Environmental Sound

Assessment

Wireless Communications Facility

at Mashpee Fire Station No. 2
101 Red Brook Road
Mashpee, Massachusetts 02649

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Prepared For:

Verizon Wireless
118 Flanders Road
Westborough, MA 01581

Blue Sky Towers LLC

Prepared By:

Modeling Specialties
30 Maple Road
Westford, MA 01886

Modeling Specialties

ENVIRONMENTAL SOUND ASSESSMENT

Blue Sky Towers and Verizon Wireless propose to build and operate a Wireless Telecommunications Facility in Mashpee, Massachusetts to support personal wireless communication in the area. The proposed installation will include antennas mounted on a new 150-foot monopole. Supporting electronic equipment will be in a fenced compound at the foot of the tower. Verizon Wireless is already planning to be an anchor tenant for the facility, which will also host antennas for the town EMS system. This report addresses the existing sound levels in the area, sources of sound expected at this installation and an evaluation of its potential to affect the neighboring land uses. The equipment configuration and siting were designed specifically to minimize environmental effects.

While only one wireless tenant is currently committed to the proposed facility, it is designed to support up to three additional commercial wireless carriers and their support equipment. A supplementary analysis was conducted for a full build-out scenario. While no engineering data are available for the additional carriers, the study reflects an installation that represents worst case for three potential additional carriers. The results of the full build-out sound analysis are provided in Appendix A.

Overview of Project and Site Vicinity

The project is located on the site of the Mashpee Fire Station #2 in Mashpee, MA. The existing large buildings have the potential to shield facility sounds to the west. However, there are no nearby receptors in the direction of the buildings.

Daytime and nighttime field measurements were made to survey existing conditions. Daytime sound includes traffic sounds, occasional military and commercial aircraft pass-bys, birds and one vehicle operating at the site for a short time. During nighttime conditions, the only sounds that could be distinguished was infrequent traffic on roadways in the area. Mashpee provides limits for the facility sound at the property line, which are evaluated in this study. Because there are single family residences in the area, it also addresses expected levels at the residences. Sound levels are reduced with distance, so only the nearest residences in each general direction are evaluated. Figure 1 is a Google Earth aerial photograph annotated to show the equipment location and surrounding area.

The equipment sound was estimated using vendor data and measurements made at similar installations. The corresponding levels expected at the nearby sensitive locations were estimated using noise modeling techniques prescribed in acoustical literature. Plans and equipment details were provided by Blue Sky Towers to support this evaluation of sounds. The report is based on plans issued by ProTerra Design Group dated 9/27/17 that include an engineered configuration of Verizon Wireless equipment. This conservative study is based on the highest sound levels that the equipment is expected to make even though it makes that sound only a small fraction of the time.

Figure 1: Project Area Showing the Proposed Equipment Compound and Nearest Receptors

Discussion of General Noise Analysis Methods

There are a number of ways in which sound (noise) levels are measured and quantified. All of them use the logarithmic decibel (dB) scale. Following is a brief introduction to the noise measurement terminology used in this assessment.

Noise Metrics

The Sound Level Meter used to measure noise is a standardized instrument.[1] It contains "weighting networks" to adjust the frequency response of the instrument to approximate that of the human ear under various circumstances. One of these is the *A-weighting* network. A-weighted sound levels emphasize the middle frequency sounds and de-emphasize lower and higher frequency sounds; they are reported in decibels designated as "dBA." All broadband levels represented in this study are weighted using the A-weighting scale. Figure 2 illustrates typical sound levels produced by sources that are familiar to most people.

The sounds in our environment usually vary with time, so they cannot always be described with a single number. Two methods are used for describing variable sounds. These are *exceedance levels* and *equivalent level.* Both are derived from a large number of moment-to-moment A-weighted sound level measurements. Exceedance levels are designated L_n, where "n" can have any value from 0 to 100 percent. For example:

- L_{90} is the sound level in dBA exceeded 90 percent of the time during the measurement period. The L_{90} is close to the lowest sound level observed. It is essentially the same as the *residual* sound level, which is the sound level observed when there are no loud, transient noises.

- L_{50} is the median sound level: the sound level in dBA exceeded 50 percent of the time during the measurement period.

- L_{10} is the sound level in dBA exceeded only 10 percent of the time. It is close to the maximum level observed during the measurement period. The L_{10} is sometimes called the *intrusive* sound level because it is caused by occasional louder noises like those from passing motor vehicles.

By using exceedance levels it is possible to separate prevailing, steady sounds (L_{90}) from occasional, louder sounds (L_{10}) in the environment.

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1 *American National Standard Specification for Sound Level Meters*, ANSI S1.4-1983, published by the Standards Secretariat of the Acoustical Society of America, NY.

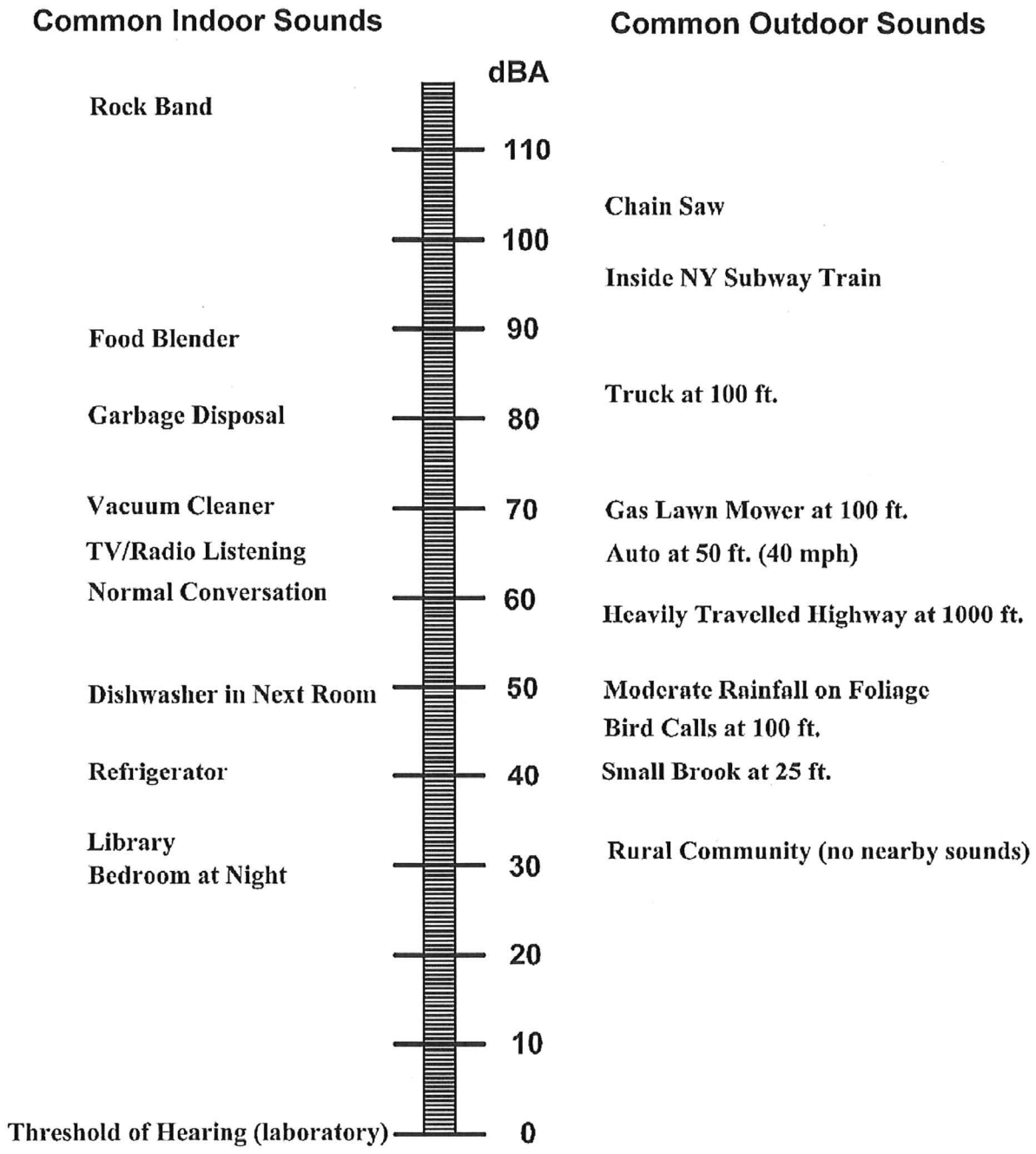

Figure 2:
Typical Sound Levels from Everyday Experience

The *equivalent level* is the level of a hypothetical steady sound that has the same energy as the actual fluctuating sound observed. The equivalent level is designated L_{eq}, and is also A-weighted. The equivalent level is strongly influenced by occasional loud, intrusive noises. When a steady sound is observed, all of the Ln and Leq are equal. The Day-Night level is a special kind of equivalent level. It is based on the 24-hour average Leq, but accounts for a greater sensitivity in communities during nighttime hours by adjusting levels between 10:00 pm and 6:00 am.

In the design of noise control treatments, it is essential to know something about the frequency spectrum of the sound of interest. Noise control treatments do not function like the human ear, so simple A-weighted levels are not useful for noise-control design or the identification of tones. The spectra of sounds are usually stated in terms of *octave band sound pressure levels*, in dB, with the octave frequency bands being those established by standard.[2] The sounds at the proposed site were evaluated with respect to the octave band sound pressure levels, as well as the A-weighted equivalent sound level. Only the A-weighted values are presented here since they represent the more easily recognized sound scale that is relevant to the Town and regional standards.

Noise Regulations and Criteria

Sound compliance is judged on two bases: the extent to which governmental regulations or guidelines are met, and the extent to which it is estimated that the community is protected from the excessive sound levels. The governmental regulations that may be applicable to sound produced by activities at the project site are summarized below.

Federal

- Occupational noise exposure standards: 29 CFR 1910.95. This regulation restricts the noise exposure of employees at the workplace as referred to in OSHA requirements. Workers will not routinely attend this facility. Furthermore, the facility will emit only occasional sounds of modest levels, as demonstrated by this study.

State

- In Massachusetts, noise is regulated as an air pollutant. 310 CMR §7.10 U qualitatively prohibits "unnecessary emissions from [a] source of sound that may cause noise". This is interpreted quantitatively by MDEP's Form BWP AQ SFP3 and their DAQC Policy 90-001. The MDEP's Noise Policy states that a new noise intrusion may not increase the broadband sound level by more than 10 dBA over the pre-existing L_{90} ambient level. Tonal sounds, defined as any octave band level that exceeds the levels in adjacent octave bands by 3 dB or more, are also

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[2] *American National Standard Specification for Octave, Half-octave and Third-octave Band Filter Sets*, ANSI S1.11-1966(R1975).

prohibited. The MDEP usually defers to applicable quantitative local ordinances when available.

Local

- The Town of Mashpee has the same noise standard used by the Cape Cod Commission (CCC) for their review, 50 dB (Ldn) at the property line. The Ldn metric is the 24-hour average equivalent level that is adjusted to account for a greater sensitivity at night.

Existing Community Sound Levels

A daytime site survey and noise measurement study were conducted on November 1, 2017 to measure the existing sound levels at and around the site. The measured levels included occasional intrusive sound from traffic, dogs barking, birds and aircraft. The area around the current fire station is paved for access and parking. It is surrounded by pine forest, which is not suited for measurement of sound by ANSI Standards. For this reason, measurements were made within the open area outside the paved surfaces at the fire station. The nighttime survey was conducted during the quiet hours of the night on the same day. The routine operation of the cabinet cooler or generator is never expected at night, but the nighttime sound levels were used as a reference and also to evaluate the L_{dn} metric.

Measurement Methodology

Since sound impacts are greatest when existing sound levels are lowest, this study was designed to measure community sound levels under conditions typical of "quiet periods" for the area. This study uses methodology to support both a MDEP type study (increase in ambient) and also the Day-Night level property line analysis. The MDEP uses the background metric (L_{90}), which statistically excludes all non-steady sources. The L_{90} metric gives the lowest 10 percent of the many samples gathered during a 20-minute measurement taken in the project area. In contrast, the Ldn study is based on the measured ambient equivalent level. Meteorological conditions during the daytime included clear skies, a temperature of 42° F, with calm air. Nighttime survey conditions included scattered clouds, a temperature of 35° F with calm air. All meteorological conditions were noted from field observations, but are consistent with the official reports at Cape Cod Coast Guard Air Station (KFMH).

The measurement location was in the open area near the Fire Station parking lot. Based on spot observations in the area, the levels represent both the site and the community. Daytime and nighttime attended sound level measurements were made with a Rion NA-28 sound level meter. The meter meets the requirements of ANSI S1.4 Type 1 – Precision specification for sound level meters. The meter was mounted at approximately 5 feet above the ground. The microphone was fitted with factory recommended foam windscreen. The meter was used to sample the environmental sound and to process the sound into various statistical metrics for use in this analysis. The meter is equipped with

real time octave band filter set, which allowed it to process sound levels into 1/3 octave bands. While frequency specific data were collected, the survey results are reported only in combined A-weighted levels for simplicity and consistency with the local criteria. The filters comply with the requirements of the ANSI S1-11 for octave band filter sets. The meter was calibrated in the field using a Larsen Davis Cal-200 sound level calibrator before and after the measurement sessions. The results of the field calibration indicated that the meter did not drift during the study.

The results of the surveys allow both quantitative and qualitative analyses of the acoustical environment surrounding the proposed equipment. The characterization of ambient sound levels reflects the variations caused by volume of traffic on local roadways, occasional aircraft passes and community sounds.

Measurement Results

The measured background levels in the project area ranged from 39 dBA during the daytime to 26 dBA in the quietest hours of the night. The corresponding Leq values of 60 and 44 dBA produce a Day-Night level of 59 dBA. The measurement results are summarized in Table 1.

Table 1: Measured Background Sound Levels in the Project Area

Period	Time	Leq dBA	L_{90} dBA
Daytime	9:15 AM	60	39
Nighttime	12:20 AM	44	26

Sounds from the Proposed Installation

The tower's current plans include Verizon Wireless equipment and provides some engineering detail for their proposed equipment. The Mashpee Emergency Services equipment will be included but is not expected to have any sound sources. The tower is expected to attract other carriers, but each carrier designs their system based on the particular needs of their network. For that reason, this study addresses the sound from only the equipment proposed in the current plan.

Most of the equipment planned for this facility has no potential of emitting sound. Cabling and piping for utilities will be underground. Only two occasional sources are planned for this facility as quantified in this study. The antennas will be supported by cabinet mounted radio electronics in a fenced compound at the foot of the tower. Also in the compound will be an emergency generator installed inside an acoustical enclosure. This study is based on the levels produced during its infrequent operation. Figure 3 shows the layout of the tower and the proposed fenced equipment compound. Figure 4 shows the elevation sketch of the proposed facility configuration.

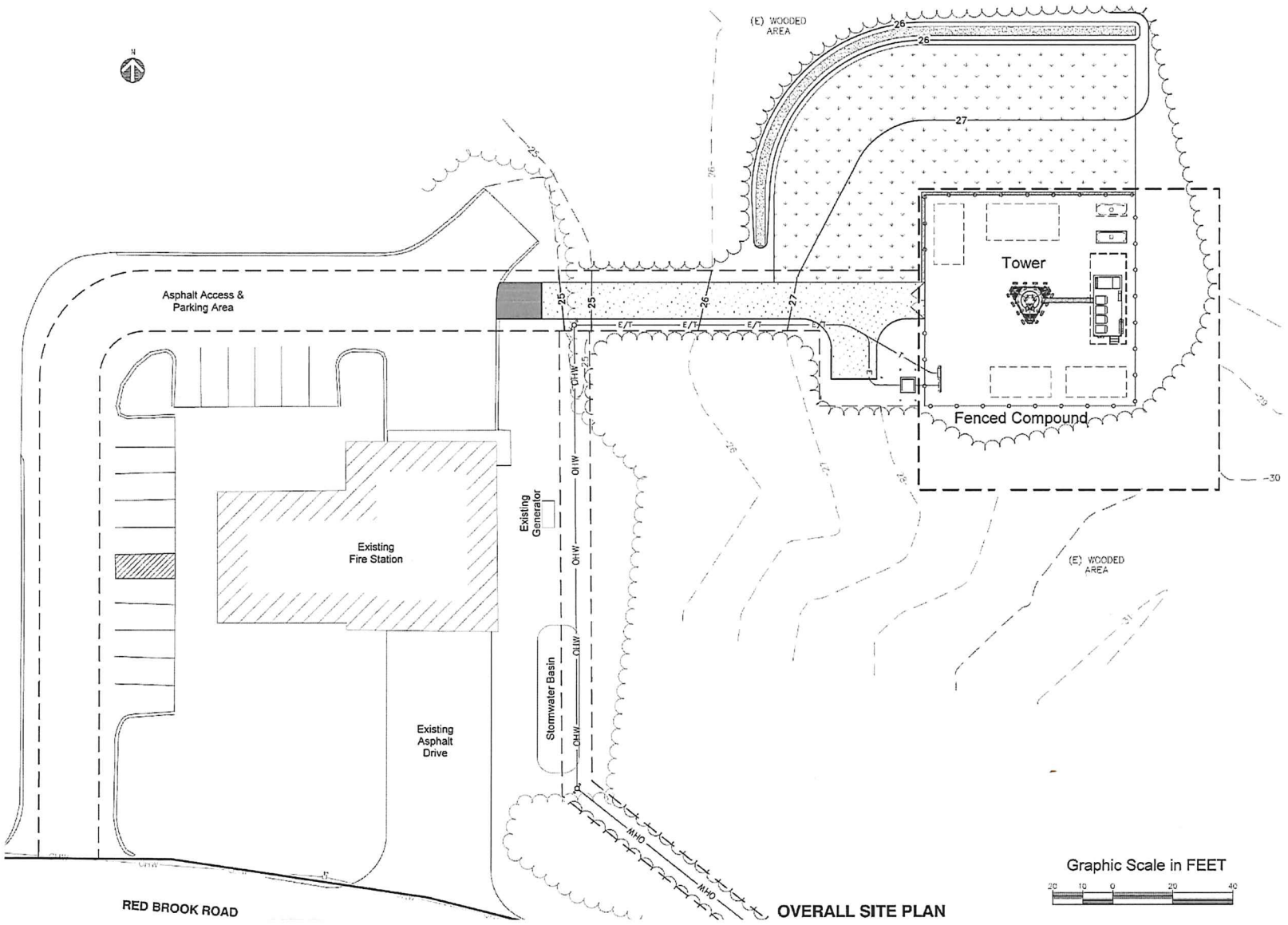


Figure 3: Plan Showing the Equipment Compound and the Existing Fire Station

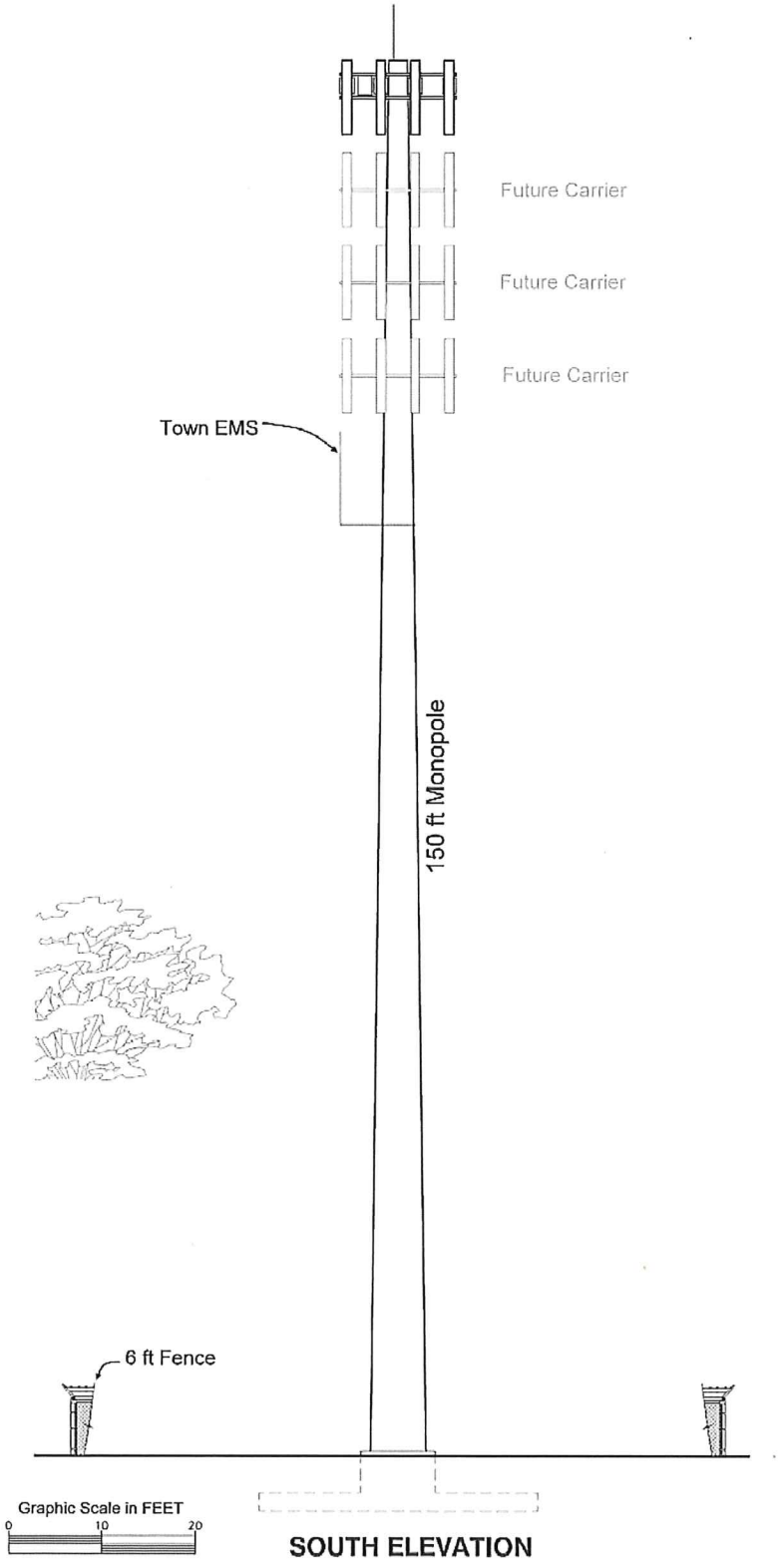


Figure 4: Elevation Plan Showing the Vertical Character of the Proposed Tower and Compound

Routine Sound Emissions

The only routine sound emissions planned for the Verizon Wireless equipment is from the electronics cabinet fan. The small fan on the front door of the cabinet draws air into the unit. It has a smooth broadband character that produces about 50 dBA at 3 feet from the unit. The fan on the electronics cabinet will operate continuously, so there will be no variation from moment to moment or cycling from equipment startup. The fan is mounted on the inside of the cabinet, so it is hardly heard from the outside of the cabinet (which will always remain closed). In this way, the cabinet configuration is designed for minimal effect on the surrounding area. The field image to the right shows the fan unit and the battery cabinet. The electronics equipment in the cabinets is temperature sensitive. When the ambient conditions exceed a safe temperature, a heat exchanger mounted on the cabinet doors will provide cooling for the equipment. Under maximum cooling the heat exchanger produces about 50 dBA at a distance of 23 feet from the unit. This is less than most window air conditioners or outdoor condensers used to support residences. Like residential air conditioners, the cabinet cooler will only be needed during periods of high ambient temperature.

Non-Routine Sound Emissions

The installation will include a generator installed inside a sound reducing enclosure. The proposed MTU Onsite Energy generator is rated for 25 kW and is powered by propane with a rated sound level of 65 dBA or less at 23 feet. The unit will never provide routine power to the facility. It will operate only under two conditions. The unit will be remotely tested for a half-hour every week during daytime hours, a maintenance function that assures availability. If utility power is lost, the facility will instantly switch to battery power. When the batteries are partially depleted, the generator will be launched to power the facility and recharge the batteries. In this way, the facility will provide service even in an extended power outage.

The Verizon Wireless equipment will be monitored remotely and tested regularly. This assures the safe and effective operation of the equipment.

Modeling Details

Noise prediction modeling was performed using CADNA software under downwind weather conditions as assumed in the standard ISO 9613-2. Table 2 summarizes the modeling input parameters.

Table 2: Modeling Input Parameters

Item	Modeling Input and Description
Terrain	Flat Terrain assumed
Temperature	10°C
Relative Humidity	70%
Weather Condition	6.5 mph, directly from facility to receptor*
Ground Attenuation	0.2, hard surface (0.5 = soft ground, 0.0 = pure reflection)
Atmospheric Inversion	CONCAWE – Category F**
# of Sound Reflections	2
Receptor Height	1.5 meter above ground level

** Propagation calculations incorporate the adverse effects of certain atmospheric and meteorological conditions on sound propagation, such as gentle breeze of 1 to 5 m/s (ISO 1996-2: 1987) from source to receiver.*

*** Category F represents a stable atmosphere that promotes noise propagation.*

Sound Level Modeling Results

Since all the equipment with the potential to emit sound will be at ground level, the sound will be shielded in some directions by existing buildings and surrounding forest. The building is included in the modeling, but the conservative study did not take any credit for attenuation by the forest. The worst-case equipment levels will be 40 dBA or less at the property line. This is roughly at the daytime ambient level. Sounds that are less than the ambient level are not noticed in a typical community. For this reason, the daytime tests are expected to be compatible with existing daytime traffic and Fire Station sources and not be noticed at the residences beyond the property line. Tables 3 and 4 provide a summary of the modeling results. A graphical summary of the modeling results is also provided in Figure 5.

Table 3: Summary of Modeling Results of Property Line Sound Levels

Receptor Location	Dist (Ft)	Ambient Level Day/Night (dBA)	Baseline (dBA, L_{dn})	Verizon (dBA)	Expected (dBA, L_{dn})	Compliance
P/L North	207	60 / 44	59	40	59	Yes
P/L South	238	60 / 44	59	39	59	Yes

Table 4: Summary of Modeling at the Residences Sound Levels

Receptor Location	Dist (Ft)	Ambient Level Day (dBA)	Combined VZW (dBA)	Increase (dB)
Res Northwest	535	39	33	+1
Res North	390	39	34	+1
Res Northeast	435	39	33	+1
Res Southeast	473	39	33	+1

Conclusions

The potential sound of the proposed Wireless Telecommunications Facility was evaluated using measured field data and numerical modeling methods. Ambient sound levels were established by field measurements using equipment that is standardized to the current ANSI standards. Equipment operating sound levels were quantified using vendor estimates confirmed by representative field measurement at other installations. Most of the time, the proposed facility will produce no sound. The cabinet cooler will operate only at ambient temperatures over 90° F. This source was included in this study to represent the worst-case cabinet sound, which will result in property line levels of 23 dBA or less. The sound from this daytime-only source is well below the property line criteria. It is also below the ambient level, so is never expected to be noticed in the community.

Infrequently, for one half-hour per week, the proposed facility sounds will include the daytime testing of the emergency generator. During that test, the combined sound from the Verizon Wireless facility is expected to be 40 dBA or less at the property line. This represents the facility's worst-case sound and is at the daytime ambient level. The generator sound remains well below the 50 dBA property line standard and will be less than the daytime ambient level at all community residences.

The analysis shows that the facility sources will usually emit no sound that can be noticed outside the equipment compound. Under conditions of very high ambient temperatures, the cabinet cooler will operate as needed to protect the cabinet electronics. One half-hour each week, the facility generator will be tested. The study is based on the facility's worst-case sound, which is a rare combination of both the cooler and generator. The results of the study indicate the worst-case facility equipment sound will remain in compliance with the property line standards under all operating conditions.

Figure 5: Graphical Summary of the Facility Sound Modeling with Cabinet Cooler and also Generator

APPENDIX A

Cumulative Impact Evaluation

The proposed tower already has Verizon as a carrier, as introduced in the main body of the Sound Study. The tower proposal is based on the proposed tower and Verizon Wireless, who provided some engineering details of their equipment configuration. This study cannot address which carriers might decide to lease space on the proposed tower or the equipment configuration that they will need to best utilize the site. Each carrier designs the sites and equipment configuration to meet their specific network needs. However, a separate analysis can offer some carrier configurations that have been seen that produce more sound than other sites. This is based on visiting several hundred wireless sites and measuring the sound at some of them. A typical site has more than one carrier. Verizon is usually the one with the most equipment that can produce sound. They are also the most likely carrier to require a generator to support their equipment. It is common to have only one generator at a site, which is operated by Verizon. This supplemental study is offered as a conservative estimate of the sound that can be expected from the site in the full build-out condition.

There are several items of equipment that are typical at cell towers. There is a telephone cabinet, which is the interface for the wireless signal and the landline or fiber connection to the carrier networks. The telephone cabinet is not a source of sound. There is often a pad-mount transformer to support the compound. Like all transformers they have the potential for some sound in low frequencies, but are seldom audible outside the compound area. The propane tank is not usually a source of sound, but could introduce the need for pressure regulation. The regulator can have a high frequency hiss but is usually not audible outside the compound area. It was already stated that the Town EMS equipment has minimal support equipment. Town systems are usually not a source of sound. The primary purpose for this supplemental study is to address the carriers that may find a home at this site in the future.

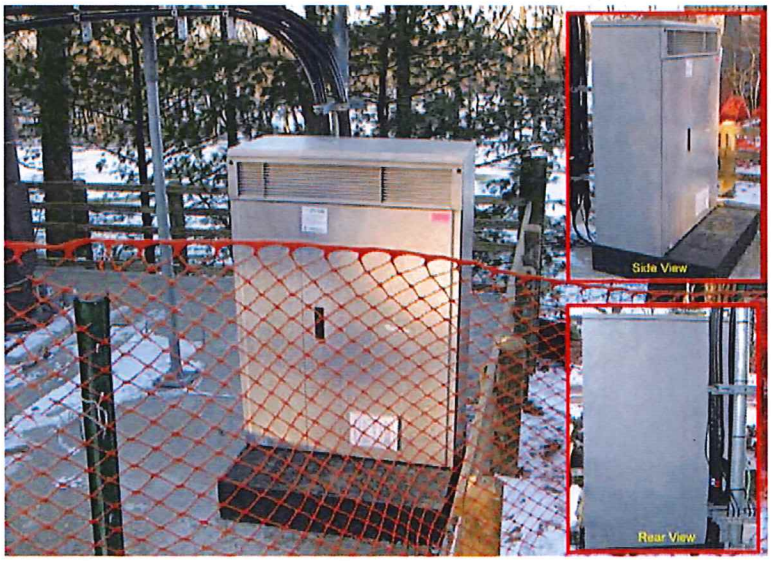
Generators

If there are two generators at a site, they will usually be operated by Verizon and AT&T. A typical sound-mitigated generator will emit sound at over 70 dBA. This is consistent with many personal residential generators. So, while larger generators tend to make more sound, the design goal for genset manufacturers is about 70 dBA at the distance of 23 ft regardless of size. Because the wireless sites are unattended and have the potential of community impact, carrier generators are usually more mitigated within enclosures and emit 65 dBA or less @ 23 ft. The proposed site is already equipped to support two generators. They are conservatively assumed to operate at 65 dBA each. When necessary, additional mitigation features can be purchased from the manufacturer or designed into the facility.

AT&T

AT&T is the carrier that is commonly second in terms of sound producing equipment. Historically, AT&T would have a shelter with two wall-mount HVAC units to provide cooling support. This is still a possibility, but AT&T usually elects to install cabinet(s) to support their sites. These cabinets produce sound on the order of 50 dBA at a distance of 23 feet. Their equipment cabinets are equipped with door mounted coolers like those proposed by Verizon Wireless. Since the shelter configuration produces the most sound, it is assumed at this site. The wall mount HVAC such as Marvaire can emit sound that is over 60 dBA at a standard distance of 23 feet.

T-Mobile



T-Mobile uses a different configuration of equipment cabinet that they call a BTS cabinet. Their cabinets emit a gentle fan sound from the front of the cabinet. At some sites there are multiple cabinets to handle the necessary load. It is common for a new site to be fitted with a single cabinet and expand as additional capacity for the site is needed. The cabinets operate at approximately 60 dBA @ 23 feet.

Metro PCS

Some sites have had Metro PCS equipment operating. Their cabinets had a gentle fan sound from the front of the cabinet. Metro PCS was incorporated into the T-Mobile. For that reason, Metro PCS is not a potential carrier for the proposed site.

Sprint

The Sprint network only operates in the higher frequency PCS bands. Their equipment is small and not offensive from a sound standpoint.

Conclusions of the Cumulative Impact Evaluation

It is noted that the combined analysis is designed differently than the Verizon Wireless results. In the Verizon study, the worst-case conditions occur very rarely – only when the generator is tested during the hottest days of the summer at the same time that the cabinet coolers operate. In this conservative analysis, sounds from all sources are assumed to be emitted continuously and at the same time for a combined effect.

Of all the equipment that might support this facility, this study is based on the highest sound level that is expected. Verizon Wireless is included because they already intend to be a tenant. By ranking the other carriers by sound emissions, this study assumes that AT&T has a shelter with HVAC units on one end of the shelter. T-Mobile will be a represented with two BTS cabinets. While Sprint is typically a very limited source of sound, they represent several other carriers that emit little sound. The Verizon Wireless sound is described in detail in the basic study. The sound from AT&T equipment, T-Mobile and Sprint equipment was added to the study. The facility is designed for two propane tanks to support two generators. It is assumed that Verizon operates one and another carrier operates the other.

The modeling indicates that the combined energy from all sources is slightly louder than the sound from Verizon Wireless alone. The highest sound expected at any modeled receptors is 43 dBA at the north property line. If the cumulated energy from the full build-out were to be emitted consistently for 24 hours, it would produce a property line Ldn level of 49 dBA. This is still below the regulatory standard of 50 dBA at the property line. Based on these results, shown graphically in Figure A1, the very conservative estimates of sound from the combined facility remain within the Mashpee and Cape Cod Commission standard.

Figure A1: Graphical Summary of the Cumulative Sound Modeling Results