TRAFFIC NOISE REPORT

Mid-Currituck Bridge Study

Currituck and Dare Counties

STIP Project No. R-2576
WBS Project No. 34470.1.TA1

Prepared for:

North Carolina Turnpike Authority
a division of the
North Carolina Department of Transportation

Submitted by:

WSP USA

June 2018

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Accepted by:

North Carolina Department of Transportation
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Executive Summary

The North Carolina Turnpike Authority, a division of the North Carolina Department of Transportation (NCDOT), in cooperation with the Federal Highway Administration (FHWA), is evaluating proposed transportation improvements in the Currituck Sound area, including consideration of a Mid-Currituck Bridge. The project Preferred Alternative includes widening of existing roadways and construction of a new interchange, bridge, and roadway in Currituck and Dare Counties (refer to Figure 1). The Preferred Alternative is shown in Figures 2-1 thru 2-18.

The project's Final Environmental Impact Statement (FEIS) was approved in 2012 and an FEIS Reevaluation is currently being prepared. The purpose of the FEIS Reevaluation is to note the major changes in project settings, alternatives, and impacts since the FEIS was published.

Federal funds will be used for this project and the project is included in the NCDOT State Transportation Improvement Program (STIP) as Project R-2576. The Date of Public Knowledge will be the date the Record of Decision (ROD) is issued. After this date, federal and state governments are no longer responsible for providing noise abatement measures for new development within the noise impact area of the proposed project. NCDOT advocates the use of local government authority to regulate land development, planning, design and construction in such a way that noise impacts are minimized.

Per FHWA Procedures for Abatement of Highway Noise (23 CFR 772.5(2)) and the 2016 NCDOT Traffic Noise Policy (NCDOT Policy), the proposed project is a "Type I" project. This Traffic Noise Report (TNR) documents the methodologies, results, and recommendations in compliance with 23 CFR 772, NCDOT Policy, and the accompanying NCDOT Traffic Noise Manual.

Traffic noise impacts and temporary construction noise impacts can be a consequence of transportation projects. This Traffic Noise Report utilized computer models created with the Federal Highway Administration Traffic Noise Model® (FHWA TNM v.2.5) to predict future noise levels and define impacted receptors along the proposed project. Design Year 2040 build condition traffic noise is predicted to impact 59 noise-sensitive receptors. Noise impacts were identified along US 158 in Barco, Coinjock, and Southern Shores, and along NC 12 in Corolla. All predicted noise impacts were due to future Design Year 2040 build traffic noise levels approaching or exceeding the applicable Noise Abatement Criteria (NAC). No noise impacts due to a predicted substantial increase above existing noise levels were identified.

Consideration for noise abatement measures was given to all impacted receptors. Each Noise Study Area (NSA) along the project corridor where receptors were impacted by Design Year 2040 traffic noise was evaluated to determine if a noise barrier would be preliminarily found to be feasible and reasonable. One (1) NSA was identified along the project corridor that warranted evaluation of noise abatement measures.

A total of three (3) traffic noise barriers were assessed using validated FHWA TNM v.2.5 models and are described in the table below:

PRELIMINARY NOISE WALL EVALUATION RESULTS

Noise Barrier Location	Length / Height (feet)	Surface Area (square feet)	Number of Benefited Receptors	Square Feet per Benefited Receptor / Allowable Square Feet per Benefited Receptor	Preliminarily Recommended for Construction
NSA 1 / -NW1.1-	396 / 17	6,732	2	3,366 / 1,500	No
NSA 1 / -NW1.2-	848 / 13	11,024	2	5,512 / 1,500	No
NSA 1 / -NW1.3-	602 / 9	5,418	2	2,709 / 1,500	No

NCDOT Policy requires the identification as to whether it is "likely" or "unlikely" that noise abatement measures will be installed for each NSA identified. "Likely" does not mean a firm commitment. The final decision on the installation of the abatement measures shall be made upon completion of the project design, the public involvement process, and concurrence with the NCDOT Policy.

The three evaluated noise barriers do not meet feasibility and reasonableness criteria and are considered to be "unlikely" for the Mid-Currituck Bridge project assessed in this TNR.

Construction noise impacts may occur due to the proximity of numerous noise-sensitive receptors to project construction activities. All reasonable efforts should be made to minimize exposure of noise-sensitive land uses to construction noise. Such efforts may include, but are not explicitly limited to, appropriate scheduling of construction activities, noise attenuating measures on construction equipment, and a consistent and open public involvement program.

None of the traffic noise abatement measures considered in this Traffic Noise Report meet the feasible and reasonable criteria detailed in the NCDOT Policy. Consequently, no traffic noise abatement measures are recommended for incorporation into the project plan. Additional traffic noise analysis will not be necessary during project final design unless modifications to the proposed roadway design occur, additional alignments are considered, or changes to Design Year 2040 traffic volumes are predicted.

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Traffic Noise Report

Mid-Currituck Bridge Study

1.0 PROJECT LOCATION, DESCRIPTION AND BACKGROUND

The North Carolina Turnpike Authority, a division of the North Carolina Department of Transportation (NCDOT), in cooperation with the Federal Highway Administration (FHWA), is evaluating proposed transportation improvements in the Currituck Sound area, including consideration of a Mid-Currituck Bridge (TIP Project No. R-2576) within Currituck and Dare Counties. Figure 1 illustrates the project area, which spans 5.4 miles of US 158 in Currituck County, 6.7 miles of proposed new bridge and roadway between US 158 in Coinjock and NC 12 in Corolla, 0.7 miles of NC 12, and 0.3 miles of US 158 in Dare County.

The project purpose is to respond to three underlying needs in the project area:

- The need to substantially improve traffic flow on the project area's thoroughfares (US 158 and NC 12);
- The need to substantially reduce travel time for persons traveling between the Currituck County mainland and the Currituck County Outer Banks; and
- The need to reduce substantially hurricane evacuation times from the Outer Banks for residents and visitors who use US 158 and NC 168 as an evacuation route.

The project's Preferred Alternative preliminary design proposes:

- Reversal of the US 158 center turn lane for hurricane evacuation between NC 168 and the US 158/Mid-Currituck Bridge interchange;
- Construction of a new interchange, bridge over Maple Swamp, and roadway between US 158 and the western shore of Currituck Sound in Aydlett;
- Construction of the new Mid-Currituck Bridge (MCB) across Currituck Sound between Aydlett and Corolla;
- Widening of NC 12 to 4-lanes in proximity to the new MCB – NC 12 roundabout;
- Addition of a left turn lane from Albacore Street to southbound NC 12; and
- Addition of a short hurricane evacuation lane near the NC 12 and US 158 intersection in Dare County.

The existing posted speed limit along US 158 varies from 45 to 55 miles per hour (mph) between NC 168 and Aydlett Road and is 50 mph within the US 158 section of the project area in Dare County. The existing posted speed limit along NC 12 is 45 mph.

The proposed Design Year 2040 design speeds along US 158 are 50 to 60 mph between NC 168 and Aydlett Road and 55 mph within the US 158 section of the project area in Dare County. The

proposed Design Year 2040 design speed is 30 mph along the 4-lane section of NC 12 and 60 mph for the Mid-Currituck Bridge.

1.1 Prior Traffic Noise Analyses

As part of the project Draft Environmental Impact Statement (DEIS) document, a previous traffic noise analysis was completed for the Mid-Currituck Bridge Project. The DEIS study evaluated the No-Build Alternative, the FEIS Preferred Alternative and ER2, as well as several variations on existing road improvements combined with a Mid-Currituck Bridge (Parsons Brinckerhoff, November 2009). The study was completed in accordance with Federal Highway Administration highway traffic noise standards (23 CFR, Part 772) and NCDOT Traffic Noise Abatement Policy (NCDOT, September 2004). It included field measurements throughout the project area, noise model validation, prediction of existing and future noise levels, identification of impacted sites, and noise barrier evaluations.

An addendum to the traffic noise analysis reflecting the revised Preferred Alternative roadway design was also completed for the Final Environmental Impact Statement (FEIS) (Parsons Brinckerhoff, November 2011) to comply with the NCDOT Traffic Noise Abatement Policy (NCDOT, July 2011).

A noise analysis update was later completed for the project's Reevaluation of Final Environmental Impact Statement report (WSP, February 2018) to account for revised traffic forecasts, revised roadway design alternatives, and new sensitive land uses. In addition, the study was updated to comply with the updated NCDOT Traffic Noise Policy and Traffic Noise Manual, both of which became effective on October 6, 2016.

1.2 Existing and Proposed Land Uses

In accordance with NCDOT Policy, the initial study area for the traffic noise assessment was established by extending 500-feet from the proposed project improvements in all directions. Existing and proposed noise-sensitive land uses within the study area were identified and categorized into the appropriate Activity Category, as described in Table 2 and further detailed in Section 7.2.

Noise-sensitive land uses within the project area include existing and permitted single-family residences (Category B); outdoor recreation areas, active sports areas, and pools (Category C); places of worship and medical facilities without exterior use (Category D); and restaurants with exterior use (Category E). Land uses that are not noise-sensitive within the project area include offices and restaurants without exterior use, retail, warehousing (Category F), and undeveloped lands without approved building permits (Category G.)

1.3 Noise Study Areas

To group noise-sensitive land uses that are geographically near one another and exposed to similar noise sources, the project study area was further segmented into six discrete Noise Study Areas

(NSAs). Figure 1 shows the NSAs identified within the project limits and a description of the location of each NSA is included below.

- **NSA 1** is located on the Currituck County mainland and extends along US 158 from NC 168 to the Intracoastal Waterway.

- **NSA 2** is located on the Currituck County mainland and extends along US 158 from the Intracoastal Waterway to 0.5 miles south of Aydlett Road.

- **NSA 3** is located on the Currituck County mainland and extends along the proposed future bridge and roadway alignment between US 158 and the western shore of Currituck Sound in Aydlett.

- **NSA 4** is located on the Currituck County Outer Banks and extends along NC 12 from 500 feet north of Herring Street to the Bonita Street/Monteray Drive intersection. NSA 4 also includes the area between the proposed Mid-Currituck Bridge terminus at the eastern shore of Currituck Sound and the roundabout at NC 12.

- **NSA 5** is located on the Currituck County Outer Banks and extends along Albacore Street from 500 feet west of NC 12 to 800 feet east of NC 12.

- **NSA 6** is located on the Dare County Outer Banks and extends along US 158 from 700 feet west of Birch Lane to 500 feet east of Cyprus Knee Trail.

2.0 PROCEDURE

This Traffic Noise Report represents the preliminary analysis of traffic noise impacts from the proposed Mid-Currituck Bridge project (R-2576).

The Federal Highway Administration Traffic Noise Model® version 2.5 (TNM) was used to predict Base Year 2015 existing, Design Year 2040 No-Build and Design Year 2040 Build condition hourly equivalent traffic noise levels, $L_{eq(h)}$, for the noise-sensitive receptors near the proposed project (refer to Figure 2).

The process for developing this Traffic Noise Report included:

- Measurement of existing noise levels that generally follow the guidelines contained in the FHWA's publication titled *Measurement of Highway Noise* (https://www.fhwa.dot.gov/environment/noise/measurement/). Land uses were identified, addresses obtained for all properties, weather data and unusual events recorded, field data logs and site sketches prepared and noise measurement locations were photographed at eight measurement locations on February 26th – February 28th, 2018 (refer to Appendix A).

- Developing a TNM traffic noise model to represent existing conditions. The model elements included receptors, roadways, terrain lines, ground zones, and fixed-height

barriers (to represent existing structures and jersey barriers). Traffic data collected during the time of the measurements was input into the TNM models as part of the validation process (refer to Appendix C).

- Incorporating the Build condition design elements, as defined in the NCDOT Traffic Noise Manual, into the validated existing-condition TNM models. Traffic noise impacts were assessed per the NCDOT Noise Abatement Criteria (NAC) and Substantial Increase criteria (the increase in predicted Design Year loudest-hour equivalent noise levels relative to Base Year baseline loudest-hour equivalent noise levels), as shown in Tables 2 and 4 and Appendix B. Design Year noise contours were created to assist land use planning efforts by local governments (see Section 8.0).

- Assessment of potential noise abatement measures as defined by the NCDOT Traffic Noise Policy for all traffic noise impacts resulting from the project. The noise barriers represent optimized designs that will preliminarily indicate feasibility and reasonableness of noise abatement for predicted traffic noise impacts (refer to Appendix E).

- Consideration of potential impacts from project-related construction noise. See Section 10.0 for a discussion of construction noise.

3.0 CHARACTERISTICS OF NOISE

Noise is commonly defined as unwanted sound and is emitted from many natural and man-made sources. Highway traffic noise is usually a combination of noise from vehicle engine exhaust, drive train, and tire-roadway interaction.

The magnitude, or loudness, of sound is determined by comparing the acoustic pressure (in Pascals) to a reference pressure of twenty micro-Pascals (20μPa). Because humans can perceive sounds over many orders of magnitude when expressed as a pressure, a base-10 logarithmic scale is used to compress the range of audible sound to a smaller scale, with the magnitude of sound then being expressed as a sound pressure level in units of decibels (dB). The commonly accepted range of human hearing is between the threshold of hearing at 0 decibels and the threshold of pain at 140 decibels.

All sound contains energy at multiple frequencies distributed across a frequency spectrum. The frequency, or pitch, of a sound is expressed in units of Hertz (Hz) and corresponds to the number of cycles per second of a sound wave. Traffic noise consists of low frequency components (engine "rumble") as well as middle and high frequency components (tire-roadway "whine"). The frequency spectrum can be grouped into ranges, or 'bands', which are typically defined as one 'octave' or '1/3 octave'. Overall sound pressure levels represent the combined acoustic energy present across a range of frequency bands.

The commonly accepted frequency range of human hearing is between 20 Hz and 20,000 Hz but human hearing is most sensitive to the frequencies between 1,000 Hz – 6,000 Hz. To account for how humans are not equally sensitive to sound across the audible frequency range, frequency

weightings are used to adjust the sound pressure level spectrum to better correspond with human perception. The "A-weighting" scale is applied to traffic noise levels and the resulting sound pressure levels are expressed a "A-weighted decibels", or dB(A).

Common indoor and outdoor noise levels are presented in Table 1. The degree of disturbance or annoyance from exposure to noise depends upon three factors:

1. The amount, nature, and duration of the intruding noise;

2. The relationship between the intruding noise and the existing (ambient) sound environment; and

3. The situation in which the disturbing noise is heard.

In considering the first of these factors, it is important to note that individuals have varying sensitivity to noise. Loud noises bother some people more than other people. The time patterns and durations of noise(s) also affect perception as to whether it is offensive. For example, noises that occur during nighttime (sleeping) hours are typically considered to be more offensive than the same noises in the daytime.

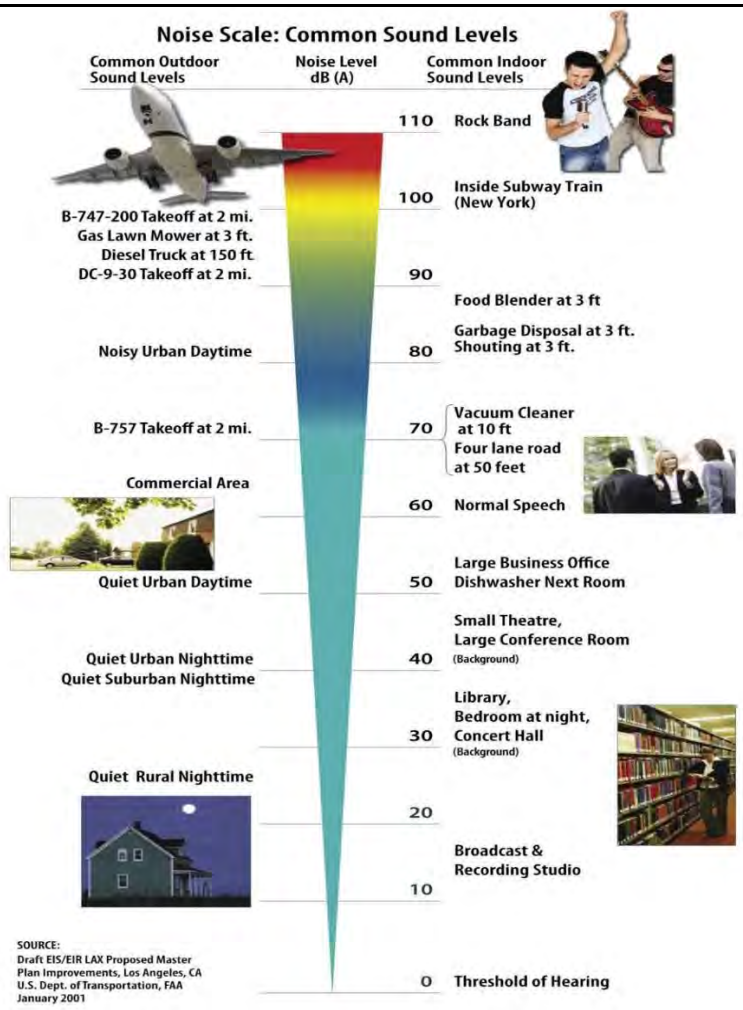
Regarding the second factor, individuals tend to judge the annoyance of an unwanted noise in terms of its relationship to noise from other sources (background noise). A car horn blowing at night when background noise levels are low would generally be more objectionable than one blowing in the afternoon when background noise levels are typically higher. The response to noise stimulus is analogous to the response to turning on an interior light. During the daytime, an illuminated bulb simply adds to the ambient light, but when eyes are conditioned to the dark of night, a suddenly illuminated bulb can be temporarily blinding.

The third factor, situational noise, is related to the interference of noise with activities of individuals. In an environment with an ambient noise level of 60 dB(A), such as is commonly found in a large business office, normal conversation would be possible, while sleep might be difficult. Loud noises may easily interrupt activities that require a quiet setting for greater mental concentration or rest; however, the same loud noises may not interrupt activities requiring less mental focus or tranquility.

Over time, individuals tend to become accustomed to the noises that intrude into their lives on a regular basis. However, exposure to prolonged and/or extremely loud noise(s) can prevent the full use of exterior and interior spaces, and could potentially pose health risks.

Appropriately, regulations exist to control noise from many particularly offensive sources, including airplanes, factories, railroads, and highways. For all federal, state, or federal-aid highway projects in the State of North Carolina that meet the definition of "Type I", analysis of noise from traffic and roadway construction is required as dictated by NCDOT Policy.

Table 1: Common Indoor and Outdoor Noise Levels



4.0 NOISE ABATEMENT CRITERIA

4.1 Title 23 Code of Federal Regulations, Part 772 (23 CFR 772)

The Federal Highway Administration has developed Noise Abatement Criteria (NAC) and procedures to be used when analyzing traffic noise in the planning and design of highways. The noise abatement criteria and procedures are set forth in Title 23 CFR Part 772. The purpose of 23 CFR 772 is "to provide procedures for noise studies and noise abatement measures to help protect the public's health, welfare and livability, to supply noise abatement criteria, and to establish requirements for information to be given to local officials for use in the planning and design of highways approved pursuant to title 23 U.S.C." The regulation also states that, "in abating traffic noise impacts, a highway agency shall give primary consideration to exterior areas where frequent human use occurs".

A summary of the NAC for various land uses is presented in Table 2. The $L_{eq(h)}$, or equivalent hourly sound level, is the equivalent steady-state sound level that contains the same acoustic energy as a time-varying sound level over one hour. Traffic noise levels are expressed as $L_{eq(h)}$ noise levels, in units of dB(A), to account for the fluctuating nature of traffic noise over time.

4.2 North Carolina Department of Transportation Traffic Noise Policy

The North Carolina Department of Transportation Traffic Noise Policy (October 6, 2016) establishes the state's official policy on highway noise and abatement. This policy describes the NCDOT process that is used in determining traffic noise impacts, construction noise impacts and abatement measures, and the equitable and cost-effective expenditure of public funds for traffic noise abatement. Where the FHWA has given highway agencies flexibility in implementing the 23 CFR 772 standards, this policy describes the NCDOT's approach to implementation. This policy is included as Appendix F of this report.

4.3 Noise Abatement Criteria

The two categories of traffic noise impacts are defined as (1) traffic noise levels that "approach" or exceed the FHWA Noise Abatement Criteria (NAC), as shown in Table 2, and (2) traffic noise levels that represent a "substantial increase" over existing noise levels as defined by NCDOT. NCDOT defines "approach" as noise levels within 1 dB(A) of the NAC (e.g. 66 dB(A) for Activity Category B). An impact that represents a "substantial increase" is based on a comparison of the Base Year noise level ($L_{eq(h)}$) with respect to a predicted increase in noise levels in the Design Year of 10 dB(A) or greater.

Table 2: Noise Abatement Criteria			
Hourly Equivalent A-Weighted Sound Level (dB(A))			
Activity Category	**Activity Criteria[1] $L_{eq(h)}$[2]**	**Evaluation Location**	**Activity Description**
A	57	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B [3]	67	Exterior	Residential
C [3]	67	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, daycare centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section4(f) sites, schools, television studios, trails, and trail crossings
D	52	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios
E [3]	72	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F
F	--	--	Agriculture, airports, bus yards, emergency services, industrial, logging maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing
G	--	--	Undeveloped lands that are not permitted

1 The $L_{eq(h)}$ Activity Criteria values are for impact determination only, and are not design standards for noise abatement measures.
2 The equivalent steady-state sound level which in a stated period of time contains the same acoustic energy as the time-varying sound level during the same time period, with $L_{eq(h)}$ being the hourly value of L_{eq}.
3 Includes undeveloped lands permitted for this activity category.

5.0 AMBIENT NOISE LEVELS

Ambient noise is ever-present noise caused by natural and manmade sources and events. It includes the wind, rain, thunder, birds chirping, insects, household appliances, HVAC equipment, commercial operations, lawn mowers, airplanes, automobiles, etc. It is the summation of all noise sources that are present in an area.

The ambient noise environment varies depending on the location within the Mid-Currituck Bridge project area. Along US 158 within NSAs 1, 2, and 6, traffic noise from US 158 was the dominant noise source observed during ambient noise monitoring. Along NC 12 within NSAs 4 and 5, traffic noise from NC 12 was the dominant noise source during ambient noise monitoring at most locations. Along the proposed project alignment in Aydlett (NSA 3), where there are no existing major roadway noise sources, audible existing noise sources included birds, aircraft overpasses, local traffic, wind in trees, and the surf from Currituck Sound.

Ambient noise monitoring was completed at eight locations from February 26 – 28, 2018. At each location, 20-minute long noise measurements were completed to establish existing sound levels and to collect data to be used for validation of the traffic noise model. The ambient noise monitoring locations are shown in Figures 2-1 thru 2-18 labeled with the prefix "V". The measured ambient noise levels ranged from 40 to 69 dB(A) L_{eq}.

To establish noise levels in areas where the existing environment is not dominated by roadway traffic noise sources, long-term noise monitoring was completed at:

- Site LT-1: 115 Lighthouse View, Aydlett (NSA 3)
- Site LT-2: 358 Narrow Shore Road, Aydlett (NSA 3)
- Site LT-3: 983 Ocean Forest Court, Corolla (NSA 4)

These locations were selected to represent other nearby residences exposed to similar existing noise sources and are shown in Figures 2-14 and 2-15. At all three sites, the distance and/or shielding from major roadway noise sources resulted in traffic noise not being the dominant existing noise source. Noise levels were measured for 24 to 48-hours at each location between February 26 and March 1, 2018. After reviewing the measurement results, site LT-1 was selected to represent all receptors in Aydlett (NSA 3) because the measured noise levels were lower than site LT-2, resulting in a more conservative assessment of existing loudest-hour noise levels. Based on the long-term measurements, the existing loudest-hour noise level was determined to be 47 dB(A) $L_{eq(h)}$ at both LT-1 and LT-3.

Noise monitoring was completed using equipment complying with ANSI S1.4 Type I or Type II precision. Sound level meters that were used for short-term measurements were a Bruel & Kjaer 2250, Bruel & Kjaer 2238, and Larson Davis LxT. Three (3) Larson Davis model 720 noise monitors were used for the long-term measurements. A hand-held Bruel & Kjaer 4231 calibrator was used to check equipment calibration in the field. All sound level meters were equipped with a 3-inch foam windscreen during measurements and calibrated by a certified laboratory within 2 years of use.

The noise monitoring results, concurrent traffic counts, estimated vehicle speeds, weather information for the monitoring sites, and photographs of each location are included in Appendix A.

6.0 NOISE MODEL VALIDATION

To validate the noise models developed for the project, measured traffic noise levels were compared to TNM-predicted noise levels at the field measurement locations. For each monitoring location, traffic volumes counted during the 20-minute ambient noise monitoring periods were used to calculate 1-hour traffic volumes. These hourly traffic volumes were then assigned to the corresponding project area roadways to simulate vehicle traffic that was observed during the actual measurement period. Modeled and measured sound levels were then compared to one another to validate the accuracy of the model, the results of which are included in Appendix C.

7.0 PROCEDURE FOR PREDICTING EXISTING AND FUTURE NOISE LEVELS

In accordance with industry standards and accepted best-practices, detailed TNM models were developed to predict existing and future traffic noise levels. Appendix B includes a comprehensive list of noise-sensitive receptors along with their Base Year 2015 and predicted Design Year 2040 traffic noise levels.

The TNM noise prediction algorithms account for the distance between the roadway noise source and receptor location, the number and type of vehicles on the planned roadway, vehicle speeds, the physical characteristics of the road (curves, hills, depressions, elevations, etc..), and intervening objects (buildings, barriers, hills, etc..) between the roadway and receptor.

Traffic noise consists of three primary components: tire/pavement noise, engine noise, and exhaust noise. Of these sources, tire/pavement noise is typically the most offensive at unimpeded travel speeds. Sporadic noises such as horns, squealing brakes, screeching tires, etc. are considered anomalous and are not included within the predictive model algorithm.

Because traffic noise emissions are different for various types of vehicles, the TNM model's algorithms distinguish between the source emissions from the following vehicle types depicted in Table 3: Automobiles (FHWA vehicle classifications 2 and 3), Medium Trucks (FHWA vehicle classification 5), Heavy Trucks (FHWA vehicle classifications 6 – 13), Buses (FHWA vehicle classification 4), and Motorcycles (vehicle classification 1). All two-axle, four wheel vehicles – including pickup trucks – are categorized as Automobiles. Two-axle, six wheel vehicles (e.g. delivery trucks and small box trucks) are categorized as Medium Trucks. All other trucks are categorized as Heavy Trucks. The Bus category encompasses all types of buses (e.g. school, inter-city, and intra-city buses).

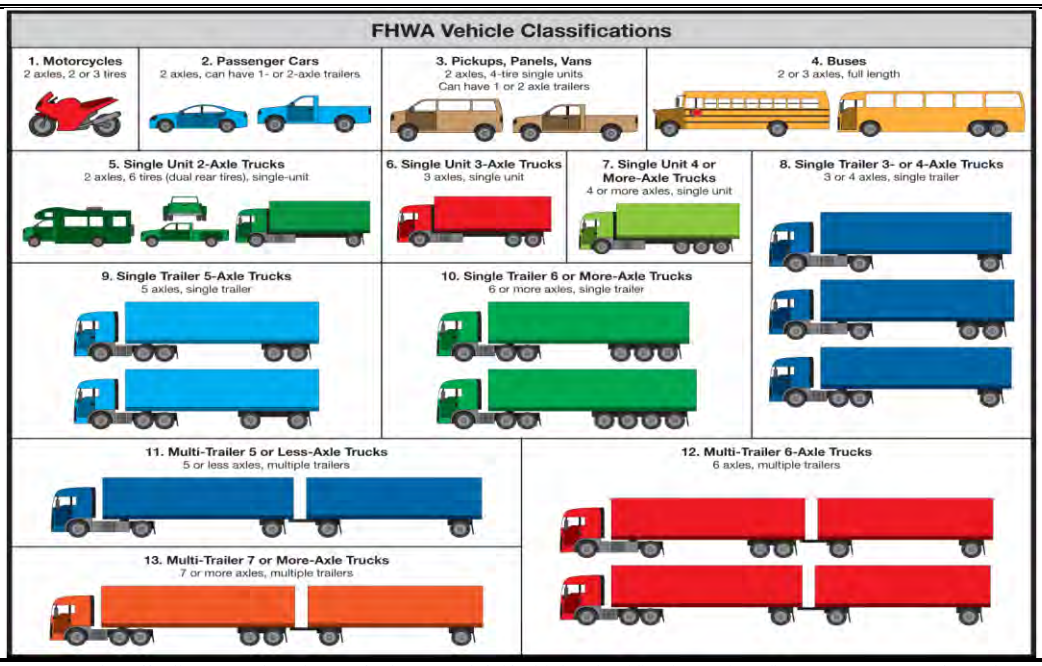
7.1 Traffic Forecasts

Per FHWA guidelines, the predictions documented in this report are based upon the traffic conditions resulting in the loudest predicted hourly-equivalent traffic noise levels for each receptor. Traffic forecast volumes were based on the Project Level Traffic Forecast Report (WSP-Parsons Brinckerhoff, June 2016). In accordance with NCDOT Policy, design hour volume (DHV) traffic forecasts were compared to level of service (LOS) C roadway capacity volumes for US 158 and NC 12. DHV forecasts corresponding to the summer weekend condition of the Base Year 2015

and Design year 2040 were utilized because it resulted in the worst-case (highest) traffic volumes. If the DHV forecast exceeded the LOS C volume for a roadway, then LOS C volumes were used for the noise analysis, otherwise DHV forecasts were used.

Modeled vehicle types include automobiles, medium trucks, and heavy trucks. Recreational vehicles that were included in the DHV forecasts along NC 12 were modeled as medium trucks in TNM. The predicted traffic volumes used for TNM model input are included in Appendix D.

Table 3: Traffic Noise Model (TNM) Vehicle Classification Types



Source: http://onlinemanuals.txdot.gov/txdotmanuals/tri/vehicle_classification_using_fhwa_13category_scheme.htm

7.2 Existing Noise Levels

Base Year 2015 noise levels were predicted at all noise-sensitive receptor locations within the Mid-Currituck Bridge project area using the validated TNM models and loudest-hour traffic volumes and speeds. The existing and proposed noise-sensitive land uses identified within each NSA (as defined in Section 1.3) are discussed below.

- **NSA 1**: Existing land uses within NSA 1 includes single family residences (Category B); tennis courts and a soccer field at the Currituck County Middle and High School, a library with an exterior use area (Category C); a medical facility and a place or worship without exterior use areas (Category D); a restaurant with exterior seating (Category E); offices without exterior use areas, retail, and warehousing (Category F); and undeveloped lands (Category G.) The noise-sensitive receptor locations within NSA 1 are located along US 158 (Caratoke Highway) and adjacent cross streets in Barco and Coinjock.

- **NSA 2**: Existing land uses within NSA 2 includes single family residences (Category B); retail and warehousing (Category F); and undeveloped lands (Category G.) The noise-sensitive receptor locations within NSA 2 are located along US 158 (Caratoke Highway) or adjacent cross streets in Coinjock.

- **NSA 3**: Existing land uses within NSA 3 include single family residences (Category B) and undeveloped lands (Category G.) The noise-sensitive receptor locations within NSA 3 are located along Lighthouse View and Narrow Shore Road in Aydlett.

- **NSA 4**: Existing land uses within NSA 4 include single family residences (Category B); pool and tennis courts (Category C); and undeveloped lands (Category G.) The noise-sensitive receptor locations within NSA 4 are located along Cane Garden Bay Circle, Corolla Drive, Pelican Court, Harbor View, Ocean Forest Court, Misty Pond Court, Sunset Crescent, Sea View Court, and Soundside Court in Corolla.

- **NSA 5**: Existing land uses within NSA 5 include single family residences (Category B); a pool, tennis courts, basketball courts, an outdoor mini golf course (Category C); restaurants with outdoor seating (Category E); and retail (Category F.) The noise-sensitive receptor locations within NSA 5 are located along Ocean Trail, Broad Street, W Meeting Street, and Orions Way in Corolla.

- **NSA 6**: Existing land uses within NSA 6 include single family residences (Category B); the Duck Woods County Club golf course (Category C); offices without exterior use areas and retail (Category F); and undeveloped lands (Category G.) The noise-sensitive receptor locations within NSA 6 are located along Birch Lane, Windsor Place, and Dogwood Trail in Kitty Hawk and Southern Shores.

Undeveloped land that is permitted for development is considered noise-sensitive and included in traffic noise assessments if a building permit for an individual lot or site is approved prior to the Date of Public Knowledge for the project. A land use review was completed as part of the FEIS Reevaluation in May 2017 and updated in March 2018 by reviewing building permit records supplied by Currituck and Dare Counties and investigating sites under construction during field review. Within the study area, the sites below were identified as having an approved building permit and included in the noise assessment.

- 112 Simpson Road, Barco (R-2 in NSA 1) – single-family residence
- 972 Ocean Forest Court, Corolla (R-183 in NSA 4) – single-family residence
- 969 Ocean Forest Court, Corolla (R-188 in NSA 4) – single-family residence
- 931 Soundside Court, Corolla (R-256 in NSA 4) – single-family residence

For this Traffic Noise Report, loudest-hour existing noise levels were identified as either the TNM-predicted noise levels based on existing loudest-hour traffic estimates, or the ambient noise levels

obtained by measurements at representative locations in the field.[1] Measured ambient noise levels were used for the traffic noise assessment at receptors represented by the long-term measurement locations discussed in Section 5.0 because the measured loudest-hour noise levels were higher than the TNM-predicted noise levels. Measured ambient noise levels were utilized for receptors R-93 – R-103 in Aydlett (NSA 3) and receptors R-178 and R-179 along Ocean Forest Court in Corolla (NSA 4). At all other receptor locations, the TNM-predicted loudest-hour existing noise levels were used in the assessment.

TNM-predicted 2015 Existing condition noise levels ranged from 37 to 76 dB(A) $L_{eq(h)}$. Existing noise levels are highest at first-row receptors within NSA 1 and NSA 2 due to the high existing traffic volumes and vehicle travel speeds along US 158. Existing noise levels are lowest at second- and third-row receptor locations in NSA 4 because the sites are well shielded from existing NC 12 traffic noise by building structures.

7.3 Future Noise Levels

Future Year 2040 No-Build noise levels were predicted by modifying the Existing condition TNM model to include traffic input data to correspond to future No-Build loudest-hour traffic conditions.

Predicted 2040 No-Build condition noise levels ranged from 38 to 77 dB(A) $L_{eq(h)}$. The predicted increase at individual receptor locations in 2040 No-Build condition noise levels above Existing condition noise levels ranged from 0 to 2 dB(A) $L_{eq(h)}$. The No-Build condition involves no improvements to existing roadways in NSAs 1 – 5, so increases in predicted No-Build condition noise levels at individual receptor locations relative to the Existing condition are solely due to increases in future loudest-hour traffic volumes in these areas. In NSA 6, along US 158 east of the Wright Memorial Bridge, the No-Build condition assumes US 158 would be a four-lane superstreet constructed by STIP Project R-3419. Thus, the predicted No-Build condition noise levels in this area also reflect the greater future traffic volumes that a four-lane superstreet roadway would facilitate.

Future Year 2040 Build noise levels were predicted by modifying the Existing condition TNM model roadways and terrain features, and adding new roadways and bridge structures based on the proposed preliminary roadway plans. The model was also updated to include traffic input data corresponding to future Build loudest-hour traffic conditions.

Predicted 2040 Build condition noise levels ranged from 38 to 77 dB(A) $L_{eq(h)}$. The predicted increase at individual receptor locations in 2040 Build condition noise levels above Existing condition noise levels ranged from 0 to 9 dB(A) $L_{eq(h)}$. The increases in predicted future Build condition noise levels relative to the Existing condition are due to several factors, including:

- Increased future loudest-hour traffic volumes throughout the project area;

[1] Per 23 CFR 772.5, existing noise levels are defined as "the worst noise hour resulting from the combination of natural and mechanical sources and human activity usually present in a particular area." If the TNM-predicted existing loudest-hour *traffic* noise levels are lower than the hourly-equivalent noise levels obtained in the field, then existing noise levels are assessed as the latter.

- Proposed widening of existing US 158 and NC 12 roadways in NSAs 2 and 4; and
- Proposed addition of the new interchange, roadway, bridges, and roundabout between US 158 and NC 12 in NSAs 2, 3 and 4.

2040 Build condition noise levels are also predicted to be up to 4 dB(A) $L_{eq(h)}$ lower than Existing condition noise levels at some receptors in NSA 4. This is due to the decrease in vehicle travel speeds for the proposed 4-lane section of NC 12 near the roundabout compared to the existing 2-lane roadway. The existing posted speed limit in this area is 45 mph and the proposed posted speed limit is 30 mph.

8.0 TRAFFIC NOISE IMPACTS AND NOISE CONTOURS

Traffic noise impacts occur when the predicted traffic noise levels either: (1) approach or exceed the FHWA noise abatement criteria (with "approach" meaning within 1 dB(A) of the NAC values listed in Table 2), or (2) substantially exceed the existing noise levels in the design year by 10 dB(A) or greater. FHWA and NCDOT require that feasible and reasonable measures be considered to abate traffic noise at all predicted traffic noise impact locations. Measures considered include highway alignment selection, traffic systems management, buffer zones, noise walls, and earthen berms.

As shown in Table 4, traffic noise levels are predicted to cause 59 impacts in the 2040 Build condition. 55 impacts are predicted at Category B (residential) receptor locations and 4 impacts are predicted at Category C (recreational and library) receptor locations. All impacts are due to future noise levels exceeding the NAC and no receptors are predicted to experience an impact due to a substantial increase in noise levels.

Impacted receptors are identified in the noise level results table in Appendix B as cells highlighted red and shown on Figures 2-1 thru 2-18 with either a red or blue circle, depending on whether the receptor is also benefited by a potential noise barrier.

Table 4: Traffic Noise Impact Summary for the 2040 Build Condition

REASON FOR NOISE IMPACT	SUMMARY OF IMPACTED RECEPTORS[7] 2040 BUILD CONDITION							
	BY ACTIVITY CATEGORY							
	A	B	C	D	E	F[5]	G[6]	ALL ACTIVITY CATEGORIES
Based on NAC Criteria Only[1]	0	55	4	0	0	0	0	59
Based on Substantial Increase Criteria Only[2]	0	0	0	0	0	0	0	0
Based on Both Criteria[3]	0	0	0	0	0	0	0	0
TOTAL IMPACTS[4]	0	55	4	0	0	0	0	59

Note 1: Predicted traffic noise level impacts due to design year worst hour build-condition noise levels approaching or exceeding the NCDOT Noise Abatement Criteria (NAC)

Note 2: Predicted design year worst hour noise levels exceeding existing worst hour noise levels by 10 dB(A) or greater. (NCDOT Substantial Increase Criteria).

Note 3: Predicted traffic noise level impacts due to both 1 and 2 above.

Note 4: Only one of the Note 1 and Note 2 conditions must be met for an impact to exist.

Note 5: There are no impact criteria for land use facilities in this activity category and no analysis of noise impacts is required.

Note 6: There are no impact criteria for undeveloped lands but some noise levels may need to be provided to local officials to aid them in future land use planning efforts.

Note 7: Values noted for Activity Category C, D, and E represent Equivalent Receptor values for these non-residential land uses.

Predicted 2040 Build condition traffic noise level contours are not a definitive means by which to assess traffic noise level impacts; however, they can aid in future land use planning efforts in presently undeveloped areas. Due to the variety of future traffic conditions and roadway sections for this project, noise level contours vary throughout the project area. Correlating to the traffic noise impact thresholds for FHWA NAC "B" and "E" land uses, respectively, the 66 and 71 dB(A) noise level contour distances for the Mid-Currituck Bridge project are shown in Table 5.

Table 5: Design Year 2040 Noise Contours

Location	Distance to Noise Level Contour (feet) [1]	
	66 dB(A)	71 dB(A)
NSA 1, east of US 158	200	75
NSA 2, east of US 158 and north of interchange	225	125
NSA 2, east of US 158 NB on-ramp	175	75
NSA 2, east of US 158 NB off-ramp	200	100
NSA 2, west of US 158 and south of interchange	100	25
NSA 3, south of proposed roadway in Aydlett	75	25
NSA 4, west of NC 12 and north of roundabout	75	25
NSA 4, north of roadway between MCB and roundabout	25	10

Location	Distance to Noise Level Contour (feet) [1]	
	66 dB(A)	71 dB(A)
NSA 4, east of NC 12 and south of roundabout	25	10
NSA 6, south of US 158	150	75

1 The contour distance is from the proposed edge of the nearest travel lane.

Per 23 CFR 772.9(c) and NCDOT Policy, noise contour lines shall not be used for determining highway traffic noise impacts. However, the 71 dB(A) and 66 dB(A) noise level contour information could assist local authorities in exercising control over the remaining undeveloped lands in order to avoid creating incompatible situations involving new developments adjacent to the roadways.

9.0 POTENTIAL TRAFFIC NOISE ABATEMENT MEASURES

FHWA and NCDOT require that feasible and reasonable noise abatement measures be considered and evaluated for the benefit of all predicted Build condition traffic noise impacts. Feasibility and reasonableness are distinct, well defined, and separate considerations. Feasibility is the consideration of whether noise abatement measures *can* be implemented. Reasonableness is the consideration of whether noise abatement measures *should* be implemented. Per NCDOT Policy, the following traffic noise abatement measures may be considered: highway alignment selection, traffic systems management, buffer zones, noise barriers (earthen berms and noise walls), and noise insulation of Activity Category D land use facilities.

9.1 Highway Alignment Selection

Highway alignment selection for traffic noise abatement purposes involves modifying the horizontal and vertical geometry of the proposed roadway(s) to minimize traffic noise affecting noise-sensitive receptors. The selection of alternative alignments for noise abatement purposes must consider the balance between noise impacts and other engineering and environmental factors. This abatement option was not considered practicable because several portions of the project are widening existing roadways in developed areas with limited space available to shift the roadway alignment. Additionally, bridge alignment alternatives have been studied as part of prior environmental documents (DEIS and FEIS) and the current alignment has been selected to minimize overall environmental impacts.

9.2 Traffic System Management Measures

Traffic management measures such as prohibition of heavy truck traffic, lowering speed limits, limiting of traffic volumes, and/or limiting time of operation were considered as possible traffic noise impact abatement measures. However, part of the purpose of the Mid-Currituck Bridge project is to improve traffic flow and reduce travel times along between the Currituck County mainland and the Currituck County Outer Banks. The prohibition of certain vehicle types, reduction of the existing or future speed limit, or limiting of overall traffic volumes on US 158 or NC 12 would not support the purpose of the project, and are thus not considered practicable.

9.3 Buffer Zones

Buffer zones are typically not practical and/or cost effective for noise abatement due to the substantial amount of right-of-way required, and would not be a feasible noise abatement measure for this project due to the proximity of existing development to the right of way. Furthermore, if the acquisition of a suitable buffer zone had been feasible, the associated costs would exceed the NCDOT reasonable abatement cost threshold per benefited receptor.

9.4 Noise Barriers

Physical barriers, walls and berms can be an effective means of noise abatement because they reduce the amount of sound energy that reaches a receptor by extending the source-to-receptor sound transmission path and prevent people from seeing the noise source in question.

Highway noise barriers are primarily constructed as earthen berms or solid-mass walls adjacent to limited-access freeways that are near noise-sensitive land use(s). To be effective, a noise barrier must long enough and tall enough to shield the impacted receptor(s). Generally, the noise barrier length must extend in each direction by at least four-times the distance from the barrier to the receptor. For example, if a receptor is 200 feet from the roadway, an effective barrier would be approximately 1,600 feet long – with the receptor in the horizontal center. Assuming a suitable barrier length can be achieved, then the most important factor determining the noise reduction effectiveness of a barrier will be its height.

A noise barrier should be tall enough to block the line-of-sight between the noise source(s) and the receptor(s), keeping in mind that heavy truck exhaust stacks can extend to a height of 12 feet above pavement. Blocking the line-of-sight will result in a noise reduction of approximately 5 decibels. Increasing the height of a barrier will improve its noise reduction performance at a rate of approximately 2 decibels for every 3 feet of additional height.

In the case of highways with direct access for driveways, noise barriers are typically not feasible because the openings render the barrier ineffective in impeding the transmission of traffic noise. Moreover, the barriers could pose a risk from the driver's visibility perspective. Due to the requisite lengths for effectiveness, noise barriers are typically determined to not be economically justified in cases involving isolated or sporadically developed areas. This is often due to not having enough receptors that could potentially be benefited by the barrier to adequately distribute the barrier cost.

Consideration for noise abatement measures was given to all impacted receptors. The project corridor was analyzed for areas where there were traffic noise impacts from the proposed project and where sufficient area to locate a barrier, if deemed feasible and reasonable, exists. The noise barrier analyses for each NSA are discussed below and additional details can be found in Table 6 and Appendix E.

- NSA 1 – Fifty-two (52) residences, a sports field, and a library without outdoor use were identified as impacted and noise barriers were evaluated at three locations in NSA 1.

  There is frequent direct-access to US 158 in NSA 1 from residential driveways, side streets, or parking lots as can be seen in Figures 2-1 to 2-5. Noise barriers for impacted receptors R-4, R-7 – R-12, R-14 – R-21, R-23 – R-25, R-27 – R-34, R-36 – R-45, R-47, R-49 – R-55, and R-58 – R-62 were determined not to be feasible because a barrier would adversely impact property access. In addition, many of the impacted receptors are isolated and a single noise barrier would not be able to benefit two impacted receptors. Therefore, these sites are not eligible for noise abatement and noise abatement is Unlikely.

  -NW1.1- was evaluated to provide noise abatement for two impacted residential receptors (R-3 and R-5) west of US 158 to the north of Swains Lane, as shown in Figure 2-1. A 17-foot tall and 396-foot long wall would benefit both impacts with an average of 3,366 square-feet per benefitted receptor. -NW1.1- was found to meet NCDOT feasibility criteria but did not meet NCDOT criteria for reasonableness because the area of barrier per benefited receptor exceeded the allowable area of 1,500 square-feet per benefitted receptor. Thus, this site is not eligible for noise abatement and noise abatement is Unlikely.

  -NW1.2- was evaluated to provide noise abatement for the impacted Currituck County High School tennis courts and soccer field (R-35 receptor array) to the east of US 158, as shown in Figure 2-3. Equivalent Receptors (ERs) are used to represent non-residential land uses such as sports fields. The calculation of Equivalent Receptors for this site can be found in Appendix B. The ER calculations show that this site has an ER value of 2. A 13-foot tall and 848-foot long wall would benefit 2 ERs with an average of 5,512 square-feet per benefitted receptor. -NW1.2- was found meet NCDOT feasibility criteria but did not meet criteria for reasonableness because the area of barrier per benefited receptor exceeded the allowable area of 1,500 square-feet per benefitted receptor. Therefore, this site is not eligible for noise abatement and noise abatement is Unlikely.

  -NW1.3- was evaluated to provide noise abatement for two impacted residences (R-63 and R-65) along Worth Guard Road directly east of US 158, as shown in Figure 2-5. A 9-foot tall and 602-foot long wall would benefit both impacts with an average of 2,709 square-feet per benefitted receptor. -NW1.3- was found to meet NCDOT feasibility criteria but did not meet criteria for reasonableness because the area of barrier per benefited receptor exceeded the allowable area of 1,500 square-feet per benefitted receptor. Thus, this site is not eligible for noise abatement and noise abatement is Unlikely.

- NSA 2 – Two residences (R-84 and R-91) were identified as impacted in NSA 2. Both residences, shown in Figures 2-9 and 2-10, are isolated from other impacted receptor locations. A noise barrier at either site would not be able to benefit at least two impacted receptors, so noise barriers were determined not to be feasible per NCDOT policy.

Therefore, these sites are not eligible for noise abatement and noise abatement is Unlikely.

- NSA 3 – No sites were identified as impacted in NSA 3, so this area is not eligible for noise abatement.

- NSA 4 – One (1) residence and a community pool were identified as impacted in NSA 4. The impacted residence (R-173), shown in Figure 2-15, is isolated from other impacted locations. A noise barrier at this site would not be able to benefit at least two impacted receptors, so a noise barrier was determined not to be feasible per NCDOT policy. Therefore, this site is not eligible for noise abatement and noise abatement is Unlikely.

  The impacted pool (R-225), shown in Figure 2-16, is located west of NC 12 north of Bonita Street/Monteray Drive. The receptor is 300-feet south of the NC 12 project improvement limits. There are no differences between the NC 12 roadway design or traffic forecasts for the Existing, No Build, and Build conditions in this area. Further, no increase in Build condition noise level relative to the Existing condition is predicted at this receptor. Therefore, the noise impact at this site has been determined not to be caused by the project, so this site is not eligible for noise abatement and noise abatement is Unlikely.

- NSA 5 – No sites were identified as impacted in NSA 5, so this area is not eligible for noise abatement.

- NSA 6 – A section of the Duck Woods Country Club golf course (R-282 receptor array) was identified as impacted in NSA 6. This site can be seen in Figure 2-18. Equivalent Receptors (ERs) are used to represent non-residential land uses such as golf courses. The calculation of Equivalent Receptors for this site can be found in Appendix B. The ER calculations show that this site has an ER value of 1. A noise barrier at this site would not be able to benefit at least two receptors, so a noise barrier was determined not to be feasible per NCDOT policy. Therefore, this site is not eligible for noise abatement and noise abatement is Unlikely.

Table 6: Preliminary Noise Wall Evaluation Results

Noise Barrier Location	Length / Height (feet)	Surface Area (sq-ft)	Number of Benefited Receptors	Square Feet per Benefited Receptor / Allowable Square Feet per Benefited Receptor	Preliminarily Recommended for Construction
NSA 1 / -NW1.1-	396 / 17	6,732	2	3,366 / 1,500	No
NSA 1 / -NW1.2-	848 / 13	11,024	2	5,512 / 1,500	No
NSA 1 / -NW1.3-	602 / 9	5,418	2	2,709 / 1,500	No

None of the noise abatement measures evaluated in this Traffic Noise Report meet the feasible and reasonable criteria detailed in the NCDOT Policy. Consequently, no traffic noise abatement measures are recommended for incorporation into the project plan.

9.5 Noise Insulation

Two interior noise-sensitive land uses (activity category D) are located along the project corridor within NSA 1. The NAC D land uses described below were evaluated for interior noise levels because outdoor use areas were not identified in the field:

- Albtuck Family Medical and Care, a medical facility located at 4039 Caratoke Highway, is predicted to be exposed to a Build noise level of 68 dB(A) $L_{eq(h)}$ at the exterior of the building. There is no outdoor use area associated with the facility. When Building Noise Reduction Factors are applied assuming a masonry structure and single glazed windows, as shown in Table 7, the interior sound level of 43 dB(A) is not an impact based on NAC activity category D.

- New Life of Currituck Church, located at 4143 Caratoke Highway, is predicted to be exposed to a Build noise level of 72 dB(A) $L_{eq(h}$ at the exterior of the church. There is no outdoor recreation area associated with the church. When Building Noise Reduction Factors are applied assuming a masonry structure and single glazed windows, as shown in Table 7, the interior sound level of 47 dB(A) is not an impact based on NAC activity category D.

Since no activity category D traffic noise impacts are predicted to occur for the Mid-Currituck Bridge project, interior noise insulation was not considered as a potential traffic noise abatement measure.

Table 7: Building Reduction Factors

Building Type	Window Condition	Noise Reduction Due to Exterior of the Structure
All	Open	10 dB(A)
Light Frame	Ordinary Sash (closed)	20 dB(A)
	Storm Windows	25 dB(A)
Masonry	Single Glazed	25 dB(A)
	Double Glazed	35 dB(A)

Source: FHWA-PD-96-046, Measurement of Highway Related Noise, Final Report, May 1996.

10.0 CONSTRUCTION NOISE

Construction activities associated with this project are expected to include earth removal, hauling, grading, paving, and pile driving. Typical construction noise emission levels for these activities are presented in Table 8.

Temporary and localized construction noise impacts may occur because of earth removal, hauling, grading and paving activities. During daytime hours, the potential effects of these impacts would be temporary speech interference for passers-by and those individuals living or working near the project.

For this project, earth removal, grading, hauling, and paving is expected to occur in the near vicinity of several residential areas:

- Residences along US 158 near Young Road and Aydlett Road in Coinjock (NSA 2), in proximity to the proposed US 158 interchange construction.
- Residences along Lighthouse View and Narrow Shore Road in Aydlett (NSA 3), to the north and south of the proposed roadway construction between the bridges over Maple Swamp and Currituck Sound.
- Residences to the east and west of NC 12 in Corolla (NSA 4), between Harbor View and Herring Street near the proposed widening of NC 12 and roundabout construction.

Extremely loud construction noise activities such as usage of pile-drivers to install structural piles and impact-hammers (jack hammer, hoe-ram) could cause temporary, sporadic and acute construction noise impacts at nearby noise-sensitive locations.

Pile driving as part of construction of the Maple Swamp Bridge and the Mid-Currituck Bridge is expected to occur in the near vicinity of several residential areas:

- Residences along Lighthouse View and Narrow Shore Road in Aydlett (NSA 3), to the north and south of the proposed Maple Swamp Bridge and Mid-Currituck Bridge alignments.
- Residences along Ocean Forest Court and Cruz Bay Lane in Corolla (NSA 4), near the proposed Mid-Currituck Bridge terminus at the eastern shore of Currituck Sound.

Because existing noise levels are relatively low in the residential areas near the proposed pile driving activities, there is a likelihood that pile driving will result in construction noise levels that are significantly higher than existing ambient noise levels in these areas.

Generally, low-cost and easily implemented construction noise control measures should be incorporated into the project plans and specifications (e.g. work-hour limits, equipment exhaust muffler requirements, haul-road locations, elimination of “tail gate banging”, ambient-sensitive backup alarms, construction noise complaint mechanisms, and consistent and transparent community communication and rapport).

Although construction noise impact abatement should not place an undue burden upon the financial cost of the project or the project construction schedule, pursuant to the requirements of 23 CFR 772.19, it is the recommendation of this Traffic Noise Report that:

- Earth removal, grading, hauling, paving, and pile driving activities near the residential areas noted above should be limited to weekday daytime hours.
- If meeting the project schedule requires that earth removal, grading, hauling, paving and/or pile driving must occur during evening, nighttime and/or weekend hours near the residential areas noted above, the Contractor shall notify NCDOT as soon as possible. In such instance(s), all reasonable attempts shall be made to notify and to make appropriate arrangements for the abatement of the predicted construction noise impacts upon the affected property owners and / or residents.
- If construction activities must occur during context-sensitive hours near noise-sensitive areas, discrete construction noise abatement measures including, but not limited to portable noise barriers, equipment-quieting devices such as noise attenuating enclosures or resilient pile caps (to mitigate pile-driving noise), or the use of alternative (quieter) equipment or construction techniques, shall be considered.

For additional information on construction noise, please refer to the FHWA Construction Noise Handbook (FHWA-HEP-06-015) and the Roadway Construction Noise Model (RCNM), available online at: http://www.fhwa.dot.gov/environment/noise/cnstr_ns.htm.

Table 8: Construction Equipment Typical Noise Level Emissions[1]

Equipment	Noise Level Emissions (dB(A)) at 50 Feet From Equipment[2] (70 – 80 – 90 – 100)
Pile Driver[3]	
Jack Hammer	
Tractor	
Road Grader	
Backhoe	
Truck	
Paver	
Pneumatic Wrench	
Crane	
Concrete Mixer	
Compressor	
Front-End Loader	
Generator	
Saws	
Roller (Compactor)	

1. Adapted from *Noise Construction Equipment and Operations, Building Equipment, and Home Appliances*. U.S. Environmental Protection Agency. Washington D.C. 1971.
2. Cited noise level ranges are typical for the respective equipment. For "point sources" such as the construction equipment listed above, noise levels generally dissipate at a rate of -6 dB(A) for every doubling of distance. For example, if the noise level from a pile driver at a distance of 50 feet = 100 dB(A), then at 400 feet, it might be 82 dB(A) or less.
3. Due to project safety and potential construction noise concerns, pile driving activities are typically limited to daytime hours.

11.0 NOISE-COMPATIBLE LAND USE

One of the most effective means to prevent future traffic noise impacts is noise-sensitive land use development. The compatibility of highways and neighboring local areas is essential for continued growth, and can be achieved if local governments and developers require and practice noise-sensitive land use planning. Although regulation of land use is not within the purview of FHWA

or NCDOT, some widely accepted techniques for noise-sensitive land use planning near existing and proposed highway facilities include:

- Locating retail, industrial, manufacturing, and other noise-compatible land uses adjacent to highways
- Incorporating effective traffic noise mitigating features, such as earth berms and solid-mass noise walls, as part of residential developments
- Utilization of noise-sensitive architectural design and site planning, such as the orientation of quiet spaces away from roadways
- Required use of sound insulating building materials and construction methods

As indicated in the NCDOT Traffic Noise Policy (October 6, 2016), local jurisdictions with zoning control should use the information contained in this report to develop policies and/or ordinances to limit the growth of noise-sensitive land uses located adjacent to roadways. Furthermore, NCDOT encourages the dissemination of this information to all people who may be affected by, or who might influence others affected by, traffic noise.

12.0 CONCLUSION

Traffic noise and temporary construction noise can be a consequence of transportation projects, especially in areas near high-volume and high-speed roadways. This Traffic Noise Report utilized computer models created with the FHWA Traffic Noise Model software (TNM 2.5), validated to field-collected traffic noise monitoring data, to predict future noise levels and define impacted receptors along the proposed new highway project.

For Design Year 2040 traffic volumes the Build condition is predicted to create 59 traffic noise impacts. Furthermore, construction noise impacts – some of them potentially substantial – may occur due to the proximity of numerous noise-sensitive receptors to project construction activities. It is the recommendation of this Traffic Noise Report that all reasonable efforts should be made to minimize exposure of noise-sensitive areas to construction noise impacts.

Consideration for noise abatement measures was given to all impacted receptors. However, none of the traffic noise abatement measures considered in this Traffic Noise Report meet the feasible and reasonable criteria detailed in the NCDOT Policy. Consequently, no traffic noise abatement measures are recommended for incorporation into the project plan. Additional traffic noise analysis will not be necessary during project final design unless modifications to the proposed roadway design occur, additional alignments are considered, or changes to Design Year 2040 traffic volumes are predicted.

13.0 REFERENCES

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FIGURES

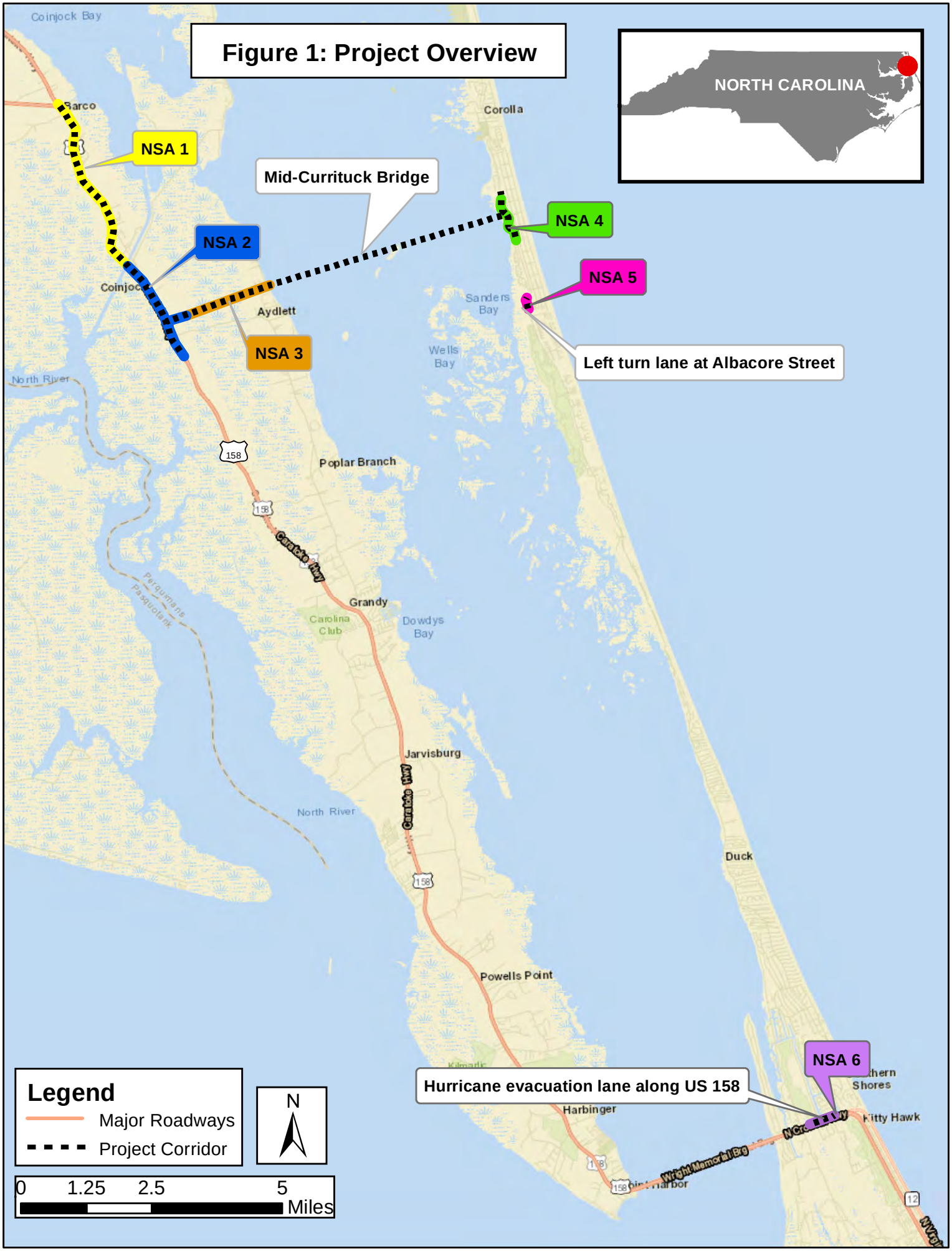


Figure 1: Project Overview
NORTH CAROLINA
NSA 1
NSA 2
NSA 3
NSA 4
NSA 5
NSA 6
Mid-Currituck Bridge
Left turn lane at Albacore Street
Hurricane evacuation lane along US 158
Coinjock Bay
Sarco
Corolla
Coinjock
Aydlett
Sanders Bay
Wells Bay
North River
Poplar Branch
Grandy
Carolina Club
Dowdys Bay
Jarvisburg
Duck
Powells Point
Harbinger
Kitty Hawk
Legend
Major Roadways
Project Corridor
N
0 1.25 2.5 5 Miles

Mid-Currituck Bridge
TIP Project R-2576
Currituck and Dare Counties

North Carolina Department of Transportation

Project Improvements
Study Area Limits
Noise Measurement Location
Non Noise Sensitive Properties

Noise Receptors
Impacted & Benefited
Impacted & Not Benefited
Not Impacted & Benefited
Not Impacted & Not Benefited

Preliminary Evaluated Noise Barriers
Feasible and Reasonable
Feasible and Not Reasonable
Not Feasible

0 100 200 400 Feet

Mid-Currituck Bridge
Traffic Noise Report

Figure 2-1
Noise Study Area 1
Noise Receptors, Measurement Locations, and Build Alternative Results

Mid-Currituck Bridge
TIP Project R-2576
Currituck and Dare Counties

North Carolina Department of Transportation

Project Improvements
Study Area Limits
Noise Measurement Location
Non Noise Sensitive Properties

Noise Receptors
Impacted & Benefited
Impacted & Not Benefited
Not Impacted & Benefited
Not Impacted & Not Benefited

Preliminary Evaluated Noise Barriers
Feasible and Reasonable
Feasible and Not Reasonable
Not Feasible

0 100 200 400 Feet

Mid-Currituck Bridge
Traffic Noise Report

Figure 2-2
Noise Study Area 1
Noise Receptors, Measurement Locations, and Build Alternative Results

Mid-Currituck Bridge
TIP Project R-2576
Currituck and Dare Counties

North Carolina Department of Transportation

Project Improvements
Study Area Limits
Noise Measurement Location
Non Noise Sensitive Properties

Noise Receptors
Impacted & Benefited
Impacted & Not Benefited
Not Impacted & Benefited
Not Impacted & Not Benefited

Preliminary Evaluated Noise Barriers
Feasible and Reasonable
Feasible and Not Reasonable
Not Feasible

0 100 200 400 Feet

Mid-Currituck Bridge
Traffic Noise Report

Figure 2-3
Noise Study Area 1
Noise Receptors, Measurement Locations, and Build Alternative Results

Mid-Currituck Bridge
TIP Project R-2576
Currituck and Dare Counties

North Carolina Department of Transportation

Project Improvements
Study Area Limits
Noise Measurement Location
Non Noise Sensitive Properties

Noise Receptors
Impacted & Benefited
Impacted & Not Benefited
Not Impacted & Benefited
Not Impacted & Not Benefited

Preliminary Evaluated Noise Barriers
Feasible and Reasonable
Feasible and Not Reasonable
Not Feasible

0 100 200 400 Feet

Mid-Currituck Bridge
Traffic Noise Report

Figure 2-4
Noise Study Area 1
Noise Receptors, Measurement Locations, and Build Alternative Results

Mid-Currituck Bridge
TIP Project R-2576
Currituck and Dare Counties

North Carolina Department of Transportation

Project Improvements
Study Area Limits
Noise Measurement Location
Non Noise Sensitive Properties

Noise Receptors
Impacted & Benefited
Impacted & Not Benefited
Not Impacted & Benefited
Not Impacted & Not Benefited

Preliminary Evaluated Noise Barriers
Feasible and Reasonable
Feasible and Not Reasonable
Not Feasible

0 100 200 400 Feet

Mid-Currituck Bridge
Traffic Noise Report

Figure 2-5
Noise Study Area 1
Noise Receptors, Measurement Locations, and Build Alternative Results

Mid-Currituck Bridge
TIP Project R-2576
Currituck and Dare Counties

North Carolina Department of Transportation

Project Improvements
Study Area Limits
Noise Measurement Location
Non Noise Sensitive Properties

Noise Receptors
Impacted & Benefited
Impacted & Not Benefited
Not Impacted & Benefited
Not Impacted & Not Benefited

Preliminary Evaluated Noise Barriers
Feasible and Reasonable
Feasible and Not Reasonable
Not Feasible

0 100 200 400 Feet

Mid-Currituck Bridge
Traffic Noise Report

Figure 2-6
Noise Study Area 1
Noise Receptors, Measurement Locations, and Build Alternative Results

Mid-Currituck Bridge
TIP Project R-2576
Currituck and Dare Counties

North Carolina Department of Transportation

Project Improvements
Study Area Limits
Noise Measurement Location
Non Noise Sensitive Properties

Noise Receptors
Impacted & Benefited
Impacted & Not Benefited
Not Impacted & Benefited
Not Impacted & Not Benefited

Preliminary Evaluated Noise Barriers
Feasible and Reasonable
Feasible and Not Reasonable
Not Feasible

0 100 200 400 Feet

Mid-Currituck Bridge
Traffic Noise Report

Figure 2-7
Noise Study Area 1
Noise Receptors, Measurement Locations, and Build Alternative Results

Mid-Currituck Bridge
TIP Project R-2576
Currituck and Dare Counties

North Carolina Department of Transportation

Project Improvements
Study Area Limits
Noise Measurement Location
Non Noise Sensitive Properties

Noise Receptors
Impacted & Benefited
Impacted & Not Benefited
Not Impacted & Benefited
Not Impacted & Not Benefited

Preliminary Evaluated Noise Barriers
Feasible and Reasonable
Feasible and Not Reasonable
Not Feasible

0 100 200 400 Feet

Mid-Currituck Bridge
Traffic Noise Report

Figure 2-8
Noise Study Area 2
Noise Receptors, Measurement Locations, and Build Alternative Results

Mid-Currituck Bridge
TIP Project R-2576
Currituck and Dare Counties

North Carolina Department of Transportation

Right-of-Way Acquisition
Project Improvements
Study Area Limits
Noise Measurement Location
Non Noise Sensitive Properties

Noise Receptors

Impacted & Benefited
Impacted & Not Benefited
Not Impacted & Benefited
Not Impacted & Not Benefited

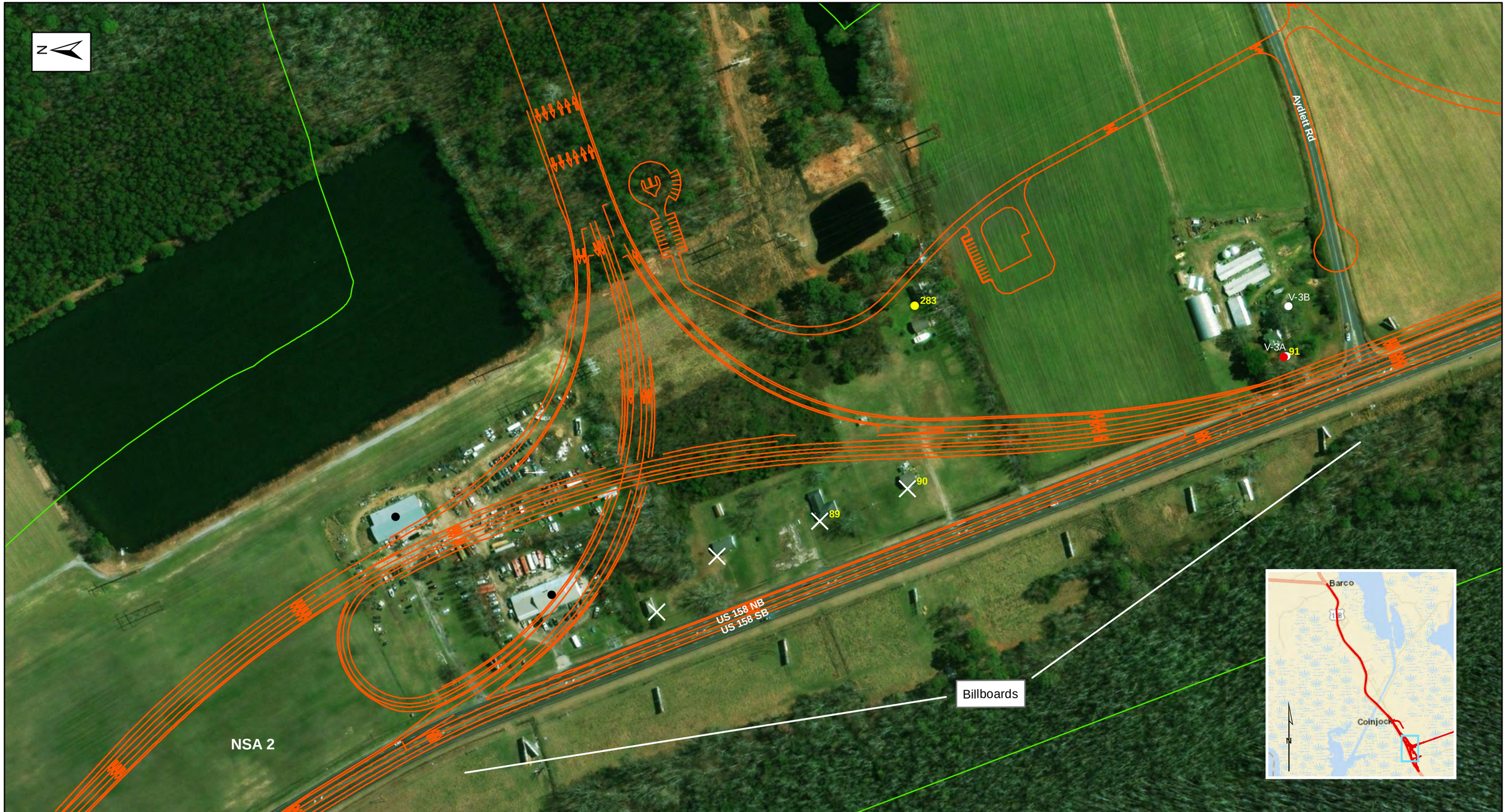
Preliminary Evaluated Noise Barriers

Feasible and Reasonable
Feasible and Not Reasonable
Not Feasible

0 100 200 400 Feet

Mid-Currituck Bridge
Traffic Noise Report

Figure 2-9
Noise Study Area 2
Noise Receptors, Measurement Locations, and Build Alternative Results



Mid-Currituck Bridge
TIP Project R-2576
Currituck and Dare Counties

North Carolina Department of Transportation

Right-of-Way Acquisition
Project Improvements
Study Area Limits
Noise Measurement Location
Non Noise Sensitive Properties

Noise Receptors
- Impacted & Benefited
- Impacted & Not Benefited
- Not Impacted & Benefited
- Not Impacted & Not Benefited

Preliminary Evaluated Noise Barriers
- Feasible and Reasonable
- Feasible and Not Reasonable
- Not Feasible

0 100 200 400 Feet

Mid-Currituck Bridge
Traffic Noise Report

Figure 2-10
Noise Study Area 2
Noise Receptors, Measurement Locations, and Build Alternative Results

Mid-Currituck Bridge
TIP Project R-2576
Currituck and Dare Counties

North Carolina Department of Transportation

Project Improvements
Study Area Limits
Noise Measurement Location
Non Noise Sensitive Properties

Noise Receptors
Impacted & Benefited
Impacted & Not Benefited
Not Impacted & Benefited
Not Impacted & Not Benefited

Preliminary Evaluated Noise Barriers
Feasible and Reasonable
Feasible and Not Reasonable
Not Feasible

0 100 200 400 Feet

Mid-Currituck Bridge
Traffic Noise Report

Figure 2-11
Noise Study Area 2
Noise Receptors, Measurement Locations, and Build Alternative Results

Mid-Currituck Bridge
TIP Project R-2576
Currituck and Dare Counties

North Carolina Department of Transportation

Project Improvements
Study Area Limits
Noise Measurement Location
Non Noise Sensitive Properties

Noise Receptors
Impacted & Benefited
Impacted & Not Benefited
Not Impacted & Benefited
Not Impacted & Not Benefited

Preliminary Evaluated Noise Barriers
Feasible and Reasonable
Feasible and Not Reasonable
Not Feasible

0 100 200 400 Feet

Mid-Currituck Bridge
Traffic Noise Report

Figure 2-12
Noise Study Area 3
Noise Receptors, Measurement Locations, and Build Alternative Results

Mid-Currituck Bridge
TIP Project R-2576
Currituck and Dare Counties

North Carolina Department of Transportation

Project Improvements
Study Area Limits
Noise Measurement Location
Non Noise Sensitive Properties

Noise Receptors
Impacted & Benefited
Impacted & Not Benefited
Not Impacted & Benefited
Not Impacted & Not Benefited

Preliminary Evaluated Noise Barriers
Feasible and Reasonable
Feasible and Not Reasonable
Not Feasible

0 100 200 400 Feet

Mid-Currituck Bridge
Traffic Noise Report

Figure 2-13
Noise Study Area 3
Noise Receptors, Measurement Locations, and Build Alternative Results

Mid-Currituck Bridge
TIP Project R-2576
Currituck and Dare Counties

North Carolina Department of Transportation

Project Improvements
Study Area Limits
Noise Measurement Location
Non Noise Sensitive Properties

Noise Receptors
Impacted & Benefited
Impacted & Not Benefited
Not Impacted & Benefited
Not Impacted & Not Benefited

Preliminary Evaluated Noise Barriers
Feasible and Reasonable
Feasible and Not Reasonable
Not Feasible

0 100 200 400 Feet

Mid-Currituck Bridge
Traffic Noise Report

Figure 2-14
Noise Study Area 3
Noise Receptors, Measurement Locations, and Build Alternative Results

Mid-Currituck Bridge
TIP Project R-2576
Currituck and Dare Counties

North Carolina Department of Transportation

- Project Improvements
- Study Area Limits
- Noise Measurement Location
- Non Noise Sensitive Properties

Noise Receptors

- Impacted & Benefited
- Impacted & Not Benefited
- Not Impacted & Benefited
- Not Impacted & Not Benefited

Preliminary Evaluated Noise Barriers

- Feasible and Reasonable
- Feasible and Not Reasonable
- Not Feasible

0 100 200 400 Feet

Mid-Currituck Bridge
Traffic Noise Report

Figure 2-15
Noise Study Area 4
Noise Receptors, Measurement Locations, and Build Alternative Results

Mid-Currituck Bridge
TIP Project R-2576
Currituck and Dare Counties

North Carolina Department of Transportation

LEGEND

- Project Improvements
- Study Area Limits
- Noise Measurement Location
- Non Noise Sensitive Properties

Noise Receptors

- Impacted & Benefited
- Impacted & Not Benefited
- Not Impacted & Benefited
- Not Impacted & Not Benefited

Preliminary Evaluated Noise Barriers

- Feasible and Reasonable
- Feasible and Not Reasonable
- Not Feasible

0 100 200 400 Feet

Mid-Currituck Bridge
Traffic Noise Report

Figure 2-16
Noise Study Area 4
Noise Receptors, Measurement Locations, and Build Alternative Results

Mid-Currituck Bridge
TIP Project R-2576
Currituck and Dare Counties

North Carolina Department of Transportation

Project Improvements
Study Area Limits
Noise Measurement Location
Non Noise Sensitive Properties

Noise Receptors
Impacted & Benefited
Impacted & Not Benefited
Not Impacted & Benefited
Not Impacted & Not Benefited

Preliminary Evaluated Noise Barriers
Feasible and Reasonable
Feasible and Not Reasonable
Not Feasible

0 100 200 400 Feet

Mid-Currituck Bridge
Traffic Noise Report

Figure 2-17
Noise Study Area 5
Noise Receptors, Measurement Locations, and Build Alternative Results

Mid-Currituck Bridge
TIP Project R-2576
Currituck and Dare Counties

North Carolina Department of Transportation

Project Improvements
Study Area Limits
Noise Measurement Location
Non Noise Sensitive Properties

Noise Receptors
Impacted & Benefited
Impacted & Not Benefited
Not Impacted & Benefited
Not Impacted & Not Benefited

Preliminary Evaluated Noise Barriers
Feasible and Reasonable
Feasible and Not Reasonable
Not Feasible

0 100 200 400 Feet

Mid-Currituck Bridge
Traffic Noise Report

Figure 2-18
Noise Study Area 6
Noise Receptors, Measurement Locations, and Build Alternative Results