# TRAFFIC NOISE REPORT

## US 1 (Capital Boulevard) Freeway Upgrade

STIP Project No. U-5307
Wake County

Prepared For:

North Carolina Department of Transportation
Environmental Analysis Unit
Traffic Noise and Air Quality Group

Prepared By:


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100 Regency Forest Drive, Suite 130
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March 2022

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## Executive Summary

The North Carolina Department of Transportation (NCDOT) State Transportation Improvement Program (STIP) Project U-5307 proposes to upgrade US 1 (Capital Boulevard) to a freeway from I-540 to the intersection of SR 1931 (Harris Road) and SR 1909 (Purnell Road) in Wake County (STIP No. U-5307). As part of this project, NCDOT proposes removing signals from the mainline of US 1 and replace with a fully controlled freeway mainline with new interchanges at Burlington Mills Road and Harris/Purnell Roads. NCDOT also proposes the addition of the third westbound lane at I-540/US 1 (which is then dropped at the US 1 interchange) as part of this project. Service road locations will be studied further as the project progresses. Preparation of a federal Categorical Exclusion (CE) is currently underway.

The project is included in the NCDOT State Transportation Improvement Program as Project U-5307 and will utilize federal funds. The Date of Public Knowledge for this project will be the approval date of the final Categorical Exclusion (CE) environmental document. 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 Federal Highway Administration (FHWA) Procedures for Abatement of Highway Noise (23 CFR 772.5(2)) and the 2021 NCDOT Traffic Noise Policy (NCDOT Policy), the proposedproject 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.

A single mainline alternative was used in the development of this Traffic Noise Report (TNR). Two additional ramp Alternatives are being considered for the Burlington Mills Road interchange and the Harris/Purnell Road interchange. Modeling efforts have accounted for both ramp Alternatives (Alternative 1 and Alternative 3) at the intersection of US 1 and Burlington Mills Road and (Alternative 1 and Alternative 2) at the intersection of US 1, Harris and Purnell Roads. Four NSAs were evaluated under different interchange alternatives in addition to Alternative 1. NSAs 8, 9a and 9b evaluated an Alternative 3 interchange at Burlington Mills Road while NSA 23 evaluated an Alternative 2 interchange at Harris/Purnell Road. The results for Alternative 1 are detailed below. Results specific to NSAs 8, 9a, 9b, (Alternative 3) and 23 (Alternative 2) are discussed individually in the NSA descriptions found in Section 1.0 and 10.5.1 of this report. Design Year 2040 conditions for Alternative 1 is predicted to result in traffic noise impacts at 206 receptors, representing 182 residential land uses, one apartment complex pool ((1 Equivalent Residence (ER)), one sport area (1 ER), one playground (1 ER), one cemetery, 16 trail receptors (3 ERs), and four outdoor dining areas. It should be noted that the only differences in noise impacts from Alternative 1 and the subsequent interchange alternatives are within NSA 8. Under the Alternative 3 interchange design, NSA 8 would have 15 additional properties acquired and have five less noise impacts due to those acquired receptors.

Noise abatement measures were evaluated for all impacted receptors. NCDOT policy requires the identification of whether it is "likely" or "unlikely" that noise abatement measures will be provided for each noise study area identified. "Likely" does not mean a firm commitment to construct noise abatement will be made during the Preliminary Design phase of the project. Noise barriers were considered and deemed feasible and reasonable for NSAs 2a, 5, 10a, 14, 15, 23 and 24 and mitigation is “likely” for construction as part of the U-5307 Project within these NSAs. Noise barriers were considered and deemed feasible but not reasonable for NSAs 8, 11, and parts of 23 and mitigation is “unlikely” for construction as part of the U-5307 Project within these NSAs. Noise mitigation was considered for NSA 2b, 4, 20, 21, and 25 where impacts are predicted; however, these locations are not feasible for the construction of noise abatement due to residential driveway/roadway access and utility conflicts. Noise mitigation was not considered for NSAs 6 (1 ER), 7 (1 ER) 9a, 13, 16, and 22 due to single isolated receptor impacts that do not meet NCDOT Policy feasibility requirements.

Seven (7) assessed noise barriers, NW 2-1, NW 5-1, NW 10-1, NW 14-1, NW 15-1, NW 23-1 and NW 24-1, meet the NCDOT Policy feasible and reasonableness criteria and are considered "likely" for the STIP U-5307 project. Preliminary NW 2-1 spans approximately 941 feet, has an average height of 15.8 feet, and benefits nine residences and one sport field (1 ER). Preliminary NW 5-1 spans approximately 1,234 feet, has an average height of 17.6 feet, and benefits 43 residences. Preliminary NW 10-1 spans approximately 1,392 feet, has an average height of 14.5 feet, and benefits 14 residences. Preliminary NW 14-1 spans approximately 1,919 feet, has an average height of 17.7 feet, and benefits 61 residences and one apartment complex pool (1 ER). Preliminary NW 15-1 spans approximately 2,279 feet, has an average height of 17.5 feet, and benefits 38 residences. Preliminary NW 23-1 spans approximately 940 feet, has an average height of 12 feet, and benefits eight residences and three trail points (1 ER). Preliminary NW 24-1 spans approximately 2,170 feet, has an average height of 17.9 feet, and benefits 36 residences.

Unless modifications to the Preliminary Design occur, including consideration of additional alternative alignments and/or changes to predicted Design Year 2040 traffic volumes, seven (7) traffic noise abatement measures are recommended for detailed analysis in conjunction with Final Design activities. This analysis completes the traffic noise requirements of the Title 23 CFR Part 772 and the NCDOT Traffic Noise Policy.

The predominant construction activities associated with this project are expected to be earth removal, hauling, grading, and paving. Temporary and localized construction noise impacts will likely occur as a result of these activities. During daytime hours, the predicted effects of these impacts will be temporary speech interference for passers-by and those individuals living or working near the project. During evening and nighttime hours, steady-state construction noise emissions such as from paving operations will be audible and may cause impacts to activities such as sleep. Sporadic evening and nighttime construction equipment noise emissions such as backup alarms, lift gate closures (“slamming” of dump truck gates), etc., will be perceived as distinctly louder than the steady-state acoustic environment, and will likely cause severe impacts to the general peace and usage of noise-sensitive areas, particularly residences. However, these impacts will be temporary and will cease when construction is complete.

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## 1.0 PROJECT LOCATION, DESCRIPTION and BACKGROUND

The North Carolina Department of Transportation (NCDOT) State Transportation Improvement Program (STIP) Project U-5307 proposes to upgrade US 1 (Capital Boulevard) to a freeway from I-540 to the intersection of SR 1931 (Harris Road) and SR 1909 (Purnell Road) in Wake County (STIP No. U-5307). As part of this project, NCDOT proposes removing signals from the mainline of US 1 and replace with a fully controlled freeway mainline with new interchanges at Burlington Mills Road and Harris/Purnell Road. These improvements will be known as Alternative 1. Additionally, two interchange alternatives were studied at Burlington Mills Road and Harris/Purnell Roads. The Burlington Mills Road Alternative 1 interchange consists of a diamond interchange, while the Alternative 3 interchange is a skewed partial cloverleaf interchange. Both alternatives include an overpass and extension of Burlington Mills Road connecting to a proposed service road. Both the Harris/Purnell Road interchange (Alternative 1 and Alternative 2) are generally the same. However, there is a slight shift in the US 1 northbound on and off ramps from Harris Road in Alternative 2. The project location is shown on the Regional Location Map (***Figure 1***). Detailed alternative locations are shown on ***Figures 1*** *through* ***Figure 16.***

US 1 is a multi-lane highway, with additional lanes for turning movements, and currently has an existing posted speed of 55 miles per hour (mph). The proposed posted speed for US 1 is 65 mph while the design speed for the facility is 70 mph. In accordance with NCDOT Traffic Noise Policy, the analysis should use posted plus five mph (not to exceed the design speed) or the design speed. In this case, posted plus five mph and the proposed design speeds match. Therefore, the design speed of 70 mph was utilized for the study. The project is currently in the Preliminary Design phase, with a current Design Year of 2040.

The overall need for this project is to relieve traffic congestion, thereby improving travel times and maintaining regional mobility and local connectivity. As an additional benefit, the proposed project may reduce or eliminate certain crash scenarios. The Date of Public Knowledge for this project will be the approval date of the final Categorical Exclusion (CE) environmental document.

The project area currently consists of a mix of land uses along the corridor. The predominant land uses are comprised of residential and commercial development. Current land uses include, but are not limited to, single and multi-family residential dwellings, playgrounds, recreational facilities, retail facilities, cemeteries, pools, trails, churches, hotels, medical facilities, schools, restaurants, and a reception facility.

Ambient noise monitoring data, corresponding traffic count data, photographs, event logs, and field sketches were obtained throughout the project study area on May 20th and May 21st, 2019. Information on the ambient noise monitoring data can be found in ***Appendix A***.

Twenty-eight (28) Noise Study Areas (NSAs) were investigated for the Preliminary Design Noise Analysis completed for STIP project U-5307. Three (3) NSAs (2a/b, 9a/b and 10a/b) experienced design changes adjacent to their study limits during the analysis and had to be expanded to encompass all noise sensitive receptors in the study area. Due to these alterations, these NSAs were broken into a/b sections for simplicity. Each NSA is briefly described below.

**Noise Study Area 1 (*NSA 1*)**

NSA 1 is located west of US 1, along Cheviot Hills Dr, near the southern terminus of the project limits. NSA 1 contains one modeling site (1-01), which represents the Casa De Su Presencia Church, a Category D receptor. The receptor location is shown on ***Figure 2-1 and Figure 2-2***. The dominant noise source in NSA 1 is traffic noise from US 1.

**Noise Study Area 2a (*NSA 2a*)**

NSA 2a is located east of US 1, between Jacqueline Lane and Homestead Dr. NSA 2a contains two model validation sites (2a – 2b) used to collect baseline noise levels and to validate the TNM model. NSA 2a consists of 73 modeling sites, 2a-01 to 2a-73, all of which represent frequent human usage areas. Sites in NSA 2a represent Category B receptors and three Category C receptors, representing two (2) playgrounds and one (1) sport field. The sport field is calculated at (.8 ERs); however, the (.8 ER) value would be rounded to a total of 1 (ER). The sport field and one playground are associated with the Homestead village community. The receptor locations are shown on ***Figure 2-2***. The dominant noise source in NSA 2 is traffic noise from US 1. NSA 2 was split into two separate NSAs because of recent design modifications. One (1) receptor (02a-01) within this NSA is proposed to be a right-of-way acquisition under the proposed design alternative.

**Noise Study Area 2b (*NSA 2b*)**

NSA 2b is located east of US 1 and south of Perry Creek Road. NSA 2b consists of 55 modeling sites, 2b-01 to 2b-55, all of which represent frequent human usage areas and are categorized as Category B receptors. The receptor locations are shown on ***Figure 2-3***. The dominant noise source in NSA 2b is traffic noise from Perry Creek Road. One (1) receptor (02b-06) within this NSA is proposed to be a right-of-way acquisition under the proposed design alternative.

**Noise Study Area 3 (*NSA 3*)**

NSA 3 is located west of US 1 and north of Durant Road. NSA 3 consists of three (3) modeling sites, 3-01 to 3-03, all of which represent frequent human usage areas. Sites in NSA 3 represent Category B receptors and Dunkin Donuts outdoor dining, a Category E receptor. The receptor locations are shown on ***Figure 2-3 and Figure 2-4***. The dominant noise source in NSA 3 is traffic noise from US 1. All three (3) receptors (3-01 – 3-03) within this NSA are proposed to be right-of-way acquisitions under the current design alternative.

**Noise Study Area 4 (*NSA 4*)**

NSA 4 is located east of US 1, between US 1 and Wadford Drive. NSA 4 consists of four (4) modeling sites, 4-01 to 4-04, all of which represent frequent human usage areas. Sites in NSA 4 represent Category D receptors (Strayer University and Celebration Church) and outdoor dining at Sheetz and the Korner Pocket, both Category E receptors. The receptor locations are shown on ***Figure 2-4***. The dominant noise source in NSA 4 is traffic noise from US 1.

**Noise Study Area 5 (*NSA 5*)**

NSA 5 is located east of US 1, within the River Haven Apartments Complex. NSA 5 contains three (3) model validation sites (5a – 5c) used to collect baseline noise levels and to validate the TNM model. NSA 5 consists of 68 modeling sites (including 1st, 2nd, and 3rd floor apartments), 5-01 to 5-24, all of which represent frequent human usage areas. Sites in NSA 5 represent Category B receptors, as well as one (1) playground and one (1) pool which are categorized as Category C receptors. The receptor locations are shown on ***Figure 2-5.*** The dominant noise source in NSA 5 is traffic noise from US 1.

**Noise Study Area 6 (*NSA 6*)**

NSA 6 is located west of US 1, adjacent to the Neuse River. NSA 6 consists of nine (9) modeling sites, 6-01 to 6-09, all of which represent frequent human usage areas along the Neuse River Greenway trail, representing Category C trail receptors. The trail totals .63 ER (rounding to 1 ER) with each trail receptor representing .11 ER. The receptor locations are shown on ***Figure 2-5***. The dominant noise source in NSA 6 is traffic noise from US 1.

**Noise Study Area 7 (*NSA 7*)**

NSA 7 is located east of US 1, adjacent to the Neuse River. NSA 7 consists of nine (9) modeling sites, 7-01 to 7-09, all of which represent frequent human usage areas along the Neuse River Greenway trail, representing Category C trail receptors. The trail totals .63 ER (rounding to 1 ER) with each trail receptor representing .11 ER. The receptor locations are shown on ***Figure 2-5***. The dominant noise source in NSA 7 is traffic noise from US 1.

**Noise Study Area 8 (*NSA 8*)**

NSA 8 is located west of US 1, along Circle Drive. NSA 8 contains two (2) model validation sites (8a – 8b) used to collect baseline noise levels and to validate the TNM model. NSA 8 consists of 16 modeling sites, 8-01 to 8-16, all of which represent frequent human usage areas and categorized as Category B receptors. The receptor locations are shown on ***Figure 2-6***. The dominant noise source in NSA 8 is traffic noise from US 1. Under proposed ramp Alternative 1, only one (1) right-of-way acquisition is proposed at receptor 8-16. Under proposed ramp Alternative 3 design scenario, all 16 receptors (8-01 – 8-16) within this NSA are proposed to be right-of-way acquisitions under the current design alternative.

**Noise Study Area 9a (*NSA 9a*)**

NSA 9a is located east of US 1, along Meadstone Way. NSA 9a contains two (2) model validation sites (9a – 9b) used to collect baseline noise levels and to validate the TNM model. NSA 9a consists of five (5) modeling sites, 9a-01 to 9a-05, all of which represent frequent human usage areas and categorized as Category B receptors. The receptor locations are shown on ***Figure 2-7***. The dominant noise source in NSA 9a is traffic noise from Burlington Mills Road. NSA 9 was split into two separate NSAs, due to design modifications by the project team.

**Noise Study Area 9b (*NSA 9b*)**

NSA 9b is located east of US 1, along Burlington Mills Road. NSA 9b consists of 49 modeling sites, 9b-01 to 9b-49, all of which represent frequent human usage areas and categorized as Category B receptors. The receptor locations are shown on ***Figure 2-7***. The dominant noise source in NSA 9b is traffic noise from Burlington Mills Road.

**Noise Study Area 10a (*NSA 10a*)**

NSA 10a is located east of US 1, along Star Road, north of Leighton Ridge Drive. NSA 10a contains three (3) model validation sites (10a – 10c) used to collect baseline noise levels and to validate the TNM model. NSA 10a consists of 22 modeling sites, 10a-01 to 10a-22, all of which represent frequent human usage areas. Sites in NSA 10a represent Category B receptors and the Living Word Family Church, a Category D receptor. The receptor locations are shown on ***Figure 2-7 and Figure 2-8***. The dominant noise source in NSA 10a is traffic noise from US 1. NSA 10 was split into two separate NSAs, due to recent design modifications by the project team.

In addition, an active development in the vicinity of NSA 10a is currently being proposed. Additional information is not available for the Villagio at La Scala Apartment complex at the time of this TNR. Additional study of this area should be completed during the Final Design phase of the project.

**Noise Study Area 10b (*NSA 10b*)**

NSA 10b is located east of US 1, along Sovereign Way and Forest Road. NSA 10b consists of 27 modeling sites, 10b-01 to 10b-27, all of which represent frequent human usage areas. Sites in NSA 10b represent Category B receptors and a Category D medical office. The receptor locations are shown on ***Figure 2-10***. The dominant noise source in NSA 10b is ambient noise with minor contributions from South Main Street.

**Noise Study Area 11 (*NSA 11*)**

NSA 11 is located west of US 1, along Ponderosa Service Road and Wakefield Commons Drive. NSA 11 contains two (2) model validation sites (11a – 11b) used to collect baseline noise levels and to validate the TNM model. NSA 11 consists of 15 modeling sites, 11-01 to 11-15, all of which represent frequent human usage areas. Sites in NSA 11 represent Category B receptors and three (3) Category E receptors, representing outdoor dining (i.e., Sweet Spoons Frozen yogurt, Bruegger's, and Starbuck's). The receptor locations are shown on ***Figure 2-8 and Figure 2-9***. The dominant noise source in NSA 11 is traffic noise from US 1. Two (2) receptors (11-10 – 11-11) within this NSA are proposed to be right-of-way acquisitions under the current design alternative.

**Noise Study Area 12 (*NSA 12*)**

NSA 12 is located west of US 1, between Common Oaks Drive and Falls of Neuse Road. NSA 12 consists of three (3) modeling sites, 12-01 to 12-03, all of which represent frequent human usage areas. Sites in NSA 12 represent two Category D receptors (Rex Healthcare of Wakefield and MSI Radiology) and one Category C receptor (Holiday Inn Express pool). The receptor locations are shown on ***Figure 2-9 and Figure 2-11***. The dominant noise source in NSA 12 is traffic noise from US 1.

**Noise Study Area 13 (*NSA 13*)**

NSA 13 is located east of US 1 and south of Caveness Shoppes Drive and Royall Cotton Road. NSA 13 contains one (1) model validation sites (13a) used to collect baseline noise levels and to validate the TNM model. NSA 13 consists of two (2) modeling sites, 13-01 to 13-02, both of which represent frequent human usage areas. Sites in NSA 13 represent a Category B receptor and Tlaquepaque Mexican outdoor dining, a Category E receptor. The receptor locations are shown on ***Figure 2-11***. The dominant noise source in NSA 13 is traffic noise from US 1.

**Noise Study Area 14 (*NSA 14*)**

NSA 14 is located west of US 1, within the Kingston at Wakefield Plantation Residential Complex. NSA 14 contains three (3) model validation sites (14a – 14c) used to collect baseline noise levels and to validate the TNM model. NSA 14 consists of 170 modeling sites, 14-01 to 14-170, all of which represent frequent human usage areas. Sites in NSA 14 represent Category B receptors and a residential complex pool (one (1) ER), representing a Category C receptor. The receptor locations are shown on ***Figure 2-11***. The dominant noise source in NSA 14 is traffic noise from US 1. A detailed map of NSA 14 can also be viewed on ***Figure 2-11a and Figure 2-11b***.

**Noise Study Area 15 (*NSA 15*)**

NSA 15 is located east of US 1, within the Caveness Farms Apartment Complex. NSA 15 contains two (2) model validation sites (15a – 15b) used to collect baseline noise levels and to validate the TNM model. NSA 15 consists of 66 modeling sites, 15-01 to 15-40, all of which represent frequent human usage areas. Sites in NSA 15 represent Category B receptors, including multi-story screened in porches associated with the Caveness Farms Apartment Complex and a Dental Works office, a Category D receptor. The receptor locations are shown on ***Figure 2-11***. The dominant noise source in NSA 15 is traffic noise from US 1.

**Noise Study Area 16 (*NSA 16*)**

NSA 16 is located west of US 1 and south of Dr. Calvin Jones Highway. NSA 16 consists of three (3) modeling sites, 16-01 to 16-03, all of which represent frequent human usage areas. Sites in NSA 16 represent two (2) Category E receptors, which are outdoor dining locations at the Carolina Ale House and Panera Bread, and one (1) medical office, a Category D receptor. The receptor locations are shown on ***Figure 2-11 and Figure 2-12***. The dominant noise source in NSA 16 is traffic noise from US 1 and Dr. Calvin Jones Highway.

**Noise Study Area 17 (*NSA 17*)**

NSA 17 is located west of US 1 and north of Dr. Calvin Jones Highway. NSA 17 consists of three (3) modeling sites, 17-01 to 17-03, all of which represent frequent human usage areas. Sites in NSA 17 represent Category E receptors, which are outdoor dining locations at Freddy's, Goodberry's, and Buffalo Brothers. The receptor locations are shown on ***Figure 2-12***. The dominant noise source in NSA 17 is traffic noise from US 1 and Dr. Calvin Jones Highway.

**Noise Study Area 18 (*NSA 18*)**

NSA 18 is located west of US 1, along Cloverleaf Drive. An exact address could not be obtained for site 18-05. Confirmation of this address should be done in final design. NSA 18 consists of five (5) modeling sites, 18-01 to 18-05, all of which represent frequent human usage areas. Sites in NSA 18 represent one (1) Category E receptor (Candlewood Hotel outdoor patio), two (2) Category C receptors (basketball courts), and two (2) Category D receptors (Wakefield 9th Grade Center and a medical office). The receptor locations are shown on ***Figure 2-12 and 2-13***. The dominant noise source in NSA 18 is traffic noise from US 1.

**Noise Study Area 19 (*NSA 19*)**

NSA 19 is located west of US 1, between US 1 and Wake Union Church Road. NSA 19 consists of three (3) modeling sites, 19-01 to 19-03, all of which represent frequent human usage areas. Sites in NSA 19 represent a Category D receptor (Porter and Rabinowitz Chiropractor) and two (2) outdoor dining Category E receptors (Charlie's Kabob Grill and Dairy Queen). The receptor locations are shown on ***Figure 2-13***. The dominant noise source in NSA 19 is traffic noise from US 1.

**Noise Study Area 20 (*NSA 20*)**

NSA 20 is located east of US 1, along Durham Road. NSA 20 consists of 35 modeling sites, 20-01 to 20-35, all of which represent frequent human usage areas. Sites in NSA 20 represents 33 Category B receptors, one (1) Category D receptor (Rainbow Kids Pediatrics) and one (1) outdoor dining Category E receptor (McDonald's). The receptor locations are shown on ***Figure 2-13***. The dominant noise source in NSA 20 is traffic noise from US 1 and Durham Road.

**Noise Study Area 21 (*NSA 21*)**

NSA 21 is located east of US 1, along Durham Road. NSA 21 consists of 41 modeling sites, 21-01 to 21-41, all of which represent frequent human usage areas. Sites in NSA 21 represents 39 Category B receptors, one Category D church (St. John's Episcopal Church), and one Category C playground. The receptor locations are shown on ***Figure 2-13***. The dominant noise source in NSA 21 is traffic noise from US 1 and Durham Road. Two (2) receptors (21-01 and 21-41) within this NSA are proposed to be a right-of-way acquisitions under the current design alternative.

**Noise Study Area 22 (*NSA 22*)**

NSA 22 is located east of US 1, between Stadium Drive and Agora Drive. NSA 22 consists of five (5) modeling sites, 22-01 to 22-05. Sites in NSA 22 represent three Category E and two Category D receptors, which are outdoor dining locations at Sonic Drive-In, Blackfin's Crab house and Showmar's and two (2) dental offices. The receptor locations are shown on ***Figure 2-14***. The dominant noise source in NSA 22 is traffic noise from US 1.

**Noise Study Area 23 (*NSA 23*)**

NSA 23 is located west of US 1, between Jenkins Road and Purnell Road. NSA 23 contains two (2) model validation sites (23a – 23b) used to collect baseline noise levels and to validate the TNM model. NSA 23 consists of 99 modeling sites, 23-01 to 23-99, all of which represent frequent human usage areas. Sites in NSA 23 represent Category B receptors, Category C receptors (two playgrounds, an unnamed recreational walking trail represented by 36 trail points (.03 ERs per receptor), community garden, and the Wake Union Baptist Church cemetery, Category D receptors (Wake Union Baptist Church and Wake Forest Presbyterian Church), and Category E receptors at The Sutherland venue. The receptor locations are shown on ***Figure 2-14 and Figure 2-15***. It should be noted that during field measurement, a formalized memorial gathering area was observed at the Wake Union Baptist Church Cemetery. It should also be noted that attempts to confirm trail usage within this NSA were made, however, definitive usage was not able to be determined by an official. It is recommended that additional attempts be made in the Design Phase to confirm the trail usage. The dominant noise source in NSA 23 is traffic noise from US 1 and Jenkins Road. Receptors (23-37 – 23-39), (23-44 – 23-49), (23-85 – 23-86) and site 23-99 are anticipated to be right-of-way acquisitions under both Alternative 1 and Alternative 2 designs.

Although receptor sites 23-40, 23-41, and 23-42 are impacted, the ER values found in ***Appendix G*** total less than two impacts, the amount needed to achieve feasibility for impacted sites. Therefore, this area of NSA 23 was not included in the mitigation analysis.

**Noise Study Area 24 (*NSA 24*)**

NSA 24 is located east of US 1, north of Stadium Drive. NSA 24 contains three (3) model validation sites (24a – 24c) used to collect baseline noise levels and to validate the TNM model. NSA 24 consists of 74 modeling sites, 24-01 to 24-74, all of which represent frequent human usage areas. Sites in NSA 24 represent 53 Category B receptors, two (2) playgrounds and the E. Carroll Joyner Park trail, representing 18 trail points (Category C receptors), and the Joyner Park Community Center (Category D receptor). It should be noted that attempts were made to confirm trail usage, however, definitive usage was not able to be determined by an official. It is recommended that additional attempts be made in the Design Phase to confirm the trail usage if determined to be impacted as part of the project. The receptor locations are shown on ***Figure 2-14 and 2-15***. The dominant noise source in NSA 24 is traffic noise from US 1.

An active development in the vicinity of NSA 24 is currently being proposed. Contact was made with the Wake County Planning Department regarding the Devon Square Development. As of September 9, 2021, there are no active building permits for this proposed development. Additional study of this area should be completed during the Final Design phase of the project.

**Noise Study Area 25 (*NSA 25*)**

NSA 25 is located east of US 1, north of Purnell Drive. NSA 25 contains two (2) model validation sites (25a – 25b) used to collect baseline noise levels and to validate the TNM model. NSA 25 consists of 21 modeling sites, 25-01 to 25-21, all of which represent frequent human usage areas and categorized as Category B receptors. The receptor locations are shown on ***Figure 2-15 and Figure 2-16***. The dominant noise source in NSA 25 is traffic noise from US 1 and Purnell Road. Under both ramp alternatives, receptors 25-01 – 25-04 and sites 25-10 and 25-14 are anticipated to be right-of-way acquisitions under the design alternative.

Noise abatement measures in the form of noise walls were considered for 14 locations within nine (9) of the NSAs. As outlined in the 2021 NCDOT *Traffic Noise Policy*, noise walls meet the feasible and reasonableness criteria at seven (7) locations along the project corridor. In addition, noise walls were evaluated in eight (8) additional locations and were determined to be feasible but not reasonable since the square feet per benefited receptor exceeds the maximum requirements determined by policy.

Finally, noise walls do not meet feasibility criteria in accordance with the 2021 NCDOT *Traffic Noise Policy* in all or parts of six (6) NSAs (NSA 6 (1 ER), 7 (1 ER), 9a, 13, 16, and 22) because these locations did not have more than one (1) impacted receptor. The Policy requires two (2) impacted receptors that receive at least a 5-dB(A) reduction in noise levels to meet feasibility requirements. NSA 2b has predicted impacts directly caused by existing Perry Creek Road and not the corresponding service road. However, a noise wall would not be feasible due to existing driveway access, utility conflicts and limited right-of-way clearances preventing a noise wall from being a reasonable length to protect the community. In addition, there are no proposed improvements as part of this project along this portion of Perry Creek Road. NSA 4 has predicted impacts directly caused by existing US 1. However, a noise wall would not be feasible for NSA 4 as a result of existing business access preventing a noise wall from being a reasonable length to protect the impacted land uses. NSA 20 and 21 have predicted impacts directly caused by existing Durant Road. However, a noise wall would not be feasible as a result of existing residential driveway access preventing a noise wall from being a reasonable length to protect the community. Finally, NSA 25 has predicted impacts directly caused by existing US 1. However, a noise wall would not be feasible as a result of existing residential driveway access preventing a noise wall from being a reasonable length to protect the community.

## 2.0 PROCEDURE

This Traffic Noise Report documents the preliminary analysis of STIP Project U-5307 predicted traffic noise impacts and abatement measures and the equitable and cost-effective expenditure of public funds for noise abatement.

The Federal Highway Administration Traffic Noise Model® (FHWA TNM v.2.5) was used to predict Base Year 2015 Existing, Design Year 2040 No-Build and Design Year 2040 Build condition hourly equivalent traffic noise levels, Leq(h), for the potential noise-sensitive receptors near the proposed project (see ***Appendix B***). The procedures by which this Preliminary Noise Analysis was completed are documented as follows:

- <u>Initial project scoping</u>: Obtained project Preliminary Design; field maps were prepared; project mapping, GIS data, aerial photography, traffic data, and other available pertinent information was reviewed. Project area reconnaissance was performed, and a noise analysis work plan was submitted to NCDOT on May 1, 2019 for approval prior to initiation of any noise measurements or modeling.

- <u>Monitoring / Fieldwork</u>: Ambient sound level data was acquired at 31 measurement locations on May 20 and May 21, 2019 (refer to photographs in ***Appendix A*** and ***Figures 2-1 through 2-16***), according to §8.8 of the NCDOT Traffic Noise Manual,and the FHWA's *Noise Measurement Handbook*. Classified traffic volume data was captured during each monitoring session by use of a video camera. This traffic was later counted and categorized in the office. Traffic speeds during each monitoring session were determined by driving the corridor. Types of land use and property addresses were determined for all noise-sensitive receptors. Weather data was acquired using cellphone data while on site and verified using historical weather data from www.weatherunderground.com. Finally, a field monitoring site sketch and eventlog was created for each noise monitoring session.

- Baseline TNM model: A TNM model representing existing conditions was created utilizing receptors, roadways, terrain lines, ground zones, and barriers (to represent structures). Classified traffic and speed data during each monitoring session was applied to validate the baseline TNM model at all ambient noise monitoring locations for which traffic noise was the dominant source to within ± 3 decibels (dB(A)). NCDOT approved the validated TNM models in June 2019 (refer to ***Appendix C***). Monitoring site 5c did not validate. This site would not validate due to air conditioning units, pressure washers, and leaf blowers nearby contributing to the ambient condition in which the model cannot account for.
- Impact Assessment: Base year Existing 2015, and Design Year 2040 No-build and Build conditions TNM-classified hourly traffic volumes and speeds calculated per Manual §8.4 from NCDOT project traffic diagrams were input into the validated baseline TNM models; TNM-predicted traffic noise levels were evaluated at all project noise-sensitive receptors for all project conditions; and loudest hourly-equivalent noise levels were assessed as the louder of TNM-predicted traffic noise-levels or ambient noise monitoring data acquired at correlating locations. It should be noted that all traffic volume segments for Existing 2015, Design Year 2040 No-Build, and Design Year 2040 Build utilized the lesser DHV percentage of the AADT when comparing LOS C to forecasted volumes. Traffic segments and calculations can be found in ***Appendix F***. Furthermore, as per NCDOT TNR preferences, the use of a 50/50 directional split as shown in Section 8.4 of the NCDOT Traffic Noise Manual was applied to the corridor to create a worst-case modeling scenario. TNM model elements were incorporated into the validated TNM model(s) to represent the project's Preliminary Design per Manual §8. Traffic noise impacts were assessed per the NCDOT Noise Abatement Criteria (NAC) (***Table 3***) and Substantial Increase Criteria (10 dB(A)) increase in predicted design year loudest-hour equivalent noise levels over existing base year loudest-hour equivalent noise levels), refer to ***Table 6*** and ***Appendix B***. Design Year traffic noise level impact contours were evaluated to assist land use planning efforts by local governments (see Section 11.0). For non-residential land-use receptors, the numbers of Equivalent Receptors (or ER values) were determined per Manual §11.5 (refer to ***Appendix G***).

- Abatement Analysis: Acceptable noise abatement measures as defined by the NCDOT Traffic Noise Policy were assessed for the potential benefit of all STIP Project U-5307 traffic noise impacts. Locations for which sound barriers in the form of earth berms or noise barriers may be feasible were identified, and sound barriers were incorporated into the Design Year 2040 Build-condition TNM models per Manual §8.10.4. TNM Sound Barrier Assessments, and if applicable, TNM Parallel Barrier Assessments, were used to identify optimized barriers that provide the greatest amount of traffic noise level reduction per barrier quantity, provide noise level reduction benefits to as many predicted impacted receptors as possible, meet applicable feasibility and reasonableness criteria, and address all other pertinent engineering considerations.

- Construction Noise Impact Analysis: Project-related construction noise was evaluated for potential impacts to noise-sensitive receptors throughout the project corridor, and in areas of anticipated project construction activities outside the project corridor (e.g., construction haul routes; refer to Section 12.0).

# 3.0 CHARACTERISTICS OF NOISE

Noise is defined as unwanted sound. It is emitted from many natural and man-made sources. Highway traffic noise is usually a composite of noises from vehicle engine exhaust, vehicle drive trains and tire/pavement interaction.

The magnitude of noise is usually described by a ratio of its sound pressure to a reference sound pressure, which is usually 20 micro-Pascals (20 μPa). Since the range of sound pressure ratios varies greatly – over many orders of magnitude, a base-10 logarithmic scale is used to express sound levels in dimensionless units of decibels (dB). The commonly accepted limits of detectable human hearing sound magnitudes are between the threshold of hearing at 0 decibels and the threshold of pain at 140 decibels.

Sound frequencies are reported in units of Hertz (Hz), which correspond to the number of vibrations per second of a given tone. A cumulative 'sound level' is equivalent to 10 times the base-10 logarithm of the ratio of the sum of the sound pressures of all frequencies to the reference sound pressure. To simplify the mathematical process of determining sound levels, sound frequencies are grouped into ranges, or 'bands.' Sound levels are then calculated by adding the cumulative sound pressure levels within each band – which are typically defined as one 'octave' or '1/3 octave' of the sound frequency spectrum.

The commonly accepted limitation of human hearing to detect sound frequencies is between 20Hz and 20,000 Hz, and human hearing is most sensitive to the frequencies between 1,000 Hz –6,000 Hz. Although people are generally not as sensitive to lower-frequency sounds as they are to higher frequencies, most people lose the ability to hear high-frequency sounds as they age. To accommodate varying receptor sensitivities, frequency sound levels are commonly adjusted, or 'filtered', before being logarithmically added and reported as a single 'sound level' magnitude of that filtering scale. The 'A-weighted' decibel filtering scale applies numerical adjustments to sound frequencies to emphasize the frequencies at which human hearing is sensitive, and to minimize the frequencies to which human hearing is not as sensitive (***Table 1***).

| Table 1: Comparison of Unweighted vs. A-Weighted Sound Levels for a Truck | | | |
|---|---|---|---|
| Octave -Band Center Frequency (Hz) | A | B | C=A+B |
| | Unweighted Sound Level from a Truck (dB) | Adjustment of Unweighted Sound to Reflect What Human Ear Hears (dB) | Sound Level that Human Ear Perceives = A-Weighted Sound Level or dB(A) |
| 31 | 75 | -39 | 36 |
| 63 | 78 | -26 | 52 |
| 125 | 83 | -16 | 67 |
| 250 | 84 | -9 | 75 |
| 500 | 81 | -3 | 78 |
| 1000 | 75 | 0 | 75 |
| 2000 | 71 | 1 | 72 |
| 4000 | 63 | 1 | 64 |
| 8000 | 54 | -1 | 53 |
| | **89** | | **82** |
| | **Total Unweighted Sound Level in dB** | | **Total A-Weighted Sound Level in dB(A)** |

**From the 2016 NCDOT Traffic Noise Manual*

The A-weighted scale is commonly used in highway traffic noise studies because the typical frequency spectrum of traffic noise is higher in magnitude at the frequencies at which human hearing is noise sensitive (1,000 Hz to 6,000 Hz).

Several examples of noise levels expressed in dB(A) are listed in ***Table 2***. A review of ***Table 2*** indicates that most individuals are exposed to high noise levels from many sources on a regular basis. In order to perceive sounds of greatly varying pressure levels, human hearing has a non-linear sensitivity to sound pressure exposure. For example, doubling the sound pressure results in a three-decibel change in the noise level; however, variations of three decibels (3 dB(A)) or less are commonly considered “barely perceptible” to normal human hearing. A five decibel (5 dB(A)) change is more readily noticeable. By definition, a ten-fold increase in the sound pressure level correlates to a 10 decibel (10 dB(A)) noise level increase; however, it is judged by most people as only a doubling of the loudness – sounding “twice as loud”.

**Table 2: Common Indoor and Outdoor Noise Levels**

| Common Outdoor Noise Levels | Noise Level (dB(A)) | Common Indoor Noise Levels |
|---|---|---|
| | 110 | Rock Band |
| Jet Flyover at 1,000 feet | 100 | Inside Subway Train (NY) |
| Gas Lawn Mower at 3 feet | | |
| Diesel Truck at 50 feet | 90 | Food Blender at 3 feet |
| Noisy Urban Daytime | 80 | Garbage Disposal at 3 feet |
| Gas Lawn Mower at 100 feet | 70 | Vacuum Cleaner at 10 feet |
| Commercial Area | | Normal Speech at 3 feet |
| | 60 | |
| | | Large Business Office |
| Quiet Urban Daytime | 50 | Dishwasher Next Room |
| Quiet Urban Nighttime | 40 | Small Theater, Large ConferenceRoom (Background) |
| Quiet Suburban Nighttime | | Library |
| | 30 | |
| Quiet Rural Nighttime | | Bedroom at Night, Concert Hall(Background) |
| | 20 | |
| | 10 | Broadcast and Recording Studio |
| | 0 | Threshold of Hearing |

Adapted from Guide on Evaluation and Attenuation of Traffic Noise, American Association of State Highway andTransportation Officials (AASHTO). 1974 (revised 1993).

The degree of disturbance or annoyance from exposure to unwanted sound - 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 or not 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 a 60 dB(A) environment 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 accept the noises that intrude into their lives on a regular basis. However, exposure to prolonged and/or extremely loud noise(s) can prevent use of exterior and interior spaces and has been theorized to pose health risks. Appropriately, regulations exist for noise control or abatement from many particularly offensive sources, including airplanes, factories, railroads, and highways. For "Type I" federal, state, or federal-aid highway projects in the State of North Carolina, traffic and construction noise impact analysis and abatement assessment is dictated by the NCDOT Traffic Noise Policy. The definition of a Type I project can be found in the NCDOT Policy, a copy of which is contained in ***Appendix H*** of this report. STIP project U-5307 is a Type I project because it proposes the removal of signals from the mainline of US 1, in place of a fully controlled freeway mainline with new interchanges at Burlington Mills Road and Harris/Purnell Road. The design also proposes the addition of the third westbound lane at I-540/US 1.

# 4.0 NOISE ABATEMENT CRITERIA

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

The FHWA has developed Noise Abatement Criteria (NAC) and procedures to be used in the planning and design of highways. The purpose of 23 CFR, Part 772 is:

> …To provide procedures for noise studies and noise abatement measures to help protect the public 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 United States Code (U.S.C.).

The abatement criteria and procedures are set forth in Title 23 CFR Part 772, which also states:

> …in determining and abating traffic noise impacts, primary consideration is to be given to exterior areas where frequent human use occurs.

A summary of the NAC for various land uses is presented in ***Table 3***: ***Noise Abatement Criteria***. The $L_{eq}$, or equivalent sound level, is the equivalent steady-state sound level which in a stated period of time contains the same acoustic energy as a time-varying sound level during the same period. With regard to traffic noise, fluctuating sound levels of traffic noise are represented in terms of $L_{eq}$, the steady, or 'equivalent', noise level with the same energy.

### 4.2 North Carolina Department of Transportation Traffic Noise Policy

The NCDOT Traffic Noise Policy, effective November 29, 2021, establishes official policy on highway noise. This policy describes the NCDOT process that is used in determining traffic 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 Title 23 CFR 772 standards, this policy describes the NCDOT approach to implementation. The NCDOT Policy is included as ***Appendix H*** of this report.

### 4.3 Noise Abatement Criteria

The two categories of traffic noise impacts are defined as 1) those that "approach" (defined by the NCDOT Policy as reaching one (1) decibel less than) or exceed the FHWA Noise Abatement Criteria (NAC) as shown in ***Table 3***, or those that represent a "substantial increase" over existing noise levels. NCDOT defines substantial as 10 dB(A) or greater. An impact that represents a "substantial increase" is based on a comparison of the existing noise level [Leq(h)] with the predicted increase in noise levels in the design year of at least 10 dB(A).

| Table 3: Noise Abatement Criteria | | | |
|---|---|---|---|
| Hourly Equivalent A-Weighted Sound Level (decibels (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 that noise which is all around us caused by natural and manmade events. It includes the wind, rain, thunder, birds chirping, insects, household appliances, commercial operations, lawn mowers, airplanes, automobiles, etc. It is all noise that is present in a particular area.

Existing traffic noise exposure varies throughout the U-5307 project study area. Within the project corridor, the dominant sources of existing traffic noise are US 1, Perry Creek Rd, Burlington Mills Rd, Alt. 1 (S. Main St.), Falls of Neuse Rd, Rt. 98, and Durham Rd. The influence of existing traffic noise is dependent upon proximity of noise-sensitive areas to these respective roadways. In addition to gathering information and making general observations about the project study area, ambient noise monitoring and field work is conducted to collect noise level and classified vehicle count data that can be used to develop a comparison between hourly-equivalent noise levels measured in the field, at locations where traffic noise is the dominant noise source, and the predicted values obtained from TNM. This exercise is performed to validate the model to local conditions so that it can be used with confidence to predict the future loudest-hour equivalent noise levels and assess potential traffic noise impacts. Ambient noise monitoring is also used to define ambient noise levels at locations where traffic noise is not the primary noise source.

Noise measurement data was collected throughout the U-5307 study area at a total of 30 short term model validation sites with a duration of 20 minutes each. These modeling locations were used to serve as the foundation for the creation of a validated TNM for modeling existing and future noise levels.

One (1) long-term noise measurement was collected for the U-5307 Project between 2:43 pm and 1:33 pm the following day, on a residential lot located along Height Lane. The intent of this measurement was to capture background sound levels within the project area. The results of this measurement indicate a background noise level of 55 dB(A) for the duration of the long-term site monitoring. The ambient noise environment in the project area, other than traffic noise, generally consists of general neighborhood noises (residents' voices, light wind, local traffic, birds, etc.). The noise monitoring locations are shown in ***Figures 2-1 through Figure 2-16***. Information pertaining to the ambient monitoring locations, the noise monitoring results, concurrent traffic counts, estimated vehicle speeds, and weather information for the monitoring sites are included in ***Appendix A***.

For this Traffic Noise Report, loudest-hour existing noise levels were assessed as the TNM-predicted noise levels based on existing loudest-hour traffic estimates. 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 (background level of 55 dBA), then existing noise levels are assessed as the latter. For general descriptions of monitoring locations, aerial imagery, ground view photographs and traffic breakdowns please refer to ***Section 6.0*** and ***Appendix A***.

Ambient (24-hr) monitoring receptors are not used for model validation due to the inability to capture ambient, non-traffic, noise sources in TNM. Existing (2015) and Design Year (2040) modeling sites sound levels have been adjusted in NSAs where the predicted noise level falls below the ambient (24-hr) monitoring level. In this case, where levels are predicted to fall below the ambient noise level of 55 dBA, adjustments to those levels were made (see ***Appendix B***). The 55 dBA ambient noise level was applied to all cases where applicable. The location of the 24-hr receptor was selected based on its distance from US 1, the dominant noise source in the project area. Although the location of this site was adjacent to a gravel road, the minimal volume and low speeds were considered adequate to produce an absolute ambient noise level. The measured noise level data obtained at this site was consistent with typical 24-hr monitoring in this type of setting.

# 6.0 NOISE MODEL VALIDATION

The modeling process begins with model validation, accomplished by using FHWA TNM V2.5 to compare the traffic noise levels measured in the field to TNM-predicted hourly-equivalent traffic noise levels (Leq(h)) at the field measurement locations. Model inputs include the classified traffic volumes and speeds evaluated from traffic data acquired from the dominant traffic noise source(s) during each of the noise measurement sessions.

For each monitoring location, traffic volumes counted during the 20-minute ambient noise monitoring periods were normalized to 1-hour volumes. These normalized volumes were assigned to the corresponding project area roadways to simulate the noise source strength at the roadways during the actual measurement period. TNM-predicted hourly-equivalent traffic noise levels were then compared to noise levels measured in the field to determine the accuracy of the model. The NCDOT-accepted tolerance for TNM model validation is ±3.0 dB(A). Of the 30 short-term monitoring sites, 29 were able to be validated to within +/- 3 dB(A) tolerance required by NCDOT, when compared to the noise levels measured in the field.

One (1) location, 5c, was not able to be validated based on the observed traffic counts and noise monitoring data collected on site. After investigation, the project team concluded that background, or ambient noise contributed to the higher than predicted levels measured at the site. Residential air conditioner noise, leaf blowers and pressure washers influenced the site causing the abnormal excessive ambient noise in which the model could not account for. The validation process was the basis upon which the Traffic Noise Models for predicting existing year and design year noise levels were built. NCDOT approved the validated TNM models and noise model validation report in June 2019. The results of the TNM model validation for this project are shown in ***Table 4*** and further discussed in ***Appendix C***.

# 7.0 PROCEDURE FOR PREDICTING EXISTING 2015 NOISE LEVELS

Computer modeling is the accepted technique for predicting Existing (2015), Design Year (2040) No-Build and Design Year (2040) Build noise levels associated with traffic-induced noise. Currently, the FHWA Traffic Noise Model (FHWA TNM V2.5) is the approved highway noise prediction model. Traffic noise emission is composed of several variables, including the number, types, and travel speeds of the vehicles, as well as the geometry of the roadway(s) on which the vehicles travel. Additional variables such as weather and intervening topography affect the transmission of traffic noise from the vehicle(s) to noise sensitive receptors.

The Traffic Noise Model has been established as a reliable tool for representing noise generated by highway traffic. The information applied to the modeling effort includes the following: highway design files (existing and proposed design), traffic data, roadway cross-sections, and surveying of terrain. Base mapping and aerial photography were used to identify noise-sensitive land uses within the corridor and any terrain features that may shield roadway noise.

| Table 4: TNM Validation | | | | |
|---|---|---|---|---|
| Measurement Location | Address | TNM- Predicted Leq(h)[1] (A) | Measured Leq(h)[1] (B) | Validation Change (A-B) |
| 2a | 4204 Jacqueline Ln, Raleigh, NC 27616 | 64.4 | 63.3 | 1.1 |
| 2b | 4304 Jacqueline Ln, Raleigh, NC 27616 | 61.4 | 61.3 | 0.1 |
| 5a | 4850 Neuse Vista Way, Raleigh, NC 27616 | 64.3 | 64.4 | -0.1 |
| 5b* | 4850 Neuse Vista Way, Raleigh, NC 27616 | 59.1 | 61.7 | -2.6 |
| 5c* | 4840 Neuse Vista Way, Raleigh, NC 27616 | 56.1 | 60.1 | -4 |
| 8a | 2429 Circle Dr, Wake Forest, NC, 27587 | 64.7 | 63.6 | 1.1 |
| 8b | 2425 Circle Dr, Wake Forest, NC, 27587 | 60.1 | 59.8 | 0.3 |
| 9a | 2517 Burlington Mills Rd, Wake Forest, NC, 27587 | 64.8 | 64.3 | 0.5 |
| 9b | 2521 Burlington Mills Rd, Wake Forest, NC, 27587 | 64.2 | 65.5 | -1.3 |
| 10a | 2106 Edgar Ln, Wake Forest, NC, 27587 | 63.4 | 62.6 | 0.8 |
| 10b | 2607 Edgar Ln, Wake Forest, NC, 27587 | 63 | 60.6 | 2.4 |
| 10c | 2610 Edgar Ln, Wake Forest, NC, 27587 | 60.5 | 58.7 | 1.8 |
| 11a | 10727 Ponderosa Service Rd, Wake Forest, NC, 27587 | 59.8 | 59.1 | 0.7 |
| 11b | 10725 Ponderosa Service Rd, Wake Forest, NC, 27587 | 57.4 | 56 | 1.4 |
| 13a | 11300 Capital Blvd, Wake Forest, NC, 27587 | 64.4 | 63.3 | 1.1 |
| 14a | 115 Mezzanine Dr, Raleigh, NC, 27614 | 58.6 | 57.3 | 1.3 |
| 14b | 114 Mezzanine Dr, Raleigh, NC, 27614 | 54.3 | 53.5 | 0.8 |
| 14c | 101 Mezzanine Dr, Raleigh, NC, 27614 | 51.5 | 50.4 | 1.1 |
| 15a | 944 Horsetrail Way, Wake Forest, NC, 27587 | 63.8 | 64.7 | -0.9 |
| 15b | 953 Horsetrail Way, Wake Forest, NC, 27587 | 59.4 | 61.4 | -2 |
| 21a | 860 Durham Rd, Wake Forest, NC, 27587 | 62.7 | 64.1 | -1.4 |
| 21b | 854 Durham Rd, Wake Forest, NC, 27587 | 60.6 | 59.4 | 1.2 |
| 23a | 1101 Chilmark Ave, Wake Forest, NC, 27587 | 55.8 | 53.6 | 2.2 |
| 23b | 1105 Chilmark Ave, Wake Forest, NC, 27587 | 51.4 | 49.9 | 1.5 |
| 23c | 1109 Chilmark Ave, Wake Forest, NC, 27587 | 51.6 | 49.9 | 1.7 |
| 24a | 998 St. Catherines Dr, Wake Forest, NC, 27587 | 65 | 62.2 | 2.8 |
| 24b | 994 St. Catherines Dr, Wake Forest, NC, 27587 | 57.6 | 55.2 | 2.4 |
| 24c | 990 St. Catherines Dr., Wake Forest, NC, 27587 | 51.9 | 51.6 | 0.3 |
| 25a | 13701 Capital Blvd, Wake Forest, NC, 27587 | 64.9 | 63.4 | 1.5 |
| 25b | 2101 Possum Trot, Wake Forest, NC, 27587 | 55.3 | 54.7 | 0.6 |
| LT1 | 2616 Height Ln, Wake Forest, NC 27587 | N/A | 55.0 | N/A |
| * | Sites were exposed to various background noise sources during the monitoring session (i.e., leafblowers, pressure washers, A/C units) that cannot be captured in TNM or stripped from the measurment data set. | | | |

The validated noise model becomes the base noise model for the remainder of the noise analysis. Modeling sites were added to the validated model to predict Existing (2015) loudest hourly-equivalent traffic noise levels throughout the project corridor. Additional traffic noise modeling was performed for existing conditions using 2015 traffic data that was calculated for project U-5307 and Design Year 2040 traffic volumes for Build and No-Build conditions. Under all conditions, forecasted traffic volumes were compared to the Level of Service C (LOS C) volumes and whichever were the lesser volume was applied to the roadway segment. This methodology produces loudest hour sound levels and traffic volumes. ***Appendix B*** provides a summary of the Existing (2015) loudest hourly-equivalent traffic noise levels.

# 8.0 PROCEDURE FOR PREDICTING FUTURE 2040 NOISE LEVELS

Following the development of the existing conditions model and the prediction of Existing (2015) loudest hourly-equivalent traffic noise levels, the assessment continued with the prediction of

Design Year (2040) No-Build and Build noise levels. Design Year (2040) No- Build noise levels were predicted without the proposed project improvements in place. DesignYear (2040) Build noise levels were predicted by accounting for the proposed project improvements and applying Design Year (2040) traffic volumes and composition to the validated computer model. All traffic volume segments utilized the lesser DHV percentage of the AADT when comparing LOS C to forecasted volumes. Traffic segments and calculations can be found in ***Appendix F***. Furthermore, as per NCDOT TNR preferences, the use of a 50/50 directional split as shown in Section 8.4 of the NCDOT Traffic Noise Manual was applied to the corridor to create a worst-case modeling scenario. It should be noted that while traffic forecast diagrams show Scenarios A-E, Scenario A was used for the entire project as it was the most comprehensive and aligned best with the proposed design. Scenarios B-E consisted of minor alterations to Scenario A, which would be non-influential as part of this study. Thus, Scenario A was used throughout the corridor.

The next step in the noise analysis was to determine if future noise levels at the noise sensitive receptors would approach or exceed the FHWA/NCDOT NAC. If the criteria are approached or exceeded at any receptor, noise abatement would be considered in an attempt to reduce future traffic noise per applicable NCDOT criteria. Noise levels at each modeled receptor for the Existing (2015) and Design Year (2040) No-Build and Build conditions are shown in ***Appendix B***.

Design Year (2040) Build traffic volumes, vehicle composition, and speeds were assigned to proposed roadways (Refer to ***Table 5*** for vehicle classification breakdowns used in the TNM modeling process). Traffic data used in the Design Year (2040) noise analysis are included in ***Appendix E***. Detailed traffic data was developed in coordination with the Project Team and NCDOT to determine appropriate volumes for the Design Year (2040).

## 9.0 TRAFFIC NOISE IMPACTS

Traffic noise impacts occur when the predicted hourly-equivalent traffic noise levels (Leq(h)) either: [a] approach or exceed the FHWA noise abatement criteria (with "approach" defined in the NCDOT Policy as reaching one decibel less than the NAC values listed in ***Table 3***), or [b] substantially exceed the existing noise levels (refer to ***Section 4.3***). FHWA and NCDOT require that feasible and reasonable measures be considered to abate traffic noise at all predicted traffic noise impacts. Measures to be considered include alteration of horizontal and vertical alignments, traffic management measures, establishment of buffer zones, construction of noise barriers, and noise insulation (of Activity Category D land uses). The number and types of predicted traffic noise impacts in the Design Year (2040) Build condition is shown in ***Table 6***.

**Table 5: Traffic Noise Model (TNM) Vehicle Classification Types**

| TNM Vehicle Type | Description |
|---|---|
| Autos | All vehicles with two axles and four tires, including passenger cars and light trucks, weighing 9,900 pounds or less |
| Medium Trucks | All vehicles having two axles and six tires, weighing between 9,900 and 26,400 pounds |
| Heavy Trucks | All vehicles having three or more axles, weighing more than 26,400 pounds |
| Buses | All vehicles designed to carry more than nine passengers |
| Motorcycles | All vehicles with two or three tires and an open-air driver / passenger compartment |

Sources: FHWA Measurement of Highway-Related Noise, § 5.1.3 Vehicle Types.
FHWA Traffic Monitoring Guide, § 4.1 Classification Schemes

**Table 6: Traffic Noise Impact Summary for Build Condition**

| DETAILED STUDY ALTERNATIVE | REASON FOR NOISE IMPACT | SUMMARY OF IMPACTED RECEPTORS[7] BY ACTIVITY CATEGORY | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F[5] | G[6] | ALL ACTIVITY CATEGORIES |
| 1 | Based on NAC Criteria Only[1] | 0 | 180 | 7 | 0 | 4 | 0 | 0 | 191 |
| | Based on Substantial Increase Criteria Only[2] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Based on Both Criteria[3] | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 |
| | TOTAL DSA IMPACTS[4] | 0 | 182 | 7 | 0 | 4 | 0 | 0 | 193 |
| 2 | Based on NAC Criteria Only[1] | 0 | 180 | 7 | 0 | 4 | 0 | 0 | 191 |
| | Based on Substantial Increase Criteria Only[2] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Based on Both Criteria[3] | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 |
| | TOTAL DSA IMPACTS[4] | 0 | 182 | 7 | 0 | 4 | 0 | 0 | 193 |
| 3 | Based on NAC Criteria Only[1] | 0 | 177 | 7 | 0 | 4 | 0 | 0 | 188 |
| | 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 DSA IMPACTS[4] | 0 | 177 | 7 | 0 | 4 | 0 | 0 | 188 |

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.

# 10.0 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 and separate considerations. Feasibility is the consideration as to whether noise abatement measures *can* be implemented. Feasibility is determined by a combination of acoustical and engineering factors including, but not limited to:

- A noise reduction of 5 dB(A) must be achieved for at least two (2) impacted receptors;and
- Engineering feasibly is determined by whether it is possible to design and construct the noise abatement measure. The factors related to the design and construction include: safety, barrier height, topography, drainage, utilities, maintenance of the abatement measure, maintenance access to adjacent properties, and general access to adjacent properties (i.e. arterial widening projects).

Reasonableness is the consideration as to whether noise abatement measures *should* be implemented. Reasonableness is determined based on social, economic, and environmental factors including, but not limited to:

- Preferences of property owners and tenants;
- Cost reasonableness of abatement measures; and
- Noise reduction design goal of 7 dB(A) for at least one benefited receptor, whether impacted or not.

Per the NCDOT Policy, traffic noise abatement measures that may be considered include highway alignment selection, traffic systems management, buffer zones, noise barriers (earth berms and noise barriers), and noise insulation of Activity Category D land use facilities. These measures are discussed in greater detail below.

## 10.1 Roadway Alignment Selection

Roadway alignment selection for traffic noise abatement measures involves modifying the horizontal and vertical geometry of the proposed facility to minimize traffic noise to noise-sensitive receptors. The selection of alternative alignments for noise abatement purposes must consider the balance between noise impacts and other engineering and environmental parameters. For noise abatement, horizontal alignment selection is primarily a matter of locating the roadway at a sufficient distance from noise sensitive receptors. Appreciable reductions in traffic noise transmissions to sensitive receptors can be made by adjusting the vertical roadway alignment and/or section geometry. For example, lowering a roadway belowexisting grade creates a cut section which could act similarly as an earth berm, depending upon the relative location(s) of noise-sensitive receptor(s). The roadway alignment was carefully selected in order to minimize impacts to existing structures throughout this developed corridor.As such, modifying the roadway alignment is not considered practicable.

### 10.2 Traffic System Management Measures

Traffic management measures such as prohibition of truck traffic, lowering speed limits, limiting of traffic volumes, and/or limiting time of operation were considered as possible traffic noise impact abatement measures. The purpose of the U-5307 project is to increase the functional capacity of the roadway facility. Prohibition of truck traffic, reduction of the speed limit below the existing 55 mph and proposed 65 mph for US 1 (Capital Boulevard) or screening total traffic volumes would diminish the functional capacity of the roadway facility and are not considered practicable.

### 10.3 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. Furthermore, if the acquisition of a suitable buffer zone had been feasible, the associated costs would exceed the NCDOT Policy reasonable abatement cost threshold per benefited receptor.

### 10.4 Building Insulation

Since no traffic noise impacts for the U-5307 project are predicted to occur for interior noise-sensitive areas (NAC "D"), interior noise insulation was not considered as a potential traffic noise impact abatement measure as part of the abatement evaluation for this Preliminary Design noise analysis.

### 10.5 Noise Barriers

Passive noise abatement measures are effective because they absorb sound energy, extend the source-to-receptor sound transmission path, or both. Sound absorption is a function of abatement medium (e.g. earth berms absorb more sound energy than noise barriers of the same height because earth berms are more massive). The source-to-receptor path is extended by placement of an obstacle, such as a barrier, that sufficiently blocks the transmission of sound waves that travel from the source to the receptor.

Highway noise barriers are primarily constructed as earth berms or solid-mass barriers adjacent to limited-access freeways that are in close proximity to noise-sensitive land use(s). To be effective, a noise barrier must be long enough and tall enough to shield the impacted receptor(s). On roadway facilities with direct access for driveways, sound barriers are typically not feasible because the openings render the barrier ineffective in impeding the transmission of traffic noise. This was the case for impacted receptors within NSAs 4, 20, 21, and 25. These receptors were evaluated and found to be not feasible for noise abatement due to the presence of intersections and driveway access within the vicinity. It should be noted that Areas within NSA 2b have predicted impacts directly caused by existing Perry Creek Road (receptor sites 2b-49 to 2b-51). However, a noise wall would not be feasible because of existing underground gas utility conflicts and right-of-way constraints within the vicinity. The location in which a noise wall would need to be modeled, currently does not provide sufficient right-of-way maintenance clearance for a noise wall to be constructed. In addition, sidewalk and driveway access constraints along Perry Creek Road prevent a noise wall from being a reasonable length to protect the community.

Due to right-of-way constraints, noise barriers were considered the only form of abatement having the potential to reduce Design Year (2040) Build noise levels. Noise barriers were evaluated for land uses impacted under Build Alternatives 1, 2, and 3. Under Build Alternative 1, 206 receptors, representing 193 ERs, are predicted to be impacted within the project limits for STIP Project U-5307. Impacted receptors are predicted within 19 of the 28 NSAs in the project area. Nine (9) NSAs (NSAs 2a, 5, 8, 10a, 11, 14, 15, 23 and 24) warrant noise mitigation and meets the feasibility criteria. However, only seven (7) of the nine (9) (NSAs 2a, 5, 10a, 14, 15, 23, and 24) contain noise barriers that are considered to be "likely" for inclusion in construction for the STIP U-5307 project.

Once the final project design is available, a final decision on feasibility and reasonableness will be made upon completion of a review of the findings of this TNR. If necessary, a Design Noise Report (DNR) will be prepared and reviewed by NCDOT. Changes may occur as more detailed information on mapping and Final Design becomes available. Final survey mapping and Final Design, which were not available for this report, may reveal issues related to feasibility or reasonableness not known at this time.

### 10.5.1 Barrier Evaluation for Impacted Land Uses

As discussed in ***Section 10.5*** there are impacts within the project area which are restricted due to their proximity to intersections and driveway access or are limited to one impacted receptor. Those impacts located in NSAs 2a, 5, 8, 10a, 11, 14, 15, 23 and 24, which were not restricted by intersections or driveway access or had the potential to meet the feasibility criteria, were evaluated for potential noise abatement. The following paragraphs summarize the barrier evaluation for these NSAs that were conducted for the impacted land uses (NAC B, C, and E) within the US 1 Project limits. Additional details of the barrier analysis are included in ***Table 7*** on page 28 and ***Appendix D***.

**<u>NSA 2a</u>**

**NW 2-1**
The Build Alternative 1 is predicted to impact receptors within NSA 2a along a proposed service road adjacent to US 1. Noise Wall NW 2-1 was evaluated to provide abatement for impacted residences, one playground (1 ER) and one sport field. The sport field is calculated at (.8 ERs); however, the (.8 ER) value would be rounded to a whole number of (1 ER). Noise Wall NW 2-1 would be located along the outside edge of pavement of Jacqueline Road and a proposed service road. This noise wall would benefit 10 land uses, including nine (9) of the 13 impacted receptors, and would provide 7 dB(A) or more of noise reduction to two (2) residences. The Preliminary Design of an optimized wall at this location is approximately 941 feet long with an average modeled height of 15.8 feet. This barrier has an area of 14,865 square feet and averages 1,487 square feet per benefited receptor. Noise Wall NW 2-1 preliminarily meets feasibility and reasonableness criteria and is "likely" to be recommended for construction as part of this project.

**<u>NSA 2b</u>**

Areas within NSA 2b have predicted impacts directly caused by existing Perry Creek Road (receptor sites 2b-49 to 2b-51). However, a noise wall would not be feasible because of existing underground gas utility conflicts and right-of-way constraints within the vicinity. The location in which a noise wall would need to be modeled, currently does not provide sufficient right-of-way maintenance clearance for a noise wall to be constructed. In addition, sidewalk and driveway access constraints along Perry Creek Road prevent a noise wall from being a reasonable length to protect the community. Therefore, a noise wall is considered not feasible and is not recommended for further consideration.

**NSA 4**

Areas within NSA 4 have predicted impacts directly caused by existing US 1 (receptor sites 4-02 - 4-04). However, a noise wall would not be feasible as a result of existing retail access, preventing a noise wall from being sufficient in length to protect the outdoor dining areas at the Korner Pocket and Sheetz. Therefore, a noise wall is considered not feasible and is not recommended for further consideration.

**NSA 5**

**NW 5-1**
The Build Alternative 1 is predicted to impact receptors within NSA 5, the River Haven Residential Complex, in the southeastern portion of the project area. Noise Wall NW 5-1 was evaluated to provide abatement for these impacted residences. Noise Wall NW 5-1 would be located along the outside edge of pavement along US 1 northbound. This noise wall would benefit 43 land uses, including 28 of the 36 impacted residences, and would provide 7 dB(A) or more of noise reduction to 31 residences. The Preliminary Design of an optimized wall at this location is approximately 1,234 feet long with an average modeled height of 17.6 feet. This barrier has a modeled area of 21,721 square feet and averages 505 square feet per benefited receptor. Noise Wall NW 5-1 preliminarily meets feasibility and reasonableness criteria and is "likely" to be recommended for construction as part of this project.

**NSA 6**

The Build Alternative 1 is predicted to impact receptors within NSA 6, the Neuse River Greenway portion of the project area The trail totals .63 ER (rounding to 1 ER) with each trail receptor representing .11 ER.. Although NSA 6 has impacted receptors, this area is not warranted for noise abatement because the total combined ER value along the trail totals less than two impacts. Therefore, NSA 6 does not meet the feasibility criteria for noise abatement.

**NSA 7**

The Build Alternative 1 is predicted to impact receptors within NSA 7, the Neuse River Greenway portion of the project area. The trail totals .63 ER (rounding to 1 ER) with each trail receptor representing .11 ER. Although NSA 7 has impacted receptors, this area is not warranted for noise abatement because the total combined ER value along the trail totals less than two impacts. Therefore, NSA 7 does not meet the feasibility criteria for noise abatement.

## NSA 8

### NW 8-1

The Build Alternative 1 in this location is predicted to impact receptors within NSA 8, south of the proposed Burlington Mills Road extension and west of US 1. Two (2) noise barriers were separately evaluated for NSA 8. Noise Wall NW 8-1A was evaluated to provide abatement for all impacted residences in NSA 8. Noise Wall NW 8-1A would be located along the outside edge of the proposed US 1 southbound on-ramp from the Burlington Mills Road extension. This noise wall would benefit two (2) land uses, including two (2) of the five (5) impacted receptors, and would provide 7 dB(A) or more of noise reduction to one (1) receptor. The Preliminary Design of an optimized noise wall at this location is approximately 696 feet long with an average modeled height of 20 feet. This barrier has a modeled area of 16,594 square feet and averages 5,531 square feet per benefited receptor. A shorter noise wall, NW8-1B was evaluated, in addition to NW8-1A, for impacted sites 8-14 and 8-15. The Preliminary Design of NW8-1B at this location is approximately 664 feet long with an average modeled height of 16 feet. This barrier has a modeled area of 10,597 square feet and averages 5,299 square feet per benefited receptor. This noise wall would benefit two (2) land uses, including two (2) of the five (5) impacted receptors, and would provide 7 dB(A) or more of noise reduction to one receptor. Both Noise Walls, NW 8-1A and NW 8-1B preliminarily meet the feasibility criteria, however, do not meet the reasonableness criteria and are “unlikely” to be recommended for construction as part of this project. NW 8-1A alignment is shown on ***Figure 2-9.*** NW 8-1B is not shown, as it is the same alignment, but shorter in length.

Under Build Alternative 3 in this location, all residential land uses within NSA 8 will be acquired with no noise impacts predicted. Therefore, a noise barrier was not warranted for this Alternative.

## NSA 10a

### NW 10-1

The Build Alternative 1 is predicted to impact receptors within NSA 10a east of US 1 and Star Road. Noise Wall NW 10-1 was evaluated to provide abatement for these impacted residences. Noise Wall NW 10-1 would be located along the outside edge of pavement of proposed US 1 northbound lanes. This noise wall would benefit 14 land uses, including eight (8) of the nine (9) impacted receptors, and would provide 7 dB(A) or more of noise reduction to five (5) receptors. The Preliminary Design of an optimized wall at this location is approximately 1,392 feet long with an average modeled height of 14.5 feet. This barrier has a modeled area of 20,113 square feet and averages 1,437 square feet per benefited receptor. Noise Wall NW 10-1 preliminarily meets feasibility and reasonableness criteria and is “likely” to be recommended for construction as part of this project.

## NSA 11

### NW 11-1

The Build Alternative 1 is predicted to impact receptors within NSA 11, along Ponderosa Service Road, west of US 1 southbound lanes. Two (2) noise barriers were separately evaluated for NSA 11. Noise Wall NW 11-1A was evaluated to provide abatement for all impacted residences within this NSA. Noise Wall NW 11-1A would be located along the outside edge of the proposed US 1 southbound on-ramp from the Burlington Mills Road extension and US 1 southbound lanes. This noise wall would benefit eight (8) land uses, including all six (6) of the impacted receptors, and would provide 7 dB(A) or more of noise reduction to two (2) receptors. The Preliminary Design of an optimized noise wall at this location is approximately 1,483 feet long with an average modeled height of 15.9 feet. This barrier has a modeled area of 23,687 square feet and averages 2,961 square feet per benefited receptor. A shorter noise wall, NW11-1B was evaluated in addition to NW11-1A, to provide benefit for sites 11-01 to 11-09. The Preliminary Design of NW11-1B at this location is approximately 1,260 feet long with an average modeled height of 13.3 feet. This barrier has a modeled area of 16,700 square feet and averages 2,783 square feet per benefited receptor. This noise wall would benefit six (6) land uses, including five (5) of the six (6) impacted receptors, and would provide 7 dB(A) or more of noise reduction to one (1) receptor. Both Noise Walls, NW 11-1A and NW 11-1B preliminarily meet the feasibility criteria, however, do <u>not</u> meet the reasonableness criteria and are "unlikely" to be recommended for construction as part of this project. NW 11-1A alignment is shown on ***Figure 2-9.*** NW 11-1B is not shown, as it is the same alignment, but shorter in length.

**<u>NSA 14</u>**

**NW 14-1**

The Build Alternative 1 is predicted to impact receptors within NSA 14 west of US 1, in the area of Corona Boulevard. Noise Wall NW 14-1 was evaluated to provide abatement for the impacted land uses within the Kingston at Wakefield Plantation Residential Community. Noise Wall NW 14-1 would be located along the outside edge of pavement of proposed US 1 southbound lanes. This noise wall would benefit 62 land uses, including all 34 impacted receptors, and would provide 7 dB(A) or more of noise reduction to 38 receptors. The Preliminary Design of an optimized wall at this location is approximately 1,919 feet long with an average modeled height of 17.7 feet. This barrier has a modeled area of 33,923 square feet and averages 547 square feet per benefited receptor. Noise Wall NW 14-1 preliminarily meets feasibility and reasonableness criteria and is "likely" to be recommended for construction as part of this project.

**<u>NSA 15</u>**

**NW 15-1**

The Build Alternative 1 is predicted to impact receptors within NSA 15 east of US 1 and north of Caveness Farms Avenue. Noise Wall NW 15-1 was evaluated to provide abatement for these impacted residences. Noise Wall NW 15-1 would be located along the proposed right-of-way for a span of approximately 1,600 feet and then transition to the edge-of-pavement of the off ramp from US 1 northbound to Dr. Calvin Jones Highway. This noise wall would benefit 38 land uses, including 36 of the 37 impacted receptors, and would provide 7 dB(A) or more of noise reduction to 23 receptors. The Preliminary Design of an optimized wall at this location is approximately 2,279 feet long with an average modeled height of 17.5 feet. This barrier has a modeled area of 39,914 square feet and averages 1,050 square feet per benefited receptor. Noise Wall NW 15-1 preliminarily meets feasibility and reasonableness criteria and is "likely" to be recommended for construction as part of this project.

**<u>NSA 20</u>**

Areas within NSA 20 have predicted impacts directly caused by existing Durham Road and proposed ramps (receptor sites 20-10, and 20-34). However, a noise wall would not be feasible as a result of existing driveway access preventing a noise wall from being a reasonable length to protect the community.

**NSA 21**

Areas within NSA 21 have predicted impacts directly caused by existing Durham Road and proposed ramps (receptor sites 21-02, 21-06 and 20-20). However, a noise wall would not be feasible as a result of existing driveway access preventing a noise wall from being reasonable length to protect the community. Therefore, a noise wall is considered not feasible and is not recommended for further consideration.

**NSA 23**

**NW 23-1**
Build **Alternative 1** and **Alternative 2** are predicted to impact the same receptors within NSA 23 west of US 1 and south of Club Villas Drive. It should be noted that there are minor changes to the proposed ramps north of this NSA which has no influence or additional impacts on predicted results. Therefore, the results were combined for this NSA wall discussion. Noise Wall NW 23-1 was evaluated to provide abatement for 11 of the 20 impacted residences in NSA 23. Noise Wall NW 23-1 would be located adjacent to the proposed ramp from US 1 southbound to Jenkins Road. Approximately 830 ft of this noise barrier is outside of right-of-way in order to utilize terrain to design the most effective noise barrier within the vicinity. This noise wall would benefit nine (9) land uses, including all impacted receptors, and would provide 7 dB(A) or more of noise reduction to eight (8) receptors. The three impacted and benefited receptors representing the trail points equal a total of .09 ERs; however, this value is rounded to the nearest whole number (or 1 if value is less than 1). The benefited trail point equals a total of 1 ER of benefit. The Preliminary Design of an optimized wall at this location is approximately 940 feet long with an average modeled height of 12 feet. This barrier has a modeled area of 11,286 square feet and averages 1,254 square feet per benefited receptor. Noise Wall NW 23-1 preliminarily meets feasibility and reasonableness criteria and is "likely" to be recommended for construction as part of this project. Noise wall NW 23-1 is preliminarily studied approximately 32 feet outside of the proposed right-of-way. Additional verification of feasibility of NW 23-1 is recommended during the Final Design phase of the project.

**NW 23-2**
Build **Alternative 1** and **Alternative 2** are predicted to impact the same receptors within NSA 23, along Club Villas Drive and a proposed service road. Two (2) noise barriers were separately evaluated for this area within NSA 23. Noise Wall NW 23-2A was evaluated to provide abatement for these impacted residences. Noise Wall NW 23-2A would be located along the outside edge of pavement of the proposed service road and Club Villas Drive eastbound lane. This noise wall would benefit two (2) land uses, including two (2) of the three (3) impacted receptors, and would provide 7 dB(A) or more of noise reduction to two (2) receptors. The Preliminary Design of an optimized noise wall at this location is approximately 1,026 feet long with an average modeled height of 11.7 feet. This barrier has a modeled area of 12,078 square feet and averages 6,039 square feet per benefited receptor. A shorter noise wall, NW 23-2B was evaluated in addition to NW 23-2A. The Preliminary Design of NW 23-2B at this location is approximately 590 feet long with an average modeled height of 11.6 feet. This barrier has a modeled area of 5,921 square feet and averages 2,961 square feet per benefited receptor. This noise wall would benefit two (2) land

uses, including both impacted receptors, and would provide 7 dB(A) or more of noise reduction to two

(2) receptors. Noise walls NW 23-2A and NW 23-2B are preliminarily studied approximately 52 feet outside of the proposed right-of-way. Both Noise Walls, NW 23-2A and NW 23-2B preliminarily meet the feasibility criteria, however, do not meet the reasonableness criteria and are "unlikely" to be recommended for construction as part of this project. NW 23-2A alignment is shown on ***Figure 2-9.*** NW 23-2B is not shown, as it is the same alignment, but shorter in length.

**NW 23-3**

Build **Alternative 1** and **Alternative 2** are predicted to impact receptors within NSA 23, along US 1. Noise Wall NW 23-3 was evaluated to provide abatement for these impacted residences. Noise Wall NW 23-3 would be located outside edge of pavement of proposed US 1. This noise wall would benefit two (2) land uses, including both impacted receptors, and would provide 7 dB(A) or more of noise reduction to two (2) receptors. The Preliminary Design of an optimized wall at this location is approximately 1,034 feet long with a modeled height of 15.3 feet. This barrier has a modeled area of 15,864 square feet and averages 7,932 square feet per benefited receptor. Noise

Wall NW 23-3 preliminarily meets the feasibility criteria, however, does not meet the reasonableness criteria and is "unlikely" to be recommended for construction as part of this project.

**NSA 24**

**NW 24-1**

The Build Alternative is predicted to impact receptors within NSA 24 east of US 1 and the US 1 northbound on-ramp from Stadium Drive. Noise Wall NW 24-1 was evaluated to provide abatement for these impacted residences. Noise Wall NW 24-1 would be located along the proposed edge-of-pavement of US 1 northbound lanes. This noise wall would benefit 36 land uses, including all of the impacted receptors, and would provide 7 dB(A) or more of noise reduction to 20 receptors. The Preliminary Design of an optimized wall at this location is approximately 2,170 feet long with an average modeled height of 17.9 feet. This barrier has a modeled area of 38,852 square feet and averages 1,079 square feet per benefited receptor. It should be noted that the current alignment in this area may include property impacts that may require acquisition of certain land uses during the Final Design phase of the project. Once Final Design alignments are refined, NW24-1 should be re-analyzed to adjust potential differences in impacts and benefits and to ensure it meets all design requirements. At this time, noise wall NW 24-1 preliminarily meets feasibility and reasonableness criteria and is "likely" to be recommended for construction as part of this project.

### 10.5.2 Barrier Evaluation Summary

After completion of the project's Final Design and the public involvement process, a final decision on feasible and reasonable noise abatement will be recommended for the proposed project. Due to the preliminary status of the project's design at the time of this TNR, the noise barrier alignment ground profiles evaluated as part of this study should be considered preliminary in nature. It is the recommendation of this TNR that a comprehensive noise abatement design review and analysis be conducted as part of the project's Final Design and a Design Noise Report should be prepared and completed at that time

The final decision on feasibility and reasonableness as well as the installation of noise barriers will be made upon completion of the project design and the public involvement process. Changes may occur as more detailed information on mapping and Final Design alignments become available. Any changes in noise abatement measures as detailed in this report must be accepted by NCDOT

prior to implementation. Final survey mapping and Final Design alignments, which were not available for this report, may reveal issues related to feasibility or reasonableness not known at this time.

**Table 7: Barrier Feasibility and Reasonableness for Build Condition**

| Barrier | Number of Benefited Land Uses | Combined Noise Barrier Length | Average Noise Barrier Height | Area (sf) | Total sf. per benefit | Allowable Max/SF per Benefited Receptor | Feasible? | Reasonable? |
|---|---|---|---|---|---|---|---|---|
| NW2-1 | 10 | 941 | 15.8 | 14,865 | 1,487 | 1,500 | Yes | Yes |
| NW5-1 | 43 | 1,234 | 17.6 | 21,721 | 505 | 1,500 | Yes | Yes |
| NW8-1A Alt. 1 | 3 | 696 | 16.0 | 11,156 | 3,719 | 2,000 | Yes | No |
| NW8-1B Alt. 1 | 2 | 664 | 16.0 | 10,597 | 5,299 | 2,000 | Yes | No |
| NW10-1 | 14 | 1,392 | 14.5 | 20,113 | 1,437 | 1,500 | Yes | Yes |
| NW11-1A | 8 | 1,483 | 15.9 | 23,687 | 2,961 | 2,000 | Yes | No |
| NW11-1B | 6 | 1,260 | 13.3 | 16,700 | 2,783 | 2,000 | Yes | No |
| NW14-1 | 62 | 1,919 | 17.7 | 33,923 | 547 | 1,500 | Yes | Yes |
| NW15-1 | 38 | 2,279 | 17.5 | 39,914 | 1,050 | 1,500 | Yes | Yes |
| NW23-1 | 9 | 940 | 12.0 | 11,286 | 1,254 | 2,000 | Yes | Yes |
| NW23-2A | 2 | 1,026 | 11.7 | 12,078 | 6,039 | 2,000 | Yes | No |
| NW23-2B | 2 | 509 | 11.6 | 5,921 | 2,961 | 2,000 | Yes | No |
| NW23-3 | 2 | 1,034 | 15.3 | 15,864 | 7,932 | 2,000 | Yes | No |
| NW24-1 | 36 | 2,170 | 17.9 | 38,852 | 1,079 | 1,500 | Yes | Yes |

# 11.0 TRAFFIC NOISE LEVELS FOR UNDEVELOPED LANDS WHERE NO BUILDING PERMITS HAVE BEEN ISSUED

Per 23 CFR 772.9(c) and the NCDOT Noise 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 should assist local authorities in exercising land use control over the remaining undeveloped lands (NAC "G"), to avoid development of incompatible activities in the vicinity of the U-5307 project corridor.

Noise contours were developed for representative locations throughout the project study area. However, for individual locations, the distance at which traffic noise impacts will occur can vary depending on several factors including, but not limited to, traffic volumes, nearby topography, shielding from nearby structures, etc. All noise level contour distances were measured from the edge of each roadway. ***Table 8*** provides a listing of areas where noise level contours were estimated. It is noted herein that this contour information is for general informational purposes only. Therefore, detailed traffic noise studies should be performed based on specific project locations and proposed development grading plans and survey information to determine more finite results.

| Table 8: Predicted Traffic Noise Contour Distances | | | |
|---|---|---|---|
| Area | Roadway Segment | Predicted Maximum Contour Approximate Distances (feet) From Edge of Pavement | |
| | | 66 dB(A) | 71 dB(A) |
| 1 | US 1 from Nuese River to Burlington Mills Road | 200 | <50 |
| 2 | US 1 from Height Lane to Alt. 1 (S. Main St.) | 270 | 170 |
| 3 | US 1 from Dr. Calvin Jone Highway to Durham Road | 300 | 150 |
| 4 | US 1 from Stadium Drive to Harris Road | 250 | 150 |

### 11.1 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 in the vicinity of 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 barriers, 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 2021 NCDOT *Traffic Noise Policy*, 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 CONSTRUCTION NOISE

The predominant construction activities associated with this project are expected to be earth removal, hauling, grading, and paving. Temporary and localized construction noise impacts will likely occur as a result of these activities. During daytime hours, the predicted effects of these impacts will be temporary speech interference for passers-by and those individuals living or working near the project. During evening and nighttime hours, steady-state construction noise emissions such as from paving operations will be audible and may cause impacts to activities such as sleep. Sporadic evening and nighttime construction equipment noise emissions such as from backup alarms, lift gate closures ("slamming" of dump truck gates), etc., will be perceived as distinctly louder than the steady-state acoustic environment, and will likely cause severe impacts to the general peace and usage of noise-sensitive areas – particularly residences, hospitals, and hotels.

Extremely loud construction noise activities such as usage of pile-drivers and impact-hammers (jackhammer, hoe-ram) will provide sporadic and temporary construction noise impacts in the vicinity of those activities, as shown in ***Table 9***. All residences and exterior frequent human use areas in close proximity to US 1 and ramp improvement areas are most likely to be temporarily impacted by loud construction activities. It is the recommendation of this Traffic Noise Report that construction activities that will produce extremely loud noises be scheduled during times of the day when such noises will create as minimal disturbance as possible.

Generally, low-cost, and easily implemented construction noise control measures should be incorporated into the project plans and specifications to the extent possible. These measures include, but are not limited to, 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.

While discrete construction noise level prediction is difficult for a particular receiver or group of receivers, it can be assessed in a general capacity with respect to distance from known or likely project activities. For this project, earth removal, grading, hauling, and paving is anticipated to occur in the near vicinity of numerous noise-sensitive receptors. Although construction noise impact abatement should not place an undue burden upon the financial costof 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, and paving activities in the vicinity of residences should be limited to weekday daytime hours.

- If meeting the project schedule requires that earth removal, grading, hauling and / or paving must occur during evening, nighttime and / or weekend hours in the vicinity of residences, 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 noise activities must occur during context-sensitive hours in the vicinity of noise-sensitive areas, discrete construction noise abatement measures including, but not limited to portable noise barriers and / or other equipment-quieting devices shall be considered.

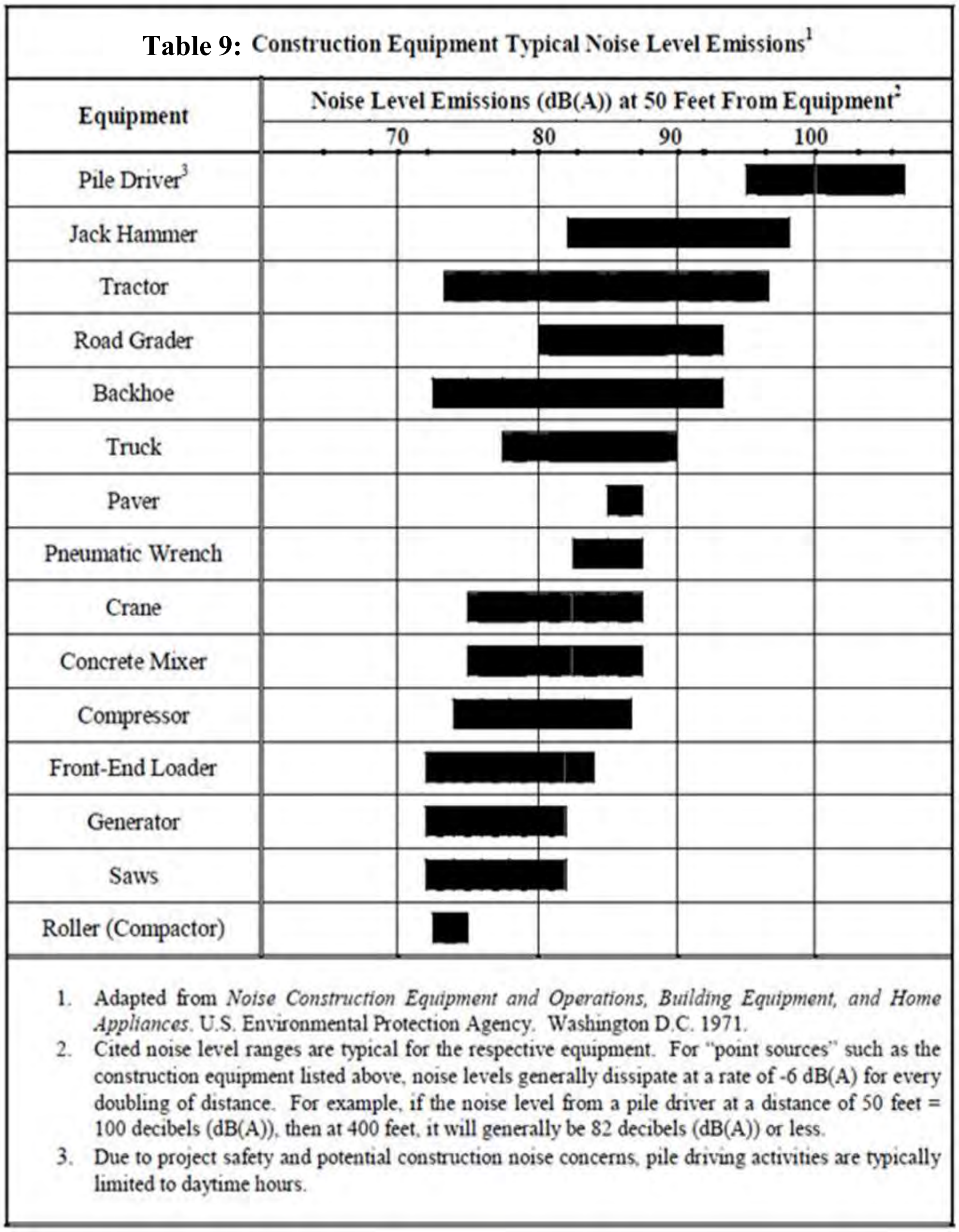

**Table 9:** Construction Equipment Typical Noise Level Emissions[1]

| 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 decibels (dB(A)), then at 400 feet, it will generally be 82 decibels (dB(A)) or less.
3. Due to project safety and potential construction noise concerns, pile driving activities are typically limited to daytime hours.

# 13.0 CONCLUSION

Traffic noise and temporary construction noise can be a consequence of transportation projects, especially in areas close to high-volume and high-speed existing steady-state traffic noise sources. This Traffic Noise Report utilized computer models created with the FHWA Traffic Noise Model software (FHWA TNM V2.5), validated to field-collected traffic noise monitoring data, to predict future noise levels and define impacted receptors along the proposed new highway project.

Design Year 2040 traffic volumes and the proposed Preliminary Design for Alternative 1 is predicted to result in traffic noise impacts at 206 receptors, representing 182 residential land uses, one apartment complex pool (1 ER), one sport area (1 ER), one playground (1 ER), one cemetery, 16 trail receptors (3 ERs), and four outdoor dining areas. In total, 193 ERs are impacted. It should be noted that the only differences in noise impacts from Alternative 1 and the subsequent interchange alternatives are within NSA 8. Under the Alternative 3 interchange design, NSA 8 would have 15 additional properties acquired and have five less noise impacts due to those acquired receptors (refer to ***Table 6***).

Nine (9) noise barriers were analyzed for NSAs 2a, 5, 8, 10a, 11, 14, 15, 23, and 24 in an attempt to mitigate Design Year (2040) Build noise impacts. NW 2-1, NW 5-1, NW 10-1, NW 14-1, NW 15-1, NW 23-1, and NW 24-1 were found to be both feasible and reasonable and are considered "likely" for construction. Noise barriers were considered and deemed feasible but not reasonable for NSAs 8, 11, and 23 and are "unlikely" for construction as part of the U-5307 Project. Noise mitigation was considered for NSA 4, 20, 21, and 25 where impacts are predicted; however, these locations are not feasible for the construction of noise abatement due to residential driveway access conflicts. Noise mitigation was considered for NSA 2b where impacts are predicted; however, this location is not feasible for the construction of noise abatement due to driveway access and underground gas utility conflicts. Noise mitigation was not considered for NSAs 6 (1 ER), 7 (1 ER), 9a, 13, 16, and 22 due to single isolated receptor impacts that would not meet the feasibility requirements.

Based on the Preliminary Design information available at the time of this TNR, twenty-eight (28) receptor sites are presumed to be acquired as a result of the project. No commitments on noise abatement will be made until further study and refinements are made during the Final Design phase of the project.

Construction noise impacts are anticipated to occur due to the proximity of numerous noise-sensitive receptors throughout the project corridor. This Traffic Noise Report recommends that all reasonable efforts should be made to minimize exposure of noise-sensitive areas to construction noise impacts. This analysis completes the traffic noise requirements of the Title 23 CFR Part 772 and the NCDOT Traffic Noise Policy.

# 14.0 REFERENCES

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