Noise Technical Report

November 2022

Interstate 64 Improvements:

Exit 205 to Exit 234

PRELIMINARY NOISE STUDY

Noise Technical Report

UPC # 109885

Project #: 00064-800-25632396

New Kent County and James City County, Virginia

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1.0 Executive Summary

The Virginia Department of Transportation (VDOT), in cooperation with the Federal Highway Administration (FHWA), is studying the environmental consequences of the proposed widening of Interstate 64 (I-64) from Exit 205 – Route 33/New Kent Highway to 1.15 miles west of Exit 234 – Route 199/646/Humelsine Parkway/Newman Road (MM 204.96 to MM 233.26) from four to six lanes. The study corridor encompasses approximately 30 miles along I-64 within New Kent County and James City County, Virginia. The widening will take place in the median of I-64 within the existing right-of-way and will avoid impacts to existing interchanges.

The widening of I-64 from Exit 205 to 1.15 miles west of Exit 234 will tie into the following recently completed widening projects along I-64:

- Widening I-64 from four to six lanes from Exit 200 – I-295 to Exit 205 – Route 33 at the western terminus; and
- Widening I-64 from four to six lanes from approximately 1.15 miles west of Exit 234 – Route 199 to 1.05 miles west of Exit 242 – Route 199 at the eastern terminus.

The project scope does not include improvements to the interchanges within the study area, except for improvements to the auxiliary lanes along I-64 at the Exit 205 interchange at the western project terminus. It is assumed that all other auxiliary lanes along I-64 will remain in their current configuration.

This Preliminary Noise Study is being prepared in accordance with the Virginia *State Noise Abatement Policy* that was developed to implement the requirements of 23 Code of Federal Regulations (CFR) Part 772, Procedures for Abatement of Highway Traffic Noise and Construction Noise (July 13, 2011), FHWA's *Highway Traffic Noise: Analysis and Abatement Policy and Guidance* (December 2011)[1]. The current VDOT *State Noise Abatement Policy* became effective on July 13, 2011 and was last updated on February 15, 2022. The results are summarized in the Categorical Exclusion (CE) prepared for this project pursuant to the National Environmental Policy Act (NEPA) of 1969, as amended, and in accordance with FHWA regulations[2]. The purpose of this project is to improve traffic operations and safety on I-64 from MM 204.96 to MM 233.96. The corridor in this area has recurring congestion, including congestion resulting from incidents along I-64, and high crash frequency and crash severity. The project proposes to provide an additional travel lane in each direction along eastbound and westbound I-64. Based on this information, as well as the proposed improvement, in accordance with 23 CFR 772, this project is considered a Type I project and requires noise analysis.

This Noise Technical Report evaluates potential traffic noise impacts and abatement measures associated with the proposed project. Potential traffic noise impacts are assessed within the construction limits of the project, in accordance with the procedures and criteria approved by FHWA and VDOT. This report documents predicted noise levels associated with the improvements outlined in the Interstate 64 Improvements: Exit 205 to Exit 234 project for the Existing Conditions (2019), Future Design Year (2048)

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[1] Title 23 of the Code of Federal Regulations (CFR) Part 772, Procedures for Abatement of Highway Traffic Noise and Construction Noise.

[2] NEPA and FHWA's regulations for Environmental Impact and Related Procedures can be found at 42 USC § 4332(c), as amended, and 23 CFR § 771, respectively.

No-Build Alternative, and the Future Design Year (2048) Build Alternative. Since the future design year Build Alternative noise levels are predicted to exceed the Noise Abatement Criteria (NAC), noise mitigation must be evaluated in accordance with Virginia *State Noise Abatement Policy* and guidance. This report describes the corridor and the evaluated noise mitigation in three segments – Segment A is between MM 204.9 and MM 215.6; Segment B is between MM 215.6 and MM 225.4; and Segment C is between MM 225.4 and MM 234.

Existing noise levels were assessed using field monitoring and FHWA's Traffic Noise Model (TNM). The field monitoring consisted of short-term ambient noise monitoring sessions. These sessions were conducted to assess the existing noise environment and provide a reference for testing the accuracy of TNM simulation. In total, noise monitoring was conducted at 36 locations. These locations were then modelled within TNM simulation, along with the existing roadway elements and topography. The existing condition TNM simulation did not include any existing noise barriers.

Following the completion of the field sampling, the noise measurements collected were used to validate the existing condition TNM simulation. The validation exercise found consistent agreement between the noise levels measured in the field and those predicted by TNM. The mean difference between the measured and modeled existing noise levels was 1.4 dB(A).

Once model validation was achieved, the existing condition TNM run was modified to reflect the proposed improvements. The effect of the proposed improvements on traffic noise levels included noise sensitive properties within approximately 500 feet of the proposed edge of pavement. Sites at greater distances were evaluated as needed to determine the edge of predicted traffic noise impact. Noise sensitive receptors were identified within this study area using recent aerial photographs and field reconnaissance (conducted in 2022). Receivers (or modeling sites) were placed into TNM to represent these receptors (discrete noise sensitive sites), either individually or in groups. A total of 378 receivers were created to represent 381 noise receptors. Of the modeled receivers:

- 326 receivers were used to study 329 residential receptors;
- 51 receivers were used to study 51 receptors located within outdoor use areas at community facilities; and
- One receiver was used to study interior noise impact at one interior receptor[3];

Under existing conditions, the TNM simulation indicates that noise levels range from 45 to 74 dB(A), with impacts predicted at 62 receivers. This group includes 60 residential receptors and 4 community facility receptors. Under the No-Build Alternative exterior noise levels are predicted to range from 47 to 74 dB(A), with impacts predicted at 76 receivers, including 68 residential receptors and 10 community facility receptors. Under the Build Alternative, exterior noise levels are predicted to range from 48 to 74 dB(A), with impacts predicted at 112 receivers, including 97 residential receptors and 17 community facility receptors. **Table 1-1** provides a summary of predicted noise level ranges and total noise impacts. All noise impacts are due to levels approaching or exceeding the applicable NAC. Predicted noise levels for all noise

[3] Exterior receptor sites were used to evaluate the interior noise levels within the project area. A noise reduction factor was applied to each interior site based on the building material and window type/condition per Table 6 of the 2011 FHWA Highway Traffic Noise Analysis and Abatement Policy and Guidance.

sensitive receptors are discussed for affected Common Noise Environments (CNE) in **Section 6.0** and shown in **Appendix B.**

Table 1-1: Summary of Sound Levels and Traffic Noise Impacts

Range of Predicted Exterior Sound Levels (dB(A))			Total Number of Noise Impacts (Receptors with Predicted Noise Levels that Approach or Exceed NAC)		
Existing Conditions (2019)	Future Design Year No Build Alternative (2048)	Future Design Year Build Alternative (2048)	Existing Conditions (2019)	Future Design Year No Build Alternative (2048)	Future Design Year Build Alternative (2048)
45 to 74	47 to 74	48 to 74	64	78	114

Thirty-four (34) new noise barriers were evaluated for areas predicted to be impacted by traffic noise under the Build Alternative. As shown in **Table 1-2**, five of the 34 barriers met the feasible and reasonable criteria. The table based the cost of each barrier using a unit cost of $42 per square feet (material and installation costs), with the total cost based on the total area of the barrier multiplied by the unit cost. No additional engineering costs (e.g., retaining walls, utility relocation, right-of-way acquisition, drainage considerations, etc.) were included. The noise barrier locations are shown on the graphics located in **Appendix A**. Refer to **Section 7.0** for a discussion regarding the design and evaluation of noise abatement.

Table 1-2: Evaluated Noise Barriers

Barrier Name	CNE	Total Benefited Receptors	Average Noise Reduction (dB(A))[1]	Barrier Length (ft.)	Average Barrier Height (ft.)	Barrier Surface Area (SF)	Surface Area per Benefited Receptor (sq.ft./BR)	Barrier Cost ($42/sq.ft.)	Feasible and Reasonable
				Segment A					
Barrier A	***A***	***49***	***7***	***3,560***	***20.2***	***71,994***	***1,469***	***$3,023,748***	***Yes***
Barrier A1	***A***	***10***	***8***	***713***	***22.3***	***15,905***	***1,591***	***$668,010***	***Yes***
Barrier A2	A	1	7	454	26.0	11,771	11,771	$494,382	No
Barrier B	***B***	***20***	***8***	***1,838***	***16.4***	***30,168***	***1,508***	***$1,267,056***	***Yes***
Barrier C	C	2	6	748	16.0	11,999	6,000	$503,958	No
Barrier D1	D	1	7	1,563	24.7	38,637	38,637	$1,622,754	No
Barrier D2	D	2	8	1,152	20.0	23,002	11,501	$966,084	No
Barrier E	E	2	6	1,345	18.0	24,291	12,146	$1,020,222	No
Barrier F	F	3	7	1,752	19.6	34,305	11,435	$1,440,810	No
Barrier H1	H	2	8	499	12.0	5,999	3,000	$251,958	No
Barrier H2	H	3	6	1,548	16.3	25,307	8,436	$1,062,894	No
Barrier H3	H	4	5	1,850	22.0	40,665	10,166	$1,707,930	No
Barrier I1	I	2	6	849	20.2	17,198	8,599	$722,316	No
Barrier I2	I	2	6	949	22.0	20,889	10,445	$877,338	No
Barrier J	J	9	7	1,604	23.9	38,315	4,257	$1,609,230	No
Barrier K	K	1	7	498	20.0	10,002	10,002	$420,084	No
Barrier L	L	1	7	807	14.0	11,287	11,287	$474,054	No
				Segment B					
Barrier M	M	3	5	1,199	24.0	28,793	9,598	$1,209,306	No
Barrier N	N	2	7	1,019	22.0	22,439	11,220	$942,438	No
Barrier P	P	3	7	1,373	30.0	41,132	13,711	$1,727,544	No
				Segment C					
Barrier S	S	11	6	1,380	21.2	29,270	2,661	$1,229,340	No
Barrier V	V	1	7	770	18.0	13,882	13,882	$583,044	No
Barrier W1	W	14	6	3,500	15.4	54,042	3,860	$2,269,764	No

Barrier Name	CNE	Total Benefited Receptors	Average Noise Reduction (dB(A))[1]	Barrier Length (ft.)	Average Barrier Height (ft.)	Barrier Surface Area (SF)	Surface Area per Benefited Receptor (sq.ft./BR)	Barrier Cost ($42/sq.ft.)	Feasible and Reasonable
Barrier W2	W	2	6	1,348	19.1	25,615	12,808	$1,075,830	No
Barrier X	X	2	6	1,915	13.6	26,193	13,097	$1,100,106	No
Barrier Y1	Y	1	7	1,263	28.4	35,866	35,866	$1,506,372	No
Barrier Y2	Y	2	6	1,813	15.4	28,063	14,032	$1,178,646	No
Barrier Y3	Y	1	7	813	25.2	20,448	20,448	$858,816	No
Barrier Z	***Z***	***26***	***6***	***1,545***	***26.3***	***40,657***	***1,564***	***$1,707,594***	***Yes***
Barrier AA	AA	4	6	1,170	16.5	19,359	4,840	$813,078	No
Barrier AB	AB	15	6	4,490	12.7	56,852	3,790	$2,387,784	No
Barrier AC	***AC***	***6***	***5***	***890***	***10.8***	***9,595***	***1,599***	***$402,990***	***Yes***
Extended Barrier AC	AC, AE	10	6	2,669	11.3	29,932	2,993	$1,257,144	No
Barrier AD	AD	2	6	1,270	24.0	30,461	15,231	$1,279,362	No

1 Average reduction for benefited receptors.

A more detailed assessment of noise impacts will be completed during final design. As such, noise barriers that are found to be feasible and reasonable by this assessment may also not be recommended for further consideration in the future. Conversely, noise barriers that were not considered feasible and reasonable may meet the established criteria and be recommended for construction. Additional noise abatement considerations (i.e., rail noise, noise reflection from proposed wall structures, commitments for further evaluation based on new design information, and alternatives to proposed noise barrier placement) will be addressed during the final design phase.

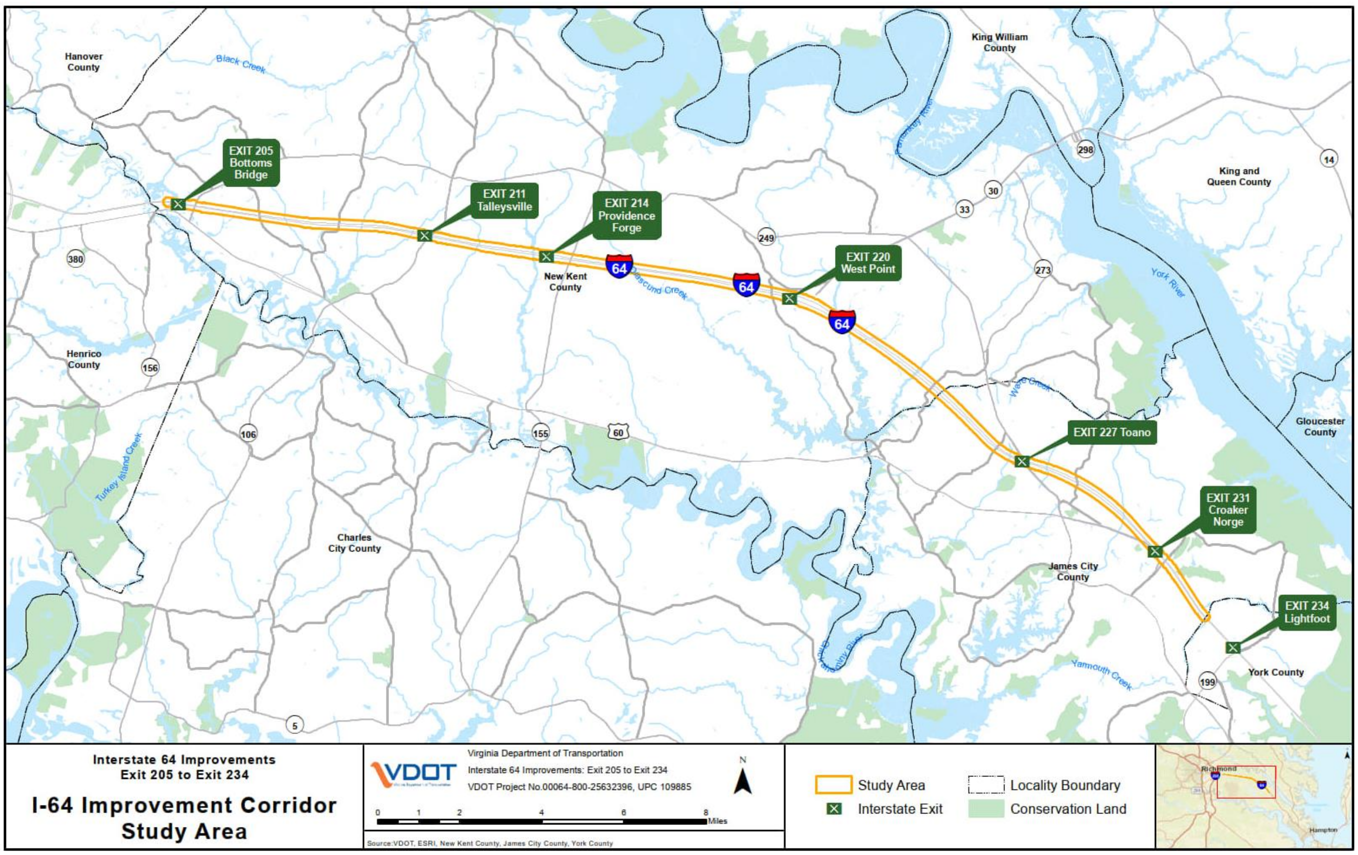
Noise generated during project construction was not included in the TNM simulations. However, construction activities may cause intermittent fluctuations in noise levels. To help reduce the impact of construction noise, this report identifies reasonable measures that can be taken to minimize noise impact from these activities. The discussion of construction noise is provided in **Section 8.0**.

2.0 Introduction

2.1 Project Description & Termini

The Virginia Department of Transportation (VDOT), in coordination with the Federal Highway Administration (FHWA), as the lead federal agency, is preparing a Categorical Exclusion (CE) for the I-64 Improvements: Exit 205 to Exit 234 project. The project would take place in New Kent County and James City County, Virginia. The project limits extend from the I-64 interchanges at Exit 205 (Route 33/New Kent Highway, MM 204.96) to 1.15 miles west of Exit 234 (Route 199/646/Humelsine Parkway/Newman Road), MM 233.26), as shown in **Figure 2-1**.

Figure 2-1. Noise Analysis Study Area Boundaries



The total project length is approximately 30 miles. The primary scope of work involves widening I-64 from four to six lanes between the project limits. The widening will take place in the median of I-64, within the existing right-of-way and will avoid impacts to existing interchanges. This Preliminary Noise Study is being prepared in accordance with the Virginia *State Noise Abatement Policy* that was developed to implement the requirements of 23 Code of Federal Regulations (CFR) Part 772, Procedures for Abatement of Highway Traffic Noise and Construction Noise (July 13, 2011), FHWA's *Highway Traffic Noise Analysis and*

Abatement Policy and Guidance (December 2011)[4]. The current VDOT *State Noise Abatement Policy* became effective on July 13, 2011, it and was last updated on February 15, 2022. Pursuant to the NEPA, as amended, and in accordance with FHWA regulations[5], a CE is being prepared to analyze the potential social, economic, and environmental effects associated with the proposed improvements.

2.2 Study Area

The study corridor for the proposed project encompasses approximately 30 miles along I-64. The widening will take place in the median of I-64 within the existing right-of-way and will avoid impacts to existing interchanges. The widening of I-64 from Exit 205 to 1.15 miles west of Exit 234 will tie into the following recently completed widening project along I-64:

- Widening I-64 from four to six lanes from Exit 200 – I-295 to Exit 205 – Route 33 at the western terminus; and
- Widening I-64 from four to six lanes from approximately 1.15 miles west of Exit 234 – Route 199 to 1.05 miles west of Exit 242 – Route 199 at the eastern terminus.

2.3 Project Purpose and Need

The purpose of this project is to improve traffic operations and safety on I-64 from MM 204.96 to MM 233.26. The corridor in this area has recurring congestion, including congestion resulting from incidents along I-64 and high crash frequency and crash severity.

2.4 Scope of the Preliminary Noise Analysis

Impacts associated with traffic noise are often of prime concern when evaluating roadway improvement projects. Roadway construction on new location or improvements to the existing transportation network may cause impacts to the noise-sensitive environment located adjacent to the project corridor. For this reason, FHWA has issued guidelines for noise evaluation as established in 23 CFR 772. Highway traffic noise studies, noise abatement procedures, coordination requirements and design noise levels in 23 CFR 772 constitute the noise standards mandated by 23 United States Code (U.S.C.) 109(i). FHWA and VDOT have established a noise analysis methodology and associated noise level criteria to assess the potential noise impacts associated with the construction and use of transportation related projects.

In accordance with 23 CFR 772, this project is considered a Type I project and requires a noise analysis. As part of the project design process, this Preliminary Noise Study evaluates potential traffic noise impacts and abatement measures associated with the widening of I-64 required for the I-64 Improvements: Exit 205 to Exit 234 project. Potential traffic noise impacts are assessed within the direct construction limits of the project, in accordance with the procedures and criteria approved by FHWA and VDOT.

[4] Title 23 of the Code of Federal Regulations (CFR) Part 772, Procedures for Abatement of Highway Traffic Noise and Construction Noise.
[5] NEPA and FHWA's regulations for Environmental Impact and Related Procedures can be found at 42 USC § 4332(c), as amended, and 23 CFR § 771, respectively.

This Noise Technical Report documents the steps involved in the Preliminary Noise Analysis for the I-64 Improvements project, including:

- a description of noise terminology,
- the applicable standards and criteria,
- results of ambient noise monitoring and validation efforts,
- a description of the computations of existing and future noise levels,
- identification of potential noise impacts,
- evaluation of measures to mitigate noise impacts,
- noise abatement evaluation and design,
- a discussion of construction noise, and
- a discussion of the public involvement process.

This report documents predicted noise levels associated with the improvements for the Existing Conditions (2019), Future Design Year (2048) No-Build Alternative and the Future Design Year (2048) Build Alternative.

2.4.1 Preliminary Noise Analysis Study Area

Consistent with FHWA/VDOT noise policy and guidance, the study area of the Preliminary Noise Study (hereafter referred to as "noise study area") is limited to 500 feet (or farther as needed to determine the edge of predicted traffic noise impact) from the proposed edge of pavement of the roadway improvements as defined by the roadway construction limits, unless otherwise extended for neighborhood continuity. This area includes approximately 30 miles of I-64 between Exit 205 (Route 33/New Kent Highway) to 1.15 miles west of Exit 234 (Route 199/646/Humelsine Parkway/Newman Road). Intersecting roadways and interchanges included in the noise study area are also shown in **Figure 2-1.**

2.5 Existing Conditions

The existing I-64 facility within the study area currently consists of two eastbound and two westbound lanes, supplemented in several locations by auxiliary lanes, and acceleration/deceleration lanes at on/off-ramps. Grade-separated interchanges provide access to and from I-64 at: Route 33/New Kent Highway; Route 609 (Emmaus Church Road); and Route 199/646/Humelsine Parkway/Newman Road. I-64 connects Richmond, VA west of the noise study area to Williamsburg, VA east of the noise study area. The posted speed limit is 70 mph.

The western portion of the Study Area, between Exit 205 and Exit 211, is predominately medium density residential with multi-family housing and single-family homes. Two recreation areas are also located within this area; Brookwoods Golf Club near VA 665/ North Henpeck Road and Pine Fork Park, near Route 609. The center portion of the Study Area, between Exit 211 to Exit 231, is mostly rural, with neighborhoods interspersed along roads connecting SR 60 to the south to Route 249 to the north intersecting the I-64 project corridor. Two recreation areas are also located within this area; Stonehouse Golf Course and Williamsburg RV and Camping Resort. The eastern portion of the Study Area, between Exit 231 and Exit 234, is more densely populated near the communities of Toano, Norge, and Lightfoot before entering the City of Williamsburg. One recreation area is also located within this area; Williamsburg

Recreational Vehicles (RV) and Camping Resort. Recently, projects to widen I-64 between Exits 234 to Exit 255 in Newport News were completed and added an additional 12-foot travel lane in each direction.

2.6 Alternatives

Based on the project's purpose and need, VDOT developed two alternatives: one build alternative and the No-Build alternative. The Build Alternative includes the proposed widening of I-64 from four to six lanes. The No-Build Alternative[6] assumes that VDOT takes no action to address the project purpose and need, other than those typically completed as part of existing system preservation (i.e., resurfacing, landscape management, sign replacement, etc.). There are no related projects that would influence the Build or No-Build Alternatives.

2.6.1 No-Build Alternative

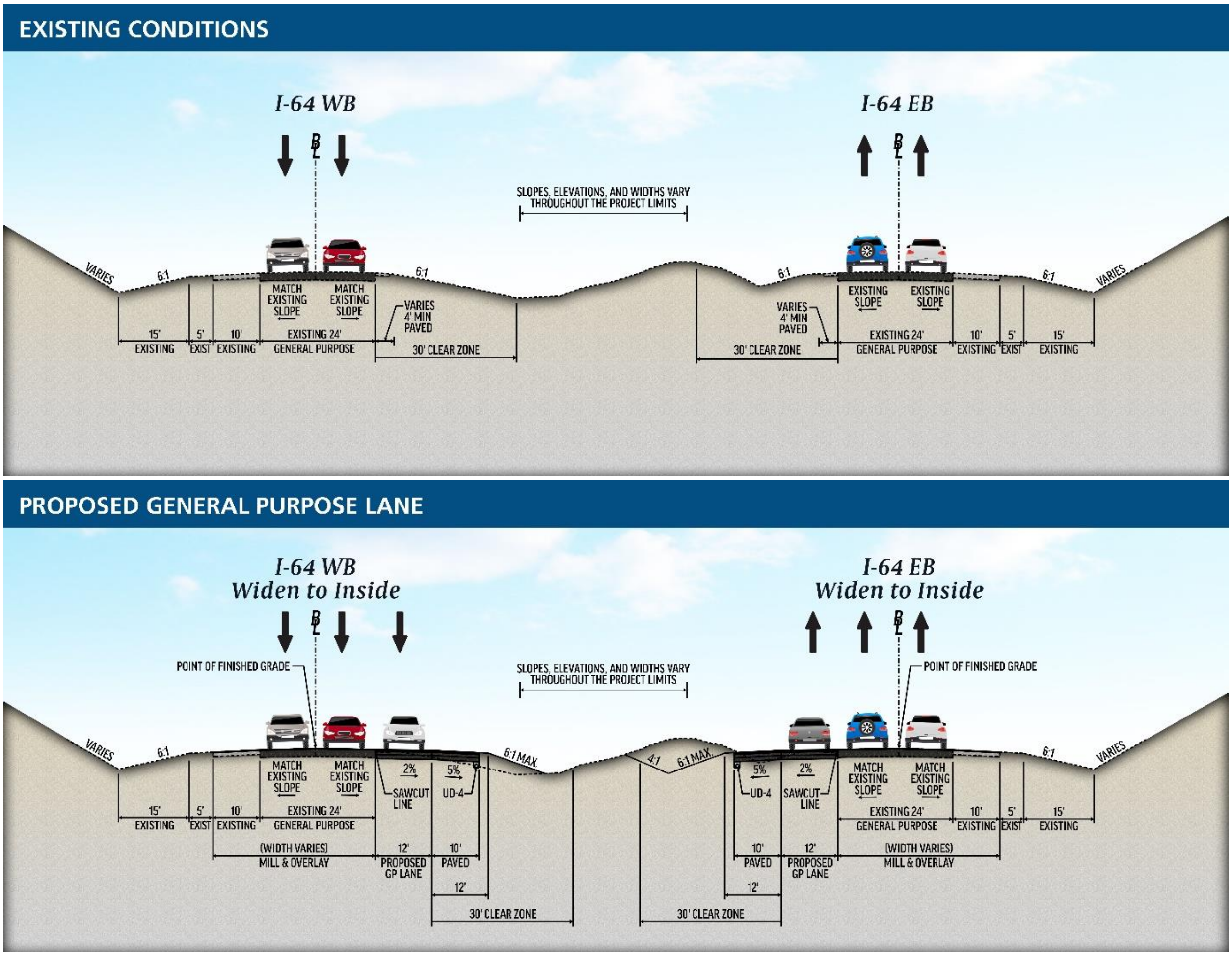
For the Preliminary Noise Study, the No-Build Alternative was modeled and evaluated for noise impact and to assess "constructive use" for Section 4(f) properties identified within the study area, consistent with 23 CFR 774.15, *Parks, Recreation Areas, Wildlife and Waterfowl Refuges, and Historic Sites (Section 4(f)) – Constructive Use Determinations*.

2.6.2 Build Alternative

The proposed improvements include adding one general purpose (GP) lane in each direction along the I-64 corridor. The GP lanes will tie into the recently completed widening of I-64 from four to six GP lanes from Exit 200 – I-295 to Exit 205 – Route 33 at the western terminus and the widening of I-64 from four to six lanes from approximately 1.15 miles west of Exit 234 – Route 199 to 1.05 miles west of Exit 242 – Route 199 at the eastern terminus. The new GP lanes will be completed largely within the existing I-64 median. The project scope does not include improvements to the interchanges within the study area, with the exception of improvements to the auxiliary lanes along I-64 at the Exit 205 interchange at the western project terminus. It is assumed that all other auxiliary lanes along I-64 will remain in their current configuration. **Figure 2-2** shows the existing and proposed typical sections.

[6] According to FHWA guidelines, the consideration of a No-Build Alternative is a requirement under NEPA. The Build Alternative must be reasonable and practicable enough to dismiss the No-Build Alternative (FHWA, 1990).

Figure 2-2. Existing and Build Condition Typical Sections



3.0 Legislation and Noise Fundamentals

3.1 Regulatory Requirements

The Noise Control Act of 1972 gives the US Environmental Protection Agency (USEPA) the authority to establish noise regulations to control major noise sources, including motor vehicles and construction equipment. Furthermore, the USEPA is required to set noise emission standards for motor vehicles used for interstate commerce and the FHWA is required to enforce the USEPA noise emission standards through the Office of Motor Carrier Safety. NEPA gives broad authority and responsibility to Federal agencies to evaluate and mitigate adverse environmental impacts caused by Federal actions. FHWA is required to comply with NEPA including mitigating adverse highway traffic noise effects. The Federal-Aid Highway Act of 1970 mandates FHWA to develop standards for mitigating highway traffic noise. It also requires that FHWA establish traffic noise level criteria for various types of land uses. The Act prohibits FHWA from approving federal-aid highway projects unless adequate consideration has been made for noise abatement measures to comply with the standards. FHWA's highway regulations contain NAC, which represent the maximum acceptable level of highway traffic noise for specific types of land uses. The regulation does not mandate that the NAC be met in all situations, but rather that reasonable and feasible efforts be made to provide noise mitigation when the NAC are approached or exceeded (23 CFR § 772, 2010).

VDOT's *State Noise Abatement Policy* was developed to implement the requirements of 23 CFR 772[7], FHWA's *Highway Traffic Noise Analysis and Abatement Policy and Guidance*[8], and the noise-related requirements of NEPA. The current VDOT *State Noise Abatement Policy* became effective on July 13, 2011 and was last updated on February 15, 2022. The methodologies applied to the noise analysis for the I-64 Improvements project are in accordance with VDOT's *State Noise Abatement Policy*, and VDOT's *Highway Traffic Noise Guidance Manual*[9]. This policy is applicable to Type I federal-aid highway projects. Since the proposed project consists of the addition of travel lanes, the proposed project is classified as a Type I project and requires a noise study.

3.2 Sound Level Metrics

Noise is generally defined as an unwanted or annoying sound. Airborne sound occurs by a rapid fluctuation of air pressure above and below atmospheric pressure. Sound pressure levels are usually measured and expressed in decibels (dB). The decibel scale is logarithmic and expresses the ratio of the sound pressure unit being measured to a standard reference level.

Most sounds occurring in the environment do not consist of a single frequency, but rather a broad band of differing frequencies. Because the human ear does not respond to all frequencies equally, the method commonly used to quantify environmental noise consists of evaluating all the frequencies of a sound per a-weighting system. It has been found that the A-weighted filter on a sound level meter, which includes circuits to differentially measure selected audible frequencies, best approximates the frequency response

7 Effective date: July 13, 2011.
8 Revision date: December, 2011.
9 Updated: February 15, 2022.

of the human ear and has been found to strongly correlate with human perceptions of traffic noise. Consequently, A-weighted decibels (dB(A)) are used by FHWA.

Although the A-weighted noise level may adequately indicate the level of environmental noise at any instant in time, community noise levels vary continuously. Most environmental noise includes a conglomeration of noise from distant sources, creating a relatively steady background noise in which no specific source is identifiable. To describe the time-varying character of traffic noise, a statistical noise descriptor called the equivalent hourly sound level, or $L_{eq(1h)}$, is commonly used. $L_{eq(1h)}$ describes a noise sensitive receptor's cumulative exposure from all noise-producing events over a one-hour period (herein referenced as "L_{eq}").

Because decibels are logarithmic units, sound levels cannot be added by ordinary arithmetic means. The following general relationships provide a basic understanding of sound generation and propagation:

- An increase, or decrease, of 10-dB will be perceived by a receptor to be a doubling, or halving, of the sound level, respectively;
- Doubling the distance between a highway and receptor will produce a 3-dB sound level decrease; and
- A 3-dB sound level increase is barely perceptible by the human ear.

4.0 Noise Abatement Criteria & Methodology

4.1 Noise Abatement Criteria

The *State Noise Abatement Policy* has adopted the NAC established by FHWA (23 CFR 772) for determining traffic noise impacts for a variety of land uses. The NAC listed in **Table 4-1** represent the upper limit of acceptable traffic noise conditions and a balancing of that which may be desirable with that which may be achievable.

Table 4-1: FHWA Noise Abatement Criteria

Hourly A Weighted Sound Level Decibels (dB(A))			
Activity Category	Activity $L_{eq(h)}$	Evaluation Location	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*	67	Exterior	Residential
C*	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	---	Exterior	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
* Includes undeveloped lands permitted for this activity category			

Source: FHWA, 23 CFR 772

The NAC applies to areas having frequent human use and where lowered noise levels are desired. They do not apply to the entire tract of land on which the activity is based, but only to that portion where the activity takes place. The NAC is given in terms of the hourly, A-weighted, equivalent sound level in decibels (dB(A)). The conclusions presented in this noise impact assessment are based on the guidelines listed in **Table 4-1.**

4.2 Definition of Traffic Noise Impact

This first phase of the traffic noise abatement process is to determine if highway traffic noise abatement consideration is warranted for the affected communities and receptors. Traffic noise impacts most frequently occur if either of the following two conditions are met:

- The predicted traffic noise levels approach or exceed the NAC, as shown **Table 4-1**. The VDOT *State Noise Abatement Policy* defines that the approach shall be one dB(A) less than the NAC for Activity Categories A to E. For example, for a NAC B receptor, 66 dB(A) would approach 67 dB(A) and would be considered an impact. If predicted design year noise levels "approach or exceed" the NAC, then the receptor is considered to be an impact.

- The predicted design year (Build Alternative) traffic noise levels are substantially higher than the existing year (Existing Conditions) noise levels. VDOT's *State Noise Abatement Policy* defines a substantial noise increase as a predicted (Build Alternative) traffic noise levels which exceeds existing year (Existing Conditions) noise levels by 10 dB(A) or more. For example, if a receptor's predicted noise level under the Existing Conditions is 50 dB(A) and the predicted noise level under the Build Alternative is 60 dB(A), then it would be considered to "substantially exceed" existing year noise levels and would be considered an impact. Predicted noise levels do not have to exceed the appropriate NAC to be considered a substantial increase impact.

If traffic noise impacts are identified under either criterion, then the consideration of noise abatement measures is necessary. The final decision on whether to provide noise abatement will consider the feasibility of the design and overall cost weighted against the environmental benefit of the proposed abatement (FHWA, 2011).

4.2.1 Section 4(f) Noise Impacts

Section 4(f) refers to the original section within the U.S. Department of Transportation Act of 1966 which makes provisions for the preservation of:

- Publicly owned public parks, recreation areas, and wildlife or waterfowl refuges; and
- Publicly or privately-owned historic site listed or eligible for listing on the National Register of Historic Places (NRHP).

Under Section 4(f), FHWA cannot approve a transportation project that uses a Section 4(f) property, as defined in 23 CFR 774.17, unless a determination is made that:

- There is no feasible and prudent avoidance alternative to the use of land from the property, and the action includes all possible planning to minimize harm to the property resulting from such use (23 CFR 774.3(a)); or
- The use of the Section 4(f) property, including any measures to minimize harm (such as avoidance, minimization, mitigation, or enhancement measures) committed to by the applicant, would have a *de minimis* impact on the property (23 CFR 774.3(b)).

Under Section 4(f), a use of a Section 4(f) property occurs (23 CFR 774.17):

- When land is permanently incorporated into a transportation facility;
- When there is a temporary occupancy of land that is adverse in terms of the statute's preservation purpose; or
- When there is constructive use of land.

A *de minimis* use of a public park, recreational area, wildlife and waterfowl refuge, or historic site is defined as that which does not "*adversely affect the features, attributes or activities qualifying the property for protection under Section 4(f)*". This determination can be made only with the concurrence of the official with jurisdiction over the property and can be made only after an opportunity for public review and comment after the proposed determination has been provided.

The requirements of Section 4(f) are separate from 23 CFR 772, but may also call for consideration of noise impacts to lands subject to Section 4(f). A noise impact does not necessarily constitute a Section 4(f) use. However, even when noise increases do not constitute a Section 4(f) use, noise impacts may still require consideration for abatement under 23 CFR 772. Proposed abatement measures may result in additional impacts that require consideration under Section 4(f), NEPA, and Section 106.

FHWA's regulations governing implementation of Section 4(f) includes specific discussion to aid in assessing whether noise impacts would constitute a constructive use and require a Section 4(f) evaluation. In general, a constructive use occurs when, "*The projected noise level increase attributable to the project substantially interferes with the use and enjoyment of a noise-sensitive facility of a property protected by Section 4(f)*" (23 CFR § 774, 2018).

Conversely, 23 CFR 774.15(f) states that a constructive use does not occur when:

- The impact of projected (predicted) traffic noise levels of the proposed highway project on a noise-sensitive activity does not exceed the NAC, as shown in **Table 4-1**; and
- The projected (predicted) noise levels exceed the NAC of this section because of high existing noise, but the increase in the projected (predicted) noise levels if the proposed project is constructed (Build Alternative), when compared with the projected noise levels if the project is not built (No-Build Alternative), is barely perceptible (3 dB(A) or less).

As with Section 4(f), the consideration of historic properties under Section 106 of the Historic Preservation Act is a separate requirement but may be related to the assessment of noise impacts under 23 CFR 772. To qualify for protection under Section 106, a resource must be listed on the National Register of Historic Properties (NRHP) or be determined eligible to be listed. The determination of eligibility is made by the State Historic Preservation Officer (SHPO). At present, there is no metric for analyzing when a change in noise constitutes an effect under the regulations implementing Section 106. A metric has not been established because the assessment of noise impacts on historic resources is highly dependent on the characteristics which made it eligible for listing on the NRHP (see 36 C.F.R. § 800, 2012). Some properties, such as designed or cultural landscapes where the landscape itself is the significant feature or where the setting is especially important, may be extremely sensitive to any change that can be perceived by the human ear. Refer to **Section 4.4.5** for the discussion of Section 4(f) Properties that were identified. Refer to **Sections 6.2** and **6.3** for the results of the Section 4(f) noise analysis.

4.3 Highway Noise Computation Model

A review of the noise study area has established roadway traffic as the dominant source of noise for the project. Since roadway noise can be predicted accurately through computer modeling techniques for areas that are dominated by road traffic, existing and future design year traffic noise calculations have been predicted using FHWA’s Traffic Noise Model (TNM) Version 2.5, which is an approved version and required under 23 CFR 772[10]. TNM estimates vehicle noise emissions and resulting noise levels based on reference energy mean emission levels. The existing and proposed alignments (horizontal and vertical)

[10] TNM was developed and sponsored by the U.S. Department of Transportation and John A. Volpe National Transportation Systems Center, Acoustics facility.

are input into the model, along with the receptor locations, traffic volumes of cars, medium trucks (vehicles with two axles and six tires), heavy trucks, average vehicle speeds, and any traffic control devices. TNM utilizes acoustic algorithms to predict noise levels at the selected receptor locations by considering sound propagation variables such as atmospheric absorption, divergence, intervening ground, barriers, building rows, and sometimes heavy vegetation (FHWA, 2004).

4.4 Data Sources

4.4.1 Roadways and Design Files

Existing roadways were located and digitized using survey data provided by VDOT. The build alternative was obtained by placing a third lane to the inside using similar elevations to the existing left lane.

4.4.2 Existing Shielding and Terrain Features

Existing shielding and terrain features such as existing retaining walls, building rows, and terrain lines were incorporated to account for shielding effects of these existing features within the project corridor. Elevation data for these features were generally obtained through a combination of data triangulated 3D surface derived from LiDAR data provided by VDOT. This noise study area does not contain any existing noise barriers.

4.4.3 Traffic Volumes and Flow Control

Traffic data for this noise study was prepared by WRA, consisting of hourly volumes and design-operational speeds by roadway segment for the Existing Conditions, No-Build Alternative, and Build Alternative. In situations where design-operational speeds were not available, posted speed limits were used. The traffic data was prepared for all interstate mainline segments, interchange ramps, and adjacent arterial roadways (i.e., roadways with Average Daily Traffic (ADT)>3000), within the noise study area. The traffic data is displayed in **Appendix E.**

4.4.4 TNM Receivers and Representative Receptors

Receptors are defined as a discrete or representative location of a noise sensitive area(s) for any of the land uses described in **Table 4-1** (VDOT, 2022). TNM receiver inputs were used to represent predicted noise receptors and in some cases were used to represent multiple noise receptors. Receptors were primarily identified within approximately 500 feet of the proposed edge of pavement based on an aerial photo review and confirmed during the site visit associated with the noise monitoring effort. A default height of 4.92 feet above the base ground elevation was used for all ground level receptors; 14.92 and 24.92 were used for second and third floor balconies of multi-family housing. Specific receptor placement was generally based on exterior areas where there is frequent human use.

4.4.5 Identification of Section 4(f) Sites

Based on FHWA regulations and guidance, a review of parcel and land use data within the noise study area was conducted to identify potential Section 4(f) sites. The following resources were evaluated to identify Section 4(f) resources in the noise study area:

- Aerial images and internet resources;

- Virginia Cultural Resource Information System (V-CRIS) online application;
- Recreational facility/park lists; and
- Comprehensive plans.

It was determined that there are no wildlife or waterfowl refuges. The only type of recreational resource that was identified is a local park, Pine Fork Park and a future field at Pine Fork Park.

Coordination with the project team confirmed that no historic sites were identified within the noise study area of the project:

Section 6.3 of the report discusses the results of the constructive use evaluation for receptors located within the study area.

4.4.6 Undeveloped Lands and Permitted Developments

Highway traffic noise analyses are (and would be) performed for developed lands as well as undeveloped lands if they are considered "permitted." Undeveloped lands are deemed to be permitted when there is a definite commitment to develop land with an approved specific design of land use activities as evidenced by the issuance of at least one building permit. In accordance with the VDOT *Traffic Noise Policy and Guidance Manual,* an undeveloped lot is planned, designed, and programmed if a building permit has been issued by the local authorities prior to the Date of Public Knowledge for the relevant project. VDOT considers the "Date of Public Knowledge" as the date that the final NEPA approval is made. VDOT has no obligation to provide noise mitigation for any undeveloped land that is permitted or constructed after the date of public knowledge. The project currently does not have a NEPA approval date.

Coordination was performed in May 2022 with New Kent County, James City County, and York County to identify areas of planned and future development (although work is not planned within York County, the 500-foot study area extends into York County). Based on the information provided by New Kent County, James City County, and York County, there is one planned development within the noise study area that is anticipated to receive its building permit prior to the anticipated date of public knowledge. Hearth at Patriots Landing is an apartment complex proposed in the southeast quadrant of the I-64/New Kent Highway interchange (Exit 205) in New Kent County. A total of 27 receivers were modeled for receptors within the noise study area. Coordination with the local jurisdictions will occur again in Final Design to ensure that all noise sensitive land uses are evaluated in the Final Design noise analysis where building permits have been issued prior to the NEPA document approval date. Correspondence regarding undeveloped lands is included in **Appendix K**.

5.0 Existing Noise Environment

5.1 Noise Monitoring

To assess existing noise conditions within the noise study area, short-term monitoring was conducted. Short-term monitoring, described in **Section 5.1.1**, was conducted to evaluate the accuracy of the noise prediction model. As noted previously, a windshield survey of noise-sensitive land uses and identification of major sources of acoustical shielding was conducted to inform the mapping of noise sensitive receptors and the selection of noise monitoring locations.

5.1.1 Short-Term Noise Monitoring

The purpose of short-term noise monitoring is to gather data that is used to develop a comparison between the monitored results and the output obtained from the noise prediction model. This validation exercise is required[11] so that TNM can be used with confidence to determine the loudest hour noise levels, predict the existing / future noise levels, assess noise impacts, and design and evaluate potential noise attenuation alternatives (i.e., noise barriers/berms). 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.

A noise monitoring plan consistent with guidance from FHWA's *Noise Measurement Handbook* (FHWA, 2018) was developed to identify candidate noise monitoring sites, access locations, and traffic collection sites. Field reconnaissance was conducted to confirm monitoring site access (including scheduling access for selected sites) and address any potential safety issues associated with the monitoring sites. Optimum locations were also confirmed for the placement of the video equipment used for collection of traffic data during the monitoring sessions.

Short-term noise measurements of 20 minutes duration were obtained at 36 locations within the noise study area on April 12-13, 2022. The short-term noise measurements were collected using Rion NL42 and Casella 633-1A sound level meters. Rion NC-74 and Quest QC10 Acoustical Calibrators were used for field calibrations. Refer to **Appendix C** for calibration certificates of the sound level meters and calibrator.

Readings were taken on the A-weighted scale and reported in dB(A). The data collection procedure involved the collection of L_{eq} measurements in consecutive 10-second intervals. This method allowed for individual time intervals that include noise events unrelated to traffic noise (such as aircraft over flights) to be excluded from consideration for model validation purposes. Data collected by the noise meter included time, L_{eq}, minimum noise level (L_{min}), maximum noise level (L_{max}), percentile sound levels (e.g. L_5, L_{10}, L_{50}, L_{90}, L_{95}), and the SEL for each interval. $L_{eq(1h)}$ values were derived at each location from the 20-minute L_{eq} values. Existing noise measurements were collected under meteorologically acceptable conditions when the pavement was dry and winds were calm or light. Additional data collected at each monitoring location included atmospheric conditions and the observation of non-traffic noise events.

[11] TNM Validation is required by 23 CFR 772.11(d)(2).

The monitoring schedule included a total of 36 monitoring sites. These sites were divided into 19 traffic count sessions, based upon similar sources of traffic noise. During each session, traffic conditions on the dominant highway noise sources were counted and compiled by field personnel. Traffic was grouped into one of the three categories: automobiles (Class 2 and 3), medium trucks (Class 5) and heavy trucks (Class 6 through 13), per FHWA vehicle classifications. Buses (Class 4) were combined with the medium trucks and motorcycles (Class 1) were included with the automobiles (FHWA, 2016).

The field data sheets, datalogger outputs (raw and adjusted), and the traffic observed with each monitoring session are presented in **Appendix D**. The location of each short-term noise monitoring site in relation to the project, is shown on the graphics located in **Appendix A.**

A summary of the short-term noise monitoring results[12] are presented in **Table 5-1.** For each site, the table lists:

- the assigned monitoring site number,
- the location of the monitoring site,
- a description of the associated land use for each site,
- the dominant sources of noise at each site, and
- the monitored sound levels.

The monitored L_{eq} in the study corridor ranged from 56.6 dB(A) to 69.4 dB(A). I-64 was the dominant source of noise within the noise study area.

Table 5-1: Short-term Noise Monitoring Summary

Site	Location	Land use Description	Dominant Sources of Noise	Monitored Noise Level L_{eq} (dB(A))
ST-1	2710 Kings Cross Quay	Single-Family Home	I-64	60.8
ST-2	7921 Patriots Landing Place	Single-Family Home	I-64	62.8
ST-3	7510 Winding Jasmine Road	Single-Family Home	I-64	62.0
ST-4	7503 Fairway Ridge Drive	Single-Family Home	I-64	67.9
ST-5	2901 Walnut Drive	Single-Family Home	I-64	68.5
ST-6	7701 Walnut Drive	Single-Family Home	I-64	63.1
ST-7	3875 Autumn Hills Lane	Single-Family Home	I-64	61.5
ST-8	4790 Old Field Lane	Single-Family Home	I-64	62.0
ST-9	Ashland Farm Road	Agriculture	I-64	62.7
ST-10	7400 Airport Road	Single-Family Home	I-64	61.4
ST-11	5800 Pine Fork Road	Single-Family Home	I-64	66.4
ST-12	9000 Piney Branch Lane	Single-Family Home	I-64	63.7
ST-13	14375 Maine Corps Drive	Single-Family Home	I-64	64.1
ST-14	5801 Good Hope Road	Single-Family Home	I-64	66.2
JAC-1	3700 Ropers Church Road	Camp/ conference center	I-64	56.6
JAC-2	17025 Wedgewood Court	Single-Family Home	I-64	58.0
JAC-3	3800 Ropers Church Road	Single-Family Home	I-64	60.3
JAC-4	3855 Ropers Church Road	Single-Family Home	I-64	61.1
JAC-6	101 Racefield Drive	Single-Family Home	I-64	57.4
JAC-9	111 Racefield Drive	Single-Family Home	I-64	60.0

[12] 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.

Site	Location	Land use Description	Dominant Sources of Noise	Monitored Noise Level L_{eq} (dB(A))
JAC-13	122 Racefield Drive	Single-Family Home	I-64	62.5
JAC-19	3544 Merestep Way	Single-Family Home	I-64	62.1
JAC-20	4001 Mt Laurel Road	Single-Family Home	I-64	62.5
JAC-22	169 Sand Hill Road	Single-Family Home	I-64	60.3
JAC-25	319 Louise Lane	Single-Family Home	I-64	61.9
JAC-28	4224 Cedar Point Lane	Single-Family Home	I-64	65.3
JAC-31	4301 Rochambeau Drive	RV Campground	I-64	57.6
JAC-31B	4301 Rochambeau Drive	RV Campground	I-64	64.5
JAC-32	4107 Rochambeau Drive	Church	I-64	66.4
JAC-33	4391 Cedar Point Lane	Single-Family Home	I-64	58.7
JAC-37	4531 Cloverleaf Lane	Single-Family Home	I-64	62.8
JAC-38	4600 Rochambeau Drive	Single-Family Home	I-64	68.6
JAC-39	4650 Fenton Mill Road	Single-Family Home	I-64	66.3
JAC-44	4797 Fenton Mill Road	Single-Family Home	I-64	69.4
JAC-45	101 Wilderness Lane	Single-Family Home	I-64	63.1
JAC-47	4801 Fenton Mill Road	Single-Family Home	I-64	63.8

5.2 Noise Model Validation

Computer modeling is the accepted technique for predicting noise levels associated with traffic-induced noise for the Existing Conditions and the Build Alternative. The modeling process begins with model validation, per FHWA/VDOT requirements. This is accomplished by comparing the monitored noise levels and the noise levels predicted by TNM, using traffic volumes and speeds that were observed during the monitoring process (i.e., 20-minute traffic data was converted to one-hour traffic data for validation of the model). This validation ensures that reported changes between the existing and future design year conditions are due to changes in traffic, and not discrepancies between monitoring and/or modeling techniques. According to FHWA guidance and VDOT policy and guidance, a difference of plus or minus 3 dB(A) or less between the monitored and modeled levels is considered to be acceptable since this is the limit of change that is barely perceptible by a typical human ear (FHWA, 2011 and VDOT, 2022). A summary of the model validation is provided in **Table 5-2**.

As shown, for all sites, the difference between the modeled and monitored noise levels range from -2.2 to +2.4 dB(A). The predicted levels that were modeled in TNM can differ from the recorded levels due to several factors. Such factors include:

- atmospheric conditions[13] (upwind, neutral, or downwind) (NCHRP, 2018),
- existing shielding by structures that may be difficult to model,
- limited survey data,
- pavement properties that differ from the average pavement required for use in TNM,

[13] Sound levels on the down-wind side of a sound source are often considerably higher than sound levels on the upwind side. On the downwind side, sound rays are curved downward which could allow multiple sound rays to arrive at a receiver. On the upwind side, sound rays are curved upward, which causes a sound shadow (zone) to occur. Sound rays enter the shadow region primarily due to a scattering of sound waves by atmospheric turbulence. Similar to the influence of wind, sound rays are curved by temperature variations in the atmosphere. Consequently, since specific atmospheric conditions are not modeled in TNM, predicted noise levels would most likely deviate from observed noise monitoring results.

- complex roadway and/or receptor geometry[14] (FWHA, 2004), and
- the representativeness of louder vehicles which pass by the sound level meter during the measurement period.

Other types of environmental factors (i.e., non-traffic related noise) were witnessed during the monitoring events that cannot be replicated in TNM. This non-traffic related noise can even include the following: airplane overflights, compression release engine brakes (commonly known as Jake or Jacobs Brakes), transit events, emergency sirens, HVAC systems, lawnmowers (i.e., motorized lawn care activities), or backup alarms. The noise from these external environmental factors was removed from the noise monitoring data when it had a noticeable effect on the monitored noise levels. There are also factors in the noise model that may cause differences with the measured noise levels including 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.

Table 5-2: Noise Model Validation

Site	Monitored Noise Level L_{eq} (dB(A))	Predicted Noise Level Leq (dB(A))	Difference (Predicted Monitored) L_{eq} (dB(A))
ST-1	60.8	62.5	1.7
ST-2	62.8	65.7	2.9
ST-3	62.0	64.8	2.8
ST-4	67.9	70.0	2.1
ST-5	68.5	68.4	-0.1
ST-6	63.1	61.1	-2.0
ST-7	61.5	63.2	1.7
ST-8	62.0	64.1	2.1
ST-9	62.7	63.5	0.8
ST-10	61.4	63.8	2.4
ST-11	66.4	68.3	1.9
ST-12	63.7	63.6	-0.1
ST-13	64.1	65.5	1.4
ST-14	66.2	64.8	-1.4
JAC-1	56.6	58.4	1.8
JAC-2	58.0	59.9	1.9
JAC-3	60.3	60.0	-0.3
JAC-4	61.1	61.5	0.4
JAC-6	57.4	55.9	-1.5
JAC-9	60.0	61.4	1.4
JAC-13	62.5	63.0	0.5
JAC-19	62.1	64.4	2.3
JAC-20	62.5	61.3	-1.2
JAC-22	60.3	62.5	2.2
JAC-25	61.9	61.4	-0.5

[14] Limits have been placed on the number of barriers and the number of ground points that are calculated in TNM. TNM has been designed to handle up to two barrier objects (i.e. existing barriers / retaining walls, multi-story residential / commercial / industrial buildings, objects input using TNM's barrier input tool) located within the source-receiver path. If three or more barrier type objects are encountered, TNM will choose the most effective pair of barriers based on their input heights and then discards all other barrier objects for the remainder of the analysis. TNM next determines how many points in the geometry cause the shortest path from the source to receiver to diffract downward. These "highest path points" (HPPs) could be barriers or ground points, which could be associated with berms, terrain lines or roadways. If three or more HPPs are encountered, TNM will not compute diffraction from all of them, and only the most effective pair is retained for calculation.

Site	Monitored Noise Level L_{eq} (dB(A))	Predicted Noise Level Leq (dB(A))	Difference (Predicted Monitored) L_{eq} (dB(A))
JAC-28	65.3	66.7	1.4
JAC-31	57.6	58.1	0.5
JAC-31B	64.5	65.6	1.1
JAC-32	66.4	66.3	-0.1
JAC-33	58.7	60.2	1.5
JAC-37	62.8	64.3	1.5
JAC-38	68.6	69.7	1.1
JAC-39	66.3	67.9	1.6
JAC-44	69.4	69.8	0.4
JAC-45	63.1	64.3	1.2
JAC-47	63.8	65.2	1.4
		Mean Difference (dB)	**1.4**

The predicted noise level for all 36 monitoring sites was within 3 dB(A) of the monitored levels. This meets the criteria for validation of the TNM models.

5.3 Common Noise Environments

The noise study area was delineated by extending a 500-foot buffer around the proposed edge of pavement of the roadway improvements as defined by the roadway construction limits. This study area was divided into 31 CNEs. CNEs are a group of receptors that are exposed to similar noise sources and levels; traffic volumes, traffic mix, and speed; and topographic features. **Table 5-3** describes the location of each CNE, as well as the land uses found therein. **Appendix A** contains graphics with all the modeled receiver locations by CNE.

Table 5-3. CNE Descriptions

CNE ID	Land Use Description
	Segment A
A	This CNE is located on the eastbound side of I-64, from VA 33/ New Kent Highway to just east of VA 665/ North Henpeck Road. The CNE is comprised of a mix of medium and low density residential suburban lots in the Patriots Landing and Five Lakes subdivisions (NAC B), outdoor recreation facilities at Brookwoods Golf Club (NAC C), and undeveloped woodlands (NAC G). There is an apartment complex, the Hearth at Patriots Landing, planned at the west end of CNE A adjacent to the VA 33/ New Kent Highway interchange. The CNE's noise sensitive land uses include 86 single-family homes, 27 multi-family units, and five golf course tees/holes.
B	This CNE is located on the westbound side of I-64 and extends from VA 33/ New Kent Highway eastward approximately 0.75 miles. The CNE is comprised of low-density residential lots (NAC B) along Walnut Drive, Timber Drive, and Woodbrook Road, and undeveloped woodlands (NAC G). The CNE's noise sensitive land uses include 28 residences, all single-family homes.
C	This CNE is located on the westbound side of I-64, from the west side of VA 665/ North Henpeck Road eastward approximately 0.5 miles. The CNE is comprised of low-density residential lots (NAC B) along Autumn Hills Lane. The CNE's noise sensitive land uses include 10 residences, all single-family homes.
D	This CNE is located on the eastbound side of I-64, from 0.5 miles east of VA 665/ North Henpeck Road to VA 640/ Old Roxbury Road. The CNE is comprised of low-density residential lots (NAC B) and undeveloped woodlands (NAC G). The CNE's noise sensitive land uses include four residences, all single-family homes.
E	This CNE is located on the westbound side of I-64, from just west of VA 640/ Old Roxbury Road eastward approximately 0.2 miles. The CNE is comprised of low-density residential lots (NAC B) and undeveloped woodlands (NAC G). The CNE's noise sensitive land uses include five residences, all single-family homes.
F	This CNE is located on the eastbound side of I-64, from east of VA 640/ Old Roxbury Road eastward approximately 0.4 miles. The CNE is comprised of low-density residential lots (NAC B) accessed from Old Field Lane. The CNE's noise sensitive land uses include seven residences, all single-family homes.

CNE ID	Land Use Description
G	This CNE is located on the westbound side of I-64, from VA 612/ Airport Road westward approximately 0.2 miles. The CNE is comprised of a low-density residential lot (NAC B). The CNE's noise sensitive land use includes one residence, a single-family home.
H	This CNE is located on the westbound side of I-64, from VA 612/ Airport Road eastward approximately 1.3 miles. The CNE is comprised of low-density residential lots (NAC B) along VA 610/ Pine Fork Road. The CNE's noise sensitive land uses include 17 residences, all single-family homes.
I	This CNE is located on the eastbound side of I-64, from VA 612/ Airport Road eastward approximately 0.9 miles. The CNE is comprised of low-density residential lots (NAC B) and agricultural lands (NAC F) accessed from VA 676/ Ashland Farm Road. The CNE's noise sensitive land uses include seven residences, all single-family homes.
J	This CNE is located on the westbound side of I-64, from 0.9 miles west of VA 609/ Emmaus Church Road eastward approximately 0.4 miles. The CNE is comprised of low-density residential lots (NAC B) and Pine Fork Park recreation facilities (NAC C) accessed from VA 610/ Pine Fork Road. Additionally, an area identified as fields at Pine Fork Park is adjacent to the existing developed park. The CNE's noise sensitive land uses include four residences, all single-family homes and a recreational trail.
K	This CNE is located on the eastbound side of I-64, from VA 618/ Olivet Church Road eastward approximately 0.45 miles. The CNE is comprised of low density residential (NAC B) and undeveloped woodlands (NAC G) accessed from VA 677/ Piney Branch Lane. The CNE's noise sensitive land uses include eight residences, all single-family homes.
L	This CNE is located on the eastbound side of I-64, from 0.3 miles west to 1.05 miles east of VA 155/ North Courthouse Road. The CNE is comprised of one low-density residential lot (NAC B), agriculture lands (NAC F), and undeveloped woodlands (NAC G). The CNE's noise sensitive land use includes one residence, a single-family home.
Segment B	
M	This CNE is located on the westbound side of I-64, from VA 627/ Good Hope Road eastward approximately 0.3 miles. The CNE is comprised of low to medium density residential lots (NAC B) and undeveloped woodlands (NAC G). The CNE's noise sensitive land uses include three residences, all single-family homes.
N	This CNE is located on the eastbound side of I-64 from the I-64/ VA 33/ Eltham Road interchange westward approximately 0.3 miles. The CNE is comprised of low density residential (NAC B) electrical transmission facilities (NAC F), undeveloped woodlands (NAC G), and an outdoor recreational use, New Kent Paintball. The CNE's noise sensitive land uses include one single-family home and one recreational use.
O	This CNE is located on the westbound side of I-64 from 0.2 miles west of the I-64/ VA 33/ Eltham Road interchange westward approximately 0.2 miles. The CNE is comprised of low density residential (NAC B), electrical transmission facilities (NAC F), and undeveloped woodlands (NAC G). The CNE's noise sensitive land uses include two residences, both single-family homes.
P	This CNE is located on the westbound side of I-64 and from approximately 0.3 miles west of VA 620/ Homestead Road to 0.25-mile east of VA 621/ Ropers Church Road. The CNE is entirely comprised of low-density rural land uses. The CNE's noise sensitive land uses include six residences, all of which are single-family homes (NAC B).
Q	This CNE is located on the eastbound side of I-64, between Diascund Creek Reservoir and VA 621/ Ropers Church Road. The CNE is comprised of a single property which is permitted to operate as a campground by New Kent County (NAC C). The portion of the campground which lies within the study area does not contain areas of frequent human use; however, a receptor was included to estimate sound levels within the study area.
R	This CNE is located on the eastbound side of I-64, from Ropers Church Road eastward 0.2 miles. The CNE is comprised of an undeveloped lot (NAC G) and a property containing a single-family home (NAC B).
Segment C	
S	This CNE is located on the eastbound side of I-64, from VA 601/ Barnes Road westward approximately 1.0 miles. The CNE is comprised of a mix of undeveloped woodlands (NAC G), low density rural homesteads (NAC B and G), and medium-density suburban land uses (NAC B). The CNE's noise sensitive land uses include 26 parcels containing residences. All 26 are single-family homes.
T	This CNE is located on the westbound side of I-64, from VA 601/ Barnes Road westward approximately 0.5 miles. The CNE is comprised of a single, large property that contains a single-family home (NAC B).
U	This CNE is located on the westbound side of I-64 between VA 601/ Barnes Road and VA 30/ Old Stage Road. The CNE contains a single, large property that contains a single-family home (NAC B). The remaining areas are occupied by undeveloped woodlands (NAC G).
V	This CNE is located on the westbound side of I-64 from VA 30/ Old Stage Road eastward approximately 0.6 miles. The CNE contains the southernmost portion of the Stonehouse Golf Course (NAC C). Specifically, the CNE includes three areas which are considered noise sensitive: one tee box and two putting greens. The remaining areas are occupied by a parking lot (NAC F) and undeveloped woodlands (NAC G).

CNE ID	Land Use Description
W	This CNE is located on the eastbound side of I-64, from VA 600/ Six Mt. Zion Road to Sand Hill Road. The CNE is comprised mostly of low-density rural land uses, including twenty parcels containing residences. All twenty residences are single-family homes (NAC B). The remaining area is occupied by undeveloped woodlands (NAC G).
X	This CNE is located on the eastbound side of I-64, from US 30/ Rochambeau Drive westward approximately 0.3 miles. The CNE is comprised of rural homesteads (NAC-B), agricultural fields (NAC F), and undeveloped woodland (NAC G). The CNE's noise sensitive land uses include two residences, all single-family homes.
Y	This CNE is located on the westbound side of I-64, from VA 607/ Croaker Road westward approximately 1.1 miles. The CNE is comprised of a mix of rural homesteads (NAC B), agricultural fields (NAC F), and undeveloped woodlands. The CNE's noise sensitive properties include seven residences, all single-family homes.
Z	This CNE is located on the eastbound side of I-64, from VA 607/ Croaker Road westward approximately 0.5 miles. This CNE includes one property containing a single-family home (NAC B), the grounds surrounding the Faith Baptist Church (NAC D), and the northern half of the Williamsburg RV and Camping Resort (NAC C). There are no outdoor areas of frequent human use at the Faith Baptist Church; therefore, the corner of the church was assessed to determine interior sound levels. The portion of the Campground that falls within the CNE boundary includes outdoor recreation facilities (e.g., mini-golf course, horseshoe pits, shuffleboard court, etc.), an indoor pool, six rental cabins, permanent housing for the campground's staff, and numerous sites for RVs.
AA	This CNE is located on the westbound side of I-64 between 0.4 mile east of VA 607/ Croaker Road to 0.2 mi west of Fenton Mill Road. The CNE is comprised of undeveloped woodlands (NAC G) and medium-density suburban land uses (NAC B). The CNE's noise sensitive land uses include four residences, all of which are single family homes.
AB	This CNE is located on the eastbound side of I-64 between VA 607/ Croaker Road and 0.2 miles east of Wilderness Lane. The CNE is comprised of undeveloped woodlands (NAC G) and medium-density suburban land uses (NAC B). The CNE's noise sensitive land uses include 26 residences, all of which are single family homes.
AC	This CNE is located on the westbound side of I-64 from Fenton Mill Road eastward approximately 0.3 miles. The CNE is comprised of a mix of undeveloped woodlands (NAC G) and medium density suburban lots (NAC B). The CNE's noise sensitive land uses include 15 residences, all single-family homes.
AD	The CNE is located on the eastbound side of I-64, from 0.2 miles east of Wilderness Lane eastward approximately 0.5 miles. The CNE is comprised of undeveloped woodlands (NAC G) and low density suburban lots (NAC B). The CNE's noise sensitive land uses include two residences, both of which are single family homes.
AE	The CNE is located on the westbound side of I-64, from 0.4 miles east of Wilderness Lane eastward approximately 0.4 miles. The CNE is comprised of undeveloped woodlands (NAC G) and medium density suburban lots (NAC B). The CNE's noise sensitive land uses include two residences, both of which are single family homes.

All residential receptors were modeled under NAC B. Receptors at outdoor recreational areas were modeled under NAC C. Interior noise levels for places of worship were modeled under NAC D[15]. **Appendix A** contains graphics with all the modeled receiver locations by CNE.

5.4 Selection of the Loudest Noise Hour

As required by FHWA and VDOT, the noise analysis was performed for the loudest "worst noise" hour of the day. According to FHWA guidance, the "worst hourly traffic noise impact" occurs at a time when truck volumes and vehicle speeds are the greatest, typically when traffic is free flowing and at or near level of service (LOS) C conditions (FHWA, 2011).

While the peak traffic hour often coincides with the loudest noise hour of the day, there are some conditions which would require the evaluation of non-peak traffic hours to determine the loudest noise hour of the day. Specifically, this can occur when the combination of peak hour traffic volumes and

[15] Exterior receptors were used to evaluate the interior noise levels within the project area. Since the exterior for the evaluated buildings are largely composed of masonry material and appear to have modern air conditioning installed, the reduction in noise levels in the interior as a result of the building is predicted to be 25 dB(A) (FHWA, 2011).

operational speeds approach the capacity of a facility (LOS E or worse), or when there are substantial differences in truck percentages between the peak and off-peak hours (FHWA, 2015).

5.4.1 Methodology

Traffic data for the traffic noise study were developed using the VDOT ENTRADA: Environmental Traffic Data Tool, with traffic data prepared by WRA in coordination with VDOT (VDOT, 2020). The ENTRADA output was imported into VDOT's web application Loudest Hour Determination Tool for identifying loudest hours for noise modeling purposes. This predictive screening tool calculates reference L_{eq}'s at 50 feet for the most common TNM[16] vehicle types (e.g. autos, medium trucks, and heavy trucks), utilizing interrupted operational speeds and hourly peak-hour volumes (for each hour of the day) over flat ground. The data from the loudest hour spreadsheet was then used to estimate the total sound levels associated with both directions of the Interstate by using the following methodology.

- For receptors on the westbound side of I-64, it was assumed that the westbound roadway (the near roadway) was 50 feet from the representative receptor, while the eastbound roadway (the far roadway) was 175 feet from the receptor (using the following formula [*change in sound level = 10Log (distance 2/distance 1) where distance 1 = 50 feet and distance 2 = 175 feet]*). Then the sound levels for each side were logarithmically added to estimate the total sound level.
- For receptors on the eastbound side of I-64, it was assumed that the eastbound roadway (the near roadway) was 50 feet from the representative receptor, while the westbound roadway (the far roadway) was 175 feet from the receptor. Then the sound levels for each side were logarithmically added to estimate the total sound level.

A screening worksheet that was prepared for the Build (2048) condition shows the predicted total sound level for each side of the roadway for each hour of the day, then compares those results to the identified maximum level (see **Appendix K**). The hours of 7:00 AM, 8:00 AM, 3:00 PM, and 4:00 PM were identified as the loudest hours in each condition.

Data from these four hours was then further evaluated in TNM for the segments most likely to warrant noise abatement consideration, Exit 205 to 211 (EB 4 and WB 7), Exit 220 to 227 (EB 7 and WB 4), Exit 227 to 231 (EB 8 and WB 3), and Exit 231 to 234 (EB 9 and WB 2) (see **Figure 5-1** and **Table 5-4**). The loudest hour determination process considered the number of receptors within each CNE, giving more consideration to those with more receptors, the loudest hours of the adjacent segments, and how close the results were among the evaluated hours, with the understanding that a difference of 3 dB(A) is considered to be barely perceptible to the human ear.

[16] Federal Highway Administration's (FHWA) Traffic Noise Model (TNM), version 2.5.

Figure 5-1. Traffic Segments

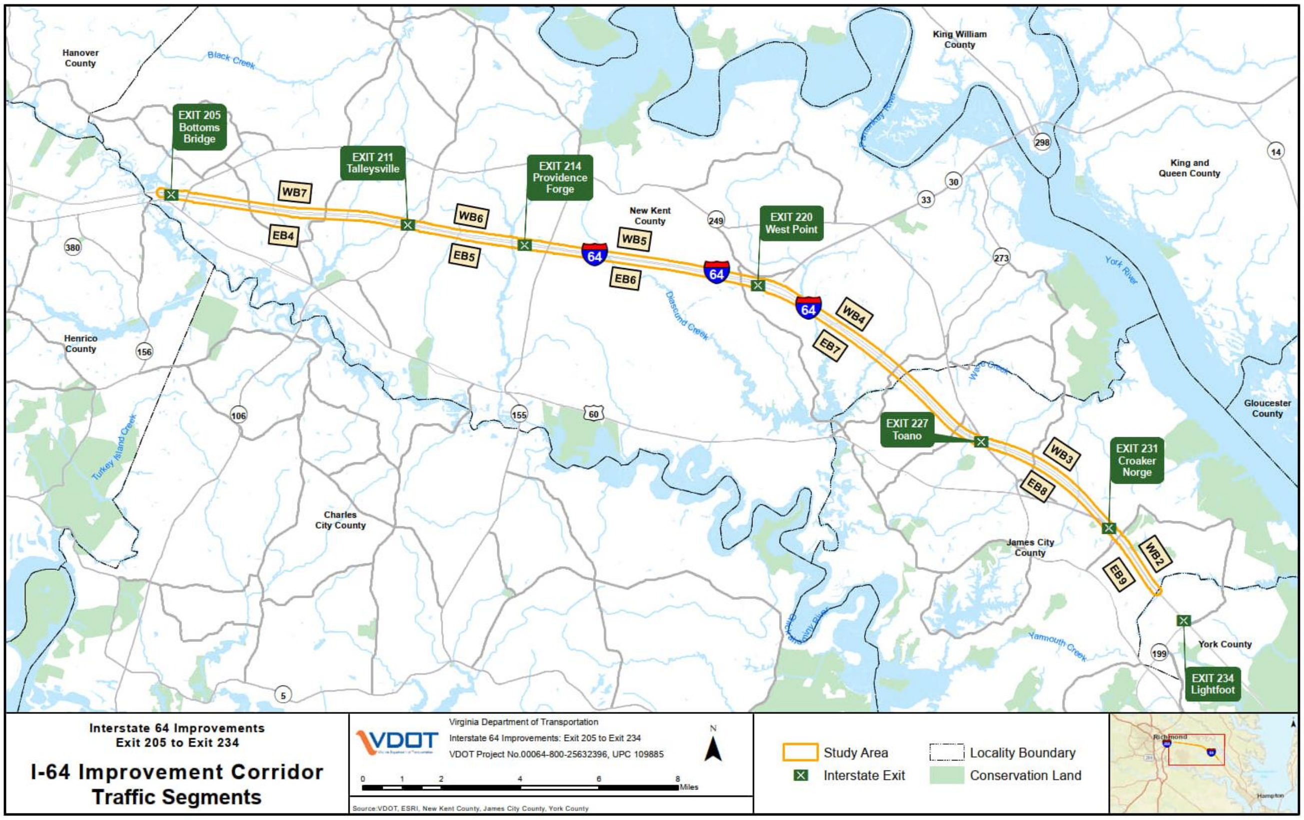


Table 5-4: TNM Results for Loudest Hour Analysis

Segment	Direction	Receptor	# of receptors in CNE	TNM Results (dB(A)) 7:00 AM	8:00 AM	3:00 PM	4:00 PM	MAX	Difference from MAX 7:00 AM	8:00 AM	3:00 PM	4:00 PM
Exit 205 to 211 (EB4 and WB7)	EB	A-19	93	68.90	69.20	69.10	69.10	69.20	0.3	0	0.1	0.1
	EB	A-49		72.80	73.10	73.00	73.10	73.10	0.3	0	0.1	0
	WB	B-10	28	69.10	69.30	69.20	68.80	69.30	0.2	0	0.1	0.5
	WB	C-07	10	59.70	60.00	59.90	59.60	60.00	0.3	0	0.1	0.4
	EB	F-06	7	67.10	67.40	66.90	66.80	67.40	0.3	0	0.5	0.6
	WB	H-14	17	65.20	65.40	65.30	65.00	65.40	0.2	0	0.1	0.4
Exit 220 to 227) EB7 and WB4	EB	S-14	27	66.90	67.40	67.30	67.00	67.40	0.5	0	0.1	0.4
	EB	S-26		56.50	57.20	56.90	56.30	57.20	0.7	0	0.3	0.9
Exit 227 to 231) EB8 and WB3	EB	W-03	20	68.60	68.80	68.40	68.20	68.80	0.2	0	0.4	0.6
	EB	W-10		66.60	66.80	65.90	65.70	66.80	0.2	0	0.9	1.1
	WB	Y-07	7	63.10	63.40	63.50	63.20	63.50	0.4	0.1	0	0.3
	EB	Z-04	34*	60.70	61.00	60.10	59.70	61.00	0.3	0	0.9	1.3
Exit 231 to 234 (EB9 and WB2)	WB	AA-04	5	69.10	69.50	70.00	69.90	70.00	0.9	0.5	0	0.1
	WB	AA-05		66.80	67.20	67.30	67.20	67.30	0.5	0.1	0	0.1
	EB	AB-11	26	70.00	71.20	70.60	70.50	71.20	1.2	0	0.6	0.7
	EB	AB-17		64.90	65.20	64.20	63.90	65.20	0.3	0	1	1.3
	EB	AB-18		65.90	66.20	65.30	65.10	66.20	0.3	0	0.9	1.1
	EB	AB-20		69.70	69.90	69.10	69.00	69.90	0.2	0	0.8	0.9
	WB	AC-01	15	68.00	68.30	68.90	68.80	68.90	0.9	0.6	0	0.1
	WB	AC-04		67.00	67.40	67.90	67.70	67.90	0.9	0.5	0	0.2
	WB	AC-05		64.50	65.00	65.60	65.30	65.60	1.1	0.6	0	0.3

* Sample receptors used in the LHD may differ from the number of modeling receptors used in the noise impact assessment.

**CNE ZK-04 consists of an RV camping area with 3422 receptors, based upon a 100 x 100- foot grid pattern of receptors representing the area as described in Appendix E of the VDOT Highway Traffic Noise Guidance Manual.

5.4.2 Summary of Loudest Noise Hour

The loudest hours within Exit 205 to 211 (EB 4 and WB 7), in the western portion of the study area, generally occurred in the 8:00 AM and 7:00 AM hours. Since the majority of Segment 4 receptors (60%) are located in CNE A and there is only a difference of 0.3 dB(A) or less between the 7:00 AM hour and the adjacent loudest hours, the 7:00 AM hour was determined to best represent the loudest hour for the western portion of the study area.

The loudest hours within Exit 220 to 227 (EB 7 and WB 4), Exit 227 to 231 (EB 8 and WB 3), and Exit 231 to 234 (EB 9 and WB 2), the eastern portion of the study area, were also generally in the 8:00 AM and 7:00 AM hours. Since CNEs Z and AB have the greatest number of receptors in the eastern portion of the study area and there is only a difference of 1.2 dB(A) or less between the 7:00 AM hour and the adjacent loudest hours, the 7:00 AM hour was determined to best represent the loudest hour for the eastern portion of the study area.

In conclusion, the 7:00 AM is being used as the loudest hour for the entire study corridor.

5.5 Receptor Identification and NAC Categorization

Per the VDOT *Traffic Noise Policy and Guidance Manual*, Section 7.3.7 states that noise analysis is not required for land use Activity Category F as it is not sensitive to highway traffic noise, while Section 7.3.8 states that undeveloped lands per land use Activity Category G are not considered noise sensitive unless there are active building permits predating the Date of Public Knowledge. If an active building permit is identified on undeveloped land, then the land use will be assessed under the appropriate Activity Category. There was one Activity Category G land use with an anticipated building permit identified in this study. The permitted development proposes 27 new residences, which were incorporated into the analysis of CNE A.

A total of 378 noise receivers were modeled to represent 381 noise receptors to predict how the proposed improvements would affect the noise levels throughout the project area. Of the modeled receivers:

- 326 modeled receivers were created to represent 329 residential receptors (NAC B),
- 51 modeled receivers were created to represent 51 receptors located in community facilities with exterior use areas (NAC C),
- 1 modeled receiver was created to represent one interior receptors (NAC D),

Table 5-5 provides a list of receptors and receivers located in each CNE by NAC category. The location of all the receptors modeled in TNM are shown in **Appendix A**.

Table 5-5. Receptor and Receiver Summary by CNE and NAC

CNE	NAC Activity Category (Receiver / Receptor)					
	All	A	B	C	D	E
A	118	-	113	5	-	-
B	28	-	28	-	-	-
C	10	-	10	-	-	-
D	4	-	4	-	-	-
E	5	-	5	-	-	-
F	7	-	7	-	-	-
G	1	-	1	-	-	-
H	17	-	17	-	-	-
I	7	-	7	-	-	-
J	17	-	4	13	-	-
K	8	-	8	-	-	-
L	1	-	1	-	-	-
M	3	-	3	-	-	-
N	2	-	1	1	-	-
O	2	-	2	-	-	-
P	6	-	6	-	-	-
Q	1	-	-	1	-	-
R	1	-	1	-	-	-
S	26	-	26	-	-	-
T	1	-	1	-	-	-
U	1	-	1	-	-	-
V	3	-	-	3	-	-
W	20	-	20	-	-	-
X	2	-	2	-	-	-
Y	7	-	7	-	-	-
Z	34	-	5	28	1	-
AA	4	-	4	-	-	-
AB	26	-	26	-	-	-
AC	12 / 15	-	12 / 15	-	-	-
AD	2	-	2	-	-	-
AE	2	-	2	-	-	-
Total	**378 / 381**	**-**	**326 / 329**	**51**	**1**	**-**

Segment A

CNE A contains 118 receptors, 86 are associated with single-family homes, 27 are associated with a planned three-story apartment complex, and five are associated with Stonehouse Golf Course. Receptors A-55 and A-57 are located within putting greens, and Receptors A-54, A-56, and A-63 are located on tee boxes. A detailed map of CNE A can be found in Figures A-2 to A-4 located in Appendix A.

CNE B contains 28 noise receptors, all of which are associated with single-family homes. A detailed map of CNE B can be found in Figures A-2 and A-3 located in Appendix A.

CNE C contains 10 noise receptors, all of which are associated with single-family homes. A detailed map of CNE C can be found in Figures A-4 and A-5 located in Appendix A.

CNE D contains four noise receptors, all of which are associated with single-family homes. A detailed map of CNE D can be found in Figure A-5 located in Appendix A.

CNE E contains five noise receptors, all of which are associated with single-family homes. A detailed map of CNE E can be found in Figure A-5 and A-6 located in Appendix A.

CNE F contains seven noise receptors. Five of the receptors are associated with single-family homes. The remaining two receptors (F-01 and F-07) are associated with large homesteads which contain residential structures. A detailed map of CNE F can be found in Figures A-5 and A-6 located in Appendix A.**CNE G** contains one noise receptor, which is associated with a single-family home. A detailed map of CNE G can be found in Figure A-7 located in Appendix A.

CNE H includes 17 noise receptors. Sixteen of the receptors are associated with single-family homes. The remaining receptor (H-05) is associated with a large homestead which contains a residential structure. A detailed map of CNE H can be found in Figures A-7 and A-8 located in Appendix A.

CNE I contains seven receptors noise receptors, all of which are associated with single-family homes. A detailed map of CNE I can be found in Figures A-7 and A-8 located in Appendix A.

CNE J contains 17 receptors noise receptors, four of which are associated with single-family homes, 12 are associated with Pine Forest Park, and one is associated with an area identified as fields at Pine Forest Park adjacent to the existing developed park. The park and the planned field are Section 4(f) resources. A detailed map of CNE J can be found in Figure A-9 located in Appendix A.

CNE K contains eight noise receptors, all of which are associated with single-family homes. A detailed map of CNE K can be found in Figures A-12 and A-13 located in Appendix A.

CNE L contains one noise receptor which is associated with a single-family home. A detailed map of CNE L can be found in Figures A-15 and A-16 located in Appendix A.

Segment B

CNE M contains three noise receptors, all of which are associated with single-family homes. A detailed map of CNE M can be found in Figures A-21 and A-22 located in Appendix A.

CNE N contains two noise receptors, one of which is a single-family home and one is a community facility. A detailed map of CNE N can be found in Figure A-22 located in Appendix A.

CNE O contains two receptors, all of which are associated with single-family homes. A detailed map of CNE O can be found in Figure A-22 located in Appendix A.

CNE P contains six receptors, all of which are associated with single-family homes. A detailed map of CNE P is provided in Figures A-26 to A-28 in Appendix A**.**

CNE Q contains one receptor which is associated with a structure located near the campground's entrance. The receptor is located on the grounds surrounding one of the campground's structures. The portion of the campground which lies within the study area does not contain areas of frequent human use; however, this receptor was included to estimate sound levels within the study area. A detailed review of this area's usage will be evaluated in final design. A detailed map of CNE Q is provided in Figure A-27 in Appendix A.

CNE R contains one receptor which is associated with a single-family home. A detailed map of CNE R is provided in Figures A-27 and A-28 in Appendix A.

Segment C

CNE S contains 26 receptors. Twenty-five of the receptors are associated with single-family homes. The remaining receptor (S-02) is associated with a large homestead which contains a residential structure. A detailed map of CNE S is provided in Figures A-29 and A-30 in Appendix A.

CNE T contains one receptor which is associated with a single-family home. A detailed map of CNE T is provided in Figure A-30 in Appendix A.

CNE U contains one receptor which is associated with a single-family home. A detailed map of CNE T is provided in Figures A-30 and A-31 in Appendix A**.**

CNE V contains three receptors, all of which are associated with portions of the Stonehouse Golf Course. Receptors V-01 and V-02 are located within putting greens, and Receptor V-03 is located on a tee box. A detailed map of CNE V is provided in Figures A-31 and A-32 in Appendix A.

CNE W contains 20 receptors, all of which are associated with single-family homes. A detailed map of CNE W is provided in Figures A-33 and A-34 in Appendix A.

CNE X contains two receptors, both of which are associated with a single-family home. A detailed map of CNE X is provided in Figure A-35 in Appendix A.

CNE Y contains seven receptors. Five of the receptors are associated with single-family homes. The remaining two receptors (Y-02 and Y-05) are associated with large homesteads which contain residential structures. A detailed map of CNE Y is provided in Figures A-34 to A-36 in Appendix A.

CNE Z contains a total of 34 receptors. Receptor Z-1 is in the grounds of the Faith Baptist Church. Since the grounds do not contain areas of frequent human use, this receptor was not used to make impact or abatement determinations. Receptor Z-02 is associated with a single-family home. The remaining receptors are associated with use areas throughout the Williamsburg RV and Camping Resort. Receptors Z-07, Z-08, Z-16, and Z-22 are associated with permanent housing used by the Resort's staff. The permanent housing consists of four mobile homes used by the campground's caretakers year-round. The remaining receptors are associated with communal use areas (*i.e.,* recreational facilities, fire pits, and picnic areas), camp sites, and rental cabins. A detailed review of this area's usage will be evaluated in final design. A detailed map of CNE Z is provided in Figures A-35 and A-36 in Appendix A.

CNE AA contains four receptors, all of which are associated with single-family homes. A detailed map of CNE AA is provided in Figures A-37 and A-38 in Appendix A.

CNE AB contains 26 receptors, all of which are associated with single-family homes. A detailed map of CNE AB is provided in Figures A-37 and A-38 in Appendix A**.**

CNE AC contains 12 receptors, representing 15 single-family homes. A detailed map of CNE AC is provided in Figures A-37 and A-38 in Appendix A.

CNE AD contains two receptors, both of which are associated with single-family homes. A detailed map of CNE AD is provided in Figure A-38 in Appendix A.

CNE AE contains two receptors, both of which are associated with single-family homes. A detailed map of CNE AE is provided in Figure A-38 in Appendix A.

6.0 Noise Impact Evaluation

Assessment of traffic noise impact requires these comparisons:

- The noise levels under Existing conditions must be compared to those under the Build Alternative. This comparison shows the change in noise levels that would occur between the existing year and the design year if the project is constructed, to determine if the substantial increase impact criteria has been met; and
- The noise levels under Build Alternative must be compared to the applicable NAC. This comparison determines if the impact criteria has been met under the Build Alternative and can be used to assist in noise compatible land use planning.

6.1 Evaluation of the No-Build Alternative

An evaluation of the No-Build Alternative was completed per Section 6.4.7 of VDOT's *Highway Traffic Noise Guidance Manual*. Under the NEPA requirements, the No-Build Alternative analysis assists with making informed decisions on whether future increases in noise levels (i.e., associated with the Build Alternative) over the No-Build Alternative would be considered "significant." The noise increase in the Build Alternative over the No-Build Alternative per receptor would average 0.6 dB(A). All noise impacts in the No Build Alternative would also be present in the Build Alternative. Under the No Build Alternative, exterior noise levels are predicted to range from 47 to 74 dB(A), with impacts predicted at 76 receivers, including 68 residential receptors and 10 community facility receptors. Predicted sound levels for every receptor in the No-Build Alternative are provided in **Appendix B**.

6.2 Evaluation of the Build Alternative

Noise levels in the noise study area were predicted using separate TNM runs for the Existing Conditions (2019), the No Build Alternative (2048) and the Build Alternative (2048)[17]. For all modeled receptors, the Build Alternative noise levels are predicted to range from 48 to 74 dB(A). Most CNEs show a slight increase in sound levels between the No Build and Build Alternatives. This increase is caused by the distribution of traffic volumes over three lanes instead of two lanes, with the third lane being further from the receptors and the median berm being removed in most locations.

The Build Alternative is predicted to impact 112 receivers, representing 97 residential receptors and 17 community facility receptors. None of the sites are predicted to be impacted under the substantial increase criterion. The following section describes the loudest hour sound levels expected to occur at each CNE in the Build Year (2048) condition if the proposed improvements are implemented. **Table 6-1** provides a summary of how noise conditions are expected to change in each CNE if the proposed improvements are completed.

[17] The TNM files are retained in VDOT's technical files.

Table 6-1. Build Condition Predicted Sound Levels

CNE	Map Figure Number(s) Appendix A	Number of Receptors	NAC Activity Category	Predicted Range of Sound Levels (dB(A))[1]	Predicted Increase over Existing Conditions (dB(A))	Predicted Increase over No Build Alternative[2] (dB(A))	Total Number of Impacted Receptors
Segment A							
A	A-2 to A-4	118	B, C	48 to 74	0.7 to 2.0	0.6 to 3.1	16
B	A-2 to A-3	28	B	55 to 73	1.2 to 2.8	-0.2 to 1.1	11
C	A-4 to A-5	10	B	56 to 68	1.5 to 2.7	0.3 to 1.1	1
D	A-5	4	B	58 to 69	1.4 to 1.8	-0.3 to 0.4	3
E	A-5 and A-6	5	B	62 to 66	1.3 to 1.7	-0.2 to 0.2	1
F	A-5 and A-6	7	B	58 to 68	1.5 to 1.9	-0.2 to 0.3	1
G	A-7	1	B	63	1.4	0.3	0
H	A-7 and A-8	17	B	55 to 73	0.9 to 3	-0.1 to 1.7	5
I	A-7 and A-8	7	B	59 to 70	1.7 to 2.2	0.3 to 1	2
J	A-9	17	B, C	60 to 68	1.5 to 2.3	0.2 to 1	6
K	A-12 and A-13	8	B	57 to 69	0.7 to 2.6	-0.3 to 1.5	1
L	A-15 and A-16	1	B	70	1.3	0.2	1
Segment B							
M	A-21 and A-22	3	B	64 to 70	1.2 to 1.3	0.1 to 0.2	2
N	A-22	2	B, C	66 to 69	1.0 to 1.5	0 to 0.5	2
O	A-22	2	B	57	1.7 to 1.9	0.4 to 0.7	0
P	A-26 to A-28	6	B	58 to 67	1.0 to 2.8	0.1 to 1.9	2
Q	A-27	1	C	63	2.2	1.2	0
R	A-27 and A-28	1	B	60	1.8	0.8	0
Segment C							
S	A-29 and A-30	26	B	54 to 68	1.4 to 2.9	0.4 to 1.5	3
T	A-30	1	B	60	2.5	1.3	0
U	A-30 and A-31	1	B	65	1.3	0.2	0
V	A-31 and A-32	3	C	50 to 71	1.7 to 2.1	0.2 to 0.8	1
W	A-33 and A-34	20	B	57 to 70	2.0 to 4.6	0.9 to 3.3	12
X	A-35	2	B	68 to 69	2.1 to 2.6	1.0 to 1.4	2
Y	A-34 to A-36	7	B	62 to 73	1.8 to 3.1	0.7 to 1.7	4
Z	A-35 and A-36	34	B, C, D	56 to 69	1.7 to 2.9	0 to 1.3	10
AA	A-37 and A-38	4	B	68 to 72	2.8 to 3.9	1.8 to 3.3	4
AB	A-37 and A-38	26	B	61 to 73	2.0 to 4.6	0.6 to 4.8	14
AC	A-37 and A-38	15	B	59 to 71	2.8 to 3.6	1.7 to 2.8	8
AD	A-38	2	B	64 to 70	3.6 to 3.7	4.2 to 4.9	1
AE	A-38	2	B	65 to 67	3.2 to 3.3	3.0 to 3.3	1
TOTALS				**48 to 74**	**0.7 to 4.6**	**-0.3 to 4.9**	**114**

[1] Sound level ranges for interior NAC D sites are shown as the exterior equivalent sound level. A 25 dB(A) noise reduction factor was applied to the one interior site based on the building material and window type/condition per FHWA guidance. This calculated sound level was compared to the NAC to identify impacts. Refer to Appendix B for the predicted sound levels.

For a detailed list of existing, no build, and build condition noise levels by receptor, see **Appendix B**. Figures displaying the location of each receptor are provided in **Appendix A**. The graphics in **Appendix A** also illustrate the noise study area boundary as well as the modeled results for the 2048 Build Alternative.

Segment A

CNE A contains 118 receivers, representing 113 residential receptors and five recreational receptors (see **Table 5-5** and **Figures A-2 to A-4**). Under existing year (2019) conditions, five residential receptors are expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under design year (2048) no-build condition, 9 receptors representing 9 residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Under design year (2048) build condition, 16 receptors representing 16 residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were found to exceed the NAC, consideration of noise abatement is warranted for CNE A and is discussed in Section 7.4 below.

CNE B contains 28 receivers, representing 28 residential receptors (see **Table 5-5** and **Figures A-2 and A-3**). Under existing year (2019) conditions, 11 residential receptors are expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under design year (2048) no-build condition, 11 receptors representing 11 residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Under design year (2048) build condition, 11 receptors representing 11 residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were found to exceed the NAC, consideration of noise abatement is warranted for CNE B and is discussed in Section 7.4 below.

CNE C contains 10 receivers, representing 10 residential receptors (see **Table 5-5** and **Figures A-4 and A-5**). Under existing year (2019) conditions, one residential receptor is expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under design year (2048) no-build condition, one receptor representing one residence is expected to experience noise levels which approach or exceed the applicable NAC criterion. Under design year (2048) build condition, one receptor representing one residence is expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were found to exceed the NAC, consideration of noise abatement is warranted for CNE C and is discussed in Section 7.4 below.

CNE D contains four receivers, representing four residential receptors (see **Table 5-5** and **Figure A-5**). Under existing year (2019) conditions, three residential receptors are expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under design year (2048) no-build condition, three receptors representing three residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Under design year (2048) build condition, three receptors representing three residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were found to exceed the NAC, consideration of noise abatement is warranted for CNE D and is discussed in Section 7.4 below.

CNE E contains five receivers, representing five residential receptors (see **Table 5-5** and **Figures A-5 and A-6**). Under existing year (2019) conditions, no residential receptors are expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under design year (2048) no-build condition, one receptor representing one residence is expected to experience noise levels which approach or exceed the applicable NAC criterion. Under design year (2048) build condition, one receptor representing one residence is expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were found to exceed the NAC, consideration of noise abatement is warranted for CNE E and is discussed in Section 7.4 below.

CNE F contains seven receivers, representing seven residential receptors (see **Table 5-5** and **Figures A-5 and A-6**). Under existing year (2019) conditions, one residential receptor is expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under design year (2048) no-build condition, one receptor representing one residence is expected to experience noise levels which approach or exceed the applicable NAC criterion. Under design year (2048) build condition, one receptor representing one residence is expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were found to exceed the NAC, consideration of noise abatement is warranted for CNE F and is discussed in Section 7.4 below.

CNE G contains one receiver, representing one residential noise receptor (see **Table 5-5** and **Figure A-7**). Under existing year (2019) conditions, the residential receptor is not expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under the design year (2048) no-build condition, the residential receptor is not expected to experience noise levels which approach or exceed the applicable NAC criterion. Under the design year (2048) build condition, the residential receptor is not expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were not found to exceed the NAC, consideration of noise abatement is not warranted for CNE G and is not discussed in Section 7.4 below.

CNE H contains 17 receivers, representing 17 residential receptors (see **Table 5-5** and **Figures A-7 and A-8**). Under existing year (2019) conditions, three residential receptors are expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under design year (2048) no-build condition, four receptors representing four residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Under design year (2048) build condition, five receptors representing five residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were found to exceed the NAC, consideration of noise abatement is warranted for CNE H and is discussed in Section 7.4 below.

CNE I contains seven receivers, representing seven residential receptors (see **Table 5-5** and **Figures A-7 and A-8**). Under existing year (2019) conditions, one residential receptor is expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under design year (2048) no-build condition, two receptors representing two residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Under design year (2048) build condition, two receptors representing two residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were found to exceed the NAC, consideration of noise abatement is warranted for CNE I and is discussed in Section 7.4 below.

CNE J contains 17 receivers, representing four residential receptors and 13 recreational receptors (see **Table 5-5** and **Figure A-9**). Under existing year (2019) conditions, no residential or recreational receptors are expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under design year (2048) no-build condition, four receptors representing four recreational sites are expected to experience noise levels which approach or exceed the applicable NAC criterion. Under design year (2048) build condition, six receptors representing six recreational sites are expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were found to exceed the NAC, consideration of noise abatement is warranted for CNE J and is discussed in Section 7.4 below.

CNE K contains eight receivers, representing eight residential receptors (see **Table 5-5** and **Figures A-12 and A-13**). Under existing year (2019) conditions, one residential receptor is expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under design year (2048) no-build condition, one receptor representing one residence is expected to experience noise levels which approach or exceed the applicable NAC criterion. Under design year (2048) build condition, one receptor representing one residence is expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were found to exceed the NAC, consideration of noise abatement is warranted for CNE K and is discussed in Section 7.4 below.

CNE L contains one receiver representing a single residential receptor (see **Table 5-5** and **Figures A-15 and A-16**). Under existing year (2019) conditions, one residential receptor is expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under design year (2048) no-build condition, one receptor representing one residence is expected to experience noise levels which approach or exceed the applicable NAC criterion. Under design year (2048) build condition, one receptor representing one residence is expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were found to exceed the NAC, consideration of noise abatement is warranted for CNE L and is discussed in Section 7.4 below.

Segment B

CNE M contains three receivers, representing three residential receptors (see **Table 5-5** and **Figures A-21 and A-22**). Under existing year (2019) conditions, two residential receptors are expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under design year (2048) no-build condition, two receptors representing two residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Under design year (2048) build condition, two receptors representing two residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were found to exceed the NAC, consideration of noise abatement is warranted for CNE M and is discussed in Section 7.4 below.

CNE N contains two receivers, representing one residential receptor and one recreational receptor (see **Table 5-5** and **Figure A-22**). Under existing year (2019) conditions, one residential receptor is expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under design year (2048) no-build condition, two receptors representing one residence and one recreational site facility are expected to experience noise levels which approach or exceed the applicable NAC criterion. Under design year (2048) build condition, two receptors representing one residence and one recreational site are expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were found to exceed the NAC, consideration of noise abatement is warranted for CNE N and is discussed in Section 7.4 below.

CNE O contains two receivers, representing two residential receptors (see **Table 5-5** and **Figure A-22**). Under existing year (2019) conditions, none of the residential receptors are expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under the design year

(2048) no-build condition, the residential receptors are not expected to experience noise levels which approach or exceed the applicable NAC criterion. Under the design year (2048) build condition, the residential receptors are not expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were not found to exceed the NAC, consideration of noise abatement is not warranted for CNE O and is not discussed in Section 7.4 below.

CNE P contains six receivers, representing six residential receptors (see **Table 5-5** and **Figure A-26 to A-28**). Under the existing year (2019) conditions, none of the residential receptors is expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under the design year (2048) no build condition, one receptor representing one residence is expected to experience noise levels which approach or exceed the applicable NAC criterion. Under the design year (2048) build condition, two receptors representing two residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were found to exceed the NAC, consideration of noise abatement is warranted for CNE P and is discussed in Section 7.4 below.

CNE Q contains one receiver, representing one recreational receptor (see **Table 5-5** and **Figure A-27**). Under the existing year (2019) conditions, the recreational receptor is not expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under the design year (2048) no build condition, the recreational receptor is not expected to experience noise levels which approach or exceed the applicable NAC criterion. Under the design year (2048) build condition, the recreational receptor is not expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were not found to exceed the NAC, consideration of noise abatement is not warranted for CNE Q and is not discussed in Section 7.4 below.

CNE R contains one receiver, representing one residential receptor (see **Table 5-5** and **Figures A-27 and A-28**). Under the existing year (2019) conditions, the residential receptor is not expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under the design year (2048) no build condition, the residential receptor is not expected to experience noise levels which approach or exceed the applicable NAC criterion. Under the design year (2048) build condition, the residential receptor is not expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were not found to exceed the NAC, consideration of noise abatement is not warranted for CNE R and is not discussed in Section 7.4 below.

Segment C

CNE S contains 26 receivers, representing 26 residential receptors (see **Table 5-5** and **Figures A-29 and A-30**). Under the existing year (2019) conditions, two residential receptors are expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under the design year (2048) no build condition, two receptors representing two residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Under the design year (2048) build condition, three receptors representing three residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were found to exceed the NAC, consideration of noise abatement is warranted for CNE S and is discussed in Section 7.4 below.

CNE T contains one receiver, representing one residential receptor (see **Table 5-5** and **Figure A-30**). Under the existing year (2019) conditions, the residential receptor is not expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under the design year (2048) no build condition, the residential receptor is not expected to experience noise levels which approach or exceed the applicable NAC criterion. Under the design year (2048) build condition, the residential receptor is not expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were not found to exceed the NAC, consideration of noise abatement is not warranted for CNE T and is not discussed in Section 7.4 below.

CNE U contains one receiver, representing one residential receptor (see **Table 5-5** and **Figures A-30 and A-31**). Under the existing year (2019) conditions, the residential receptor is not expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under the design year (2048) no build condition, the residential receptor is not expected to experience noise levels which approach or exceed the applicable NAC criterion. Under the design year (2048) build condition, the residential receptor is not expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were not found to exceed the NAC, consideration of noise abatement is not warranted for CNE U and is not discussed in Section 7.4 below.

CNE V contains three receivers, representing three recreational receptors (see **Table 5-5** and **Figures A-31 and A-32**). Under the existing year (2019) conditions, one recreational receptor is expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under the design year (2048) no build condition, one receptor representing one recreational site is expected to experience noise levels which approach or exceed the applicable NAC criterion. Under the design year (2048) build condition, one receptor representing one recreational site is expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were found to exceed the NAC, consideration of noise abatement is warranted for CNE V and is discussed in Section 7.4 below.

CNE W contains 20 receiver(s), representing 20 residential receptors (see **Table 5-5** and **Figures A-33 and A-34**). Under the existing year (2019) conditions, six residential receptors are expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under the design year (2048) no build condition, eight receptors representing eight residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Under the design year (2048) build condition, 12 receptors representing 12 residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were found to exceed the NAC, consideration of noise abatement is warranted for CNE W and is discussed in Section 7.4 below.

CNE X contains two receivers, representing two residential receptors (see **Table 5-5** and **Figure A-35**). Under the existing year (2019) conditions, two residential receptors are expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under the design year (2048) no build condition, two receptors representing two residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Under the design year (2048) build condition, two receptors representing two residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were found to exceed the NAC, consideration of noise abatement is warranted for CNE X and is discussed in Section 7.4 below.

CNE Y contains seven receivers, representing seven residential receptors (see **Table 5-5** and **Figures A-34 to A-36**). Under the existing year (2019) conditions, four residential receptors are expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under the design year (2048) no build condition, four receptors representing four residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Under the design year (2048) build condition, four receptors representing four residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were found to exceed the NAC, consideration of noise abatement is warranted for CNE Y and is discussed in Section 7.4 below.

CNE Z contains 34 receiver(s), representing five residential receptors, 28 recreational receptors, and one interior receptor (see **Table 5-5** and **Figures A-35 and A-36**). Under the existing year (2019) conditions, three recreational receptors are expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under the design year (2048) no build condition, five receptors representing one residence and four recreational sites are expected to experience noise levels which approach or exceed the applicable NAC criterion. Under the design year (2048) build condition, 10 receptors representing one residential and nine recreational sites are expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were found to exceed the NAC, consideration of noise abatement is warranted for CNE Z and is discussed in Section 7.4 below.

CNE AA contains four receivers, representing four residential receptors (see **Table 5-5** and **Figures A-37 and A-38**). Under the existing year (2019) conditions, three residential receptors are expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under the design year (2048) no build condition, four receptors representing four residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Under the design year (2048) build condition, four receptors representing four residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were found to exceed the NAC, consideration of noise abatement is warranted for CNE AA and is discussed in Section 7.4 below.

CNE AB contains 26 receivers, representing 26 residential receptors (see **Table 5-5** and **Figures A-37 and A-38**). Under the existing year (2019) conditions, six residential receptors are expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under the design year (2048) no build condition, three receptors representing three residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Under the design year (2048) build condition, 14 receptor(s) representing 14 residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were found to exceed the NAC, consideration of noise abatement is warranted for CNE AB and is discussed in Section 7.4 below.

CNE AC contains 12 receivers, representing 15 residential receptors (see **Table 5-5** and **Figures A-37 and A-38**). Under the existing year (2019) conditions, four receivers representing six residential receptors are expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under the design year (2048) no build condition, four receptors representing six residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Under the design year (2048) build condition, six receptors representing eight residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were found to exceed the NAC, consideration of noise abatement is warranted for CNE AC and is discussed in Section 7.4 below.

CNE AD contains two receiver(s), representing two residential receptors (see **Table 5-5 and Figure A-38**). Under the existing year (2019) conditions, one residential receptor is expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under the design year (2048) no build condition, neither of the receptors are expected to experience noise levels which approach or exceed the applicable NAC criterion. Under the design year (2048) build condition, one receptor representing one residence is expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were found to exceed the NAC, consideration of noise abatement is warranted for CNE AD and is discussed in Section 7.4 below.

CNE AE contains two receivers, representing two residential receptors (see **Table 5-5 and Figure A-38**). Under the existing year (2019) conditions, neither of the residential receptors are expected to experience noise levels which approach or exceed the applicable NAC criterion (see Appendix B). Under the design year (2048) no build condition, neither of the receptors representing residences are expected to experience noise levels which approach or exceed the applicable NAC criterion. Under the design year (2048) build condition, one receptor representing one residence is expected to experience noise levels which approach or exceed the applicable NAC criterion. Since design year build noise levels were found to exceed the NAC, consideration of noise abatement is warranted for CNE AE and is discussed in Section 7.4 below.

6.3 Constructive Use Evaluation of Section 4(f) Properties

23 CFR 774.15(f) states that a noise-related constructive use does not occur if one of two conditions are meet. The first condition is that the predicted noise levels do not exceed the applicable NAC. The second condition is that, if the projected noise levels exceed the relevant NAC because of high existing noise, the increase in the projected noise levels if the proposed project is constructed, when compared with the projected noise levels if the project is not built, is barely perceptible (3 dB(A) or less). Based on these conditions, none of the Section 4(f) properties located within the study area are expected to experience a constructive use due to the presence of intensification of highway noise (see **Table 6-2**).

Table 6-2. Noise Condition Summary for Section 4(f) Resources

4(f) Property	Representative Receptor	Loudest Hour Noise Levels			
		Existing	No Build Alternative	Build Alternative (2048)	Relative Change Between No Build and Build
Pine Forest Park	J-05	59	60	61	1
	J-06	61	62	63	1
	J-07	62	63	64	1
	J-08	62	63	64	1
	J-09	62	64	65	1
	J-10	64	65	66	1
	J-11	65	66	67	1
	J-12	65	66	67	1
	J-13	65	67	68	1
	J-14	65	66	67	1
	J-15	63	65	66	1
	J-16	61	63	64	1
Area Identified as Fields at Pine Forest Park	J-17	59	61	61	0

7.0 Noise Abatement Determination

Noise Abatement Determination has three phases. The first phase determines if highway traffic noise abatement consideration is warranted for the affected communities and/or affected receptors. The warranted criterion specifically pertains to traffic noise impacted receptors, defined back in **Section 6.0**. Since predicted noise levels for the future design year (2048) build condition either approach or exceed the NAC, per VDOT's *State Noise Abatement Policy*, noise abatement considerations are warranted for these impacted noise sensitive areas.

Once noise abatement consideration is determined to be warranted, the process proceeds to Phases 2 and 3. These phases address the feasibility and reasonableness, respectively, of the noise abatement measures being considered. The criteria associated with these measures is discussed in **Sections 7.1** and **7.2**. Following the completion of all three phases, a determination can be made regarding the feasibility and reasonableness of the noise abatement options.

7.1 Abatement Measures Evaluation

FHWA/VDOT guidelines recommend a variety of mitigation measures that should be considered in response to transportation-related noise impacts. While noise barriers and/or earth berms are generally the most effective form of noise mitigation, additional mitigation measures exist which have the potential to provide considerable noise reductions, under certain circumstances. Mitigation measures considered for this project include:

- Traffic control measures;
- Alteration of horizontal and vertical alignments;
- Acoustical insulation of public use and non-profit facilities;
- Acquisition of buffering land;
- Construction of noise barriers; and
- Construction of earth berms.

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

> *"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 will be given to these measures during the final design stage, where feasible."*

7.1.1 Traffic Control Measures (TCM)

Traffic control measures, such as speed limit restrictions, truck traffic restrictions, and other traffic control measures that may be considered for the reduction of noise emission levels are not practical for this project. These traffic control measures would be counterproductive to the project's objective of alleviating traffic and reducing congestion. Reducing speeds will not be an effective noise mitigation measure since a substantial decrease in speed is necessary to provide adequate noise reduction. Typically, a 10-mph reduction in speed will result in only a 2 dB(A) decrease in noise level, which would not effectively reduce impacts.

7.1.2 Alteration of Horizontal and Vertical Alignments

The alteration of the horizontal and vertical alignment has been considered to reduce or eliminate the impacts created by the proposed project. Shifting the horizontal alignment to the outside or inside will create undesirable impacts such as right-of-way acquisition, temporary/permanent easements, and retaining walls. Furthermore, shifting the roadway alignment away from the impacted residences will increase impacts to other residences located on the opposite side of the interstate.

7.1.3 Acoustical Insulation of Public Use and Non-Profit Facilities

This noise abatement measure option applies only to public and institutional use buildings. Since no public use or institutional structures are anticipated to have interior noise levels exceeding FHWA's interior NAC, this noise abatement option will not be applied.

7.1.4 Acquisition of Buffering Land

The purchase of property for the creation of a "buffer zone" to reduce noise impacts is only considered for predominantly unimproved properties. This is because the amount of property required for this option to be effective can create significant additional impacts (e.g., in terms of residential displacements). In urbanized areas, the social and financial cost of displacements outweigh the acoustic benefits.

7.1.5 Construction of Berms & Noise Barriers

Construction of noise barriers can be an effective way to reduce noise levels in areas of outdoor activity. Noise barriers can be wall structures, earthen berms, or a combination of the two. The effectiveness of a noise barrier depends on the distance and elevation difference between roadway and receptor and the available placement location for a barrier. Gaps between overlapping noise barriers also decrease the effectiveness of the barrier, as opposed to a single continuous barrier. The barrier's ability to attenuate noise decreases as the gap width increases.

Noise barriers and earth berms are often implemented into the highway design in response to the identified noise impacts. The effectiveness of a freestanding (post and panel) noise barrier and an earth berm of equivalent height are relatively consistent; however, an earth berm is perceived as a more aesthetically pleasing option. In contrast, the use of earth berms is not always an option due to the excessive space they require adjacent to the roadway. At a standard slope of 2:1, every foot in height would require four feet of horizontal width. This requirement becomes more difficult to meet in urban settings where residential properties often abut the target roadway. In these situations, implementation of earth berms can require significant property acquisitions to accommodate noise mitigation, and the cost associated with the acquisition of property to construct a berm can significantly increase the total cost to implement this form of noise mitigation to the point it becomes unreasonable.

Availability of fill material to construct the berm also needs to be considered. On proposed projects where proposed grading yields excess waste material, earth berms can often be a cost-effective mitigation option. On balance or borrow projects the implementation of earth berms is often an expensive solution due to the need to identify, acquire, and transport the material to the project site. Earth berms may be considered a viable mitigation option throughout the project area and would be evaluated further where possible in the final design stage.

As a general practice, noise barriers are most effective when placed at a relatively high point between the roadway and the impacted noise sensitive land use. To achieve the greatest benefit from a potential noise barrier, the goal of the barrier should focus on breaking the line-of-sight (to the greatest degree possible) from the roadway to the receptor. In roadway fill conditions, where the highway is above the natural grade, noise barriers are typically most effective when placed on the edge of the roadway shoulder or on top of the fill slope. In roadway cut conditions, where the roadway is located below the natural grade, barriers are typically most effective when placed at the top of the cut slope. Engineering and safety issues have the potential to alter these typical barrier locations.

7.2 Feasibility Criterion for Noise Barriers

All receptors that meet the warranted criterion must progress to the "feasible" phase. Phase 2 of the noise abatement criteria requires that both of the following acoustical and engineering conditions be met:

- At least a 5 dB(A) highway traffic noise reduction at impacted receptors. Per 23 CFR 772, FHWA requires the highway agency to determine the number of impacted receptors required to achieve at least 5 dB(A) of reduction. VDOT requires that fifty percent (50%) or more of the impacted receptors experience five (5) dB(A) or more of insertion loss to be feasible; and
- The determination that it is possible to design and construct the noise abatement measure. Factors related to the design and construction would include safety, barrier height, topography, drainage, utilities, and maintenance of the abatement measure, maintenance access to adjacent properties, and general access to adjacent properties (i.e., arterial widening projects).

The noise abatement measure is said to be feasible if it meets both criteria.

7.3 Reasonableness Criteria

All receptors that meet the feasibility criterion must progress to the "reasonableness" phase. Phase 3 of the noise abatement criteria requires that all of the following conditions be considered:

- VDOT's Noise Reduction Design Goal,
- Cost-effectiveness Value, and
- The viewpoints of the Benefited Receptors.

7.3.1 Noise Reduction Design Goal

The design goal is a reasonableness factor indicating a specific reduction in noise levels that VDOT uses to identify that a noise abatement measure effectively reduces noise. The design goal establishes a criterion, selected by VDOT, which noise abatement must achieve. VDOT's noise reduction design goal is defined as a 7 dB(A) of insertion loss for at least one impacted receptor, meaning that at least one impacted receptor is predicted to achieve a 7 dB(A) or greater noise reduction with the proposed barrier in place. The design goal is not the same as acoustic feasibility, which defines the minimum level of effectiveness for a noise abatement measure. Acoustic feasibility indicates that the noise abatement measure can, at a minimum, achieve a discernible reduction in noise levels.

Noise reduction is measured by comparing the future design year build condition pre-and post-barrier noise levels. This difference between unabated and abated noise levels is known as "insertion loss" (IL). It is important to optimize the noise barrier design to achieve the most effective noise barrier in terms of both noise reduction (insertion losses) and cost. Although at least a 5 dB(A) reduction is required to meet the feasibility criteria, the following tiered noise barrier abatement goals are used to govern barrier design and optimization:

- Reduction of future highway traffic noise by 7 dB(A) at one (1) or more of the impacted receptor sites (required criterion),
- Reduction of future highway traffic noise levels to the low-60-decibel range when practical (desirable), and
- Reduction of future highway traffic noise levels to existing noise levels when practical (desirable).

7.3.2 Cost-effectiveness

Typically, the limiting factor related to barrier reasonableness is the cost effectiveness value, where the total surface area of the barrier is divided by the number of benefited receptors receiving at least a five dB(A) reduction in noise level. VDOT's approved cost is based on a maximum square footage of abatement per benefited receptor, a maximum value of 1,600 square feet per benefited receptor (SF/BR).

Where multi-family housing includes balconies at elevations that exceed a 30-foot-high noise barrier or the topography causes receptors to be above the elevation of a 30-foot barrier, these receptors are not assessed for barrier benefits and are not included in the computation of the barrier's reasonableness.

For non-residential properties such as parks and public use facilities, a special calculation is performed to quantify the type and duration of activity and compare to the cost effectiveness criterion. The determination is based on cost, severity of impact (both in terms of noise levels and the size of the impacted area and the activity it contains), and amount of noise reduction.

7.3.3 The Viewpoints of the Benefited Receptors

VDOT shall solicit the viewpoints of all benefited receptors through certified mailings and obtain enough responses to document a decision as to whether there is a desire for the proposed noise abatement measure. Fifty percent (50%) or more of the respondents shall be required to favor the noise abatement measure in determining reasonableness. Community views in and of themselves are not sufficient for a barrier to be found reasonable if one or both of the other two reasonableness criteria are not satisfied.

7.4 Noise Barrier Evaluation

Of the 34 noise barriers assessed in this preliminary study, five new noise barriers evaluated in the Build alternative were found to be both feasible and reasonable per the VDOT three-phased approach to noise abatement determination and, as such, are recommended for further consideration during final design. The abatement determinations made in this section will be re-evaluated when the project enters final design.

At an average of 1,563 square feet of abatement per benefited receptor, the five recommended barriers total 8,546 feet in length and 168,319 square feet in area and would benefit 23 recreational locations and 73 residences. Of the 44 impacted receptors benefited by the recommended barriers, 73 percent, or 32 receptors, would receive the desired noise reduction design goal of 7-dB(A) insertion loss.

Noise barriers have the potential to reflect sound from the highway; this effect typically occurs with parallel noise barriers (*i.e.*, a barrier located on both sides of the highway) or combinations of noise barriers and retaining walls. Typically, reflected noise occurs when the distance between reflective surfaces is less than 20 times the height of the barriers. At this distance, the barriers can create reverberations by reflecting sound back and forth across a roadway multiple times, potentially increasing noise levels at receptors and degrading acoustical performance in both barriers. As currently proposed, there are two proposed barriers that would fall under the definition of parallel noise barriers. The distance between Barriers A and B is less than 20 times the height and therefore absorptive materials are recommended for Barrier A and Barrier B. The location of barriers will be reassessed during final design to identify any potential for reflective noise.

The proposed barrier locations are shown on the graphics located in **Appendix A**. A summary of the evaluated proposed barriers is shown in **Table 7-1**. **Appendix H** lists the Build Alternative (2048) noise levels, the abated noise levels, and the net insertion losses for the proposed barriers and barrier systems that were evaluated. Also, **Appendix H** contains start-end coordinates, top and bottom elevations, and absolute elevation and heights of all proposed noise barriers at per-panel resolution. Warranted, Feasible, and Reasonable Worksheets for the evaluated barriers are included in **Appendix I**.

Table 7-1. Summary of Evaluated Noise Barriers

Barrier Name	CNE	Total Benefited Receptors	Average Noise Reduction (dB(A))[1]	Barrier Length (ft.)	Barrier Height Range (ft.)	Average Barrier Height (ft.)	Barrier Surface Area (SF)	Surface Area per Benefited Receptor (sq.ft./BR)	Barrier Cost ($42/sq.ft.)	Feasible	Reasonable
Segment A											
Barrier A	***A***	***49***	***7***	***3,560***	***12 to 26***	***20.2***	***71,994***	***1,469***	***$3,023,748***	***Yes***	***Yes***
Barrier A1	***A***	***10***	***8***	***713***	***12 to 30***	***22.3***	***15,905***	***1,591***	***$668,010***	***Yes***	***Yes***
Barrier A2	A	1	7	454	26	26.0	11,771	11,771	$494,382	Yes	No
Barrier B	***B***	***20***	***8***	***1,838***	***12 to 18***	***16.4***	***30,168***	***1,508***	***$1,267,056***	***Yes***	***Yes***
Barrier C	C	2	6	748	16	16.0	11,999	6,000	$503,958	Yes	No
Barrier D1	D	1	7	1,563	24 to 26	24.7	38,637	38,637	$1,622,754	Yes	No
Barrier D2	D	2	8	1,152	20	20.0	23,002	11,501	$966,084	Yes	No
Barrier E	E	2	6	1,345	18	18.0	24,291	12,146	$1,020,222	Yes	No
Barrier F	F	3	7	1,752	16 to 20	19.6	34,305	11,435	$1,440,810	Yes	No
Barrier H1	H	2	8	499	12	12.0	5,999	3,000	$251,958	Yes	No
Barrier H2	H	3	6	1,548	16 to 18	16.3	25,307	8,436	$1,062,894	Yes	No
Barrier H3	H	4	5	1,850	22	22.0	40,665	10,166	$1,707,930	Yes	No
Barrier I1	I	2	6	849	12 to 30	20.2	17,198	8,599	$ 722,316	Yes	No
Barrier I2	I	2	6	949	22	22.0	20,889	10,445	$877,338	Yes	No
Barrier J	J	9	7	1,604	18 to 26	23.9	38,315	4,257	$1,609,230	Yes	No
Barrier K	K	1	7	498	20	20.0	10,002	10,002	$420,084	Yes	No
Barrier L	L	1	7	807	14	14.0	11,287	11,287	$474,054	Yes	No
Segment B											
Barrier M	M	3	5	1,199	24	24.0	28,793	9,598	$1,209,306	Yes	No
Barrier N	N	2	7	1,019	22	22.0	22,439	11,220	$942,438	Yes	No
Barrier P	P	3	7	1,373	30	30.0	41,132	13,711	$1,727,544	Yes	No
Segment C											
Barrier S	S	11	6	1,380	16 to 30	21.2	29,270	2,661	$1,229,340	Yes	No
Barrier V	V	1	7	770	18	18.0	13,882	13,882	$583,044	Yes	No
Barrier W1	W	14	6	3,500	8 to 24	15.4	54,042	3,860	$2,269,764	Yes	No
Barrier W2	W	2	6	1,348	16 to 20	19.1	25,615	12,808	$1,075,830	Yes	No
Barrier X	X	2	6	1,915	8 to 20	13.6	26,193	13,097	$1,100,106	Yes	No
Barrier Y1	Y	1	7	1,263	22 to 30	28.4	35,866	35,866	$1,506,372	Yes	No
Barrier Y2	Y	2	6	1,813	12 to 20	15.4	28,063	14,032	$1,178,646	Yes	No
Barrier Y3	Y	1	7	813	20 to 30	25.2	20,448	20,448	$858,816	Yes	No
Barrier Z	***Z***	***26***	***6***	***1,545***	***20 to 30***	***26.3***	***40,657***	***1,564***	***$1,707,594***	***Yes***	***Yes***
Barrier AA	AA	4	6	1,170	12 to 20	16.5	19,359	4,840	$813,078	Yes	No
Barrier AB	AB	15	6	4,490	8 to 16	12.7	56,852	3,790	$2,387,784	Yes	No
Barrier AC	***AC***	***6***	***5***	***890***	***9 to 13***	***10.8***	***9,595***	***1,599***	***$402,990***	***Yes***	***Yes***
Extended Barrier AC	AC, AE	10	6	2,669	10 to 16	11.3	29,932	2,993	$1,257,144	Yes	No
Barrier AD	AD	2	6	1,270	20 to 30	24.0	30,461	15,231	$1,279,362	Yes	No

1 Average reduction for benefited receptors.

Segment A

Barrier A

Barrier A, shown on Figures A-2 and A-3, was evaluated to address 11 impacted residential receptors in CNE A. Barrier A is located along the eastbound travel lanes of I-64 and extends east of New Kent Highway. Barrier A is comprised of a single and continuous ground-mounted noise wall. The barrier ranges in height from 12 to 26 feet and has an average height of 20.2 feet. The evaluated barrier has a length of 3,560 feet and a total surface area of 71,994 square feet. Barrier A benefits all 11 impacted receptors, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier A also benefits 38 non-impacted receptors. Based on current design documents, Barrier A does not contain any site features that would appear to affect the engineering feasibility of construction. Barrier A satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of 66 benefited receptors, Barrier A is considered reasonable since the square footage per benefited receptor ratio is 1,469 SF/BR, which is less than the maximum SF/BR of 1,600.

Based on the current design information, Barrier A meets VDOT's feasibility and reasonableness criterion and therefore is recommended for further consideration during final design.

Barrier A1

Barrier A1, shown on Figure A-4, was evaluated to address four impacted residential receptors in CNE A. Barrier A1 is located along the eastbound travel lanes of I-64 and extends west from Henpeck Road. Barrier A1 is comprised of a single and continuous ground-mounted noise wall. The barrier ranges in height from 12 to 30 feet, then tapers to ground at the western edge, and has an average height of 22.3 feet. The evaluated barrier has a length of 713 feet and a total surface area of 15,905 square feet. Barrier A1 benefits all four impacted receptors, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier A1 also benefits six non-impacted receptors. Based on current design documents, Barrier A1 does not contain any site features that would appear to affect the engineering feasibility of construction. Barrier A1 satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of 10 benefited receptors, Barrier A1 is considered reasonable since the square footage per benefited receptor ratio is 1,591 SF/BR, which is less than the maximum SF/BR of 1,600.

Based on the current design information, Barrier A1 meets VDOT's feasibility and reasonableness criterion and therefore is recommended for further consideration during final design.

Barrier A2

Barrier A2, shown on Figure A-4, was evaluated to address a single impacted residential receptor in CNE A. Barrier A2 is located along the eastbound travel lanes of I-64 and extends east from Henpeck Road. Barrier A2 is comprised of a single and continuous ground-mounted noise wall. The barrier height is 26 feet. The evaluated barrier has a length of 454 feet and a total surface area of 11,771 square feet. Barrier A2 benefits the one impacted receptor, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier A2 does not benefit any non-impacted receptors. Based on current design documents, Barrier A2 does not contain any site features that would appear to affect the engineering feasibility of construction. Barrier A2 satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of one benefited receptor, Barrier A2 is not considered reasonable since the square footage per benefited receptor ratio is 11,771 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier A2 meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier B

Barrier B, shown on Figures A-2 and A-3, was evaluated to address 11 impacted residential receptors in CNE B. Barrier B is located along the westbound travel lanes of I-64 and extends east of New Kent Highway. Barrier B is comprised of a single and continuous ground-mounted noise wall. The barrier ranges in height from 12 to 18 feet and has an average height of 16.4 feet. The evaluated barrier has a length of 1,838 feet and a total surface area of 30,168 square feet. Barrier B benefits all 11 impacted receptors, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier B also benefits nine non-impacted receptors. Based on current design documents, Barrier B does not contain any site features that would appear to affect the engineering feasibility of construction. Barrier B satisfies VDOT's noise reduction design goal by providing a 7 a dB(A) noise reduction to at least one impacted receptor. With a total of 20 benefited receptors, Barrier B is considered reasonable since the square footage per benefitted receptor ratio is 1,508 SF/BR, which is less than the maximum SF/BR of 1,600.

Based on the current design information, Barrier B meets VDOT's feasibility and reasonableness criterion and therefore is recommended for further consideration during final design.

Barrier C

Barrier C, shown on Figure A-4, was evaluated to address a single impacted residential receptor in CNE C. Barrier C is located along the westbound travel lanes of I-64 and extends west from Henpeck Road. Barrier C is comprised of a single and continuous ground-mounted noise wall. The barrier height is 16 feet. The evaluated barrier has a length of 748 feet and a total surface area of 11,999 square feet. Barrier C benefits the one impacted receptor, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier C also benefits one non-impacted receptor. Based on current design documents, Barrier C does not contain any site features that would appear to affect the engineering feasibility of construction. Barrier C satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of two benefited receptors, Barrier C is not considered reasonable since the square footage per benefited receptor ratio is 6,000 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier C meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier D1

Barrier D1, shown on Figure A-5, was evaluated to address a single impacted residential receptor in CNE D. Barrier D1 is located along the eastbound travel lanes of I-64 between Henpeck Road and Old Roxbury Road. Barrier D1 is comprised of two overlapping ground-mounted noise walls that allow existing drainage features to remain in place. The barrier ranges in height from 24 to 26 feet and has an average height of

24.7 feet. The evaluated barrier has a length of 1,563 feet and a total surface area of 38,637 square feet. Barrier D1 benefits the one impacted receptor, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier D1 does not benefit any non-impacted receptors. Based on current design documents, Barrier D1 does not contain any site features that would appear to affect the engineering feasibility of construction. Barrier D1 satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of one benefited receptor, Barrier D1 is not considered reasonable since the square footage per benefited receptor ratio is 38,637 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier D1 meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier D2

Barrier D2, shown on Figures A-5 and A-6, was evaluated to address two impacted residential receptors in CNE D. Barrier D2 is located along the eastbound travel lanes of I-64 west of Old Roxbury Road. Barrier D2 is comprised of a single ground-mounted noise wall. The barrier height is 20 feet. The evaluated barrier has a length of 1,152 feet and a total surface area of 23,002 square feet. Barrier D2 benefits two impacted receptors, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier D2 does not benefit any non-impacted receptors. Based on current design documents, Barrier D2 does not contain any site features that would appear to affect the engineering feasibility of construction. Barrier D2 satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of two benefited receptors, Barrier D2 is not considered reasonable since the square footage per benefited receptor ratio is 11,501 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier D2 meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier E

Barrier E, shown on Figures A-5 and A-6, was evaluated to address a single impacted residential receptor in CNE E. Barrier E is located along the westbound travel lanes of I-64 east of Old Roxbury Road. Barrier E is comprised of two overlapping ground-mounted noise walls that allow existing drainage features to remain in place. The barrier height is 18 feet. The evaluated barrier has a length of 1,345 feet and a total surface area of 24,291 square feet. Barrier E benefits the one impacted receptor, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier E also benefits one non-impacted receptor. Based on current design documents, Barrier E does not contain any site features that would appear to affect the engineering feasibility of construction. Barrier E satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of two benefited receptors, Barrier E is not considered reasonable since the square footage per benefited receptor ratio is 12,146 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier E meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier F

Barrier F, shown on Figure A-6, was evaluated to address a single impacted residential receptor in CNE F. Barrier F is located along the eastbound travel lanes of I-64 east of Old Roxbury Road. Barrier F is comprised of two overlapping ground-mounted noise walls that allow existing drainage features to remain in place. The barrier ranges in height from 16 to 20 feet and has an average height of 19.6 feet. The evaluated barrier has a length of 1,752 feet and a total surface area of 34,305 square feet. Barrier F benefits the one impacted receptor, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier F also benefits two non-impacted receptors. Based on current design documents, Barrier F does not contain any site features that would appear to affect the engineering feasibility of construction. Barrier F satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of three benefited receptors, Barrier F is not considered reasonable since the square footage per benefited receptor ratio is 11,435 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier F meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier H1

Barrier H1, shown on Figure A-7, was evaluated to address two impacted residential receptors in CNE H. Barrier H1 is located along the westbound travel lanes of I-64 east of Airport Road. Barrier H1 is comprised a single ground-mounted noise wall. The barrier height is 12 feet. The evaluated barrier has a length of 499 feet and a total surface area of 5,999 square feet. Barrier H1 benefits two impacted receptors, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier H1 does not benefit any non-impacted receptors. Based on current design documents, Barrier H1 does not contain any site features that would appear to affect the engineering feasibility of construction. Barrier H1 satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of two benefited receptors, Barrier H1 is not considered reasonable since the square footage per benefited receptor ratio is 3,000 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier H1 meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier H2

Barrier H2, shown on Figure A-8, was evaluated to address two impacted receptors in CNE H. Barrier H2 is located along the westbound travel lanes of I-64 east of Airport Road. Barrier H2 is comprised of three overlapping ground-mounted noise walls that allow existing drainage features to remain in place. The barrier ranges in height from 16 to 18 feet and has an average height of 16.3 feet. The evaluated barrier has a length of 1,548 feet and a total surface area of 25,307 square feet. Barrier H2 benefits two impacted receptors, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier H2 also benefits one non-impacted receptor. Based on current design documents, Barrier H2 does not contain any site features that would appear to affect the engineering feasibility of construction. Barrier H2 satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of three benefited receptors, Barrier H2 is not considered reasonable since the square footage per benefited receptor ratio is 8,436 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier H2 meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier H3

Barrier H3, shown on Figure A-8, was evaluated to address one impacted receptor in CNE H. Barrier H3 is located along the westbound travel lanes of I-64 east of Airport Road. Barrier H3 is comprised of a single ground-mounted noise wall. The barrier height is 22 feet. The evaluated barrier has a length of 1,850 feet and a total surface area of 40,665 square feet. Barrier H3 benefits one impacted receptor, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier H3 also benefits three non-impacted receptors. Based on current design documents, Barrier H3 does not contain any site features that would appear to affect the engineering feasibility of construction. Barrier H3 satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of four benefited receptors, Barrier H2 is not considered reasonable since the square footage per benefited receptor ratio is 10,166 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier H3 meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier I1

Barrier I1, shown on Figure A-7, was evaluated to address a single impacted residential receptor in CNE I. Barrier I1 is located along the eastbound travel lanes of I-64 and extends east from Airport Road. Barrier I1 is comprised of a single ground-mounted noise wall. The barrier ranges in height from 12 to 30 feet and has an average height of 20.2 feet. The evaluated barrier has a length of 849 feet and a total surface area of 17,198 square feet. Barrier I1 benefits the one impacted receptor, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier I1 also benefits one non-impacted receptor. Based on current design documents, Barrier I1 does not contain any site features that would appear to affect the engineering feasibility of construction. Barrier I1 satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of two benefited receptors, Barrier I1 is not considered reasonable since the square footage per benefited receptor ratio is 8,599 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier I1 meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier I2

Barrier I2, shown on Figure A-8, was evaluated to address a single impacted residential receptor in CNE I. Barrier I2 is located along the eastbound travel lanes of I-64 east of Airport Road. Barrier I2 is comprised of a single ground-mounted noise wall. The barrier height is 22 feet. The evaluated barrier has a length of

949 feet and a total surface area of 20,889 square feet. Barrier I2 benefits the one impacted receptor, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier I2 also benefits one non-impacted receptor. Based on current design documents, Barrier I2 does not contain any site features that would appear to affect the engineering feasibility of construction. Barrier I2 satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of two benefited receptors, Barrier I2 is not considered reasonable since the square footage per benefited receptor ratio is 10,445 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier I2 meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier J

Barrier J, shown on Figure A-9, was evaluated to address six impacted community recreational receptors in CNE J. Barrier J is located along the westbound travel lanes of I-64 west of Emmaus Church Road. Barrier J is comprised of two overlapping ground-mounted noise walls that allow existing drainage features to remain in place. The barrier ranges in height from 18 to 26 feet and has an average height of 23.9 feet. The evaluated barrier has a length of 1,604 feet and a total surface area of 38,315 square feet. Barrier J benefits six impacted receptors, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier J also benefits three non-impacted receptors. Based on current design documents, Barrier J does not contain any site features that would appear to affect the engineering feasibility of construction. Barrier J satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of nine benefited receptors, Barrier J is not considered reasonable since the square footage per benefited receptor ratio is 4,257 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier J meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier K

Barrier K, shown on Figure A-12, was evaluated to address a single impacted residential receptor in CNE K. Barrier K is located along the eastbound travel lanes of I-64 and extends east from Olivet Church Road. Barrier K is comprised of a single ground-mounted noise wall. The barrier height is 20 feet. The evaluated barrier has a length of 498 feet and a total surface area of 10,002 square feet. Barrier K benefits one impacted receptor, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier K does not benefit any non-impacted receptors. Based on current design documents, Barrier K does not contain any site features that would appear to affect the engineering feasibility of construction. Barrier K satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of one benefited receptor, Barrier K is not considered reasonable since the square footage per benefited receptor ratio is 10,002 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier K meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier L

Barrier L, shown on Figures A-15 and A-16, was evaluated to address a single impacted residential receptor in CNE L. Barrier L is located along the eastbound travel lanes of I-64 east of North Courthouse Road. Barrier L is comprised of a single ground-mounted noise wall. The barrier height is 14 feet. The evaluated barrier has a length of 807 feet and a total surface area of 11,287 square feet. Barrier L benefits one impacted receptor, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier L does not benefit any non-impacted receptors. Based on current design documents, Barrier L does not contain any site features that would appear to affect the engineering feasibility of construction. Barrier L satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of one benefited receptor, Barrier L is not considered reasonable since the square footage per benefited receptor ratio is 11,287 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier L meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

<u>Segment B</u>

Barrier M

Barrier M, shown on Figures A-21 and A-22, was evaluated to address two impacted residential receptors in CNE M. Barrier M is located along the westbound travel lanes of I-64 and extends east from Good Hope Road. Barrier M is comprised of a single ground-mounted noise wall. The barrier height is 24 feet. The evaluated barrier has a length of 1,199 feet and a total surface area of 28,793 square feet. Barrier M benefits two impacted receptors, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier M also benefits one non-impacted receptor. Based on current design documents, Barrier M does not contain any site features that would appear to affect the engineering feasibility of construction. Barrier M satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of three benefited receptors, Barrier M is not considered reasonable since the square footage per benefited receptor ratio is 9,598 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier M meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier N

Barrier N, shown on Figure A-22, was evaluated to address two impacted receptors (one residential and one community facility) in CNE N. Barrier N is located along the eastbound travel lanes of I-64 east of Good Hope Road. Barrier N is comprised of a single ground-mounted noise wall. The barrier height is 22 feet. The evaluated barrier has a length of 1,019 feet and a total area of 22,439 square feet. Barrier N benefits two impacted receptors, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier N does not benefit any non-impacted receptors. Based on current design documents, Barrier N does not contain any site features that would appear to affect the engineering feasibility of construction. Barrier N satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of two benefited receptors, Barrier N is not considered reasonable since the square footage per benefited receptor ratio is 11,220 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier N meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier P

Barrier P, shown on Figure A-27, was evaluated to address two impacted residential receptors in CNE P. Barrier P is located along the westbound travel lanes of I-64 and extends west from Ropers Church Road. Barrier P is comprised of a single and continuous ground-mounted noise wall. The barrier height is 30 feet. The evaluated barrier has a length of 1,373 feet and a total surface area of 41,132 square feet. Barrier P benefits two impacted receptors, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier P also benefits one non-impacted receptors. Based on current design documents, Barrier P does not contain any site features that would affect the engineering feasibility of construction. Barrier P does not satisfy VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of three benefited receptors, Barrier P is not considered reasonable since the square footage per benefited receptor ratio is 13,711 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier P meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness and noise reduction. However, this barrier will be reevaluated during final design.

<u>Segment C</u>

Barrier S

Barrier S, shown on Figures A-29 and A-30, was evaluated to address three impacted residential receptors in CNE S. Barrier S is located along the eastbound travel lanes of I-64 northwest of Barnes Road. Barrier S is comprised of a single and continuous ground-mounted noise wall. The barrier ranges in height from 16 to 30 feet and has an average height of 21.2 feet. The evaluated barrier has a length of 1,380 feet and a total surface area of 29,270 square feet. Barrier S benefits three impacted receptors, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier S also benefits eight non-impacted receptors. Based on current design documents, Barrier S does not contain any site features that would affect the engineering feasibility of construction. Barrier S satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of 11 benefited receptors, Barrier S is not considered reasonable since the square footage per benefited receptor ratio is 2,661 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier S meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier V

Barrier V, shown on Figure A-32, was evaluated to address one impacted recreational receptor in CNE V. Barrier V is located along the westbound travel lanes of I-64 southeast of Old Stage Road. Barrier V is comprised of a single and continuous ground-mounted noise wall. The barrier height is 18 feet. The evaluated barrier has a length of 770 feet and a total surface area of 13,882 square feet. Barrier V benefits one impacted receptor, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier V does not benefit any non-impacted receptors. Based on current design documents, Barrier V does not contain any site features that would affect the engineering feasibility of construction. Barrier V satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of one benefited receptor, Barrier V is not considered reasonable since the square footage per benefited receptor ratio is 13,882 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier V meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier W1

Barrier W1, shown on Figures A-33 and A-34, was evaluated to address ten impacted residential receptors in CNE W. Barrier W1 is located along the eastbound travel lanes of I-64 southeast of Six Mt Zion Road. Barrier W1 is comprised of a single and continuous ground-mounted noise wall. The barrier ranges in height from 8 to 24 feet and has an average height of 15.4 feet. The evaluated barrier has a length of 3,500 feet and a total surface area of 54,042 square feet. Barrier W1 benefits ten impacted receptors, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier W1 also benefits four non-impacted receptors. Based on current design documents, Barrier W1 does not contain any site features that would affect the engineering feasibility of construction. Barrier W1 satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of 14 benefited receptors, Barrier W1 is not considered reasonable since the square footage per benefited receptor ratio is 3,860 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier W1 meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier W2

Barrier W2, shown on Figure A-34, was evaluated to address two impacted residential receptors in CNE W. Barrier W2 is located along the eastbound travel lanes of I-64 southeast of Six Mt Zion Road near Sand Hill Road. Barrier W2 is comprised of a single and continuous ground-mounted noise wall. The barrier ranges in height from 16 to 20 feet and has an average height of 19.1 feet. The evaluated barrier has a length of 1,348 feet and a total surface area of 25,615 square feet. Barrier W2 benefits two impacted receptors, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier W2 does not benefit any non-impacted receptors. Based on current design documents, Barrier W2 does not contain any site features that would affect the engineering feasibility of construction. Barrier W2 satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of two benefited receptors, Barrier W2 is not considered reasonable since the square footage per benefited receptor ratio is 12,808 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier W2 meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier X

Barrier X, shown on Figures A-35 and A-36, was evaluated to address two impacted residential receptors in CNE X. Barrier X is located along the eastbound travel lanes of I-64 northwest of Croaker Road. Barrier X is comprised of a single and continuous ground-mounted noise wall. The barrier ranges in height from 8 to 20 feet and has an average height of 13.5 feet. The evaluated barrier has a length of 1,915 feet and a total surface area of 26,193 square feet. Barrier X benefits two impacted receptors, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier X does not benefit any non-impacted receptors. Based on current design documents, Barrier X does not contain any site features that would affect the engineering feasibility of construction. Barrier X satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of two benefited receptors, Barrier X is not considered reasonable since the square footage per benefited receptor ratio is 13,097 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier X meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier Y1

Barrier Y1, shown on Figures A-34 and A-35, was evaluated to address one impacted residential receptor in CNE Y. Barrier Y1 is located along the westbound travel lanes of I-64 and extends southeast of Six Mt Zion Road. Barrier Y1 is comprised of a single and continuous ground-mounted noise wall. The barrier ranges in height from 22 to 30 feet and has an average height of 28.4 feet. The evaluated barrier has a length of 1,263 feet and a total surface area of 35,866 square feet. Barrier Y1 benefits one impacted receptor, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier Y1 does not benefit any non-impacted receptors. Based on current design documents, Barrier Y1 does not contain any site features that would affect the engineering feasibility of construction. Barrier Y1 satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of one benefited receptor, Barrier Y1 is not considered reasonable since the square footage per benefited receptor ratio is 35,866 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier Y1 meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier Y2

Barrier Y2, shown on Figures A-35 through A-36, was evaluated to address two impacted residential receptors in CNE Y. Barrier Y2 is located along the westbound travel lanes of I-64 northwest of Croaker Road. Barrier Y2 is comprised of a single and continuous ground-mounted noise wall. The barrier ranges in height from 12 to 20 feet and has an average height of 15.4 feet. The evaluated barrier has a length of 1,813 feet and a total surface area of 28,063 square feet. Barrier Y2 benefits two impacted receptors, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier Y2 does not benefit any non-impacted receptors. Based on current design documents, Barrier Y2 does not contain any site features that would affect the engineering feasibility of construction. Barrier Y2 satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of two benefited receptors, Barrier Y2 is not considered reasonable since the square footage per benefited receptor ratio is 14,032 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier Y2 meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier Y3

Barrier Y3, shown on Figure A-36, was evaluated to address one impacted residential receptor in CNE Y. Barrier Y3 is located along the westbound travel lanes of I-64 and extends northwest from Croaker Road. Barrier Y3 is comprised of a single and continuous ground-mounted noise wall. The barrier ranges in height from 20 to 30 feet and has an average height of 25.2 feet. The evaluated barrier has a length of 813 feet and a total surface area of 20,448 square feet. Barrier Y3 benefits one impacted receptor, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier Y3 does not benefit any non-impacted receptors. Based on current design documents, Barrier Y3 does not contain any site features that would affect the engineering feasibility of construction. Barrier Y3 satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of one benefited receptor, Barrier Y3 is not considered reasonable since the square footage per benefited receptor ratio is 20,448 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier Y3 meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier Z

Barrier Z, shown on Figure A-36, was evaluated to address one impacted residential receptor and nine impacted recreational receptors in CNE Z. Barrier Z is located along the eastbound travel lanes of I-64 and extends northwest from Croaker Road. Barrier Z is comprised of a single and continuous ground-mounted noise wall. The barrier ranges in height from 20 to 30 feet and has an average height of 26.3 feet. The evaluated barrier has a length of 1,545 feet and a total surface area of 40,657 square feet. Barrier Z benefits ten impacted receptors, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier Z also benefits 16 non-impacted receptors. Based on current design documents, Barrier Z does not contain any site features that would affect the engineering feasibility of construction. Barrier Z satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of 26 benefited receptors, Barrier Z is considered reasonable since the square footage per benefited receptor ratio is 1,564 SF/BR, which is less than the maximum SF/BR of 1,600.

Based on the current design information, Barrier Z meets VDOT's feasibility and reasonableness criteria and therefore is recommended for further consideration during final design.

Barrier AA

Barrier AA, shown on Figure A-37, was evaluated to address four impacted residential receptors in CNE AA. Barrier AA is located along the westbound travel lanes of I-64 southeast of Croaker Road. Barrier AA is comprised of a single and continuous ground-mounted noise wall. The barrier ranges in height from 12 to 20 feet and has an average height of 16.5 feet. The evaluated barrier has a length of 1,170 feet and a total surface area of 19,359 square feet. Barrier AA benefits four impacted receptors, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier AA does not benefit any non-impacted receptors. Based on current design documents, Barrier AA does not contain any site features that would affect the engineering feasibility of construction. Barrier AA satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of four benefited receptors, Barrier AA is not considered reasonable since the square footage per benefited receptor ratio is 4,840 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier AA meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier AB

Barrier AB, shown on Figures A-37 and A-38, was evaluated to address 14 impacted residential receptors in CNE AB. Barrier AB is located along the eastbound travel lanes of I-64 and extends southeast from Croaker Road. Barrier AB is comprised of a single and continuous ground-mounted noise wall. The barrier ranges in height from 8 to 16 feet and has an average height of 12.7 feet. The evaluated barrier has a length of 4,490 feet and a total surface area of 56,852 square feet. Barrier AB benefits 14 impacted receptors, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier AB also benefits one non-impacted receptors. Based on current design documents, Barrier AB does not contain any site features that would affect the engineering feasibility of construction. Barrier AB satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of 15 benefited receptors, Barrier AB is not considered reasonable since the square footage per benefited receptor ratio is 3,790 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier AB meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier AC

Barrier AC, shown on Figure A-38, was evaluated to address six impacted residential receptors in CNE AC. Barrier AC is located along the westbound travel lanes of I-64 south of Croaker Road. Barrier AC is comprised of a single and continuous ground-mounted noise wall. The barrier ranges in height from 9 to 13 feet and has an average height of 10.8 feet. The evaluated barrier has a length of 890 feet and a total surface area of 9,595 square feet. Barrier AC benefits six impacted receptors, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier AC does not benefit any non-impacted receptors. Based on current design documents, Barrier AC does not contain any site features that would affect the engineering feasibility of construction. Barrier AC satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of six benefited receptors, Barrier AC is considered reasonable since the square footage per benefited receptor ratio is 1,599 SF/BR, which is less than the maximum SF/BR of 1,600.

Based on the current design information, Barrier AC meets VDOT's feasibility and reasonableness criteria and therefore is recommended for further consideration during final design.

Extended Barrier AC

Extended Barrier AC, shown on Figure A-38, was evaluated to address nine impacted residential receptors in CNE AC. Extended Barrier AC is located along the westbound travel lanes of I-64 south of Croaker Road. Extended Barrier AC is comprised of a single and continuous ground-mounted noise wall. The barrier ranges in height from 10 to 16 feet and has an average height of 11.3 feet. The evaluated barrier has a length of 2,669 feet and a total surface area of 29,932 square feet. Extended Barrier AC benefits nine impacted receptors, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Extended Barrier AC benefits one non-impacted receptor. Based on current design documents, Extended Barrier AC does not contain any site features that would affect the engineering feasibility of construction. Extended Barrier AC satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of ten benefited receptors, Barrier AC is not considered reasonable since the square footage per benefited receptor ratio is 2,993 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Extended Barrier AC meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

Barrier AD

Barrier AD, shown on Figure A-38, was evaluated to address one impacted residential receptor in CNE AD. Barrier AD is located along the eastbound travel lanes of I-64 south of Wilderness Lane. Barrier AD is comprised of a single and continuous ground-mounted noise wall. The barrier ranges in height from 20 to 30 feet and has an average height of 24.0 feet. The evaluated barrier has a length of 1,270 feet and a total surface area of 30,461 square feet. Barrier AD benefits one impacted receptor, satisfying VDOT's acoustic feasibility criterion by providing at least a 5 dB(A) noise reduction to at least 50% of the CNE's impacted receptors. Barrier AD also benefits one non-impacted receptor. Based on current design documents, Barrier AD does not contain any site features that would affect the engineering feasibility of construction.

Barrier AD satisfies VDOT's noise reduction design goal by providing a 7 dB(A) noise reduction to at least one impacted receptor. With a total of two benefited receptors, Barrier AD is not considered reasonable since the square footage per benefited receptor ratio is 15,231 SF/BR, which is more than the maximum SF/BR of 1,600.

Based on the current design information, Barrier AD meets VDOT's feasibility criterion but fails to satisfy its reasonableness criterion for cost-effectiveness. However, this barrier will be reevaluated during final design.

8.0 CONSTRUCTION NOISE CONSIDERATIONS

VDOT is also concerned with noise generated during the construction phase of the proposed project. While the degree of construction noise impact will vary, it is directly related to the types and number of equipment used and the proximity to the noise-sensitive land uses within the project area. Land uses that are sensitive to traffic noise are also potentially sensitive to construction noise. Any construction noise impacts that do occur because of roadway construction measures are anticipated to be temporary in nature and will cease upon completion of the project construction phase. One method of controlling construction noise is to establish the maximum level of noise that construction operations can generate. In view of this, VDOT has developed and FHWA has approved a specification that establishes construction noise limits. This specification can be found in VDOT's *2020 Road and Bridge Specifications*, Section 107.16(b.3), “Noise” (VDOT, 2020). The contractor will be required to conform to this specification to reduce the impact of construction noise on the surrounding community. 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.
- VDOT 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.
- VDOT may prohibit or restrict to certain portions of the project any work that produces objectionable noise between 10 PM and 6 AM. If other hours are established by local ordinance, the local ordinance shall govern.
- Equipment shall in no way be altered 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.

9.0 PUBLIC INVOLVEMENT PROCESS

FHWA and VDOT policies require that VDOT provides certain information to local officials within whose jurisdiction the highway project is located, to minimize future traffic noise impacts of Type I projects on currently undeveloped lands. (Type I projects involve highway improvements with noise analysis.) This information must include details on noise-compatible land-use planning and noise impact zones for undeveloped lands within the project corridor. Additional information about VDOT's noise abatement program has also been included in this section.

9.1 Noise Compatible Land Use Planning

Sections 12.1 and 12.2 of VDOT's *Highway Traffic Noise Guidance Manual* outlines VDOT's approach to communication with local officials and provide information and resources on highway noise and noise-compatible land-use planning. VDOT's intention is to assist local officials in planning the uses of undeveloped land adjacent to highways to minimize the potential impacts of highway traffic noise (VDOT, 2022).

Entering the Quiet Zone (FHWA 2002) is a brochure that provides general information and examples to elected officials, planners, developers, and the general public about the problem of traffic noise and effective responses to it. A link to this brochure on FHWA's website is provided:

http://www.fhwa.dot.gov/environment/noise/noise_compatible_planning/federal_approach/land_use/qz00.cfm

A wide variety of administrative strategies may be used to minimize or eliminate potential highway noise impacts, thereby preventing the need or desire for costly noise abatement structures such as noise barriers in future years. There are five broad categories of such strategies:

- Zoning,
- Other legal restrictions (subdivision control, building codes, health codes),
- Municipal ownership or control of the land,
- Financial incentives for compatible development, and
- Educational and advisory services.

The Audible Landscape: A Manual for Highway and Land Use (FHWA 1974) is a very well-written and comprehensive guide addressing these noise-compatible land use planning strategies, with significant detailed information.

FHWA/VDOT noise policy and guidance also require that estimates of future design noise levels at distances where they meet NAC approach limits, for exterior land uses be provided. To estimate these distances, noise levels are predicted at various distances from the edge of the project roadways for undeveloped[18] and other exterior noise sensitive areas within the noise study area. Then, the distances from the edge of the roadway to the NAC approach sound levels are determined through interpolation.

[18] With respect to undeveloped lands, future design year 66 dB(A) noise contours are shown on the graphics based on the existing terrain. If such lands were to be developed (e.g., site grading, cut/fill activities) the location of the impact contour may change. As such, noise contours are only to be used as a planning level tool.

Distances vary in the project corridor due to changes in traffic volumes, terrain features, or existing structures, and noise barriers. Based on the interpolation of distances to the appropriate NAC approach limits, the approximate location of the 66 dB(A) noise contours for NAC B/C receptors is represented in the graphics in **Appendix A**[19].

9.2 VDOT's Noise Abatement Program

Information on VDOT's noise abatement program is available on VDOT's Website, at: http://www.virginiadot.org/projects/pr-noise-walls-about.asp. The site provides information on VDOT's noise program and policies, noise walls, and a downloadable noise wall brochure.

9.3 Voting Procedures

For noise barriers determined to be feasible and reasonable in the final design phase, the affected public that would be benefited by the proposed mitigation will be given an opportunity to decide whether they are in favor of construction of the noise barrier. A final determination to construct a barrier will be made after the design public hearing process. Before final decisions and approvals can be made to construct a noise barrier, a final design noise analysis will be performed. For barriers that are determined to be feasible and reasonable, input from the owners and residents of those receptor units that will be benefited by the proposed mitigation may vote by completing and returning the noise barrier survey form that they receive in the mail. The initial citizen survey is sent out as certified mail so the disposition of the letters can be tracked. Of the votes tallied, 50 percent or more must be in favor of a proposed noise barrier in order for that barrier to be considered further. Upon completion of the citizen survey, the VDOT Noise Abatement staff will make recommendations to the Chief Engineer for approval. Approved barriers will be incorporated into the road project plans. A technical memorandum of the results of the public survey will be prepared and submitted to FHWA.

9.3.1 Public Preference Surveys

Property owners and residents, including tenants, of all properties that would be benefited by the recommended noise barrier will be sent survey letters by certified mail. Twenty-one (21) calendar days from the anticipated delivery date is required to provide the recipients ample time to review and respond to the survey. The letters and surveys will ask 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 will be provided to homeowners and residents. The mailings will give the affected property owners/residents an understanding of the proposed barriers, an opportunity to ask questions, and a formal survey form for expressing their views. Only the owners and residents of those receptor units that will be benefited by the proposed mitigation may vote on whether the proposed noise

[19] While noise contour lines are useful for screening and to provide information to local officials (23 CFR 772.17), FHWA guidance states that noise contours shall not be used for the determination of traffic-noise impacts (FHWA, 2011). The 66 dB(A) contour line is assumed to represent first floor noise levels, including any existing noise barriers or shielding effects. Due to this fact, future design year impacts identified in Appendix B may not always correlate to the color-coding of the receptors shown in the Appendix A graphics. Areas with receptors located on the second floor (or higher) or for CNEs where an in-kind noise barrier extension was evaluated (because the existing noise barrier is removed for the analysis) may be different than future design year noise impacts in the study area. The noise contours are only shown where they extend past the proposed right-of-way.

barrier should be constructed. The owner/resident of each benefited receptor unit shall be entitled to one weighted vote, regardless of the number of owners of that receptor unit unless they are the owners of a rental facility or the developer of lands.

Survey recipients will be informed that to register a vote in favor of the barrier, a "YES" survey form would have to be returned. In addition, a non-response does not assume that the survey recipient is in favor of the barrier's construction. Votes will be tallied on a noise barrier by noise barrier basis, so it is recommended that the project team tally the votes and summarize the results on a project map showing votes by location. Final interpretation of the voting results will be made by VDOT and its consultants, considering all the feedback gained during the public involvement process. The weighting system used during the voting process is provided in **Table 9-1**.

Table 9-1. Public Opinion Survey Weighting System

Public Opinion Survey Weighting System[6]				
Impact and Benefit Category	**Activity Category[4]**	**Owner and Resident**	**Non Resident Owner**	**Renter[5]**
Impacted & Benefited	A	See note below		
Not Impacted & Benefited				
Impacted & Benefited	B[1]	5	3	2
Not Impacted & Benefited	B[1]	3	2	1
Impacted & Benefited	C[2]		5	
Not Impacted & Benefited	C[2]		3	
Impacted & Benefited	D		2	
Not Impacted & Benefited	D		1	
Impacted & Benefited	E		2	
Not Impacted & Benefited	E		1	

1 *For activity Category B Receptors only one vote per single family unit will be counted. However, the owner of a multiple-family dwelling unit will be granted one vote per benefited unit. In addition, the developer of permitted lands will also be granted one vote per benefited lot of the permitted phase where construction has not occurred.*

2 *For activity Category C Receptors only 1 vote per facility will be granted.*

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APPENDICES

Appendix A: Graphics (2048 Build Alternative)

Appendix B: Summary of Predicted Sound Levels

Appendix C: Calibration Certificates

Appendix D: Short-Term Monitoring Data

Appendix E: TNM Traffic Inputs

Appendix F: Loudest Hour Memo

Appendix G: Alternative Mitigation Measures Response

Appendix H: Predicted Noise Barrier Insertion Loss (Build Alternative)

Appendix I: Warranted, Feasible and Reasonable Worksheets

Appendix J: List of Preparers/Reviewers

Appendix K: Correspondence Regarding Undeveloped Lands