Sandbar Station Sound Assessment

Milton, Vermont

PREPARED FOR

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Introduction

Vermont Electric Power Company, Inc. and VT Transco, LLC (together "VELCO") are proposing an expansion to the Sandbar Station (the "Project") located at 586 Bear Trap Road in Milton, Vermont. The proposed expansion will introduce new equipment, SmartValve Advanced Power Flow Control (APFC) solution built by Smart Wires, which has the potential to increase sound emissions from the overall site. Each SmartValve module is a single-phase modular Status Series Synchronous Compensator (m-SSSC) of which there are 4 in series per phase (12 total) for this project. VHB conducted a sound assessment of the existing and future sound conditions for the proposed expansion at the Project site. The existing sound condition was determined using sound monitoring conducted by VHB at and around the Project site. This assessment includes a summary of the ambient sound monitoring, modeling of the future sound conditions with the planned expansion, and an evaluation of the potential for undue sound conditions from the Project.

Site Description

The VELCO Sandbar station is located off of Bear Trap Road in Milton, approximately 1/3-mile northwest of the Lamoille River and approximately 1.25 miles east of Lake Champlain. U.S. Route 2 (Roosevelt Highway) is immediately west of the station, approximately 550 feet from the proposed equipment.

The existing station currently contains a control building, capacitor bank, Phase Shifting Transformer (PST), Overload Mitigation System (OMS) reactors, switches, and breakers. Changes to the station include the addition of twelve (12) SmartValve modules to be located on the east side of the existing station footprint. No existing equipment is planned to be relocated or replaced.

The closest residence is 4 Cub Road, located approximately 800 feet southwest of the existing transformer. The property at 584 Bear Trap Road is owned by VELCO and VELCO plans to demolish the house.

Regulatory Context

The Project is located in the Town of Milton, Vermont which has no quantifiable noise regulations.

American National Standards Institute Noise Standard

The American National Standards Institute (ANSI) Standard S12.9 Parts 4 and 5 (2017), "American National Standard Quantities of Procedure for Description and Measurement of Environmental Sound – Part 4: Noise Assessment and Prediction of Long-term Community Response" and "Part 5: Sound Level Descriptors for Determination of Compatible Land Use" specify methods to assess environmental sounds and predict potential annoyance response of a residential community to long-term outdoor noise. This is a general noise guideline that is often used to evaluate noise from energy facilities; however, there is no regulatory requirement for the Project to meet this noise standard. The ANSI sound standard accounts for the characteristics of the sound, such as tonality, onset rate, impulsivity, time of day, and day of week. A 5 dB penalty is applied to sounds that are tonal, as they have a greater potential to cause tonal conditions and would operate at night. The Project has the potential to cause tonal conditions and would operate at night, so the ANSI standard recommends an exterior nighttime noise limit of 40 dBA (Leq) applied outside residential buildings.

World Health Organization Guidelines

The World Health Organization (WHO) has "Night Noise Limits for Europe" guidelines which do not constitute a regulation or requirement. This guideline is generally considered to be the most stringent restriction of nighttime sound. Based on research of nighttime noise effects, WHO recommends a target outdoor night noise guideline (NNG) level of 40 dBA to protect the public, including the most vulnerable groups such as children, the chronically ill, and the elderly. An outdoor nighttime noise level of 55 dB is recommended as an interim target for countries where the NNG cannot be achieved in the short term for various reasons, and where policymakers choose to adopt a stepwise approach. This noise limit is applied outside residential buildings where nighttime noise may have an effect on people.

Consistent with the above-referenced ANSI Standard and WHO Standard, for VT Transco projects, VT Transco strives for sound goals of 40 dBA at the nearest residential building at nighttime and 45 dBA at the nearest property line.

Sound Monitoring

VHB has conducted sound monitoring at the existing station site. Sound monitoring included five short-term (approximately 5 minutes) measurements and long-term measurement (24-hours). The short-term measurements were conducted to establish the sound levels attributed to the existing transformer while the long-term measurement was used to determine the ambient sound level at the property line. Measurements were conducted using sound level meters meeting Type I accuracy according to the ANSI Standard S1.4 "Specifications for Sound Level Meters." The sound level meter was calibrated in the field prior to and following the short-term measurements and long-term measurements in addition to annually by a laboratory traceable to the National Institute of Standards and Technology. **Figure 1** shows the measurement locations around the Project Site.

The sound measurement data includes one-second time histories and overall period results including A-weighted and one-third octave band sound levels. Measurement results include the minimum, maximum, equivalent continuous (Leq), and sound level statistics such as the L10, L50, and L90. Observations of existing sources of sound in the vicinity of the Project were made during the short-term measurements and during deployment and retrieval of the long-term equipment. For constant sources of sound, such as transformers, the sound level statistic, L90, can be used to characterize the sound emissions. The L90 sound level excludes transient sources of sound such as cars passing, birds chirping, or wind. See **Attachment 1** for further background on concepts of sound.

Short-term Sound Monitoring

VHB conducted short-term (5-minute) sound measurements at five locations around the station to capture the sound emissions of the existing transformer and station on December 20, 2024. The transformer fans and pumps were all turned on to the second stage cooling condition (ODAF2) to capture the maximum sound emissions from the equipment. During these measurements, atmospheric conditions included temperatures around 24°F, wind speeds less than 5 mph, and no precipitation. At all five locations measured around the inside of the fenced perimeter of the station with the transformer operating at ODAF2, sound levels ranged from 53 dBA to 67 dBA (L90). The variation in measured sound levels is a function of the orientation of the transformer and the distance between the sound monitor and the transformer, which ranged from 45 to 170 feet. **Table 1** presents the measurement results that represent the contribution of both ambient sources and the existing station operating at ODAF2.

Table 1: Short-Term Sound Measurement Results

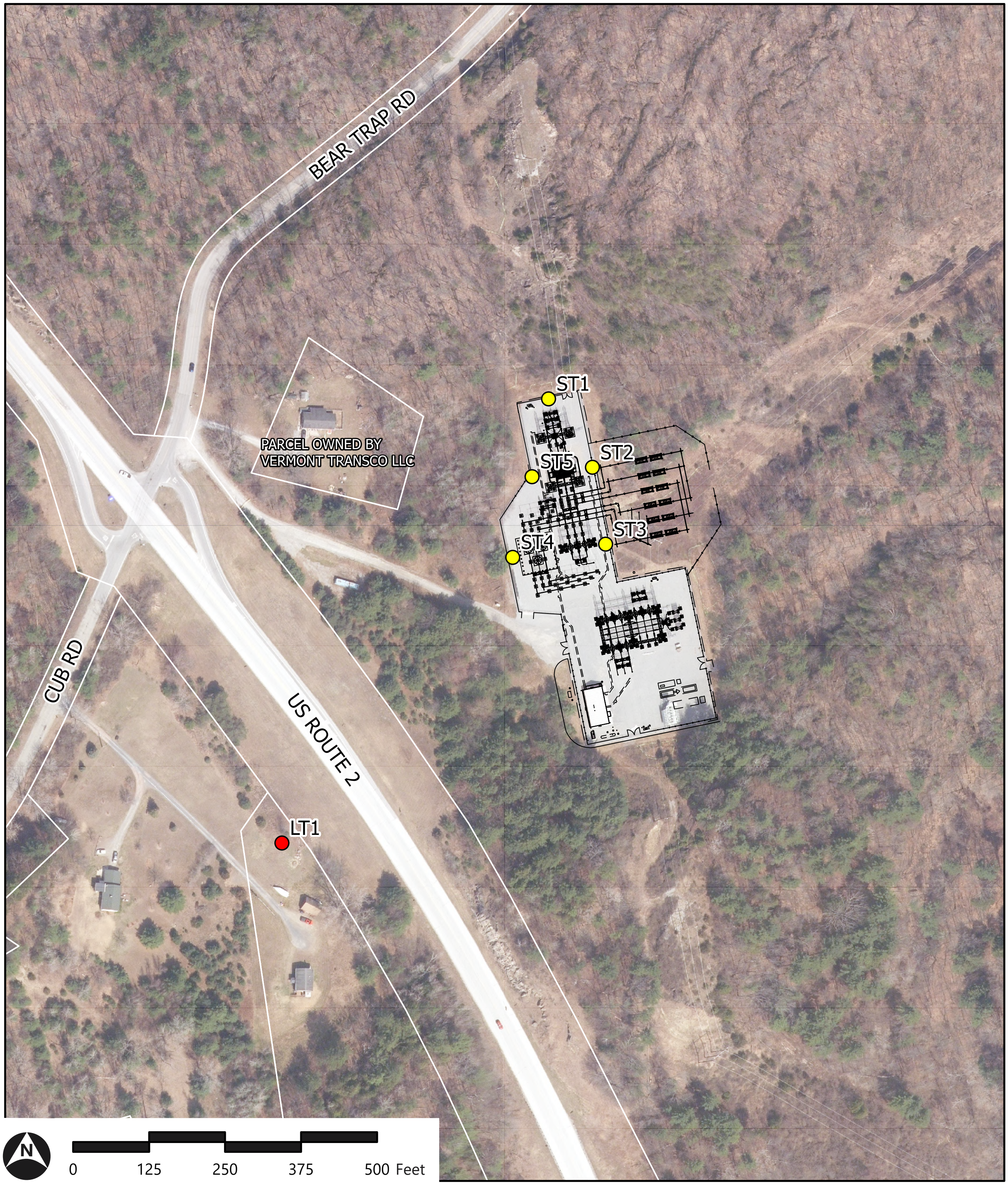
Measurement Site	Location	Distance (feet)[1]	Sound Level (Leq, dBA)	Sound Level (L90, dBA)
ST1	North of transformer	115	60.4	59.9
ST2	East of transformer	45	67.3	67.0
ST3	Southeast of transformer	145	58.1	57.6
ST4	Southwest of transformer	170	55.5	53.1
ST5	West of transformer	55	67.3	66.8

Source: VHB, 2025.
1 Distance between the transformer and the measurement site

Long-term Sound Monitoring

VHB conducted a long-term monitoring setup at 4 Cub Road as it represents the nearest residential property line to the station. The long-term monitoring was conducted continuously from April 28 to 29, 2025. Long-term monitoring site 1 (LT1) was located approximately 800 feet southwest of the transformer. Atmospheric conditions during the measurement included temperatures ranging from 48°F to 71°F, and wind speeds less than 10 mph. The long-term hourly sound levels ranged from 30 dBA to 67 dBA (L90). During the nighttime (10:00 PM to 7:00 AM), hourly sound levels ranged from 30 dBA to 64 dBA (L90). The daytime (7:00 AM to 10:00 PM) ambient hourly sound levels ranged from 49 dBA to 67 dBA (L90). Sound level measurement results by hour for the long-term measurements are included in **Table B1** in **Attachment 2**.

Field observations of the dominant source of sound at the site were made during deployment and retrieval of the equipment. Observations indicated that while in operation, the transformer was not audible from LT1 at 4 Cub Road. Traffic on U.S. Route 2 was the dominant source of sound for LT1. Review of the monitoring data indicates that there is substantially less vehicular traffic on Route 2 from 10:00 PM until 5:00 AM, with L90 sound levels in the 30's dBA compared to other hours of the day in the 60's dBA. Additional sources of sound included natural sources such as birds chirping and wind rustling leaves.



Long-term Monitoring Location

Short-term Monitoring Location

Site Layout

Path: \\vhb.com\gis\proj\SBurlington\59175.01 VELCO Sand Bar Sub Sound\Project\Sound Study\Sound Study.aprx (rshedd, 6/26/2025)

Figure 1: Noise Measurement Locations

VT Transco Sandbar Station

Milton, Vermont

June 26, 2025

Source: VCGI, and VHB 2025.

Sound Modeling Methodology

VHB prepared a sound model of the proposed station using Cadna-A sound prediction software. Cadna-A implements the International Standards Organization (ISO) 9613-2 (2024) "Outdoor Sound Propagation" standard. This model considers sound emissions levels, ground cover, terrain, and intervening objects such as buildings or barriers. The area-wide ground cover has been assumed to have an absorption coefficient (G) of 1.0 to represent soft ground where grassy or forested areas are present, an absorption coefficient of 0 to represent hard ground when pavement is present, and an absorption coefficient of 0.6 at the station where gravel is present. No sound attenuation has been assumed for trees or foliage. The ISO standard conservatively assumes there are moderate downwind conditions where the wind would blow from the source to each receptor location.

The Project will include the expansion of the existing station to include SmartValve modules on an expanded fenced area of the station to the east. The modules were modeled using vertical area sources with the sound power level input data associated with each of the four sides - with fans on the long sides of the enclosure and closed ends on the short sides. The approach to modeling the SmartValve with vertical area sources was validated in the Cadna-A model using receptors at the 2-meter reference distance described in the SmartValve noise test report. Each façade of the equipment was validated for use in the prediction modeling analysis.

The existing transformer was modeled as a point source at a height of 20-ft (6.1 m) to conservatively represent the top of the equipment. The sound level input for the transformer was derived from the field measured data collected by VHB on December 20, 2024, and then validated for all 5 short-term measurement locations.

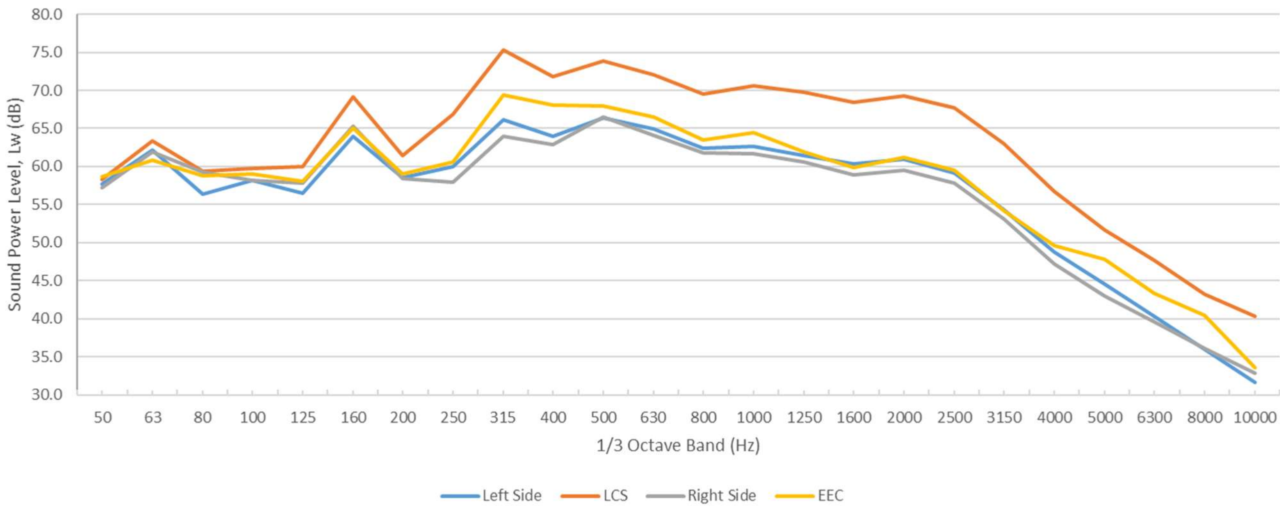
The existing equipment, including the transformer and capacitor bank, will remain. The overall sound level data for the proposed modules, existing transformer, and capacitor bank are shown in **Table 2** below. **Figure 2** presents the one-third octave band sound levels for the proposed SmartValve modules by side of the enclosure, with the LCS fans at 40%, pumps at 50%, EC internal fans at 50%, and external fans at 40%. This fan configuration was modeled based on the anticipated environmental conditions at the site requiring this fan configuration to maintain operation during peak temperatures.

Table 2: Summary of Equipment Sound Power Levels

Equipment	Total Quantity	Overall, dBA
Transformer[1]	1	101
Capacitor Bank[2]	3	76.0
SmartValve Module Left Hand Side[3] (LHS)	12	71.9
SmartValve Module Liquid Cooling System Side[3] (LCS)	12	79.8
SmartValve Module Right Hand Side[3] (RHS)	12	71.0
SmartValve Module Enclosure Cooler System Side[3] (EEC)	12	73.3

1 Sound level emissions established through field measurements on December 20, 2024.
2 Sound level emissions established from 2019 Sound Study performed by RSG.
3 Sound level emissions established from Smart Wires SmartValve 10-1800 v1.04 R1 (Prototype 4) Noise Test Report for LCS fans at 40%, pumps at 50%, EC internal fans at 50%, and external fans at 40%. Dated January 29, 2025.

Figure 2: 1/3 Octave Band Average Sound Power Level by Equipment Side



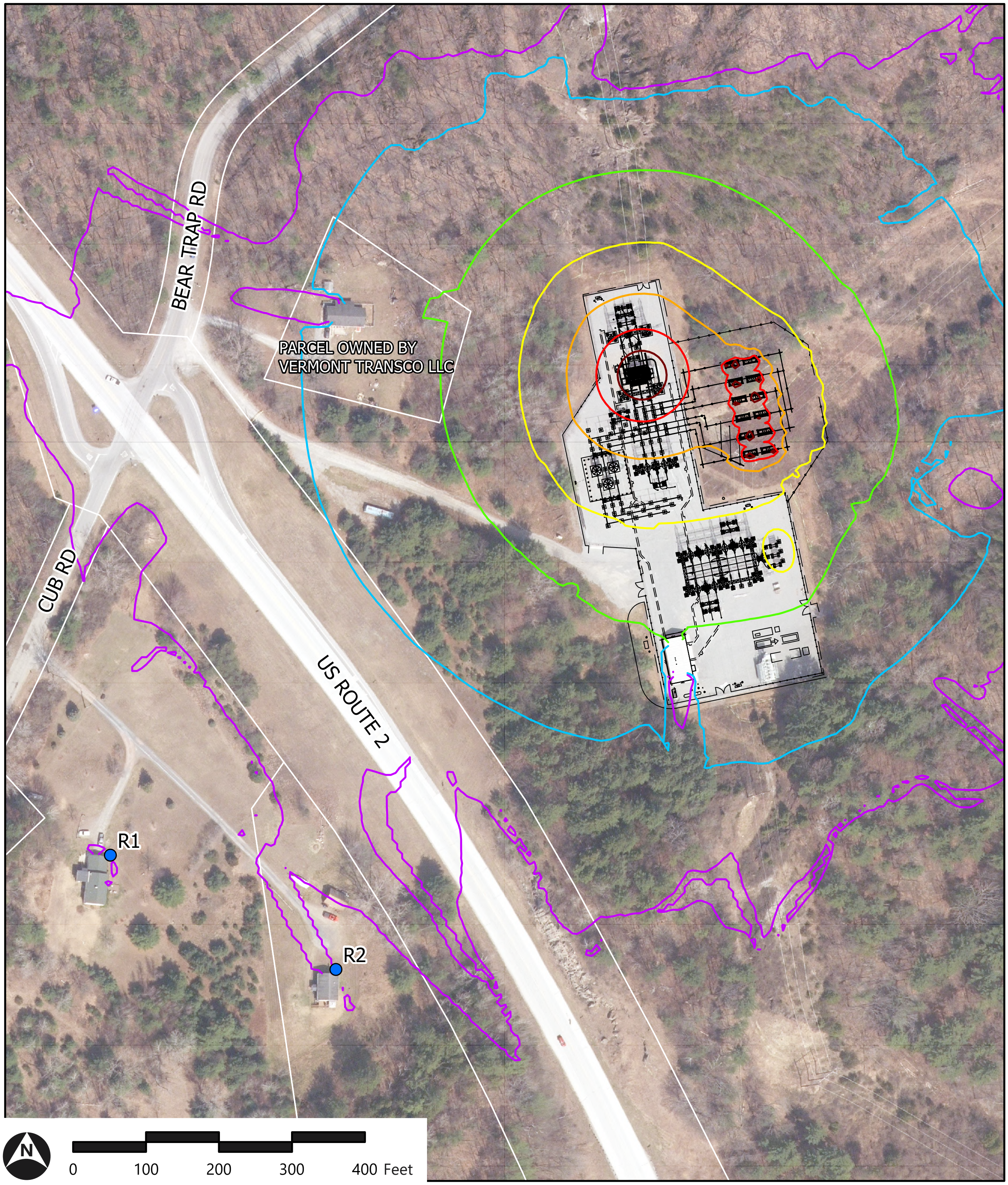
Sound Modeling Predictions

The Project is proposing the installation and operation of 12 SmartValve modules to be located to the east of the existing station. The modeling includes the existing transformer (ODAF2), the existing capacitor bank, and the proposed SmartValve modules operating simultaneously. **Table 3** presents the predicted sound levels associated with this operation. As shown in the table, the predicted project generated sound levels at the nearest residence, 4 Cub Road, would be below the noise goal of 40 dBA at the nearest residential building. **Figure 3** presents the receptor locations and the predicted sound level contours (i.e. lines of constant sound level) from the Project. **Figure 4** presents the one-third octave band sound levels for each receptor.

Table 3: Summary of Predicted Sound Level Results, dBA

Receptor ID	Address	Project Generated Sound Level[1]	Increase over Limit[2]
R1	8 Cub Road	38.2	-1.8
R2	4 Cub Road	38.2	-1.8

1 At the nearest residential building
2 Limit is established as 40 dBA at the nearest residential building during the nighttime and 45 dBA at the nearest property line at all times of day.



Sound Level Contours, dBA

- 40
- 45
- 50
- 55
- 60
- 65
- 70

● Receivers

Figure 3: Modeled Sound Level Contours and Receptor Locations
VT Transco Sandbar Station
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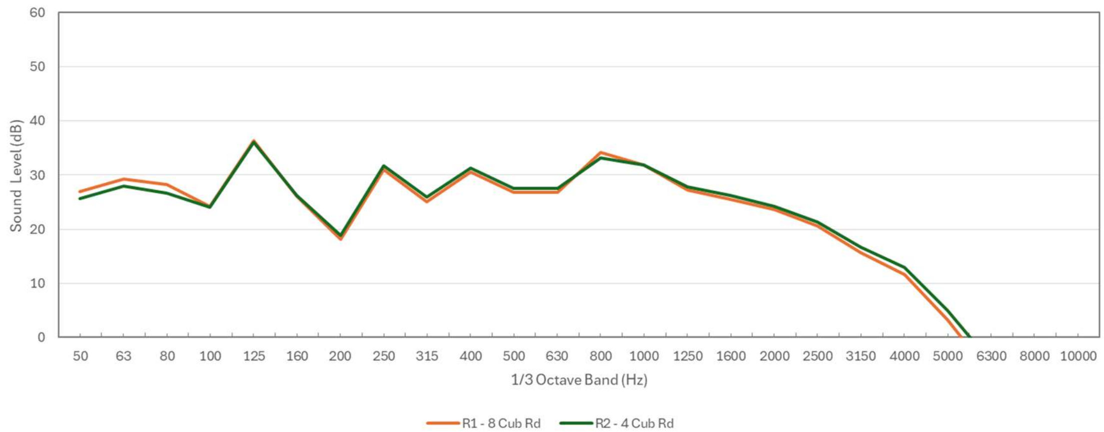
Source: VCGI, and VHB 2025.

Figure 4: 1/3 Octave Band Sound Level Results by Receptor



Conclusion

VHB conducted a sound study to evaluate the proposed installation of 12 SmartValve modules at the Sandbar Station located at 586 Bear Trap Road in Milton, Vermont. The existing transformer and capacitor bank located at the site would remain. VHB's sound study included conducting sound monitoring at the site and sound prediction modeling using the Cadna-A software. Long-term monitoring occurred at the closest residential property line, 4 Cub Road, approximately 800-feet southwest of the existing transformer. At the long-term measurement location (LT1), 4 Cub Road, the existing daytime sound levels ranged from 49 dBA to 67 dBA (L90) and during the nighttime, sound levels ranged from 30 dBA to 64 dBA (L90). Additionally, short-term measurements were conducted within the site fence line to capture the operating transformer.

Consistent with the ANSI Standard, WHO Standard, and previously approved Section 248 projects, VT Transco has applied a noise goal of 40 dBA at the nearest residential building and 45 dBA at the nearest property line. The sound modeling effort demonstrated that the maximum predicted sound levels of the proposed Project at the nearest residential building, 4 Cub Road, would be 38.2 dBA. This would be approximately 2 dBA below the ANSI Standard of 40 dBA at the nearest residential building during the nighttime and would be within the range of measured ambient sound levels at 4 Cub Road. As such, the Project as proposed is not anticipated to result in any unduly adverse sound conditions.

Attachments

1. Sound Level Concepts
2. Sound Measurement Results

Attachment 1: Sound Level Concepts

Sound is the rapid fluctuations of air pressure above and below ambient pressure levels. Noise is defined as unwanted or excessive sound. Sound becomes unwanted when it interferes with normal activities such as sleep, work, communication or recreation. How people perceive sound depends on several measurable physical characteristics including:

Sound Level - Sound level is based on the amplitude change in pressure and is related to the loudness or intensity. Human hearing covers a wide range of changes in sound pressure amplitude. Therefore, sound levels are most often measured on a logarithmic scale of decibels (dB) relative to 20 micro-pascals. The decibel scale compresses the audible range of acoustic pressure levels, which can vary from the threshold of hearing (0 dB) to the threshold of pain (1 20 dB). Because sound levels are measured in dB, the addition of two sound levels is not linear. For example, adding two equal sound levels results in a 3 dB increase in the overall level. Research indicates the general relationships between sound level and human perception are as follows:

- A 3-dB increase is a doubling of acoustic energy and is approximately the smallest difference in sound level that can be perceived in most environments.
- A 10-dB increase is a tenfold increase in acoustic energy and is generally perceived as a doubling in loudness to the average person.

Frequency - Sounds are comprised of acoustic energy distributed over a range of frequencies. Acoustic frequencies, commonly referred to as tone or pitch, are typically measured in Hertz. Human hearing generally ranges from 20 to 20,000 Hz; however, the human ear does not perceive sound levels from each frequency as equally loud. To compensate for this phenomenon in perception, a frequency filter known as A-weighting is commonly used to evaluate environmental noise levels and sound levels are denoted as “dBA”.

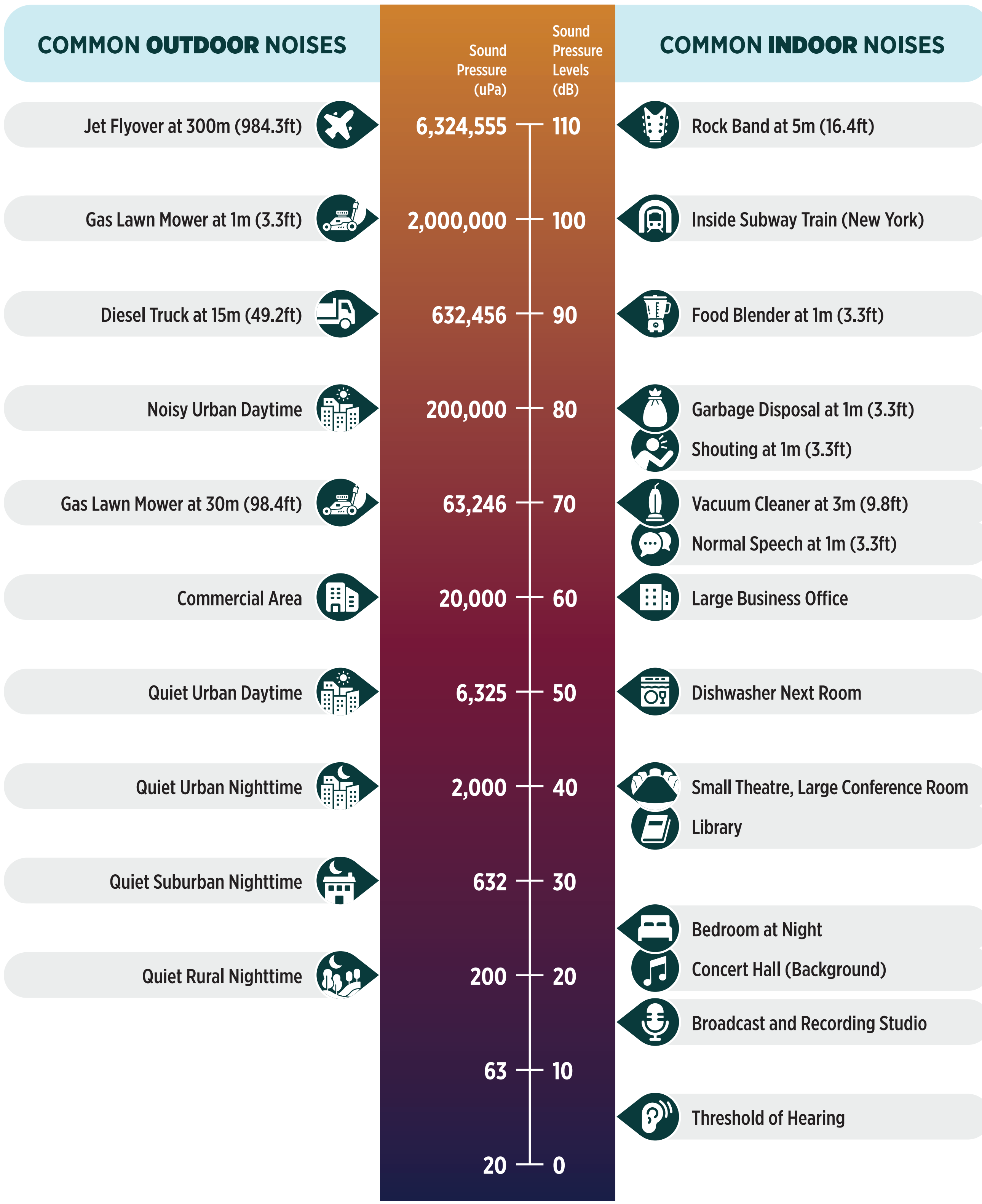
- Sound levels reported in octave or one-third-octave frequency bands are often used to describe the frequency content of different sounds. Some sources of sound can generate “pure tones” which is when there is a concentration of sound within a narrow frequency range such as a whistle. Humans can hear pure tones very well and such conditions can be a cause of increased annoyance.

A variety of sound level descriptors can be used for environmental noise analyses. These descriptors relate to the way sound varies in level over time. The following is a list of common sound level descriptors:

- **Statistical Sound Levels** – Sound level metrics such as L_{10}, L_{50}, or L_{90}, represent the levels that are exceeded for a particular percentage of time over a given period. For example, L_{10} is the level that is exceeded for 10 percent of the time. Therefore, it represents the higher end of the range of sound levels. The L_{90}, on the other hand, is the level that is exceeded 90 percent of the time, and therefore, is representative of the background sound level and of constant sources of sound that are present.
- **Equivalent Sound Level (Leq)** – Leq is a single value, which represents the same acoustic energy as the fluctuating levels that exists over a given period of time. The Leq takes into account how loud noise events are during the period, how long they last, and how many times they occur. Leq is commonly used to describe environmental noise and relates well to human annoyance.
- **Day-night Average Sound Level (Ldn)** – Ldn is similar to the Leq in that it is a single value, which represents the same acoustic energy as the fluctuating levels, that exists over a 24-hour period. The Ldn takes into account how loud sound events are, how long they last, how many times they occur over a 24-hour period, and whether

they occur during the day (7:00 AM to 10:00 PM) or night (10:00 PM to 7:00 AM). Sound that occurs during the night is given a 10-dB penalty to account for the increased human sensitivity to noise at night. If sound levels are constant over a 24-hour period, the Ldn is 6.4 dB greater than the Leq level due to the 10-dB nighttime penalty

- **Maximum Sound Level (Lmax)** – Many sources of sound, including mobile sources and stationary sources, change over time. It is common to describe sound in terms of the maximum (Lmax) sound level emissions. The following figure presents a list of the maximum sound levels of common outdoor and indoor sources.


COMMON OUTDOOR NOISES
Sound Pressure (uPa)
Sound Pressure Levels (dB)
COMMON INDOOR NOISES
Jet Flyover at 300m (984.3ft)
6,324,555
110
Rock Band at 5m (16.4ft)
Gas Lawn Mower at 1m (3.3ft)
2,000,000
100
Inside Subway Train (New York)
Diesel Truck at 15m (49.2ft)
632,456
90
Food Blender at 1m (3.3ft)
Noisy Urban Daytime
200,000
80
Garbage Disposal at 1m (3.3ft)
Shouting at 1m (3.3ft)
Gas Lawn Mower at 30m (98.4ft)
63,246
70
Vacuum Cleaner at 3m (9.8ft)
Normal Speech at 1m (3.3ft)
Commercial Area
20,000
60
Large Business Office
Quiet Urban Daytime
6,325
50
Dishwasher Next Room
Quiet Urban Nighttime
2,000
40
Small Theatre, Large Conference Room
Library
Quiet Suburban Nighttime
632
30
Bedroom at Night
Concert Hall (Background)
Quiet Rural Nighttime
200
20
Broadcast and Recording Studio
63
10
Threshold of Hearing
20
0

Attachment 2: Sound Measurement Results

Table B1: Long-Term Sound Measurement Results Summary at LT1, dBA

		Leq		L90	
		Monday	Tuesday	Monday	Tuesday
Time	Duration	4/28/2025	4/29/2025	4/28/2025	4/29/2025
00:00:00	01:00:00.0		56.7		33.8
01:00:00	01:00:00.0		55.8		33.3
02:00:00	01:00:00.0		51.8		30.1
03:00:00	01:00:00.0		58.8		31.3
04:00:00	01:00:00.0		60.7		33.4
05:00:00	01:00:00.0		64.6		57.5
06:00:00	01:00:00.0		67.8		63.7
07:00:00	01:00:00.0		69.3		66.5
08:00:00	01:00:00.0		68.2		64.8
09:00:00	01:00:00.0		67.9		63.4
10:00:00	01:00:00.0	67.0	66.5	62.4	63.5
11:00:00	01:00:00.0	66.8	65.8	63.1	63.6
12:00:00	01:00:00.0	66.1	66.0	63.4	63.2
13:00:00	01:00:00.0	66.2	66.4	63.4	62.7
14:00:00	01:00:00.0	66.6	67.5	62.8	64.6
15:00:00	01:00:00.0	67.0	67.9	64.4	64.3
16:00:00	01:00:00.0	68.4		65.8	
17:00:00	01:00:00.0	68.4		64.8	
18:00:00	01:00:00.0	66.5		62.6	
19:00:00	01:00:00.0	66.0		62.0	
20:00:00	01:00:00.0	63.5		56.6	
21:00:00	01:00:00.0	60.4		49.4	
22:00:00	01:00:00.0	59.1		36.2	
23:00:00	01:00:00.0	60.2		37.4	