

December 9, 2022

Mr. Peter Bemis
Engineering Design Consultants, Inc.
32 Turnpike Road
Southborough, MA 01772

Office: (508) 480-0225 x11
e-Mail: pbemis@edcma.com

Subject: Proposed Warehouse Sound Analysis
Hopping Brook Industrial Park
555 Hopping Brook Road, Holliston, MA

Dear Mr. Bemis,

A warehouse facility is being proposed for a site in the Hopping Brook Industrial Park at 555 Hopping Brook Road, Holliston, MA. This is a new warehouse on a vacant industrially zoned parcel of land. Figure 1 is an aerial view of the proposed facility, with local roads labeled for reference. You have requested Cavanaugh Tocci to determine whether sound produced by the proposed warehouse building will meet applicable local and state standards for sound.

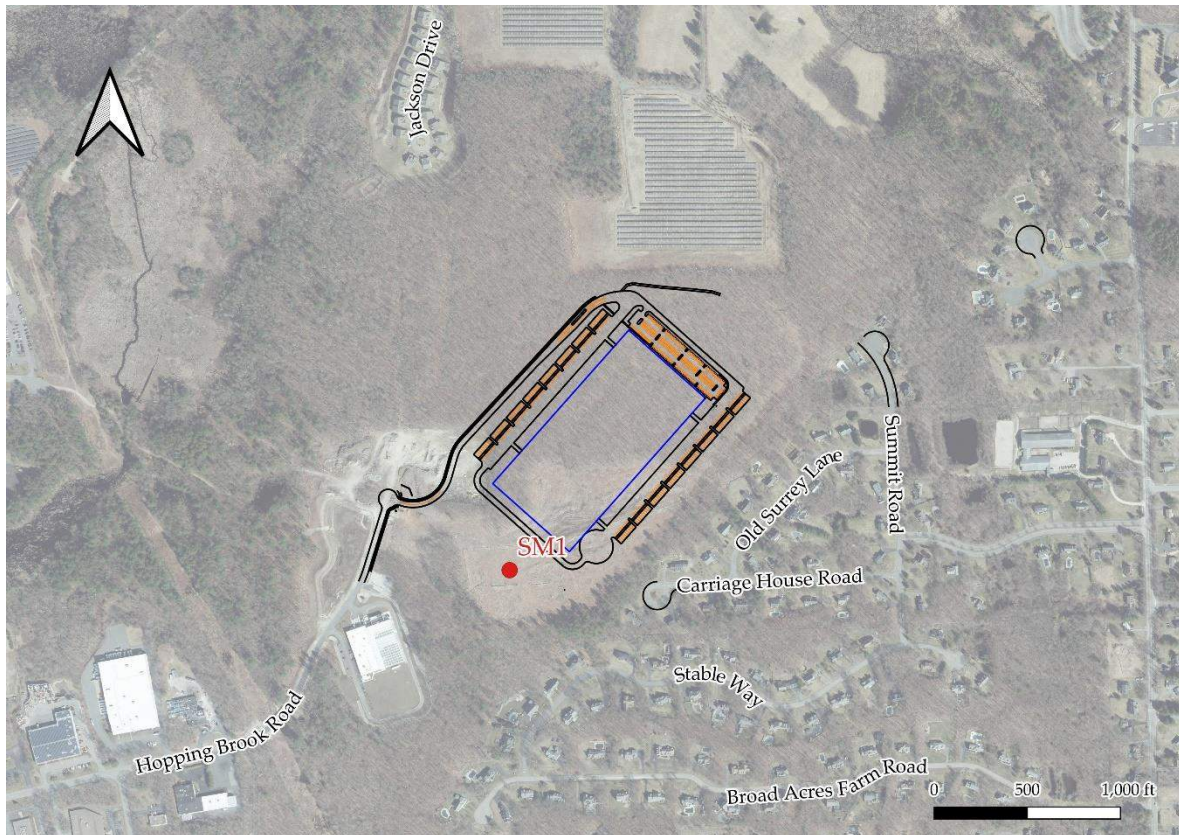


Figure 1. Part plan of the proposed warehouse site
Proposed Warehouse, 555 Hopping Brook Road, Holliston, MA

On the southeast, Olde Surrey Lane and Carriage House Way residences are 400-500 feet from the proposed building, with closest trailer space 275 feet from 12 Carriage House Way and closest trucking

activity 315 feet from 15 Carriage House Way. Cavanaugh Tocci monitored sound levels at the location identified as SM1 in Figure 1. The facility will be a warehouse with straight trucks (FHWA medium truck) and tractor trailers (FHWA heavy truck) arriving and leaving the facility, and with limited shuttling of trailers between dock doors and trailer parking up to 24 hours per day. The warehouse presently does not have a tenant, but typical warehouse operations involve conveyance systems and forklifts moving materials within the building and in and out of trailers sealed against dock door openings.

Sound sources are of two types, mobile and stationary. Mobile sources of sound include engine sound, trailer connect/disconnect sound, and backup alarms to name a few. Stationary equipment sources of sound include rooftop make-up air units, a ground mounted emergency generator, and conveyor and materials handling sound produced within the building and emitted to the environment through occasionally open bay doors.

Comparison with the 2020 Project

In 2020, a larger 800,420-sf facility was proposed similarly positioned at the site, and also having docks on the east and west sides of the building. The present project is a 550,000-sf warehouse with its access drive along a less steep grade on the west side of the project that is screened from the Medway neighborhood by the building. For the 2020 project acoustical analysis, truck movements were more typical of those of a package handling facility. The present project is expected to be a warehouse less focused on nighttime truck activity, and having less trailer shuttling. Furthermore, a greater proportion of trucks are expected to be straight trucks classified as medium trucks by FHWA, producing less sound than tractor trailers classified as heavy trucks. Finally, finished paved and truck activity areas are about 40 feet further from nearest Medway residential areas.

Applicable Codes—Stationary Noise Sources

The purpose of this study is to outline the codes applicable to sound potentially emitted by the proposed warehouse and controls include in site design to meet code limits. For completeness, this study has evaluated sound with respect to achieving limits of the following codes:

- Holliston Zoning 2015 and 2019 Bylaws
- Commonwealth of Massachusetts 310 CMR 7.00
- Massachusetts Department of Environmental (MassDEP) Noise Policy 90-001
- Medway Zoning Bylaw, May 22, 2018

This noise study has been prepared for submission to the Town of Holliston Planning Board. It evaluates compliance of potential project sound with required provisions of the 2015 Holliston Zoning Bylaw, which applies to this definitive subdivision lot. The study also evaluates compliance of project sound with provisions of the 2019 Holliston Zoning Bylaw §V-N Noise Performance Standards. Commonwealth regulations are applicable to sound produced by the proposed warehouse, as well. The Medway noise provision of its Zoning Bylaw is not applicable but has been considered in this evaluation since the proposed facility borders the Claybrook Farms residential neighborhood.

Holliston 2015 Zoning Bylaw

The Holliston 2015 Zoning Bylaw, applicable to this project, §V-N Performance Standards state:

4. Noise. No use shall be permitted within the town of Holliston which, by reason of excessive noise generated therefrom, would cause nuisance or hazard to persons or property. Exempt from the provisions of this subsection are (a) vehicles not controlled by an owner or occupant of a lot within the town...(c) occasionally used safety signals, warning devices...For the purposes of this by-law the standards in the following table shall apply:

a. **Noise Standards:**
Table E-1

For Sound Generated Continuously from any Source Not Otherwise Exempted above and Measured	Maximum Permitted Sound Levels (in dBA)
(a) At or beyond the lot line of an adjacent or nearby residence or institutional use, weekdays during the hours of 7 a.m. to 6 p.m.	60
(b) At or beyond the lot line of an adjacent to nearby residence or institutional use, Sundays or during the hours of 6 p.m. to 7 a.m. weekdays	50
(c) At or beyond the lot line of an adjacent business use	65
(d) At or beyond the lot line of an adjacent industrial use	70

- b. Exceptions for Intermittent Noise. The levels (dBA) specified in Table 1 may be exceeded by ten (10) dBA, weekdays during the hours of 7 a.m. to 6 p.m., but not at any other time, for a period not to exceed twenty (20) minutes during any one (1) day.
- c. Impact Noise. Impact noise such as from a punch press, drop forge hammer, or similar equipment, shall be measured using the fast response of the sound level meter, and shall not exceed the levels specified in Table 1 by more than ten (10) dBA.

With respect to the 2015 Holliston Zoning Bylaw, the most restrictive limit applying to facility acoustical design is the 50 dBA limit at nearest residential property lines for stationary sources, sources within the building, and vehicles resident to the facility. As the facility may operate 24 hours per day, the §V-N(4b) exception permitting higher levels for intermittent noise during the day has not been included in this analysis. The facility, being used as a warehouse, is not expected to house equipment producing impact noise of the types indicated in §V-N(4c), however occasional impacts produced by tractors connecting or disconnecting trailers, or other miscellaneous impacts may occur. For these, the 50-dBA limit of §V-N(4a)(b) may be increased to 60 dBA during weekday daytime hours.

Holliston 2019 Zoning Bylaw

The Holliston 2019 Zoning Bylaw, applicable to this project, §III(G) Industrial and Outdoor Uses states:

V-N PERFORMANCE STANDARDS

4. Noise. No use shall be permitted within the Town of Holliston which, by reason of excessive noise generated therefrom, would cause nuisance or hazard to persons or property. Exempt from the provisions of this subsection are (a) vehicles not controlled by an owner or occupant of a lot within the town, (b) temporary construction activities occurring during the hours of 7 a.m. to 6 p.m. on weekdays and 8 a.m. to 6 p.m. on Saturday, (c) occasionally used safety signals, warning devices, emergency pressure relief valves, or other such temporary activity, (d) use of power tools and equipment such as lawn mowers, snow blowers, chainsaws, tractors, and similar equipment for the maintenance of property between the hours of 7 a.m. and 8 p.m. on weekdays and 8 a.m. and 6 p.m. on weekends. For the purposes of this by-law the standards in the following shall apply:

Ambient Noise Level. No person shall operate or cause to be operated any source sound in a manner that creates a sound level of 10 dBA above ambient, as set forth in 310 CMR 7.10, measured at the property boundary of the receiving land use nor shall any source produce a pure-tone condition at the property line (or at the nearest inhabited buildings). A pure tone condition exists if the sound pressure level, at any given octave band center frequency, exceeds the levels of the two adjacent octave bands by three (3) or more decibels.

The Commonwealth of Massachusetts regulation and the Massachusetts Department of Environmental Protection (MassDEP) noise policy, implementing the Massachusetts regulation are discussed below.

Commonwealth of Massachusetts

The Commonwealth of Massachusetts regulation 310 CMR 7.10 U prohibits producing a condition of noise that constitutes a nuisance, but does not provide specific, measurable limits. The regulation states:

- (1) No person owning, leasing, or controlling a source of sound shall willfully, negligently, or through failure to provide necessary equipment, service, or maintenance or to take necessary precautions cause, suffer, allow, or permit unnecessary emissions from said source of sound that may cause noise.

310 CMR 7.10 U (2) and (3) respectively require controls for construction devices and exempts several types of activities such as parades, emergency warnings, etc.

MassDEP Noise Policy

The general prohibitions of 310 CMR 7.10 U (1) do not establish specific, measurable amounts of sound that constitute a condition of noise that can be used for engineering design purposes. The responsibility and authority for identifying when a condition of noise exists has been assigned to the Massachusetts

Department of Environmental Protection (MassDEP). MassDEP Noise Policy 90-001 (see Appendix A) states the following:

A source of sound will be considered to be violating the Department's noise regulation (310 CMR 7.10) if the source:

- 1. Increases the broadband sound level by more than 10 dB(A) above the ambient, or*
- 2. Produces a "pure tone" condition – when any octave band center frequency sound pressure level exceeds the two adjacent center frequency sound pressure levels by 3 decibels or more.*

These criteria are measured both at the property line and at the nearest inhabited residence. Ambient is defined as the background A-weighted sound level that is exceeded 90% of the time measured during equipment operating hours. The ambient may also be established by other means with the consent of the Department.

It is our understanding that the MassDEP Noise Policy applies to stationary equipment and does not apply to sound produced by vehicles.

Medway Zoning Bylaw

The Medway Zoning Bylaw, strictly speaking is not applicable to this project located within Holliston. However, this study has considered the Medway limit along with those of the Town of Holliston and the Commonwealth of Massachusetts. Medway Zoning Bylaw Section 7.3(2) establishes limits on sound for developments under its authority. It is as follows:

2. Noise.

- a. Maximum permissible sound pressure levels-measured at the property line nearest to the noise source for noise radiated continuously from the noise source between 10 PM and 7 AM shall be as follows:

Frequency Band (Cycles per Second)	Sound Pressure Level (Decibels re 0.0002 Dyne/CM²)
2 – 72	69
75 – 150	54
150 – 300	47
300 – 600	41
600 - 1,200	37
1,200 - 2,400	34
2,400 - 4,800	31
4,800 - 10,000	28
Corresponding A-weighted sound level	45 dBA

- b. For noise levels between 7 A.M. and 10 P.M., and if the noise is not smooth and continuous, the following corrections shall be added to each of the decibel levels given above:

Daytime operation only: +5

Noise source operated less than 20% of any 1-hour period: +5

The Bylaw sets limits in the old octave bands that were replaced in the 1960s by the preferred octave bands by ANSI S1.11 2014 (R2019). The corresponding A-weighted sound level (45 dBA) is shown inserted into the text.

Summary

As the facility may operate 24 hours per day, the following are nighttime limits on sound levels at nearest residences. Though the limits may be specifically imposed at property lines, we have imposed them at second-floor windows as well where sound levels are likely to be higher than at property lines.

- Holliston 2015 Zoning Bylaw—50 dBA
(Legally binding to project stationary equipment and site activities)
- Holliston 2019 Zoning Bylaw—Same as MassDEP
(Same as MassDEP Noise Policy)
- Commonwealth of Massachusetts (310 CMR 7.10 U)—Creating condition of noise not permitted
(Legally binding, no specific, measurable limits established)

- MassDEP Noise Policy—Not more than 10 dBA above background (a limit of 40 dBA as discussed below); pure tone sound not permitted.
(Legally binding to project stationary equipment)
- Medway Zoning Bylaw—45 dBA
(Advisory only, not legally binding for Holliston projects)

Existing Ambient Sound Measurements

The MassDEP Noise Policy requires that the background sound level in the vicinity of sensitive receptors be measured. Measurements were completed at location SM1 in Figure 1 during the period Saturday, December 5 to Thursday, December 10, 2020. Ambient sound levels at the measurement location are representative of those at nearby residences. Prior to measurements, the site had been cleared with no tree foliage overhead. Negligible activity at the commercial facility south of the proposed warehouse was observed during monitor install and retrieval.

Sound monitoring was conducted using a Rion NL-52 meter was set to fast meter response and calibrated before use. The microphone was tripod-mounted with a windscreen 5-6 feet above grade. This instrument and its use conform to IEC 61672 for Class 1 precision sound measurement instrumentation. The meter recorded sound level data onto a flash card that, after the completion of measurements, was removed from the unit and downloaded into a PC.

The monitor was programmed to measure several hourly A-weighted sound level descriptors including the 90th percentile sound level ($LAF_{90,1-hr}$), equivalent sound level ($LA_{eq,1-hr}$), and first percentile ($LAF_{01,1-hr}$) sound level.

- The 90th percentile sound level ($LAF_{90,1-hr}$) is the background or residual sound level in an area and is the lowest level of sound typically occurring. It is the A-weighted sound level exceeded 90% of each hour monitored. It is of special relevance as the MassDEP Noise Policy defines the background sound level as the lowest $LAF_{90,1-hr}$ reached.
- The equivalent sound level ($LA_{eq,1-hr}$) is the energy average sound level for each hour monitored.
- The first percentile sound level ($LAF_{01,1-hr}$) is the sound level exceeded one percent of each hour and is representative of the highest sound levels reached in each hour.

Sound monitoring data measured at SM1 are shown in Figure 2. As with most acoustic environments, sound levels are generally higher during the day than during the night. Weather data have been shown alongside sound monitoring data to identify any occasions when weather conditions might have influenced sound levels. These data are as obtained from the National Weather Service's (NWS) Automated Surface Observing Systems (ASOS) program for station OWD (Norwood Memorial Airport)¹.

¹ https://mesonet.agron.iastate.edu/request/download.phtml?network=MA_ASOS

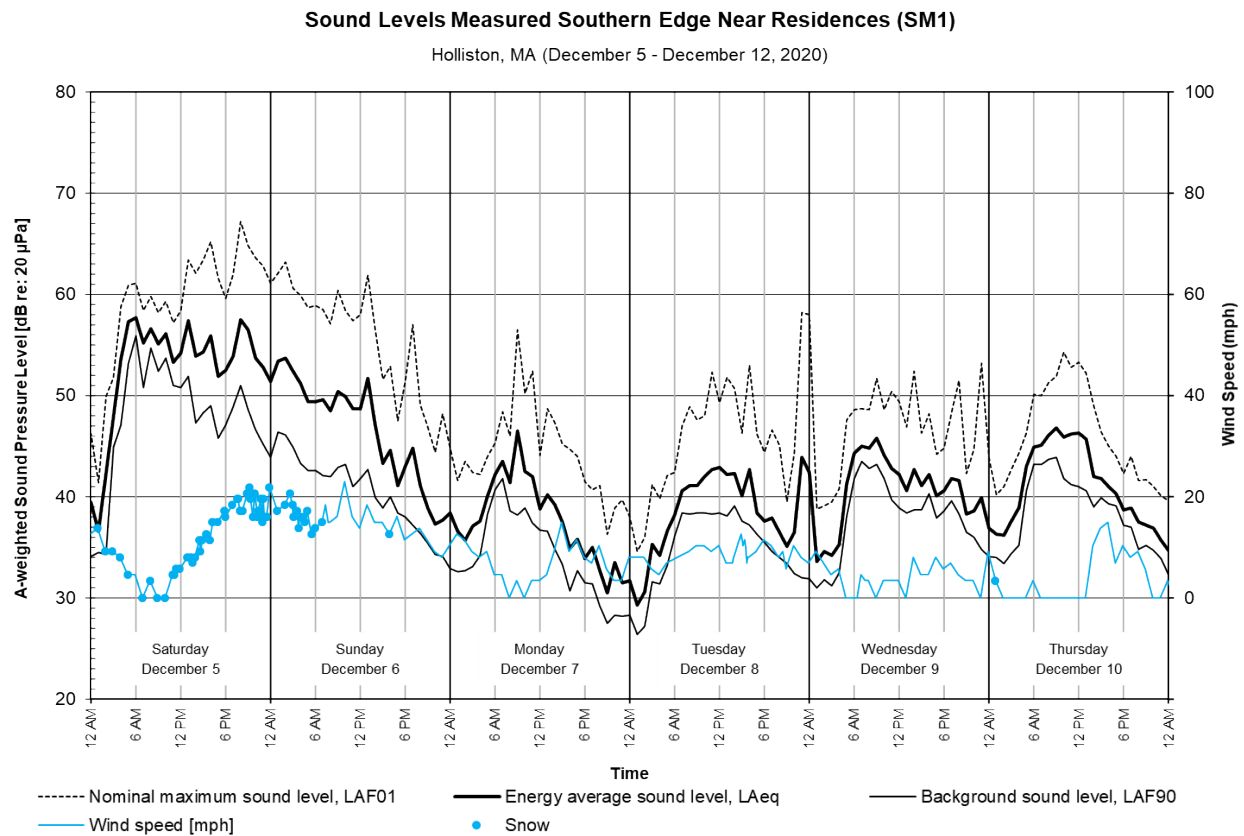


Figure 2. Sound monitoring data measured at SM1
Proposed Warehouse, 555 Hopping Brook Road, Holliston, MA

S1

From Figure 2, the lowest $LAF_{90,1-hr}$ reached was 26 dBA during a condition of little wind and 12-inch snow cover on-site. Because of the snow cover, this level is lower than expected for typical, quiet conditions. Accordingly, we have used 30 dBA as a more realistic background sound level typically occurring under more usual site conditions. The corresponding MassDEP Noise Policy limit for sound produced by stationary equipment would then be 40 dBA.

Computer Modeling

Computer modeling has been used to estimate sound levels at nearest residences. Estimated sound levels have been compared with regulatory standards on facility sound at nearest residential uses. Computer modeling has also included the benefit of noise reductions obtained through berms and sound barrier walls proposed to be built atop berms.

Modeling of facility sound was completed using Cadna/A (Datakustik GmbH, Version 2022 MR 1, 32-bit). Cadna/A is a computer program that implements the modeling techniques of ISO 9613-1 and ISO 9613-2 to estimate source sound levels at community receptor locations. The Cadna model accounts for propagation losses in facility sound associated with distance, shielding by intervening structures, berms, barriers, and topography, and absorption of sound by the atmosphere and porous surfaces.

The Cadna model uses sound power levels for all facility equipment sound sources modeled. Sound power level quantifies the amount of sound energy produced by a source and is expressed in decibels referenced to 1 picoWatt (pW or 10^{-12} watts). The distinction between “sound power” and “sound pressure” is quite important.

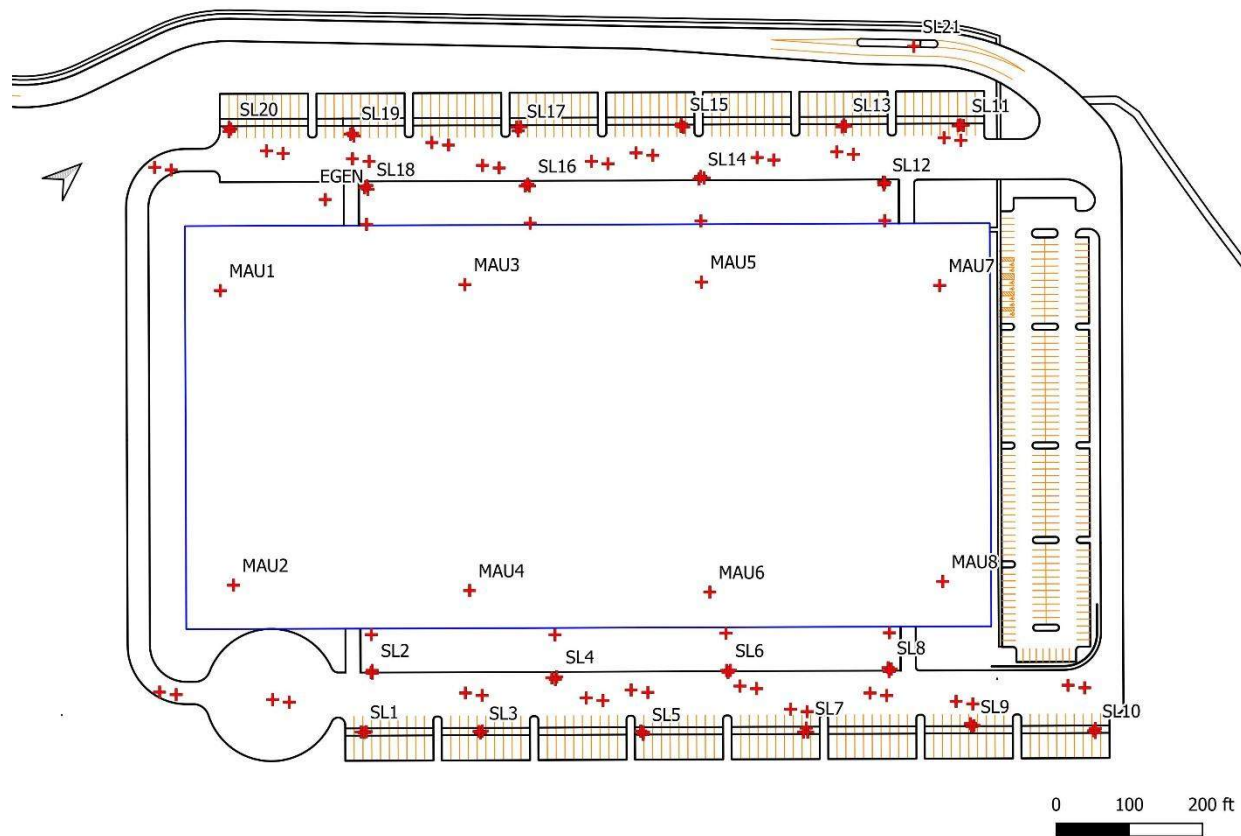
Sound power is analogous to the power rating in watts of a light bulb. *Sound pressure* is analogous to the light intensity (perceived as brightness) at a given distance from a light bulb. The shorter the distance from the bulb, the greater the light intensity or perceived brightness at a particular location. Conversely, the longer the distance from the bulb, the less the light intensity or perceived brightness at a particular location. Note that the bulb’s power rating does not change with viewing distance from the bulb; however, the light intensity and apparent brightness do. Similarly, the sound power of a source does not change with distance from the source, but the sound pressure does.

Sound power levels have been determined from measurements of sound produced by trucking activity at a similar facility. Sound power levels produced by facility sound, potentially a source of community complaints, are presented in Table 1.

Source	Sound power spectra									A-Wt. dBA
	31.5	63	125	250	500	1000	2000	4000	8000	
Sources of Continuous Sound										
Warehouse interior equipment	93	91	90	87	88	88	86	82	78	93
Rooftop make-up air unit	100	100	91	90	88	85	84	80	75	91
Emergency generator	108	108	107	101	93	87	88	84	82	97
Sources of Transient Sound										
Truck high idle	100	104	102	103	103	99	97	92	85	105
Backup alarm, tonal	54	68	78	79	89	107	91	86	77	107
Tractor-trailer pass-by	107	104	110	109	107	105	101	98	94	110
Medium truck pass-by	89	110	109	105	102	101	98	94	89	106
Truck accelerating	117	127	121	110	104	106	105	105	108	114
Trailer disconnect	105	110	113	115	111	112	106	99	93	115

**Table 1. Sound power spectra of facility sources [dB re: 1 pW]
Proposed Warehouse, 555 Hopping Brook Road, Holliston, MA**

The computer modeling of receptor sound levels requires that the location of sources, receptors, and attenuating elements be defined. Figure 3 shows eleven facility transient sound source groups SL1-SL21, and the stationary sources MAU-1 through 8 and the emergency generator (E-Gen) used in computer modeling. A source group is the location of one or more specific sources. For example, a source group may have a trailer disconnect, back-up alarm, and truck pass-by, all occurring at about the same physical location on-site. For modeling, sources groups have been distributed throughout the trucking yard. Receptor study locations R1-R10 used in facility computer modeling are shown in Figure 4.



**Figure 3. Facility sound source locations used in computer modeling
Proposed Warehouse, 555 Hopping Brook Road, Holliston, MA**



**Figure 4. Facility receiver locations used in computer modeling
Proposed Warehouse, 555 Hopping Brook Road, Holliston, MA**

Estimated Source Sound Levels

Table 2 presents estimated facility sound levels at residential receptor locations R1-R10. Data presented in the table have been computed with the mitigation shown in project the design drawings comprised of an 8-foot tall barrier atop a berm extending from along the south edge of the site, around the east and north sides, and ending at the northwest edge of the site. The barrier must be continuous without cracks or significant undercut, and have a minimum surface weight of 4 psf. Along the east side of the project site, the berm is roughly 30 feet above trailer parking pavement grade. Receptor sound levels produced by all stationary sources operating, as determined from computer modeling with the barrier and berm constructed as shown in the project drawings, are listed in Table 2, together with applicable limits.

Stationary Sources	R1	PL1	R2	PL2	R3	PL3	R4	PL4	R5	PL5	R6	PL6	R7	PL7	R8	PL8	R9	PL9	R10	PL10
Warehouse interior equipment	21	20	22	20	22	20	23	22	23	23	25	24	26	23	27	24	16	25	17	23
Rooftop make-up air unit	30	26	31	30	32	26	33	30	34	31	35	34	36	33	35	33	21	28	24	26
Emergency generator	10	10	10	10	10	10	11	11	11	12	12	13	14	14	15	14	19	29	27	24
Total Continuous	30	27	31	30	32	27	33	30	34	32	35	35	36	34	36	33	24	32	29	29
Holliston 2015 Zoning Bylaw	50																			
Holliston 2019 Zoning Bylaw	40																			
MassDEP Noise Policy	40																			
Medway Zoning Bylaw	45																			

Table 2. Summary of stationary equipment sound levels at 2nd floor receptors locations R1-R10 and property line locations PL1-PL10, and applicable limits Proposed Warehouse, 555 Hopping Brook Road, Holliston, MA

Transient Sources	R1	PL1	R2	PL2	R3	PL3	R4	PL4	R5	PL5	R6	PL6	R7	PL7	R8	PL8	R9	PL9	R10	PL10
Truck high idle	36	37	37	36	38	38	38	39	39	39	40	39	41	38	40	38	30	37	32	35
Backup alarm, tonal	35	35	33	33	36	36	37	36	37	36	39	37	41	38	40	37	30	37	32	35
Large truck pass-by	40	41	41	40	43	42	44	42	44	44	45	44	46	43	45	44	33	42	38	39
Med truck pass-by	36	37	38	37	40	38	40	40	40	40	41	41	42	39	42	40	29	38	34	35
Truck accelerating	41	35	37	35	37	35	35	34	32	31	33	31	34	31	33	31	35	42	36	40
Trailer disconnect	46	48	47	46	48	49	49	49	49	49	50	49	51	48	51	48	40	48	42	46

Table 3. Summary of maximum transient sound levels at 2nd floor receptors locations R1-R10 and property line locations PL1-PL10 Proposed Warehouse, 555 Hopping Brook Road, Holliston, MA

Maximum transient sound levels from the locations SL1-SL21, as determined from computer modeling, are reported in Table 3. There are no fixed limits as they are vehicle or backup alarm source sound levels; nonetheless, all maximum transient sound levels fall below the Holliston 2015 Zoning Bylaw limit of 50 dBA applicable to stationary sources except for 1-dBA exceedances at residences R7 and R8.

Conclusions

The design of the proposed warehouse for the Hopping Brook Industrial Park at 555 Hopping Brook Road, Holliston, MA abuts the Claybrook Farm Road neighborhood in Medway. Nearest residences on Olde Surrey Lane in Medway are 400-500 feet from the proposed building, with the closest trailer space 275 feet from 12 Carriage House Way and closest trucking activity 315 feet from 15 Carriage House Way. Applicable limits on project sound are the Holliston 2015 Zoning Bylaw limit of 50 dBA at night and the MassDEP Noise Policy of 40 dBA based on sound monitoring conducted on-site in December 2020. Though not legally applicable, the Medway Zoning Bylaw of 45 dBA has been considered in evaluating sound potentially produced by the proposed warehouse in Holliston.

The presently proposed project is a smaller warehouse building with its access road screened from nearest Medway neighborhoods by the building. The proposed project also is also likely to have more straight trucks producing less sound than tractor trailers.

Facility site design includes a substantial berm extending around the southern, eastern, and northern project boards. The berm is topped by an 8-foot tall sound barrier. Stationary equipment serving the building are 8 rooftop make-up air units and an emergency generator located on the ground outdoors on the west side of the building, well shielded from Medway residences.

With the proposed barrier/berm screening of sound, stationary equipment sound levels at nearest residences determined using computer modeling would comply with all applicable code limits on sound levels at residences. Tonal backup alarm sound ranging from 32 to 41, though understood to be not subject to code limits, are expected to be below stationary limits, and for much of the time below existing ambient sound levels rendering them minimally audible.

If we can provide any further detail, please do not hesitate to contact us. Thank you.

Sincerely,
CAVANAUGH TOCCI



Gregory C. Tocci, Sr. Principal Consultant



Bradley M. Dunkin, Senior Consultant

Appendix A

**Massachusetts Department of
Environmental Protection (MassDEP)
Noise Policy 90-001**



The Commonwealth of Massachusetts
Executive Office of Environmental Affairs
Department of Environmental Quality Engineering
Division of Air Quality Control
One Winter Street, Boston 02108

February 1, 1990

DAQC Policy 90-001

DIVISION OF AIR QUALITY CONTROL POLICY

This policy is adopted by the Division of Air Quality Control. The Department's existing guideline for enforcing its noise regulation (310 CMR 7.10) is being reaffirmed.

P O L I C Y

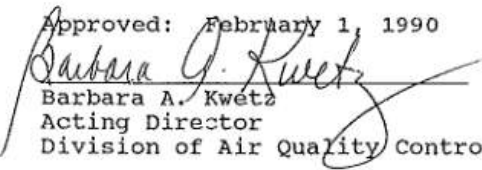
A source of sound will be considered to be violating the Department's noise regulation (310 CMR 7.10) if the source:

1. Increases the broadband sound level by more than 10 dB(A) above ambient, or
2. Produces a "pure tone" condition - when any octave band center frequency sound pressure level exceeds the two adjacent center frequency sound pressure levels by 3 decibels or more.

These criteria are measured both at the property line and at the nearest inhabited residence. Ambient is defined as the background A-weighted sound level that is exceeded 90% of the time measured during equipment operating hours. The ambient may also be established by other means with the consent of the Department.

Approved: February 1, 1990

Effective: Immediately


Barbara A. Kwetz
Acting Director
Division of Air Quality Control

100% Recycled Paper