ACOUSTIC STUDY FOR THE PROPOSED LELWD PEAK POWER GENERATORS

LITTLETON, MASSACHUSETTS

April 2019

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ELECTRIC LIGHT & WATER DEPARTMENTS

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ACOUSTIC STUDY FOR THE PROPOSED LELWD PEAK POWER GENERATORS

LITTLETON, MASSACHUSETTS

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TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

List of Tables

List of Figures

1.0 EXECUTIVE SUMMARY

This study's objective is to demonstrate that the proposed future peak power generators in Littleton (the "Project") will comply with the Massachusetts Department of Environmental Protection ("MassDEP") Noise Policy for both broadband and tonal noise at the nearest residential property lines and residences and will comply with the Littleton Noise Bylaw. The Project is located at the Littleton Electric Light and Water Departments (LELWD) property on 39 Ayer Road (Route 2A). The Project includes two 2.5-MW generators for peak power production located on the northern half of the site. The site is located on the northside of Ayer Road. Directly abutting land uses are commercial and industrial properties to the east and south and residential uses to the north along New Estates Road and to the east along Sleigh Ride Lane. To the west is the Koerper Field, which is part of the LELWD property. The nearest residences to the project site are houses on New Estates Road and further to the east on Sleigh Ride Lane.

The first step of the study was to measure sound levels at locations near the Project site to document the existing acoustic environment prior to construction of the proposed project. The second step was to use the Cadna-A acoustic model, based on International Standard ISO 9613, to calculate sound level impacts from the future peak power generators in operation. The predicted sounds levels at the property lines and nearby residences were then compared with limits established by the MassDEP Noise Policy and by the Littleton Noise Bylaw. The Cadna-A acoustic modeling assumed simultaneous operation of all equipment. The potential sources of sound at the facility are:

- Two (2) CAT G3520 2.5 MW gas-fired peaking power generators, or equal, with engine enclosures capable of reducing mechanical sound to 65 dBA +/- 3 dB at 50 feet (i.e. approximately 25 dB reduction);
- Two (2) "super quiet" radiators emitting 57 dBA at 50 feet; and
- Two (2) engine exhausts mitigated to produce a sound level of 77 dBA at 5 feet.

Existing 1-hour sound levels were measured near the north property boundary of the LELWD property from Tuesday, March 5, 2019 through Thursday, March 7, 2019. Short-term sound measurements for comparison were collected near the closest residences on New Estate Road and Sleigh Ride Lane. The one-hour background levels (L_{90}) near the north property boundary, during

times when the peak power generators would operate, ranged from 44 to 48 dBA. The lowest one-hour L_{90} level of 44 dBA (7:00 p.m. to 8:00 p.m.) on Wednesday, March 6, 2019 is defined as the "ambient level" for the nearest residential property lines under the MassDEP Noise Policy. This sound level was used to represent ambient conditions at the residential property lines. Short-term baseline sound levels were also measured at four monitoring locations representative of the nearest residences. The background levels (L_{90}) at the nearest residences, during times when the peak power generators would operate, ranged from 37 to 40 dBA. These sound levels were used to represent ambient conditions at the residential dwellings.

The MassDEP Noise Policy regulates sound from mechanical equipment operation on the site, limiting the increase in the ambient level to no more than 10 dBA at the site property lines and nearest residences. The Noise Policy also prohibits the creation of a pure tone at these same locations. The modeling results demonstrate full compliance with the MassDEP Noise Policy. Predicted sound levels from the project at the nearest site property line and the nearest residence are 50 dBA and 37 dBA, respectively. The Project will not produce a pure tone, and will increase the ambient level by 7 dBA or less at the nearest site property line and by 2 dBA or less at the nearest residence.

The Town of Littleton has adopted a noise bylaw under Chapter 173, Article XVII of the Littleton Zoning Bylaw. The bylaw limits the maximum allowable sound levels from a continuous source in each land use district to the sound level limits. The sound level limits are provided in decibels, and we have assumed that they are based on an A-weighted scale. Daytime sound level limits are defined as those that occur between the hours of 7:00 a.m. and 9:00 p.m. on all days, except Sundays and legal holidays. Daytime is defined as the hours between 12:00 p.m. and 9:00 p.m. on Sundays and legal holidays. The peak power generators will operate anytime between 12:00 p.m. and 8:00 p.m. The maximum allowable sound limits for continuous sound sources are 50 dBA (residential district); 55 dBA (business district) and 65 dBA (industrial district). The results produce residential impacts as high as 50 dBA, which is compliant with the Littleton Noise Bylaw residential limit of 50 dBA, and industrial impacts as high as 46 dBA, which is compliant with the Littleton Noise Bylaw industrial limit of 65 dBA.

2.0 COMMON MEASURES OF COMMUNITY NOISE

Audible sound is reported as a sound pressure level[1] in decibels (dB). The decibel scale is logarithmic to accommodate the wide range of sound intensities to which the human ear is subjected. A property of the decibel scale is that the sound pressure levels of two separate sounds are not directly additive. For example, if a sound of 70 dB is added to another sound of 70 dB, the total is only a 3-decibel increase (or 73 dB), not a doubling to 140 dB. Thus, every 3-dB increase represents a doubling of sound energy. For broadband sounds, a 3-dB change is the minimum change perceptible to the human ear. Table 1 below gives the perceived change in loudness of different changes in sound pressure levels.[2]

TABLE 1

SUBJECTIVE EFFECT OF CHANGES IN SOUND PRESSURE LEVELS

CHANGE IN SOUND LEVEL	APPARENT CHANGE IN LOUDNESS
3 dB	Just perceptible
5 dB	Noticeable
10 dB	Twice (or half) as loud

The acoustic energy level of a source is known as its sound power level (L_w), which is also measured on a decibel scale. The sound power level of a source is the same at any distance; therefore, L_w values do not have reference distances. In contrast, sound pressure levels vary with distance from the source. Sound power levels are typically greater than 100 dBA; these large L_w numbers should not be confused with the sound pressure levels we hear.

Non-steady noise exposure in a community is commonly expressed in terms of the A-weighted sound level (dBA); A-weighting approximates the frequency response of the human ear. Levels of many

[1] The sound pressure level is defined as $20*\log_{10}(P/P_o)$ where P is the sound pressure and P_o is the reference pressure of 20 micro-Pascals (20 μPa), which by definition corresponds to 0 dB.

[2] American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., 1989 ASHRAE Handbook--Fundamentals (I-P) Edition, Atlanta, GA, 1989.

sounds change from moment to moment. Some are sharp impulses lasting 1 second or less, while others rise and fall over much longer periods of time. There are various measures of sound pressure designed for different purposes. To establish the background sound level in an area, the $\mathbf{L_{90}}$ metric, which is the sound level exceeded 90 percent of the time, is typically used. The $\mathbf{L_{90}}$ can also be thought of as the level representing the quietest 10 percent of any time period. This is a broadband sound pressure measure, i.e., it includes sounds at all frequencies. The $\mathbf{L_{eq}}$, or equivalent sound level, is the steady-state sound level over a period of time that has the same acoustic energy as the fluctuating sounds that actually occurred during that same period. It is commonly referred to as the average sound level. The $\mathbf{L_{max}}$, or maximum sound level, represents the one second peak level experienced during a given time period.

Sound level measurements typically include an analysis of the sound spectrum into its various frequency components to determine tonal characteristics. The unit of frequency is Hertz (Hz), measuring the cycles per second of the sound pressure waves, and typically the frequency analysis examines eleven octave bands from 16 to 16,000 Hz. MassDEP Noise Policy states that a source creates a pure tone if acoustic energy is concentrated in a narrow frequency range and one octave band has a sound level 3 dB greater than both adjacent octave bands.

The acoustic environment in a suburban area such as Littleton results from numerous sources and the major source is motor vehicle traffic on Route 2A (Ayer Road). Typical sound levels associated with various activities and environments are presented in Table 2.

TABLE 2

COMMON SOUND LEVELS

Sound Level (dBA)	Common Indoor Sounds	Common Outdoor Sounds
110	Rock Band	Jet Takeoff at 1000’
100	Inside NYC Subway Train	Chain Saw at 3’
90	Food Blender at 3’	Impact Hammer (Hoe Ram) at 50’
80	Garbage Disposal at 3’	Diesel Truck at 100’
70	Vacuum Cleaner at 10’	Lawn Mower at 100’
60	Normal Speech at 3’	Auto (40 mph) at 100’
50	Dishwasher in Next Room	Busy Suburban Area at night
40	Empty Conference Room	Quiet Suburban Area at night
25	Empty Concert Hall	Rural Area at night

3.0 NOISE REGULATIONS

3.1 Massachusetts DEP Noise Policy

The Massachusetts Department of Environmental Protection (MassDEP) regulates noise through 310 CMR 7.10, "Air Pollution Control". In these regulations "air contaminant" is defined to include sound and a condition of "air pollution" includes the presence of an air contaminant in such concentration and duration as to "cause a nuisance" or "unreasonably interfere with the comfortable enjoyment of life and property". Regulation 7.10 prohibits "unnecessary emissions" of noise. The MassDEP Noise Policy (Policy Statement 90-001, February 1, 1990) interprets a violation of this noise regulation to have occurred if the source causes either:

1) An increase in the broadband sound pressure level of more than 10 dBA above the ambient, or

2) A "pure tone" condition.

The “ambient level” is defined as the lowest 1-hout L_{90} level measured during facility operating hours. However, the proposed peak power generators will only operate during the time period of 12:00 p.m. to 8:00 p.m. and for evaluating their sound impacts the ambient level is defined as the lowest 1-hour L_{90} sound level in that time period. A "pure tone" condition occurs when any octave band sound pressure level exceeds both of the two adjacent octave band sound pressure levels by 3 dB or more. The limits are applied at the nearest residence and residential property line. The Noise Policy does not apply to uninhabited areas where there is no possibility of residential construction.

3.2 Littleton Noise Bylaw

The Town of Littleton has adopted a noise bylaw under Chapter 173, Article XVII of the Littleton Zoning Bylaw. The bylaw limits the maximum allowable sound levels from a continuous source in each land use district to the sound level limits in Table 3. The sound level limits are provided in decibels, and we have assumed that they are based on an A-weighted scale. Daytime sound level limits are defined as those that occur between the hours of 7:00 a.m. and 9:00 p.m. on all days, except Sundays and legal holidays. Daytime is defined as the hours between 12:00 p.m. and 9:00 p.m. on Sundays and legal holidays.

TABLE 3

TOWN OF LITTLETON NOISE BYLAW
MAXIMUM ALLOWABLE SOUND LEVELS FOR CONTINOUS SOURCES

District	Daytime (decibels)	Nighttime (decibels)
Residential	50	40
Business	55	45
Industrial	65	50

The bylaw has also established maximum allowable sound levels for noise sources other than continuous sounds, based on the type of sound. For a dominant tone and impulsive sound, 5 dBA is subtracted from the sound level limits in Table 3. For a sporadic sound, 10 dBA is added to the sound level limits in Table 3. The bylaw does not allow noise levels in excess of 90 decibels at the property line or street, except for sporadic noise. Also, Section 173-78 B (3) and (7) of the bylaw states that the regulations shall not apply to any noise produced by a registered motor vehicle, provided that such vehicle is equipped with all noise suppression devices required for legal operation under such registration by the laws of the Commonwealth and construction equipment between the hours of 7:00 a.m. and 7:00 p.m. only.

4.0 PRE-CONSTRUCTION SOUND LEVEL MEASUREMENTS

Pre-construction sound level monitoring was performed on both a long-term and short-term basis. The monitoring methodology and results are presented below.

4.1 Long-term Sound Monitoring

To identify the lowest L_{90} background level of the nearest residential areas surrounding the Project site, a long-term sound analyzer was used to measure hourly sound levels over a three-day period to provide a complete picture of 24-hour sound conditions at the site. These baseline measurements were performed at the site property boundary closest to the nearest residence on New Estates Road. The long-term sound analyzer measured hourly sound levels and octave band levels from Tuesday, March 5, 2019 through Thursday, March 7, 2019. The location of the long-term sound level measurements (LT-1) is presented in Figure 1.

The long-term measurements were collected with a Larson Davis 831 sound level analyzer. This analyzer is equipped with a 1/2" precision condenser microphone and has an operating range of 5 dB to 140 dB, and an overall frequency range of 3.5 to 20,000 Hz. This analyzer meets or exceeds all requirements set forth in the American National Standards Institute (ANSI) Type 1 Standards for quality and accuracy. Prior to and immediately following the measurement session, the sound analyzer was calibrated (no level adjustment was required; therefore, it was monitoring accurately) with an ANSI Type 1 calibrator, which has an accuracy traceable to the National Institute of Standards and Technology (NIST). For the measurement session, the microphone was fitted with a 7-inch windscreen to negate the effect of air movement across microphone diaphragm. All data were downloaded to a computer following the measurement session for further analysis.

A summary of the long-term background L_{90} sound measurement results is provided in Table 4. Table 4 only presents the measured L_{90} sound levels between 12:00 p.m. and 8:00 p.m., when the proposed peak power generators would operate. The one-hour background levels (L_{90}) ranged from 44 to 48 dBA. One-hour average sound levels (L_{eq}) ranged from 47 to 59 dBA, and maximum sound levels (L_{max}) ranged from 61 to 87 dBA during those same hours.

The lowest one-hour L_{90} level of 44 dBA (7:00 p.m. to 8:00 p.m.) on Wednesday, March 6, 2019 was selected as the existing background sound level. This sound level was used to represent ambient conditions at the residential property lines. Weather conditions at this time were acceptable for accurate acoustic measurements. Skies were clear with no precipitation; the temperature was 19°F and winds were 5 to 10 mph out of the west.[3] Appendix A presents a summary of the L_{max}, L_{eq} and L_{90} sound level measurements for the entire sampling period.

The overall sound levels measured are typical of a suburban area located near busy roads and with surrounding commercial/industrial areas. These measurements are considered conservative because they were taken in winter; in other seasons, existing sound levels likely would be higher due to higher traffic volumes and to natural sounds, such as insects, birds, and tree frogs.

TABLE 4

SUMMARY OF LONG-TERM BASELINE SOUND LEVELS (L_{90}, dBA)
Tuesday, March 5, 2019 to Thursday, March 7, 2019, 12:00 p.m. to 8:00 p.m.

Hour Starting	Measured L_{90} Broadband Hourly Sound Levels (dBA)		
	Tues. 3/5/19	Wed. 3/6/19	Thurs. 3/7/19
Noon	45	48	47
1 p.m.	46	47	48
2 p.m.	47	48	47
3 p.m.	46	48	48
4 p.m.	46	47	48
5 p.m.	46	47	46
6 p.m.	45	45	46
7 p.m.	44	44	45

3 https://mesowest.utah.edu, Laurence G Hanscom Field Airport, downloaded March 22, 2019.

4.2 Short-term Sound Monitoring

Short-term baseline sound levels were measured during the afternoon hours on Tuesday March 5, 2019 at four monitoring locations. Weather conditions were acceptable for accurate acoustic measurements during the short-term monitoring sessions. Skies were clear with no precipitation; the temperature ranged from 24°- 27°F, and wind speeds were calm to 8 mph[4]. The approximate locations of the short-term sound level measurements are presented in Figure 1. One set of sound level measurements, of 20 minutes in duration, was collected during the afternoon hours (12:00 p.m. to 1:00 p.m.) at each of these locations. Broadband A-weighted L_{max}, L_{eq} and L_{90} sound levels were measured at each location to provide a complete picture of sound conditions in the residential areas surrounding the site.

All short-term (20-minute) sound level measurements were collected by acoustic engineers using a Larson Davis 831 or a Bruel and Kjaer 2250 ANSI Type 1 (high precision) real-time sound level analyzers, which were equipped with precision condenser microphone, windscreen, and frequency analyzers. These analyzers are equipped with a 1/2" precision condenser microphone and have an operating range of 5 dB to 140 dB, and an overall frequency range of 3.5 to 20,000 Hz. These analyzers meet or exceed all requirements set forth in the American National Standards Institute (ANSI) Type 1 Standards for quality and accuracy. Prior to and immediately following each measurement session, the sound analyzers were calibrated (no level adjustment was required; therefore, they were monitoring accurately) with an ANSI Type 1 calibrator, which has an accuracy traceable to the National Institute of Standards and Technology (NIST). For each measurement session, the microphones were fitted with a 7-inch windscreen to negate the effect of air movement across microphone diaphragm. All data were downloaded to a computer following the measurement session for further analysis. Concurrent observations of audible activity from sound-producing sources was recorded by the acoustic engineers.

Summaries of the short-term sound measurement results are provided in Table 5. The average sound levels (L_{eq}) ranged from 44 to 54 dBA, maximum sound levels (L_{max}) ranged from 60 to 77 dBA, and background levels (L_{90}) ranged from 37 to 40 dBA. These sound levels were used to represent ambient conditions at the residential dwellings.

4 https://mesowest.utah.edu, Laurence G Hanscom Field Airport, downloaded March 6, 2019.

The dominant sources of sound were distant and local traffic, commuter rail operations, and pedestrians. The overall sound levels measured are typical of a suburban area located near busy roads and with surrounding commercial/industrial areas.

TABLE 5

SUMMARY OF SHORT-TERM SOUND LEVELS (dBA)
SURROUNDING THE PROJECT SITE
TUESDAY, MARCH 5, 2019
12:00 p.m. to 12:45 p.m.

Sound Level Measurement	**(Location #1) 174 New Estate Road 12:00 p.m. – 12:20 p.m.**	**(Location #2) 146 New Estate Road 12:25 p.m.- 12:45 p.m.**	**(Location #3) 1A Sleigh Ride Lane 12:00 p.m. – 12:20 p.m.**	**(Location #4) 5 Sleigh Ride Lane 12:23 p.m. – 12:43 p.m.**
Broadband (dBA)				
Background (L_{90})	40.2	37.0	37.3	37.1
Average (L_{eq})	54.0	52.8	48.4	43.9
Maximum (L_{max})	72.8	76.7	72.1	60.3
Octave Band L_{90} (dB)				
16 Hz	54.2	54.6	55.4	55.7
31.5 Hz	54.1	49.6	50.4	52.1
63 Hz	45.0	41.2	41.4	43.2
125 Hz	37.0	37.2	37.2	36.5
250 Hz	37.4	36.7	37.2	36.1
500 Hz	37.9	35.9	35.8	36.0
1000 Hz	36.7	31.0	31.4	31.7
2000 Hz	26.3	19.7	24.4	23.3
4000 Hz	20.9	16.8	21.0	20.2
8000 Hz	20.5	18.3	17.6	17.7
16000 Hz	17.1	15.7	12.7	12.7
Pure Tone?	No	No	No	No

Figure 1. Long-Term and Short-Term Monitoring Locations
LELWD Peak Power Generators
35 Ayer Road, Littleton, MA

5.0 FUTURE SOUND SOURCES

The two (2) future peak power generators in Littleton are expected to include gas-fired engines and associated generator sets with radiator cooling systems. The engine and engine and generator will operate inside of a weatherproof and sound attenuated enclosure. The sound emitted from the exhaust stacks will be mitigated with an exhaust silencer, or series of exhaust silencers. The radiator cooling systems will be outside of the engine and generator enclosure, and at ground-level. These units will typically operate between 12:00 p.m. and 8:00 p.m. when peak energy demands are highest.

The potential sources of sound at the facility are:

- Two (2) CAT G3520 2.5 MW gas-fired peaking power generators, or equal, with engine enclosures capable of reducing mechanical sound to 65 dBA +/- 3 dB at 50 feet (i.e. approximately 25 dB reduction);
- Two (2) “super quiet” radiators emitting 57 dBA at 50 feet; and
- Two (2) engine exhausts mitigated to produce a sound level of 77 dBA at 5 feet.

6.0 CALCULATED FUTURE SOUND LEVELS

6.1 Acoustic Modeling of Facility Operations

Predicted future sound levels at the nearest residences, and at the site property lines, were calculated with the Cadna-A acoustic model, assuming simultaneous operation of all equipment at their maximum loads. Cadna-A is a sophisticated 3-D model for sound propagation and attenuation based on International Standard ISO 9613[5]. Atmospheric absorption is the process by which sound energy is absorbed by the air and was calculated using ANSI S1.26-1995.[6] Absorption of sound assumed standard day conditions and is significant at large distances and at high frequencies. ISO 9613 was used to calculate propagation and attenuation of sound energy by hemispherical divergence with distance, surface reflection, ground, and shielding effects by barriers, buildings, and ground topography. Offsite topography was determined using official USGS digital elevation data for the study area.

Predicted future sound levels were calculated along the Project site property boundary closest to the nearest residences on New Estates Road (i.e. the north property line) and at the site property boundary closest to the nearest residences along Sleigh Ride Lane (i.e. the east property line). Predicted future sound levels were also calculated at the upper story windows of the nearest residents on New Estates Road and on Sleigh Ride Lane. Additionally, predicted future sound levels were also calculated at the nearest shared industrial property line locations. In total, predicted future sound levels were calculated at twenty-two (22) property line modeling locations, and at nineteen (19) residential upper story window modeling locations. All acoustic modeling results are included in Appendix B.

[5] International Standard, ISO 9613-2, Acoustics – Attenuation of Sound During Propagation Outdoors, -- Part 2 General Method of Calculation.

[6] American National Standards Institute, ANSI S1.26-1995, American National Standard Method for the Calculation of the Absorption of Sound by the Atmosphere, 1995.

6.2 MassDEP Noise Policy Compliance Determination

The condensed results presented below include the acoustic modeling results at four (4) representative residential locations where the short-term monitoring was conducted, as well as at a 5th residential location with the greatest future sound levels from the Project are predicted (i.e. 166 New Estate Road). These locations are illustrated in Figure 2 and are as follows:

- Location #1: 174 New Estate Road
- Location #2: 145 New Estate Road
- Location #3: 1A Sleigh Ride Lane
- Location #4: 5 Sleight Ride Lane
- Location #5: 166 New Estate Road

The results of these calculations, presented in Tables 6 and 7, demonstrate that the Project will fully comply with the MassDEP Noise Policy at those noise-sensitive locations. The Project will increase the ambient levels at upper story windows of the nearest residences by 2 dBA or less, and by 7 dBA or less at the nearest residential property lines. The acoustic modeling calculations (see Appendix B) also confirm that the Project will not create any pure tones. (Note that octave band results in Appendix B are un-weighted or linear decibels.)

Figure 2. Project Location and Acoustic Modeling Locations
LELWD Peak Power Generators
35 Ayer Road, Littleton, MA

TABLE 6

SUMMARY OF MASSDEP NOISE COMPLIANCE DEMONSTRATION AT THE UPPER STORY WINDOWS OF THE NEAREST NOISE SENSITIVE AREAS

Receptor Locations	Ambient Sound Level (L_{90})	Predicted Project Sound Levels	Total Future Sound Level	Predicted Sound Level Increase	Complies with MassDEP Noise Policy?
#1: 174 New Estate Road	40 dBA	36 dBA	42 dBA	+1 dBA	Yes
#2: 146 New Estate Road	37 dBA	32 dBA	38 dBA	+1 dBA	Yes
#3: 1A Sleigh Ride Lane	37 dBA	28 dBA	38 dBA	+1 dBA	Yes
#4: 5 Sleigh Ride Lane	37 dBA	34 dBA	39 dBA	+2 dBA	Yes
#5: 166 New Estate Road	40 dBA	39 dBA	43 dBA	+2 dBA	Yes

TABLE 7

SUMMARY OF MASSDEP NOISE COMPLIANCE DEMONSTRATION AT THE PROPERTY LINES OF THE NEAREST NOISE SENSITIVE AREAS

Receptor Locations	Ambient Sound Level (L_{90})	Predicted Project Sound Levels	Total Future Sound Level	Predicted Sound Level Increase	Complies with MassDEP Noise Policy?
#1: 174 New Estate Road	44 dBA	45 dBA	47 dBA	+3 dBA	Yes
#2: 146 New Estate Road	44 dBA	44 dBA	47 dBA	+3 dBA	Yes
#3: 1A Sleigh Ride Lane	44 dBA	30 dBA	44 dBA	+0 dBA	Yes
#4: 5 Sleigh Ride Lane	44 dBA	38 dBA	45 dBA	+1 dBA	Yes
#5: 166 New Estate Road	44 dBA	50 dBA	51 dBA	+7 dBA	Yes

6.3 Littleton Noise Bylaw Compliance Determination

The condensed results presented below include the acoustic modeling results at the residential property line locations presented above, as well as the nearest industrial property line locations. The results of these calculations, presented in Tables 8, demonstrate that the Project will fully comply with the Littleton Noise Bylaw at the residential property line locations, as well as the nearest industrial property line locations.

TABLE 8

SUMMARY OF LITTLETON NOISE BYLAW COMPLIANCE DEMONSTRATION AT THE CLOSEST LAND USE DISTRICTS

Receptor Locations	Land Use	Predicted Facility Sound Level	Littleton Noise Bylaw Sound Limits	Compliance? (Yes/No)
174 New Estate Road	Residential	45 dBA	50 dBA	Yes
146 New Estate Road	Residential	44 dBA	50 dBA	Yes
1A Sleigh Ride Lane	Residential	30 dBA	50 dBA	Yes
5 Sleigh Ride Lane	Residential	38 dBA	50 dBA	Yes
166 New Estate Road	Residential	50 dBA	50 dBA	Yes
37 Ayer Road	Industrial	46 dBA	65 dBA	Yes
80 Ayer Road	Industrial	27 dBA	65 dBA	Yes
53 Ayer Road	Industrial	30 dBA	65 dBA	Yes

6.4 Figure of Project Operational Sound Levels

Figure 3 shows color-coded decibel contours (5 feet above ground level) for the operation of the Project. These contours display the predicted continuous sound levels for Project. The results in Figure 3 demonstrate compliance with the MassDEP Noise Policy and Littleton Noise Bylaw at the site property lines and at all nearby residences.

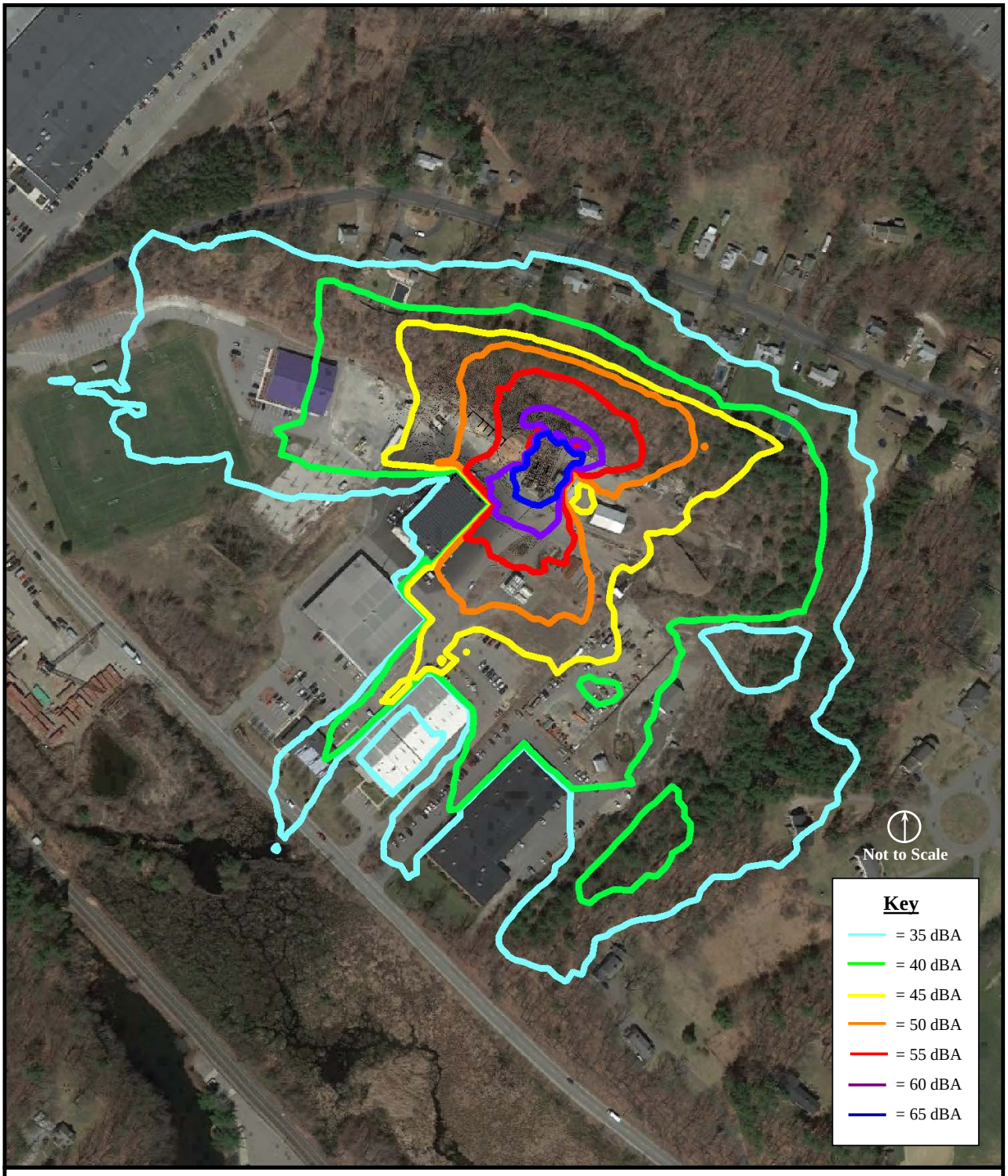

Figure 3. Predicted Future Operational Sound Levels
LELWD Peak Power Generators
35 Ayer Road, Littleton, MA

6.5 Conclusions

The results of the acoustic modeling analysis show that the proposed peak power generators will fully comply with the MassDEP Noise Policy and Littleton Noise Bylaw, and will not create a nuisance in the nearby residential areas in Littleton. In order to ensure that sound levels from the facility comply with the MassDEP Noise Policy and Littleton Noise Bylaw, the following noise mitigation elements are included in the Project design:

- Engine enclosures will reduce mechanical sound to 65 dBA +/- 3 dB at 50 feet.
- Employ “super quiet” radiators emitting no more than 57 dBA at 50 feet.
- Mitigate engine exhausts to produce a sound level of no more than 77 dBA at 5 feet from the top of the exhaust stacks.

APPENDIX A

BASELINE SOUND LEVEL MEASUREMENTS

Record #	Date	Time	Run Duration	Run Time	LAeq	LASmax	LAS90.00
1	2019-03-05	10:47:07	00:12:52.2	00:12:52.2	63.0	88.9	51.4
2	2019-03-05	11:00:00	01:00:00.0	01:00:00.0	54.1	74.8	46.7
3	2019-03-05	12:00:00	01:00:00.0	01:00:00.0	49.4	61.6	45.3
4	2019-03-05	13:00:00	01:00:00.0	01:00:00.0	59.2	87.2	46.2
5	2019-03-05	14:00:00	01:00:00.0	01:00:00.0	55.5	76.3	47.0
6	2019-03-05	15:00:00	01:00:00.0	01:00:00.0	54.8	76.4	46.0
7	2019-03-05	16:00:00	01:00:00.0	01:00:00.0	53.1	71.0	46.2
8	2019-03-05	17:00:00	01:00:00.0	01:00:00.0	48.3	66.9	45.2
9	2019-03-05	18:00:00	01:00:00.0	01:00:00.0	49.1	67.8	44.7
10	2019-03-05	19:00:00	01:00:00.0	01:00:00.0	46.9	61.2	44.3
11	2019-03-05	20:00:00	01:00:00.0	01:00:00.0	46.7	64.3	44.6
12	2019-03-05	21:00:00	01:00:00.0	01:00:00.0	45.9	61.0	43.7
13	2019-03-05	22:00:00	01:00:00.0	01:00:00.0	46.6	72.7	43.3
14	2019-03-05	23:00:00	01:00:00.0	01:00:00.0	47.4	72.9	43.0
1	2019-03-06	00:00:00	01:00:00.0	01:00:00.0	44.4	60.5	42.6
2	2019-03-06	01:00:00	01:00:00.0	01:00:00.0	44.4	60.8	42.4
3	2019-03-06	02:00:00	01:00:00.0	01:00:00.0	44.3	61.6	42.6
4	2019-03-06	03:00:00	01:00:00.0	01:00:00.0	44.4	52.8	42.7
5	2019-03-06	04:00:00	01:00:00.0	01:00:00.0	45.5	53.8	43.1
6	2019-03-06	05:00:00	01:00:00.0	01:00:00.0	49.2	59.0	44.6
7	2019-03-06	06:00:00	01:00:00.0	01:00:00.0	53.4	72.0	48.7
8	2019-03-06	07:00:00	01:00:00.0	01:00:00.0	57.6	74.3	51.0
9	2019-03-06	08:00:00	01:00:00.0	01:00:00.0	53.4	73.9	48.5
10	2019-03-06	09:00:00	01:00:00.0	01:00:00.0	52.1	66.0	47.9
11	2019-03-06	10:00:00	01:00:00.0	01:00:00.0	62.7	85.8	47.4
12	2019-03-06	11:00:00	01:00:00.0	01:00:00.0	53.3	71.2	48.1
13	2019-03-06	12:00:00	01:00:00.0	01:00:00.0	52.1	69.6	47.7
14	2019-03-06	13:00:00	01:00:00.0	01:00:00.0	56.4	85.2	47.4
15	2019-03-06	14:00:00	01:00:00.0	01:00:00.0	53.2	68.5	47.5
16	2019-03-06	15:00:00	01:00:00.0	01:00:00.0	52.7	69.7	47.6
17	2019-03-06	16:00:00	01:00:00.0	01:00:00.0	55.0	75.9	47.3
18	2019-03-06	17:00:00	01:00:00.0	01:00:00.0	49.9	63.2	46.8
19	2019-03-06	18:00:00	01:00:00.0	01:00:00.0	49.3	68.3	45.3
20	2019-03-06	19:00:00	01:00:00.0	01:00:00.0	47.9	64.7	44.0
21	2019-03-06	20:00:00	01:00:00.0	01:00:00.0	46.9	63.8	43.5
22	2019-03-06	21:00:00	01:00:00.0	01:00:00.0	54.4	80.4	43.7
23	2019-03-06	22:00:00	01:00:00.0	01:00:00.0	45.6	61.3	43.0
24	2019-03-06	23:00:00	01:00:00.0	01:00:00.0	46.1	62.3	42.9
1	2019-03-07	00:00:00	01:00:00.0	01:00:00.0	44.7	62.1	43.1
2	2019-03-07	01:00:00	01:00:00.0	01:00:00.0	46.3	65.5	43.2
3	2019-03-07	02:00:00	01:00:00.0	01:00:00.0	45.0	55.3	43.4
4	2019-03-07	03:00:00	01:00:00.0	01:00:00.0	44.6	56.0	43.0
5	2019-03-07	04:00:00	01:00:00.0	01:00:00.0	45.4	55.1	40.1
6	2019-03-07	05:00:00	01:00:00.0	01:00:00.0	48.4	57.2	44.7
7	2019-03-07	06:00:00	01:00:00.0	01:00:00.0	53.6	74.1	47.9
8	2019-03-07	07:00:00	01:00:00.0	01:00:00.0	52.7	69.1	46.9
9	2019-03-07	08:00:00	01:00:00.0	01:00:00.0	65.5	93.6	45.4
10	2019-03-07	09:00:00	01:00:00.0	01:00:00.0	51.0	63.4	48.4
11	2019-03-07	10:00:00	01:00:00.0	01:00:00.0	52.9	68.4	49.3
12	2019-03-07	11:00:00	01:00:00.0	01:00:00.0	52.0	70.7	47.7
13	2019-03-07	12:00:00	01:00:00.0	01:00:00.0	51.2	68.0	46.9
14	2019-03-07	13:00:00	01:00:00.0	01:00:00.0	59.3	84.0	47.6
15	2019-03-07	14:00:00	01:00:00.0	01:00:00.0	53.4	76.0	46.5
16	2019-03-07	15:00:00	01:00:00.0	01:00:00.0	55.1	78.4	48.3
17	2019-03-07	16:00:00	01:00:00.0	01:00:00.0	58.1	83.2	47.8
18	2019-03-07	17:00:00	01:00:00.0	01:00:00.0	49.4	66.9	46.0
19	2019-03-07	18:00:00	01:00:00.0	01:00:00.0	49.8	66.0	46.0
20	2019-03-07	19:00:00	01:00:00.0	01:00:00.0	49.8	66.3	45.1
21	2019-03-07	20:00:00	01:00:00.0	01:00:00.0	46.9	58.1	43.8
22	2019-03-07	21:00:00	01:00:00.0	01:00:00.0	46.7	62.3	43.6
23	2019-03-07	22:00:00	01:00:00.0	01:00:00.0	45.6	58.3	43.1
24	2019-03-07	23:00:00	01:00:00.0	01:00:00.0	48.2	64.9	43.4
1	2019-03-08	00:00:00	01:00:00.0	01:00:00.0	46.0	62.2	43.1
2	2019-03-08	01:00:00	01:00:00.0	01:00:00.0	45.7	63.9	43.4
3	2019-03-08	02:00:00	01:00:00.0	01:00:00.0	44.4	53.8	43.6
4	2019-03-08	03:00:00	01:00:00.0	01:00:00.0	44.9	55.1	43.8
5	2019-03-08	04:00:00	01:00:00.0	01:00:00.0	45.5	52.1	42.0
6	2019-03-08	05:00:00	01:00:00.0	01:00:00.0	49.6	72.9	45.9
7	2019-03-08	06:00:00	01:00:00.0	01:00:00.0	51.6	70.5	48.7
8	2019-03-08	07:00:00	01:00:00.0	01:00:00.0	54.4	79.1	48.3
9	2019-03-08	08:00:00	01:00:00.0	01:00:00.0	53.2	77.1	47.0
10	2019-03-08	09:00:00	01:00:00.0	01:00:00.0	49.7	64.2	45.8
11	2019-03-08	10:00:00	01:00:00.0	01:00:00.0	50.0	69.7	46.1
12	2019-03-08	11:00:00	01:00:00.0	01:00:00.0	53.8	73.0	46.8
13	2019-03-08	12:00:00	00:19:59.6	00:19:59.6	50.6	65.4	46.0

APPENDIX B

ACOUSTIC MODELING RESULTS

Name	M.	ID	Level Lr		Limit. Value		Octave Band Day									Land Use			Height		Coordinates		
			Day	Night	Day	Night	31	63	125	250	500	1000	2000	4000	8000	Type	Auto	Noise Type			X	Y	Z
			(dBA)	(dBA)	(dBA)	(dBA)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)				(m)		(m)	(m)	(m)
186 New Estate Road (window)		Res	35.7	35.7	0	0	34	44.1	37.1	33.4	31.3	31.5	28.4	23.5	8.9			Total	4.57	r	198776.6	921664.88	91.44
186 New Estate Road (PL)		Res	40.6	40.6	0	0	37.1	48.4	40.8	35.8	34.3	36.1	34.3	31	19			Total	1.52	r	198750.43	921629.21	81.25
184 New Estate Road (window)		Res	38	38	0	0	35.6	45.8	38.8	35.3	33.3	33.6	30.8	26.7	14.8			Total	4.57	r	198808.52	921649.76	91.86
184 New Estate Road (PL)		Res	42	42	0	0	36.6	46.8	40.1	37.1	35.9	37	35.4	33.7	25.2			Total	1.52	r	198798.86	921623.5	88.3
174 New Estate Road (window)		Res	36.3	36.3	0	0	37.4	47.3	39.7	34.9	32.4	31.8	28.2	23.8	14.8			Total	1.52	r	198882.45	921642.2	88.79
174 New Estate Road (PL)		Res	44.9	44.9	0	0	40.1	50.1	43.5	40.5	39.8	39.5	38	36.8	31.7			Total	1.52	r	198852.11	921607.86	88.52
170 New Estate Road (window)		Res	36.3	36.3	0	0	37.6	47.5	39.9	35	32	31.7	28.1	23.8	15.3			Total	1.52	r	198915.42	921636.42	88.71
170 New Estate Road (PL)		Res	49.7	49.7	0	0	43	52.8	46.6	43.8	42.9	44	42.9	42.3	39.5			Total	1.52	r	198897.09	921593.41	88.25
166 New Estate Road (window)		Res	39.1	39.1	0	0	37.8	47.8	40.5	36.1	33.7	34.6	32.2	28.8	18.3			Total	4.57	r	198942.31	921630.12	91.65
166 New Estate Road (PL)		Res	50	50	0	0	43.4	53.1	47.1	44.3	43.2	44.3	43	42.4	40.3			Total	1.52	r	198925.64	921583.11	88.09
160 New Estate Road (window)		Res	35.1	35.1	0	0	37.1	47	39.3	34.5	30.4	30.7	26.8	22.2	13.5			Total	1.52	r	198975.91	921615	88.3
160 New Estate Road (PL)		Res	47.8	47.8	0	0	41.9	51.8	45.5	42.8	41.3	42.2	41	40.2	37.2			Total	1.52	r	198954.91	921572.66	88.03
156 New Estate Road (window)		Res	34	34	0	0	36.3	46.2	38.7	34	30.2	29.2	25.1	20	10.9			Total	1.52	r	199005.73	921600.3	88.12
156 New Estate Road (PL)		Res	48.5	48.5	0	0	40	50.2	44	41.5	40.3	42.5	42.2	41.7	37.7			Total	1.52	r	198983.73	921559.63	87.7
152 New Estate Road (window)		Res	33.9	33.9	0	0	35.3	45.3	37.9	33.4	29.8	29.4	25.5	20.3	8.9			Total	1.52	r	199032.19	921591.06	87.98
152 New Estate Road (PL)		Res	46.2	46.2	0	0	40.7	52.1	44.4	39.7	38.4	40.4	40.1	39	33.1			Total	1.52	r	199010.52	921547.05	86.31
146 New Estate Road (window)		Res	32.2	32.2	0	0	34.1	44.1	36.9	32	27.5	27.7	23.7	17.8	2.5			Total	1.52	r	199064.12	921578.46	87.67
146 New Estate Road (PL)		Res	44.3	44.3	0	0	36.6	47.8	41.5	38.2	37.9	39.5	37.9	36	28.2			Total	1.52	r	199038.11	921534.12	87.54
132 New Estate Road (window)		Res	35.5	35.5	0	0	32.7	42.9	36.1	33.1	31	31.1	28.4	23.8	8.2			Total	4.57	r	199106.96	921551.15	90.46
132 New Estate Road (PL)		Res	35	35	0	0	33.5	43.6	36.9	33.3	30.3	30.7	27.6	22.5	7.2			Total	1.52	r	199089.62	921508.48	87.13
126 New Estate Road (window)		Res	28	28	0	0	31	40.9	33.6	28.5	23.7	23.5	18.7	10.6	-10.8			Total	1.52	r	199150.68	921530.31	85.89
126 New Estate Road (PL)		Res	31.5	31.5	0	0	31.6	41.7	34.9	30.9	27.4	27.2	23.3	16.5	-3.4			Total	1.52	r	199134.34	921488.64	86.86
122 New Estate Road (window)		Res	28.9	28.9	0	0	30	40	33.1	28.6	24.7	24.8	20.4	12.1	-12.7			Total	1.52	r	199183.68	921516.3	86.38
122 New Estate Road (PL)		Res	30	30	0	0	30.5	40.6	33.8	29.7	26.3	25.7	21.5	14	-8.7			Total	1.52	r	199162.34	921472.96	86.32
118 New Estate Road (window)		Res	29.7	29.7	0	0	29.2	39.4	32.6	28.9	25.8	25.6	21.6	13.7	-11.9			Total	4.57	r	199211.68	921499.3	90.28
118 New Estate Road (PL)		Res	29.3	29.3	0	0	29.8	39.9	33.1	29	25.7	24.9	20.7	12.6	-12.2			Total	1.52	r	199185.68	921460.63	87.12
1A Sleigh Ride Lane (window)		Res	28.2	28.2	0	0	28.5	38.6	31.8	28	24.7	23.9	19.4	10.2	-18.7			Total	4.57	r	199236.02	921463.3	89.99
1A Sleigh Ride Lane (PL)		Res	30.3	30.3	0	0	30.6	40.7	34	29.9	26.6	25.9	21.8	14.3	-8.2			Total	1.52	r	199158.68	921463.97	86.93
1 Sleigh Ride Lane (window)		Res	29.7	29.7	0	0	29.5	39.8	33	29.1	26.4	25.4	21.2	12.9	-12.6			Total	4.57	r	199180.68	921415.62	90.05
1 Sleigh Ride Lane (PL)		Res	32.6	32.6	0	0	32.3	42.5	35.7	31.8	29	28.1	24.3	17.9	-0.5			Total	1.52	r	199093.67	921424.96	86.43
3 Sleigh Ride Lane (window)		Res	30	30	0	0	29.8	40	33.2	29.4	26.7	25.7	21.6	13.6	-11.3			Total	4.57	r	199156.68	921382.95	89.69
3 Sleigh Ride Lane (PL)		Res	34.1	34.1	0	0	33.2	43.4	36.6	32.9	30.3	29.7	26.3	20.8	4.6			Total	1.52	r	199071	921427.63	86.47
5 Sleigh Ride Lane (window)		Res	34	34	0	0	33.3	42.2	35.8	32.5	30	30	26.3	19.2	-4			Total	4.57	r	199123.34	921347.61	89.59
5 Sleigh Ride Lane (PL)		Res	37.5	37.5	0	0	35.7	47.5	40.2	34.4	32.6	33.3	30.2	25	9			Total	1.52	r	199064.33	921416.62	85.89
7 Sleigh Ride Lane (window)		Res	34.7	34.7	0	0	32.2	43.5	36.9	32.7	29.4	30.7	27.5	21.4	0.9			Total	4.57	r	199051.99	921302.94	88.3
7 Sleigh Ride Lane (PL)		Res	36.2	36.2	0	0	35.6	46.1	39.4	33.5	31.1	32.1	28.8	23	5.6			Total	1.52	r	199035.99	921364.28	79.49
9 Ayer Road (window)		Res	38	38	0	0	31.5	43.4	34.5	32.4	31.6	34	32.1	26.8	5.4			Total	4.57	r	198936.36	921221.31	87.5
9 Ayer Road (PL)		Res	39.8	39.8	0	0	34.7	46.8	37.9	32.6	31.9	35.5	34.2	29.9	12			Total	1.52	r	198923.36	921261.99	82.42
37 Ayer Road (PL)		Ind	46.2	46.2	0	0	43.6	54.6	47.2	41.4	38.8	41.5	39.5	37.6	32.7			Total	1.52	r	198928.88	921449.26	70.12
80 Ayer Road (PL)		Ind	27.3	27.3	0	0	31.9	40.6	32.6	26.8	22	23.1	18.9	10.8	-12.4			Total	1.52	r	198655.19	921382.66	69.74
53 Ayer Road (PL)		Ind	30.2	30.2	0	0	28.6	38.9	32	28.5	26.7	26.1	22.3	13.5	-14.6			Total	1.52	r	198568.32	921626.1	74.15

MassDEP Pure Tone Analysis:									
	Octave Band (Hz)								
	31	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
at Upper Story Window	**(dB)**	**(dB)**	**(dB)**	**(dB)**	**(dB)**	**(dB)**	**(dB)**	**(dB)**	**(dB)**
166 New Estate Road (window)	38	48	41	36	34	35	32	29	18
Ambient Sound Level	50	41	37	37	36	31	20	17	18
Total Sound Level	50	49	42	39	38	36	32	29	21
MassDEP Pure Tone?		No	No	No	No	No	No	No	
	Octave Band (Hz)								
	31	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
at Property Line	**(dB)**	**(dB)**	**(dB)**	**(dB)**	**(dB)**	**(dB)**	**(dB)**	**(dB)**	**(dB)**
166 New Estate Road (PL)	43	53	47	44	43	44	43	42	40
Ambient Sound Level	53	45	43	39	41	41	32	28	28
Total Sound Level	54	54	49	45	45	46	43	43	41
MassDEP Pure Tone?		No	No	No	No	No	No	No	