3.12 NOISE AND VIBRATION

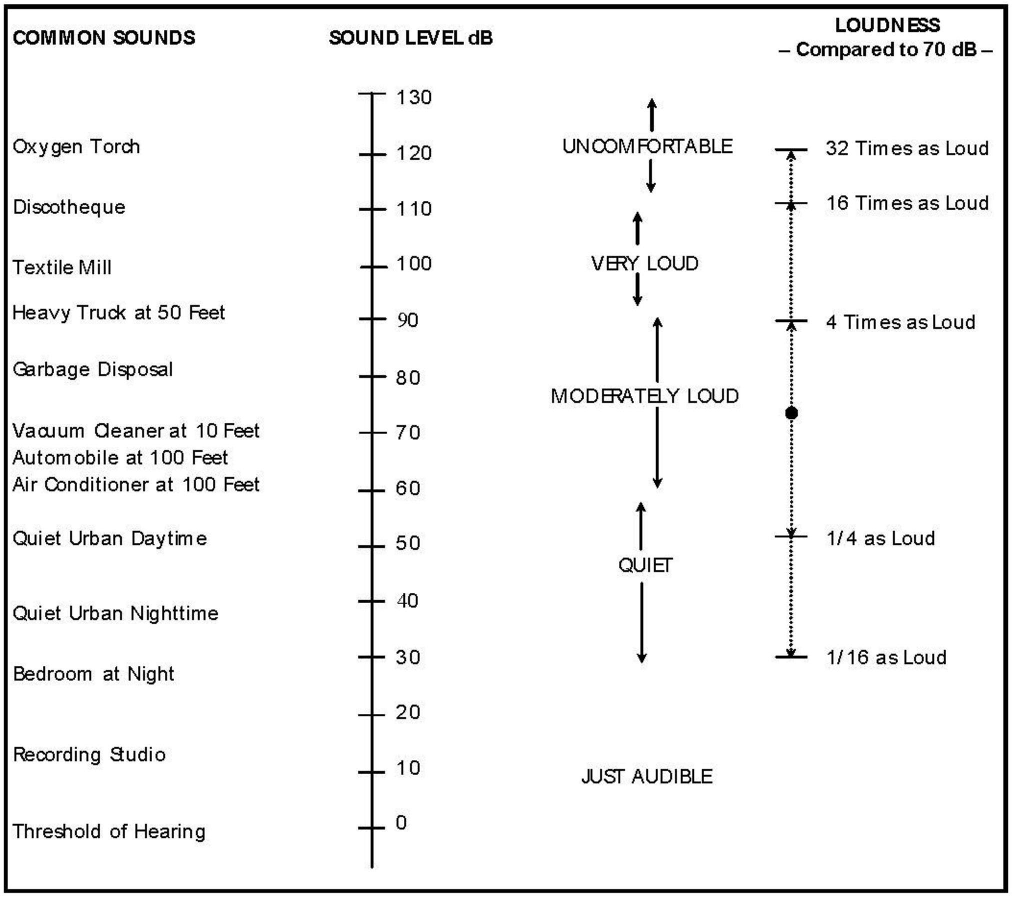
The purpose of this section is to characterize existing noise levels at various locations within the Project study area identified in Figure 1.6-1, where they may be affected by the Navy Base ICTF. This section includes a general discussion of the metrics that are used to quantify noise and vibration effects on the environment, and the findings of a noise monitoring program that was undertaken to establish the existing noise levels in the study area. It also contains limited data collected specifically for the noise and ground vibration related to railroad operations in the study area. More detailed findings of existing noise and vibration levels in the study area are included in Appendix H.

3.12.1 Noise Characteristics

Noise is defined as unwanted sound. Sound is all around us; sound becomes noise when it interferes with normal activities, such as sleep or conversation. The sound waves generated by various sources, such as a passing train, vehicular traffic, or construction equipment, constitute noise to people and can disrupt normal activities when they reach a certain level.

The human ear is responsive to sounds having an extremely wide range of intensity. For this reason, sound levels are expressed using a logarithmic unit of decibel (dB). The normal human ear can detect sounds that range in frequency from about 20 Hz to about 15,000 Hz. All sounds in this wide range of frequencies, however, are not heard equally by the human ear, which is most sensitive to frequencies in the 1,000 to 4,000 Hz range. Weighting curves have been developed to correspond to the sensitivity and perception of different types of sound. A-weighting accounts for frequency dependence by adjusting the very high and very low frequencies (below approximately 500 Hz and above approximately 10,000 Hz) to approximate the human ear's lower sensitivities to those frequencies. Sound pressure levels measured on the A-scale of a sound level meter are abbreviated dB(A). The A-weighted sound levels in dB(A) are used in environmental noise studies for transportation noise sources, such as aircraft flyovers, road traffic or railroads.

Figure 3.12-1 is a chart of A-weighted sound levels of typical sounds. Some noise sources (air conditioner, vacuum cleaner) are continuous sounds which levels are constant for some time. Some (automobile, heavy truck) are the maximum sound during a vehicle pass-by. Some (urban daytime, urban nighttime) are averages over extended periods. Several noise metrics have been developed to describe noise over different time periods, as discussed below.



Source: *Handbook of Noise Control*, C.M. Harris, Editor, McGraw-Hill Book Co., 1979, and FICAN 1992.

Figure 3.12-1. Typical A-weighted Sound Levels of Common Sounds

Noise levels fluctuate with time. A common descriptor of environmental noise is the equivalent (energy average) sound level (L_{eq}). The equivalent sound level is the steady state, aggregate sound level that contains the same amount of acoustic energy as the actual time varying, A-weighted sound level over a specified period of time. If the time period is one hour, the descriptor is the *Hourly Equivalent Sound Level* ($L_{eq(h)}$). This metric is typically specified for evaluating traffic noise, as well as rail noise when evaluating land uses with primarily daytime and evening use. The L_{eq} is used in this section for describing the existing noise conditions in the study area and in Section 4.12 for evaluating noise from traffic, construction activities, and operations of the Navy Base ICTF facility.

The *Day-Night Average Sound Level* (DNL) describes the aggregate noise exposure from all events over a full 24-hour period, with events occurring between 10 pm and 7 am increased by 10 dB to account for greater nighttime sensitivity to noise. The DNL metric is specified for description of community noise impacts of various sources, such as aircraft flyovers or industrial facilities. The DNL is used in Section 4.12 for evaluating rail noise for sensitive land uses based on the modeling results. Field measurements of DNL are typically very limited as accurate data collection requires long monitoring times (from weeks up to several months) due to time variability.

Ambient noise is the all-encompassing noise associated with a given environment at a specified time, being usually a composite of sounds from many sources at many directions, both near and far, that provide a relatively stable noise exposure with no particular dominant sound (Harris 1991).

Community environmental noise refers to outdoor noise in the vicinity of inhabited areas. It varies greatly in magnitude and character among locations – from quiet suburban areas to downtown city streets. It generally varies with time of day, being relatively quiet at night when activities are at a minimum and noisier in morning and afternoons during peak traffic periods. Even within a small area, the noise environment may vary significantly depending on proximity to local noise sources (e.g., near airports or major roadways).

3.12.2 Vibration Characteristics

In contrast to airborne noise, ground-borne vibration is not a common environmental problem. It is unusual for vibration from sources such as buses and trucks to be perceptible, even in locations close to major roads. Some common sources of ground-borne vibration are trains, buses on rough roads, and construction activities such as blasting, pile-driving and operating heavy earth-moving equipment. Ground-borne vibration can be annoying to nearby neighbors of a railway or maintenance facility, causing buildings to shake and rumbling sounds to be heard.

The effects of ground-borne vibration include feelable movement of the building floors, rattling of windows, shaking of items on shelves or hanging on walls, and rumbling sounds. In extreme cases, the vibration can cause damage to buildings. Building damage is not a factor for normal transportation projects, with the occasional exception of blasting and pile-driving during construction.

Annoyance from vibration often occurs when the vibration exceeds the threshold of perception by only a small margin. A vibration level that causes annoyance will be well below the damage threshold for normal buildings.

The ground-borne vibration is characterized in terms of the root mean square (RMS) *Vibration Velocity Level* (L_v) in units of VdB (with the reference velocity of 1 micro inch per second).

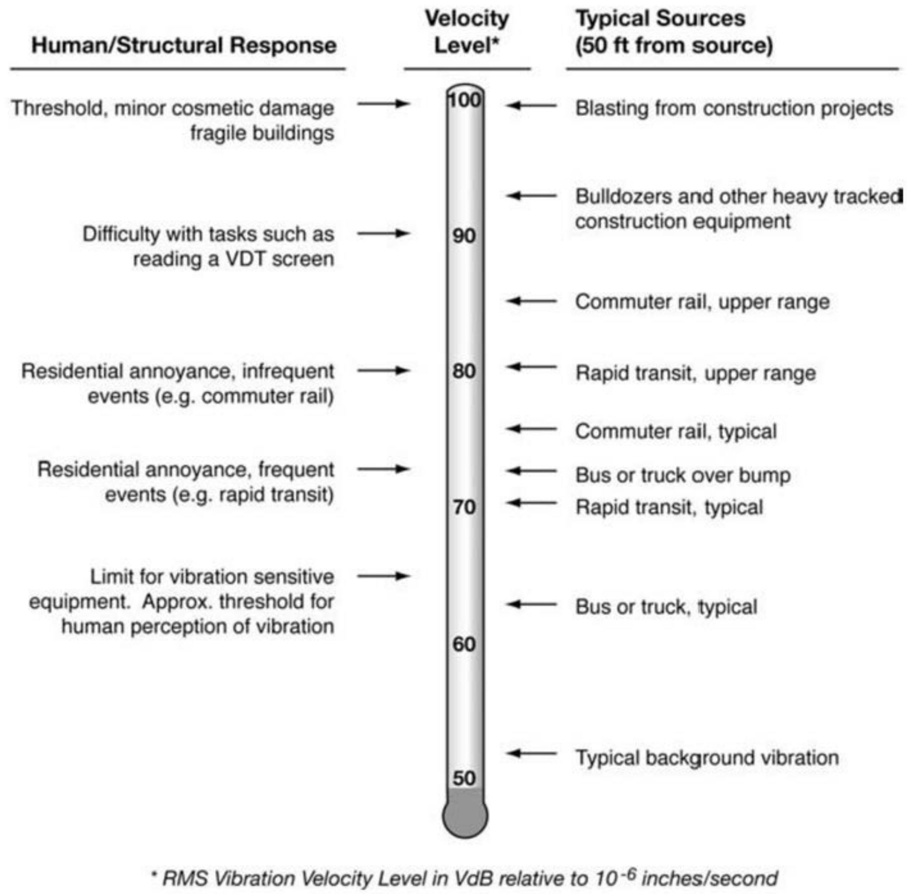
Figure 3.12-2 (FTA 2006) illustrates common vibration sources and the human and structural response to ground-borne vibration. The range of interest is from approximately 50 VdB to 100 VdB. Background vibration is usually well below the threshold of human perception and is of concern only when the vibration affects very sensitive manufacturing or research equipment. The background vibration velocity level in residential areas is usually 50 VdB or lower, well below the threshold of perception for humans which is around 65 VdB. Most perceptible indoor vibration is caused by sources within buildings such as operation of mechanical equipment, movement of people or slamming of doors. Typical outdoor sources of perceptible ground-borne vibration are construction equipment, steel-wheeled trains, and traffic on rough roads. If the roadway is smooth, the vibration from traffic is rarely perceptible.

For vibrations generated by railroad train activities, the ground-borne vibration is caused by the interaction of the steel wheels and rails, which causes vibration in the ground beneath the track. The vibration spreads through the ground. When the ground waves reach nearby buildings, the interaction with the building structure creates vibration within the building.

Pile driving can also result in varying degrees of ground vibration that spread through the ground and diminish in strength with distance. The vibration velocity level L_v generated by typical impact pile drivers is approximately 104 VdB at a distance of 25 feet, with the upper range reaching 112 VdB (FTA 2006). Buildings in proximity to pile driving operations respond to these vibrations with varying results ranging from no perceptible effects at the lowest levels, rumbling sounds and perceptible vibrations at moderate levels, and slight damage at the highest levels.

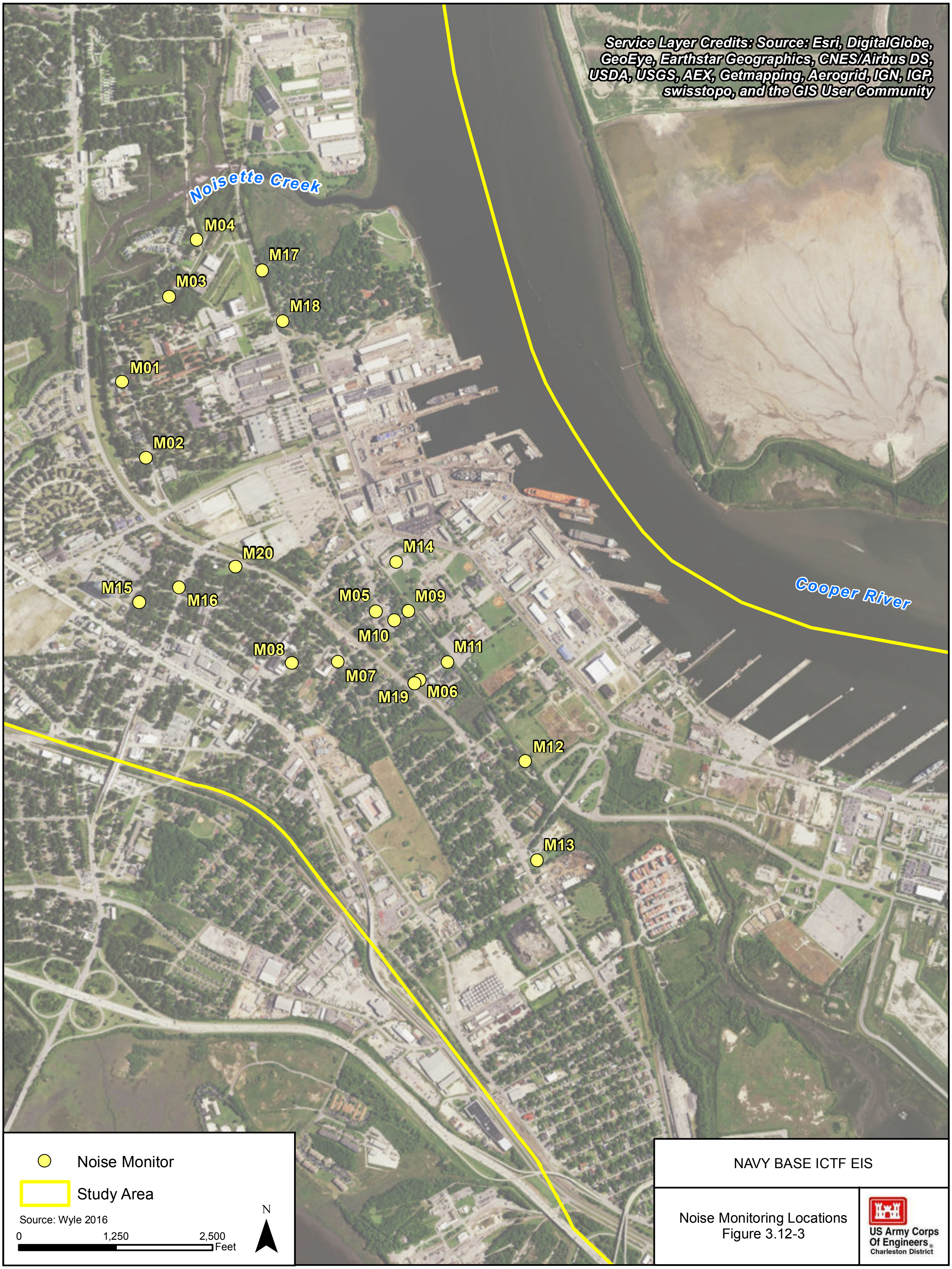
3.12.3 Existing Noise Conditions

The initial step in a noise analysis involves determining the existing baseline noise conditions in the vicinity of the Project site. A noise survey was conducted in the Navy Base ICTF study area in July and August 2014. The survey included noise monitoring in 20 locations, which were selected in proximity to Alternative 1 (Proposed Project) and project alternative sites where potential noise effects are anticipated; relatively close (within 1,000 feet) to the ICTF footprint. A mix of land uses was monitored including residential, institutional, public and recreational areas. The noise monitoring locations are shown in Figure 3.12-3.



(Source: FTA 2006)

Figure 3.12-2. Typical Levels of Ground-Borne Vibration



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Noise Monitoring Locations
Figure 3.12-3

US Army Corps Of Engineers® Charleston District

In each noise monitoring location, short-term L_{eq} measurements (15-minute data samples) were collected during the noise survey. It should be noted that the existing noise measurements in the neighborhoods surrounding the proposed ICTF were taken early in the project development process in order to assess the general ambient noise levels in the communities. For the purposes of the study, measurements were taken in 15-minute intervals and then converted to hourly averages. Longer duration and overnight measurements were not feasible due to the coordination needed with property owners, as well as a lack of secure location for the equipment. Table 3.12-1 provides a summary of the ambient noise levels recorded.

Table 3.12-1
Existing Noise Levels

Location	Description	Land Use	Date	Time (hours)	15-min L_{eq} dB(A)
M1	St. John Catholic Church and School	Institutional	7/28/14	1212-1227	56.3
M2	Reddin Rd. and St. Johns Ave.	Residential	7/28/14	1302-1317	51.2
M3	Hunter St. and St. Johns Ave.	Residential	7/28/14	1505-1520	50.1
M4	4171 St. Johns Ave.	Residential	7/28/14	1545-1600	48.8
M5	Washington United Methodist Church	Institutional	7/29/14	0730-0745	56.5
M6	Community Garden (N. Carolina Ave. and Calvert St.)	Recreational	7/29/14	0802-0817	57.5
M7	Chicora Elementary School (closed)	Institutional	7/29/14	1544-1559	55.3
M8	St. Matthew Baptist Church	Institutional	7/29/14	1612-1627	55.3
M9	1801 Success St.	Residential	7/30/14	0817-0832	48.6
M10	Success St. next to 3200 Leland St.	Residential	7/30/14	0836-0851	52.6
M11	1800 Calvert St.	Residential	7/30/14	0903-0918	50.5
M12	1801-1 English St.	Residential	7/30/14	0932-0947	50.8
M13	Cemetery (next to K-Con Inc.)	Public	7/30/14	1000-1015	60.6
M14	1530 Calumet St. Community Center/Gym	Recreational	7/30/14	1038-1053	51.8
M15	3447 Apache St. (next to Naval Hospital)	Residential	7/30/14	1248-1303	51.0
M16	1922-D Cosgrove Ave.	Business	7/30/14	1320-1335	62.8
M17	1527 Manley Ave.	Residential	7/30/14	1404-0419	52.6
M18	1415-1421 Manley Ave.	Residential	7/30/14	1433-1448	58.6
M19	Spruill Av. and Calvert St.	Traffic counts	8/1/14	1525-1540	58.9
M20	Spruill Av. and Cosgrove Ave.	Traffic counts	8/1/14	1550-1605	62.5

Source: Appendix H.

The noise monitoring locations M5 through M12 were selected within the community immediately adjacent to the Project site (e.g., Chicora-Cherokee neighborhoods) as these locations are located directly adjacent to the proposed ICTF and would be expected to experience the greatest increase in noise from the proposed action. These locations represent the worst case scenario with respect to potential impacts; the other locations are located further from the proposed ICTF and potential noise impacts would be less as noise dissipates over distance. It can be seen from Table 3.12-1 that the measured noise levels in these locations varied in the range from approximately 49 to 58 dB(A), as they were affected at times by local vehicular traffic, aircraft overflights, lawn mowing, running air conditioning units, etc. The noise levels measured in locations M14 (1530 Calumet Street, Community Center/Gym located within the Proposed Project footprint) and M15 (3447 Apache Street, next to the Naval Hospital) also fall within this range; however, the noise levels measured at locations M13 (cemetery) and M16 (1922-D Cosgrove Avenue) were higher, in the 61 to 63 dB(A) range, affected by higher traffic volumes on the adjacent streets. In the noise monitoring locations M1 through M4, M17, and M18 (selected in the immediate vicinity of the River Center project site), the measured noise levels varied in the range from 49 dB(A) to 59 dB(A), which is similar to that discussed above for the locations near the Project site. The two sites thus have comparable existing noise environments.

The noise monitoring locations M19 and M20 were selected along Spruill Avenue at distances of 78 feet and 46 feet from the centerline, respectively. Traffic counts were conducted in these locations concurrently with the noise measurements. The data collected was used for validating a noise model that was constructed to predict future traffic noise levels at the site for the Proposed Project, project alternatives, and No-Action Alternative, as described in Section 4.12.

3.12.4 Train Noise and Vibration

The project study area incorporates several freight rail lines servicing the existing CSX and NS intermodal facilities and the Port of Charleston. Train operations on the existing tracks generate noise and ground-borne vibration which can be of concern for nearby neighbors. Ground-borne vibration of high amplitude may cause buildings to shake and rumbling sounds to be heard. In contrast to airborne noise, ground-borne vibration is not a common environmental problem. It is unusual for vibration from sources such as trucks and buses to be perceptible, even in locations close to major roads. It is not uncommon for freight trains to be the source of intrusive ground-borne vibration.

Locomotive horn soundings are also part of railroad operations. Under the Train Horn Rule (49 C.F.R. Part 222), locomotive engineers must begin to sound train warning horns from 15 to 20 seconds in advance of all public grade crossings. In many geographic locations, and during much of the year, motor vehicles operate with windows rolled up and air conditioning and radios in use. Therefore, audible warning signals must be sufficiently loud to be perceived. Federal regulations require the train horn to be at least 96 dB(A) 100 feet in front of the train in its direction of travel (49 C.F.R. 229).

Unfortunately, the locomotive horn can substantially disturb those living or working near highway-rail grade crossings. Noise levels experienced as a result of a locomotive horn sounding are shown in Figure 3.12-4.

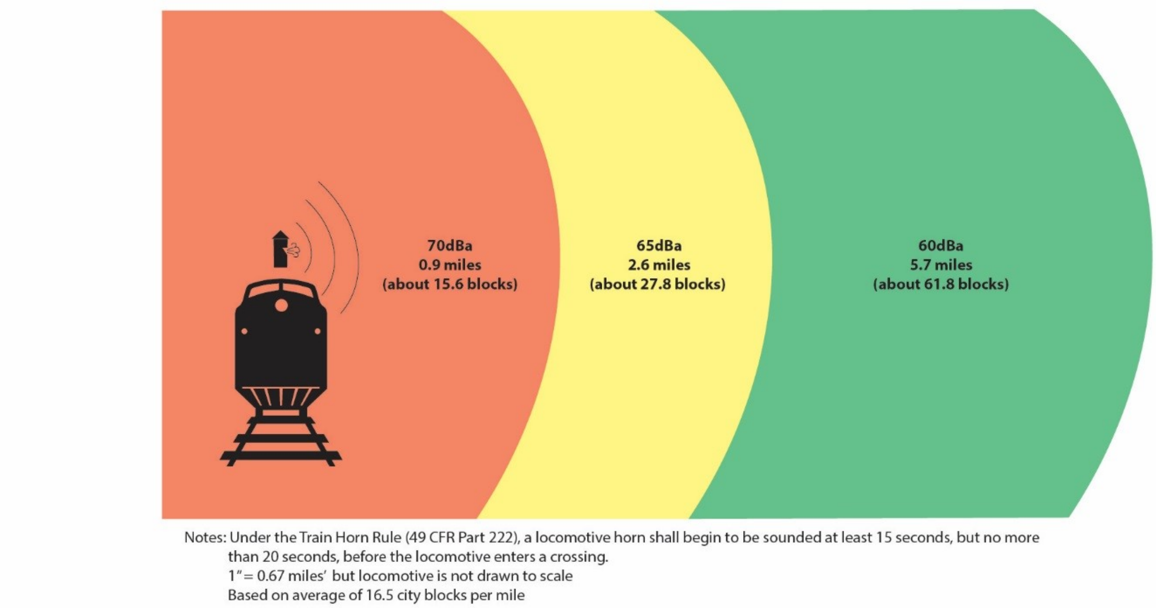

Figure 3.12-4. Train Horn Noise

Five at-grade crossings in the study area currently defined as 24-hour quiet zones by the U.S. Department of Transportation (USDOT) and listed below by street name and corresponding USDOT identification number (Figure 3.12-5) are as follows:

- Rivers Ave. (631985M)
- S. Rhett Ave. (631986U)
- Spruill Ave. at Bexley Ave. (918388D)
- Montague St. (632153Y)
- Meeting St. (631984F)

In a quiet zone, railroads have been directed to cease the routine sounding of horns when approaching public highway-rail grade crossings.

Train wheels rolling on rails create oscillatory motion energy that is transmitted through the track support system into the ground and propagates through the soil to the foundations of nearby buildings. Locomotives and rail cars with wheel flats are the sources of the highest vibration levels. The vibration propagates from the foundation throughout the remainder of the building structure, generating movements of the building floors, rattling of windows, shaking of items on shelves or hanging on walls, and rumbling sounds. The rumble is the noise radiated from the motion of the room surfaces. Building damage is not a factor for normal transportation projects. Annoyance from vibration often occurs when the vibration exceeds the threshold of perception by a small margin. A vibration level that causes annoyance is much below the damage threshold for normal buildings.

In order to estimate the existing rail noise and vibration conditions in the study area, a freight train pass by event was monitored near the CSX at-grade Crossing 10 (a single track) at the intersection of Spruill Avenue and Bexley Street[65]. Figure 3.12-6 shows the noise and vibration monitor locations, both at a distance of 50 feet from the track centerline.

Prior to the train pass by, the ambient noise level was measured at the site for 3 minutes. A freight train with two diesel engine locomotives and 32 rail cars passed the noise monitor in about 4 minutes. The train speed is estimated to be below 10 mph. Table 3.12-2 presents a summary of the noise levels recorded for the ambient condition and train pass by.

Table 3.12-2
Noise Levels Measured at Rail Crossing 10

Location	Operation	Date	Time (hr:min)	Duration (min)	L_{eq} dB(A)
Rail Crossing at Spruill Av. and Bexley St. (50 ft. from curved track centerline)	Ambient (no train)	7/30/14	15:43	3	61.5
Same	Train pass by	7/30/14	16:42	4	89.2

Source: Appendix H.

It can be seen from Table 3.12-2 that the train noise measured during the pass by markedly exceeded the ambient noise near the at-grade crossing. Loud squeal noise generated by wheels on the curved track was evident during the pass by. No locomotive horn sounding was produced near the crossing with a designated 24-hour quiet zone.

Results of the vibration measurements (in the vertical direction) near the crossing are summarized in Table 3.12-3.

Table 3.12-3
Ground-Borne Vibration Levels Measured at Rail Crossing 10

Location	Operation	Date	Time (hr:min)	Duration (min)	L_v VdB
Rail Crossing at Spruill Ave. and Bexley St. (50 ft. from curved track centerline)	Ambient (no train)	7/30/14	15:29	2	81
Same	Train pass by	7/30/14	16:41	3	103

Source: Atkins 2018.

[65]A very low number (one or two per day) and irregular schedule of freight operations in the study area precluded additional train monitoring within the time frame allocated for the measurements. The future rail noise and vibration assessments in Section 4.12 are based on the modeling results and do not require measurements. Further noise measurement of train activities in a rail yard setting was conducted and used for the assessment of the project operational noise as described in Appendix H.

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Quiet Zones

Figure 3.12-5


Service Layer Credits: Esri, USDA Farm Service Agency
Leesville St
Rugheimer Ave
Beaver St
Oakwood Ave
Glenshaw St
Dodge St
Justice St
Lambert St
Bexley St
Bexley St
Aragon Ave
Spruill Ave
Noise Monitor
Vibration Monitor
Source: Wyle 2016
0
200
400
Feet
N
NAVY BASE ICTF EIS
Train Pass By
Noise and Vibration
Measurement Locations
Figure 3.12-6
US Army Corps
Of Engineers
Charleston District

The measured average ambient vibration level of 81 VdB with no train present on the track noticeably exceeded the typical background vibration levels in the range from 50 to 60 VdB (FTA 2006). At the time of this measurement, the at-grade crossing was open to street traffic, and the vehicles passing the rail crossing generated additional ground vibration. Further, the vibration measurement was taken on a section of curved track which can greatly increase vibration levels.

The average L_v of 103 VdB measured during the train pass by (with no street traffic moving) markedly exceeded the ambient vibration level at the site. The measurement was taken on a section of curved track and, as the result, is considerably higher than what would be expected for a straight-line track due to the rail curvature in the vicinity of the measurement location. Up to three receptors would be located along segments of curved track under Alternatives 2, 3 or 6 (see Section 4.12).

This single monitoring event is not sufficient to determine a general baseline condition in proximity to the freight rail tracks, but demonstrates the worst-case scenario due to the measurement location near a curved track, where the highest noise and vibration levels are generated. The rail noise and vibration impact analyses described in Section 4.12 are based on the modeling rather than measurement results and are not affected by the limited monitoring data.

3.13 AIR QUALITY

3.13.1 Existing Conditions

Air quality impacts have the potential to affect both the local area as well as having a regional impact. Due to pollution, transport areas outside of the immediate vicinity of the Project site could be negatively affected by any proposed project. The regional study area for air quality is represented by the Tri-County area of South Carolina, which consists of Charleston, Berkeley, and Dorchester counties (Figure 3.13-1). This area is located in the southeastern area of South Carolina and is bordered by the Atlantic Ocean on its southeastern side.

3.13.1.1 Air Resources

Air quality in a given location is described as the concentration of various pollutants in the atmosphere. Air quality is determined by several factors; including the type and amount of pollutants emitted into the atmosphere, the size and topography of the air basin, and the prevailing meteorological conditions.

This section describes existing air quality conditions. Topics discussed in this section include climatology, air resource management, National Ambient Air Quality Standards (NAAQS), and local air quality of the Project site. More detailed discussions of existing air quality conditions are included in Appendix I.