CONCORD EXPANSION PROJECT

BASELINE SOUND SURVEY AND NOISE IMPACT ASSESSMENT

Pelham, New Hampshire

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TABLES

1.0 INTRODUCTION

El Paso Corporation (the Applicant) proposes to construct and operate a new compressor station, referred to as the Concord Expansion Project (or the Project) in this report, on an undeveloped parcel of property located in the Town of North Pelham (Hillsborough County), New Hampshire. In support of the environmental permitting process, Tetra Tech EC Inc. has completed a screening level noise impact assessment (NIA) to determine the feasibility of the Project to operate in compliance with all applicable regulatory environmental noise limits.

1.1 Project Acoustic Study Area

The project acoustic study area is of mixed use including residential, commercial, industrial, and undeveloped forested lands. An industrial park and cargo container storage facility is located to the south and southwest of the Project site. There are several residential structures within the acoustic study area consisting of both single family and multi-family dwellings. These residential areas were identified as the potential noise sensitive areas (NSAs) for the purposes of the Noise Impact Assessment (NIA). While the Project site is located in North Pelham, there are several NSAs to the north and east of the project site within the adjacent Town of Windham in Rockingham County. The project plot plan and the linear distance from the stack to discrete NSA locations is provided in Appendix A, Figure A-1.

1.2 Acoustic Terminology

Noise is typically defined as unwanted sound. When a sound becomes noise is a highly subjective determination. The unit of sound pressure is the decibel (dB). The decibel scale is logarithmic to accommodate the large dynamics of sound intensities to which the human ear is subjected. By definition, the decibel corresponds to a logarithmic scale formed by taking 20 times the logarithm (base 10) of the ratio of two sound pressures (L_P): the measured sound pressure divided by a reference sound pressure. The reference sound is 20 dB re μPa (0 dB), the approximate threshold of human perception of sound at a frequency of 1000 Hz. The loudness of a sound is typically reported by equipment manufacturers as the source sound power level (L_W), or the total acoustic power radiated in decibels referenced to 10-12 watts. Sound power ratings are independent of environmental conditions in comparison to received sound pressure levels, which include the effects of propagation and attenuation that occur between the source and receptor. An inherent property of the logarithmic decibel scale is that the sound pressure levels of two separate sounds are not directly additive. For example, if a

sound of 50 dB is added to another sound of 50 dB, the total is a 3-decibel increase (or 53 dB), not an arithmetic doubling to 100 dB.

Environmental sound is typically composed of acoustic energy across a wide range of frequencies, referred to as the frequency spectra; however, the human ear does not interpret the sound level from each frequency as equally loud. To compensate for the physical response of the human ear, the A-weighting filter is commonly used for describing environmental sound levels. A-weighting filters the frequency spectrum of sound levels to correspond to the human ear frequency response (attenuating low and high frequency energy similar to the way people hear sound). Sound levels that are A-weighted to reflect human response are presented as dBA. The A-weighted sound level is the most widely accepted descriptor for community noise assessments. Unweighted sound levels are referred to as linear decibels, dB or dBL.

Sound levels can be measured and presented in various formats. The most common sound metric used in community sound surveys is the equivalent sound level (Leq). The Leq level is the energy averaged, A-weighted sound pressure level that occurs over a given time period, i.e., the steady, continuous sound level which has the same acoustic energy as the time-varying sound levels over the same time period. The Leq has been shown to provide both an effective and uniform method for comparing time-varying sound levels and has been routinely employed in environmental NIAs.

Another sound metric often used in assessing noise impacts is the Day-Night sound level (Ldn). The Ldn is an energy average of the daytime Leq (i.e., Leq-d) and nighttime Leq (i.e., Leq-n) plus 10 dB. For an essentially steady sound source (e.g., gas compressor station) that operates continuously over a 24-hour period and effectively controls the environmental sound level, the Ldn is approximately 6.4 dB above the steady state Leq. Lmax is the maximum A-weighted sound level as measured during a specified time period. It can also be described as the maximum amount of acoustic energy generated by a piece of equipment.

The noise metrics defined are broadband, i.e., inclusive of sound across the entire audible frequency spectrum. In addition to broadband, sound level data typically includes an analysis of the various frequency components of the sound spectrum to determine the potential for tonal characteristics and for use in designing effective noise mitigation measures. 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 Hz (low) to 16,000 Hz (high).

2.0 EXISTING CONDITIONS

A baseline sound survey was completed on August 22 and 23, 2007 to document existing sound levels in the vicinity of the proposed Project. Specifically baseline conditions were assessed near four of the NSAs. NSAs are defined as the nearest residences in all geographical directions around the Project site, and can also include churches and schools.

2.1 Sound Survey Methodology

Ambient sound level measurements of a minimum 30-minute duration were taken near four of the closest NSAs in the vicinity of the Project site on August 22 and 23, 2007. Nighttime measurements were completed from 11 p.m. to 2 a.m., and daytime levels were recorded between 11 a.m. to 3 p.m. All measurements were taken with a Larson Davis 831 real-time sound level analyzer that has an operating range of 15 to 140 dBA and an overall frequency range of 3.5 to 20,000 Hz. This meter meets or exceeds all requirements set forth in the American National Standards Institute (ANSI) Standards (S1.4 and S1.11) for Type 1 instruments in terms of quality and accuracy. All instrumentation was laboratory calibrated within the previous 12-month period. Prior to, and immediately following both measurement sessions, the sound analyzer was calibrated (no level adjustment was required) with an ANSI Type 1 calibrator which has an accuracy traceable to the National Institute of Standards and Technology (NIST). For all measurement sessions, the microphone was fitted with a 3" windscreen and tripod-mounted at approximately five feet above the ground in open areas away from vertical reflecting surfaces. Extraneous sound events and cricket noise (seasonal) were systematically removed from the baseline data set.

Weather conditions during the sound survey were conducive to accurate sound level monitoring. August 22-23 had partial cloudy to overcast skies, calm to variable light winds (under 6 mph), and an average temperature of 75°F (daytime) and 55°F (nighttime). There was no precipitation during or preceding any of the measurements, and area roadways were dry. Figure 1 (Appendix A, page A-1) presents the proposed Concord Expansion station and the location of the baseline noise monitoring positions in relation to the actual noise sensitive areas:

NSA 1 Western Winds adult condominium complex multifamily residential units with closest unit #19 approximately 210 meters N of the proposed turbine building. (Windham)

NSA 2 Two houses at #84 and #86 Mammoth Road near the intersection of Glance and Pleasant Streets with the closest house approximately 208 meters NE of the proposed turbine building. (Windham)

NSA 3	Two houses at #88 and #90 Mammoth Road with the closest house approximately 197 meters E of the proposed turbine building. (Windham)
NSA 4	#573 Mammoth Road and a second house under construction. The closest house is approximately 181 meters SE of the proposed turbine building (Pelham)

2.2 Sound Measurement Results

At the sound measurement positions, the equivalent (Leq) sound levels in A-weighted decibels sound pressure levels (SPLs) were data logged with results summarized in Table 1. Existing Leq sound levels were fairly consistent across the entire acoustic study area and ranged from 33 to 34 dBA at night and 43 to 47 dBA during the day, with slightly lower levels measured at receptor locations with greater setback distances in relation to area roadway due to reduced traffic noise exposure. Table 1 also includes the calculated Ldn at each NSA measurement position, interpolated from the representative daytime and nighttime short term monitoring results.

Table 1. Summary of Baseline Sound Survey Data - August 22 - 23, 2007

Measurement Location	Distance to Turbine Bldg (M)	Direction	Daytime Leq	Nighttime Leq	Calculated Ldn
NSA 1	210	N	43	33	43
NSA 2	208	NE	47	34	46
NSA 3	197	E	46	34	45
NSA 4	181	SE	45	33	44

The existing sound levels are typical of a rural/suburban residential area with traffic on nearby roadways and some localized industrial sources. The principal source of noise during measurements was intermittent traffic on the nearby roadways, activity at the nearby industrial complex to the south of the compressor station site occurring during the day, distant residential construction occurring within the Western Winds condominium complex to the north, and periodic aircraft flyovers. Birds, insects, and leaf rustle were the dominant sources of natural sound. The measured sound level data accurately quantifies the existing ambient sound levels around the site for the meteorological conditions that occurred during the sound survey.

3.0 NOISE REGULATIONS AND CRITERIA

3.1 Federal

The Department of Energy, under authority of the Federal Energy Regulatory Commission regulates noise from compressor stations under Part 380 – Regulations Implementing the National Environmental Policy Act (18 CFR 380.1). This regulation sets a limit for noise generated by a new or modified compressor station to an Ldn of 55 dBA at any pre-existing noise sensitive areas such as schools, hospitals, or residences.

3.2 State

There are no quantitative noise statutes or regulations in the State of New Hampshire with numerical decibel limits directly applicable to this Project.

3.3 Local

The Concord Expansion Project is proposed to be located in the Town of North Pelham, which is situated in Hillsborough County. North Pelham does not have a noise bylaw or ordinance with numerical decibel limits. The Town of Windham, which directly abuts the proposed site, has set frequency dependant noise limits which are provided in Section 714 of the *Town of Windham Zoning Ordinance and Land Use Regulations*. These noise regulations only apply to sound-emitting facilities within the Town of Windham and are therefore not applicable to the proposed Concord Expansion Project, which is located entirely within North Pelham[1]. Neither Hillsborough County nor Rockingham County, which was also considered because it is adjacent to the site, has noise regulations directly applicable to this project.

[1] Teleconference: Alfred Turner (Planning Director), Planning and Development Department, Town of Windham, November 29, 2007

4.0 ACOUSTIC MODELING METHODOLOGY

This report section describes the noise generating equipment, noise modeling procedures, and preliminary noise mitigation measures that will be incorporated into the final engineering design, as necessary, to ensure compliance with applicable regulatory limits as identified in Section 3.

4.1 Sound Source Identification

This NIA presents a conservative estimate of sound levels that would result during normal facility operation. Sound source power levels were estimated using equipment manufacturers sound specifications, engineering guidelines, and field data collected from recently sited compressor stations of similar scope and size. The following sound sources were considered in the acoustic modeling:

- Solar Centaur compressor turbine with a total station rating of 6,130 hp which includes:
  - > Turbine air intake and exhaust systems
  - > Turbine mechanical (casing) noise
  - > Exhaust line and stack
- Gas-fired Caterpillar G3406TA auxiliary generator
- Compressor building ventilation system
- External lube oil cooler (fin-fan design)
- External gas aftercooler (fin-fan design)
- Above ground compressor station piping

4.2 Acoustic Modeling Software

The operational noise impact assessment was performed using the most recent Project design layout as of November 27, 2007, employing the current release version of Datakustic GmbH's CadnaA, the computer aided noise abatement program (v 3.7). CadnaA is a comprehensive 3-dimensional acoustic model for sound propagation and attenuation. The software package calculates environmental sound in accordance with the International Standard ISO 9613 "Acoustics - Attenuation of Sound During Propagation Outdoors". ISO 9613 is an internationally recognized standard specifically developed to ensure the highly accurate calculation of environmental noise in the outdoor environment. The engineering methods specified in this standard consist of 1/1 octave band algorithms to account for propagation and attenuation of sound energy due to divergence with distance, surface and building reflections, air and ground

absorption, as well as sound wave diffraction and shielding effects caused by barriers, buildings, and ground topography. Offsite topography was determined using official USGS digital elevation data. Onsite topography changes were imported into the model using the latest Project AutoCAD gradation plan drawings. The CadnaA acoustic modeling software has been shown to be a highly accurate and effective acoustic modeling tool for modeling energy and industrial projects when appropriate modeling techniques, source data terms, and site-specific terrain conditions are considered.

The predicted maximum received SPLs are considered conservative due to the following:

- The model assumes downwind sound propagation conditions. The results presented herein also hold under a well-developed ground-based temperature inversion such as what commonly occurs on clear, calm nights.
- The model was programmed to ignore foliage attenuation by shrubs and trees. In other words, it represented worst case wintertime defoliate attenuation.
- Modeling assumes all equipment operating concurrently at maximum rated loads as would occur under normal operating conditions.
- For compliance with Federal Energy Regulatory Commission (FERC) criteria, the model assumes compressor station operation over a continuous 24-hour period to calculate the worst case 24-hour Ldn level.

4.3 Acoustic Modeling Results

The model was programmed to plot color coded sound contour isopleths at 1.52 meters above ground level, about the height of the ears of a standing person. Calculations at discrete NSA locations were made at a height of 4 meters, the approximate height of a second story window of a residential house. CadnaA acoustic modeling software assumes simultaneous operation of all sounds concurrently at their maximum rated loads under normal operating conditions. These results also include the noise reduction provided by the candidate noise mitigation measures, as summarized in Section 5 of this report.

Results from acoustic modeling are presented visually as color-coded sound contour isopleths in broadband 5 dBA increments on scaled USGS orthophotos maps, provided in Appendix A (Figures A-2 and A-3). Broadband A-weighted SPL results from the acoustic modeling are also

summarized in Table 2 at the discrete NSAs. The FERC criteria limit states that the sound contribution of the Concord Expansion Station should not exceed an Ldn of 55 dBA. The maximum Project sound levels at each NSA in terms of $Leq_{(1\text{-hour})}$ are: 47.5 dBA at NSA 1, 47.2 dBA at NSA 2, 45.7 dBA at NSA 3, and 48.3 dBA at NSA 4.

Table 2. Summary of Acoustic Modeling Results (dBA)

Measurement Location	Distance to Turbine Bldg (M)	Direction	Existing Ldn	Station Ldn	Total (Existing + Project) Ldn	Net Increase
NSA 1	210	N	43	53.9	54.2	11.2
NSA 2	208	NE	46	53.6	54.3	8.3
NSA 3	197	E	45	52.1	52.9	7.9
NSA 4	181	SE	44	54.7	55.0	11.0

5.0 CONCEPTUAL NOISE CONTROL DESIGN

The following section provides documentation of the source input data and noise control specifications used in the acoustic modeling. Any subsequent modifications to design, facility layout, equipment, building components, or elevations should be reviewed to determine effects on the results reported in this NIA.

5.1 Compressor Building Acoustic Envelope

The principal interior sound source within the compressor building will be the Solar gas turbine compressor mechanical noise.

Table 3. Estimated mechanical sound data L_w re 1 pW for Solar turbine

Octave Frequency Band (Hz)	31	63	125	250	500	1000	2000	4000	8000	A-wtd
Sound Power Level	106	110	112	112	110	108	111	118	111	121

The compressor building walls will be a self supporting dual panel type partition. As a minimum, walls/roof should be constructed with exterior steel of 24 gauge and interior layer of 6-inch thick unfaced mineral wool (e.g., 6.0-8.0 pcf uniform density) covered with a 26 gauge perforated liner or an equal noise abatement technique. Thermal insulation, such as "R-19", should not be used as a substitute for the 6.0-8.0 pcf acoustical material.

Table 4. Estimated transmission loss for compressor building wall and roof components

Octave Frequency Band (Hz)	31	63	125	250	500	1000	2000	4000	8000
TL	-6	-8	-12	-18	-22	-25	-30	-35	-35

*Modeling assumed "AVERAGE" interior acoustic conditions: building internal surfaces covered in sound absorptive material, equipment surfaces generally hard and reflective.

Personnel entry doors should be insulated steel doors with 1/4 inch thick laminated glass. Doors should be gasketed and, provide a good seal with the doorframe and be self-closing. No windows or louvers should be installed, although a few skylights could be installed in the building roof to provide natural light. All voids and openings in building walls resulting from

penetrations should be patched and well sealed. All perimeters, joints, panels should be sealed airtight with a flexible acoustical sealant. Overhead roll-up doors, as a minimum, should be a 24 gauge insulated type design (e.g., 24 gauge exterior with a 24 gauge backskin with insulation core) and should be gasketed to ensure a good seal when closed.

5.2 Building Ventilation System

The A-weighted sound level for each building air supply and exhaust fan with noise control and/or roof-mounted fan ventilator should not exceed 50 dBA at 50 feet from the fan hood. Building ventilation fans should include a metal boot enclosing the fan; a minimum 36-inch length exterior silencer and a weather hood lined with acoustical insulation to eliminate the potential for interior building noise breakout. If assuming separate roof exhaust vents are utilized, each roof exhaust vent should also include a 36-inch length silencer (i.e., baffle-type design) mounted between the building surface and vent/hood (i.e., in the ventilator throat). The fan cabinet openings should be directed away from NSAs, when practical.

If wall louvers are employed for ventilation instead of forced air fans, acoustic louvers may be utilized as an alternative. If acoustic louvers are employed, they should be designed with a minimum 12-inch thick/depth extruded acoustical-type louver system. The louvered openings should be located on turbine building sides that are directed away from noise sensitive areas and capable of providing the following free field noise reduction values.

Table 5. Estimated free field noise reduction values for acoustical louvers

Octave Frequency Band (Hz)	31	63	125	250	500	1000	2000	4000	8000
TL	-3	-7	-12	-14	-16	-18	-20	-16	-14

5.3 Turbine Exhaust System

Table 6. Estimated exhaust sound data L_w re 1 pW for Solar turbine

Octave Frequency Band (Hz)	31	63	125	250	500	1000	2000	4000	8000	A-wtd
Sound Power	127	128	127	127	131	128	122	113	101	132

Level

Exhaust noise should be attenuated with a critical grade exhaust stack silencer meeting that provides the following dynamic insertion loss (DIL) capabilities.

Table 7. Estimated exhaust silencer dynamic insertion loss (DIL) for Solar turbine

Octave Frequency Band (Hz)	31	63	125	250	500	1000	2000	4000	8000
DIL	-8	-13	-20	-31	-37	-37	-35	-25	-15

Consideration of exhaust system exterior duct break out noise should be considered in the detailed Project design phase. For the purposes of the acoustic modeling analysis, it was assumed that the exhaust silencer is to be located outside of the compressor building and the breach stack and muffler should include acoustical covering on the outside with a heavy layer of acoustical lagging such as a 3-in. thick inner layer of high-density insulation (e.g., 6.0-8.0 pcf mineral wool or ceramic fiber) covered with a heavy-gauge galvanized steel jacketing (minimum 22 gauge) or equal noise abatement techniques to achieve an adequate transmission loss.

5.4 Turbine Air Intake System

Table 8. Estimated air intake system sound data L_w re 1 pW for Solar turbine

Octave Frequency Band (Hz)	31	63	125	250	500	1000	2000	4000	8000	A-wtd
Sound Power Level	101	100	95	91	99	127	138	138	125	141

The air intake system should be attenuated using an in-line silencer with at least 1/2 of unit located within the compressor building to control intake ducting breakout noise outside of the compressor building. The turbine air intake system is located on the south wall of the proposed compressor building wall.

Table 9. Estimated air intake silencer dynamic insertion loss (DIL) for Solar turbine

Octave Frequency Band (Hz)	31	63	125	250	500	1000	2000	4000	8000
TL	-2	-4	-5	-9	-18	-41	-46	-48	-40

5.5 Turbine Lube Oil Cooler

It is recommended that the turbine manufacturer's electric motor driven low noise lube oil cooler is utilized for this Project, meeting the following noise emission sound power levels. The lube oil cooler is located on the south side of the proposed compressor station building.

Table 10. Estimated turbine lube oil cooler sound data L_w re 1 pW

Octave Frequency Band (Hz)	31	63	125	250	500	1000	2000	4000	8000	A-wtd
Sound Power Level	103	101	98	95	93	91	89	88	83	97

5.6 Station Gas Aftercooler

The compressor station gas aftercooler should be specified to meet the following sound power levels with all fans and motors operating at their maximum rated load. To meet this specification, "ultra low-noise" fans, such as Howden E-series fans (or equivalent) are required. Standard Moore gas aftercooler fans are not expected to be capable of meeting this noise design requirement. In addition, above-ground inlet pipe risers at the cooler should be covered with acoustical pipe insulation.

Table 11. Estimated gas aftercooler sound data L_w re 1 pW

Octave Frequency Band (Hz)	31	63	125	250	500	1000	2000	4000	8000	A-wtd
Sound Power Level	107	107	101	97	93	91	87	85	83	97

5.7 Aboveground Gas Piping

Our acoustical analysis has conservatively assumed that the above-ground discharge piping outside of the compressor building will be covered with acoustical pipe insulation or equal noise abatement techniques. This piping should be covered (i.e., lagged) with a minimum 3" thick fiberglass or mineral wool (e.g., minimum 6.0 - 8.0 pcf uniform density) that is covered with a mass-filled vinyl jacket (e.g., composite of 1.0 psf mass-filled vinyl laminated to 0.020" thick aluminum). It is also recommended that the aboveground gas piping should be completely separated from other metal structures such as metal gratings, walkways and stairs around the

piping. The location of above ground piping was assumed to be limited to the area between the valve shed and station gas aftercooler.

Table 12. Estimated transmission loss of pipe lagging for above ground piping

Octave Frequency Band (Hz)	31	63	125	250	500	1000	2000	4000	8000
TL	0	0	-1	-2	-8	-16	-18	-20	-20

5.8 Auxiliary Equipment

Gas blowdown silencers (i.e., unit piping purge/unit blowdown and starting gas) should be designed to meet a 60 dBA at 300 ft. as measured 5 ft. above the ground. To meet this noise goal, the "effective length" of the silencer section for the unit blowdown silencer would typically be 20-25 feet.

Fuel Gas Skids: It is recommended that any fuel gas skids be designed with regulators that can achieve 85 dBA at 3 ft. for the worst case design conditions which typically occur at maximum pressure drop and flow across the regulator valve.

Station Standby Generator: It is recommended that the generator should not exceed 70 dBA at 100 ft. from the auxiliary building at rated operating conditions. This sound specification includes, but is not limited to, the following noise sources associated with the generator: (1) noise of the engine-generator that penetrates the auxiliary building, (2) noise of the exterior jacket/auxiliary water cooler, (3) noise of the engine exhaust (hospital/critical grade muffler should be employed), and (4) noise of the air intake system.

6.0 CONCLUSIONS

This NIA involved the following five steps: (1) establishment of pre-development ambient sound levels in the vicinity of the Site; (2) identification of potential noise sources; (3) determination of noise source terms based on industry guidelines and from similar recently constructed projects; (4) conservative predictions of maximum sound levels at NSAs using the CadnaA sound propagation model that employs standard acoustic engineering calculation methods per ISO Standard 9613.2; and (5) the identification of candidate noise mitigation measures and design specifications that will ensure compliance with applicable regulatory criteria. The results of this NIA demonstrate that the proposed Project can be designed, constructed and operated to fully comply with the regulatory limits at all NSAs. In conclusion, with the mitigation outlined in this

report, the proposed Project will not create a noise nuisance condition and will fully comply with the most stringent sound level limits set by the Federal Energy Regulatory Commission.

The Concord Expansion Project is currently only at a schematic level at this time. It is important to note that this report is an NIA and does not provide the finalized detailed acoustic design. The candidate noise control mitigation measures identified in this report may not be required, i.e. pipe lagging on above ground pipe lagging. As the detailed design of the facility is finalized, potential noise sources and noise control measures may change. Once the detailed design is complete, noise associated with the Project will be reviewed and noise control measures will be adopted so as to fully comply with FERC noise criteria.

Technical References:

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5. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), 1989 ASHRAE Handbook—Fundamentals, Atlanta, Georgia, 1989.
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7. "Highway Traffic Noise Analysis and Abatement, Policy and Guidance", US Department of Transportation, Federal Highway Administration, June 1995.
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9. Edison Electric Institute, Electric Power Plant Environnemental Noise Guide, 1985.

APPENDIX A

FIGURES AND NOISE CONTOUR PLOTS

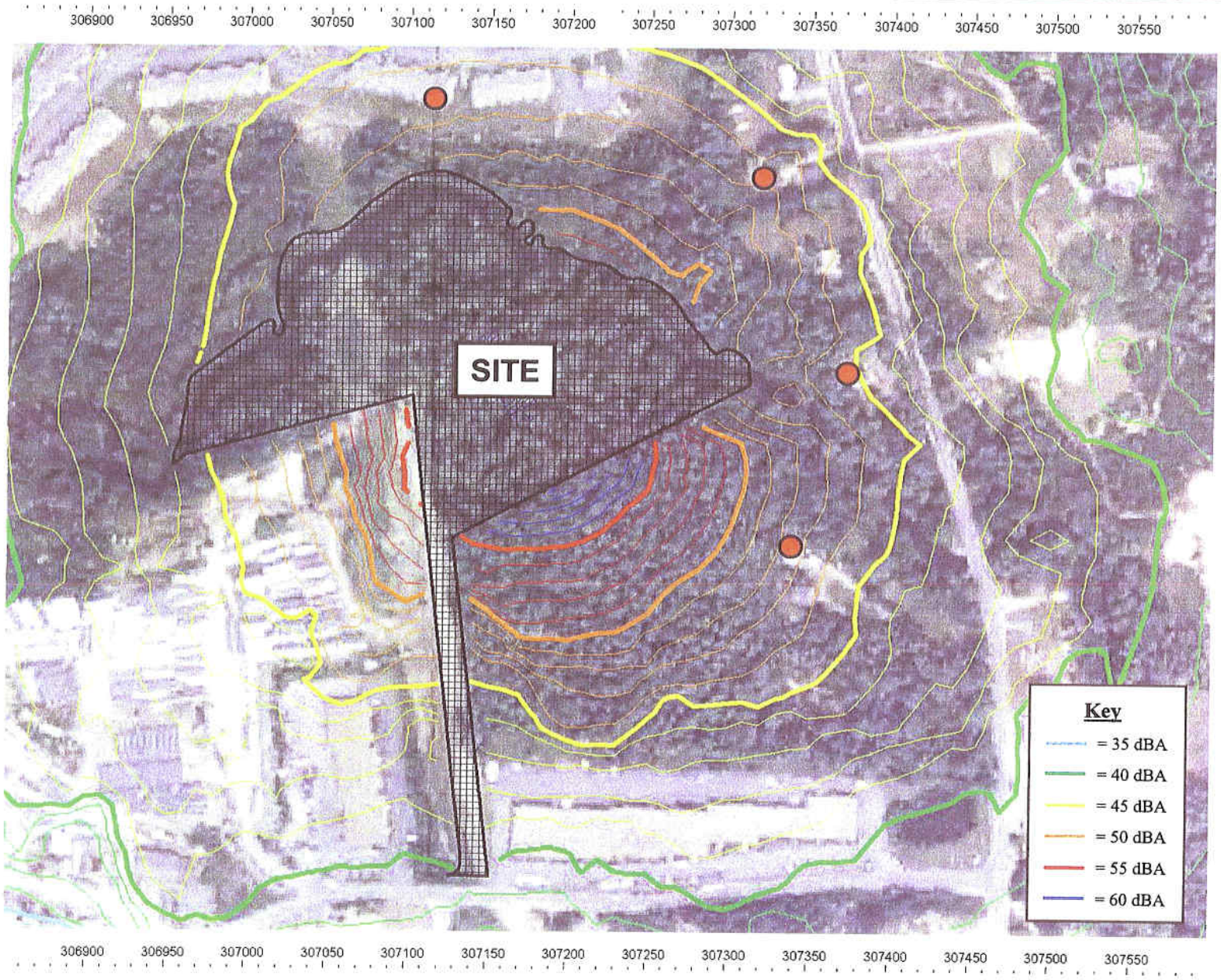

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FIGURE A-2.
Maximum Project Sound Levels at 1.52 Meters Above Grade Leq (1-hour)
Concord Expansion Project – North Pelham, NH

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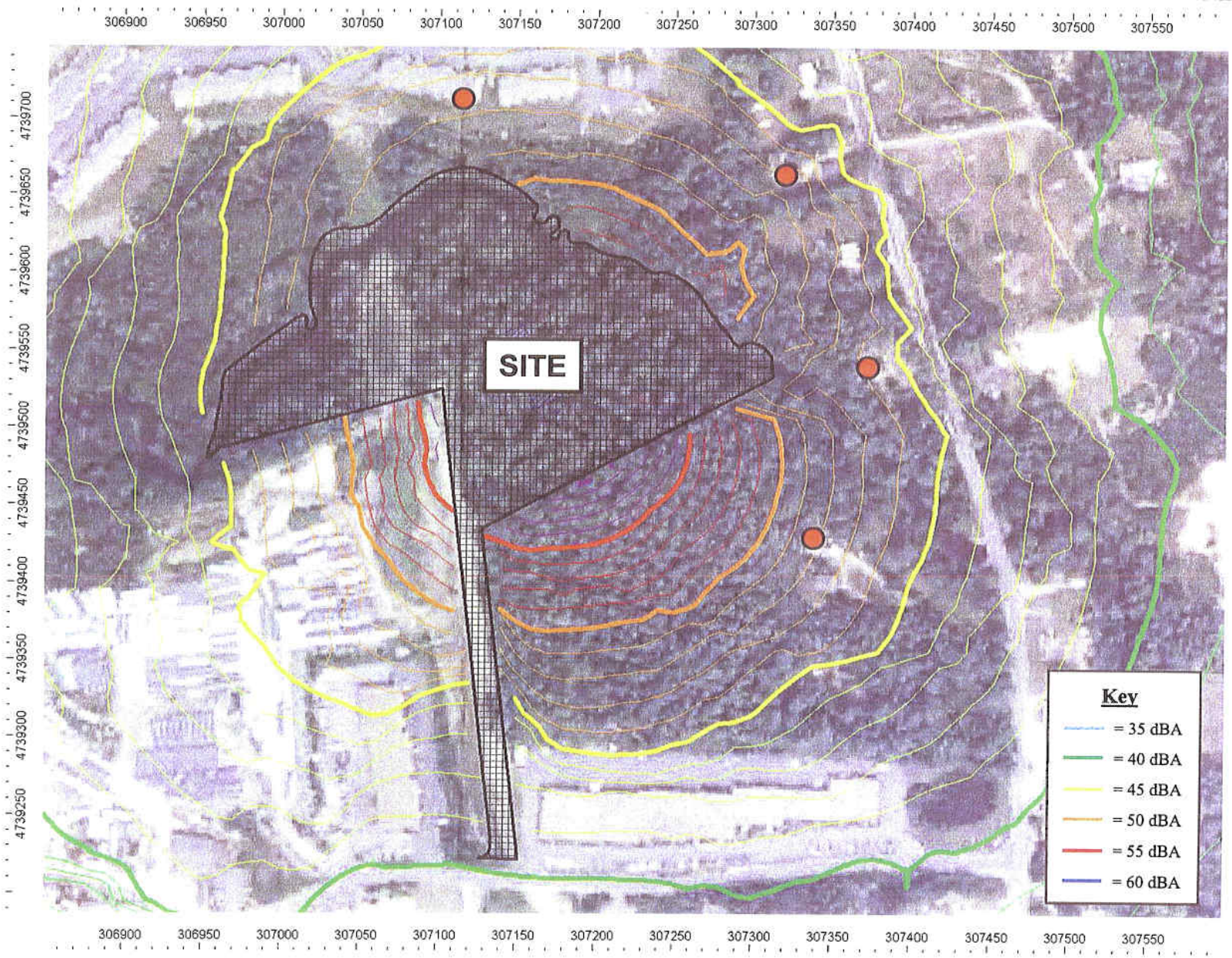

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FIGURE A-3.
Maximum Project Sound Levels at 4 Meters Above Grade Leq (1-hour)
Concord Expansion Project – North Pelham, NH

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