

Noise Technical Report for State Route 396 (Saturn Parkway) Extension Maury County, Tennessee

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TABLE OF CONTENTS

Executive Summary	1
1.0 Introduction	1
2.0 Noise Evaluation	1
2.1 Criteria for Determining Impacts	3
2.1.1 Traffic Noise Terminology	3
2.1.2 Noise Abatement Criteria (NAC)	4
2.2 Identification of Noise Analysis Areas	4
2.3 Determination of Existing Sound Levels	7
2.4 Determination of Future Sound Levels	7
2.4.1 No-Build Alternative	7
2.4.2 Build Alternative	9
2.5 Impact Determination Analysis	10
2.6 Noise Abatement Evaluation	10
2.6.1 Statement of Likelihood	10
2.7 Construction Noise	10
2.8 Information for Local Officials	10
3.0 References	12
Appendix A Noise Measurement Data Sheets and Photographs	
Appendix B Design Year Traffic Data	
Appendix C TNM Plan Views	
Appendix D Design Year Sound Levels and Impacts	

LIST OF TABLES

Table 1: Noise Abatement Criteria in 23 CFR 772	5
Table 2: Substantial Noise Level Increase	5
Table 3: Noise Analysis Areas	6
Table 4: Existing Sound Levels at Measurement Locations	7
Table 5: Impact Determination Analysis, Design Year 2037, Build Alternative	9
Table 6: Design Year 2037 Sound Levels for Undeveloped Lands	11

LIST OF FIGURES

Figure 1: Project Area	2
Figure 2: Common Sound Levels	3
Figure 3: Noise Analysis Areas	6
Figure 4: Existing and Design Year 2037 Sound Levels	8

EXECUTIVE SUMMARY

This noise study was conducted in accordance with the FHWA noise regulation, *Procedures for Abatement of Highway Traffic and Construction Noise, 23 CFR 772*, the Tennessee Department of Transportation's *Policy on Highway Traffic Noise Abatement* (TDOT's noise policy), and Section 5.3.4 (Noise) of the *Tennessee Environmental Procedures Manual*.

The study identified three areas of Category B single-family residences that might be affected by the project but concluded that these residences will not be impacted. Therefore, the study did not evaluate noise abatement measures.

1.0 INTRODUCTION

This report documents the results of an analysis of the noise impacts of the extension of State Route 396 (SR 396, Saturn Parkway). The project is Type I and involves the construction of a three-lane roadway on new alignment from the SR 396/State Route 6 (SR 6) interchange to State Route 247 (SR 247, Beechcroft Road). Figure 1 shows the project area.

2.0 NOISE EVALUATION

This study has been prepared in accordance with the FHWA noise regulation, *Procedures for Abatement of Highway Traffic and Construction Noise, 23 CFR 772* [1], the Tennessee Department of Transportation's *Policy on Highway Traffic Noise Abatement* [2], and the Tennessee Department of Transportation's *Procedures for Highway Traffic Noise Abatement* [3] and includes the following tasks:

- Identification of noise analysis areas: Identification of existing land uses in the project area that are sensitive to highway traffic noise;
- Determination of existing sound levels: Measurement of existing sound levels at sensitive land uses to characterize the existing noise environment in the project area;
- Determination of future sound levels: Prediction of future, design year, worst-hour sound levels for the No-Build and Build Alternatives;
- Determination of traffic noise impacts: Determination of noise impacts based on the increase in existing sound levels, as well as design year sound levels;
- Noise abatement evaluation: Evaluation of noise abatement for areas determined to be impacted by the project;
- Discussion of construction noise; and
- Information for local officials.

Each of these analysis steps is discussed below following a discussion of TDOT's criteria for determining noise impacts.

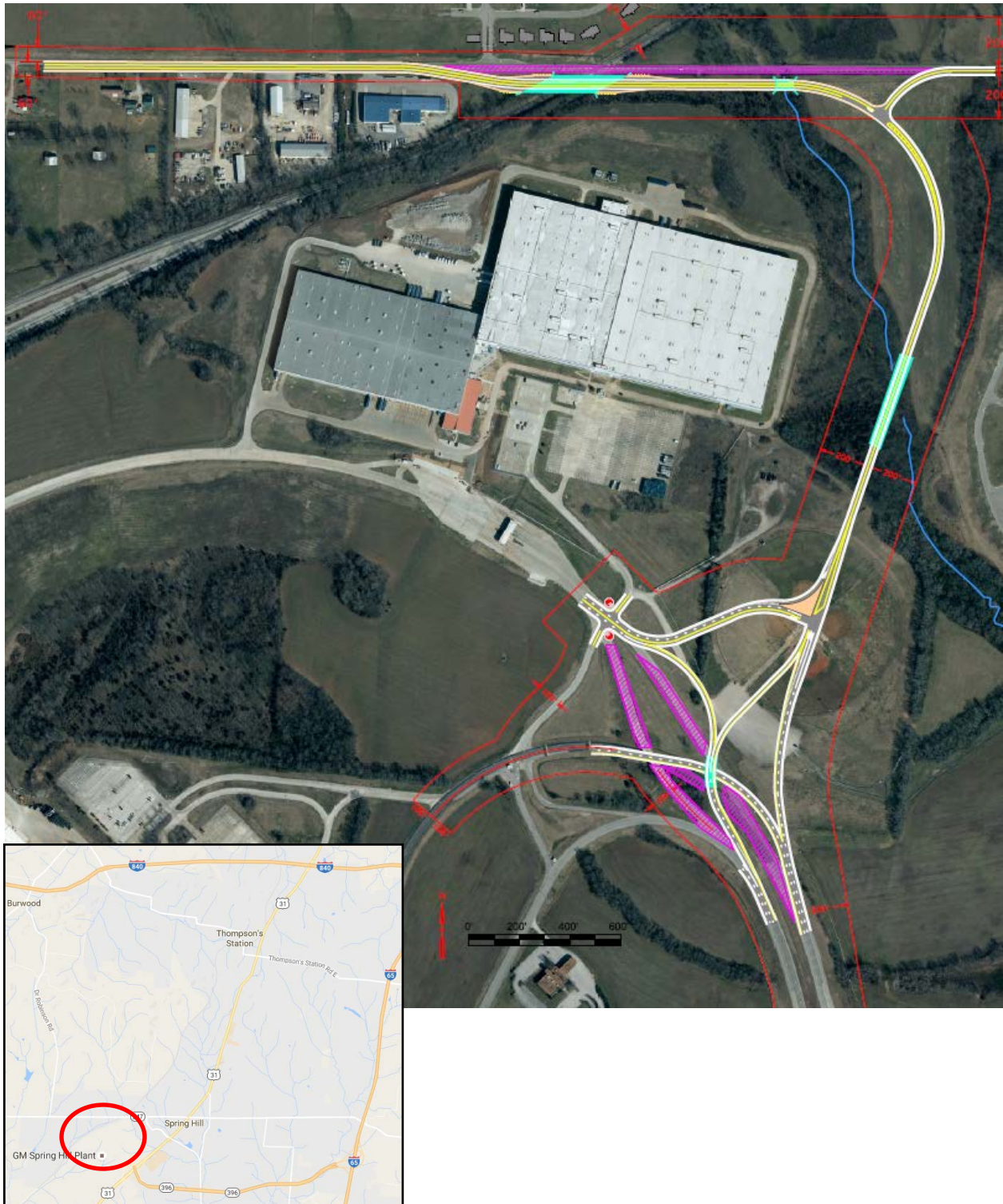


Figure 1: Project Area

2.1 CRITERIA FOR DETERMINING IMPACTS

2.1.1 Traffic Noise Terminology

Traffic noise levels are expressed in terms of the hourly, A-weighted equivalent sound level in decibels (dBA). A sound level represents the level of the rapid air pressure fluctuations caused by sources (such as traffic) that are heard as noise. A decibel is a unit that relates the sound pressure of a noise to the faintest sound the young human ear can hear.

The A-weighting refers to the amplification or attenuation of the different frequencies of the sound (subjectively, the pitch) to correspond to the way the human ear “hears” these frequencies. Generally, when the sound level exceeds the mid-60 dBA range, outdoor conversation in normal tones at a distance of three feet becomes difficult. Figure 2 shows some common indoor and outdoor sound levels.

A 9-10 dB increase in sound level is typically judged by the listener to be twice as loud as the original sound while a 9-10 dB reduction is judged to be half as loud. Doubling the number of sources (i.e. vehicles) will increase the hourly equivalent sound level by approximately 3 dB, which is usually the smallest change in hourly equivalent A-weighted traffic noise levels that people can detect without specifically listening for the change.

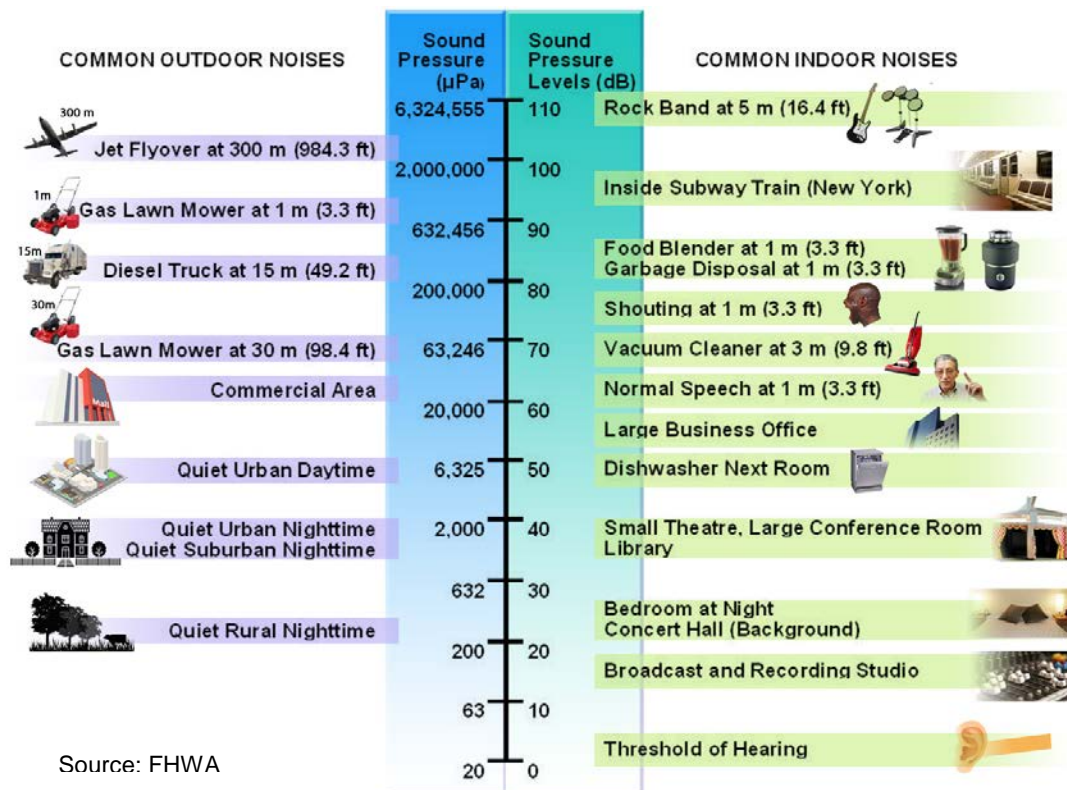


Figure 2: Common Sound Levels

Because most environmental noise fluctuates from moment to moment, it is standard practice to condense data into a single level called the equivalent sound level (L_{eq}). The L_{eq} is a steady sound level that would contain the same amount of sound energy as the actual time-varying sound evaluated over the same time-period. The L_{eq} averages the louder and quieter moments, but gives much more weight to the louder moments in the averaging. For traffic noise assessment purposes, L_{eq} is typically evaluated over the worst one-hour period and is defined as $L_{eq}(1h)$.

The term insertion loss (IL) is generally used to describe the reduction in $L_{eq}(1h)$ at a location after a noise barrier is constructed. For example, if the $L_{eq}(1h)$ at a residence before a barrier is constructed is 75 dBA and the $L_{eq}(1h)$ after a barrier constructed is 65 dBA, then the insertion loss would be 10 dB.

2.1.2 Noise Abatement Criteria (NAC)

Noise impact is determined by comparing future project sound levels: (1) to a set of Noise Abatement Criteria (NAC) for a particular land use category, and (2) to existing sound levels.

The FHWA noise regulation (contained in 23 CFR 772) and TDOT's noise policy state that traffic noise impacts require consideration of abatement when worst-hour sound levels approach or exceed the NAC listed in Table 1. TDOT's noise policy defines "approach" as one decibel below the NAC, or 66 dBA for Category B and C land uses.

The FHWA noise regulation and TDOT's noise policy also define impacts to occur if there is a substantial increase in design year sound levels. Table 2 presents TDOT's criteria for substantial noise increase.

2.2 Identification of Noise Analysis Areas

Review of available electronic mapping and field reconnaissance revealed three areas containing noise-sensitive land uses that might be affected by the project. Table 3 describes these noise analysis areas (NAAs) and Figure 3 shows the NAA locations.

As indicated, all three areas include Category B residences. Noise impacts will be identified and noise abatement will be considered if design year sound levels at the Category B land uses are 66 dBA or higher. Impacts will also be identified if there is a substantial increase in existing sound levels.

There are some Category F manufacturing, industrial and commercial properties located within the project limits. As indicated in Table 1, these land uses are not noise-sensitive and do not have an NAC. Therefore, they have not been included in the noise study.

Finally, there are tracts of Activity Category G undeveloped lands in the project area. These undeveloped lands are not noise-sensitive and have not been included in the noise analysis. However, noise impacts could occur in the future if noise-sensitive land uses are constructed near the Saturn Parkway Extension. A discussion of future sound levels and the need for noise-compatible land use planning is provided later in this report.

Table 1: Noise Abatement Criteria in 23 CFR 772

Activity Category	$L_{Aeq}(1h)$ dBA	Evaluation Location	Activity Description
A	57	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B ⁽¹⁾	67	Exterior	Residential.
C ⁽¹⁾	67	Exterior	Active sport areas, amphitheatres, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structure, radio stations, 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 structure, radio studios, recording studios, schools, and television studios.
E ⁽¹⁾	72	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D, or F.
F	---	---	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.
G	---	---	Undeveloped lands that are not permitted.

(1) Includes undeveloped lands permitted for this activity category.

Table 2: Substantial Noise Level Increase

Existing Noise Level (dBA) ⁽¹⁾	Predicted Design Year Noise Level Increase (dB) ⁽²⁾
42 or less	15 or more
43	14 or more
44	13 or more
45	12 or more
46	11 or more
47 or more	10 or more

(1) Worst-hour noise level from the combination of natural and mechanical sources and human activity.

(2) Predicted design year noise level minus existing noise level.

Table 3: Noise Analysis Areas

Noise Analysis Area	Description	Activity Category	NAC (dBA)
1	Two residences on SR 247 (Beechcroft Road).	B	67
2	Residences in the Meadows of Spring Hill subdivision.	B	67
3	Residences in the Laurels at Town Center subdivision.	B	67

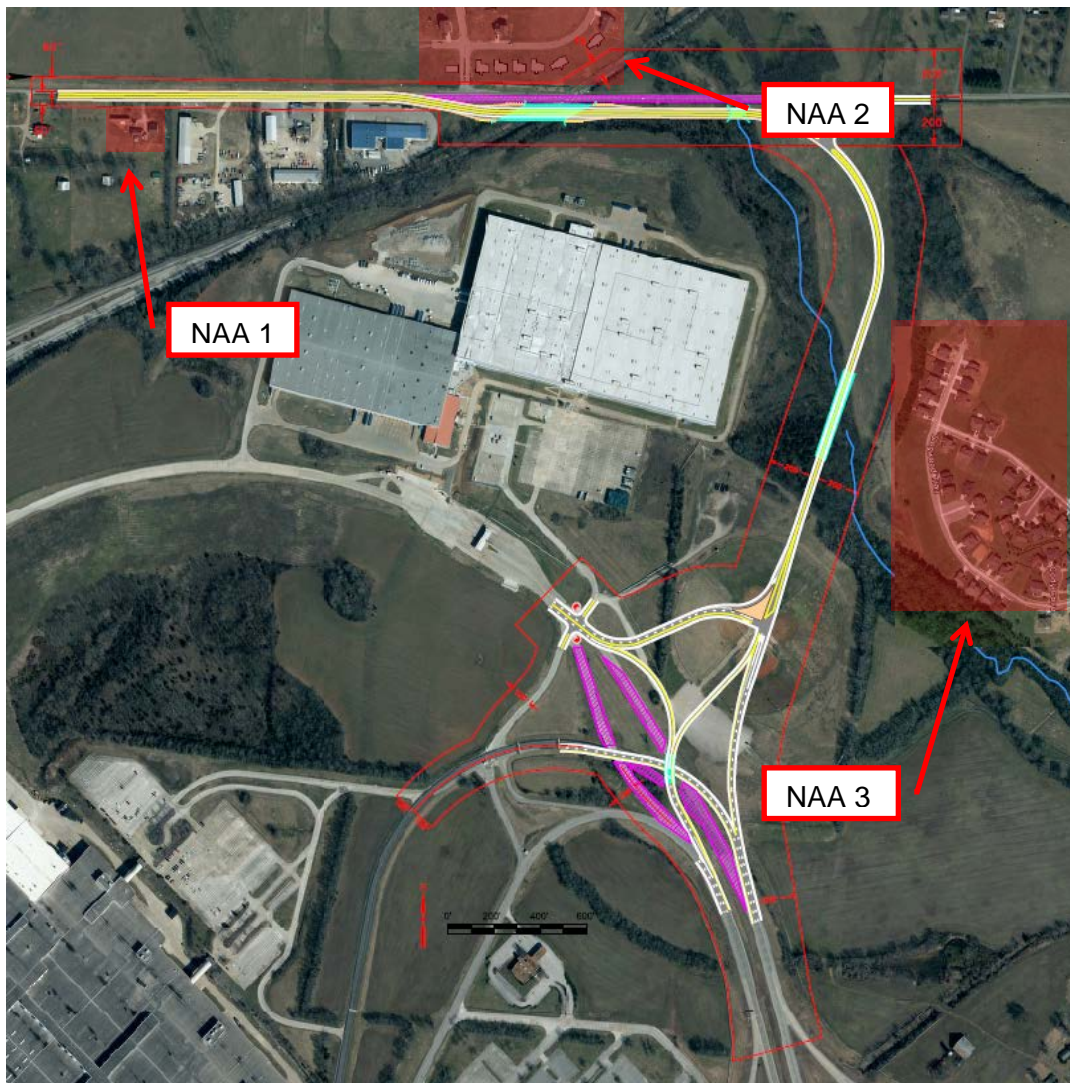


Figure 3: Noise Analysis Areas

2.3 Determination of Existing Sound Levels

Noise measurements were conducted at 1132 Wrights Mill Road in NAA 2 and 3017 Dogwood Trail in NAA 3 on September 7, 2016 between 3:30 and 5:00 PM. Table 4 and Figure 4 summarize the existing sound levels at the measurement locations. The measurements were conducted at one-minute intervals. Background noise (i.e. dog barking, sirens, etc.) during these measurements was noted, and the corresponding one-minute measurement intervals were eliminated. The noise measurement data sheets and site photographs are provided in Appendix A.

Table 4: Existing Sound Levels at Measurement Locations

Location	Noise Analysis Area	Distance to Future Saturn Parkway Extension (feet)⁽¹⁾	Date	Period	Peak Hour $L_{eq}(1h)$ (dBA)
1132 Wrights Mill Road	2	85	9/7/2016	3:39-4:38 PM	58
3017 Dogwood Trail	3	935	9/7/2016	4:27-4:47 PM	48

(1) From proposed edge-of-pavement.

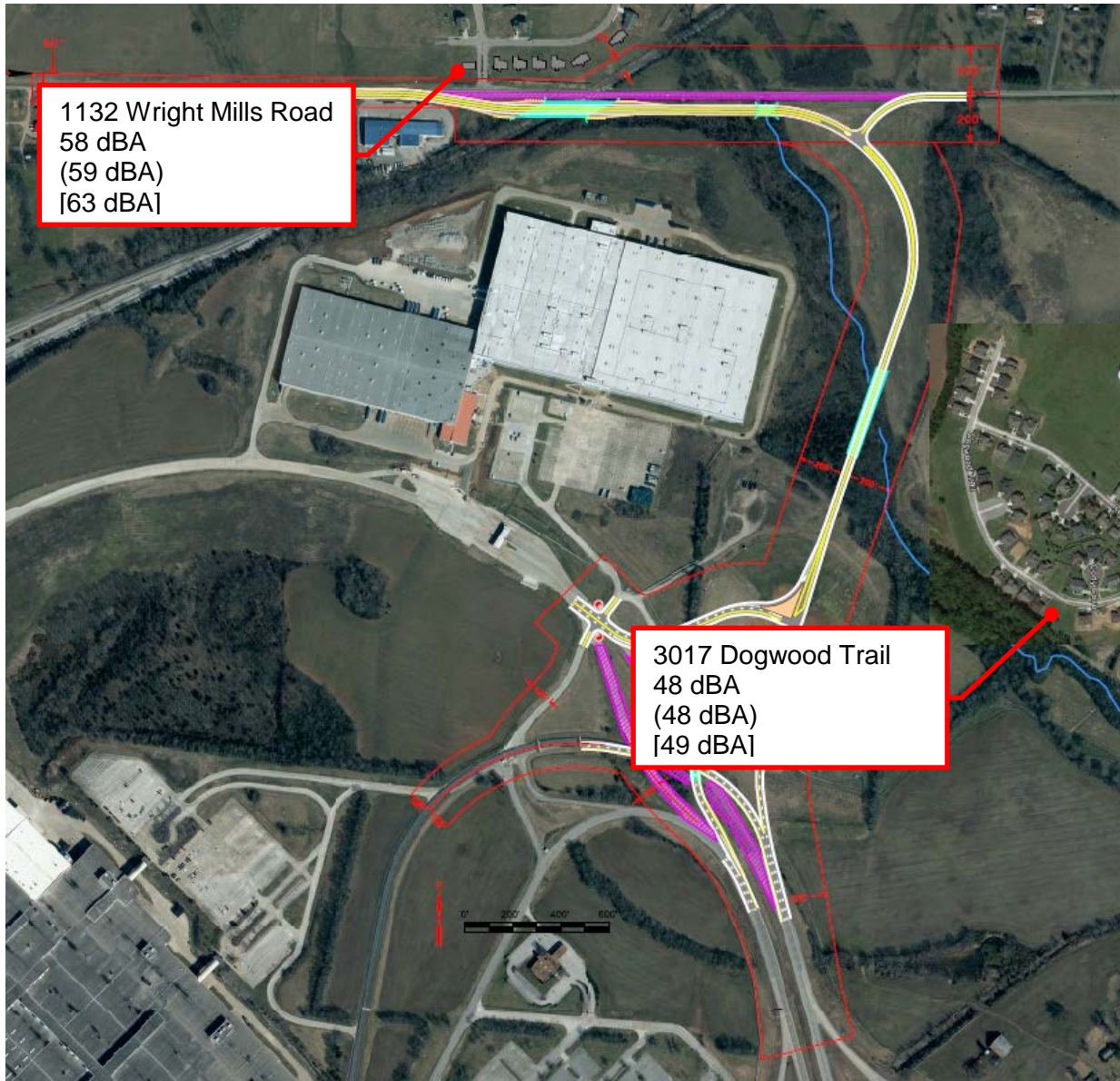
Sound levels vary throughout the day depending on the proximity of noise-sensitive land uses to local roads and to other noise sources. Sound levels can also vary with environmental changes, including shifts in wind speed and direction and changes in the vertical temperature profile. As a result, the short-term measurement data provides only a snapshot of the existing noise environment at each measurement location. However, the noise measurements were conducted during the afternoon peak period and are representative of the existing worst noise hour at each measurement location.

2.4 Determination of Future Sound Levels

TDOT's Strategic Transportation Investments Division developed traffic projections for the project for the design year 2037. These projections include traffic volumes for the "design hour" which represents a theoretical worst traffic condition. These design hour traffic projections were used for the noise analysis since they represent the highest number of vehicles expected to travel on SR 247 and the proposed Saturn Parkway Extension in a given hour and would, therefore, represent the worst noise hour. The design year traffic projections are summarized in Appendix B.

2.4.1 No-Build Alternative

Sound levels for the No-Build Alternative can be reasonably estimated by evaluating existing and future traffic volumes on SR 247. As noted previously, doubling the traffic on a roadway would result in a 3 dB increase in the sound level at a given receiver assuming all other conditions remain the same. Design year 2037 traffic volumes on SR 247 are predicted to be approximately 30% higher than existing volumes. This increase in traffic would increase sound levels at nearby residences by approximately 1 dB. Therefore, the increase in the existing sound level at 1132 Wrights Mill Road is 1 dB.



LEGEND	
-- dBA	Existing
(-- dBA)	Design Year, No-Build Alternative
[-- dBA]	Design Year, Build Alternative

Figure 4: Existing and Design Year 2037 Sound Levels

Existing sound levels at locations far from roadways would not be expected to change. Therefore, the No-Build sound levels at the residences in the Laurels at Town Center subdivision are predicted to be the same as existing sound levels. The predicted No-Build sound levels at the measurement locations are shown in Figure 4.

2.4.2 Build Alternative

Noise modeling of the project area was completed using the FHWA Traffic Noise Model (TNM 2.5) computer program. The program calculated design hour equivalent sound levels in year 2037 for the residences in the project area.

TNM modeling was conducted in accordance with *TDOT Guidelines for Noise Modeling Using FHWA's Traffic Noise Model* [4]. In developing the TNM files, the points of TNM objects (including roadways, receivers, barriers, terrain lines, and building rows) were first digitized into Microstation. Microstation's coordinate export features were then used to write these points to comma separated variable text files. The points from the text files were pasted into TNM.

As stated above, design year traffic projections provided by the TDOT Strategic Transportation Investments Division were used for the noise analysis. These projections indicated design hour volumes of 5% total trucks on SR 247 and 7% total trucks on the Saturn Parkway Extension, as shown in Appendix B. The design and posted speeds are unknown at this time in project development. The current posted speed limit on SR 247 within the project limits is 35 mph. It is possible that the posted speed could be increased since the road will be upgraded. Therefore, the analysis used a speed of 40 mph for SR 247 and the Saturn Parkway Extension.

The predicted design year sound levels for the modeled receivers in each noise analysis area are summarized in Table 5 and are discussed in the following section. TNM plan views showing all modeled TNM objects, including the locations of the modeled roadways and receivers, are provided in Appendix C. Tables showing the predicted sound levels at each modeled receiver are provided in Appendix D.

Table 5: Impact Determination Analysis, Design Year 2037, Build Alternative

Noise Analysis Area	Existing Sound Levels (dBA)	Design Year Sound Levels (dBA)	Increase in Existing Sound Levels (dBA)	Impacted?	Total Number of Impacts
1	59 - 61	63 - 64	3 to 4	No	0
2	48 - 62	51 - 63	-3 to 5	No	0
3	48	49 - 54	1 to 6	No	0
Total					0

2.5 Impact Determination Analysis

As noted previously, a location is impacted if 1) the predicted worst-hour noise level approaches or exceeds the NAC or, 2) there is a substantial increase in design year noise levels above existing noise levels.

As shown in Table 5, design year sound levels for the Build Alternative are predicted to be up to 6 dB higher than existing sound levels. These increases are not substantial in accordance with TDOT's noise policy. The project will actually reduce sound levels for the easternmost residences on Wrights Mill Road in NAA 2 because by moving SR 247 farther away. Additionally, design year sound levels at all residences are below 66 dBA. Therefore, the project is not predicted to create any noise impacts.

2.6 Noise Abatement Evaluation

Abatement is generally evaluated when impacts are predicted to occur. No impacts are predicted. Therefore, the study did not evaluate noise abatement.

2.6.1 Statement of Likelihood

Noise abatement is not proposed for this project.

2.7 Construction Noise

Transportation projects will result in intermittent and temporary noise above existing ambient noise levels due to construction activities. The sound levels resulting from construction activities will be a function of the types of equipment utilized, the duration of the activities, and the distances between construction activities and nearby land uses. However, the noise increases will be temporary and will not constitute a noise impact as defined by the FHWA noise regulation and TDOT's noise policy.

TDOT's construction specifications apply to this project, so construction procedures should be governed by the Standard Specifications for Road and Bridge Construction as issued by TDOT and as amended by the most recent applicable supplements. The contractor will be bound by Section 107.01 of the Standard Specifications to observe any noise ordinance in effect within the project limits. All construction equipment should be maintained, repaired and adjusted to keep it in full satisfactory condition.

2.8 Information for Local Officials

There are tracts of undeveloped land adjacent to SR 247 and the Saturn Parkway Extension. TDOT encourages the local governments with jurisdiction over these lands, as well as potential developers of these lands to practice noise compatibility planning in order to avoid future noise impacts. The following language is included in TDOT's noise policy:

“Highway traffic noise should be reduced through a program of shared responsibility. Local governments should use their power to regulate land development in such a way that noise-sensitive land uses are either prohibited from being located adjacent to a highway or that the developments are planned, designed and constructed in such a way that noise impacts are minimized.”

Two guidance documents on noise compatible land use planning are available from FHWA. [5, 6]

Table 6 presents design year sound levels for areas along SR 247 and the Saturn Parkway Extension where vacant and possibly developable lands exist. Noise predictions were made at distances between 25 and 200 feet from the centerline of the near lane for the design year 2037. As indicated, sound levels within approximately 60 feet of the centerline of the near lane of SR 247 and less than 25 feet of the Saturn Parkway Extension will approach or exceed the NAC of 66 dBA. Noise-sensitive land uses should generally not be constructed in these areas unless noise mitigation measures are provided. Note that the vacant land around the Saturn Parkway Extension is on the same property parcel as the General Motors plant.

Table 6: Design Year 2037 Sound Levels for Undeveloped Lands

Distance⁽¹⁾	$L_{eq}(1h)$ (dBA)⁽²⁾	
	SR 247	Saturn Parkway Extension
25 feet	69	65
50 feet	67	62
100 feet	63	59
200 feet	57	53

(1) Perpendicular distance to the center of near lane.

(2) At-grade situation.

The values in Table 6 do not represent predicted levels at every location at a particular distance back from the roadway. Sound levels will vary with changes in terrain and will be affected by the shielding of objects such as buildings. This information is being included to make local officials and planners aware of anticipated highway noise levels so that future development will be compatible with these levels.

Finally, TDOT has constructed Type II or “retrofit” noise barriers along existing highways. To be eligible for a Type II noise barrier, an area must meet the following criteria:

- The neighborhood must be located along a limited-access roadway;
- The neighborhood must be primarily residential;
- The majority (more than 50%) of residences in the neighborhood near the highway pre-dated the initial highway construction;

- A noise barrier for the neighborhood must not have been previously determined to be not reasonable or not feasible as part of a new highway construction or through-lane widening study (Type I project);
- Existing noise levels measured in the neighborhood must be above the Noise Abatement Criteria (NAC) of 66 dBA;
- A barrier must be feasible to construct and will provide substantial noise reduction; and,
- A barrier must be reasonable (barrier area per benefited residence) in accordance with TDOT's noise policy. A residence is considered "benefited" if the noise barrier will reduce the traffic noise by at least 5 dB.

3.0 REFERENCES

- [1] *Procedures for Abatement of Highway Traffic and Construction Noise*, 23 CFR 772, Federal Highway Administration.
- [2] *Policy on Highway Traffic Noise Abatement*, Tennessee Department of Transportation, July 13, 2011.
- [3] *Procedures for Highway Traffic Noise Abatement*, Tennessee Department of Transportation, July 15, 2011.
- [4] *TDOT Guidelines for Noise Modeling Using FHWA's Traffic Noise Model*, Tennessee Department of Transportation, April 2010.
- [5] *The Audible Landscape: A Manual for Highway Noise and Land Use*, FHWA, November, 1974.
- [6] *Entering the Quiet Zone: Noise Compatibility Land Use Planning*, FHWA, May, 2002.