TRAFFIC NOISE ANALYSIS

MD 355 at Cedar Lane Intersection Improvement Project
Phase 4

Bethesda, Maryland

July 2012

SHA
State Highway Administration
Maryland Department of Transportation

Executive Summary

As a result of the Base Realignment and Closure Act (BRAC), the Maryland State Highway Administration (SHA) is proposing improvements to the MD 355/Cedar Lane intersection in Bethesda, Maryland. These improvements will provide additional through-lanes and turn-lanes at the MD 355/Cedar Lane intersection. Per 23 CFR 772, the proposed improvements warrant a traffic noise analysis for this area. The purpose of the noise analysis is to determine if the seven Noise Sensitive Areas (NSAs) in the vicinity of the MD 355/Cedar Lane intersection will be impacted by traffic noise associated with the proposed intersection improvements.

The seven NSAs in the study area are comprised of single family residences, a town home community, a school, and a church (Bethesda Meeting House). The Federal Highway Administration's (FHWA) Traffic Noise Model 2.5 (TNM 2.5) was used to complete the noise analysis, which involved developing existing conditions models and predicting future sound levels at fifteen monitoring receptors and seven modeling-only receptors within the seven NSAs.

In accordance with 23 CFR 772 as defined in the SHA Noise Policy, an area is considered impacted when the noise level approaches or exceeds the Federal Noise Abatement Criteria (NAC) of 67 dB(A) for properties classified as NAC Categories B and C and 72 dB(A) for properties classified as NAC Category E. The results of the noise analysis indicate that predicted noise levels would exceed the NAC at Receptor R-6 in NSA 2. Based on the predicted noise impacts, consideration of noise abatement was warranted. A proposed barrier for NSA 2 would be feasible but would not be reasonable because it would exceed the threshold of 2,700 square feet per benefited residence as specified in the SHA Noise Policy and it would eliminate an existing pedestrian walkway that connects the residences to MD 355.

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INTRODUCTION

1.0 Introduction

1.1 Introduction

The Maryland State Highway Administration (SHA) is proposing improvements to the MD 355/ Cedar Lane intersection in Bethesda, Maryland. These improvements are necessary as a result of the Base Realignment and Closure Act (BRAC) and will provide additional through-lanes and turn-lanes at the MD 355/Cedar Lane intersection. Per 23 CFR 772, which became effective July 13, 2011, the proposed improvements warrant a traffic noise analysis for this area.

Seven noise sensitive areas (NSAs) encompass the MD 355/Cedar lane intersection and the surrounding area. ***Map 3.1*** shows the locations of the NSAs. The Federal Highway Administration's (FHWA) Traffic Noise Model 2.5 (TNM 2.5) was used to develop the existing conditions models and to predict future sound levels for this intersection.

The purpose of this noise analysis is to determine if the noise sensitive land uses will be impacted by traffic noise as a result of the proposed intersection improvements. This report presents the results of the traffic noise analysis for the MD 355 at Cedar Lane project.

1.2 Project Area Description

The project area is located at the intersection of MD 355 (Rockville Pike) and Cedar Lane. It extends approximately 1,300 feet to the north and 700 feet to the south of the intersection along MD 355 (***Figure 1***). It also extends approximately 500 feet to the west and 700 feet to the east of the intersection along Cedar Lane. Development within the project area consists of medium density, single-family homes, a town home community, office uses, a school, and a church. The seven NSAs identified for this study encompass residential, office, and institutional developments to the north of Cedar Lane and a school and open space to the south of Cedar Lane.

1.3 Existing Conditions

The MD 355/Cedar Lane intersection is the only signalized intersection within the project area. In the vicinity of this intersection, MD 355 has three through lanes in both the northbound and southbound directions. As MD 355 approaches the intersection with Cedar Lane from the north, the roadway widens to accommodate one dedicated left-turn lane and one dedicated right-turn lane. Approaching the intersection from the south, MD 355 widens to accommodate a dedicated left-turn lane and the right lane becomes a shared through/right-turn lane. Departing the intersection in both directions, MD 355 has three lanes. All travel lanes along MD 355 in the project area are twelve feet wide.

Cedar Lane has two through lanes in both the westbound and eastbound directions in the vicinity of the intersection. As Cedar Lane approaches the intersection from the west and the east, the road widens to accommodate one dedicated left-turn lane in each direction. The left through-lanes each become shared through/left-turn lanes and the right through-lanes both become shared through/right-turn lanes. The travel lanes approaching the intersection are ten feet wide, while the departing travel lanes are fifteen feet wide. The posted speed limit on MD 355 in the vicinity of Cedar Lane is currently 35 miles per hour. The posted speed limit on Cedar Lane is 30 miles per hour.

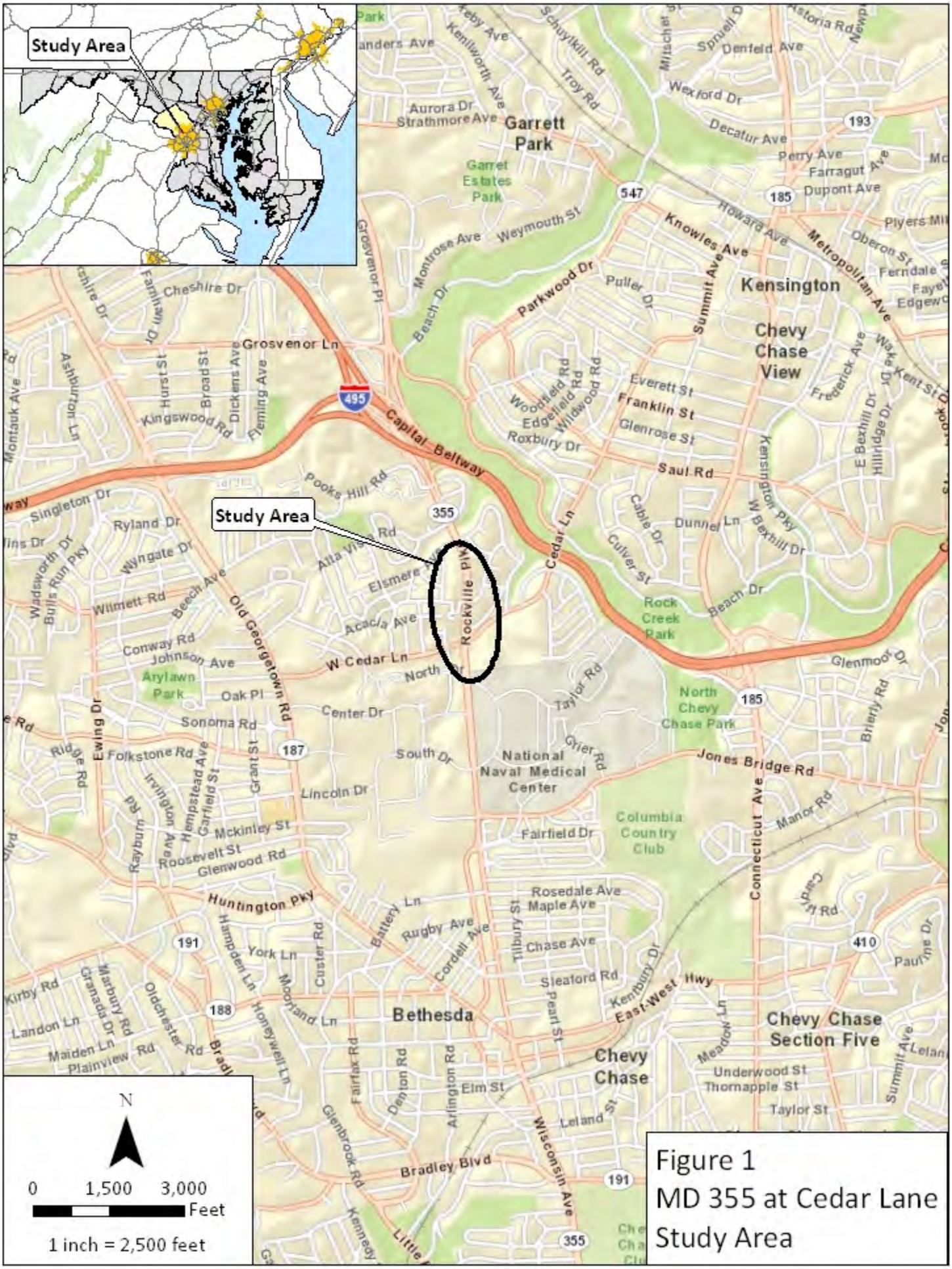


Figure 1
MD 355 at Cedar Lane
Study Area

1.4 Proposed Conditions

The SHA is proposing intersection improvements at the MD 355 at Cedar Lane intersection. The proposed improvements include:

- Addition of one through lane along northbound MD 355
- Addition of one through lane along southbound MD 355
- Addition of a dedicated right and left turn lanes along eastbound Cedar Lane
- Addition of dedicated left turn lanes along westbound Cedar Lane

With the proposed improvement in place, MD 355 would have three through lanes as well as a shared through/right-turn lane and a dedicated left-turn lane approaching Cedar Lane in the northbound direction. Four lanes would depart from the Cedar Lane intersection in the northbound direction. The right lane would taper off approximately 200 feet north of Locust Hill Road and three lanes would continue north beyond that point. The widening of northbound MD 355 north of Cedar Lane would require the removal of the existing slope between the existing roadway and the parallel service road that extends north from Elmhirst Drive and continues beyond Locust Hill Road. Between the edge of proposed MD 355 and the service road, a retaining wall would be constructed. The existing access to MD 355 at Locust Hill Road would be maintained.

Along southbound MD 355 approaching the Cedar Lane intersection, the roadway would also include three through lanes, a shared through/right turn lane, and a dedicated left-turn lane. Departing the intersection in the southbound direction, the right lane would become a dedicated right-turn lane that drops at Wilson Drive. Three lanes would continue in the southbound direction beyond that point.

On eastbound Cedar Lane, there would be two through lanes, one dedicated right-turn lane, and two dedicated left-turn lanes approaching the MD 355 intersection. Two lanes would be maintained along eastbound Cedar Lane as it departs from the MD 355 intersection.

Westbound Cedar Lane would be improved to include one through lane, one shared through/right-turn lane, and two dedicated left-turn lanes as it approaches MD 355. Two lanes would be maintained along westbound Cedar Lane as it departs from the MD 355 intersection.

The posted speed limits on MD 355 and Cedar Lane would not change as a result of the proposed improvements and would remain at 35 miles per hour and 30 miles per hour, respectively.

1.5 Highway Noise Fundamentals

The following discussion on highway noise fundamentals is included for the purpose of defining terms and criteria utilized in this report. The extent to which individuals are affected by noise sources is controlled by several factors:

- the level (magnitude), duration, and frequency (pitch) of sound
- the distance between the sound source and the receptor
- the intervening natural or man-made barriers or structures
- the ambient environment

Levels of highway traffic noise depend primarily upon traffic characteristics such as volume, speed, and the number of trucks (especially heavy trucks) in the flow of traffic. Generally, heavier traffic volumes, higher speeds, and greater numbers of trucks increase traffic noise levels. Consequently, the FHWA has established the following vehicle categories to use in traffic noise analysis studies:

- Automobiles, defined as vehicles with two axles and four wheels
- Medium trucks, defined as vehicles having two axles and six (6) wheels
- Heavy trucks, defined as vehicles having three (3) or more axles
- Buses
- Motorcycles

Heavy trucks typically produce more noise than medium trucks traveling at the same speed. Likewise, medium trucks typically produce more noise than automobiles traveling the same speed.

Traffic noise is measured and described according to FHWA guidelines, which prescribe the use of the "A-weighted" hourly equivalent sound level Leq(h) as the primary descriptor for noise analysis. Leq(h) is defined as the equivalent steady state A-weighted sound level that, in one hour, contains the same acoustic energy as the time-varying sound level during the same one-hour period.

The unit of measurement for the A-weighted Leq(h) is the decibel (dB[A]). The A-weighted scale de-emphasizes low frequencies and very high frequencies to approximate the frequency response of the human ear. ***Table 1.A*** provides examples of common outdoor noise levels, their respective noise level decibels, and correlating examples of indoor noise levels.

1.6 Federal Noise Abatement Criteria

The determination of traffic noise impacts is based on the relationship between the ambient noise levels and the established noise abatement criteria for the noise sensitive area. The effects of noise are judged in accordance with the FHWA standards in 23 CFR 772 and current SHA Policy, effective July 13, 2011, Revised August 31, 2011. The FHWA Noise Abatement Criteria (NAC) provided in ***Table 1.B*** are based on specific land uses and are used in determining impacts and the need for studying noise attenuation measures.

All of the developed land evaluated in this report is in Activity Categories B, C, and E. Categories B and C both have an exterior NAC of 67 dB(A), while Category E has an exterior NAC of 72 dB(A). Per 23 CFR 772, Category B and C land uses are considered "impacted" when traffic noise approaches or exceeds 67 dB(A) in areas of frequent human use on the property and Category E land uses are considered "impacted" when the traffic noise approaches or exceed 72 dB(A). In defining the term "approaches", SHA has adopted 66 dB(A) as the impact dB(A) threshold for Categories B and C and 71 dB(A) as the impact threshold for Category E.[1]

[1] Maryland Department of Transportation, State Highway Administration. July 13, 2011, Rev. Aug 31, 2011. Highway Noise Policy.

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

[1] *Adapted from Guide on Evaluation and Attenuation of Traffic Noise. AASHTO. 1974.*

Table 1.B: Noise Abatement Criteria (NAC) Hourly A-Weighted Sound Level in Decibels (dB[A])				
Activity Category	**Activity Criteria[1] $L_{eq}(h)$[2]**	**MD SHA Approach Criteria**	**Evaluation Location**	**Activity Description**
A	57	56	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B[3]	67	66	Exterior	Residential
C[3]	67	66	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, daycare centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.
D	52	51	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E[3]	72	71	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F.
F	--	--	--	Agriculture, airports, bus yards, emergency services, industrial, logging maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.
G	--	--	--	Undeveloped lands that are not permitted.

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

MD 355 AT CEDAR LANE

TYPE I
TRAFFIC NOISE ANALYSIS

Section 2
SOUND MEASUREMENT AND
NOISE ANALYSIS

2.0 Sound Measurement and Noise Analysis

2.1 Introduction

Noise levels in the MD 355 at Cedar Lane study area were measured in conjunction with classified traffic counts in order to establish reference points to be used in the TNM Model Validation.

The highway noise measurements were performed in conformance with the U.S. Department of Transportation FHWA's Measurement of Highway-Related Noise (FHWA-PD-96-046 May 1996). Short-term (15-minute) noise measurements were conducted for this study. Since traffic data was available from SHA travel forecasting engineers to determine the loudest-hour times and traffic volumes, 24-hour measurements were not recorded as part of this assessment.

2.2 Sound Measurement Data

Short-term (15-minute) noise monitoring was performed on March 1, 2012, March 6, 2012, and April 25, 2012. Fifteen (15) noise measurements were taken at fifteen receptor sites (R1–R15) within the seven NSAs. Receptor sites R1, R2, R3, R5, R6, R8, R9, R13, and R14 are located on properties that are classified as NAC Activity Category B. Receptor sites R4, R7, R11, R12, and R-15 are located on properties that are classified as NAC Activity Category C. Receptor site R10 is located on a property that is classified as NAC Activity Category E. All measurements were performed between the hours of 7:40 AM and 8:35 AM. ***Appendix A*** shows the sound measurement data collected at each of the 15 receptor sites.

Table 2.A summarizes the measured noise levels for each of the short-term noise measurements. The levels are rounded to the nearest whole decibel in accordance with SHA guidelines. Five receptors (R1, R2, R6, R7, and R9) within the MD 355 and Cedar Lane study area currently experience noise levels that approach or exceed the Noise Abatement Criteria (NAC) of 67 dB(A).

2.3 TNM Model Validation

Per SHA requirements, the first step in the modeling process is TNM model validation. This validation process is accomplished by comparing the monitored noise measurements with noise levels generated by the computer model using the traffic volumes, speeds, and composition that were witnessed during the noise monitoring effort. This comparison ensures that reported changes in noise levels between Existing and Design Year conditions are due to changes in traffic conditions and not discrepancies between monitoring and modeling techniques. SHA considers a TNM model to be properly validated when the modeled noise levels are within ±3 dB(A) of the measured noise levels.

After the noise measurements and traffic counts were obtained, a TNM model was developed for the MD 355 at Cedar Lane study area, inputting all pertinent roadways, terrain, and shielding

Table 2.A: Measured Noise Level Summary								
Receptor Number	**Residence Address or Property Description**		**NAC Activity Category**	**Date**	**Interval**	**Measured Noise Level[1]**	**Receptor Impacted?[2] (Yes) or (No)**	
R1	9301	Rockville Pike	B	3/6/12	7:40 AM - 7:55 AM	66	X	
R2	9309	Rockville Pike	B	3/1/12	8:15 AM - 8:30 AM	69	X	
R3	9405	Locust Hill Road	B	3/1/12	8:15 AM - 8:30 AM	59		X
R4	5001	Cedar Croft Lane	C	3/1/12	7:40 AM - 7:55 AM	64		X
R5	5010	Cedar Croft Lane	B	3/1/12	7:40 AM - 7:55 AM	57		X
R6	4900	Cedar Croft Drive	B	3/1/12	7:40 AM - 7:55 AM	67	X	
R7	9190	Rockville Pike	C	3/1/12	7:40 AM - 7:55 AM	66	X	
R8	9211	Cedar Way	B	3/1/12	7:40 AM - 7:55 AM	62		X
R9	4905	Cedar Lane	B	3/6/12	7:40 AM - 7:55 AM	67	X	
R10	9000	North Drive	E	3/1/12	7:40 AM - 7:55 AM	63		X
R11	9101	Rockville Pike	C	3/6/12	7:40 AM - 7:55 AM	62		X
R12	9101	Rockville Pike	C	3/6/12	7:40 AM - 7:55 AM	61		X
R13	9407	Locust Hill Road	B	4/25/12	8:20 AM – 8:35 AM	64		X
R14	9419	Locust Hill Road	B	4/25/12	8:20 AM – 8:35 AM	65		X
R15	9400	Rockville Pike	C	4/25/12	8:20 AM – 8:35 AM	65		X
					Total Number of Impacted Receptors		**5**	

[1] *All noise levels are shown as hourly equivalent sound levels (L_{eq1h}) with units in A-weighted decibels (dB[A]). The level is rounded to the nearest whole decibel in accordance with SHA guidelines.*

[2] *Impacted receptors are those that presently experience highway noise levels equal to or exceeding 67 dB(A).*

elements that adequately represent the study area's noise environment. Each noise measurement receptor was represented in the model by a TNM modeled receptor. The model was then validated by testing it under the traffic conditions encountered during the traffic noise monitoring session.

In order to bring the model into validation, modifications were applied by inputting additional terrain and/or other data elements in an orderly sequence of TNM runs until the validation criteria were met. The data from these validation runs are summarized in ***Table 2.B***, as well as in ***Appendix B***, with a comparison between modeled and measured noise levels.

All receptors in this study area except R8 validated to within 3 dB(A) difference between the monitored and modeled noise levels. Receptor R8 was not able to be validated due to

Table 2.B: TNM Model Validation Summary								
Receptor Number	**Residence Address or Property Description**		**Traffic Monitoring Session**	**Noise Level (L_{eq1h} dB(A))**			**Validating Model Point? (Yes) or (No)**	
				Measured	**Modeled**	**Difference**		
R1	9301	Rockville Pike	TMS-3	66	67	-1	X	
R2	9309	Rockville Pike	TMS-2	69	67	2	X	
R3	9405	Locust Hill Road	TMS-2	59	59	0	X	
R4	5001	Cedar Croft Lane	TMS-1	64	66	-2	X	
R5	5010	Cedar Croft Lane	TMS-1	57	57	0	X	
R6	4900	Cedar Croft Drive	TMS-1	67	66	1	X	
R7	9190	Rockville Pike	TMS-1	66	64	2	X	
R8	9211	Cedar Way	TMS-1	62	59	4		X
R9	4905	Cedar Lane	TMS-3	67	65	2	X	
R10	9000	North Drive	TMS-1	63	65	-2	X	
R11	9101	Rockville Pike	TMS-3	62	64	-2	X	
R12	9101	Rockville Pike	TMS-3	61	60	1	X	
R13	9407	Locust Hill Road	TMS-4	64	64	0	X	
R14	9419	Locust Hill Road	TMS-4	65	63	2	X	
R15	9400	Rockville Pike	TMS-4	65	63	2	X	
						Validating Model Points	**14**	

unmanageable background influences that occurred during the monitoring interval. These noise disturbances were caused by a residential generator and a road grader tearing out sidewalk nearby. Based on the validation results, the model is considered an accurate representation of actual existing conditions throughout the study area and has met all SHA requirements. ***Map 3.2*** in the following section of the report shows the receptor locations as well as the measured and modeled noise levels at each receptor site.

2.4 TNM Model Traffic

Short-term noise measurements were collected during four (4) 15-minute traffic monitoring sessions on March 1, 2012 from 7:40 AM to 8:30 AM, March 6, 2012 from 7:40 AM to 7:55 AM, and on April 25, 2012 from 8:20 AM to 8:35 AM. In addition, classified traffic counts were obtained during these four sessions for those roadways which were considered to be primary or potential contributors to the traffic noise environment (MD 355 and Cedar Lane). Although the FHWA has established the five vehicle categories to use in traffic noise analysis studies (automobiles, medium truck, heavy trucks, motorcycles, and buses), traffic data were only available that included three vehicle classification categories (automobiles, medium trucks, and heavy trucks). To maintain consistency, the traffic counts completed for this project only include those same three vehicle classification categories. The traffic data used for the validation model is presented in ***Table 2.C***.

The 2012 projected traffic volumes were provided by MD SHA for MD 355 and Cedar Lane. The posted speeds of 35 and 30 MPH were used on MD 355 and Cedar Lane, respectively. The 2012 projected volumes are intended to represent the future build conditions. Vehicle classifications were noted along MD 355 and Cedar Lane during the traffic monitoring sessions conducted for this project. For the purpose of this assessment, these vehicle classifications were assumed for MD 355 and Cedar Lane, respectively. The 2012 AM and PM Peak Hour projected traffic volumes for the MD 355 at Cedar Lane study area can be found in ***Table 2.D*** and ***Table***

2.E, respectively. Due to the nature of the existing travel corridor, the AM and PM traffic

Table 2.C: Traffic Monitoring Sessions					
Roadway	**Autos (vph)[1]**	**Medium Trucks (vph)[1]**	**Heavy Trucks (vph)[1]**	**Total Volume (vph)[1]**	**Speed (mph)[2]**
MD 355 Northbound South of Cedar Lane	1,056	24	24	1,104	35
MD 355 Northbound North of Cedar Lane	1,320	60	20	1,400	35
MD 355 Southbound North of Cedar Lane	2,928	44	28	3,000	35
MD 355 Southbound South of Cedar Lane	3,012	44	28	3,084	35
Cedar Lane Westbound East of MD 355	820	4	4	828	25
Cedar Lane Westbound West of MD 355	384	4	0	388	25
Cedar Lane Eastbound West of MD 355	576	8	0	584	25
Cedar Lane Eastbound East of MD 355	492	24	0	516	25
MD 355 Northbound South of Cedar Lane	1,056	8	12	1,076	35
MD 355 Northbound North of Cedar Lane	912	52	20	984	35
MD 355 Southbound North of Cedar Lane	3,384	44	8	3,400	35
MD 355 Southbound South of Cedar Lane	3,700	44	12	3,756	35
Cedar Lane Westbound East of MD 355	776	12	4	792	25
Cedar Lane Westbound West of MD 355	464	8	4	476	25
Cedar Lane Eastbound West of MD 355	524	4	4	532	25
Cedar Lane Eastbound East of MD 355	320	24	0	344	25
MD 355 Northbound South of Cedar Lane	1,236	12	8	1,256	35
MD 355 Northbound North of Cedar Lane	1,700	16	16	1,732	35
MD 355 Southbound North of Cedar Lane	2,568	32	16	2,616	35
MD 355 Southbound South of Cedar Lane	2,512	28	16	2,556	35
Cedar Lane Westbound East of MD 355	712	8	8	728	25
Cedar Lane Westbound West of MD 355	476	12	4	492	25
Cedar Lane Eastbound West of MD 355	612	4	0	616	25
Cedar Lane Eastbound East of MD 355	320	4	0	324	25
MD 355 Northbound North of Cedar Lane	664	48	32	744	35
MD 355 Southbound North of Cedar Lane	2,980	52	16	3,048	35

[1] *vph: vehicles per hour*
[2] *mph: miles per hour*

Table 2.D: 2012 AM Peak Hour Traffic Volume Summary					
Roadway	**Traffic Volume (vph)[1]**				**Speed (mph)[2]**
	Autos	**Medium Trucks**	**Heavy Trucks**	**Total Volume**	
MD 355 SB North of Cedar Lane	2,934	54	27	3,015	35
MD 355 SB South of Cedar Lane	3,600	67	33	3,700	35
MD 355 NB North of Cedar Lane	1,357	25	13	1,395	35
MD 355 NB South of Cedar Lane	1,231	23	11	1,265	35
Cedar Lane WB East of MD 355	1,149	24	2	1,175	25
Cedar Lane WB West of MD 355	333	7	1	341	25
Cedar Lane EB East of MD 355	425	9	1	435	25

Cedar Lane EB West of MD 355	406	8	3	417	25

[1] *vph: vehicles per hour*
[2] *mph: miles per hour*

Table 2.E: 2012 PM Peak Hour Traffic Volume Summary

Roadway	Traffic Volume (vph)[1]				Speed (mph)[2]
	Autos	Medium Trucks	Heavy Trucks	Total Volume	
MD 355 SB North of Cedar Lane	1,878	35	17	1,930	35
MD 355 SB South of Cedar Lane	1,834	34	17	1,885	35
MD 355 NB North of Cedar Lane	2,822	52	26	2,900	35
MD 355 NB South of Cedar Lane	3,021	56	28	3,105	35
Cedar Lane WB East of MD 355	401	8	1	410	25
Cedar Lane WB West of MD 355	328	7	1	336	25
Cedar Lane EB East of MD 355	1,105	23	2	1,130	25
Cedar Lane EB West of MD 355	787	16	3	806	25

[1] *vph: vehicles per hour*
[2] *mph: miles per hour*

volumes are essentially the same during the peak periods for the overall corridor with a greater share of the volume on southbound MD 355 in the AM and a greater share of the volume on northbound 355 in the PM.

2.5 TNM Model Results

The results presented in ***Table 2.F*** are the predicted sound levels for the PM peak traffic volumes, as determined by the TNM build condition model. In addition to the 15 measured receptor locations, seven additional modeling-only sites were added to the validated model. Design elements that were accounted for in the model validation included roadways, ground terrain lines, building rows and potential noise barriers. Jersey barriers were studied at three separate heights in order to determine potential impact mitigation.

2.6 Investigation of Noise Abatement

According to CFR, Part 772 and SHA Noise Policy, a noise study area warrants investigation of noise abatement if it is impacted in accordance with the NAC shown in ***Table 1.B***. A property classified as NAC Category B or C is considered impacted when a receptor has a sound level of 66 dB(A)or greater. A property classified as NAC Category E is considered impacted when a receptor has a sound level of 71 dB(A) or greater.

To determine feasibility of noise abatement, the SHA Noise Policy states that at least 50 percent of the impacted receptors must be benefited. The Noise Policy defines a benefited receptor as a receptor that receives a noise reduction of at least 5 dB(A). For a barrier to be considered reasonable, it must meet the minimum design goal of 7 dB(A) noise reduction for at least 50 percent of the impacted residences and be no more than 2,700 square feet per benefited residence.

The results of this noise analysis indicate that, under 2012 Build conditions, one receptor located in NSA 2 is impacted. One receptor (R6) would experience noise levels that exceed the federal NAC. Therefore, in accordance with standard MD SHA practices and the CFR, noise abatement consideration is warranted for this project. A noise barrier was evaluated for NSA 2. ***Table 2.G*** and ***Table 2.H*** below show the results of the barrier analysis. For the noise barrier to be effective,

the existing sidewalk in the area would have to be re-located, allowing the proposed single-continuous noise barrier in its modeled location. This modeled noise barrier would not be feasible if pedestrian access to addresses represented by site R6 is prevented. Access to these properties could me maintained if the sidewalk is relocated, or if the existing driveway north of the proposed barrier is considered proper access.

Table 2.F TNM Analysis Results for 2012 Build Conditions

Receptor Number	Residence Address or Property Description		NAC Activity Category	Predicted 2012 Conditions Sound Level PM Peak (Leq(h))[1]	Receptor Impacted?[2] (Yes) or (No)	
R1	9301	Rockville Pike	B	64		X
R2	9309	Rockville Pike	B	65		X
R3	9405	Locust Hill Road	B	58		X
R4	5001	Cedar Croft Lane	C	65		X
R5	5010	Cedar Croft Lane	B	57		X
R6	4900	Cedar Croft Drive	B	66	X	
R7	9190	Rockville Pike	C	64		X
R8	9211	Cedar Way	B	59		X
R9	4905	Cedar Lane	B	64		X
R10	9000	North Drive	E	66		X
R11	9101	Rockville Pike	C	65		X
R12	9101	Rockville Pike	C	61		X
R13	9407	Locust Hill Road	B	59		X
R14	9419	Locust Hill Road	B	57		X
R15	9400	Rockville Pike	C	62		X
M1	9200	Rockville Pike	B	61		X
M2	9307	Rockville Pike	B	59		X
M3	9306	Elmhirst Drive	B	57		X
M4	9205	Cedar Way	B	60		X
M5	9405	Rockville Pike	B	61		X
M6	9406	Locust Hill Road	B	51		X
M7	9410	Locust Hill Road	B	52		X
				Total Number of Impacted Receptors	**1**	

[1] *All noise levels are shown as hourly equivalent sound levels ($L_{eq}[h]$) with units in A-weighted decibels (dB[A]). The level is rounded to the nearest whole decibel in accordance with SHA guidelines.*

[2] *Impacted receptors are those that would experience highway noise levels that "approach" or exceed 67 dB(A) for NAC Activity Categories B and C and 71 dB(A) for NAC Activity Category E.*

Table 2.G Summary Noise Mitigation Evaluation in dB(A)

Preliminary Optimized Barrier Height	Receptor Site	Number of Residences	Predicted 2012 Build Conditions Sound Level	Mitigated Sound Level	Insertion Loss[1]	Receptor Benefited? (Yes) or (No)	
NSA 2							
18ft	R-5	2	57	54	3		X
	R-6	2	**66**	57	9	X	
	M-1	2	61	56	5	X	

[1] A receptor is considered benefited when it receives a noise reduction of at least 5 dB(A)

Table 2.H Noise Abatement Feasibility and Reasonableness Evaluation							
	Number of Benefited Residences	**Noise Barrier Length**	**Average Noise Barrier Height (ft.)**	**Square Footage (SF)**	**SF per Benefited Residence**	**Feasible?**	**Reasonable?**
NSA 2 Barrier	2	349	18	6,282	3,141	YES	NO

NSA 2 contains three receptors, R-5, R-6, and M-1 representing six residences. The 2012 Build condition predicts that receptor R-6 would experience noise levels that approach or exceed the NAC. A barrier located along the southbound travel lanes of MD 355 with a length of 349 feet and an average height of 18 feet was found to be feasible, but not reasonable. As indicated in Table 2.G, the two residences represented by receptor R-5 would not be benefited by the noise barrier. The four residences represented by receptors R-6 and M-1 are duplexes and do not have shared outdoor land uses. At both of these receptors, the residence furthest from MD 355 is shielded by the residence closest to the roadway. Only the residences closest to MD 355 are benefited by the noise barrier. In addition, this barrier would require the relocation of an existing pedestrian path that leads from the MD 355 roadside to the adjacent residences in NSA 2. The total square footage of the proposed noise barrier would be 6,282 s.f. With only two benefitted residences, the square footage per benefited residence is 3,141 s.f., which exceeds the threshold of 2,700 s.f. as indicated in the SHA Noise Policy.

MD 355 AT CEDAR LANE

TYPE I
TRAFFIC NOISE ANALYSIS

Section 3
MAPS


NSA 7
R-14
M-5
R-15
NSA 2
R-13
LOCUST HILL RD
R-4
355
R-3
R-5
M-2
Cedar Croft Dr
R-2
M-1
ELMHURST RD
R-6
NSA 1
CEDAR LN
R-8
R-1
NSA 4
R-7
NSA 3
R-9
R-12
R-11
R-10
NSA 6
NSA 5
355
Legend
N
Noise Receptors
Noise Sensitive Areas
0 100 200 300
Feet
1 inch = 300 feet
Map 3.1
MD 355 at Cedar Lane
Noise Sensitive Areas

Map 3.2
MD 355 at Cedar Lane
Sound Measurement & Model Validation


52
M7
51
M6
57
R-14
59
61
M5
58
R-3
57
M3
59
M2
65
R-2
64
R-1
61
R-12
65
R-11
R-13
62
R-15
65
R-4
66
R-6
61
M1
57
R-5
64
R-7
R-8
M4
59
60
64
R-9
66
R-10
Legend
Noise Receptors
ModeledSites
Noise Sensitive Areas
66 Modeled Sound Level
0
150
300
Feet
1 inch = 200 feet
Map 3.3
MD 355 at Cedar Lane
TNM Analysis Results

355

Rockville Pike

66
57
9

R-6

61
56
5

NSA 3

57
54
3

R-5

M1

Cedar Croft Dr

NSA 2

NSA 4-B

Corsica Dr

Legend

Noise Receptors

ModeledSites

Noise Sensitive Areas

Noise Barrier

66 Predicted Sound Level
66 Mitigated Sound Level
0 Insertion Loss

N

0 100 200 Feet

1 inch = 68 feet

Map 3.4
MD 355 at Cedar Lane
Noise Barrier Analysis

TYPE I
TRAFFIC NOISE ANALYSIS

Appendix A
SOUND MEASUREMENT DATA

INTRODUCTION

This appendix documents the noise measurements collected during field monitoring for the MD 355 at Cedar Lane study area. Also included are the available photographs for the noise measurement locations.

RECEPTOR R-01

General

Land Use: Residential

One short-term (15 min.) noise measurement was taken at this location on March 1, 2012 from 740 to 755 hours.

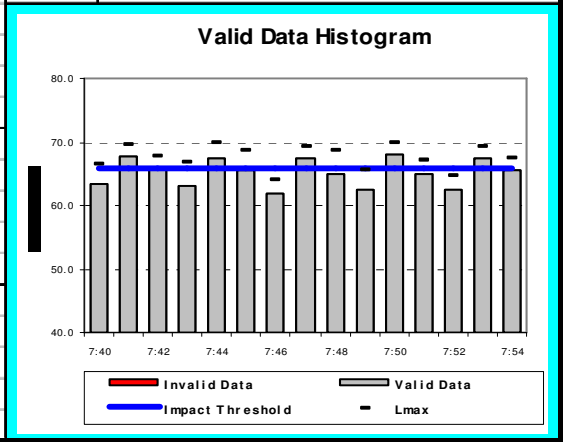
Photograph A-1: Receptor 01

2012 March 1

15-min noise measurement

TABLE A. Receptor R-01 -- 15-Minute Equivalent Sound Level (15-min Leq) Calculation -- TMSTMS 3: 2012-03-01 0740-0755 Hrs.

Noise Measurement Data						Calculated Data		Traffic Volume Nosie Level
TIME	1-min Leq	Lmax	Lpk	L(10.0)	L(99.9)	5-min Leq	15-min Leq	
	dB(A)	dB(A)	dB(C)	dB(A)	dB(A)	dB(A)	dB(A)	
7:40	63.5	66.3		66.3	61.3	66.0	65.7	66
7:41	67.7	69.6		69.4	66.2			
7:42	66.0	67.7		68.0	63.8			
7:43	63.2	66.8		66.3	60.9			
7:44	67.5	69.8		69.8	65.9			
7:45	65.6	68.7		68.6	62.4	64.9		
7:46	61.7	64.1		64.1	59.4			
7:47	67.3	69.3		69.3	65.8			
7:48	65.0	68.6		67.9	62.3			
7:49	62.4	65.5		65.2	59.6			
7:50	67.9	69.9		70.2	66.5	66.0		
7:51	64.9	67.0		67.1	61.8			
7:52	62.3	64.8		65.0	60.3			
7:53	67.4	69.1		69.1	66.3			
7:54	65.5	67.5		67.6	63.5			



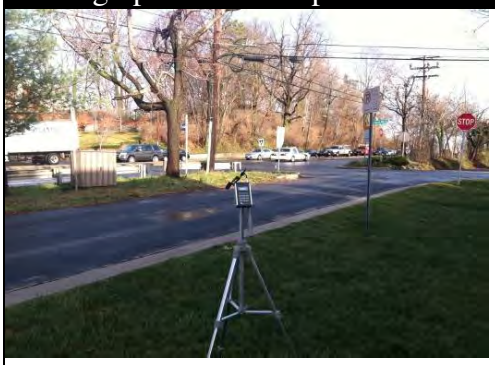
RECEPTOR R-02

General

Land Use: Residential

One short-term (15 min.) noise measurement was taken at this location on March 1, 2012 from 815 to 830 hours.

Photograph A-2: Receptor R-02

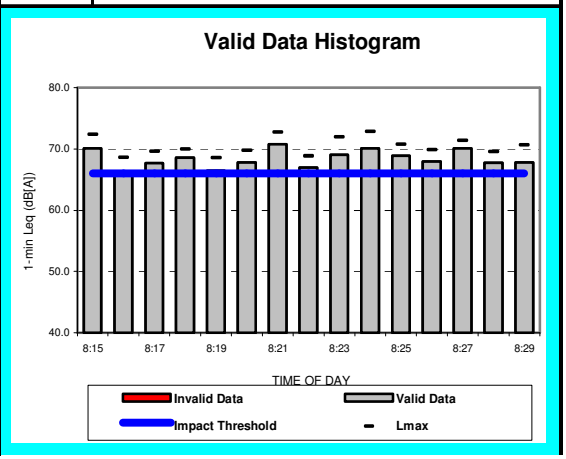


2011 March 1

15-min noise measurement

TABLE A. Receptor R-02 -- 15-Minute Equivalent Sound Level (15-min Leq) Calculation -- TMS02: 2012-03-01 0815-0830 Hrs.

Noise Measurement Data						Calculated Data		Traffic Volume Nosie Level
TIME	1-min Leq dB(A)	Lmax dB(A)	Lpk dB(C)	L(10.0) dB(A)	L(99.9) dB(A)	5-min Leq dB(A)	15-min Leq dB(A)	
8:15	70.1	72.3		71.4	67.8	68.0	68.6	**69**
8:16	66.0	68.6		67.8	63.3			
8:17	67.7	69.6		68.7	66.0			
8:18	68.6	70.0		69.3	67.2			
8:19	66.4	68.6		68.0	64.0			
8:20	67.8	69.8		69.0	65.6	69.1		
8:21	70.7	72.7		72.0	67.9			
8:22	67.0	68.9		68.5	63.3			
8:23	69.0	72.0		71.0	65.6			
8:24	70.1	72.8		72.2	66.7			
8:25	68.8	70.8		70.3	65.6	68.6		
8:26	67.9	69.9		69.1	65.0			
8:27	70.1	71.4		70.8	68.3			
8:28	67.7	69.5		68.8	65.5			
8:29	67.8	70.6		69.9	64.4			



RECEPTOR R-03

General

Land Use: Residential

One 15-minute noise measurement was taken at this location on March 1, 2012 from 815 to 830 hours.

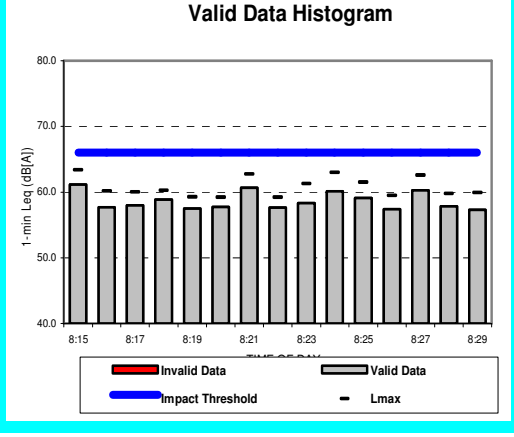
Photograph A-3: Receptor R-03

2011 March 1

15-min noise measurement

TABLE A. Receptor R-03 -- 15-Minute Equivalent Sound Level (15-min Leq) Calculation -- TMSTMS 2: 2011-05-25 0815-0830 Hrs.

Noise Measurement Data						Calculated Data		Traffic Volume Nosie Level
TIME	1-min Leq dB(A)	Lmax dB(A)	Lpk dB(C)	L(10.0) dB(A)	L(99.9) dB(A)	5-min Leq dB(A)	15-min Leq dB(A)	
8:15	61.2	63.4		62.7	59.4	58.9	58.8	**59**
8:16	57.7	60.2		59.6	56.2			
8:17	58.0	60.0		59.2	56.7			
8:18	58.9	60.3		60.2	58.2			
8:19	57.5	59.3		59.2	55.8			
8:20	57.7	59.2		59.2	55.7	59.1		
8:21	60.6	62.7		62.1	59.0			
8:22	57.6	59.2		59.2	55.4			
8:23	58.3	61.3		60.8	55.9			
8:24	60.1	63.0		62.7	58.0			
8:25	59.1	61.5		61.0	57.1	58.5		
8:26	57.4	59.4		59.2	55.2			
8:27	60.3	62.6		62.4	58.8			
8:28	57.8	59.8		59.5	56.8			
8:29	57.3	59.9		59.4	55.6			



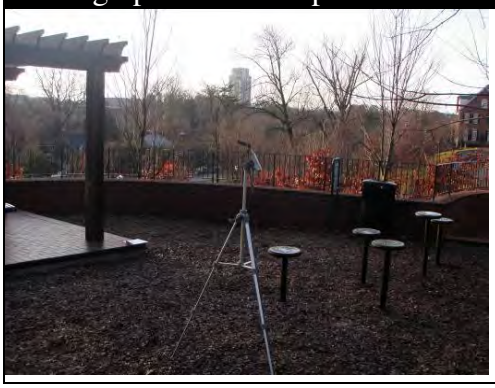
RECEPTOR R-04

General

Land Use: Public or Non-profit Institutional Structure

One 15-minute noise measurement was taken at this location on March 1, 2012 from 735 to 750 hours.

Photograph A-4: Receptor R-04

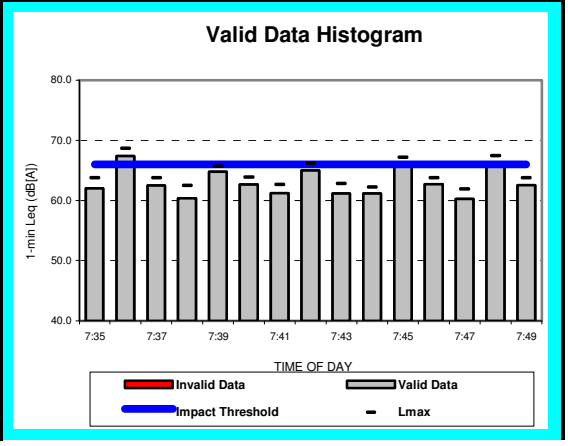


2011 March 1

15-min noise measurement

TABLE A. Receptor R-04 -- 15-Minute Equivalent Sound Level (15-min Leq) Calculation -- TMSTMS 1: 2012-03-01 0735-0750 Hrs.

Noise Measurement Data						Calculated Data		Traffic Volume Nosie Level
TIME	1-min Leq dB(A)	Lmax dB(A)	Lpk dB(C)	L(10.0) dB(A)	L(99.9) dB(A)	5-min Leq dB(A)	15-min Leq dB(A)	
7:35	62.0	63.8		63.4	60.4	64.1	63.6	64
7:36	67.4	68.7		68.5	66.3			
7:37	62.5	63.8		63.7	61.5			
7:38	60.4	62.5		62.3	58.6			
7:39	64.8	65.7		66.1	64.1			
7:40	62.6	63.9		63.9	62.0	62.5		
7:41	61.2	62.7		62.5	59.8			
7:42	65.0	66.2		66.2	64.2			
7:43	61.2	62.9		62.5	60.0			
7:44	61.1	62.3		62.1	59.7			
7:45	66.3	67.2		67.0	65.8	64.0		
7:46	62.7	63.8		63.6	61.7			
7:47	60.2	61.9		61.7	58.3			
7:48	65.8	67.5		67.1	65.1			
7:49	62.5	63.8		64.0	61.5			



RECEPTOR R-05

General

Land Use: Residential

One 15-minute noise measurement was taken at this location on March 1, 2012 from 735 to 750 hours.

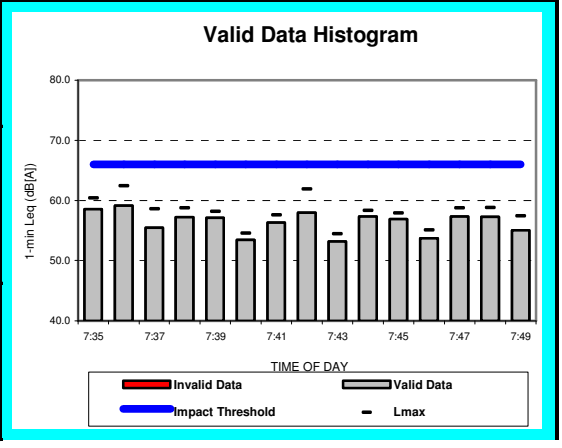
Photograph A-5: Receptor R-05

2011 March 1

15-min noise measurement

TABLE A. Receptor R-05 -- 15-Minute Equivalent Sound Level (15-min Leq) Calculation -- TMSTMS 1: 2012-03-01 0735-0750 Hrs.

Noise Measurement Data						Calculated Data		Traffic Volume Nosie Level
TIME	1-min Leq dB(A)	Lmax dB(A)	Lpk dB(C)	L(10.0) dB(A)	L(99.9) dB(A)	5-min Leq dB(A)	15-min Leq dB(A)	
7:35	58.6	60.4		60.0	57.5	57.7	56.7	**57**
7:36	59.2	62.4		61.3	57.3			
7:37	55.4	58.6		57.4	53.8			
7:38	57.2	58.8		58.5	55.7			
7:39	57.1	58.2		58.2	56.5			
7:40	53.5	54.6		54.6	52.8	56.1		
7:41	56.3	57.6		57.5	55.4			
7:42	58.0	61.9		61.5	55.6			
7:43	53.2	54.5		54.3	52.3			
7:44	57.3	58.4		58.3	56.1			
7:45	56.9	57.9		58.0	56.3	56.3		
7:46	53.7	55.1		54.9	52.5			
7:47	57.3	58.8		58.2	56.3			
7:48	57.3	58.8		58.7	56.6			
7:49	55.0	57.5		57.2	52.6			



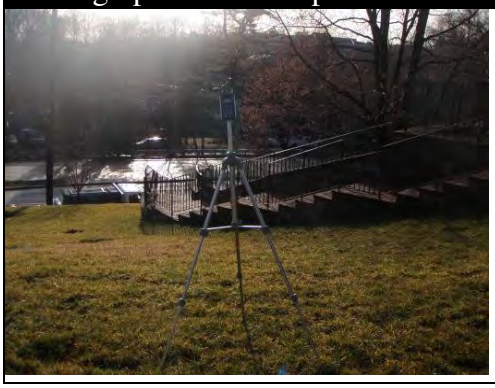
RECEPTOR R-06

General

Land Use: Residential

One 15-minute noise measurement was taken at this location on March 1, 2012 from 735 to 750 hours.

Photograph A-6: Receptor R-06

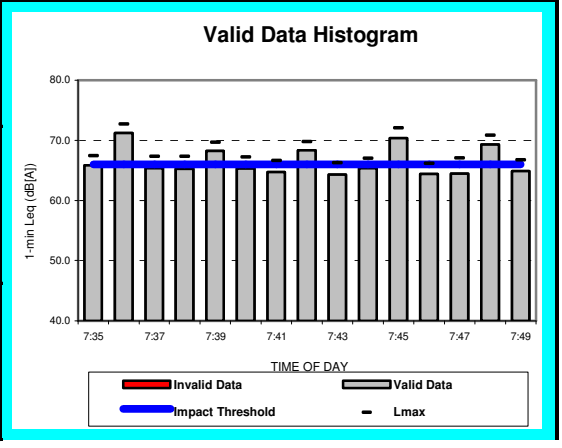


2011 March 1

15-min noise measurement

TABLE A. Receptor R-06 -- 15-Minute Equivalent Sound Level (15-min Leq) Calculation -- TMS01: 2012-03-01 0735-0750 Hrs.

Noise Measurement Data						Calculated Data		Traffic Volume Nosie Level
TIME	1-min Leq dB(A)	Lmax dB(A)	Lpk dB(C)	L(10.0) dB(A)	L(99.9) dB(A)	5-min Leq dB(A)	15-min Leq dB(A)	
7:35	65.9	67.5		66.7	63.4	67.9	67.2	**67**
7:36	71.2	72.7		72.0	69.4			
7:37	65.4	67.4		66.7	62.3			
7:38	65.3	67.4		66.9	63.3			
7:39	68.3	69.7		69.2	66.8			
7:40	65.3	67.2		66.8	62.4	65.9		
7:41	64.7	66.6		65.5	62.3			
7:42	68.4	69.8		69.0	66.8			
7:43	64.4	66.3		65.3	60.9			
7:44	65.3	67.0		66.3	63.5			
7:45	70.4	72.1		71.3	68.7	67.5		
7:46	64.5	66.2		65.7	62.2			
7:47	64.5	67.1		66.2	62.1			
7:48	69.3	70.9		70.2	67.9			
7:49	64.8	66.8		66.3	63.0			



RECEPTOR R-07

General

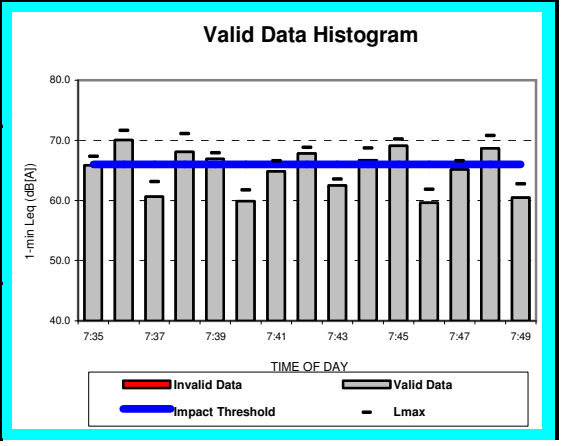
Land Use: Public or Non-profit Institutional Structure

One 15-minute noise measurement was taken at this location on March 1, 2012 from 735 to 735 hours.

Photograph A-7: Receptor R07	
	2011 March 1 15-min noise measurement

TABLE A. Receptor R-07 -- 15-Minute Equivalent Sound Level (15-min Leq) Calculation -- TMSTMS 1: 2012-03-01 0735-0750 Hrs.

Noise Measurement Data						Calculated Data		Traffic Volume Nosie Level
TIME	1-min Leq dB(A)	Lmax dB(A)	Lpk dB(C)	L(10.0) dB(A)	L(99.9) dB(A)	5-min Leq dB(A)	15-min Leq dB(A)	
7:35	65.8	67.4		67.0	63.8	67.2	66.3	**66**
7:36	70.0	71.6		71.0	68.4			
7:37	60.6	63.1		62.1	58.9			
7:38	68.1	71.1		70.1	64.1			
7:39	66.9	68.0		67.5	65.2			
7:40	59.9	61.8		61.1	57.9	65.2		
7:41	64.8	66.6		66.0	63.0			
7:42	67.8	68.9		68.5	66.6			
7:43	62.5	63.6		63.3	61.7			
7:44	66.7	68.7		68.0	65.1			
7:45	69.1	70.2		69.6	67.8	66.2		
7:46	59.7	61.9		60.9	57.6			
7:47	65.1	66.6		66.3	63.5			
7:48	68.7	70.8		70.3	67.3			
7:49	60.5	62.7		62.4	57.2			



RECEPTOR R-08

General

One 15-minute noise measurement was taken at this location on March 1, 2012 from 735 to 750 hours.

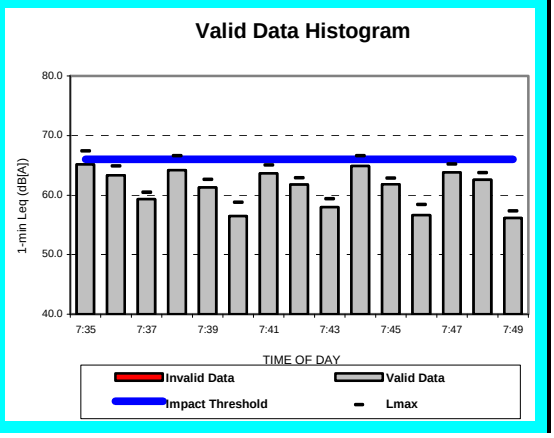
Photograph A-8: Receptor R08

2011 March 1

15-min noise measurement

TABLE A. Receptor R-08 -- 15-Minute Equivalent Sound Level (15-min Leq) Calculation -- TMSTMS 1: 2012-03-01 0735-0750 Hrs.

Noise Measurement Data						Calculated Data		Traffic Volume Nosie Level
TIME	1-min Leq dB(A)	Lmax dB(A)	Lpk dB(C)	L(10.0) dB(A)	L(99.9) dB(A)	5-min Leq dB(A)	15-min Leq dB(A)	
7:35	65.1	67.4		66.9	63.8	63.1	62.2	**62**
7:36	63.3	64.9		64.6	61.9			
7:37	59.4	60.4		60.5	58.2			
7:38	64.2	66.6		66.7	62.3			
7:39	61.2	62.6		62.9	59.7			
7:40	56.5	58.8		58.5	55.1	62.0		
7:41	63.7	65.0		65.0	62.6			
7:42	61.8	62.9		62.8	60.8			
7:43	58.0	59.4		59.1	57.1			
7:44	64.9	66.6		66.6	63.6			
7:45	61.8	62.8		62.6	61.2	61.2		
7:46	56.7	58.4		58.3	55.4			
7:47	63.8	65.2		65.0	62.7			
7:48	62.5	63.7		63.3	61.1			
7:49	56.1	57.3		57.2	55.4			



RECEPTOR R-09

General

One 15-minute noise measurement was taken at this location on March 1, 2012 from 735 to 750 hours.

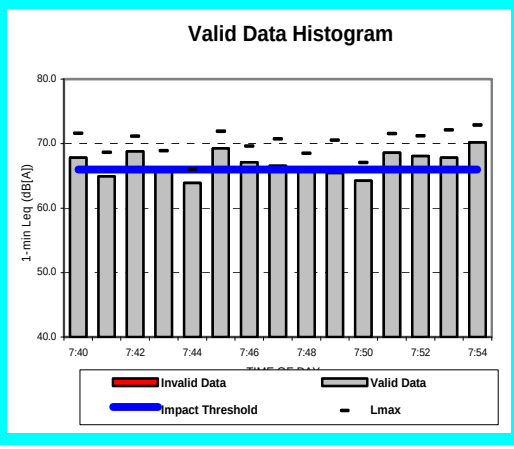
Photograph A-9: Receptor R09

2011 March 1

15-min noise measurement

TABLE A. Receptor R-09 -- 15-Minute Equivalent Sound Level (15-min Leq) Calculation -- TMSTMS3: 2012-03-01 0740-0755 Hrs.

Noise Measurement Data						Calculated Data		Traffic Volume Nosie Level
TIME	1-min Leq dB(A)	Lmax dB(A)	Lpk dB(C)	L(10.0) dB(A)	L(99.9) dB(A)	5-min Leq dB(A)	15-min Leq dB(A)	
7:40	67.8	71.6		71.2	63.8	66.7	67.4	**67**
7:41	64.9	68.7		68.8	62.9			
7:42	68.8	71.1		71.1	66.6			
7:43	66.2	68.9		69.1	62.7			
7:44	63.9	66.1		66.3	61.6			
7:45	69.3	71.9		71.7	65.8	67.1		
7:46	67.1	69.6		69.8	64.2			
7:47	66.5	70.7		70.4	61.7			
7:48	66.1	68.5		68.3	63.7			
7:49	65.5	70.5		69.2	62.4			
7:50	64.3	67.0		67.0	61.7	68.2		
7:51	68.6	71.6		71.7	64.9			
7:52	68.1	71.2		70.7	64.5			
7:53	67.8	72.1		71.7	63.3			
7:54	70.2	72.9		73.0	68.0			



RECEPTOR R-10

General

One 15-minute noise measurement was taken at this location on March 1, 2012 from 735 to 750 hours.

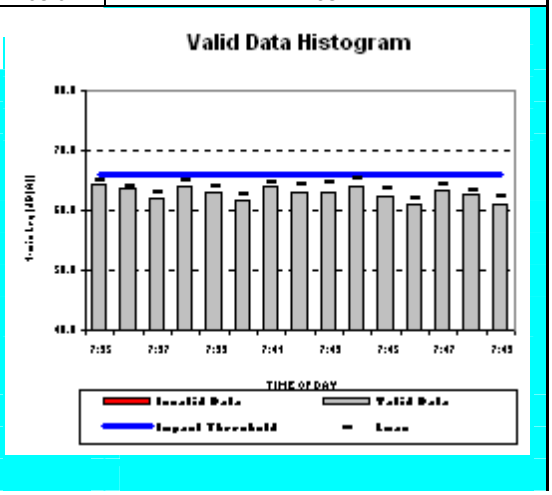
Photograph A-10: Receptor R10

2011 March 1

15-min noise measurement

TABLE A. Receptor R-10 -- 15-Minute Equivalent Sound Level (15-min Leq) Calculation -- TMS01: 2012-03-01 0735-0750 Hrs.

Noise Measurement Data						Calculated Data		Traffic Volume Nosie Level
TIME	1-min Leq dB(A)	Lmax dB(A)	Lpk dB(C)	L(10.0) dB(A)	L(99.9) dB(A)	5-min Leq dB(A)	15-min Leq dB(A)	
7:35	64.3	65.0		64.5	63.2	63.5	63.0	**63**
7:36	63.5	64.0		63.5	62.5			
7:37	62.0	63.1		62.4	60.6			
7:38	64.1	64.9		64.3	63.5			
7:39	63.2	64.0		63.6	61.9			
7:40	61.8	62.8		62.1	60.7	63.3		
7:41	64.1	64.7		64.1	63.1			
7:42	63.1	64.3		63.7	62.1			
7:43	63.0	64.6		63.9	61.3			
7:44	64.1	65.2		64.6	62.7			
7:45	62.4	63.6		62.8	61.3	62.2		
7:46	61.0	62.0		61.5	60.1			
7:47	63.4	64.3		63.8	62.3			
7:48	62.5	63.3		62.6	61.1			
7:49	61.1	62.4		61.6	60.1			



RECEPTOR R-11

General

One 15-minute noise measurement was taken at this location on March 1, 2012 from 740 to 755 hours.

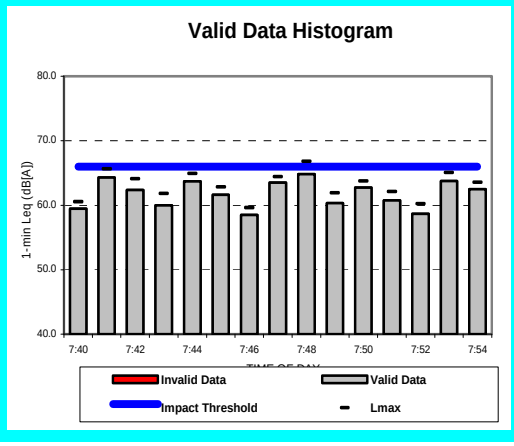
Photograph A-11: Receptor R11

2011 March 1

15-min noise measurement

TABLE A. Receptor R-11 -- 15-Minute Equivalent Sound Level (15-min Leq) Calculation -- TMS03: 2012-03-01 0740-0755 Hrs.

Noise Measurement Data						Calculated Data		Traffic Volume Nosie Level
TIME	1-min Leq dB(A)	Lmax dB(A)	Lpk dB(C)	L(10.0) dB(A)	L(99.9) dB(A)	5-min Leq dB(A)	15-min Leq dB(A)	
7:40	59.5	60.5		60.0	58.2	62.4	62.2	**62**
7:41	64.3	65.6		65.0	62.9			
7:42	62.4	64.1		63.4	59.6			
7:43	60.0	61.8		61.1	58.3			
7:44	63.7	64.9		64.3	62.4			
7:45	61.6	62.9		62.6	59.9	62.3		
7:46	58.5	59.6		59.3	57.1			
7:47	63.5	64.4		64.1	62.1			
7:48	64.8	66.8		65.9	61.8			
7:49	60.3	61.9		61.4	58.0			
7:50	62.7	63.7		63.2	61.4	62.0		
7:51	60.8	62.1		61.4	59.3			
7:52	58.6	60.2		59.4	57.1			
7:53	63.7	65.1		64.6	62.0			
7:54	62.5	63.6		63.1	61.1			

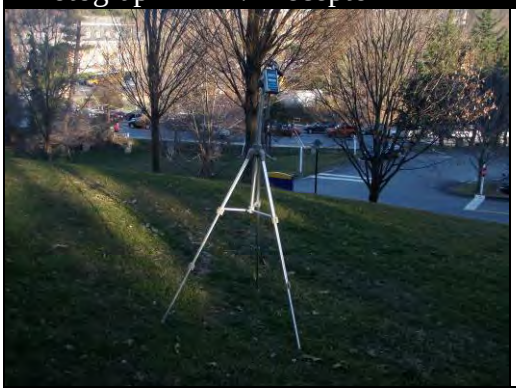


RECEPTOR R-12

General

One 15-minute noise measurement was taken at this location on March 1, 2012 from 740 to 755 hours.

Photograph A-12: Receptor R12

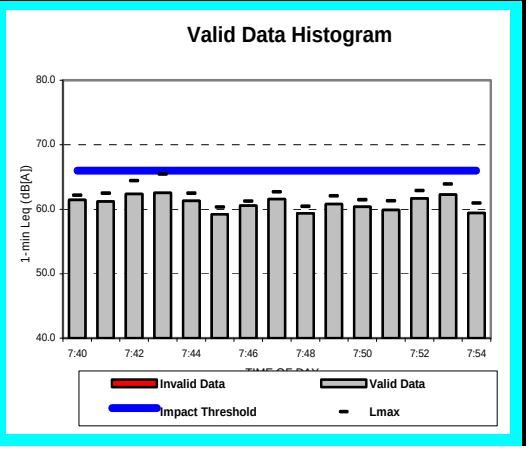


2011 March 1

15-min noise measurement

TABLE A. Receptor R-12 -- 15-Minute Equivalent Sound Level (15-min Leq) Calculation -- TMSTms 3: 2012-03-01 0740-0755 Hrs.

Noise Measurement Data						Calculated Data		Traffic Volume Nosie Level
TIME	1-min Leq dB(A)	Lmax dB(A)	Lpk dB(C)	L(10.0) dB(A)	L(99.9) dB(A)	5-min Leq dB(A)	15-min Leq dB(A)	
7:40	61.5	62.2		61.8	60.9	61.8	61.1	**61**
7:41	61.2	62.5		61.9	59.6			
7:42	62.4	64.4		63.9	59.9			
7:43	62.5	65.4		64.1	60.3			
7:44	61.3	62.5		62.1	60.1			
7:45	59.2	60.3		60.1	58.2	60.4		
7:46	60.5	61.2		61.1	59.9			
7:47	61.5	62.7		62.4	60.5			
7:48	59.3	60.4		60.0	58.5			
7:49	60.8	62.1		61.5	59.5			
7:50	60.4	61.5		61.1	59.4	60.9		
7:51	59.9	61.3		61.0	59.0			
7:52	61.7	62.9		62.6	60.4			
7:53	62.3	63.9		63.6	61.1			
7:54	59.4	60.9		60.3	58.4			

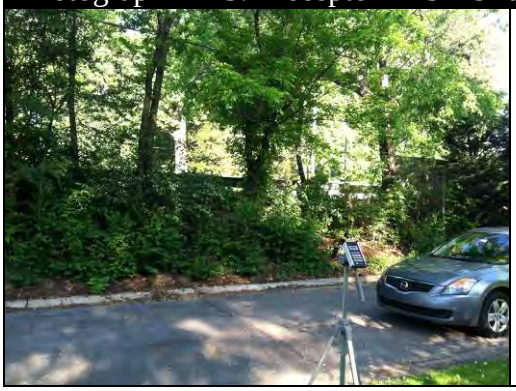


RECEPTOR R-13

General

One 15-minute noise measurement was taken at this location on April 25, 2012 from 820 to 835 hours.

Photograph A-13: Receptor R13 – 9407 Locust Hill Rd

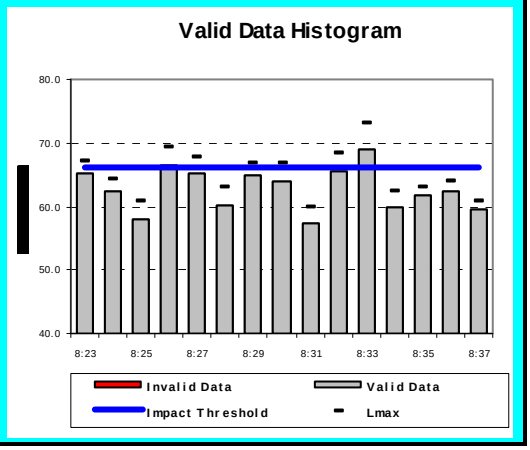


2011 April 25

15-min noise measurement

TABLE A. Receptor R-13 -- 15-Minute Equivalent Sound Level (15-min Leq) Calculation -- TMS04: 2012-04-25 0823-0838 Hrs.

Noise Measurement Data						Calculated Data		Traffic Volume Nosie Level
TIME	1-min Leq	Lmax	Lpk	L(10.0)	L(99.9)	5-min Leq	15-min Leq	
	dB(A)	dB(A)	dB(C)	dB(A)	dB(A)	dB(A)	dB(A)	
8:23	65.2	67.1		66.7	63.2	64.2	63.9	**64**
8:24	62.3	64.2		64.0	60.3			
8:25	57.9	60.8		60.3	54.9			
8:26	66.3	69.3		68.5	63.7			
8:27	65.3	67.7		67.1	63.5			
8:28	60.3	63.1		62.4	56.5	63.4		
8:29	64.8	66.7		66.2	62.6			
8:30	64.1	66.9		66.3	61.0			
8:31	57.3	59.9		59.1	54.7			
8:32	65.6	68.3		67.3	62.1			
8:33	68.9	73.0		72.2	63.7	64.1		
8:34	59.7	62.4		61.9	55.1			
8:35	61.7	62.9		62.6	60.4			
8:36	62.3	63.9		63.6	61.1			
8:37	59.4	60.9		60.3	58.4			

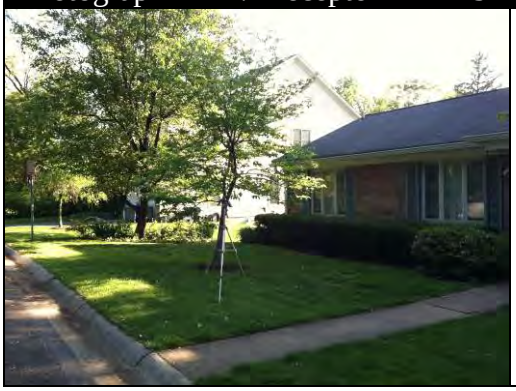


RECEPTOR R-14

General

One 15-minute noise measurement was taken at this location on April 25, 2012 from 820 to 835 hours.

Photograph A-14: Receptor R14 – 9419 Locust Hill Rd

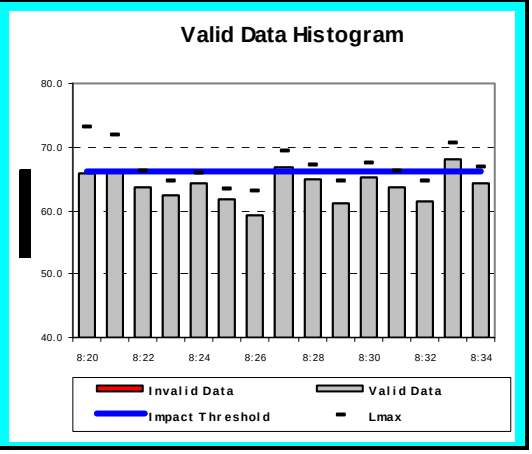


2011 April 25

15-min noise measurement

TABLE A. Receptor R-14 -- 15-Minute Equivalent Sound Level (15-min Leq) Calculation -- TMS04: 2012-04-25 0820-0835 Hrs.

Noise Measurement Data						Calculated Data		Traffic Volume Nosie Level
TIME	1-min Leq	Lmax	Lpk	L(10.0)	L(99.9)	5-min Leq	15-min Leq	
	dB(A)	dB(A)	dB(C)	dB(A)	dB(A)	dB(A)	dB(A)	
8:20	65.9	73.1		71.8	59.1	64.6	64.5	64
8:21	66.0	71.7		68.7	62.8			
8:22	63.7	66.1		65.1	61.7			
8:23	62.3	64.6		63.9	58.9			
8:24	64.2	65.9		65.2	62.4			
8:25	61.7	63.4		62.7	60.2	63.6		
8:26	59.1	63.0		61.9	54.3			
8:27	66.7	69.3		68.4	64.1			
8:28	65.0	67.0		66.4	62.6			
8:29	61.2	64.5		63.4	56.0			
8:30	65.2	67.3		66.5	63.5	65.0		
8:31	63.5	66.3		65.2	60.2			
8:32	61.5	64.4		63.3	56.6			
8:33	68.0	70.5		69.5	65.0			
8:34	64.1	66.7		65.1	62.0			



RECEPTOR R-15

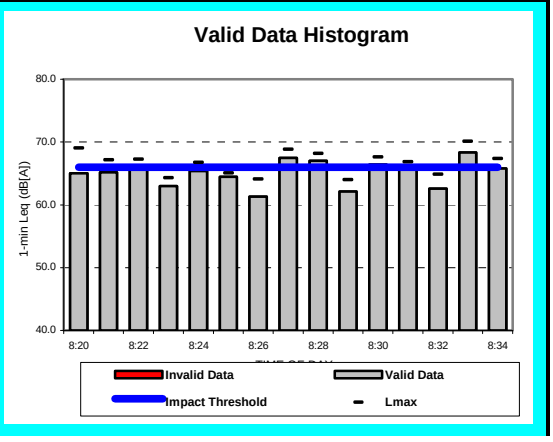
General

One 15-minute noise measurement was taken at this location on April 25, 2012 from 820 to 835 hours.

Photograph A-9: Receptor R15 – Bethesda Meeting House	
PHOTO UNAVAILABLE	2011 April 25 15-min noise measurement

TABLE A. Receptor R-15 -- 15-Minute Equivalent Sound Level (15-min Leq) Calculation -- TMS04: 2012-04-25 0820-0835 Hrs.

Noise Measurement Data						Calculated Data		Traffic Volume Nosie Level
TIME	1-min Leq dB(A)	Lmax dB(A)	Lpk dB(C)	L(10.0) dB(A)	L(99.9) dB(A)	5-min Leq dB(A)	15-min Leq dB(A)	
8:20	65.0	69.0		67.8	61.1	65.0	65.5	**65**
8:21	65.2	67.2		66.4	63.4			
8:22	66.0	67.3		67.0	64.0			
8:23	63.0	64.3		63.5	61.4			
8:24	65.4	66.8		65.9	64.0			
8:25	64.5	65.1		64.6	63.8	65.2		
8:26	61.3	64.1		62.9	58.3			
8:27	67.5	68.8		68.1	65.4			
8:28	67.0	68.2		67.6	65.5			
8:29	62.1	64.0		63.0	59.6			
8:30	66.4	67.6		67.1	64.8	66.1		
8:31	65.6	66.9		66.3	63.8			
8:32	62.6	64.9		64.3	59.7			
8:33	68.3	70.1		69.4	66.7			
8:34	65.8	67.4		66.4	64.3			



MD 355 AT CEDAR LANE

TYPE I
TRAFFIC NOISE ANALYSIS

Appendix B
TRAFFIC MONITORING SESSIONS

INTRODUCTION

This appendix documents the traffic data collected during field monitoring for the MD 355 at Cedar Lane study area. This data was used to validate the TNM noise model.

Table B-1 lists in chronological order the traffic monitoring sessions (TMS) conducted during this study and describes the interval time and duration of each session. Detailed on-site weather condition data was unavailable; information provided was gathered in the field during each TMS.

Table B-1: Traffic Monitoring Session Summary

Traffic Monitoring Session	Date	Interval	Duration	Temp (degree F)	Relative Humidity	Wind Speed (mph)	Wind Direction[1]
TMS-01	2012-03-01	0740-0855	15-min	54.0	63	2.0	ESE
TMS-02	2012-03-01	0815-0830	15-min	54.0	63	2.0	ESE
TMS-03	2012-03-06	0740-0755	15-min	55.0	30	4.0	ESE
TMS-04	2012-04-25	0820-0835	15-min	58.0	30	3.0	ESE

[1] Wind direction is defined as the direction the wind is blowing FROM. For example if the Wind Direction is North, then the wind is blowing FROM the north and TO the south.

The traffic volume noise levels measured during each TMS are listed in Appendix A.

VOLUMES

Tables B-2 through ***B-5*** depict the volumes, speeds, and vehicle mix percentages for each lane of traffic approaching the MD 355 at Cedar Lane intersection.

The data is broken down according to the five vehicle classifications defined in *Section 1.0* of this report. Counted traffic volumes were converted to vehicles per hour by multiplying the counts by the conversion factor. The conversion factor is defined as 60 minutes divided by the TMS duration in minutes (e.g., 60/20 =3).

Table B-2 TMS-01 Volume Summary		MD 355				Cedar Lane			
		Northbound North of Int.	Northbound South of Int.	Southbound North of Int.	Southbound South of Int.	Eastbound West of Int.	Eastbound East of Int.	Westbound West of Int.	Westbound East of Int.
Volume	Cars	1,320	1,056	2,928	3,012	576	492	384	820
	Medium Trucks	60	24	44	44	8	24	4	4
	Heavy Trucks	20	24	28	28	0	0	0	4
Vehicle Mix %	Cars	94.3%	95.6%	97.6%	97.7%	98.6%	95.3%	99.0%	99.0%
	Medium Trucks	4.3%	2.2%	1.5%	1.4%	1.4%	4.7%	1.0%	0.5%
	Heavy Trucks	1.4%	2.2%	0.9%	0.9%	0.0%	0.0%	0.0%	0.5%
Average/Est. Speed		35	35	35	35	25	25	25	25

Table B-3 TMS-02 Volume Summary		MD 355				Cedar Lane			
		Northbound North of Int.	Northbound South of Int.	Southbound North of Int.	Southbound South of Int.	Eastbound West of Int.	Eastbound East of Int.	Westbound West of Int.	Westbound East of Int.
Volume	Cars	912	1056	3348	3700	524	320	464	776
	Medium Trucks	52	8	44	44	4	24	8	12
	Heavy Trucks	20	12	8	12	4	0	4	4
Vehicle Mix %	Cars	92.7%	98.2%	98.5%	98.5%	98.4%	93.0%	97.5%	98.0%
	Medium Trucks	5.3%	0.7%	1.3%	1.2%	0.8%	7.0%	1.7%	1.5%
	Heavy Trucks	2.0%	1.1%	0.2%	0.3%	0.8%	0.0%	0.8%	0.5%
Average/Est. Speed		35	35	35	35	25	25	25	25

Table B-4 TMS-03 Volume Summary		MD 355				Cedar Lane			
		Northbound North of Int.	Northbound South of Int.	Southbound North of Int.	Southbound South of Int.	Eastbound West of Int.	Eastbound East of Int.	Westbound West of Int.	Westbound East of Int.
Volume	Cars	1700	1236	2568	2512	612	320	476	712
	Medium Trucks	16	12	32	28	4	4	12	8
	Heavy Trucks	16	8	16	16	0	0	4	8
Vehicle Mix %	Cars	98.2%	98.4%	98.2%	98.3%	99.4%	98.8%	96.8%	97.8%
	Medium Trucks	0.9%	1.0%	1.2%	1.1%	0.6%	1.2%	2.4%	1.1%
	Heavy Trucks	0.9%	0.6%	0.6%	0.6%	0.0%	0.0%	0.8%	1.1%
Average/Est. Speed		35	35	35	35	25	25	25	25

Table B-5 TMS-04 Volume Summary		MD 355	
		Northbound North of Int.	Southbound North of Int.
Volume	Cars	664	2980
	Medium Trucks	48	52
	Heavy Trucks	32	16
Vehicle Mix %	Cars	89.2%	97.8%
	Medium Trucks	6.5%	1.7%
	Heavy Trucks	4.3%	0.5%
Average/Est. Speed		35	35

MD 355 AT CEDAR LANE

TYPE I
TRAFFIC NOISE ANALYSIS

Appendix C
TNM MODEL INPUT

INTRODUCTION

General

This appendix documents the TNM model input used in both the TNM model validation and the barrier design. The following seven object-type categories were utilized in the TNM model to approximate the MD 355 at Cedar Lane study area.

1. Roadways
2. Receptors (Receivers)
3. Barriers
4. Terrain Lines
5. Building Rows

TNM Model Runs

The TNM model runs are divided into five categories: 1) TNM Model Validation, 2) Existing Worst-Case, 3) Design Year No-Build, 4) Design Year Build, and 5) Barrier Design. The TNM model input for categories 1, 2, and 3 are identical except for the following items:

traffic volumes
number of modeled receptors

The TNM model input for categories 4 and 5 are identical except for the following items:

Barrier design inputs

See the TNM Model Objects discussion below for further information.

TNM Model Validation

The TNM models used for validation are listed below:

Validation TMS1
Validation TMS2
Validation TMS3
Validation TMS4

See *Section 2.0* for a complete account of the TNM Model Validation.

Barrier Design

The TNM models used for the barrier designs are listed below:

Build – assumed 36” Jersey barrier at edge of proposed sidewalk.
Jersey 54 – assumed 54” Jersey barrier at edge of proposed sidewalk.
Jersey 60 – assumed 60” Jersey barrier at edge of proposed sidewalk.
R6 Barrier – barrier design to protect impacts at site R6
Wall A EOS – proposed 54” inch Jersey barrier along MD 355 northbound edge-of-shoulder.