64.2

Calibrated by:	Jeremy Gotwalt	**Authorized signatory:**	Steven E. Marshall
Signature		Signature	
Date	9/3/19	Date	9/3/2019

Results summary: Device complies with following clauses of mentioned specifications:

CLAUSES [1] FROM IEC/ANSI STANDARDS REFERENCED IN PROCEDURES:	RESULT [2,3]	EXPANDED UNCERTAINTY (coverage factor 2) [dB]
INDICATION AT THE CALIBRATION CHECK FREQUENCY - IEC61672-3 ED.2 CLAUSE 10	Passed	0.15
SELF-GENERATED NOISE - IEC 61672-3 ED.2 CLAUSE 11	Passed	0.3
FREQUENCY WEIGHTINGS: A NETWORK - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	0.2
FREQUENCY WEIGHTINGS: C NETWORK - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	0.2
FREQUENCY WEIGHTINGS: Z NETWORK - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	0.2
FREQUENCY AND TIME WEIGHTINGS AT 1 KHZ IEC 61672-3 ED.2.0 CLAUSE 14	Passed	0.2
LEVEL LINEARITY ON THE REFERENCE LEVEL RANGE - IEC 61672-3 ED.2 CLAUSE 16	Passed	0.25
LEVEL LINEARITY INCLUDING THE LEVEL RANGE CONTROL - IEC 61672-3 ED.2.0 CLAUSE 17	Passed	0.25
TONEBURST RESPONSE - IEC 61672-3 ED.2.0 CLAUSE 18	Passed	0.3
PEAK C SOUND LEVEL - IEC 61672-3 ED.2.0 CLAUSE 19	Passed	0.35
OVERLOAD INDICATION - IEC 61672-3 ED.2.0 CLAUSE 20	Passed	0.25
HIGH LEVEL STABILITY TEST - IEC 61672-3 ED.2.0 CLAUSE 21	Passed	0.1
LONG TERM STABILITY TEST - IEC 61672-3 ED.2.0 CLAUSE 15	Passed	0.1
FILTER TEST 1/1OCTAVE: RELATIVE ATTENUATION - IEC 61260, CLAUSE 4.4 & #5.3	Passed	0.25
FILTER TEST 1/3OCTAVE: RELATIVE ATTENUATION - IEC 61260, CLAUSE 4.4 & #5.3	Passed	0.25
COMBINED ELECTRICAL AND ACOUSTICAL TEST - IEC 61672-3 ED.2.0 CLAUSE 13	Passed	See test report

1 The results of this calibration apply only to the instrument type with serial number identified in this report.

2 Parameters are certified at actual environmental conditions.

3 The tests marked with (*) are not covered by the current NVLAP accreditation.

Comments: The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent testing organization responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2, to demonstrate that the model of sound level meter fully conforms to the requirements in the IEC 61672-2, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1.

Note: The instrument was tested for the parameters listed in the table above, using the test methods described in the listed standards. All tests were performed around the reference conditions. The test results were compared with the manufacturer's or with the standard's specifications, whichever are larger.
Compliance with any standard cannot be claimed based solely on the periodic tests.

Tests made with the following attachments to the instrument:

Microphone: PCB Piezotronics 377B20 s/n 110108 for acoustical test
Preamplifier: PCB 426E01 s/n 013741 for all tests
Other: line adaptor ADP005 (18pF) for electrical tests. 4' BNC-BNC cable (#1) for all tests.
Accompanying acoustical calibrator: Larson Davis CAL200 s/n 9234
Windscreen: none

Measured Data: in Test Report # 43518 of 9+1 pages.

Place of Calibration: Scantek, Inc.
6430 Dobbin Road, Suite C
Columbia, MD 21045 USA
Ph/Fax: 410-290-7726/ -9167
callab@scantekinc.com

Summary of Test Report No.:43518

NTI AG Type: XL2 Serial no: A2A-07587-E0

Customer:	**Reuter Associates LLC**
Address:	**10 Vaughan Mall, Suite 201A, Portsmouth, NH 03801**
Contact Person:	**Eric Reuter**
Phone No.:	**603-430-2081; -498-8818**
eMail:	**ereuter@reuterassociates.com**

Instrument software version: 4.10

Microphone:	PCB Piezotronics	Type: 377B20	Serial no: 110108	Sens:-26.03dB
Preamplifier	PCB	Type: 426E01	Serial no: 013741	
Calibrator:	Larson Davis	Type: CAL200	Serial no: 9234	Level:113.96dB

Measurement Results:

Indication at the calibration check frequency - IEC61672-3 Ed.2 Clause 10	Passed
Self-generated noise - IEC 61672-3 Ed.2 Clause 11	Passed
Frequency weightings: A Network - IEC 61672-3 Ed.2.0 Clause 13	Passed
Frequency weightings: C Network - IEC 61672-3 Ed.2.0 Clause 13	Passed
Frequency weightings: Z Network - IEC 61672-3 Ed.2.0 Clause 13	Passed
Frequency and time weightings at 1 kHz IEC 61672-3 Ed.2.0 Clause 14	Passed
Level linearity on the reference level range - IEC 61672-3 Ed.2 Clause 16	Passed
Level linearity including the level range control - IEC 61672-3 Ed.2.0 Clause 17	Passed
Toneburst response - IEC 61672-3 Ed.2.0 Clause 18	Passed
Peak C sound level - IEC 61672-3 Ed.2.0 Clause 19	Passed
Overload indication - IEC 61672-3 Ed.2.0 Clause 20	Passed
High level stability test - IEC 61672-3 Ed.2.0 Clause 21	Passed
Long term stability test - IEC 61672-3 Ed.2.0 Clause 15	Passed
Filter Test 1/1octave: Relative attenuation - IEC 61260, Clause 4.4 & #5.3	Passed
Filter Test 1/3octave: Relative attenuation - IEC 61260, Clause 4.4 & #5.3	Passed
Combined electrical and acoustical test - IEC 61672-3 Ed.2.0 Clause 13	Passed

Environmental conditions:

Pressure:	Temperature:	Relative humidity:
100.23	23.6	64.2

Date of calibration: 9/3/2019
Date of issue: 9/3/2019
Supervisor: Steven E. Marshall
Measurements performed by:

Jeremy Gotwalt

Software version: 6.1 T

Scantek, Inc.
6430 Dobbin Rd., Suite C, Columbia, MD 21045
Ph: 410-290-7726 eMail: callab@scantekinc.com