Rolling Road (Route 638) Widening Phase II Project

Fairfax County

Noise Abatement Design Study
Final Report

VDOT UPC 5559/109814

Project Number 0638-029-337, C501, R201

HMMH Report No. 309820.002
June 2019

Prepared for:
Virginia Department of Transportation
1401 East Broad St.
Richmond, VA 23219

HMMH
77 South Bedford Street, Burlington, MA 01803
T 781.229.0707

EXECUTIVE SUMMARY

This report describes the details of the noise impact assessment and abatement design effort performed for the Rolling Road Widening Phase II Project in Fairfax County, Virginia. The noise analysis was conducted in accordance with Federal highway Administration (FHWA) and Virginia Department of Transportation (VDOT) noise assessment regulations and guidelines, both of which were revised and updated significantly in 2011. The FHWA regulations are set forth in 23 CFR Part 772. VDOT's revised policy was updated most recently on February 20, 2018. The final design study reported here builds upon the preliminary noise analysis completed by HMMH in February 2018.

The Project proposes to widen Rolling Road (Route 638) from two lanes to four lanes between Viola Street and Kenwood Avenue with added pedestrian and bicycle facilities. The project corridor is approximately 1.3 miles in length and upon completion will decrease congestion, increase capacity, improve safety, and expand mobility for pedestrians and cyclists. On-street parking will be maintained in areas where driveways have direct access to Rolling Road. It is anticipated that right-of-way acquisitions and utility relocation will be required to complete the project.

This final design noise barrier evaluation was undertaken using the latest roadway design plans, profiles, and cross-sections. While updated traffic data were developed based upon the most recent forecasts for land use growth, the predicted noise impact along the corridor was based upon the ENTRADA data sheets that were developed for the Preliminary Noise Analysis with an Existing Year of 2016 and a Design Year of 2040.

The objective of this updated acoustical design study was to determine the feasibility and reasonableness of noise abatement measures where noise impacts are predicted for the worst noise hour conditions in the design year. Where noise barriers are determined to be feasible and reasonable, the study developed final lengths, heights, locations, expected noise reductions, reasonableness in square feet per benefited receptor, and estimated total costs of potential noise barriers. In addition, this study will include surveys of affected and potentially benefited property owners and residents on their attitudes and preferences about proposed noise barriers after VDOT and FHWA review. The following table summarizes the noise impact throughout the study area due to the Project in the 2044.

Noise Impact Summary

Alternative	Impact Type	Number of Impacted Units by Land Use and FHWA Activity Category[1]				
		Residential Exterior (B)	Recreational Exterior (C)	Institutional Interior (D)	Commercial Exterior (E)	Total
2016 Existing	NAC	11	0	0	0	11
2044 Build	NAC	108	0	0	0	108

1. The FHWA Activity Category is shown in parentheses
Source: HMMH, 2018.

The table below summarizes the designs of potential noise barriers along the project corridor, including the number of impacted receptors, the number of benefited receptors, length, height range, surface area, total cost, surface area per benefited receptor, and the barrier status. Figure 2

(sheets 1 to 4) presented in Section 4 of this report, shows the locations of the barriers on study area maps. As indicated in the following table, noise abatement measures were found to be feasible and reasonable for eight Common Noise Environments (CNEs) along the project corridor. Noise barriers were found to be "not feasible" for many residences along the project corridor due to conflicts with driveway access onto Rolling Road. All of the potential noise barriers that were found to be feasible and reasonable are recommended for construction as part of the current project, pending FHWA and VDOT review, as well as community support.

Summary of Potential Noise Barriers

Barrier ID	Number of Receptors			Noise Barrier Dimensions and Cost				Surface Area/ Benefited Receptor	Barrier Status*
	Impact	Impact & Benefit	Non-Impact & Benefit	Length (feet)	Height (feet)	Surface Area (sq-ft)	Total Cost at $42/sq-ft		
C1	1	1	2	302	12	3,641	$152,922	1,214	F & R
C2	9	9	8	1,435	12	17,234	$723,828	1,014	F & R
D	3	3	10	371	12	4,459	$187,278	343	F & R
F	1	1	4	437	12	5,222	$219,324	1,044	F & R
G	2	2	3	411	12	4,946	$207,732	989	F & R
H	6	6	4	1,028	10 to 12	10,624	$446,208	1,062	F & R
J	10	10	0	977	12	11,731	$492,702	1,173	F & R
N[1]	8	8	3	841	12	10,081	$423,402	916	F & R
N[2]	8	7	1	656	12	7,863	$330,246	983	F & R
O	10	10	1	838	12	10,083	$423,486	917	F & R
Total[3]	**50**	**49**	**33**	**6,455**	**-**	**75,803**	**$3.2M[3]**	**-**	**F & R**

Source: HMMH, 2018
* "F & R" = feasible and reasonable.
[1] This design for Noise Barrier N was approved by VDOT and presented to the affected community in a survey.
[2] The design for Noise Barrier B was revised based on comments received from the community per the survey. This design avoids a conflict with a stairway but does not benefit the homes at receptors N-026 and N-029.
[3] These Totals reflect the revised design for Noise Barrier N.

A survey of the preferences of property owners and residents who would be benefited by the feasible and reasonable barriers will be conducted in early 2019. The procedures for soliciting community response and tallying the votes will follow VDOT's current policies and guidance. A majority of the votes must be cast in favor of the noise barrier for it to proceed to construction.

Construction activity may cause intermittent fluctuations in noise levels. During the construction phase of the project, all reasonable measures will be taken to minimize noise impact from these activities.

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1 INTRODUCTION

1.1 Background and Purpose

The Federal Highway Administration (FHWA) regulations for mitigation of highway traffic noise in the planning and design of federally aided highway projects are contained in Title 23 of the United States Code of Federal Regulations Part 772 (23 CFR 772). These regulations state that a "Type I" traffic noise impact analysis is required when there is the addition of through-traffic lanes or additional interchange ramps are added or relocated.

This report documents the results of a Final Design Noise Analysis for the latest project design and updated design-year traffic data based on recent forecasts. This study builds upon the preliminary noise analysis completed by Harris Miller Miller & Hanson Inc. (HMMH) in February 2018.[1] Consistent with Virginia Department of Transportation (VDOT) policies, the current study recomputed highway traffic noise levels, reassessed noise impact, and reevaluated the feasibility and reasonableness of noise abatement for the Rolling Road (Route 638) Widening Phase II Project (the "Project"). The Project study area extends from its northern terminus at Kenwood Avenue to Viola Street, a distance of approximately 1.3 miles.

Both Phases I and II of the Rolling Road Widening project were evaluated in the preliminary noise study. Phase I of the project is a 660-foot segment at the northern terminus, between Old Keene Mill Road and Kenwood Avenue, and includes only one noise sensitive area (Common Noise Environment A) that was addressed in the preliminary noise study. The noise impact of the Phase I final design was addressed by HMMH in July 2018, and reported in a technical memorandum.[2] In that evaluation, noise abatement for the one impacted property was found to be not feasible.

Wherever noise barriers were found to be feasible and reasonable, this study confirmed their final lengths, heights, locations, expected noise reductions, reasonableness in square feet per benefited receptor, and total costs.

This report provides a summary of the noise abatement criteria and goals applied, procedures used, and the results obtained during the acoustical design of the potential noise barriers for this Project. The body of the report provides appropriate detail for a thorough understanding of the study process and results. Predicted noise levels and impact are presented, followed by details on each noise barrier evaluated, including location, length and height, computed with- and without-barrier sound levels, noise reduction provided by the barrier, number of benefited receptors, cost estimate, feasibility, and reasonableness in terms of square feet of barrier per benefited receptor. Appendices are provided with sound level tables (Appendix A), barrier profiles (App. B), noise measurement results (App. C), traffic data used in the analysis (App. D), response to HB 2577 (App. E), barrier worksheets (App. F), survey results (App G), and report preparers (App H).

Figure 1 provides an overview graphic of the study area with the locations of the short-term measurement sites used in this study. Figure 2 is the detailed graphic that shows the proposed

[1] "Preliminary Noise Analysis Final Technical Report, Rolling Road (Route 638) Widen to Four Lanes," HMMH Report No. 306780.010, February 2018.

[2] "Noise Analysis Final Design Report; Rolling Road/Rte 638 Widening, Phase I, UPC 5559(109814)," Memorandum, HMMH Project No. 306780.016, July 16, 2018.

roadway improvements, potential noise barriers, and the affected properties represented by noise receptors, and is presented in Section 4.

1.2 Summary of Proposed Roadway Improvements

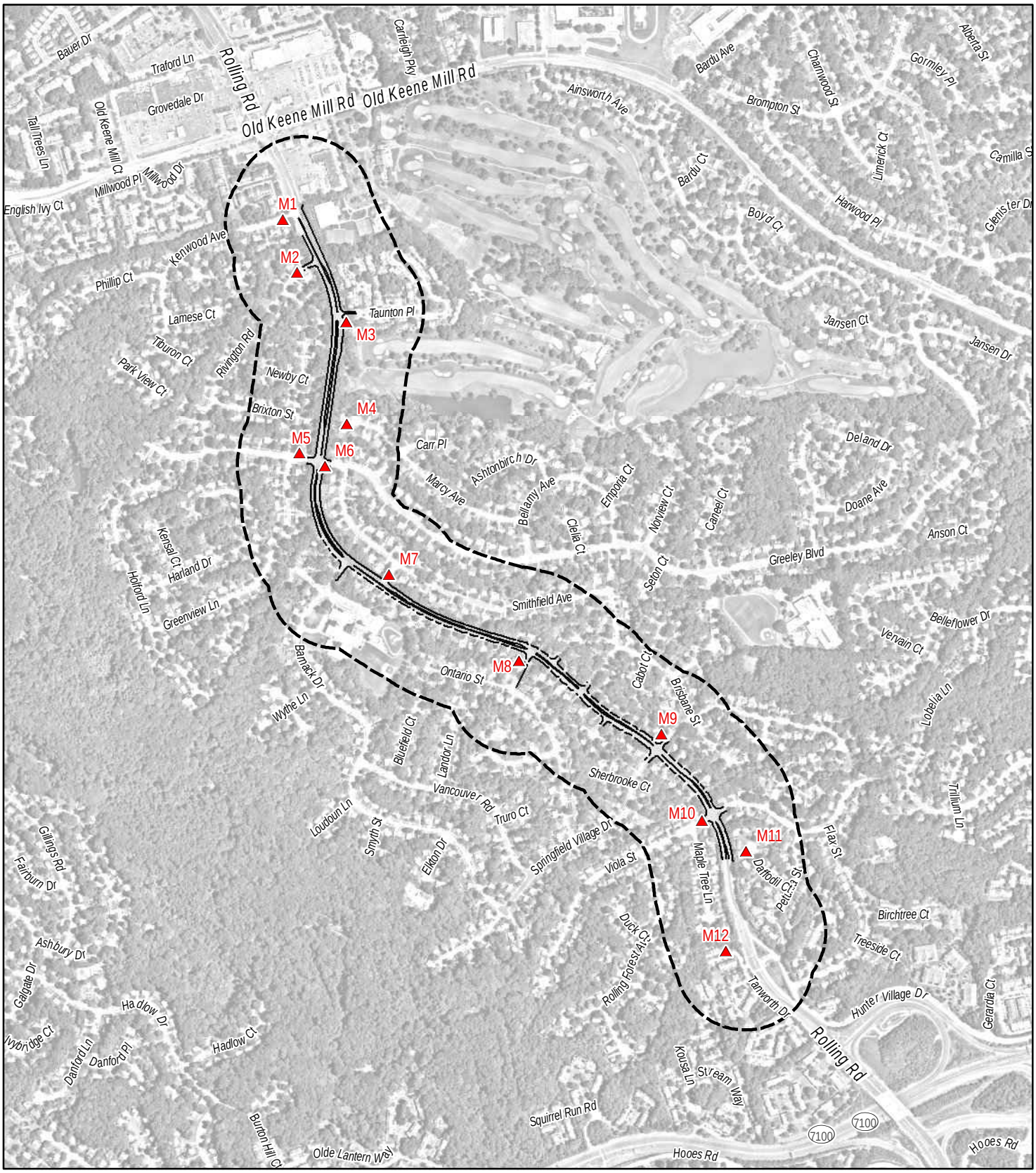
The Project proposes to widen Rolling Road (Route 638) from two lanes to four lanes between Viola Street and Kenwood Avenue with added pedestrian and bicycle facilities. The project corridor is approximately 1.3 miles in length and upon completion will decrease congestion, increase capacity, improve safety, and expand mobility for pedestrians and cyclists. On-street parking will be maintained in areas where driveways have direct access to Rolling Road. It is anticipated that right-of-way acquisitions and utility relocation will be required to complete the project.

Figures provided later in the report show the locations of the proposed roadway improvements and potential noise barrier locations.

1.3 Study Area – Common Noise Environments

Noise sensitive land uses in the project study area include single-family residences along both sides of Rolling Road, townhomes in Rhygate, the Rolling Valley Elementary School, and the Springfield Golf & Country Club. Following VDOT and FHWA policies and procedures, the receptors used in the model to represent exterior activity areas at noise-sensitive land uses were grouped into Common Noise Environments (CNEs). Receptors in a CNE are exposed to similar noise sources and levels and generally occur between secondary noise sources, such as cross-streets. The modeled receptors for the Project were grouped into the following CNEs:

- CNE B is located near the northern project limit, on the east side of Rolling Road. It is comprised of recreational land use at the Springfield Golf & Country Club, including tennis courts and the swimming pool.
- CNE C is located on the west side of Rolling Road from Kenwood Avenue to Greeley Boulevard and is comprised of single-family homes.
- CNE D is located on the east side of Rolling Road and is comprised of the townhomes in the Rhygate development, i.e. townhomes on Taunton Place, Wainfleet Court, and Eastleigh Court.
- CNE E is located on the east side of Rolling Road and includes townhomes in Rhygate, south of Taunton Place, and the golf course at the Springfield Golf & Country Club.
- CNE F is located on the east side of Rolling Road from Marcy Avenue to Greeley Boulevard and is comprised of single-family homes.
- CNE G is located on the west side of Rolling Road from Greeley Boulevard to Barnack Drive and is comprised of single-family homes. Three single-family homes on Rolling Road, just north of the intersection with Barnack Drive, have existing and future driveway access on to Rolling Road.



M# Measurement Site

Noise Study Area

0 1,200 2,400 Feet

VDOT Virginia Department of Transportation

Figure 1 - Study Area Map

Rolling Road (Route 638) Widening Project
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- CNE H is located on the east side of Rolling Road from Greeley Boulevard to Taft Drive and is comprised of single-family homes.
- CNE I is located on the west side of Rolling Road between Barnack Drive and Birmingham Lane and includes a mix of residential, recreational, and institutional land use. CNE I is comprised of single-family homes and the Rolling Valley Elementary School. All of the first row homes in this CNE have existing and future driveway access onto Rolling Road.
- CNE J is located on the east side of Rolling Road from Taft Drive to Bellamy Avenue and is comprised of residential land use.
- CNE K is located on the west side of Rolling Road between Birmingham Lane and Springfield Village Drive and is comprised of residential land use. All of the first row homes in this CNE have existing and future driveway access onto Rolling Road.
- CNE L is located on the east side of Rolling Road from Bellamy Avenue to Viola Street and is comprised of single-family homes. All of the first row homes in CNE L have existing and future driveway access onto Rolling Road.
- CNE M is located on the west side of Rolling Road between Springfield Village Drive and Viola Drive and is comprised of residential land use. All of the first row homes in CNE M have existing and future driveway access onto Rolling Road.
- CNE N is located on the west side of Rolling Road between Viola Drive and Tanworth Drive. Noise-sensitive land use in CNE N is comprised of single-family homes a row of townhomes on Tanworth Drive.
- CNE O is located near the southern project limit, along the east side of Rolling Road between Viola Street and Petunia Street. It is comprised of single-family homes.

Figure 1 provides an overview of the study area that with the locations of the noise monitoring sites, which are discussed in detail in Section 3.2

1.4 DATE OF PUBLIC KNOWLEDGE AND UNDEVELOPED LANDS

The Date of Public Knowledge for this project is February 15, 2018, when the environmental document was approved.[3] To be eligible for abatement consideration, developed and undeveloped lands are required to have been "permitted" before the Date of Public Knowledge. A property is eligible for noise abatement if there is a definite commitment to develop land with an approved specific design of noise-sensitive land use activities as evidenced by the issuance of a building permit. VDOT is under no obligation to provide noise abatement for any noise-sensitive properties that were permitted after the Date of Public Knowledge

Development along the project corridor predates the Date of Public Knowledge. Given that the project corridor is largely "built-out," with no undeveloped parcels along the corridor, it is unlikely that there would be any newly permitted land use activities since the Date of Public Knowledge

[3] Email from LJ Muchenje to C. Menge with subject "RE: Rolling Road - date of public knowledge," and dated 12/19/2018.

that would require consideration during final design of the project. Nevertheless, HMMH contacted staff within the Fairfax County Planning Department to help us identify any newly permitted land use activities between the date of the preliminary noise study and the Date of Public knowledge. The County confirmed that a review of their records did not identify any building permits in study area that would be associated with a land use change.[4] A copy of the correspondence is included as Appendix H.

2 NOISE ABATEMENT CRITERIA AND DESIGN GOALS

2.1 Regulations and Guidelines

The noise impact of the proposed Project was assessed in accordance with FHWA and VDOT noise assessment regulations and guidelines. The FHWA regulations are set forth in 23 CFR Part 772[5]. On July 13, 2010, FHWA published revised noise regulations which became effective on July 13, 2011. FHWA has also published a guidance document to support the new regulations.[6] VDOT prepared revisions to its noise policy in accordance with FHWA's requirements and revised policy. VDOT's revised policy has received approval from FHWA, and was updated on February 20, 2018.[7]

2.2 Noise Abatement Criteria

To assess the degree of impact of highway traffic and noise on human activity, the FHWA established Noise Abatement Criteria (NAC) for different categories of land use activity (see Table 1). The NAC are given in terms of the hourly, A-weighted, equivalent sound level in decibels (dBA). The A-weighted sound level is a single number measure of sound intensity with weighted frequency characteristics that corresponds to human subjective response to noise. Most environmental noise (and the A-weighted sound level) fluctuates from moment to moment, and it is common practice to characterize the fluctuating level by a single number called the equivalent sound level (L_{eq}). The L_{eq} is the value or level of a steady, non-fluctuating sound that represents the same sound energy as the actual time-varying sound evaluated over the same time period. For traffic noise assessment, L_{eq} is typically evaluated over a one-hour period, and may be denoted as $L_{eq}(h)$.

[4] Email from Zachary Krohmal to Lovejoy Muchenje and Chris Bajdek with subject "RE: Proposed Development along the Rolling Road Project Corridor (VDOT UPC 5559/109814)" and dated 1/18/2019.

[5] 23 CFR Part 772, as amended 75 FR 39820, July 13, 2010; Effective date July 13, 2011 – "Procedures for Abatement of Highway Traffic Noise and Construction Noise," Federal Highway Administration, U.S. Department of Transportation. http://www.fhwa.dot.gov/environment/noise/regulations_and_guidance/

[6] "Highway Traffic Noise: Analysis and Abatement Guidance," Federal Highway Administration, U.S. DOT, June 2010, revised January 2011. http://www.fhwa.dot.gov/environment/noise/regulations_and_guidance/analysis_and_abatement_guidance/revguidance.pdf

[7] "Highway Traffic Noise Impact Analysis Guidance Manual (Version 8)," Virginia Department of Transportation, updated February 20, 2018. http://www.virginiadot.org/projects/pr-noise-walls-about.asp

Noise-sensitive land use within the Project study area consists of residential properties (Activity Category B) and recreational areas (Activity Category C). For Categories B and C, noise impact would occur when predicted exterior noise levels, due to the project, approach or exceed 67 dBA in terms of L_{eq}(h) during the loudest hour of the day. VDOT defines the word "approach" in "approach or exceed" as within 1 decibel. Therefore, the threshold for noise impact is where exterior noise levels are within 1 decibel of 67 dBA L_{eq}(h), or 66 dBA. Noise impact also would occur wherever project noise causes a substantial increase over existing noise levels. VDOT defines a substantial increase as an increase of 10 decibels or more above existing noise levels.

Table 1 FHWA Noise Abatement Criteria

Activity Category	L_{eq}(h)[1]	Description of Activity Category
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[2]	67 (Exterior)	Residential
C[2]	67 (Exterior)	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care 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, Section 4(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	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 (without building permits)

[1] Hourly Equivalent A-weighted Sound Level (dBA)
[2] Includes undeveloped lands permitted for this activity category
Source: 23 CFR Part 772.

When the predicted design-year Build case noise levels approach or exceed the NAC during the loudest hour of the day or cause a substantial increase over existing noise levels, consideration of traffic noise reduction measures is necessary. If it is found that such mitigation measures will cause adverse social, economic or environmental effects that outweigh the benefits received, they may be dismissed from consideration. For this study, noise levels throughout the study area were determined for the 2044 design-year Build alternative.

All noise-sensitive land uses potentially affected by the project are near roads for which traffic data was developed as part of the environmental study. Therefore, all noise levels were computed from the appropriate loudest-hour traffic data.

2.3 Noise Abatement Measures, Goals and Process

FHWA has identified certain noise abatement measures that may be incorporated in projects to reduce traffic noise impact. In general, mitigation measures can include alternative measures (traffic management, the alteration of horizontal and vertical alignment, and low-noise pavement), in addition to the construction of noise barriers.

2.3.1 Alternative Noise Abatement Measures

Traffic management measures normally considered for noise abatement include reduced speeds and truck restrictions. Reduced speeds would not be an effective noise mitigation measure since a substantial decrease in speed is necessary to provide a significant noise reduction. A 10 mph reduction in speed would result in only a two decibel decrease in noise level. Restricting truck usage on Rolling Road is not practical as the diversion of truck traffic (to other roadways would increase noise levels in those areas. The alteration of the horizontal or vertical alignment of Rolling Road also would not be practical because the roadway would have to undergo a significant shift in the horizontal alignment to make the measure effective. Such shifts would require right-of-way acquisitions and would likely create new noise impact.

Additionally, the Noise Policy Code of Virginia (HB 2577, as amended by HB 2025) states:

> "*Requires that whenever the Commonwealth Transportation Board or the Department plan for or undertake any highway construction or improvement project and such project includes or may include the requirement for the mitigation of traffic noise impacts, first consideration should be given to the use of noise reducing design and low noise pavement materials and techniques in lieu of construction of noise walls or sound barriers. Vegetative screening, such as the planting of appropriate conifers, in such a design would be utilized to act as a visual screen if visual screening is required."*

Consideration was given to these measures during the final design process, where feasible. The response from project management is included in Appendix E**.**

2.3.2 Noise Barrier Feasibility and Reasonableness Criteria and Design Goals

The only remaining abatement measure investigated was the construction of noise barriers. The feasibility of noise barriers was evaluated in locations where noise impact is predicted to occur with the Build alternative. Where the construction of noise barriers was found to be physically practical, barrier noise reduction was estimated based on roadway, barrier, and receiver geometry as described below.

FHWA and VDOT require that noise barriers be both "feasible" and "reasonable" to be recommended for construction. State DOTs have established individual feasibility and reasonableness criteria within federally mandated guidelines. VDOT's criteria are summarized here.

To be feasible, a barrier must be acoustically effective, that is it must reduce noise levels at noise sensitive locations by at least 5 decibels, thereby "benefiting" the property. VDOT requires that at least fifty percent (50%) of the impacted receptors receive 5 decibels or more of insertion loss from the proposed barrier for it to be feasible.

A second feasibility criterion is that it must be possible to design and construct the barrier. Factors that enter into constructability include safety, barrier height, topography, drainage, utilities, maintenance of the barrier, and access to adjacent properties. VDOT has a maximum allowable height of 30 feet above ground level for noise barriers.

Barrier reasonableness is based on three factors: cost-effectiveness, ability to achieve VDOT's insertion loss design goal, and views of the benefited receptors. To be "cost-effective," a barrier cannot require more than 1600 square feet per benefited receptor. VDOT's maximum barrier height of 30 feet figures into the assessment of benefited receptors. Where multi-family housing includes balconies at elevations above that of a 30-ft high barrier, or terrain lifts ground-based receptors above the elevation of a 30-ft barrier, these receptors will not be assessed for barrier benefits and are thereby not included in the computation of the barrier's reasonableness.

The second reasonableness criterion is VDOT's noise reduction design goal of 7 decibels. This goal must be achieved for at least one of the impacted receptors for the barrier to be considered reasonable.

The third reasonableness criterion relates to the views of the owners and residents of the potentially benefited properties. A majority of the benefited receptors must favor the barrier for it to be considered reasonable to construct. Community views are surveyed in this, the final design phase of the roadway widening project.

2.3.3 Acoustical Design Process

The acoustical design process involves locating barriers in cost-efficient locations initially, such as at the top of slope where a roadway is in cut, and near the edge of the roadway where it is on fill and above the elevation of affected receivers. Barriers are always located within the project right of way, unless extenuating circumstances require locating a portion of a barrier on private or municipal property. Initially in the design, barriers are evaluated at several heights to determine the heights necessary to achieve sufficient noise reduction. Where sound levels are relatively high (mid-70s dBA or higher), barriers are designed to achieve notably greater noise reduction than 5 dBA, so that where possible, the resulting noise levels are below the impact threshold of 66 dBA. Achieving this goal is not always possible, however, if the reasonableness criterion of 1600 square feet of barrier per home benefited is exceeded as a result of the increased barrier height.

Normally, noise barriers are evaluated within the project limits of the roadway improvement. However, VDOT will extend noise barriers beyond project limits, if needed to maintain continuity of noise protection for a cohesive residential neighborhood. For such neighborhood continuity, noise abatement may be considered for noise impacts that are projected to occur at distances of up to 500 feet from the roadway improvements.

3 NOISE ANALYSIS METHODOLOGY

In a noise abatement design study, the noise analysis involves development of a refined model for highway traffic noise prediction and design of the barriers. That refined model is used first to determine areas where noise impact would occur in the future Design Year, then to evaluate whether noise barriers to mitigate noise impacts are both feasible and reasonable. Barriers found

to be feasible and reasonable are then taken through a detailed acoustical design process to establish location, length and height appropriate for structural design and construction.

3.1 Noise Modeling

All traffic noise calculations for this study were performed using the FHWA-mandated Traffic Noise Model[8] (TNM) first released by FHWA in April 1998 for use on Federal-aid highway noise projects. The latest version of TNM (Version 2.5) was used for all traffic noise level computations and noise barrier design.

TNM separately calculates the noise contribution of each roadway segment at a given receiver. For each roadway segment, the noise from each vehicle type is computed from the reference energy-mean emission level, and adjusted for vehicle volume, speed, grade, roadway segment length, and source-to-receiver distance. Further adjustments needed to accurately model the sound propagation from source to receiver include shielding provided by rows of buildings, the effects of different ground types, source and receiver elevations, and the effects of any intervening noise barriers or trees. The program sums the noise contributions of each vehicle type for a given roadway segment at the receiver. TNM then repeats this process for all roadway segments, summing their contributions to generate the predicted noise level at each receiver.

TNM incorporates sound emissions and sound-propagation algorithms based on well-established theory or on accepted international standards. The acoustical algorithms contained within the FHWA TNM have been validated with respect to carefully conducted noise measurement programs, and show excellent agreement in most cases for sites with and without noise barriers. TNM takes into account:

- Vehicle classifications, volumes, and speeds.
- Attenuation due to ground reflections off a large selection of ground types.
- Effects of roadway edges and other edges between ground of different types.
- Attenuation over noise walls, including their interaction with reflections from the ground.
- Attenuation over earth berms and similar intervening hills/terrain.
- Attenuation over/through rows of buildings.
- Attenuation through dense foliage.
- Combined emission/speed effects of accelerating, full-throttle traffic on on-ramps and near stop signs, traffic signals, and toll barriers.
- Combined emission/speed effects of decelerating, full-throttle vehicles on upgrades and subsequent effects as these vehicles later regain speed.

The modeling of roadway segments, terrain geometry, structural shielding, residential receivers, and proposed noise barrier locations was based on: 1.) revised Microstation roadway design files

[8] Anderson, G.S., C.S.Y. Lee, G.G. Fleming, and C.W. Menge, “FHWA Traffic Noise Model, Version 1.0 User’s Guide”. Federal Highway Administration Report No. FHWA-PD-96-009, January 1998.

supplied by VDOT; 2.) aerial photography, revised elevation and GIS data provided by and/or obtained from VDOT and third-party sources;[9,10] and 3.) limited field verification.

To fully characterize future noise levels at all noise-sensitive land uses in the study area, noise prediction receivers (also called "receptors" and/or "sites") were added to the measurement sites in the TNM model. The study area includes residential and some recreational land use adjacent to project roadways. Each receptor included in the model is representative of exterior noise-sensitive land use. All TNM runs are provided upon request in native electronic form.

3.2 Measurements of Existing Traffic Noise Levels

A noise measurement program in the Project study area was carried out to provide current and sufficient information for a model validation exercise. Short-term noise measurements of 30 minutes duration were obtained at 11 sites on October 3 and 4, 2018. Measurement sites were generally located in areas with the highest noise exposures, mostly adjacent to first-row and some second-row homes.

The measurement procedure involved the measurement of one-minute L_{eq}s so that the minutes including noise events unrelated to traffic on Rolling Road (such as aircraft over-flights and traffic on local roads) could later be excluded from consideration. Vehicle classification counts for traffic on Rolling Road were conducted simultaneously with the noise measurements, so that normalized traffic count data could be used as input to the TNM model for model validation.

Short-term noise monitoring is not a process to determine design year noise impacts or barrier locations. Short-term noise monitoring provides a level of consistency between what is present in real-world situations and how that is represented in the computer noise model. Short-term monitoring does not need to occur within every CNE to validate the computer noise model.

Short-term noise measurements were conducted using an HMMH-owned Larson-Davis 824 (ANSI Type I, "Precision") integrating sound level meter with a 1/3 octave band real-time analyzer. HMMH's noise measurement instrumentation was field calibrated at regular intervals during the measurement program. In addition, all HMMH instruments are calibrated annually at a certification laboratory, with calibrations traceable to the National Institute of Standards and Technology. A copy of the calibration certificates for the instruments used for the measurements is included in Appendix C.

Table 2 provides a summary of the noise measurement sites and locations, along with measurement date, time, duration and the measured L_{eq} from traffic on Rolling Road. As shown in the table, the measured Traffic-only L_{eq} is very nearly the same as the Total L_{eq} at each site, except M4, indicating that traffic noise from Rolling Road was the dominant source of noise throughout the study area. During the measurement at M4, a garbage truck passed the microphone at slow speed, came to a stop and idled for a period of time before proceeding. The garbage truck affected

[9] Lidar data were acquired from "United States Department of Agriculture, Natural Resource Conservation Service, National Geospatial Center of Excellence." Accessed on-line at: http://datagateway.nrcs.usda.gov/.

[10] Aerial Photography came from Bing Aerial Photography, Live stream through ArcGIS online. Tiles were exported from ArcGIS.

the measured noise level for the two minutes during which it was on Marcey Avenue (see the one-minute periods starting at 12:26 and 12:27 on the data sheet for Site M4 in Appendix D). While these minutes with the garbage truck were included in the "Total L_{eq}" shown in Table 2, they were excluded in the calculation of the "Traffic-only L_{eq}" since these two minutes were not representative of traffic on Rolling Road. The Traffic-only L_{eq} will be used for the purpose of model validation, as described in the following section. The measurement site locations are shown in Figures 1 and 2, the study area graphics.

The noise measurement field data sheets with site sketches, measured noise levels and traffic counts, along with site photographs and noise monitor sound level and calibration output are provided in Appendix C.

Table 2 Noise Measurement Summary

Site No.	Address/Location	Date	Time Start (hh:mm:ss)	Duration (minutes)	Measured Total L_{eq}, (dBA)	Measured Traffic-only L_{eq} (dBA)
M1	8301 Kenwood Ave	3-Oct-18	9:05:02	30	64.5	63.2
M2	6401 Rivington Road	3-Oct-18	9:51:02	30	57.0	57.0
M3	8261 Taunton Place	3-Oct-18	10:34:04	30	64.1	64.1
M4	8209 Marcey Ave	3-Oct-18	12:02:02	30	61.5	51.9
M5	8300 Greeley Blvd	3-Oct-18	11:20:02	30	59.3	59.3
M6	8237 Smithfield Ave	3-Oct-18	13:43:03	30	63.2	63.2
M7	8215 Smithfield Ave	3-Oct-18	14:27:02	30	58.8	58.4
M8	8110 Birmingham Lane	3-Oct-18	15:18:00	30	60.3	59.8
M9	6907 Rolling Road	4-Oct-18	8:58:00	30	59.8	59.4
M10	8101 Viola St	4-Oct-18	9:44:00	30	64.6	64.5
M11	7115 Tanworth Drive	4-Oct-18	10:40:00	30	52.9	52.8

Source: HMMH, 2018

3.3 Noise Model Validation

During the noise measurement program, simultaneous vehicle classification counts were conducted for traffic on Rolling Road. By entering normalized traffic data into the noise model developed for the study area and locating the measurement sites accurately, the accuracy of the noise model representation can be validated.

There are many factors that influence the measured noise levels that may cause differences with computed noise levels of up to several decibels. Such factors include atmospheric conditions (upwind, neutral or downwind), shielding by structures that may be difficult to model, and the representativeness of louder vehicles passing during the measurement period. Factors in the model that may cause differences with the measured noise levels include level of detail in terrain

modeling, and the degree of inclusion of smaller elements such as hard ground zones, tree zones and sparse rows of buildings.

The purpose of a validation exercise is to evaluate the success of the model in representing the important acoustical characteristics of the study area. This is determined by examining the overall trend of the differences between measured and computed values. The individual site to site differences will vary more significantly, depending on the factors mentioned in the previous paragraph. The FHWA does not allow the model to be "calibrated" or adjusted by a certain amount to make the measurements match the computed values. The reasons for this are 1) the TNM has been sufficiently validated through FHWA-funded research projects and it has been found to be highly accurate, and 2) the FHWA recognizes that many factors are present both in the measurement of noise and in developing an accurate model that can lead to variability.

The validation process compares monitored sound levels at each measurement site to the noise levels calculated with TNM using the existing site geometry and normalized traffic count data as input to the model. The modeling assumptions are refined, as necessary, until the agreement between monitored and calculated noise levels are within an acceptable range of ± 3 dBA, in accordance with VDOT policy.

The results of the model validation are shown in Table 3. The Project-wide average difference between calculated noise levels and monitored noise levels was -0.5 decibels (over all 11 sites), which shows excellent agreement between monitored and modeled sound levels and suggests confidence in the modeling assumptions. As shown in Table 3, the difference between the calculated and monitored levels was outside the acceptable range only at Site M3.

At Site M3, the calculated noise level was 60.3 dBA L_{eq}, while the monitored noise level was 64.1 dBA L_{eq}, representing an apparent under-prediction of 3.8 dBA. During the measurement at Site M3, the following factors might have each contributed a small effect (e.g. < 0.5 dBA) to the measured level, but when considered together might have accounted for the relatively small "upward" bias in the measured data (i.e. the sum of the small effects might be on the order of one decibel):

- Several noise sources unrelated to traffic on Rolling Road (e.g. traffic on Taunton Place, an abnormally loud truck, etc.) were observed and noted on the data sheet. It is likely that these other sources, which were not included in the TNM model, had some small effect on the measured level contributing to an "upward" bias in the data.[11]
- While the microphone was located more than 10 feet from large reflecting surfaces (e.g. the townhome façade, parked car), it is plausible that a reflection off a parked car also may have had some small effect on the measured level, also contributing to a small upward bias in the data.

[11] Normally, sources of noise unrelated to road traffic are "removed" or filtered out of the measurement data in the calculation of a "Traffic-only" noise level, which is then used for the validation effort. Such "non-traffic" noise sources are filtered out when they are judged (in the field) to affect the measured traffic noise level. While non-traffic sources were observed and noted at M3, in some cases, they were judged to not have an appreciable affect on the measured Leq. If we were to exclude additional periods of time that included noise sources unrelated to traffic on Rolling Road, the difference between the measured level and the modeled level would approach three decibels.

Appendix C provides tables with further detail on the validation exercise, including counted traffic data normalized to one hour and the coordinates of the measurement sites.

Table 3 Computed vs. Measured Sound Levels at Measurement Sites

Site No.	Address/Description	Land Use	Measured Traffic-Only L_{eq} (dBA)	Computed L_{eq} (dBA)	Difference (dBA)
M1	8301 Kenwood Ave	Residential	63.2	64.8	1.6
M2	6401 Rivington Road	Residential	57.0	58.7	1.7
M3	8261 Taunton Place	Residential	64.1	60.3	-3.8
M4	8209 Marcey Ave	Residential	51.9	49.4	-2.5
M5	8300 Greeley Blvd	Residential	59.3	60.2	0.9
M6	8237 Smithfield Ave	Residential	63.2	61.8	-1.4
M7	8215 Smithfield Ave	Residential	58.4	57.8	-0.6
M8	8110 Birmingham Lane	Residential	59.8	59.1	-0.7
M9	6907 Rolling Road	Residential	59.4	61.0	1.6
M10	8101 Viola St	Residential	64.5	62.7	-1.8
M11	7115 Tanworth Drive	Residential	52.8	52.2	-0.6
	Average Difference				-0.5
	Standard Deviation of Differences				1.8

Source: HMMH, 2018

3.4 Traffic Data for Noise Prediction

Traffic data used in the noise analysis must produce sound levels representative of the loudest hour of the day in the future design year, per FHWA and VDOT policy. Revised traffic data were supplied by VDOT for existing conditions (2016) and for a revised Design Year of 2044 for Rolling Road and other major arterials (Fairfax County Parkway, Franconia-Springfield Parkway, and Old Keene Mill Road). The traffic data were presented as hourly volumes in VDOT's Environmental Traffic Data (ENTRADA) spreadsheets. HMMH conducted a determination of the loudest hour of the day consistent with VDOT's current methodology. The loudest-hour evaluation began by using TNM to compute the overall traffic noise level at a reference distance of 50 feet from Rolling Road for each hour of the day. The TNM run of the complete study area was then used with all receptors to refine the selection of the loudest hour for each scenario (the Existing and design-year Build alternative) between the two hours that produced the highest noise level for each direction of travel. The worst noise hour conditions were found to correspond to the hour starting at 8:00 AM for the revised Existing conditions and 4:00 PM for the revised Design Year 2044 Build alternative. For consistency, traffic data used in the Preliminary Noise Study[12] was used for this analysis. Appendix D provides the traffic data for the roadways used in the TNM modeling for this project.

[12] See footnote 1.

3.5 Predicted Noise Levels and Impact

The study area includes residential and some recreational land use adjacent to project roadways. Each receptor represented exterior noise-sensitive land use.

All noise levels computed were the A-weighted equivalent sound level, or L_{eq}, in dBA. Loudest-hour noise levels were computed for the 2016 Existing case and the design year 2044 Build alternative. Table 4 provides the total number of impacted receptors by FHWA Activity Category. Table 5 summarizes the noise impact and ranges of predicted noise levels by CNE.

As noted in Table 5, noise impact is not predicted to occur in CNE E. The residential receptors in CNE E are located in the backyards of the townhomes in Rhygate – in exterior areas with frequent human use. These backyard receptors would be partially shielded from the source of noise generated by the tire-pavement interface. From Station 2059+50.04 to 2063+22.39, the improved Rolling Road and the shared use path on the northbound side would be elevated relative to the surrounding terrain and supported by Retaining Wall #3. The top of the retaining wall would break the line-of-sight between the tire-pavement interface and the backyard receptors, thereby attenuating (reducing) traffic noise levels at the residential receptors. The recreational receptors in CNE E are also relatively far from the improved Rolling Road and so would be exposed to lower levels due to the increased distance from the road.

Appendix A provides a table that lists the computed sound levels at all of the receptors; the individual barrier summaries in Section 4 include tables listing computed 2044 Build sound levels without and with a barrier, along with barrier insertion loss values for all receptors where noise abatement was evaluated.

Each receptor location in Figure 2 is shown with a color-coded dot that indicates the status of each receptor according to its 2044 Build noise level with and without a noise barrier. The color code and corresponding receptor status are as follows:

- Light blue – impacted (without noise barrier) and 5 or 6 dBA of insertion loss (with noise barrier)
- Dark blue – impacted (without noise barrier) and 7 dBA of insertion loss (with noise barrier)
- Red – impacted (without noise barrier) and not benefited, i.e. less than 5 dBA of insertion loss (with noise barrier)
- Green – not impacted (without noise barrier) and benefited (with noise barrier)
- Yellow – not impacted (without noise barrier) or benefited (with noise barrier)

Table 4 Number of Impacted Units by FHWA Activity Category

Alternative	Impact Type	Number of Impacted Units by Land Use and FHWA Activity Category[1]				
		Residential Exterior (B)	Recreational Exterior (C)	Institutional Interior (D)	Commercial Exterior (E)	Total
2016 Existing	NAC	11	0	0	0	11
2044 Build	NAC	108	0	0	0	108

1. The FHWA Activity Category is shown in parentheses
Source: HMMH, 2018.

Table 5 Summary of Noise Impact and Ranges of Predicted Noise Levels by CNE

CNE	FHWA Activity Category	Number of Receptors* Exposed to Noise Impact		Range of Predicted Traffic Noise Levels, dBA L_{eq}	
		2016 Existing	2044 with Project	2016 Existing	2044 with Project
B	C	0	0	51 – 55	52 – 60
C	B	0	10	44 – 65	46 – 67
D	B	0	3	45 – 62	45 – 68
E	B and C	0	0	48 – 60	51 – 64
F	B	0	1	47 – 62	50 – 66
G	B	0	5	41 – 65	43 – 68
H	B	0	6	45 – 63	47 – 68
I	B, C and D	11	17	25 – 66	28 – 68
J	B	0	16	43 – 64	45 – 69
K	B	0	12	45 – 65	48 – 68
L	B	0	14	40 – 65	40 – 69
M	B	0	6	46 – 65	49 – 68
N	B	0	8	46 – 65	49 – 68
O	B	0	10	46 – 65	49 – 68
TOTAL		**11**	**108**		

Residential or recreational receptors.
Source: HMMH, 2018.

4 SUMMARY OF FINAL NOISE BARRIER DESIGNS

Figure 2 shows the locations of each of the barriers evaluated in detail in this study. Table 6 presents a summary of each barrier's acoustical design details, including location, benefited receptors, length, height range, surface area, total cost, surface area per benefited receptor, and whether the barrier was found to be cost-reasonable. The barriers shown in Table 6 are the most cost-effective noise barrier designs that were evaluated in this study. In the following sections, detailed results tables are provided for each of the barriers that was evaluated in the study. The tables show 2044 Build sound levels are shown without and with a barrier, along with barrier insertion loss values for all receptors. In addition, Appendix A provides a table that lists the computed sound levels at all of the receptors shown in Figure 2.

Due to driveway access requirements, noise barriers were not considered for CNEs I, K, L, and M and are not addressed in this section. Information on the noise levels associated with these CNEs can be found in Appendix A.

The following sections provide a narrative and a table of calculated noise levels by receptor (including the impact/benefit status of each receptor) for each potential noise barrier. The physical

characteristics of the noise barriers needed for design, including coordinates, estimated ground elevation, and top-of-wall elevation are provided in tables in Appendix B "Barrier Profiles – Sound Attenuation Lines."

Appendix F includes the Warranted, Feasible and Reasonable Worksheets for each of the noise barriers in Table 6.

4.1 Noise Barrier C1

Barrier C1 is a potential noise barrier for the residences in CNE C between Kenwood Avenue and Rivington Road, as shown in Figure 2. The barrier would benefit the single impacted receptor in CNE C north of Rivington Road, with 8 decibels of noise reduction, as well as two additional non-impacted residential receptors. Barrier C1 would be 12 feet high and 302 feet long, with a surface area of 3,641 square feet. The potential barrier is feasible and reasonable, since it provides more than 7 decibels of noise reduction at an impacted receptor and has a square-foot per benefited receptor value of 1,214.

Table 7 shows the Build L_{eq} sound levels without and with a barrier, along with barrier insertion loss values for all receptors behind the barrier. Barrier C1 would provide an average noise reduction of 8.0 dB at the benefited receptors. The sound attenuation line for Noise Barrier C1 is in Table 18 in Appendix B.

4.2 Noise Barrier C2

Barrier C2 is a potential noise barrier for the residences in CNE C between Rivington Road and Greeley Boulevard, as shown in Figure 2. The barrier would be 12 feet high and 1,435 long, with a surface area of 17,234 square feet. Barrier C2 is feasible because it benefits all nine of the impacted receptors in CNE C south of Rivington Road, as well as eight additional non-impacted receptors. Barrier C2 is also reasonable, since it meets the 7-decibel noise reduction design goal at all of the impacted receptors, and has a surface area per benefited receptor of 1,014, which is below the VDOT maximum of 1,600.

Table 8 shows the Build L_{eq} sound levels without and with a barrier, along with barrier insertion loss values for all receptors behind the barrier. Barrier C2 would provide an average noise reduction of 9.8 dB at the benefited receptors. The sound attenuation line for Noise Barrier C2 is in Table 19 in Appendix B.

As shown in Figure 2 and in Tables 7 and 8, some "first row" receptors (i.e. those receptors that share a property line with the Project right-of-way) would be exposed to noise impact as a result of the Project, while others would not. Intervening terrain along the Project right-of-way is the primary reason for the lower predicted sound levels at receptors C-004, C-017, C-203, and C-027. In these cases, intervening terrain or the edge of the road breaks the line of sight between the tire-pavement interface and the receptors in question. In breaking the line of sight, the intervening terrain and/or edge of road attenuates (or decreases) sound levels along the propagation path such that the predicted noise levels at these receptors would be below the FHWA NAC for residential land use.

Table 6 Summary of Barrier Characteristics

Barrier ID	Barrier Details						Total Number of Impacted Receptors	Impacted and Benefited Receptors	Non-Impacted and Benefited Receptors	Total Number of Benefited Receptors	Surface Area per Benefited Receptor (SF/BR)	Barrier Status†
	Noise Reduction (dBA)		Length (feet)	Range of Heights (feet)	Surface Area (sq-ft)	Total Cost at $42/sq-ft						
	Range	Avg.										
C1	8 to 8	8.0	302	12	3,641	$152,922	1	1	2	3	1,214	F & R
C2	5 to 12	9.8	1,435	12	17,234	$723,828	9	9	8	17	1,014	F & R
D	5 to 10	7.6	371	12	4,459	$187,278	3	3	10	13	343	F & R
F	5 to 9	6.3	437	12	5,222	$219,324	1	1	4	5	1,044	F & R
G	5 to 13	7.6	411	12	4,946	$207,732	2*	2	3	5	989	F & R*
H	8 to 13	9.8	1,028	10 to 12	10,624	$446,208	6	6	4	10	1,062	F & R
J	8 to 12	11.4	977	12	11,731	$492,702	10**	10	0	10	1,173	F & R**
N***	7 to 14	11.5	841	12	10,081	$423,402	8	8	3	11	916	F & R
N‡	11 to 13	12.1	656	12	7,863	$330,246	8	7	1	8	983	F & R
O	5 to 11	7.8	838	12	10,083	$423,486	10	10	1	11	917	F & R

Source: HMMH, 2019

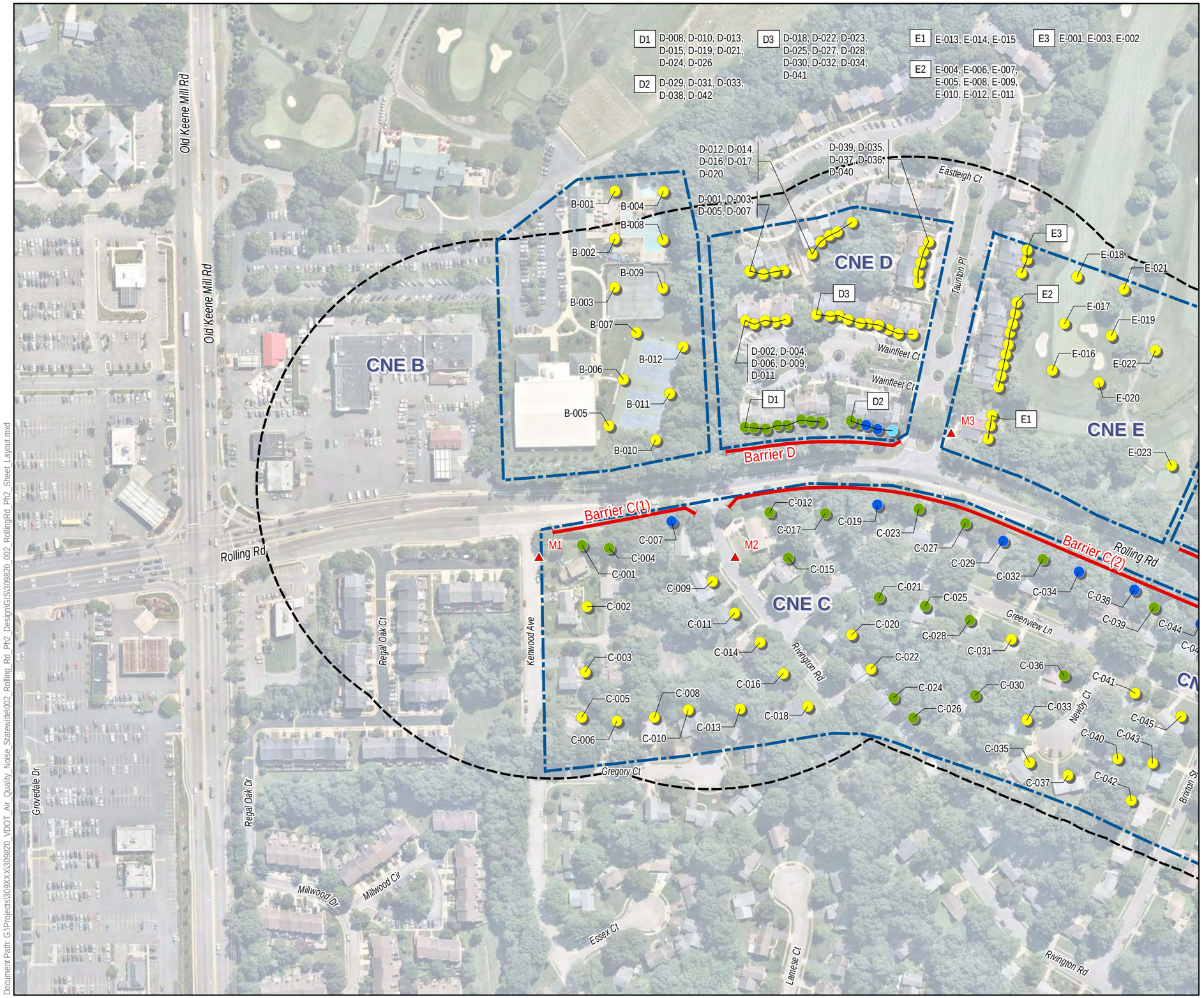
† Barrier Status: F & R – Feasible and Reasonable; F & NR – Feasible and Not Reasonable; NF – Not Feasible.

* The number of impacted and benefited receptors is indicative of noise-sensitive land use activities located directly behind the noise barrier. While three additional residences in CNE G would be exposed to noise impact as a result of the Project, those three residences have driveway access onto Rolling Road and are beyond the limits of Noise Barrier G and therefore not included in the feasibility determination. Since driveway access must be maintained in the future, noise abatement is not feasible for those three residences (receptors G-020, G-024, and G-028).

** The number of impacted and benefited receptors is indicative of noise-sensitive land use activities located directly behind the noise barrier. While six additional residences in CNE J would be exposed to noise impact as a result of the Project, those six residences have driveway access onto Rolling Road and are beyond the limits of Noise Barrier J and therefore not included in the feasibility determination. Since driveway access must be maintained in the future, noise abatement is not feasible for those six residences (receptors J-050, J-051, J-052, J-056, J-060, and J-061).

*** This design for Noise Barrier N was approved by VDOT and presented to the affected community in a survey.

‡ This revised design for Barrier N is based on community comments. It avoids a conflict with a stairway, but does not benefit receptors N-026 & N-029.



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VDOT Virginia Department of Transportation

Figure 2
Common Noise Environments, Receptors, and Potential Noise Barriers

Rolling Road (Route 638) Widening Project Noise Abatement Final Design Study

Fairfax County, VA
VDOT Project No. 0638-029-337, C501, R201;
UPC 5559/109814

Receiver Site and Number

- Impacted and 5 or 6 dBA Insertion Loss
- Impacted and 7 dBA or more Insertion Loss
- Impacted but Not Benefited
- Benefited but Not Impacted
- Not Benefited or Impacted

Note: Grouped Receiver Labels are in order of Leader Occurrence.

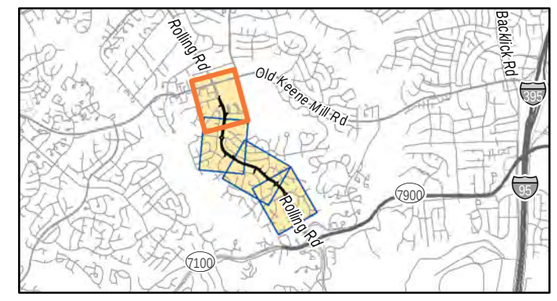
▲ M# Measurement Site

CNE Boundary
500' Noise Study Area

Service Layer Credits: ESRI, NearMap USA, June 29, 2018

0 200 400 Feet

Sheet 1 of 4



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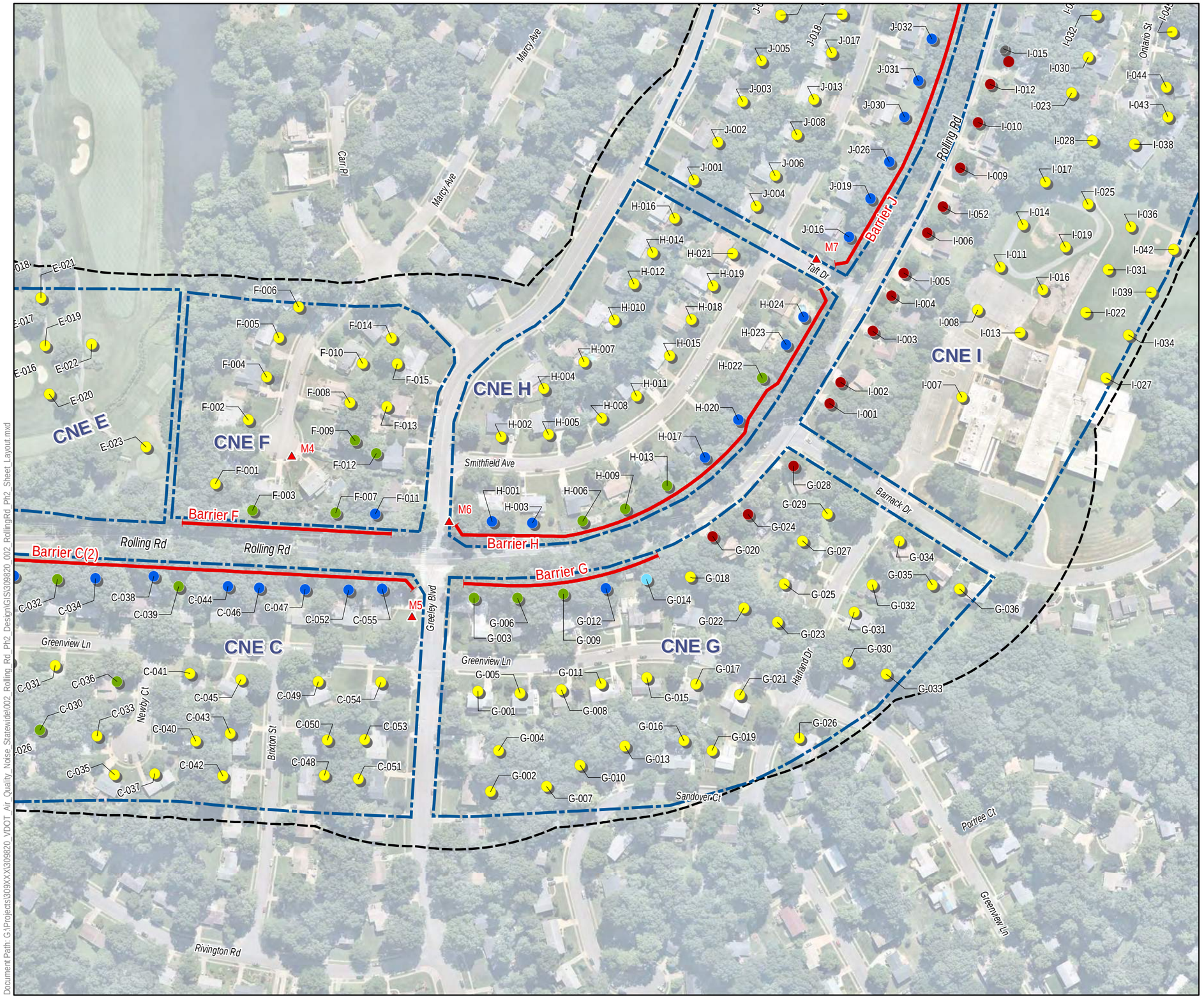

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VDOT
Virginia Department of Transportation

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- Benefited but Not Impacted
- Not Benefited or Impacted

Note: Grouped Receiver Labels are in order of Leader Occurrence.

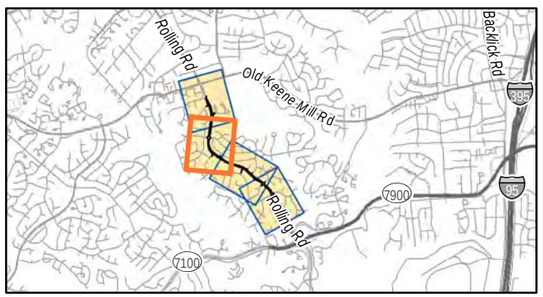
▲ M# Measurement Site

CNE Boundary
500' Noise Study Area

Service Layer Credits: ESRI, NearMap USA, June 29, 2018

0 200 400 Feet

Sheet 2 of 4



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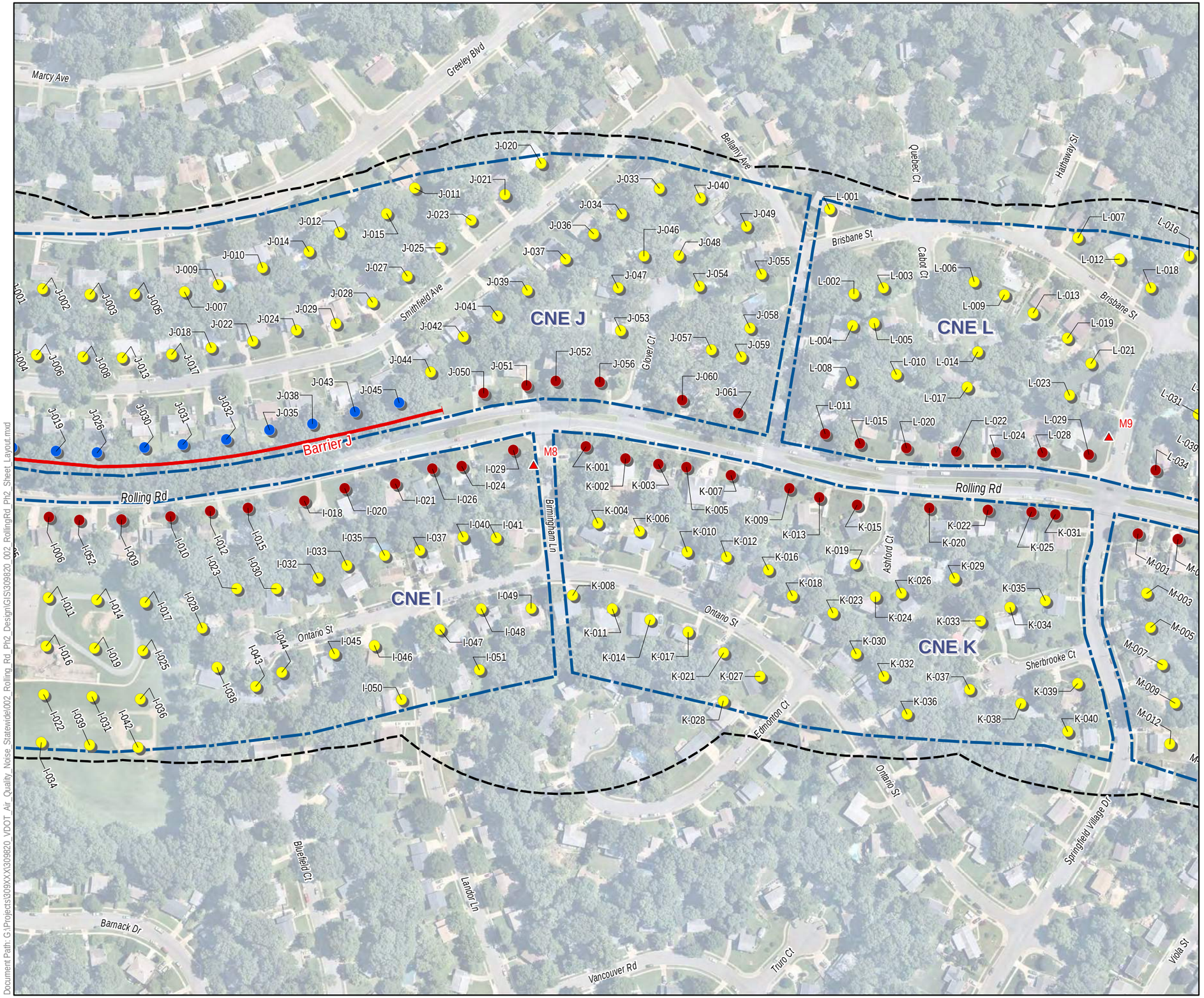

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VDOT
Virginia Department of Transportation

Figure 2
Common Noise Environments, Receptors, and Potential Noise Barriers

Rolling Road (Route 638) Widening Project
Noise Abatement Final Design Study

Fairfax County, VA
VDOT Project No. 0638-029-337, C501, R201;
UPC 5559/109814

Receiver Site and Number

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- Impacted and 7 dBA or more Insertion Loss
- Impacted but Not Benefited
- Benefited but Not Impacted
- Not Benefited or Impacted

Note: Grouped Receiver Labels are in order of Leader Occurrence.

▲ M# Measurement Site

CNE Boundary
500' Noise Study Area

Service Layer Credits: ESRI, NearMap USA, June 29, 2018

0 200 400 Feet

Sheet 3 of 4

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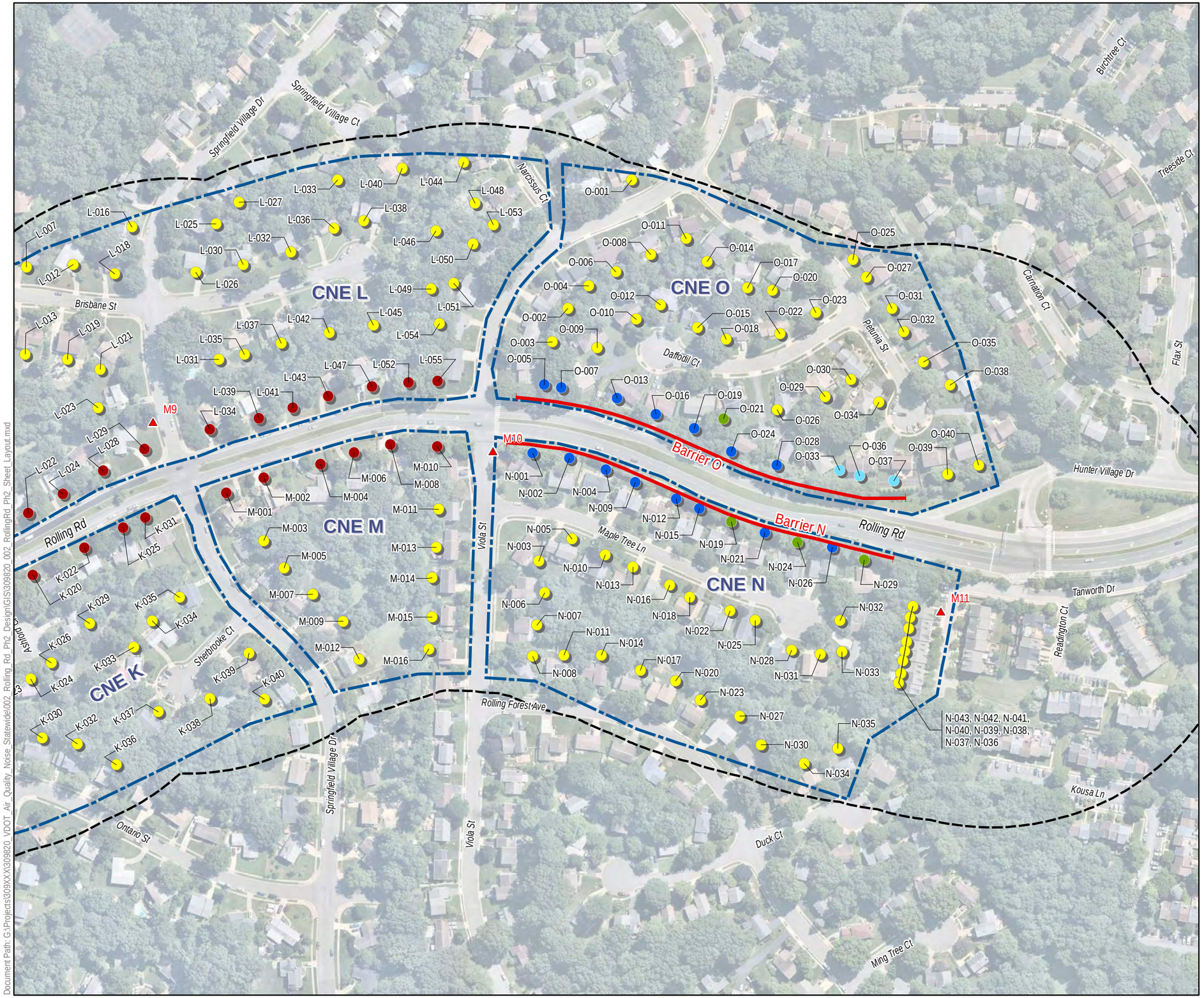

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VDOT
Virginia Department of Transportation

Figure 2
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Fairfax County, VA
VDOT Project No. 0638-029-337, C501, R201;
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Receiver Site and Number

- Impacted and 5 or 6 dBA Insertion Loss
- Impacted and 7 dBA or more Insertion Loss
- Impacted but Not Benefited
- Benefited but Not Impacted
- Not Benefited or Impacted

Note: Grouped Receiver Labels are in order of Leader Occurrence.

▲ M# Measurement Site

CNE Boundary
500' Noise Study Area

The design for Barrier N shown in this figure is superseded. Refer to Appendix I for the revised design.

Service Layer Credits: ESRI, NearMap USA, June 29, 2018

0 200 400 Feet

Sheet 4 of 4

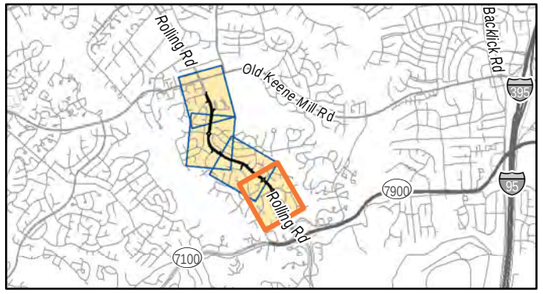

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Table 7 Barrier C1 Sound Level Results

Site ID	Address/ Description	DUs	NAC	Row	Leq w/o bar	With-bar Leq	IL	Benefit/Impact Status
C-001	8301 KENWOOD AVE	1	B	1	65	57	**8**	Benefit /No Impact
C-002	8303 KENWOOD AVE	1	B	2	52	49	2	No Impact/No Benefit
C-003	8315 KENWOOD AVE	1	B	3	50	49	1	No Impact/No Benefit
C-004	8305 KENWOOD AVE	1	B	1	63	55	**8**	Benefit/No Impact
C-005	6401 GREGORY CT	1	B	3	50	49	1	No Impact/No Benefit
C-006	6403 GREGORY CT	1	B	3	50	48	1	No Impact/No Benefit
C-007	6400 RIVINGTON RD	1	B	1	**66**	57	**8**	Benefit/Impact
C-008	6405 GREGORY CT	1	B	3	51	49	2	No Impact/No Benefit
C-009	6402 RIVINGTON RD	1	B	2	56	55	1	No Impact/No Benefit
C-010	6407 GREGORY CT	1	B	3	52	50	2	No Impact/No Benefit
C-011	6404 RIVINGTON RD	1	B	2	53	52	1	No Impact/No Benefit
C-013	6409 GREGORY CT	1	B	3	51	50	1	No Impact/No Benefit
C-014	6406 RIVINGTON RD	1	B	2	52	51	1	No Impact/No Benefit
C-016	6408 RIVINGTON RD	1	B	3	51	51	1	No Impact/No Benefit
C-018	6410 RIVINGTON RD	1	B	3	51	50	1	No Impact/No Benefit

Source: HMMH, 2018

Table 8 Barrier C2 Sound Level Results

Site ID	Address/ Description	DUs	NAC	Row	Leq w/o bar	With-bar Leq	IL	Benefit/Impact Status
C-012	6401 RIVINGTON RD	1	B	1	65	55	**10**	Benefit/No Impact
C-015	6403 RIVINGTON RD	1	B	1	56	51	**5**	Benefit/No Impact
C-017	6503 GREENVIEW LN	1	B	1	63	55	**9**	Benefit/No Impact
C-019	6505 GREENVIEW LN	1	B	1	**66**	55	**11**	Benefit/Impact
C-020	6407 RIVINGTON RD	1	B	2	52	48	4	No Impact/No Benefit
C-021	6504 GREENVIEW LN	1	B	2	54	49	**5**	Benefit/No Impact
C-022	6409 RIVINGTON RD	1	B	3	52	48	4	No Impact/No Benefit
C-023	6507 GREENVIEW LN	1	B	1	63	53	**10**	Benefit/No Impact
C-024	6411 RIVINGTON RD	1	B	3	53	48	**5**	Benefit/No Impact
C-025	6506 GREENVIEW LN	1	B	2	54	49	**5**	Benefit/No Impact
C-026	6413 RIVINGTON RD	1	B	3	54	49	**5**	Benefit/No Impact
C-027	6509 GREENVIEW LN	1	B	1	62	53	**10**	Benefit/No Impact
C-028	6508 GREENVIEW LN	1	B	2	54	49	**5**	Benefit/No Impact
C-029	6511 GREENVIEW LN	1	B	1	**66**	55	**11**	Benefit/Impact
C-030	6415 RIVINGTON RD	1	B	3	54	49	**5**	Benefit/No Impact

Site ID	Address/ Description	DUs	NAC	Row	Leq w/o bar	With-bar Leq	IL	Benefit/Impact Status
C-031	6512 GREENVIEW LN	1	B	2	54	50	4	No Impact/No Benefit
C-032	6513 GREENVIEW LN	1	B	1	65	54	**11**	Benefit/No Impact
C-033	8302 NEWBY CT	1	B	3	52	48	4	No Impact/No Benefit
C-034	6515 GREENVIEW LN	1	B	1	**66**	56	**10**	Benefit/Impact
C-035	8304 NEWBY CT	1	B	3	51	48	3	No Impact/No Benefit
C-036	8300 NEWBY CT	1	B	2	55	50	**5**	Benefit/No Impact
C-037	8305 NEWBY CT	1	B	3	51	48	3	No Impact/No Benefit
C-038	6517 GREENVIEW LN	1	B	1	**67**	56	**12**	Benefit/Impact
C-039	6519 GREENVIEW LN	1	B	1	65	55	**11**	Benefit/No Impact
C-040	8303 NEWBY CT	1	B	3	51	48	3	No Impact/No Benefit
C-041	6518 GREENVIEW LN	1	B	2	54	50	4	No Impact/No Benefit
C-042	8304 BRIXTON ST	1	B	3	49	47	2	No Impact/No Benefit
C-043	8302 BRIXTON ST	1	B	3	51	48	2	No Impact/No Benefit
C-044	6521 GREENVIEW LN	1	B	1	**66**	56	**10**	Benefit/Impact
C-045	6520 GREENVIEW LN	1	B	2	54	50	4	No Impact/No Benefit
C-046	6523 GREENVIEW LN	1	B	1	**66**	56	**10**	Benefit/Impact
C-047	6525 GREENVIEW LN	1	B	1	**66**	54	**12**	Benefit/Impact
C-048	8305 BRIXTON ST	1	B	3	46	45	1	No Impact/No Benefit
C-049	6524 GREENVIEW LN	1	B	2	53	51	3	No Impact/No Benefit
C-050	8303 BRIXTON ST	1	B	3	49	47	2	No Impact/No Benefit
C-051	8306 GREELEY BLVD	1	B	3	46	45	1	No Impact/No Benefit
C-052	6527 GREENVIEW LN	1	B	1	**66**	55	**11**	Benefit/Impact
C-053	8304 GREELEY BLVD	1	B	3	48	47	1	No Impact/No Benefit
C-054	6526 GREENVIEW LN	1	B	2	55	52	2	No Impact/No Benefit
C-055	8300 GREELEY BLVD	1	B	1	**67**	54	**12**	Benefit/Impact

Source: HMMH, 2018

4.3 Noise Barrier D

Barrier D is a potential noise barrier for the residences in CNE D, which consist of townhomes on the northbound side of Rolling Road, along Taunton Place, Wainfleet Court, and Eastleigh Court in Rhygate. The barrier, shown in Figure 2, would benefit all three of the impacted receptors, as well as 10 additional non-impacted receptors, with 5 to 10 decibels of noise reduction. The barrier would be 12 feet high, 371 feet long, and have a surface area of 4,459 square feet. The barrier would be feasible because it benefits all impacted receptors, and reasonable because it meets the 7-decibel noise reduction design goal at three impacted receptors, and has a surface area per benefited receptor of 343. Noise Barrier D would provide an average noise reduction of 7.6 dB at the benefited receptors. Table 9 provides the sound level results and receptor status for all of the noise-sensitive properties behind Noise Barrier D. The sound attenuation line for Noise Barrier D is in Table 20 in Appendix B.

Table 9 Barrier D Sound Level Results

Site ID	Address/ Description	DUs	NAC	Row	Leq w/o bar	With-bar Leq	IL	Benefit/Impact Status
D-001	6400 EASTLEIGH CT	1	B	3	49	49	0	No Impact/No Benefit
D-002	6401 WAINFLEET CT	1	B	2	52	52	1	No Impact/No Benefit
D-003	6402 EASTLEIGH CT	1	B	3	47	47	0	No Impact/No Benefit
D-004	6403 WAINFLEET CT	1	B	2	52	51	1	No Impact/No Benefit
D-005	6404 EASTLEIGH CT	1	B	3	49	49	0	No Impact/No Benefit
D-006	6405 WAINFLEET CT	1	B	2	52	51	1	No Impact/No Benefit
D-007	6406 EASTLEIGH CT	1	B	3	49	48	1	No Impact/No Benefit
D-008	6400 WAINFLEET CT	1	B	1	61	56	**5**	Benefit/No Impact
D-009	6407 WAINFLEET CT	1	B	2	52	51	1	No Impact/No Benefit
D-010	6402 WAINFLEET CT	1	B	1	61	55	**6**	Benefit/No Impact
D-011	6409 WAINFLEET CT	1	B	2	52	51	1	No Impact/No Benefit
D-012	6408 EASTLEIGH CT	1	B	3	45	44	1	No Impact/No Benefit
D-013	6404 WAINFLEET CT	1	B	1	61	54	**7**	Benefit/No Impact
D-014	6410 EASTLEIGH CT	1	B	3	46	45	0	No Impact/No Benefit
D-015	6406 WAINFLEET CT	1	B	1	61	54	**7**	Benefit/No Impact
D-016	6412 EASTLEIGH CT	1	B	3	46	46	0	No Impact/No Benefit
D-017	6414 EASTLEIGH CT	1	B	3	47	47	0	No Impact/No Benefit
D-018	6411 WAINFLEET CT	1	B	2	51	51	1	No Impact/No Benefit
D-019	6408 WAINFLEET CT	1	B	1	61	54	**7**	Benefit/No Impact
D-020	6418 EASTLEIGH CT	1	B	3	47	47	0	No Impact/No Benefit
D-021	6410 WAINFLEET CT	1	B	1	61	54	**7**	Benefit/No Impact
D-022	6413 WAINFLEET CT	1	B	2	51	51	1	No Impact/No Benefit
D-023	6415 WAINFLEET CT	1	B	2	52	51	1	No Impact/No Benefit
D-024	6412 WAINFLEET CT	1	B	1	62	53	**9**	Benefit/No Impact
D-025	6417 WAINFLEET CT	1	B	2	52	51	1	No Impact/No Benefit
D-026	6418 WAINFLEET CT	1	B	1	62	53	**9**	Benefit/No Impact
D-027	6419 WAINFLEET CT	1	B	2	52	52	1	No Impact/No Benefit
D-028	6421 WAINFLEET CT	1	B	2	53	52	1	No Impact/No Benefit
D-029	6420 WAINFLEET CT	1	B	1	64	54	**9**	Benefit/No Impact
D-030	6423 WAINFLEET CT	1	B	2	53	53	1	No Impact/No Benefit
D-031	6422 WAINFLEET CT	1	B	1	65	55	**10**	Benefit/No Impact
D-032	6425 WAINFLEET CT	1	B	2	54	54	0	No Impact/No Benefit
D-033	6424 WAINFLEET CT	1	B	1	**66**	57	**9**	Benefit/Impact
D-034	6427 WAINFLEET CT	1	B	2	55	54	0	No Impact/No Benefit
D-035	8238 TAUNTON PL	1	B	3	48	48	0	No Impact/No Benefit
D-036	8242 TAUNTON PL	1	B	3	48	48	0	No Impact/No Benefit
D-037	8240 TAUNTON PL	1	B	3	48	48	0	No Impact/No Benefit
D-038	6426 WAINFLEET CT	1	B	1	**67**	58	**9**	Benefit/Impact

Site ID	Address/ Description	DUs	NAC	Row	Leq w/o bar	With-bar Leq	IL	Benefit/Impact Status
D-039	8236 TAUNTON PL	1	B	3	48	48	0	No Impact/No Benefit
D-040	8244 TAUNTON PL	1	B	3	48	48	0	No Impact/No Benefit
D-041	6429 WAINFLEET CT	1	B	2	55	55	1	No Impact/No Benefit
D-042	6428 WAINFLEET CT	1	B	1	**68**	63	**5**	Benefit/Impact

Source: HMMH, 2018

4.4 Noise Barrier F

Barrier F is a potential noise barrier for the residences in CNE F, shown in Figure 2, and is located along the northbound side of Rolling Road, directly north of Greeley Boulevard. The barrier would benefit the single impacted receptor, as well as four additional non-impacted receptors, with 5 to 9 decibels of noise reduction. The barrier would be 12 feet high and 437 feet long, with a surface area of 5,222 square feet and a surface area per benefited receptor of 1,044. Barrier F would be both feasible and reasonable because it meets the noise reduction design goal for all impacted receptors and has a surface area per benefitted receptor under 1,600. Additionally, Barrier F is predicted to provide the same benefit at the impacted receptor at a height of 10 feet; however, there would be two fewer non-impacted receptors receiving a benefit. A minimum height of 12 feet is recommended, though, to better break the visual line of sight to passing trucks. Noise Barrier F would provide an average noise reduction of 6.3 dB at the benefited receptors. Table 10 provides the sound level results and receptor status for all of the noise-sensitive properties behind Noise Barrier F. The sound attenuation line for Noise Barrier F is in Table 21 in Appendix B.

Table 10 Barrier F Sound Level Results

Site ID	Address/ Description	DUs	NAC	Row	Leq w/o bar	With-bar Leq	IL	Benefit/Impact Status
F-001	8210 MARCY AVE	1	B	1	61	58	3	No Impact/No Benefit
F-002	8208 MARCY AVE	1	B	2	56	55	1	No Impact/No Benefit
F-003	8211 MARCY AVE	1	B	1	62	56	**6**	Benefit/No Impact
F-004	8206 MARCY AVE	1	B	2	54	53	1	No Impact/No Benefit
F-005	8204 MARCY AVE	1	B	3	52	51	1	No Impact/No Benefit
F-006	8202 MARCY AVE	1	B	3	51	50	1	No Impact/No Benefit
F-007	8209 MARCY AVE	1	B	1	64	55	**9**	Benefit/No Impact
F-008	8205 MARCY AVE	1	B	2	53	51	3	No Impact/No Benefit
F-009	8207 MARCY AVE	1	B	2	57	52	**5**	Benefit/No Impact
F-010	8203 MARCY AVE	1	B	3	51	49	2	No Impact/No Benefit
F-011	8218 GREELEY BLVD	1	B	1	**66**	60	**7**	Benefit/Impact
F-012	8216 GREELEY BLVD	1	B	2	58	53	**5**	Benefit/No Impact
F-013	8214 GREELEY BLVD	1	B	2	54	51	3	No Impact/No Benefit
F-014	8201 MARCY AVE	1	B	3	50	48	1	No Impact/No Benefit
F-015	8212 GREELEY BLVD	1	B	3	51	49	2	No Impact/No Benefit

Source: HMMH, 2018

4.5 Noise Barrier G

Barrier G is a potential noise barrier for the residences in CNE G, which is located along the southbound side of Rolling Road between Greeley Boulevard and Barnack Drive. As a result of the proposed roadway widening, five single-family homes would be exposed to traffic noise levels that approach or exceed the FHWA NAC for Activity Category B. Three of the five residences have driveway access onto Rolling Road – and so, a noise barrier would not be feasible for these homes. For the feasibility and reasonableness determination described below, the three impacted residences with driveway access onto Rolling Road were not given further consideration.

Barrier G, shown in Figure 2, would benefit both of the impacted receptors located behind it with 6 to 12 decibels of noise reduction. The barrier also would benefit three non-impacted residential receptors. Barrier G would be 12 feet high, 411 feet long, with a surface area of 4,946 square feet, and a surface area per benefitted receptor of 989 (including only those receptors behind the barrier in the accounting). Barrier G would be feasible because it would benefit both of the impacted receptors behind it. It also would be reasonable because it meets the noise reduction design goal at one of the two impacted receptors, and has a surface area per benefitted receptor lower than the maximum of 1,600. Barrier G would provide an average noise reduction of 7.6 dB at the benefited receptors.

Table 11 provides the sound level results and receptor status for all of the noise-sensitive properties behind Noise Barrier G. The sound levels in the table include the effect of a single reflection from the retaining wall supporting potential Noise Barrier H on the northbound side of Rolling Road. The sound attenuation line for Noise Barrier G is in Table 22 in Appendix B.

Table 11 Barrier G Sound Level Results

Site ID	Address/ Description	DUs	NAC	Row	Leq w/o bar	With-bar Leq	IL	Benefit/Impact Status
G-001	6600 GREENVIEW LN	1	B	2	53	52	1	No Impact/No Benefit
G-002	8307 GREELEY BLVD	1	B	3	45	45	1	No Impact/No Benefit
G-003	8301 GREELEY BLVD	1	B	1	64	59	**5**	Benefit/No Impact
G-004	8305 GREELEY BLVD	1	B	3	47	46	1	No Impact/No Benefit
G-005	6602 GREENVIEW LN	1	B	2	53	52	2	No Impact/No Benefit
G-006	6603 GREENVIEW LN	1	B	1	62	55	**7**	Benefit/No Impact
G-007	6617 SANDOVER CT	1	B	3	46	45	1	No Impact/No Benefit
G-008	6604 GREENVIEW LN	1	B	2	55	52	3	No Impact/No Benefit
G-009	6605 GREENVIEW LN	1	B	1	64	55	**9**	Benefit/No Impact
G-010	6619 SANDOVER CT	1	B	3	47	46	1	No Impact/No Benefit
G-011	6606 GREENVIEW LN	1	B	2	55	52	3	No Impact/No Benefit
G-012	6607 GREENVIEW LN	1	B	1	**67**	55	**12**	Benefit/Impact
G-013	6621 SANDOVER CT	1	B	3	45	43	1	No Impact/No Benefit
G-014	6609 GREENVIEW LN	1	B	1	**66**	60	**6**	Benefit/Impact
G-015	6608 GREENVIEW LN	1	B	2	54	52	2	No Impact/No Benefit
G-016	6623 SANDOVER CT	1	B	3	43	42	1	No Impact/No Benefit

Source: HMMH, 2018

4.6 Noise Barrier H

Barrier H is a potential noise barrier for the residences in CNE H, shown in Figure 2. Barrier H is located along the northbound side of Rolling Road between Greeley Boulevard and Taft Drive, and would benefit all six impacted receptors with 8 to 13 decibels of noise reduction. In addition, Barrier H would benefit four additional receptors in this area. The barrier would be 10 to 12 feet high and 1,028 feet long, with a surface area of 10,624 square feet. The barrier would be feasible because it benefits all impacted receptors, and reasonable both because it meets the 7-decibel noise reduction design goal at all of these receptors, and has a surface area per benefited receptor of 1,062. Barrier H would provide an average noise reduction of 9.8 dB at the benefited receptors. Table 12 provides the sound level results and receptor status for all of the noise-sensitive properties behind Noise Barrier H. The sound attenuation line for Noise Barrier H is in Table 23 in Appendix B.

Table 12 Barrier H Sound Level Results

Site ID	Address/ Description	DUs	NAC	Row	Leq w/o bar	With-bar Leq	IL	Benefit/Impact Status
H-001	8237 SMITHFIELD AVE	1	B	1	67	58	**9**	Benefit/Impact
H-002	8236 SMITHFIELD AVE	1	B	2	54	53	1	No Impact/No Benefit
H-003	8235 SMITHFIELD AVE	1	B	1	66	57	**10**	Benefit/Impact
H-004	8211 GREELEY BLVD	1	B	3	48	47	1	No Impact/No Benefit
H-005	8234 SMITHFIELD AVE	1	B	2	52	51	1	No Impact/No Benefit
H-006	8233 SMITHFIELD AVE	1	B	1	65	56	**9**	Benefit/No Impact
H-007	8209 GREELEY BLVD	1	B	3	47	46	1	No Impact/No Benefit
H-008	8230 SMITHFIELD AVE	1	B	2	52	50	2	No Impact/No Benefit
H-009	8231 SMITHFIELD AVE	1	B	1	65	56	**9**	Benefit/No Impact
H-010	8207 GREELEY BLVD	1	B	3	48	47	1	No Impact/No Benefit
H-011	8228 SMITHFIELD AVE	1	B	2	51	50	1	No Impact/No Benefit
H-012	8205 GREELEY BLVD	1	B	3	49	48	1	No Impact/No Benefit
H-013	8229 SMITHFIELD AVE	1	B	1	65	55	**10**	Benefit/No Impact
H-014	8203 GREELEY BLVD	1	B	3	49	48	1	No Impact/No Benefit
H-015	8226 SMITHFIELD AVE	1	B	2	51	49	2	No Impact/No Benefit
H-016	8201 GREELEY BLVD	1	B	3	49	48	1	No Impact/No Benefit
H-017	8227 SMITHFIELD AVE	1	B	1	67	55	**12**	Benefit/Impact
H-018	8222 SMITHFIELD AVE	1	B	2	52	50	2	No Impact/No Benefit
H-019	8220 SMITHFIELD AVE	1	B	2	53	52	1	No Impact/No Benefit
H-020	8225 SMITHFIELD AVE	1	B	1	68	55	**13**	Benefit/Impact
H-021	8218 SMITHFIELD AVE	1	B	2	54	52	1	No Impact/No Benefit
H-022	8223 SMITHFIELD AVE	1	B	1	65	56	**9**	Benefit/No Impact
H-023	8221 SMITHFIELD AVE	1	B	1	66	57	**8**	Benefit/Impact
H-024	8219 SMITHFIELD AVE	1	B	1	66	57	**9**	Benefit/Impact

Source: HMMH, 2018

4.7 Noise Barrier J

Barrier J is a potential noise barrier for the residences in CNE J. As shown in Figure 2, Barrier J is located along the northbound side of Rolling Road between Taft Drive and Bellamy Avenue. As a result of the proposed Project, 16 single-family homes would be exposed to traffic noise levels that approach or exceed the FHWA NAC for Activity Category B. However, six of the impacted residences have driveway access onto Rolling Road – and so, a noise barrier would not be feasible for these homes. For the feasibility and reasonableness determination described below, the six impacted residences with driveway access onto Rolling Road were not given further consideration.

Barrier J would benefit the ten impacted receptors located behind it, with noise reduction levels ranging from 8 to 12 decibels. Barrier J would be 12 feet high, 977 feet in length, with a surface area of 11,731 square feet. It would be feasible because it benefits all impacted receptors that can be treated, and reasonable both because it meets the 7-decibel noise reduction design goal at all of these receptors, and has a surface area per benefited receptor of 1,173. Barrier J would provide an average noise reduction of 11.4 dB at the benefited receptors. Table 13 provides the sound level results and receptor status for all of the noise-sensitive properties behind Noise Barrier J. The sound attenuation line for Noise Barrier J is in Table 24 in Appendix B.

Table 13 Barrier J Sound Level Results

Site ID	Address/ Description	DUs	NAC	Row	Leq w/o bar	With-bar Leq	IL	Benefit/Impact Status
J-001	8133 GREELEY BLVD	1	B	3	49	49	1	No Impact/No Benefit
J-002	8131 GREELEY BLVD	1	B	3	50	49	1	No Impact/No Benefit
J-003	8129 GREELEY BLVD	1	B	3	49	48	1	No Impact/No Benefit
J-004	8216 SMITHFIELD AVE	1	B	2	54	53	1	No Impact/No Benefit
J-005	8127 GREELEY BLVD	1	B	3	49	49	1	No Impact/No Benefit
J-006	8214 SMITHFIELD AVE	1	B	2	53	53	1	No Impact/No Benefit
J-007	8125 GREELEY BLVD	1	B	3	50	49	1	No Impact/No Benefit
J-008	8212 SMITHFIELD AVE	1	B	2	53	51	1	No Impact/No Benefit
J-009	8123 GREELEY BLVD	1	B	3	49	49	1	No Impact/No Benefit
J-010	8121 GREELEY BLVD	1	B	3	49	48	1	No Impact/No Benefit
J-011	8113 GREELEY BLVD	1	B	3	45	45	0	No Impact/No Benefit
J-012	8117 GREELEY BLVD	1	B	3	48	48	1	No Impact/No Benefit
J-013	8210 SMITHFIELD AVE	1	B	2	53	51	2	No Impact/No Benefit
J-014	8119 GREELEY BLVD	1	B	3	49	48	1	No Impact/No Benefit
J-015	8115 GREELEY BLVD	1	B	3	47	46	1	No Impact/No Benefit
J-016	8215 SMITHFIELD AVE	1	B	1	**68**	57	**11**	Benefit/Impact
J-017	8208 SMITHFIELD AVE	1	B	2	53	51	2	No Impact/No Benefit
J-018	8204 SMITHFIELD AVE	1	B	2	53	51	2	No Impact/No Benefit
J-019	8213 SMITHFIELD AVE	1	B	1	**68**	56	**12**	Benefit/Impact
J-020	8106 SMITHFIELD AVE	1	B	3	45	45	0	No Impact/No Benefit
J-021	8108 SMITHFIELD AVE	1	B	3	48	47	1	No Impact/No Benefit

Site ID	Address/ Description	DUs	NAC	Row	Leq w/o bar	With-bar Leq	IL	Benefit/Impact Status
J-022	8202 SMITHFIELD AVE	1	B	2	53	51	3	No Impact/No Benefit
J-023	8110 SMITHFIELD AVE	1	B	3	49	48	1	No Impact/No Benefit
J-024	8200 SMITHFIELD AVE	1	B	2	53	51	2	No Impact/No Benefit
J-025	8112 SMITHFIELD AVE	1	B	3	50	49	1	No Impact/No Benefit
J-026	8211 SMITHFIELD AVE	1	B	1	**68**	56	**12**	Benefit/Impact
J-027	8114 SMITHFIELD AVE	1	B	2	51	50	1	No Impact/No Benefit
J-028	8116 SMITHFIELD AVE	1	B	2	52	50	2	No Impact/No Benefit
J-029	8120 SMITHFIELD AVE	1	B	2	53	51	2	No Impact/No Benefit
J-030	8209 SMITHFIELD AVE	1	B	1	**66**	55	**12**	Benefit/Impact
J-031	8207 SMITHFIELD AVE	1	B	1	**67**	54	**12**	Benefit/Impact
J-032	8205 SMITHFIELD AVE	1	B	1	**67**	55	**12**	Benefit/Impact
J-033	8103 SMITHFIELD AVE	1	B	3	47	46	1	No Impact/No Benefit
J-034	8105 SMITHFIELD AVE	1	B	3	49	48	1	No Impact/No Benefit
J-035	8203 SMITHFIELD AVE	1	B	1	**66**	55	**12**	Benefit/Impact
J-036	8107 SMITHFIELD AVE	1	B	3	51	50	1	No Impact/No Benefit
J-037	8109 SMITHFIELD AVE	1	B	2	53	52	1	No Impact/No Benefit
J-038	8201 SMITHFIELD AVE	1	B	1	**67**	55	**12**	Benefit/Impact
J-039	8111 SMITHFIELD AVE	1	B	2	55	54	1	No Impact/No Benefit
J-040	6802 BELLAMY AVE	1	B	3	46	46	1	No Impact/No Benefit
J-041	8113 SMITHFIELD AVE	1	B	2	57	56	1	No Impact/No Benefit
J-042	8115 SMITHFIELD AVE	1	B	2	59	58	2	No Impact/No Benefit
J-043	8121 SMITHFIELD AVE	1	B	1	**67**	56	**11**	Benefit/Impact
J-044	8117 SMITHFIELD AVE	1	B	1	64	61	3	No Impact/No Benefit
J-045	8119 SMITHFIELD AVE	1	B	1	**67**	59	**8**	Benefit/Impact

Source: HMMH, 2018

4.8 Noise Barrier N *(superseded)*

The design presented below and the sound attenuation line given in Appendix B was approved by VDOT and presented to the community. Based on comments received from property owners at two benefited receptors at the southern end of the noise barrier, the design was revised. Consequently, the predicted noise levels in Table 14 have been superseded. Refer to Appendix I for the revised final design for Noise Barrier N with revised sound level results and a revised sound attenuation line. The revised design avoids a potential conflict with a stairway. Refer to Section 5 for a summary of the public preference survey.

Barrier N is a potential noise barrier for the residences in CNE N and is located along the southbound side of Rolling Road, between Viola St and the southern project limit. Barrier N would benefit all eight of its impacted receivers with noise level reductions ranging from 11 to 14 decibels. It would also benefit an additional three receptors in CNE N. The barrier, as shown in Figure 2, would be 12 feet high and 841 feet long, with a surface area of 10,081 square feet. It would be

feasible because it benefits all of the impacted receptors. Barrier N also would be reasonable because it meets the 7-decibel noise reduction design goal at all of the impacted receptors and it has a surface area per benefited receptor of 916. Barrier N would provide an average noise reduction of 11.5 dB at the benefited receptors. Table 14 provides the sound level results and receptor status for all of the noise-sensitive properties behind Noise Barrier N. The sound attenuation line for Noise Barrier N is in Table 25 in Appendix B.

Table 14 Barrier N Sound Level Results *(superseded)*

Site ID	Address/ Description	DUs	NAC	Row	Leq w/o bar	With-bar Leq	IL	Benefit/Impact Status
N-001	8101 VIOLA ST	1	B	1	**68**	57	**11**	Benefit/Impact
N-002	7001 MAPLE TREE LN	1	B	1	**68**	55	**12**	Benefit/Impact
N-003	7002 MAPLE TREE LN	1	B	1	52	50	1	No Impact/No Benefit
N-004	7003 MAPLE TREE LN	1	B	1	**68**	55	**12**	Benefit/Impact
N-005	7002 MAPLE TREE LN	1	B	1	56	53	3	No Impact/No Benefit
N-006	8105 VIOLA ST	1	B	1	50	48	2	No Impact/No Benefit
N-007	8107 VIOLA ST	1	B	1	51	49	2	No Impact/No Benefit
N-008	7101 ROLLING FOREST AVE	1	B	1	51	49	2	No Impact/No Benefit
N-009	7005 MAPLE TREE LN	1	B	1	**67**	55	**12**	Benefit/Impact
N-010	7004 MAPLE TREE LN	1	B	1	56	52	4	No Impact/No Benefit
N-011	7103 ROLLING FOREST AVE	1	B	1	52	50	2	No Impact/No Benefit
N-012	7007 MAPLE TREE LN	1	B	1	**66**	54	**12**	Benefit/Impact
N-013	7006 MAPLE TREE LN	1	B	1	55	52	4	No Impact/No Benefit
N-014	7105 ROLLING FOREST AVE	1	B	1	51	49	2	No Impact/No Benefit
N-015	7009 MAPLE TREE LN	1	B	1	**66**	54	**12**	Benefit/Impact
N-016	7008 MAPLE TREE LN	1	B	1	56	52	4	No Impact/No Benefit
N-017	7107 ROLLING FOREST AVE	1	B	1	52	50	2	No Impact/No Benefit
N-018	7010 MAPLE TREE LN	1	B	1	55	51	3	No Impact/No Benefit
N-019	7011 MAPLE TREE LN	1	B	1	65	53	**12**	Benefit/No Impact
N-020	7109 ROLLING FOREST AVE	1	B	1	52	50	2	No Impact/No Benefit
N-021	7013 MAPLE TREE LN	1	B	1	**67**	53	**13**	Benefit/Impact
N-022	7012 MAPLE TREE LN	1	B	1	54	51	3	No Impact/No Benefit
N-023	7111 ROLLING FOREST AVE	1	B	1	51	49	2	No Impact/No Benefit
N-024	7015 MAPLE TREE LN	1	B	1	62	53	**9**	Benefit/No Impact
N-025	7014 MAPLE TREE LN	1	B	1	54	51	3	No Impact/No Benefit
N-026	7017 MAPLE TREE LN	1	B	1	**66**	53	**14**	Benefit/Impact
N-027	7113 ROLLING FOREST AVE	1	B	1	50	48	2	No Impact/No Benefit

Site ID	Address/ Description	DUs	NAC	Row	Leq w/o bar	With-bar Leq	IL	Benefit/Impact Status
N-028	7016 MAPLE TREE LN	1	B	1	52	49	3	No Impact/No Benefit
N-029	7019 MAPLE TREE LN	1	B	1	60	53	**7**	Benefit/No Impact
N-030	7115 ROLLING FOREST AVE	1	B	1	51	48	2	No Impact/No Benefit
N-031	7018 MAPLE TREE LN	1	B	1	52	49	3	No Impact/No Benefit
N-032	7021 MAPLE TREE LN	1	B	1	54	50	4	No Impact/No Benefit
N-033	7020 MAPLE TREE LN	1	B	1	52	49	3	No Impact/No Benefit
N-034	7203 DUCK CT	1	B	1	52	49	3	No Impact/No Benefit
N-035	7205 DUCK CT	1	B	1	51	49	3	No Impact/No Benefit
N-036	7115 TANWORTH DR	1	B	1	58	57	1	No Impact/No Benefit
N-037	7115 TANWORTH DR	1	B	1	55	53	2	No Impact/No Benefit
N-038	7113 TANWORTH DR	1	B	1	53	51	2	No Impact/No Benefit
N-039	7111 TANWORTH DR	1	B	1	52	49	2	No Impact/No Benefit
N-040	7109 TANWORTH DR	1	B	1	51	48	3	No Impact/No Benefit
N-041	7107 TANWORTH DR	1	B	1	50	48	3	No Impact/No Benefit
N-042	7105 TANWORTH DR	1	B	1	49	47	3	No Impact/No Benefit
N-043	7103 TANWORTH DR	1	B	1	49	46	3	No Impact/No Benefit

Source: HMMH, 2018

4.9 Noise Barrier O

Barrier O is a potential noise barrier for the residences in CNE O, which is located along the northbound side of Rolling Road near the southern project limit between Viola Street and Petunia Street. The barrier, shown in Figure 2, would benefit all ten of the impacted receptors in the CNE O with 5 to 11 decibels of noise reduction, as well as one additional non-impacted receptor. Barrier O would be 12 feet high, 838 feet long, and have a surface area of 10,083 square-feet. The barrier would be both feasible and reasonable, as it meets the noise design reduction goal at seven of the impacted receptors, and has a surface area per benefited receptor of 917. Barrier O would provide an average noise reduction of 7.8 dB at the benefited receptors. Table 15 provides the sound level results and receptor status for all of the noise-sensitive properties behind Noise Barrier O. The sound attenuation line for Noise Barrier O is in Table 26 in Appendix B.

Table 15 Barrier O Sound Level Results

Site ID	Address/ Description	DUs	NAC	Row	Leq w/o bar	With-bar Leq	IL	Benefit/Impact Status
O-001	7914 Viola St	1	B	1	49	48	0	No Impact/No Benefit
O-002	8001 Viola St	1	B	1	56	53	3	No Impact/No Benefit
O-003	8005 Viola St	1	B	1	61	57	4	No Impact/No Benefit
O-004	7919 Viola St	1	B	1	53	52	2	No Impact/No Benefit
O-005	8009 Viola St	1	B	1	**68**	61	**7**	Benefit/Impact
O-006	7917 Viola St	1	B	1	52	51	1	No Impact/No Benefit

Site ID	Address/ Description	DUs	NAC	Row	Leq w/o bar	With-bar Leq	IL	Benefit/Impact Status
O-007	8019 Daffodil Ct	1	B	1	**68**	60	**8**	Benefit/Impact
O-008	7915 Viola St	1	B	1	50	50	1	No Impact/No Benefit
O-009	8020 Daffodil Ct	1	B	1	57	54	3	No Impact/No Benefit
O-010	8018 Daffodil Ct	1	B	1	51	51	0	No Impact/No Benefit
O-011	7913 Viola St	1	B	1	49	49	0	No Impact/No Benefit
O-012	8016 Daffodil Ct	1	B	1	50	50	0	No Impact/No Benefit
O-013	8017 Daffodil Ct	1	B	1	**67**	59	**8**	Benefit/Impact
O-014	7002 Petunia St	1	B	1	49	49	0	No Impact/No Benefit
O-015	8014 Daffodil Ct	1	B	1	52	51	1	No Impact/No Benefit
O-016	8015 Daffodil Ct	1	B	1	**67**	56	**11**	Benefit/Impact
O-017	7004 Petunia St	1	B	1	50	50	1	No Impact/No Benefit
O-018	8012 Daffodil Ct	1	B	1	53	52	1	No Impact/No Benefit
O-019	8013 Daffodil Ct	1	B	1	**67**	58	**10**	Benefit/Impact
O-020	7006 Petunia St	1	B	1	49	49	1	No Impact/No Benefit
O-021	8011 Daffodil Ct	1	B	1	64	58	**7**	Benefit/No Impact
O-022	8004 Daffodil Ct	1	B	1	52	51	1	No Impact/No Benefit
O-023	8000 Daffodil Ct	1	B	1	52	51	1	No Impact/No Benefit
O-024	8009 Daffodil Ct	1	B	1	**68**	58	**11**	Benefit/Impact
O-025	7009 Petunia St	1	B	1	51	50	0	No Impact/No Benefit
O-026	8005 Daffodil Ct	1	B	1	58	55	3	No Impact/No Benefit
O-027	7011 Petunia St	1	B	1	51	51	0	No Impact/No Benefit
O-028	8007 Daffodil Ct	1	B	1	**68**	61	**7**	Benefit/Impact
O-029	8003 Daffodil Ct	1	B	1	55	54	1	No Impact/No Benefit
O-030	8001 Daffodil Ct	1	B	1	54	53	0	No Impact/No Benefit
O-031	7013 Petunia St	1	B	1	53	52	0	No Impact/No Benefit
O-032	7015 Petunia St	1	B	1	53	53	0	No Impact/No Benefit
O-033	7020 Petunia St	1	B	1	**67**	61	**6**	Benefit/Impact
O-034	7016 Petunia St	1	B	1	54	53	0	No Impact/No Benefit
O-035	7017 Petunia St	1	B	1	54	54	0	No Impact/No Benefit
O-036	7020 Petunia St	1	B	1	**67**	60	**6**	Benefit/Impact
O-037	7022 Petunia St	1	B	1	**66**	62	**5**	Benefit/Impact
O-038	7019 Petunia St	1	B	1	55	55	0	No Impact/No Benefit
O-039	7024 Petunia St	1	B	1	64	63	1	No Impact/No Benefit
O-040	7023 Petunia St	1	B	1	62	62	0	No Impact/No Benefit

Source: HMMH, 2018

5 PUBLIC INVOLVEMENT PROCESS

This section documents the administration and results of the public preference surveys that were performed in April and May of 2019 for the nine noise barriers recommended for construction. The community outreach and voting process followed VDOT's 2018 Highway Traffic Noise Impact Analysis Guidance Manual (Version 8). As described in Section 2.3.2, the views of the benefited receptors represent the third element needed to determine the reasonableness of a potential noise barrier. The preferences of the potentially benefited property owners and residents are surveyed through a mailing process. A majority of the benefited receptors must favor the barrier for it to be considered reasonable to construct.

5.1 Public Preference Surveys

Property owners and residents, including tenants, of all properties that would be benefited by the all potential feasible and reasonable noise barriers were sent survey letters by certified mail. The letters and surveys, from the VDOT Noise Abatement Section on VDOT letterhead, asked the respondents to indicate whether they wished to have the proposed noise barriers constructed or not. In these mailings, barrier details, contact information, a survey form and return envelope were provided to provide homeowners and residents with an understanding of the proposal and its implications, an opportunity to ask questions, and a formal survey form for expressing their views. Survey recipients were informed that of the votes tallied, fifty percent (50%) or more of the respondents must be in favor of the proposed noise barrier in order for that noise barrier to be considered for construction. The first round of letters and surveys were sent out in February 2019. Due to a discrepancy between the return dates in the ballot and the cover letter, a second mailing was performed in March – extending the time period for which recipients could respond. The response rates to the first and second mailings was sufficient to recommend that eight of the noise barriers advance to construction. A follow-up mailing was required for one barrier (Barrier C1), since the number of outstanding votes might affect the outcome. The follow-up mailing for Barrier C1 yielded no additional responses; so, the outcome of the survey was based on the votes of the two respondents.

For this project, a total of 98 certified letters were mailed. The disposition of all certified letters was tracked. Appendix G includes lists by barrier area of all affected property owners to whom mailings were sent. The lists include the property owners' name(s) and the address of the affected property. In cases where the affected property is rented, first the address of the affected property is listed with "To the Residents of" as the addressee, then the owner's name and mailing address is given on the following row. Appendix G includes examples of the letter packages that were sent to the property owners and residents.

5.2 Survey Responses

Table 16 provides a summary of the survey responses for each of the barriers that was surveyed. The table indicates the number of letters sent, the number of survey forms sent back with responses in favor ("YES") and not in favor ("NO"), the combined number of unclaimed letters/undeliverable letters/vacant properties, the number of weighted votes cast ("YES" and "NO"), and the percent of votes cast by respondents ("YES" and "NO"). Appendix G includes study-

area graphics that depict the property locations of the different responses. Appendix G also includes a table that lists the response or disposition of each letter sent.

Based on the results of the public preference survey, all of the noise barriers are recommended for construction.

Table 16 Summary of Barrier Survey Letters and Responses for Noise Barriers

Noise Barrier	Total # of Letters Sent	Response: In Favor? "Yes"	Response: In Favor? "No"	Unclaimed, Undeliver-able, or Vacant	# of Weighted Votes Cast		% of Votes from Respondents	
					Yes	No	Yes	No
C1	4	2	0	0	6	0	100%	0%
C2	27	17	3	0	64	9	87.7%	12.3%
D	14	11	0	1	33	0	100%	0%
F	5	3	0	0	9	0	100%	0%
G	5	4	0	0	16	0	100%	0%
H	10	7	2	0	29	8	78.4%	21.6%
J	11	8	0	0	40	0	100%	0%
N	11	9	2	0	41	8	83.7%	16.3%
O	11	9	2	0	38	10	79.2%	20.8%

Source: HMMH, 2019

As noted in Section 4.8, based on comments received from property owners at the southern end of Barrier N, the design was revised. The revised design avoids a potential conflict with a stairway that runs between the cul-de-sac at Maple Tree Lane and the sidewalk along Rolling Road. Appendix I contains details about for the revised final design for Noise Barrier N with revised sound level results and a revised sound attenuation line.

6 CONSTRUCTION NOISE CONSIDERATION

Construction noise provisions are contained in Section 107.16(b)3 Noise of the 2016 VDOT Road and Bridge Specifications. The specifications have been reproduced below:

- The Contractor's operations shall be performed so that exterior noise levels measured during a noise-sensitive activity shall not exceed 80 decibels. Such noise level measurements shall be taken at a point on the perimeter of the construction limit that is closest to the adjoining property on which a noise-sensitive activity is occurring. A noise-sensitive activity is any activity for which lowered noise levels are essential if the activity is to serve its intended purpose and not present an unreasonable public nuisance. Such activities include, but are not limited to, those associated with residences, hospitals, nursing homes, churches, schools, libraries, parks, and recreational areas.

- The Department may monitor construction-related noise. If construction noise levels exceed 80 decibels during noise sensitive activities, the Contractor shall take corrective action before proceeding with operations. The Contractor shall be responsible for costs associated with the abatement of construction noise and the delay of operations attributable to noncompliance with these requirements.
- The Department may prohibit or restrict to certain portions of the project any work that produces objectionable noise between 10 P.M. and 6 A.M. If other hours are established by local ordinance, the local ordinance shall govern.
- Equipment shall in no way be altered so as to result in noise levels that are greater than those produced by the original equipment.
- When feasible, the Contractor shall establish haul routes that direct his vehicles away from developed areas and ensure that noise from hauling operations is kept to a minimum.
- These requirements shall not be applicable if the noise produced by sources other than the Contractor's operation at the point of reception is greater than the noise from the Contractor's operation at the same point.